A Lamp-Socket-Operated Browning-Drake Receiver

A Set with An Automatic Control and a Power Amplifier

By ARTHUR H. LYNCH

"POWERIZED" receivers have entered the radio field to stay. The operation of a radio set from the lamp socket has become practical, and conveniently obtains the high voltages all-important to the functioning of a power amplifier.

The receiver described in this article is ultra-modern and has many excellent and original features. The circuit used, the famous Browning-Drake, is noted for its sensitivity. The audio amplifier is of the resistance-capacity coupled type with a stage of power amplification, an unbeatable combination insofar as distortionless reproduction is concerned. As a whole, the outfit is as near to being fool-proof as is possible to make one. RADIO NEWS recommends it to our readers.

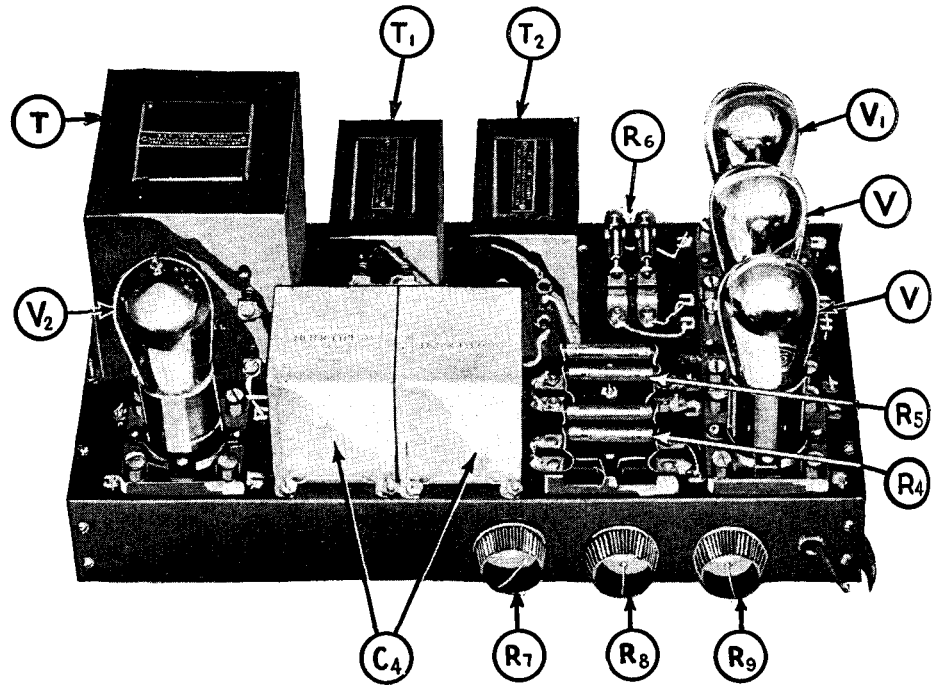


Fig. 4. A front view of the "B" power unit and resistance-coupled audio amplifier. A power tube (V1) is used in the last stage. R7 and R8 are "B" voltage regulators, and R9 is the "C" voltage control.

NEARLY three years ago Glen Browning and Frederick Drake developed, after many months of mathematical and laboratory research work, a circuit which was enthusiastically received by the radio public. Unlike most other radio circuits, the Browning-Drake has become more popular each year until now it is almost the standard of home-built sets.

When the original circuit was developed, the coils and condensers available on the radio market were not of the same high quality as those being manufactured today. By space-winding the turns of the grid coils on thin high-insulating tubes and designing special low-loss condensers, Messrs. Browning and Drake have managed to so improve the results obtainable with their circuit that the theoretical optimum of performance is now very closely approached.

But while this progress in the field of radio-frequency amplification at broadcast frequencies was being made, the audio engineers were not entirely asleep.

IMPROVEMENT IN APPARATUS

Realizing that one way to perfect amplification was by inter-tube resistance coupling, a number of scientists in different parts of the country spent a great deal of time developing suitable resistors for such use. One of the outstanding results was the development of the metallized filament resistors which give noiseless and invariable results.

But a good coupling medium alone was not sufficient. New and different tubes from those of the past were also required, and they were not long in forthcoming. We have now special R.F. amplifier tubes, special detector tubes, voltage amplification, or "high-mu" tubes, and the so-called power tubes which are capable of delivering the power required to operate satisfactorily a loud-speaker without that most common form of distortion, "blasting."

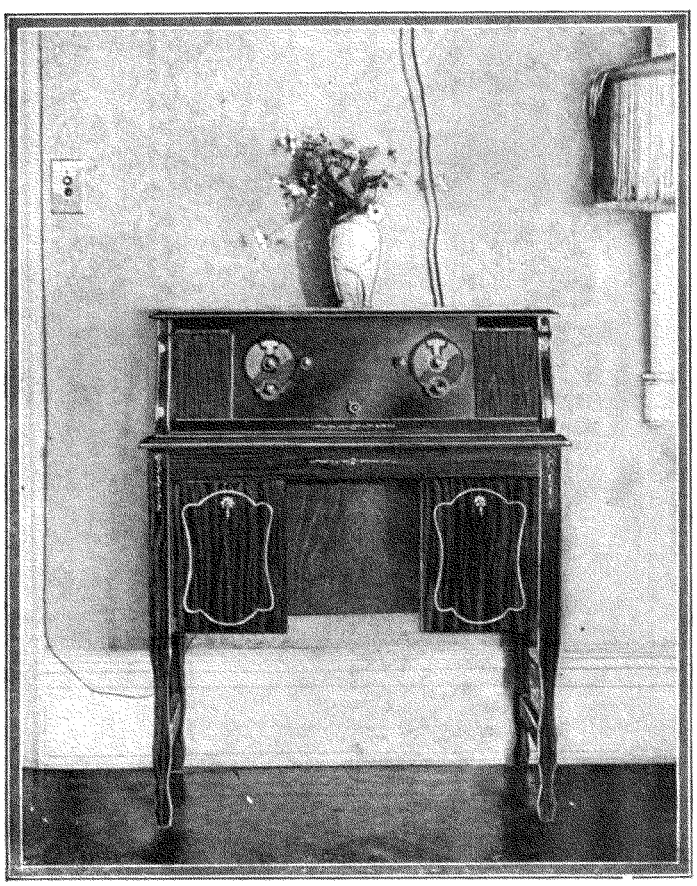
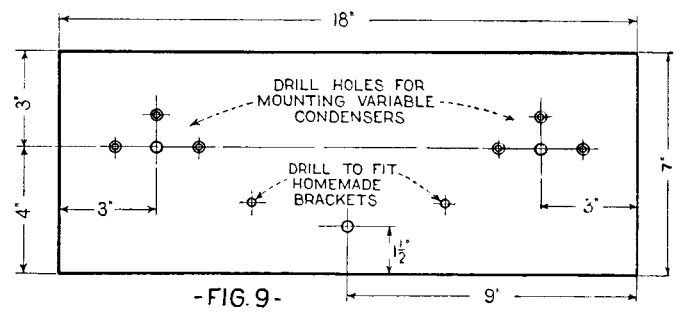
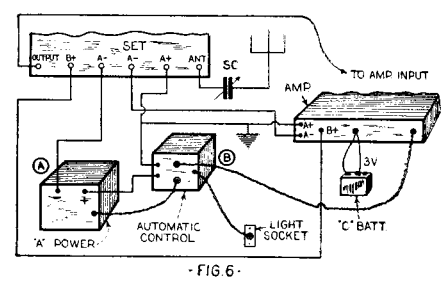


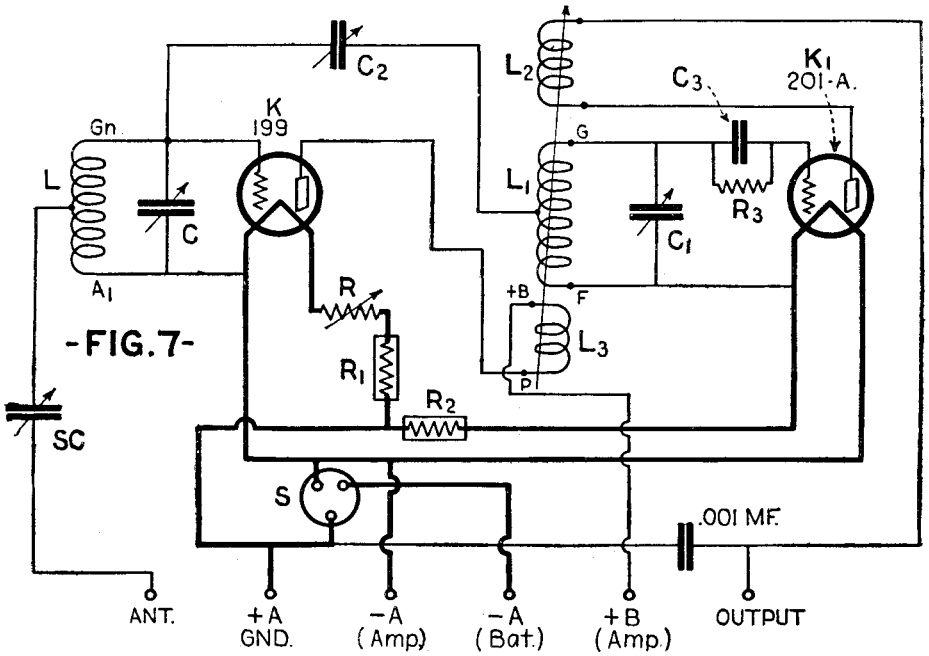
Fig. 1. Left—A view of the complete batteryless Browning-Drake receiver. The "A" and "B" power units and the audio amplifier are contained in the two compartments of the table. Fig. 6 shows the connections between the set and the power units. The automatic control B takes care of charging the "A" power unit. Details for drilling the receiver panel are given in Fig. 9.



-FIG. 9-



-FIG. 6-



Complete wiring diagram of the Browning-Drake receiver. The indicating letters correspond to those in the picture below of the receiver as seen from the rear.

With all of these essential components of a better amplifier available, it was not long before several engineers had brought them together into an amplifier that could deliver full volume with well-nigh perfect quality. Much credit for the development and design of high-grade lamp-socket amplifiers of the resistance-coupled type, such as described in this article, is due to James Millen.

And then, to complete the chain, the first models of the cone or disc speaker, with its wide and uniform frequency characteristic, were placed on the market. This fall practically all the better class of manufacturers are making speakers which almost defy further improvement.

USE OF POWER UNITS

By taking the best in the radio-frequency amplification field and combining it with the best in the audio amplification field, a truly fine receiver is obtained. But why stop here? Not only is practical lamp-socket operation an accomplished feat, but during the past year the shortcomings and imperfections of the original devices have been overcome. In many ways, such as elimination of common plate-circuit coupling, supply of high-voltage (so essential for good quality), saving in replacement and maintenance, and economy of operation, the power units have an advantage over batteries.

So far as the "A" battery is concerned, while it actually exists within the "A" power case, to all intents and purposes, it too has been replaced; for who need know that it still exists, when it requires practically no maintenance? The automatically-controlled noiseless charger runs whenever the set is not in use, keeping the battery always fully charged and ready to give the best of service. The cell vents are vapor-proof, so that no corrosive acid fumes or spray can harm or corrode the interior of the cabinet; and large reserve water space is provided above the cells in order to make the addition of water more than once a year rarely necessary. And as for economy, a battery always kept fully charged need not be nearly as large as one which must have sufficient capacity to serve for several weeks at a time between the charging periods. Thus, the initial and final cost of the complete "A" power unit differs but little from that of a large storage battery.

The result of a careful and harmonious combination of the work of the best engi-

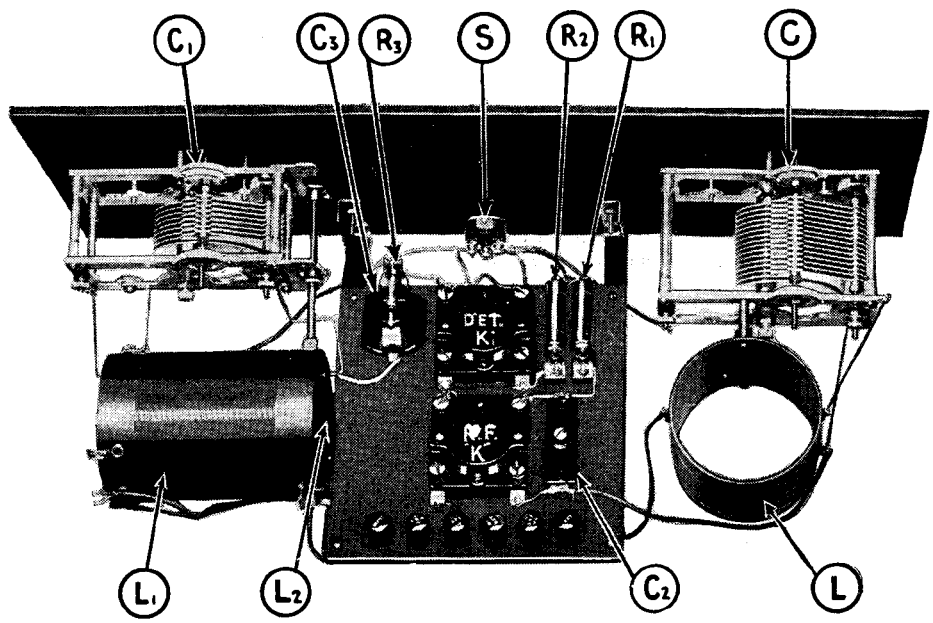
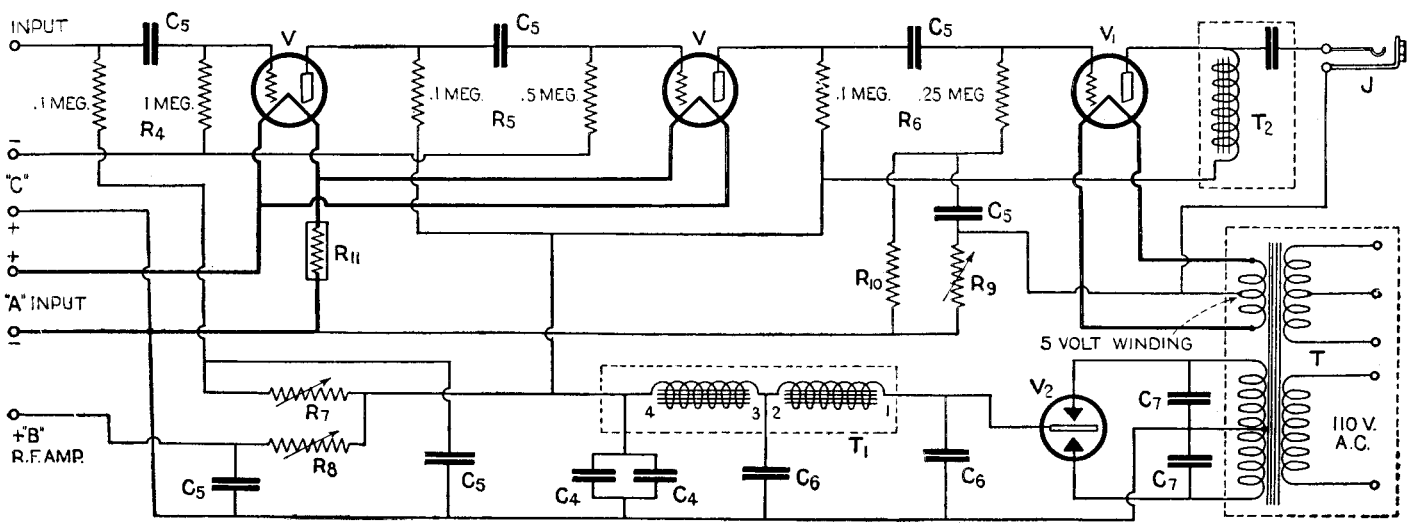


Fig. 3. Interior view of the receiver. A 199 tube is employed in the R.F. socket and a 201-A in the detector socket. C2 is the adjustable neutralizing condenser.



-FIG. 8-

The complete circuit diagram of the combination "B"-power supply and resistance-coupled audio amplifier. V are "high Mu" tubes. Note that the filament of the power tube V1 is lighted from a special 5-volt winding of the power transformer T. The "C" voltage for the power tube is supplied through the combination of R9, R10, and C5.

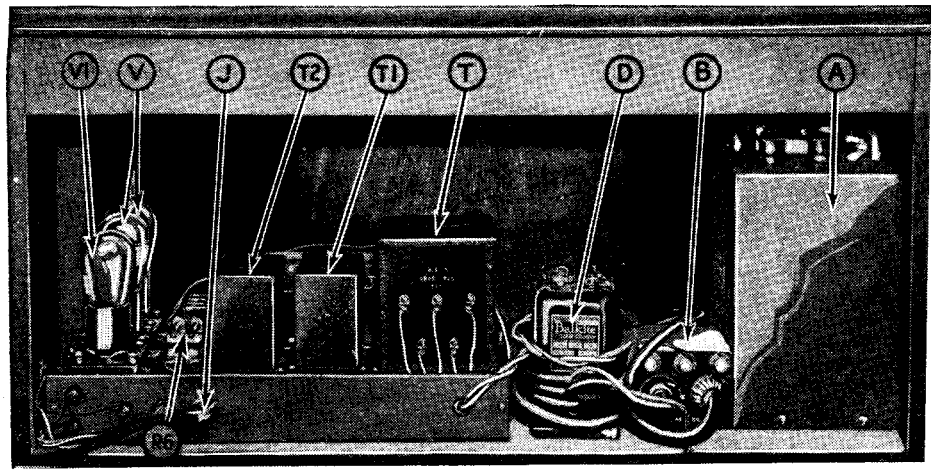


Fig. 2. The complete power-supply unit and audio amplifier. A is the low-capacity storage "A" battery, B the automatic control and D the trickle charger. The other letters correspond to those in Figs. 4, 5 and 8.

neers in their own individual fields is the receiver shown in Fig. 1.

The panel is sloped at an angle of 25 degrees from the vertical in order to facilitate operation by preventing shadows from interfering with the dial readings. The dials are of the new station-recording type, on which the call letters of the different stations may be recorded in their proper places. This arrangement is of considerable advantage, as it enables any one to tune the set immediately to the wave of any desired station without consulting log books and graphs. As a further facility to better tuning, the reduction ratio of the slow-motion vernier is variable. Thus, when tuning in local stations or going from one end of the dial to the other, the coarse adjustment saves both time and energy; yet, when fine adjustment is desired on a weak or distant station, it takes but an instant to bring the full slow-motion device into action.

Another aid to good tuning embodied in the set is the 270° S.L.F. condensers. The special plate-shaping prevents congestion on the lower part of the dial. The 270° arc through which the plates may be rotated gives the same effect as further separation of the different stations. A still further, and rather unique, advantage is the way in which this arrangement permits sharp tuning with seemingly uncritical control. In fact, the lack of necessity for critical adjustment of the tuning dials ofttimes tends to give one not familiar with the operation of the new Browning-Drake receiver the impression that it is not selective. This, is a mistake, however, as the layman will readily appreciate when he finds how completely the different stations are separated, and the engineer when he knows that the tuned-circuit resistance at 300 meters is less than 7 ohms. And last, but far from least, not more than two hands, which most of us possess, are required to tune the set.

AUTOMATIC POWER CONTROL

A unique and highly practical method of remote power control has been incorporated in this receiver. The red pilot lamp on the panel switch glows whenever the set is in use, and serves not only to control the filament circuits of the different tubes but, by means of an automatic magnetic relay, (B in Figs. 2 and 6), to switch the lamp-socket power to either the trickle charger (D) in the "A" power unit or to the "B" power unit and the filament of the power tube in the set, as required.

THE AMPLIFIER

As will be readily seen from the list of parts accompanying this article, a number of prominent manufacturers of high grade radio equipment are producing parts for the construction of good audio amplifiers. A very compact set of parts is used in the construction of the unusually small and neat three-stage lamp-socket-power resistance-coupled amplifier shown in Figs. 4 and 5.

While adaptable for use with any set, this amplifier unit was designed by the author in conjunction with James Millen primarily for incorporation in this Lynch-Browning-Drake receiver, to supply, in addition, an adjustable "B" voltage to the plates of the radio-frequency-amplifier tube and the detector tube.

By mounting the various units on a 7 x 14-inch composition panel, raised on a pair of rubber brackets, much of the wiring and many of the small parts, such as resistors, self-adjusting rheostats, by-pass and some filter condensers, are concealed from view; thus greatly enhancing the appearance of the complete unit. Each part is completely

SYMBOL	QUANTITY	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER*	
C	1	Variable Cond.	.0005 MFD.	Part of coil L	1	
L	1	Aerial Inductance		Part of condenser C	1	
C1	1	Variable Cond.	.0003 MFD.	Part of L1L2	1	
L1L2	1	R.F. Transformer		Part of Condenser C1	1	
R	1	Rheostat	30 ohms	Volume Control	28	2, 10, 32
R1	1	Self-adj. rheostat		For 199 tube	3	25
R2	1	Self-adj.rheostat		For 201-A tube	3	25
R3	1	Grid leak	2-meg.	Fixed	4	29, 37, 39
S	1	Filament Switch		With pilot light	2	14, 27, 28
C2	1	Neutralizing Cond	.00005 Mf	Lock adjustment	5	20, 26
C3	1	Grid Condenser	.00025 Mf	With grid leak mounting	6	28, 29, 30
SC	1	Variable Cond.	.000025Mf	Midget type	28	20, 26
K,K1	2	Tube socket		UX type	13	23, 24
T	1	Power Trans.		With 5 volt fil. winding	1	35,41,42,43,44,45,46
T1	1	Filter		Double Choke	1	35,41,42,43,44,45,46
T2	1	Tone Filter		Choke & 4mf condenser	1	35,41,42,43,44,45,46
V	3	Tube	5v. fil.	High Mu type	7	37, 47
V1	1	Tube	5v. fil.	171 type power tube	8	38
V2	1	Rectifier Tube		Type BH	9	
K	1	Tube	3v. fil.	199 type (RF amplifier)	7	8, 36, 38
K1	1	Tube	5v. fil.	Special Detector	7	36
R4,5,6	1	Resistance Amp.		Resistors & mountings	4	29, 37, 39
R7	1	Var. Resistance	5,000 ohm		28	2, 10, 32
R8	1	Var. Resistance	.5 meg.		28	2, 10, 32
R9	1	Var. Resistance	2500 ohms		28	2, 10, 32
C4	2	Filter condenser	4.0-mf.	Working voltage of 200	11	6, 34, 35
C5	6	Fixed Condenser	1.0-mf.	Working voltage of 200	11	6, 34, 35
C6	2	Fixed condenser	2.0-mf.	Working voltage of 200	11	6, 34, 35
C7	2	Fixed condenser	0.1-mf.	Working voltage of 500	11	6, 34, 35
R10	1	Resistor	.05-meg.	With mounting	4	29, 37, 39
R11	1	Self-adj. rheostat		For 112 type tube	3	25
J	1	Jack		Short type open circuit	2	27, 28
	1	Panel		7"X18" (For receiver)	33	21, 22
	1	Panel		7"X6" (For receiver)	33	21, 22
	1	Panel		7"X14" (For amplifier)	33	21, 22
	2	Panel		2"X14" (For amplifier)	33	21, 22
	4	Tube sockets		U.V. type (For amplifier)	24	13, 23
	2	Brackets		For receiver	14	
	2	Brackets		For amplifier	33	15, 23
	9	Binding Posts			5	13, 21, 31
	8	Bushings		Composition	16	
		Wire, Screws, etc.		Assortment		
A	1	Storage Battery	6 volts	60 ampere hours	17	40
D	1	Trickle Charger		For charging "A" battery	18	40
B	1	Automatic Control			19	27
	1	Console Cabinet			48	
	1	Loud Speaker		Cone type		22

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 National Co. Inc.	13 Eby Mfg. Co.	25 Langbein-Kaufman Co.
2 Carter Radio Co.	14 Bruno Radio Corp.	26 Hammerlund Mfg. Co.
3 Radiall Co.	15 Garfield Radio Mfg. Co	27 Yaxley Mfg. Co.
4 Arthur H. Lynch, Inc.	16 Hart & Hegeman	28 Electrad Inc.
5 K-L Radio Labs.	17 Gould Storage Batt. Co	29 Aerovox Wireless Corp.
6 Sangamo Elec. Co.	18 Fansteel Products Co.	30 Micamold Radio Co.
7 C. E. Mfg. Co.	19 L. S. Brach Mfg. Co.	31 DeJur Products Co.
8 Radio Corporation	20 Precise Mfg. Co.	32 H. H. Frost
9 Raytheon Mfg. Co.	21 Insulating Co of Amer.	33 American Hard RubberCo
10 American Mech. Labs.	22 Pausin Eng. Co.	34 Potter Mfg. Co.
11 Tobe-Deutschmann Co.	23 Benjamin Electric Co.	35 Mayolian Radio Corp.
12 Century Radio Panel Co	24 Moulded Products Corp.	36 Ken-Rad Corp.

37 Daven Radio Corp.		
38 E.T. Cunningham Inc.		
39 Durham & Co.		
40 Phila. Storage Batt.Co.		
41 General Radio Co.		
42 Dongan Elec. Mfg. Co.		
43 Acme Apparatus Co.		
44 Jefferson Elec. Mfg.Co		
45 Thordarson Elec.Mfg.Co		
46 All American RadioCorp		
47 Cleartron Vac.Tube Co.		
48 Baker-Yacht-Basin Inc.		

APPROXIMATE COST OF PARTS $ 155.00

* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

shielded in its own individual case, and all the metal cases are connected together and grounded by a common bus. Small 2 x 14-inch panels box in the under structure, and at the same time serve as terminal boards on which are located the loud-speaker jack (J) and binding posts.

The circuit employs a power transformer which supplies the high voltage to the rectifier tube, which, by the way, is one of the new "BH" tubes. This tube, like its little brother, the "B," works on the gaseous-conduction principle; having no filament, it has an almost limitless life and will serve for thousands of hours without attention. Of course, the "B" tube may be used if desired; but as the different parts of the amplifier have been selected with the "BH" tube in mind, slightly better results will be obtained by its use.

But to get back to the amplifier circuit the power transformer has also a 5-volt filament winding with center-tap for heating the filament of the last audio, or 171-type power tube. The filaments of the first two audio, or "high-mu," stages are supplied from the "A" power unit. By connecting the filaments of the two tubes in parallel a ½-ampere type of self-adjusting rheostat in the common lead is made to serve the purpose of two and an additional part obviated.

The high-voltage output of the rectifier tube is passed through a special filter circuit comprising a double choke and several filter condensers, arranged as shown in the circuit diagram, Fig. 8.

"C" VOLTAGE SUPPLY

By a rather novel arrangement of audio-frequency filter and voltage-drop resistor, the high "C" voltage (approximately 90 volts negative) required for the grid of the last audio, or 171-type tube, is obtained from the "B" supply. If an attempt were made to secure the negative "C" voltage by utilizing the voltage drop across a resistor in the negative plate-supply lead, the result would be rather discouraging; as it would be found that very little amplification was being obtained. This phenomenon is due to the fact that not only would the D.C. component of the space current of the last tube be passing through this resistor, but also the alternating or audio-frequency, component which would produce an alternating voltage. The combination of the alternating and direct voltage drops would result in a pulsating biasing voltage having such phase relations as to neutralize the input and result in greatly reduced amplification.

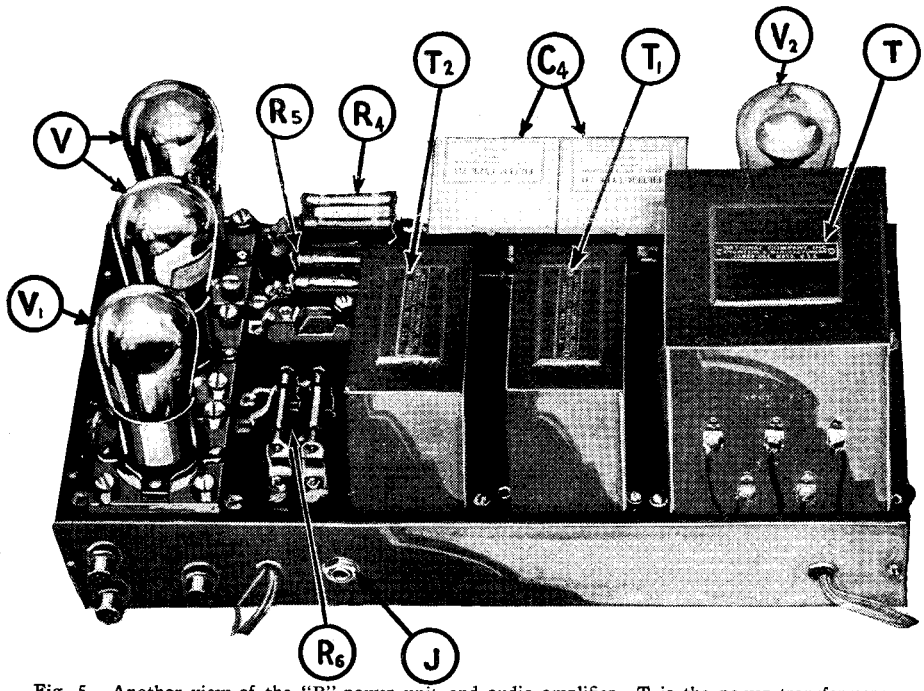


Fig. 5. Another view of the "B"-power unit and audio amplifier. T is the power transformer; T1 the double filter choke; C4 the 8-μf. filter condenser; and T2 the "tone" filter. The amplifier coupling condensers and the other filter condensers are mounted underneath the base.

By means of a simple filter circuit comprising a 1.0-μf. condenser (C5) and a .05-megohm resistor (R10) the audio-frequency current is kept from passing through the 2500-ohm variable resistor, (R9) across which the grid-voltage drop is obtained. Thus, as only pure D.C. passes through this resistor, a steady grid voltage is obtained. The proper grid-voltage for a 171-type tube with 180 volts on the plate is 40.5. At this plate voltage and grid bias, with normal load impedance and D.C. resistance, the plate current is approximately 25 milliamperes. It will be of considerable advantage to use a variable resistor for this purpose; as the plate voltage will vary, with different rectifier tubes, set loads, and line conditions, from the assumed value of 180 volts. Once the variable resistor has been properly adjusted for any given set of conditions, no further changes or adjustments will be required.

Two variable resistors are employed in order to obtain lower voltages for the R.F. and detector tubes. A 1.0-μf. condenser is connected from the low voltage side of each resistor to the ground.

The full 180 volts is applied to the plate circuits of the three resistance-coupled-amplifier tubes. Three 0.1-megohm resistors are employed in the plate circuits of the detector and the two "high-mu" tubes, while the grid resistors for the three audio tubes are 1.0-, 0.5- and .25-megohms respectively. The six resistors are mounted in three double bases, which require only one hole each for mounting. Their soldering lugs and clips are stamped from one piece of nickel-plated

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spring bronze, eliminating any possibility of a noisy contact.

In order to secure good amplification of the low notes, which is essential for natural reproduction, mellowness, and volume, coupling condensers of large capacity are used. In this amplifier three 1.0-μf. units are used, and the resultant tone quality is everything that could be desired.

CONSTRUCTION OF THE RECEIVER

The construction of the actual receiver is indeed a simple task, as there are so few parts to be mounted and wired. The coils of the special Browning-Drake units, designed by Mr. Browning himself, are mounted on the condensers in a way to insure proper relations between the two coils (their axes must be in the same plane and at right angles to each other) and the proper spacing between the coils and condensers. If the coils were placed too close to the condensers, the resistance of the tuned circuit would be materially increased and the selectivity and sensitivity of the receiver would be considerably reduced. Thus, mounting the two condensers at the same time mounts the coils. Details can be obtained from Fig. 3.

PREPARING THE PANEL

The panel on which the two Browning-Drake tuning circuits are mounted is of $\frac{3}{16}$" bakelite, 7 x 18". The holes should be carefully laid off on the panel with the aid of a scriber, pair of dividers, steel scale, and a square. When the positions of the various holes have been determined, as shown in Fig. 9 they should all be center punched and drilled for 6/32 screws. The larger holes are most conveniently made with a reamer; as few radio constructors are likely to have drills of the exact size needed.

MOUNTING THE PARTS

The filament switch, volume control and the two B.-D. units are mounted on the panel. It is wise to remove the red bulb from the pilot switch until after the set is complete and ready to operate, as otherwise it may be broken. After all of the units have been mounted on the front panel, the two dials are attached.

The two tube sockets, self-adjusting rheostats, neutralizing condenser, grid condenser, by-pass condensers and binding posts are located on a $\frac{3}{16}$-inch sub-panel or shelf, 6x7 inches. Two brackets may be made either from ½-inch brass strip, or as in the case of the set illustrated, from ½-inch angle brass; either will serve equally well. The standard brackets available on the market at present are not suitable for this use, as they are designed for use in sets with vertical instead of sloping panels.

When all the parts have been mounted the set is ready to wire; the diagram is shown in Fig. 7. As in the case of the power amplifier and "B" supply unit, it is advisable to use flexible, unvulcanized-rubber-covered (No. 18 equivalent) stranded tinned copper wire for connections.

The completed set is mounted in the front of the cabinet and the amplifier unit is placed in the battery compartment along with the "A" power unit and control relay. These units are then connected together, as indicated in Fig. 6.

AERIAL AND GROUND

With the type of antenna coil used in the Browning-Drake receiver, it has been found that the most satisfactory length of antenna for ordinary use is about 75 feet, not including the lead-in. If the use of a longer antenna is preferred, then an antenna-series condenser (SC in Fig. 7) should be used. This condenser should be variable so that it may be so adjusted as to cause the two tuning dials to read alike. Once this has been done, no further adjustments of this condenser will be required. For this reason it is not mounted on the panel, but inside of the cabinet where its adjustment is not likely to be tampered with by anyone not familiar with its purpose. For best results with a short antenna, the series condenser should not be used, unless the receiver is located close to a powerful station.

Any type of lamp-socket-operated receiver requires a good ground. General experience indicates that the most suitable ground connection is obtained by connecting to a cold-water pipe with a good ground clamp. The surface of the pipe should first be well cleaned with emery paper or an old file.

OPERATING THE RECEIVER

The 199-type tube should be placed in the R.F. amplifier (rear) socket of the receiver and the detector tube (of a new type) in the front socket. The two "high-mu" and the type-171 tubes are placed in the three sockets of the resistance-coupled amplifier. The "BH" rectifier tube is placed in the remaining socket.

The panel switch may now be turned on and if everything is right the red pilot lamp and all the tubes except the 171 (and of course, the "BH") will burn. Plugging the cord of the central relay into the lamp socket will cause the 171-tube filament to light; and, if all is properly adjusted, broadcasting will be heard.

Assuming that the amplifier has been properly adjusted as described by Mr. Mayo and the writer in the October issue of RADIO NEWS, the next step is to put the receiver in proper condition. This is best done by tuning in on a local station. As the coils and condensers used have been built with the idea of having the two dials assume similar positions for a given wavelength, it is only necessary to rotate them simultaneously from one end of the scale to the other until a station is picked up. To facilitate this operation, the variable ratio levers on the two dials should be set for the same ratios. Any ratio between 6:1 and 20:1 is obtainable. When a station has been tuned in, the two variable plate-voltage controls (of the detector and radio-frequency amplifier) located on the side of the amplifier should be adjusted for best volume and quality. They are so located on the side of the amplifier that they may be readily reached through the small door of the console table, at the lower right.

The next step is to neutralize the radio-frequency amplifier. This may best be done by turning up the volume control (left) to its maximum point and the regeneration (right) control to a point just below maximum regeneration.

Adjust the right-hand dial to the point where the signal is loudest. Then rotate the left dial up and down the scale to a point above and a point below where the strongest intensity is heard. As the left-hand dial is rotated a squeal will probably be heard. By adjusting the neutralizing condenser, this squeal may be readily eliminated. The best means of varying the neutralizing condenser is to use a long stick with one end sharpened to resemble the point of a screw driver. The use of the screw driver or other metal tool for this purpose is not satisfactory as the effect of the adjustment will be altered when the tool is removed. Once the neutralizing condenser has been properly adjusted it will require no further attention unless some change is made in the circuit. As a 199-type radio-frequency amplifier tube is employed, the process of neutralization is quite simple and should not cause any difficulty.

Whenever a station is tuned in, its call letters may be recorded directly on the dials to facilitate tuning to it again at some future time. When it has been tuned in satisfactorily, the volume may be regulated by a variation of the volume and regeneration controls. In tuning for distant stations the use of regeneration results in increased sensitivity and selectivity.

For the sake of better acoustical results and ease in tuning, the loud-speaker should be placed in a different part of the room from the set itself. If desired, extension cords may be run to several different parts of the house and the speaker placed wherever it is most convenient at different times.