ATWATER KENT
RADIO

SERVICE MANUAL

JUNE, 1931

THE FACTORY BEHIND THE PRODUCT

This Supplement, Pages 1 to 120
Supersedes Pages 1 to 146, Previously Issued

ATWATER KENT MANUFACTURING COMPANY
4700 WISSAHICKON AVENUE, PHILADELPHIA, PA.

INTRODUCTION

1. Purpose of Service Manual

The object of the Service Manual is to assist the retailer of Atwater Kent radio products in giving prompt and efficient service to the consumer-owner. Since in accordance with our Radio Service Policy, service on Atwater Kent radio products is to be handled by Atwater Kent dealers and distributors only, this publication should be considered confidential and except in special cases, is furnished only to regularly appointed outlets of Atwater Kent radio merchandise.

2. Importance of Service

Service has "come into its own" during the past few years and its importance is continually becoming more widely recognized. The value of prompt and courteous service by the dealer cannot be over-emphasized. Service is closely linked with sales—in fact the one depends on the other. The radio dealer who has foresight will build for the future by maintaining a neat and efficient repair department and employing a competent service personnel consistent with the size of his organization. There is no better step toward building good-will for Atwater Kent products in his immediate locality.

3. Dealer Service Procedure

The dealer who has a reasonably well equipped service shop will find that he is in a position to handle the servicing of practically any set which comes to him for repair, since the bulk of repairs will not be of a difficult nature.

In the event that he is unable to perform a certain repair, the set or unit should be returned to his local distributor, who maintains a complete service department similar to that of the factory. The distributor will furnish his dealers with complete instructions for return of material, such as making out of return report blanks and other routine in connection with the handling of service matters.

4. Dealer's Parts Stock

We strongly urge that every dealer carry in stock a supply of such repair parts as may be most commonly required for the more popular types of Atwater Kent sets and speakers. This will eliminate the possibility of a dissatisfied customer, resulting from the delay necessarily involved in ordering a part from the distributor.

Newly appointed dealers should consult their distributor regarding a suitable initial stock to be carried.

Repair parts must be purchased from the **distributor.** No parts are sold direct from factory to dealer.

5. Repair Charges—Warranty Repairs

The charge on a repair job for the consumer, on a set beyond the warranty, may be based on the consumer price of the repair parts used, plus a charge for the time required, at a definite rate per hour. The time charge will cover the time consumed in testing the set when repaired, and in calling for and delivering the set, if this is done.

Our factory warranty on new products, involves the replacement of parts defective in workmanship or material, and covers a period of 90 days from date of sale to the consumer.

6. Service Policy

A complete printed "Service Policy," definitely outlining the factory's plan on service matters, is sent once a year to our distributors, and such information from this as is required by the dealer will be passed on to him by the distributor. A definite understanding between dealer and distributor on all matters pertaining to service will be the means of preventing much conflict and controversy. It cannot be too strongly urged that all instructions from the distributor be carefully followed, so that complete co-operation will exist. Written instructions, such as bulletins, etc., should be kept handy in a loose-leaf note book.

7. Service Literature

The dealer will do well to keep readily available, **ALL** literature pertaining to service which comes into his place of business.

There are several excellent monthly radio trade publications which are invaluable to the retail dealer, both from a sales and service standpoint. We believe the small price of annual subscription to several of these magazines will be more than repaid by the excellent information and ideas they contain.

Two or three good text books on radio will also not be out of place on the dealer's book shelf. An easily understandable book on the theory of radio and a practical book on general radio service and repairing are suggested.

8. Factory Service Course

One of the best ways in which the recognized Atwater Kent dealer (or his service man) can familiarize himself more completely with the correct methods of servicing Atwater Kent radio products, is to spend a week or two in our factory Service Department. We have mapped out a course of training to be followed in this work, which completely covers the various steps in repairing, assembling, and testing all models of our sets, speakers, and power units.

The service course takes from one to three weeks depending on the ability of the individual. There is no charge for the instructions, but the dealer will naturally furnish the transportation and living expenses connected with this visit to Philadelphia. A letter of introduction from the local distributor is required and must be presented at the factory for identification purposes.

THEORY SECTION

Knowledge of Theory Is Essential

While the primary purpose of the Service Manual is to give the dealer information about testing and repairing Atwater Kent receiving sets, **we believe that an understanding of the fundamental principles of radio and a knowledge of how our sets function will enable him to perform this work more intelligently.** It is, of course, essential to know what to do to correct troubles, but a knowledge of the theory and functioning of the various units of the set will enable the repairman to locate the trouble more readily. If an unusual condition arises in a set, a repairman without a knowledge of the principles involved, can correct the trouble by "hit-or-miss" methods only. The service man who has this fundamental knowledge can analyze the condition and then determine the remedy.

The Theory Section

The theory section of this manual is not a complete course but it is intended for study in conjunction with a good radio text book.

Studying Radio

It requires continual study, observation, and actual experimenting to acquire a real understanding of radio. Experimenting will drive home facts that might otherwise be difficult to learn.

There are a few text books that give an outline for a course of radio experiments which require only simple and inexpensive equipment. For one who wants to learn radio, there is no better way to do it than to follow such an experimental course and supplement it with diligent study of a good radio text book.

Elements In Radio Receiver

In addition to tubes and speakers, there are only four general types of parts in a radio receiver: **Condensers, transformers, chokes,** and **resistors.**

In order to know how a receiver functions, it is necessary to understand the action of these parts on various types of current. A table covering this subject is given below, and more detailed information is given throughout the theory section.

ACTION OF RADIO PARTS ON VARIOUS TYPES OF CURRENT

Name of Part	Action of Part on Current of:			
	D. C.	A. C.		
		R. F.	I. F.	A. F.
Small Condensers, such as phone condensers, grid condensers, R. F. by-passes, etc.	Do not Pass	Pass	Pass	Do not Pass
Large Condensers, such as filter condensers, A. F. by-passes, etc.	Do not Pass	Pass	Pass	Pass
Resistors.	Oppose	Oppose**	Oppose	Oppose
R. F. Chokes or primaries of R. F. transformers.	Pass	Oppose	Pass	Pass
I. F. Chokes or primaries of I. F. transformers.	Pass	Pass*	Oppose	Pass
A. F. Chokes or primaries of A. F. transformers.	Pass	Pass*	Pass*	Oppose
Secondary of A. F. Transformers.	Pass	Pass*	Pass*	Oppose
Parallel Tuned R. F. Circuit. (Condenser and coil.)	Passes	Opposes R. F. of frequency to which it is resonant. Passes other R. F. frequencies.	Passes	Passes
Series Tuned R. F. Circuit. (Condenser and coil.)	Does not Pass	Passes R. F. of frequency to which it is resonant. Opposes other frequencies.	Opposes	Opposes
Parallel Tuned I. F. Circuit. (Condenser and coil.)	Passes	Passes	Opposes I. F. of frequency to which it is resonant. Passes other I. F. frequencies.	Passes
Series Tuned I. F. Circuit. (Condenser and coil.)	Does not Pass	Does not Pass	Passes I. F. of frequency to which it is resonant. Opposes other I. F. frequencies.	Does not Pass

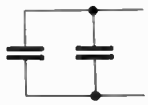
* This is true only if the I. F. or A. F. choke has a rather large distributed capacity. If the distributed capacity is small, an R. F. by-pass condenser is connected across the choke when necessary.

** In circuits carrying R. F. current, the effective value of a resistor will be reduced by the capacitance across the resistor terminals and its connecting leads, etc.

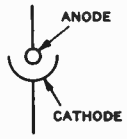
CONDENSERS

FIXED CONDENSER

FIXED CONDENSERS IN SERIES

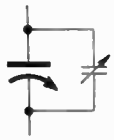


FIXED CONDENSERS IN PARALLEL



ELECTROLYTIC CONDENSER

VARIABLE CONDENSER



VARIABLE CONDENSER WITH TRIMMER

When condensers are connected in parallel, the total capacitance is equal to the sum of the values of all the condensers. When connected in series, the total capacitance is equal to the reciprocal of the sum of the reciprocals or $\frac{1}{\frac{1}{C1}+\frac{1}{C2}}$

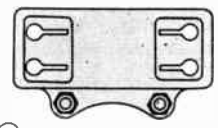
The capacitance of a variable condenser is greatest when the plates are meshed and lowest when the plates are not meshed.

PHONE OR GRID CONDENSER

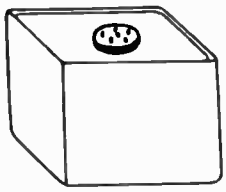
PHONE OR STOPPING CONDENSER

TRIMMER CONDENSER

MICA DIELECTRIC (INSULATION BETWEEN PLATES)

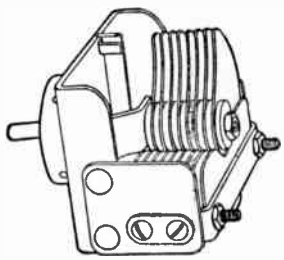


(128) BY-PASS CONDENSER



FILTER CONDENSER ASSEMBLY FOR POWER UNIT

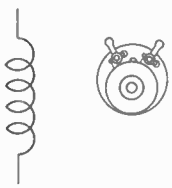
TINFOIL PLATES AND PAPER DIELECTRIC



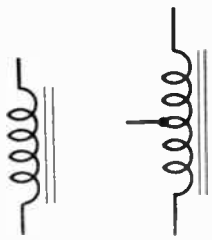
VARIABLE CONDENSER AIR DIELECTRIC

The movable plates comprise the rotor, and the stationary plates comprise the stator.

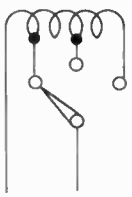
CHOKES



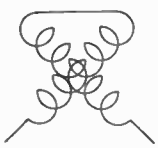
R. F. CHOKE COIL OFFERS A HIGH EFFECTIVE RESISTANCE OR IMPEDANCE TO R. F. CURRENT



A. F. CHOKE COILS OFFER A HIGH EFFECTIVE RESISTANCE OR IMPEDANCE TO A. F. CURRENT



TAPPED R. F. INDUCTANCE

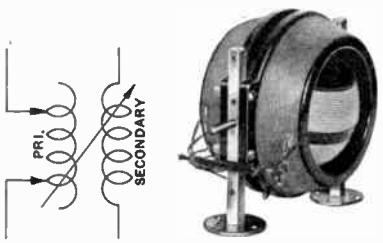


VARIOMETER OR CONTINUOUSLY VARIABLE INDUCTANCE

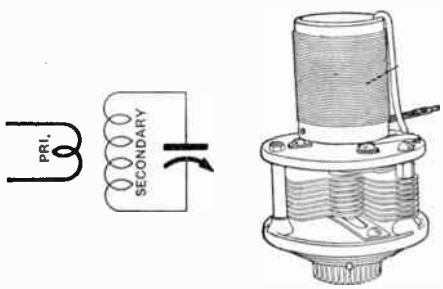
VARIOMETER

The movable coil is the rotor, and the stationary coil is the stator.

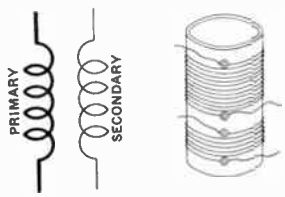
TRANSFORMERS



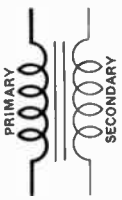
R. F. VARIO-COUPLER OR TRANSFORMER WITH TAPPED PRIMARY



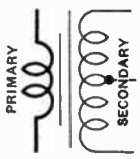
TUNED R. F. TRANSFORMER WITH VARIABLE CONDENSER



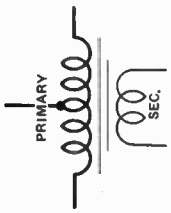
R. F. TRANSFORMER



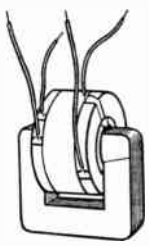
AUDIO-FREQUENCY TRANSFORMER



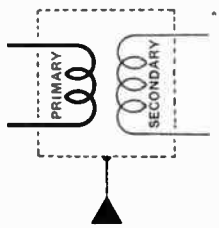
INPUT A. F. TRANSFORMER



OUTPUT A. F. TRANSFORMER



(128) AUDIO-FREQUENCY TRANSFORMER

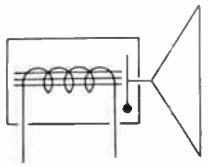


SHIELDED R. F. TRANSFORMER

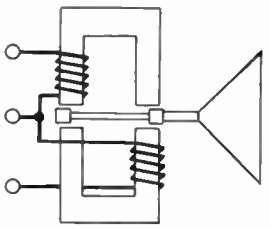
SPEAKERS

HEAD PHONES

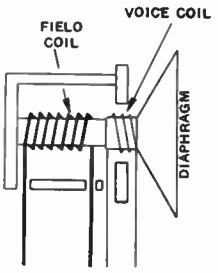
HORN SPEAKER



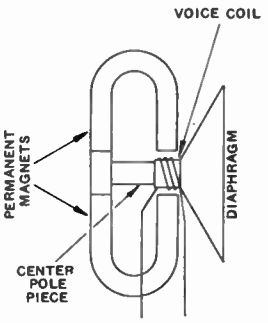
CONE SPEAKER



INDUCTOR-TYPE SPEAKER



ELECTRO-DYNAMIC SPEAKER WITH ELECTRO-MAGNET



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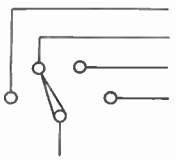
ELECTRO-DYNAMIC SPEAKER WITH PERMANENT MAGNET

SWITCHES

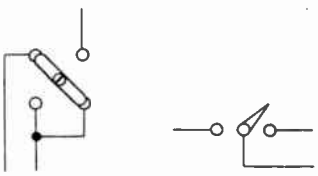
SINGLE-POLE SINGLE-THROW (S.P.-S.T.)



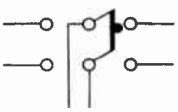
FOUR-POINT TAP SWITCH

SINGLE-POLE SINGLE-THROW (S.P.-S.T.)

THREE-POLE SINGLE-THROW (T.P.-S.T.)



SINGLE-POLE DOUBLE-THROW (S.P.-D.T.)



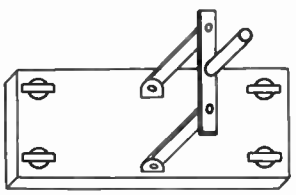
DOUBLE-POLE DOUBLE-THROW (D.P.-D.T.)

TOGGLE SWITCH

FOUR-POINT TAP SWITCH

SINGLE-POLE DOUBLE-THROW (S.P.-D.T.)

DOUBLE-POLE DOUBLE-THROW SWITCH (D.P.-D.T.)

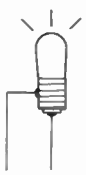


MISCELLANEOUS

ANTENNA OR AERIAL (Inside or Outside Types)

GROUND OR EARTH

CHASSIS CONNECTION (Connection to metal frame of set)



DIAL LIGHT to illuminate dial, or PILOT LIGHT to indicate when current is on or off

CRYSTAL DETECTOR

CURRENT OR VOLTAGE METER

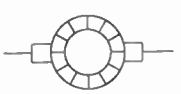
FUSE, used to prevent damage that might result from overload

WIRES CROSSED, NO CONNECTION

WIRES CONNECTED

TWISTED PAIR

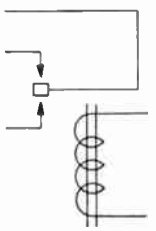
SHIELDED LEAD



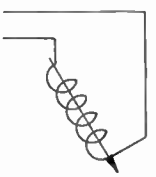
DIRECT CURRENT MOTOR OR GENERATOR

A. C. MOTOR OR GENERATOR

SINE WAVE, symbol for alternating current or cycles

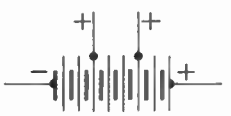


RELAY. A relay may be regarded as an electrically-operated switch. There are numerous varieties.

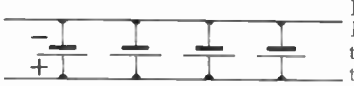


PHONOGRAPH PICK-UP. The pick-up generates a weak current corresponding to the image of the sound waves cut in the grooves on a phonograph record.

BATTERY, storage or dry types.

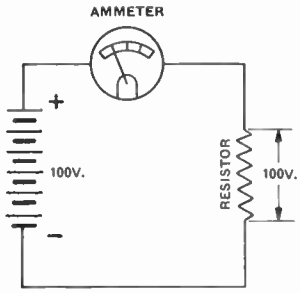


BATTERY IN SERIES. The total voltage equals the sum of the voltages of all the cells.



BATTERIES IN PARALLEL. The total voltage is the voltage of one branch.

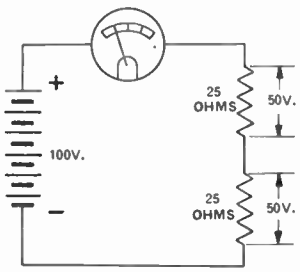
RESISTANCE AND VOLTAGE DROP



When analyzing trouble in a radio set, it is very helpful to have a clear idea of the relations between current, voltage and resistance in D. C. circuits. We therefore recommend close study of the diagrams and rules on this and the following page.

Voltage (electro-motive force or e. m. f.) is the pressure in an electrical circuit. The unit of pressure is the *volt*.

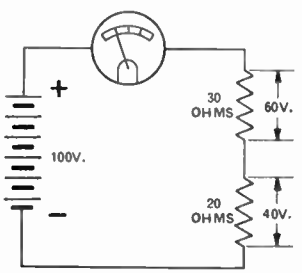
Current is rate of flow of electricity through the circuit. The unit of current is the *ampere*.



Resistance is the opposition a circuit offers to the flow of current. The unit of resistance is the *ohm*.

The relations between these units are given on the next page.

If we apply the rule regarding current to the three lower circuits shown in Figure 3, we find that in each case the current is two amperes (100 volts divided by 50 ohms equals 2 amperes). An example of parallel resistance is shown in Figure 3-A.



In a series circuit, the voltage across one part may be easily determined if we know the total resistance and the voltage in the circuit: First find the percentage that the resistance of the particular part has to the total resistance. The voltage across that part is that same percentage of the total voltage. Thus assume that in the bottom circuit of Figure 3, we want to know the voltage across the 5 ohm resistor. We know the total resistance is 50 ohms. Five ohms is 10% of the total resistance. In turn, 10% of the total voltage is 10 volts, which is the voltage across the 5-ohm resistor.

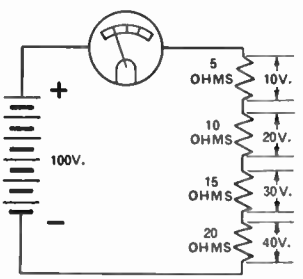
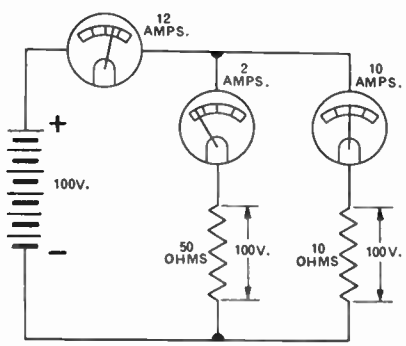
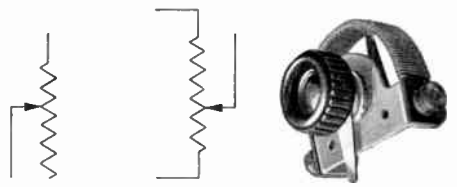
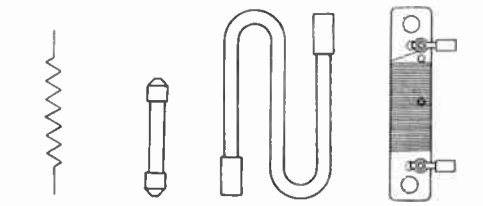


FIG. 3 (Above.) In a Series Circuit, the Voltage Across One Resistor is to the Total Voltage as the Value of that Resistor is to the Total Resistance. This is explained in the text.

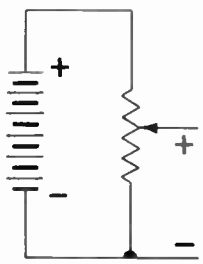




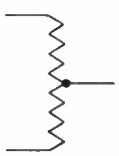
ADJUSTABLE RESISTORS



FIXED RESISTORS



POTENTIOMETER. The potentiometer or voltage divider is usually a resistor with an adjustable contact connected as shown at the left. It is used to secure any intermediate voltage from zero to maximum from a given source. In the circuit, when the slider is at the bottom of the resistor, the output voltage is zero. When the slider is at the top of the resistor, the output voltage is maximum. The potentiometer may be used in D. C., A. F., I. F., or R. F. circuits.



FILAMENT-SHUNT RESISTOR with centre tap. This is connected across A. C.-operated filaments and the grid-return leads of the tubes are connected to the centre tap. The purpose of the resistor is to minimize hum.

FIG. 3-A. RESISTORS IN PARALLEL. When resistors are connected in parallel across a known voltage, the current through each resistor may be calculated separately ($I = \frac{E}{R}$). The total current equals the sum of the currents through the various resistors.

Resistance and Voltage Drop (Continued)

VOLTS = AMPERES × OHMS
(E = I × R)

AMPERES = VOLTS ÷ OHMS
(I = V ÷ R)

OHMS = VOLTS ÷ AMPERES
(R = V ÷ I)

POWER (WATTS) = VOLTS × AMPERES
(W = V × A)

or

POWER (WATTS) = AMPERES SQUARED × OHMS (W = I × I × R)

Total value of **resistances in series** = R1 + R2 + R3, etc.

Total value of **resistances in parallel** = $\frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}}$, etc.

R1, R2, R3, etc., are the values of the separate resistors.

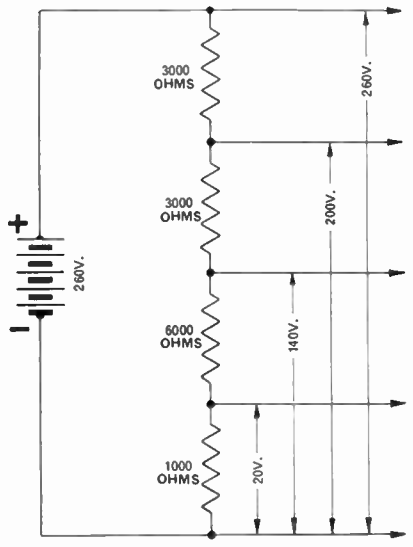


FIG. 4. VOLTAGE DISTRIBUTION ACROSS A SERIES OF RESISTORS.

The 1,000-ohm resistor is 1/13 of the total circuit resistance, so the voltage across it is 1/13 of the total voltage, or 20 volts. The first two resistors, totaling 7,000 ohms, represent 7/13 of the total resistance, so the voltage across them is 7/13 of 260, or 140 volts.

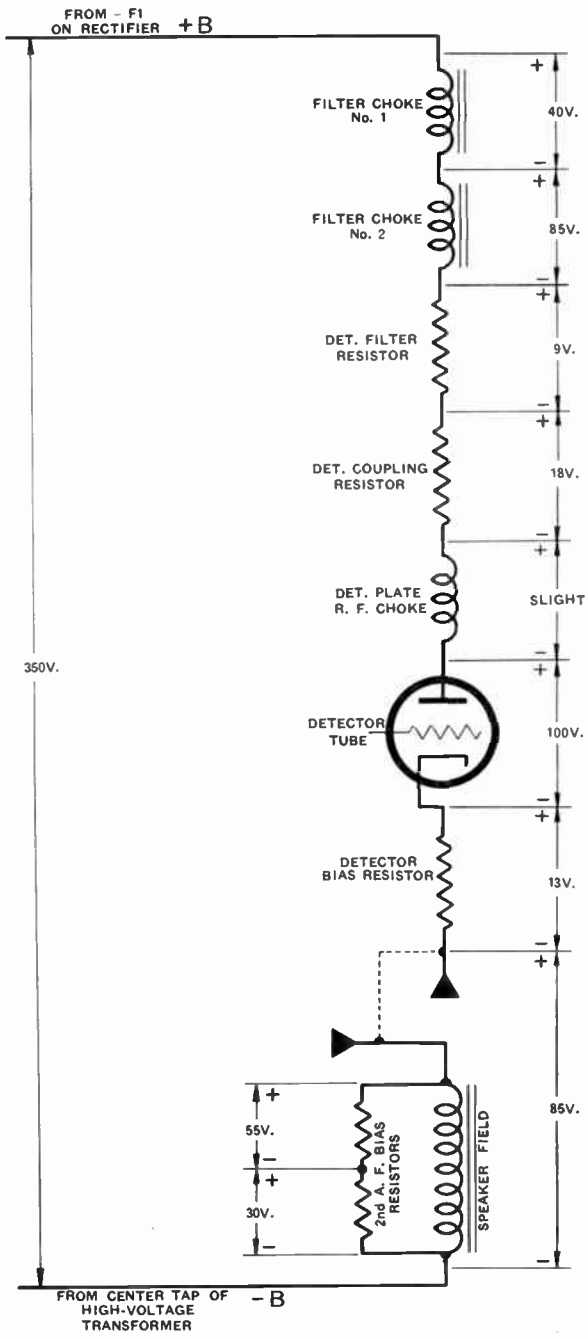


FIG. 4-A. VOLTAGE DISTRIBUTION IN DETECTOR PLATE CIRCUIT OF MODEL 55.

When making voltage measurements and diagnosing trouble in case of incorrect voltage, it is extremely helpful to have a clear idea of voltage drop across resistors in a series circuit. Practically all radio trouble-shooting consists of simple D. C. voltage measurements.

It is important to remember that when measuring across an open resistor in a series circuit, the voltmeter completes the circuit and if the normal value of the resistor and the resistance of the meter are somewhat alike, the voltage reading may be very nearly correct.

Also it is important to remember that the voltmeter resistance will affect the resistance of the circuit and in general will make the measured voltage lower than the normal operating voltage. Thus, if the 50-volt scale of a 1,000-ohm-per-volt meter (in which case the meter resistance is 50,000 ohms) is used to measure the voltage across a 50,000-ohm resistor in a series circuit containing other resistors, the effective resistance is reduced to 25,000 ohms and the measured voltage will be correspondingly lower than the actual voltage.

INDUCTANCE, CAPACITANCE, REACTANCE AND IMPEDANCE

Inductance

A coil of wire is an **inductor** and it provides a property termed **inductance.** The inductance depends, among other things, on the number of turns of wire, the size of the coil, and whether the core is magnetic or non-magnetic.

A small number of turns provide a small inductance. A large number of turns provide a large inductance. A magnetic core increases the inductance.

The unit of inductance is the **henry.**

The total *inductance* of inductors connected in series or in parallel (without any couplings between them and negligible resistance) is calculated the same as for resistors (see Page 7).

Capacitance

Two conducting plates separated by an insulator comprises a **condenser.** A condenser provides a property termed **capacitance.** The capacitance depends, among other things, on the area of the plates, the distance between the plates, and the nature of the insulation **(dielectric)** between the plates.

The capacitance may be increased by increasing the area of the plates or by decreasing the distance between them. For a given distance between the plates, a paper or mica dielectric gives a higher capacitance than air.

The unit of capacitance is the **farad.** In radio work the unit commonly used is the **micro-farad** (mfd.) which is one-millionth of a farad.

The total *capacitance* of condensers connected in **series** equals $\frac{1}{C1 + C2}$, etc. Thus if two .0005 micro-farad (mfd.) condensers are connected in series, the total capacitance is .00025 mfd.

The total *capacitance* of condensers connected in **parallel** equals C1 + C2, etc. Thus if two .0005 mfd. condensers are connected in parallel, the total capacitance is .001 mfd.

Reactance

The **opposition** offered by a condenser or inductor to the flow of an alternating current is termed the **reactance.** In a condenser, it is capacitive reactance. In an inductor, it is inductive reactance.

The *reactance* of a **condenser** decreases as the frequency of the applied voltage increases.

$$\text{The capacitive reactance in ohms.} = \frac{1}{6.28 \times \text{frequency in cycles/sec.} \times \text{capacitance in farads.}}$$

The *reactance* of an **inductor** increases as the frequency of the applied voltage increases.

$$\text{The inductive reactance in ohms.} = 6.28 \times \text{frequency in cycles/sec.} \times \text{inductance in henries.}$$

The total *reactance* of inductors in parallel or series, or the *reactance* of condensers in parallel or series, is calculated in the same way as for resistors (see Page 7).

Impedance

Impedance is the **effective resistance** or **opposition** that a circuit or part offers to the flow of alternating current. Impedance is calculated from the resistance and reactance of the circuit or part.

ELECTRO-MAGNETIC FREQUENCY SPECTRUM

Name	Approximate Wave Length	Approximate Frequency in Kilocycles Per Second	Approximate Number of 10-Kilocycle "Channels" in Each Range
"Cosmic" Rays, X-Rays and Invisible Ultra-Violet Waves.	**Extremely Short**	**Extremely High**	
Visible Waves.	From Violet 0.000039 cm. To Red 0.000077 cm.	769,000,000,000 389,600,000,000	37,940,000,000
Infra-red and Heat Waves.	From 0.000077 cm. To 0.006 cm.	389,600,000,000 5,000,000,000	38,460,000,000
Long Heat Waves. Shortest Radio Wave Commonly Used.	About 0.006 cm. 5 Meters (500 cms.)	5,000,000,000 60,000	499,994,000
Short Radio Waves.	From 5 meters To 200 meters	60,000 1,500	5,850
Broadcast Radio Waves.	From 200 meters To 545 meters	1,500 550	95
Long Radio Waves — Ship-Shore Stations, etc.	From 545 meters To 2,500 meters	550 120	43
Long Radio Waves — High-Powered International Stations, etc.	From 2,500 meters To 30,000 meters	120 10	11
Audio Frequencies	From 30,000 meters To 18,750,000 meters	10 (10,000 cycles) .016 (16 cycles)	1

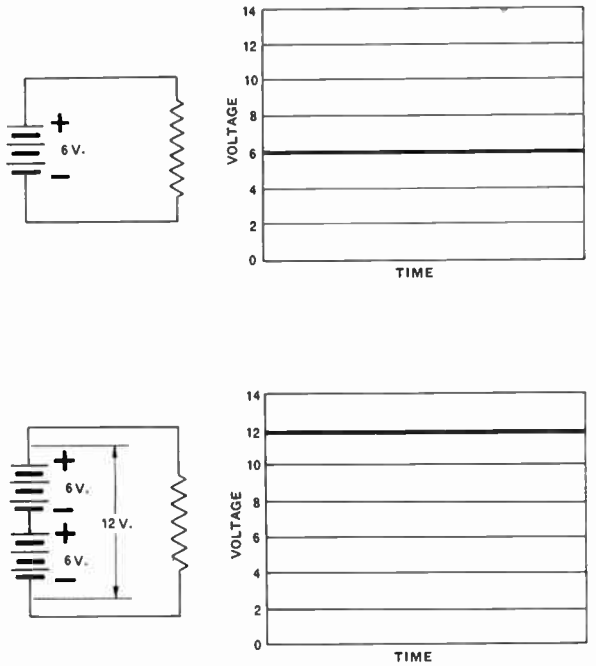
AUDIO-FREQUENCY RANGE OF A FEW MUSICAL INSTRUMENTS

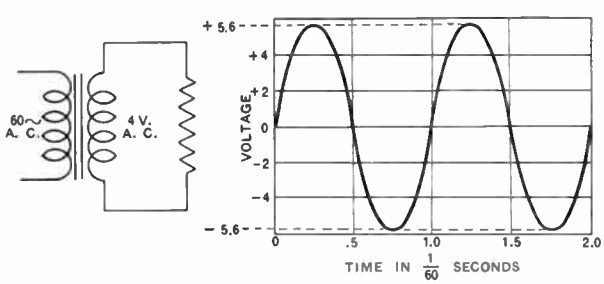
	Name	Approximate Range
String Instruments	Piano	16 to 5,200 cycles.
	Violin	192 to 3,072 cycles.
	Bass Viol	40 to 240 cycles.
Wind Instruments	Bass Tuba	44 to 340 cycles.
	Trumpet	160 to 960 cycles.
	Piccolo	512 to 4,608 cycles.
Human Voice	Bass	80 to 340 cycles.
	Tenor	128 to 480 cycles.
	Soprano	240 to 1,152 cycles.

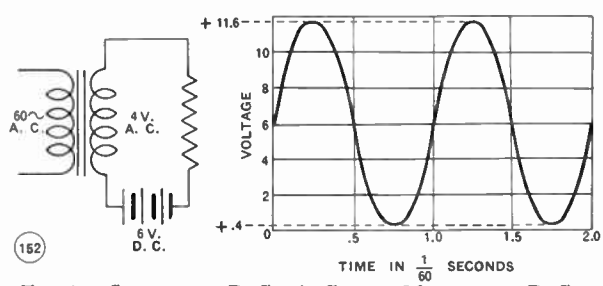
PREFIXES

Deci-	= one-tenth.
Centi-	= one-hundredth.
Mil- or Milli-	= one-thousandth.
Micro-	= one-millionth.
Kilo-	= 1,000 times.

MODULATED DIRECT CURRENT

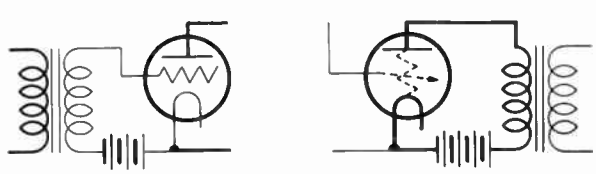






(152)

FIG. 5. GRAPHS OF D. C., A. C. AND MODULATED D. C.



(151)

FIG. 5-A. WHEN A TUBE IS IN NORMAL OPERATION THE VOLTAGE ON THE GRID AND ON THE PLATE IS MODULATED OR PULSATING D. C.

In direct current (D. C.) circuits, the polarity or positive (+) and negative (−) terminals remain the same at all times. Thus the carbon terminal of a dry cell is always positive with respect to the zinc (negative) terminal.

If the voltage or current of a direct-current circuit remains at one *value* it is termed **smooth direct current.** If the voltage or current does not remain constant but varies up and down, it is termed **pulsating or modulated direct current.**

Some form of modulated direct current is present in the grid and plate circuits of practically every tube in a radio receiver, consequently it is very important to understand the nature of this type of current.

The drawings on this page illustrate the nature of modulated direct current by showing how a direct current and an alternating current (A. C.) may be combined to produce modulated direct current.

At the top is a graph of the voltage of a battery. The voltage is six, and it remains at this value during the time indicated.

In the second drawing, two six-volt batteries are connected in series. The total voltage is twelve, and it maintains this value for the time indicated.

The third drawing shows two cycles of a four-volt sixty-cycle alternating-current supply. It will be seen that the voltage starts from zero, rises to a positive peak of 5.6 volts (the peak is about 1.4 times the effective value, as described on Page 11), decreases to zero, then increases to a negative peak of 5.6 volts, and returns to zero. This completes one cycle and requires 1/60 of a second.

If a direct current and a lower-value alternating current are combined in one circuit, the result is a modulated direct current.

Thus in the fourth drawing, four-volts A. C. and six-volts D. C. are connected in series. The battery voltage remains constant but the A. C. voltage varies between +5.6 volts and −5.6 volts. At any particular instant the total voltage is equal to the sum of the battery voltage and the voltage of the A. C. at that particular instant.

When the A. C. voltage is zero, the total voltage is 6 + 0 or 6 volts. When the A. C. voltage is at its positive peak, the total voltage is 6 + 5.6 volts or 11.6 volts. When the A. C. voltage is at its negative peak, the total voltage is 6 + (− 5.6) volts or + .4 volts. The voltage across the resistor therefor varies between a minimum of + .4 volts and a maximum of + 11.6 volts.

Modulated direct current may be compared to a cross section of the ocean. The depth of the water represents the D. C. voltage, and the waves on top represent the A. C. voltage. If the A. C. **component** (portion) is small compared to the D. C. component, we say that the D. C. voltage has an A. C. **ripple.** The terms pulsation, modulation, and ripple are sometimes used interchangeably.

In radio circuits, the A. C. component is the only useful part of modulated D. C. If we want to rock a boat, we need high waves but the depth of the water is not so important: Waves ten feet high in water twenty feet deep will rock a boat just as much as waves ten feet high in water 1,000 feet deep.

When we speak of the A. C. voltage on the grid or plate of a tube, we mean the A. C. component of the modulated D. C. voltage in the grid or plate circuit.

In order to keep the grid negative at all times we use a negative "bias" voltage of slightly greater value than the highest allowable positive voltage peak of the applied A. C. signal. Under these conditions the grid voltage never swings positive.

In the plate circuit of a tube, the action of the applied grid voltage is to increase and decrease the internal plate-cathode resistance, thus correspondingly increasing or decreasing the plate current above and below its normal value, but the plate current of a normally-operated tube never reverses.

It should be understood that the modulation does not have to be plain A. C.; it may be an irregular pulsation. The frequency may be R. F., I. F. or A. F. and these may be modulated by a lower frequency as explained on the next page.

MODULATED RADIO FREQUENCY

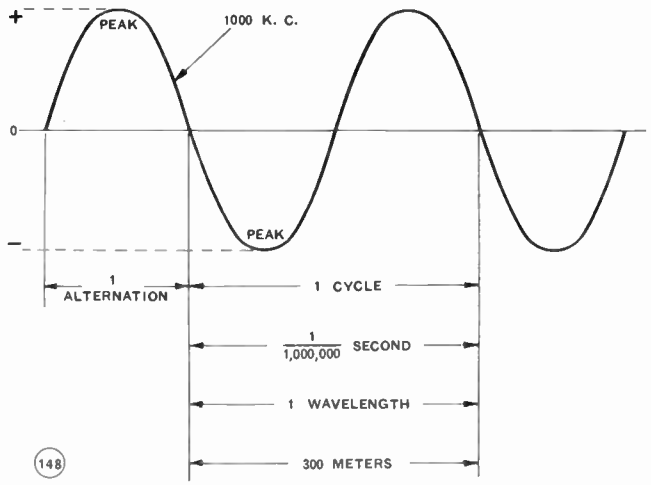


FIG. 6. TWO CYCLES OF A 1,000 K. C.-PER-SECOND SIGNAL.

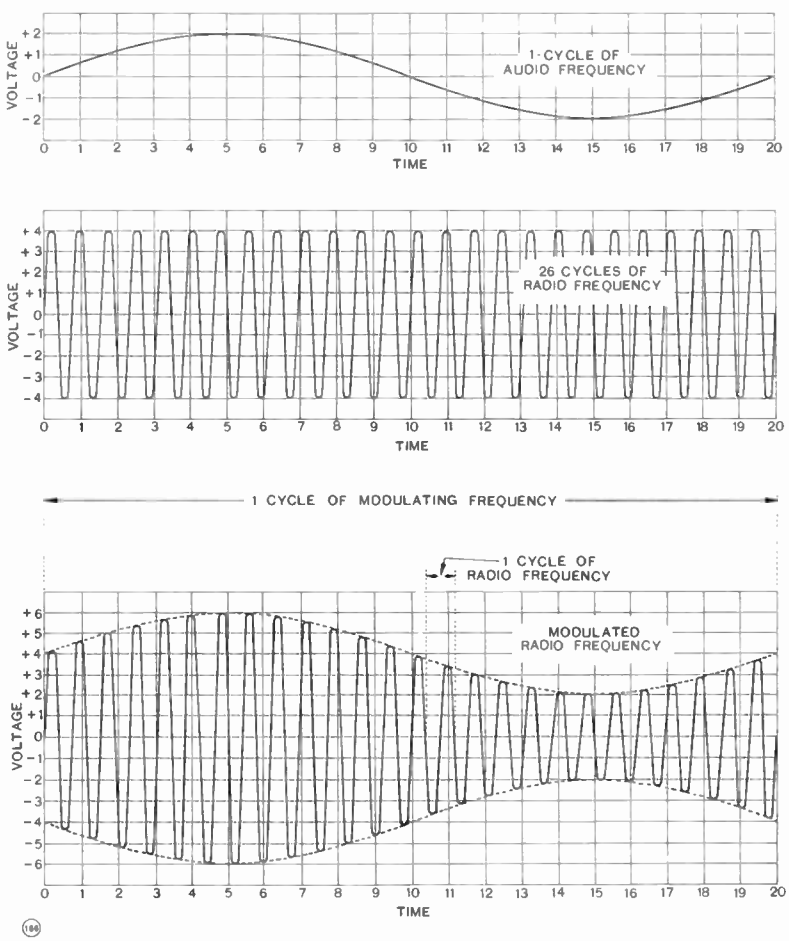


FIG. 6-A. ILLUSTRATING HOW A RADIO-FREQUENCY "CARRIER" IS MODULATED.
In these graphs, each unit of time represents one-hundred-thousandth of a second (.00001 second). The audio frequency is therefore 5,000 cycles-per-second, and the radio frequency is 130,000 cycles-per-second.

In **alternating current** (A. C.) the polarity or positive and negative terminals reverse periodically. Thus one terminal of an A. C. generator is first positive with respect to the other terminal, then it changes to negative, then back to positive, and so on. The polarity alternates.

The term negative in reference to A. C. does NOT mean less than nothing. Negative merely means that the polarity of the voltage is reversed. The negative peak has the same force as the positive peak.

The value of an alternating current is continually changing. When we speak of four volts A. C., we mean the **effective value** which is equal to the value of a direct current that would produce the same heating effect. Actually the peak of a sine wave of alternating current is approximately 1.4 times the effective value. The effective value is approximately .7 of the peak.

A cycle of A. C. is the action in which the current starts from zero, passes through one peak, then through the reverse peak, and returns to zero.

An alternation is half of a cycle.

Frequency is the number of cycles in a given time, usually one second. Radio frequencies are generally expressed in kilocycles (K. C.) per-second. One K. C. equals 1,000 cycles.

The speed of electro-magnetic waves is approximately 186,000 miles or 300,000,000 meters per second.

In an electro-magnetic wave of one cycle-per-second, the beginning of the cycle will be one second or 300,000,000 meters away from the end of the cycle so the wave length is 300,000,000 meters. If there are two cycles-per-second, the beginning of a cycle will be one-half second or 150,000,000 meters away from the end of the cycle. If there are 1,000,000 cycles-per-second, the wavelength is 300 meters, and so on. Frequency may be converted to wavelength and vice versa as follows:

Modulated Radio Frequency (Continued)

Wavelength in meters = 300,000 divided by frequency in kilocycles.

Frequency in kilocycles = 300,000 divided by wavelength in meters.

Electro-magnetic frequencies cover from less than one cycle-per-second up to trillions of cycles-per-second. A table of electro-magnetic frequencies will be found elsewhere in this section. The particular range of frequencies used in radio has been chosen because it is best suited for this work. However, higher frequencies than those in the radio range, such as invisible infra-red frequencies and visible light frequencies can and have been used for transmission as **carriers** of voice impulses.

If the peak voltage or amplitude of an alternating current remains constant, it is usually termed a **continuous wave** (C. W.). If the peak voltage or amplitude of an alternating current does not remain constant, but varies up and down from its effective value, it is termed **modulated alternating current.**

In radio we are mostly concerned with radio-frequency energy modulated at an audio frequency rate.

The process of modulation is illustrated in Figure 6-A. The second graph represents unmodulated R. F. Note that the peak voltage of each alternation remains constant. In radio telephony, the unmodulated R. F. is termed the **carrier.** When the carrier is modulated, the peak voltage changes up and down from its normal value as shown in the bottom graph.

The R. F. carrier is inaudible; even if the loud speaker could respond to such high frequencies, they would be outside the range of our hearing.

It is the audio modulation or **change in amplitude** (voltage or intensity) of the carrier that produces audible sound in the speaker after passing through the receiver. The greater the **percentage of modulation** or change in amplitude, the louder the audible response.

The percentage of modulation is the ratio of half the difference between the maximum and minimum amplitudes of a modulated wave to the average amplitude, expressed in per cent.

In the bottom graph, Figure 6-A, the modulation is 50%. To get 100% modulation, the carrier would have to change from zero up to twice its normal (unmodulated) value.

Detection

After the modulated R. F. signal has been received, it must be rectified before it can be used to produce sound.

Rectification is accomplished by the detector which suppresses the effects of one side of the R. F. alternations, and allows the audio modulation of the remaining side to affect the phones or audio amplifier.

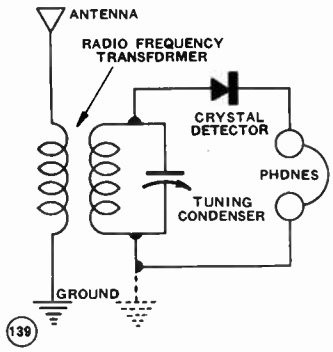


FIG. 7. ELEMENTARY RECEIVING CIRCUIT, COMPRISING AN INDUCTIVELY COUPLED R. F. TRANSFORMER WITH TUNED SECONDARY CIRCUIT, A CRYSTAL DETECTOR AND HEAD-PHONES.

An elementary receiving circuit requires an **antenna** and ground circuit to pick-up energy from the passing electro-magnetic waves, a **tuner** to select the energy of the desired frequency, a **detector** to rectify the signal, and a **sound reproducer** to convert the modulation of the rectified signal into sound.

The signal may be amplified either before or after it is rectified, or both. If amplified before, it is a radio-frequency amplifier. If amplified after, it is an audio-frequency amplifier.

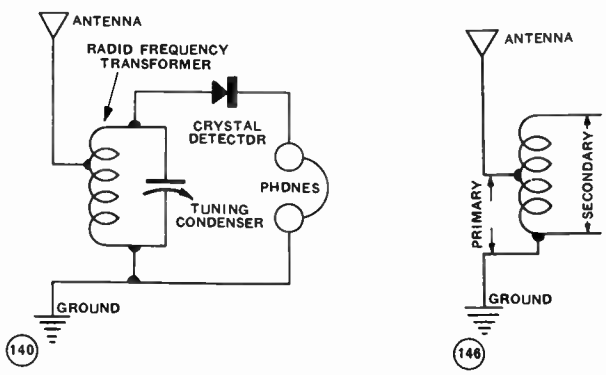


FIG. 7-A. AUTO-TRANSFORMER TYPE OF COUPLING IS USED ABOVE.

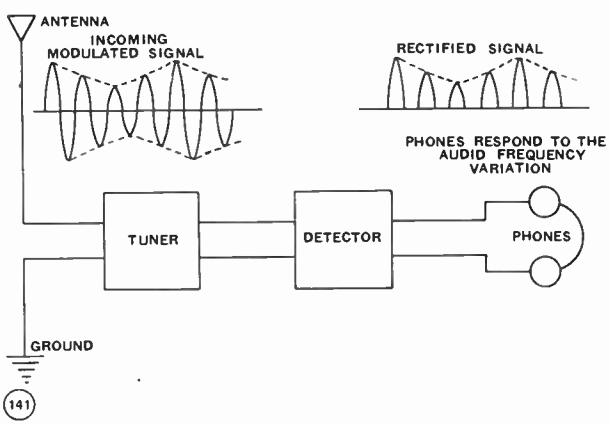


FIG. 7-B. THE DETECTOR SERVES TO CUT OFF ONE SIDE OF THE R. F. ALTERNATIONS.

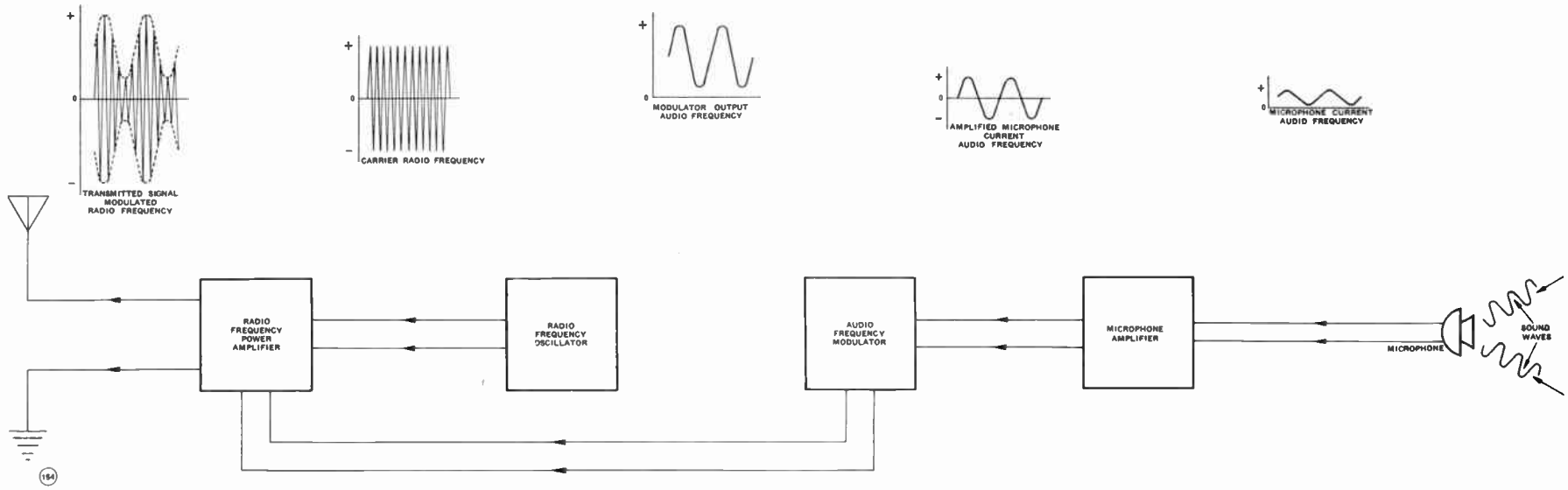


FIG. 8. FUNCTIONAL DIAGRAM OF A TRANSMITTER, INDICATING THE TYPE OF CURRENT IN EACH SECTION.

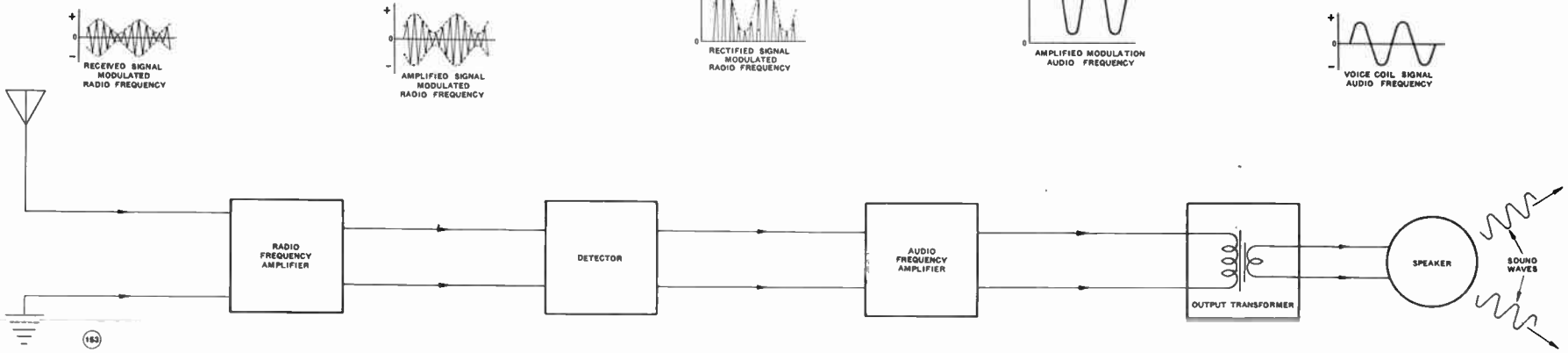
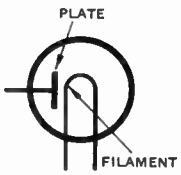
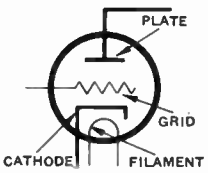


FIG. 8-A. FUNCTIONAL DIAGRAM OF RECEIVER SHOWING HOW THE RECEIVED R. F. SIGNAL IS AMPLIFIED AND RECTIFIED AND HOW THE MODULATION OF THE RECTIFIED SIGNAL IS FURTHER AMPLIFIED AND FED INTO THE SPEAKER.

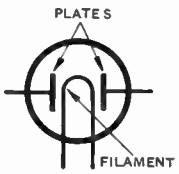
TUBE SYMBOLS AND SOCKET IDENTIFICATION



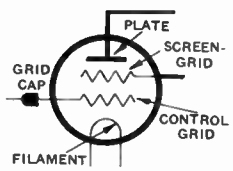
HALF-WAVE RECTIFIER. Current passes through the tube only every other half-cycle when the plate is positive. The current flow is only in one direction, or rectified.



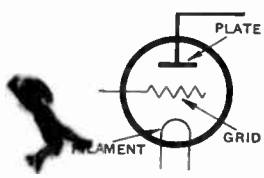
TRIODE (THREE-ELEMENT) HEATER-TYPE TUBE. Detector, amplifier, and oscillator. The '27 tube is an example of this type.



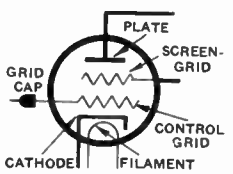
FULL-WAVE RECTIFIER. When connected as shown in Fig. 22, on Page 24, current passes in the same direction through the tube during each half-cycle of the alternating-current supply. One plate functions during one-half cycle, and the other plate functions during the next half-cycle.



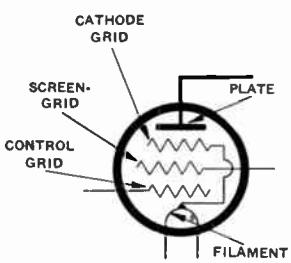
TETRODE (FOUR-ELEMENT) SCREEN-GRID PLAIN-FILAMENT-TYPE TUBE. This tube is used for radio-frequency or intermediate-frequency amplification. It provides much greater amplification than corresponding triode tubes. It is also employed as a detector. The '22 tube is of this type.



TRIODE (THREE-ELEMENT) PLAIN-FILAMENT TUBE. This type of tube is used as amplifier, detector and oscillator. A few examples of this type are the '199, '201-A, '226 and '245.



TETRODE (FOUR-ELEMENT) SCREEN-GRID HEATER-TYPE TUBE. Used as amplifier or detector in R. F. or I. F. circuits with A. C.-filament supply. The '24 tube is an example of this type.



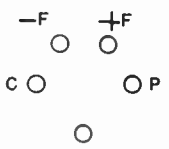
PENTODE (FIVE-ELEMENT) SCREEN-GRID PLAIN-FILAMENT TYPE TUBE. Used as a power output tube. Provides high amplification and high power output.

AMPLIFICATION FACTOR: A measure of the effectiveness of the grid voltage relative to that of the plate voltage in affecting the plate current.

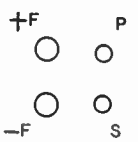
MUTUAL CONDUCTANCE: The ratio of the change in plate current to the change in grid potential producing it, under the condition of constant plate voltage.

POWER AMPLIFICATION: The ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit.

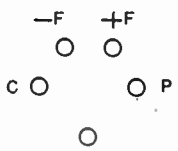
VOLTAGE AMPLIFICATION: The ratio of the alternating voltage produced at the output terminals of an amplifier to the alternating voltage impressed at the input terminals.



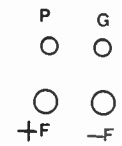
Heater-Type (A. C.) Screen-Grid Four-Element Tube



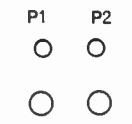
Battery-Type (D. C.) Screen-Grid Four-Element Tube



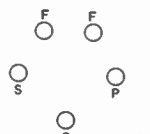
Heater-Type (A. C.) Three-Element Tube



Plain Filament (A. C. or D. C.) Three-Element Tube



Full-Wave Rectifier Tube



Plain Filament (A. C. or D. C.) Five-Element Pentode

SOCKET CONNECTIONS FROM BOTTOM

On some sockets, the +F and —F are reversed.

The markings —F and +F on A. C. sockets are used only for identification purposes, as the A. C. filaments have no fixed polarity.

RADIO TUBES

A radio tube may be thought of as an ultra-sensitive relay that will operate from exceedingly small input power of direct voltage, or alternating voltage of any frequency, and release locally-supplied energy of much greater intensity than the input power.

But even the very best mechanical relay could not begin to duplicate the versatile and amazing properties of a radio tube.

The radio tube has no mechanical action; the input voltage, without loss to itself, controls a stream of electrons inside the tube, which is caused to flow by a local source of electrical energy.

(a) Elements in Radio Tube

In a three-element tube such as the 201-A, 226, 171-A, 245, 250, etc., there are three elements or electrodes (see Fig. 10):

1. **The filament,** which is heated by a low-voltage source of electricity, **emits or gives off electrons,** which have a negative charge of electricity.

2. **The plate,** which is maintained at a high positive voltage with respect to the filament, surrounds the filament and it **attracts the negatively-charged** electrons, so that a stream of electrons flows from the filament to the plate.

This stream of electrons provides a path for current to pass from the plate to the filament. The strength of this plate-circuit current depends on the number of electrons flowing from filament to plate.

Increasing the electron-flow increases the plate-circuit current; decreasing the electron-flow decreases the plate-circuit current.

3. **The grid,** which is placed between the filament and plate, **acts to control the number of electrons flowing from the filament to the plate;** this control is exercised by the voltage on the grid with respect to its filament.

When the grid voltage is made negative with respect to the filament, the grid repels the electrons from the filament and therefore diminishes the flow of electrons from filament to plate. This decreases the plate-circuit current.

When the grid voltage is made less negative with respect to its filament, the repelling action of the grid on the electrons becomes less, consequently more electrons flow from filament to plate. This increases the plate-circuit current.

The grid, through the action of its voltage, acts as a gate or valve to control the flow of electrons from filament to plate, and it thus exercises complete control on the plate-circuit current.

There is no time-lag in this control. Even if the grid voltage varies up and down millions of times each second, it will produce a corresponding variation in the plate-circuit current.

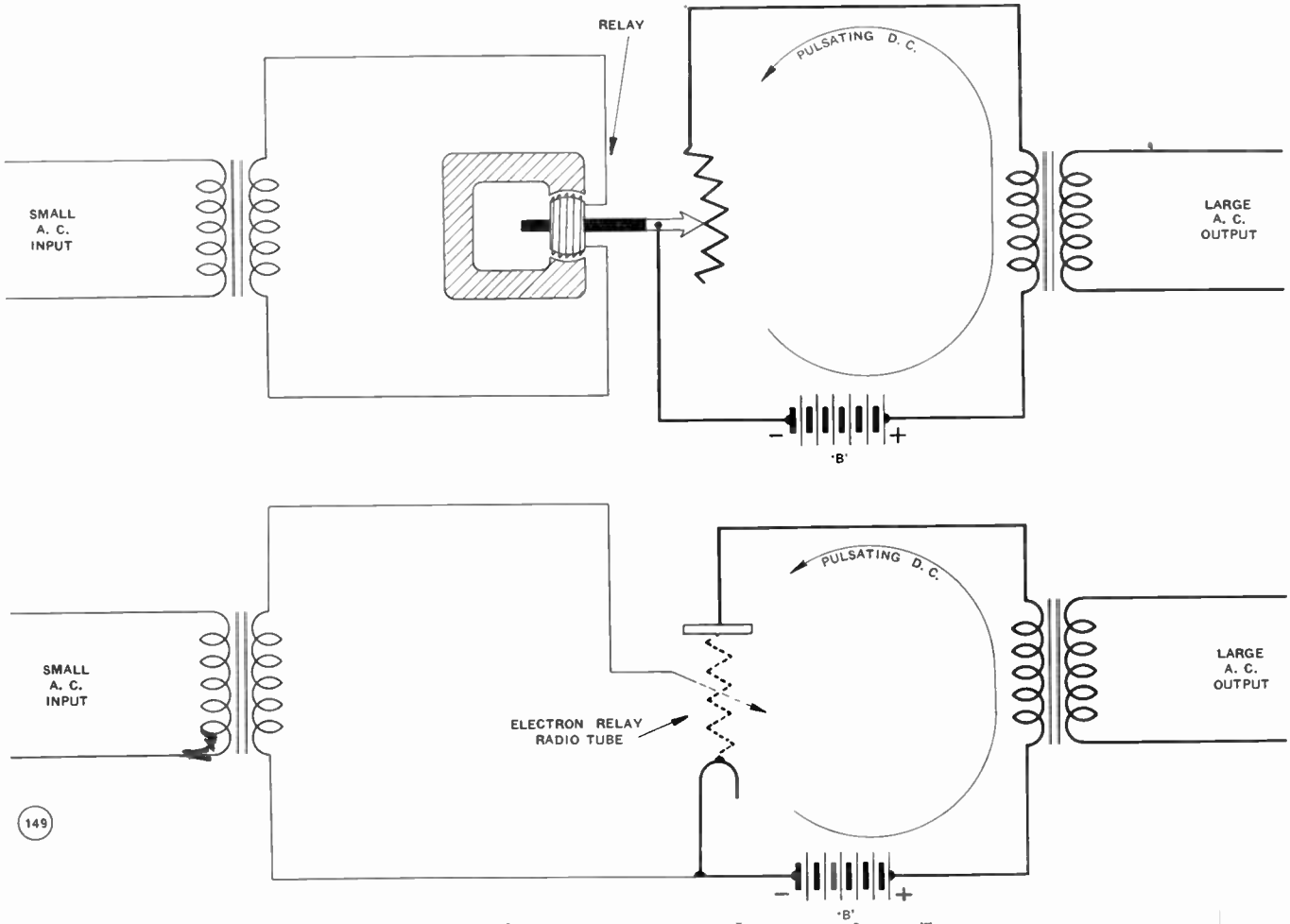


FIG. 9. ANALOGY BETWEEN MECHANICAL RELAY AND RADIO TUBE.

In the top view a mechanical relay operating from a low input voltage, controls a large output by varying the value of a resistor in the output circuit. This is analogous to the action of a radio tube in which a small input voltage on the grid controls the internal plate-to-filament resistance and thus produces a large output from the local "B" supply.

Radio Tubes (Continued)

The plate-circuit current follows the form of the grid voltage very closely, so that the output of the tube is a close duplicate of the input energy. In other words, when the tube is properly operated, there is no distortion.

For battery-operated tubes, three batteries are used:

1. The "A" or filament battery, which heats the filament.
2. The "B" or plate-circuit battery, which makes the plate positive with respect to the filament.
3. The "C" or grid-bias battery, which is used for the reasons given below.

(b) Necessity for Negative Grid Bias

If the grid voltage becomes even slightly positive with respect to the filament (or cathode), electrons will flow from filament to grid, and current will pass from grid to filament.

This is equivalent to placing a varying resistance load across the grid (input) circuit at such moments that the grid is positive.

If this condition exists in an audio-frequency amplifier, it produces distortion and decreased amplification. In a radio-frequency amplifier, it produces decreased amplification and broadened tuning.

For these reasons it is imperative in an amplifying-tube circuit that the grid be kept negative with respect to the filament (or cathode) at all times.

The negative bias must not be too great, otherwise another form of distortion will occur. The correct bias is determined from the characteristics of the tube at the operating voltages.

(c) A. C.-Filament Type of Three-Element Tube

As the number of electrons emitted by the filament depends on the temperature of the filament, it is important that the filament temperature be maintained constant, otherwise an undesired variation in the plate-circuit current will be produced.

Also, changes of voltage at any point on the filament is equivalent to changing the grid voltage with respect to that point on the filament. This will produce an undesired variation in the electron flow. This condition is encountered if we use a high A. C. voltage to heat the filament.

Therefore in A. C.-filament tubes, the filament is designed to operate at low voltages and also to have slow heating qualities. In these tubes, the change in voltage at any point on the filament is so small that its effect on the electron flow is very slight.

(d) Heater-Type Tubes

The heater-type tube is a considerable improvement over the plain A. C.-filament tube in the reduction or elimination of hum.

The heater-type tube has a filament inside a porcelain tube. A "cathode" surrounds the porcelain tube. It consists of a cylinder of metal on which is deposited a substance which freely emits electrons when heated.

The filament heats the cathode. The cathode, when heated, gives off electrons. The filament and cathode may be regarded as one element.

Owing to the construction of the cathode, it maintains a constant temperature and the same voltage all over, even when A. C. is used to heat the filament.

The electrons emitted by the cathode are attracted to the plate, and this flow of electrons is controlled by the grid in the manner previously described.

The symbol for a heater-type three-element vacuum-tube is shown in Fig. 11.

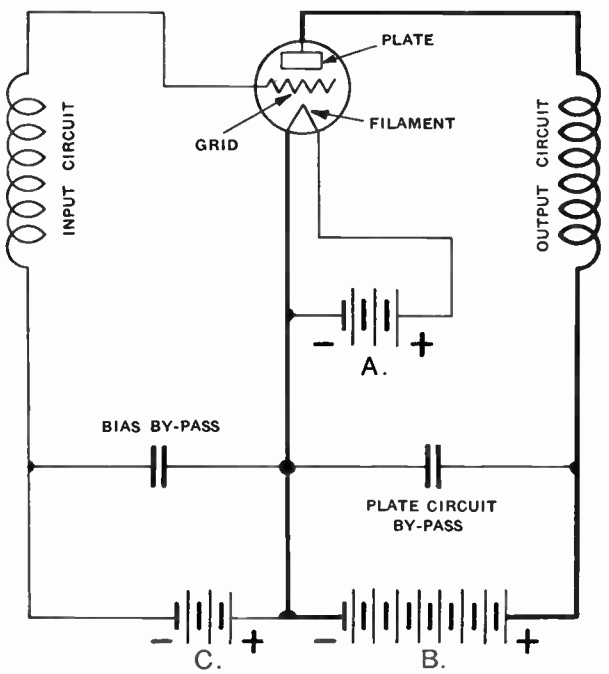


FIG. 10. THREE-ELEMENT VACUUM-TUBE CIRCUIT WITH PLAIN FILAMENT.
The output, or plate circuit, is shown in heavy lines.

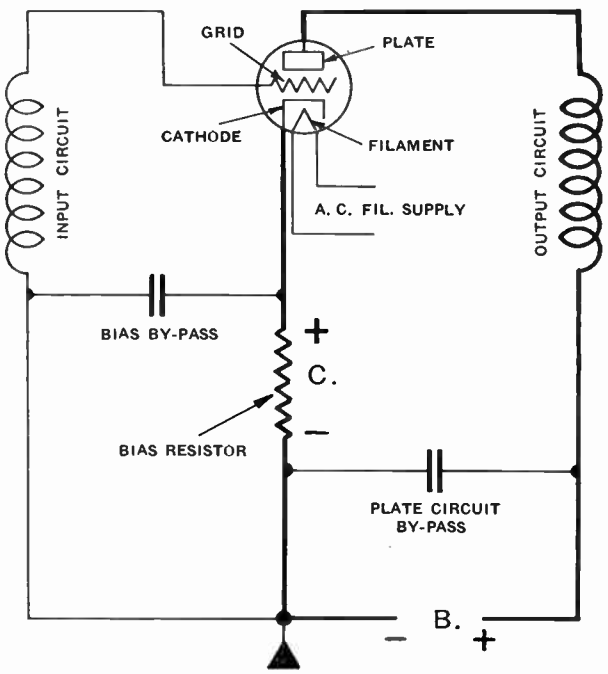


FIG. 11. HEATER-TYPE THREE-ELEMENT VACUUM-TUBE CIRCUIT.

Radio Tubes (Continued)

(e) Screen-Grid Tubes

The screen-grid tube is similar in construction to the regular three-element tube, except that an additional element, the screen, or screen-grid has been added. This screen, in the form of a spiral of wire, is placed between the control-grid and the plate. The screen also covers the top and the outside of the plate, and the bottom of the control-grid, thus completely shielding the control-grid from the plate.

The symbol for a plain-filament type of screen-grid tube is shown in Fig. 12.

In this diagram it will be noted that the screen is maintained at a positive voltage with respect to the filament.

Electrons, attracted by the positive charge on the screen flow from the filament and pass through the spaces between the wires of the control grid. Most of these electrons pass through the spaces in the screen wires and, owing to the high plate voltage, go to the plate.

The sensitivity or amplification of the screen-grid tube depends, among other things, on the screen voltage. Greatest amplification is secured when the screen is operated at its maximum rated value. The amplification decreases as the screen voltage is decreased. By making the screen voltage adjustable, the output volume of the set may be controlled. The methods of obtaining suitable ranges of screen voltage are described later.

For radio-frequency amplification the screen-grid tube has two very important advantages over the ordinary three-element tube.

First: In a three-element tube, at a given moment while a signal is being received, the following action takes place:

(1)	(2)	(3)	(4)
When the control-grid becomes more negative—	the electron flow decreases—	but the plate voltage increases—	and this tends to increase the electron flow.

From this it will be seen that (2) and (4) oppose each other, thus limiting the available amplification of the tube. (This opposition is present also when the control-grid is becoming less negative.)

In a screen-grid tube, the action is different:

(1)	(2)	(3)	(4)
When the control-grid becomes more negative—	the electron flow decreases—	and the voltage on the plate increases—	but, owing to the influence of the screen, the increase of plate voltage does not tend to increase the flow of electrons.

Therefore, in the screen-grid tube, there is negligible opposition to the control by the grid of the electron stream. As a result, the available amplification is increased.

The action of the screen in shielding the electron stream in the tube from voltage changes on the plate is the main reason why the actual R. F. amplification of the screen-grid tube is rated at about 50, compared to about 8 for the old-style three-element tube.

Second: The high amplification of the screen-grid tube could not be utilized in R. F. circuits if it were not for the fact that the screen also eliminates capacity coupling between the plate and grid electrodes within the tube, and thus prevents the possibility of feed-back between these two elements.

A more detailed explanation of this action is given on Pages 7 to 14, inclusive, of a booklet (Ser. D. 59) entitled "A Description of the New Atwater Kent Screen-Grid Receivers."

(f) The Pentode Tube

The pentode tube is a five-element power amplifier. It has twice the available undistorted output and six times greater amplification than the customary three-element output tube.

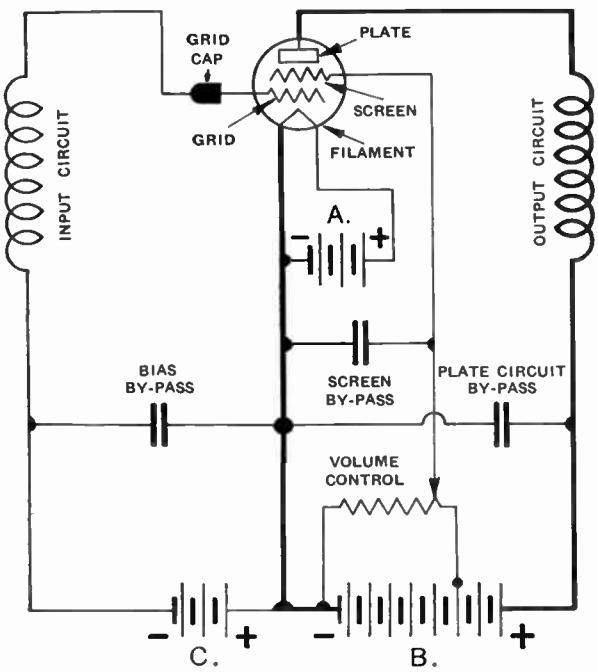


FIG. 12. FOUR-ELEMENT (SCREEN-GRID) VACUUM-TUBE CIRCUIT WITH PLAIN FILAMENT.

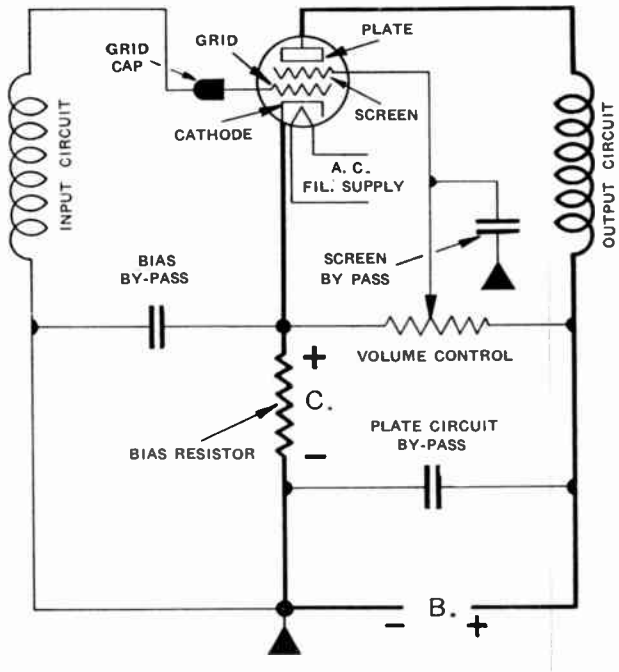


FIG. 13. HEATER-TYPE FOUR-ELEMENT (SCREEN-GRID) VACUUM-TUBE CIRCUIT.

Radio Tubes (Continued)

The principle of the screen-grid tube is utilized in the pentode to secure exceedingly high audio-frequency amplification. In addition, the pentode has one extra element, the cathode-grid, that enables the pentode to handle large output power.

In order to appreciate the advantage of the pentode, it is necessary to understand an action, termed secondary emission, that limits the available power output of an ordinary screen-grid tube.

There are three points to consider:

First.—A screen-grid tube that is intended for use as a power output tube must have a high plate current. To accomplish this, it is necessary to use a high voltage on the screen-grid (about as high as the plate voltage).

Second.—To secure the largest possible output from a tube, it is necessary to have the largest possible voltage variation across the output circuit of the tube. In other words, the variation of plate voltage (resulting from the impressed signal) must be as large as possible.

Thus if the normal plate voltage of a tube is 250 volts, greatest output will be secured if the plate voltage variations run from 250 volts down nearly to zero, then up to almost 500 volts, then back towards zero, and so on.

From this it will be seen that the plate voltage must decrease considerably below its normal value during one-half the cycle of the impressed signal. The screen voltage remains constant, and if it equals the normal plate voltage, it will be readily seen that during one-half the cycle of the impressed signal, the plate voltage becomes less than the screen voltage.

Third.—In a screen-grid tube, when electrons hit the plate they tend to dislodge other electrons from the plate. When the plate voltage is less than the screen-grid voltage, the dislodged or secondary electrons will flow from the plate to the screen-grid. This flow of secondary electrons away from the plate is just opposite to the desired flow of electrons towards the plate. If this secondary emission becomes appreciable, it makes the tube useless as a power amplifier.

(In an R. F. screen-grid tube, the plate voltage is always higher than the screen voltage, so the secondary electrons fall back on the plate and cause no harm.)

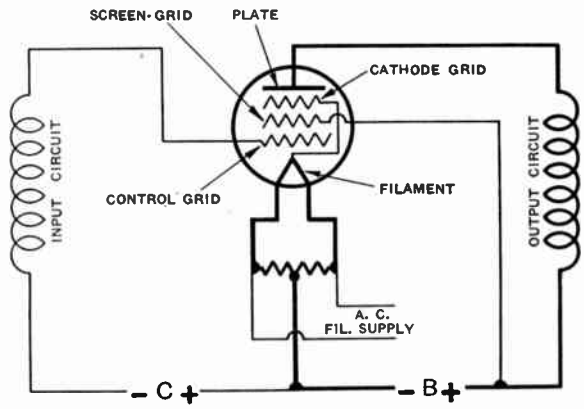


FIG. 14. FIVE ELEMENT (PENTODE) POWER TUBE WITH PLAIN FILAMENT.

From these three points we can realize that in order to get large power output from an ordinary screen-grid tube we encounter conditions that promote secondary emission and thus nullify our aim.

In the pentode tube, the effects of secondary emission are eliminated by the addition of an extra element, the cathode-grid, which is placed between the screen-grid and the plate, and is connected internally to the centre-point of the filament.

The secondary electrons emitted from the plate find themselves surrounded by the zero-potential cathode-grid, through which they would have to pass in order to reach the screen-grid. As the electrons have a negative charge they are repelled from the cathode-grid and are attracted by the positive voltage on the plate, even when the plate voltage is low, so they fall right back onto the plate and therefore have no effect whatsoever on the action of the tube.

The addition of the cathode-grid makes it possible to use a high screen-grid voltage, and also allows the plate-voltage variations to decrease almost to zero, thus providing high output power without any ill-effects from secondary emission.

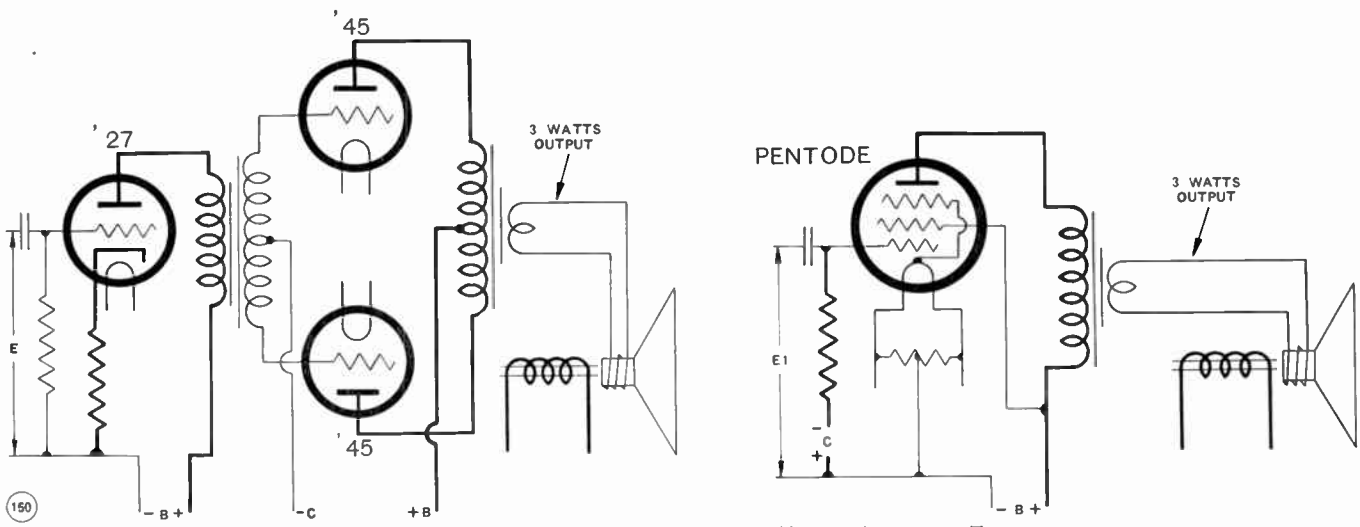


FIG. 15. ONE PENTODE DOES THE WORK OF THREE ORDINARY TUBES.
For the same input voltage at E and E1, the one pentode provides as much audio amplification and power output as the combination of one '27 and two '45s.

AN EXPLANATION OF THE ACTION OF ATWATER KENT TUNED-R. F. SCREEN-GRID RECEIVERS

Some idea of the action of Atwater Kent tuned-R. F. screen-grid receivers may be gained by studying the diagram of early Model 55 and 55-C in Fig. 15-A.

We will first briefly review the nature of radio broadcast energy, then consider the receiving circuit, and finally the power supply system in A.C.-operated models.

A. Energy Radiated from Transmitter

The electro-magnetic energy radiated by the antenna of a broadcast station has a definite normal frequency somewhere in the broadcast range of radio frequencies. The broadcast range extends from 550,000 cycles-per-second to 1,500,000 cycles-per-second. (This may also be expressed as 550 K. C. to 1,500 K. C., where K. C. is the abbreviation of kilocycles and is equivalent to 1,000 cycles-per-second.)

This normal operating frequency of a broadcast station is known as the "carrier" or carrier frequency.

When the broadcast station is transmitting voice or music, the audible sound, operating through a microphone and amplifier, causes audio-frequency variations in the strength, or intensity, of the carrier frequency.

This variation of the strength of the carrier frequency is known as modulation. The carrier frequency is inaudible. It is the effect of the audio-frequency variation of intensity of the carrier, i. e., the modulation, that produces audible sound in the speaker after passing through the receiver.

The audible sound from the speaker, caused by the modulation of the carrier, is a close duplicate of the original sound at the transmitter.

(Note.—In many of the diagrams in this section of the Manual, we have intentionally omitted the by-pass condensers in order to make the diagrams clearer. Also note that it is standard engineering practice to measure the plate, screen, and grid voltages of a tube with respect to the cathode terminal in heater-type tubes, and with respect to the negative filament terminal (—F) in plain-filament type tubes. This practice is followed closely in the service manual.)

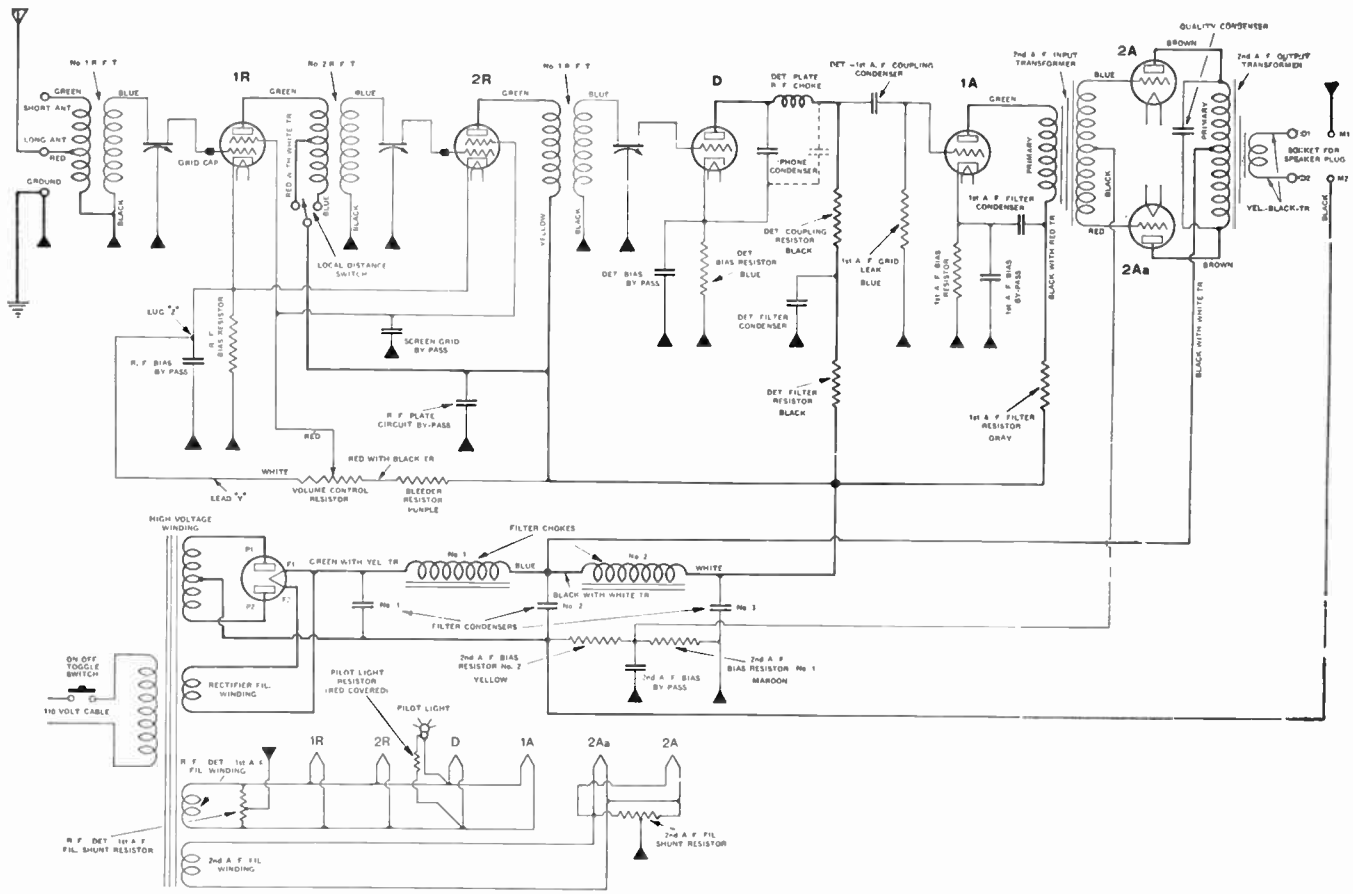


FIG. 15-A. CIRCUIT DIAGRAM OF EARLY MODEL 55 AND 55-C WITH TRANSFORMER COUPLED R.F. AMPLIFIER.

This circuit has two stages of screen-grid radio-frequency amplification, plate-detection, one stage of resistance-coupled audio-frequency amplification, and a "double-audio" output stage. Volume is controlled by changing the screen voltage of both R. F. tubes. An explanation of the action of this circuit is given in the accompanying text.

B. TUNED-R. F. SCREEN-GRID AMPLIFIER

A very small portion of the electro-magnetic energy radiated by the antenna of the broadcast station is intercepted in the antenna circuit of the receiver. It then acts upon the radio-frequency amplifier in the manner described below.

(a) Action of R. F. Amplifier with Transformer Coupling

In the early type of Atwater Kent screen-grid receivers, the R. F. transformers are of the usual inductively-coupled type as shown in Fig. 16. Each of these transformers has a primary winding and a secondary winding.

(b) Action of No. 1 R. F. T.

The electro-magnetic R. F. energy intercepted by the antenna causes an R. F. voltage to be developed in the antenna circuit which causes a current flow through the primary of No. 1 R. F. T.

The current in the primary coil sets up a magnetic R. F. field around the coil. This field "cuts" the turns of the secondary coil and induces a voltage in the secondary. This voltage is greater as the voltage across the primary becomes greater.

If the transformer is not tuned to the frequency of the signal, the voltage across the primary will be small and hence also the secondary voltage will be small.

When the transformer is tuned to the signal frequency, the voltage across both the primary and secondary coils will be a maximum and thus the maximum voltage will be applied to the input of the 1st-R. F. tube.

(c) Action of the 1st-R. F. Tube

The R. F. voltage across the secondary of No. 1 R. F. T. is applied to the grid and cathode of the 1st-R. F. tube. This causes an R. F. variation in the grid voltage of the 1st-R. F. tube.

The varying grid voltage affects the electron-flow between cathode and plate, thus producing variations in the plate-circuit current. These variations in the plate-circuit current are identical in form to the antenna-current variations, but of much greater intensity, owing to the amplifying properties of the 1st-R. F. screen-grid tube.

(d) Coupling Between 1st- and 2nd-R. F. Tubes

The R. F. variations or pulsations in plate-circuit current set up a corresponding R. F. voltage across the primary of No. 2 R. F. T., which is a maximum when the secondary circuit is tuned to the frequency of the pulsations in the primary circuit. The induced R. F. voltage across the secondary of No. 2 R. F. T. is likewise a maximum under this condition.

(e) Action of 2nd-R. F. Tube

The R. F. voltage across the secondary of No. 2 R. F. T. causes a variation in the grid voltage of the 2nd-R. F. tube. The grid-voltage variation affects the cathode-plate electron-flow and produces current variations in the plate circuit of the 2nd-R. F. tube. These pulsations are similar to those in the 1st-R. F. plate circuit, but of much greater intensity, owing to the amplifying properties of the 2nd-R. F. screen-grid tube.

(When a 3rd stage of radio-frequency amplification is used, its action is similar to that of the 2nd-R. F. stage.)

(f) Coupling Between 2nd-R. F. and Detector Tubes

The current-variations or pulsations in the plate circuit of the 2nd-R. F. tube set up an R. F. voltage across the primary of No. 3 R. F. T.

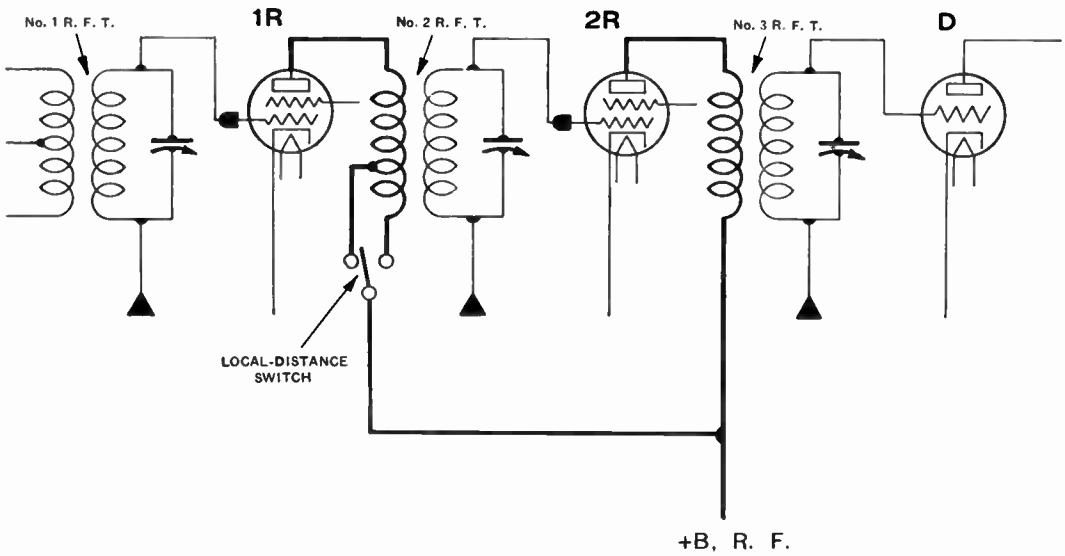


FIG. 16. ELEMENTARY CIRCUIT OF RADIO-FREQUENCY AMPLIFIER USING TWO SCREEN-GRID TUBES WITH TRANSFORMER COUPLING.

Tuned-R. F. Screen-Grid Amplifier (Continued)

The R. F. voltage across the secondary of No. 3 R. F. T. is applied to the grid and cathode of the detector tube, as described later.

(g) Prevention of Feed-Back

As mentioned previously, the screen in each R. F. amplifying tube prevents feed-back of R. F. energy from the plate (output) circuit to the grid (input) circuit.

The use of screen-grid tubes, with their high amplification properties in R. F. circuits, combined with correct engineering design of the circuit, results in an extremely sensitive and selective R. F. amplifier.

(h) Action of the Local-Distance Switch (Fig. 16)

The primary of No. 2 R. F. T. is tapped and connected to a "local-distance" switch in such a way that either a part of the primary winding, or the entire primary winding, may be connected in the plate circuit of the 1st-R. F. tube.

By using only a part of the primary, the R. F. voltage which can be built up across this section of the primary is greatly reduced.

When receiving local stations, the switch is turned anti-clockwise so that only a portion of the primary of No. 2 R. F. T. is in use.

This decreases the total R. F. amplification and reduces the possibility of overloading the detector tube when receiving local stations. It also reduces the possibility of distortion which may occur in early-type models when, in order to reduce the volume, the volume control is turned near minimum, thus making the screen-voltage almost zero. However, this condition can be brought about only if the local-distance switch is incorrectly turned to the "distance" position when receiving local or powerful stations.

In later-type models, the screen voltage cannot be reduced below a certain minimum value, thereby eliminating the possibility of the distortion described in the paragraph above.

(i) Action of R. F. Amplifier with Auto-Transformer Coupling

In later-type models the R. F. tubes are coupled with auto-transformers (No. 2 and No. 3 R. F. T.) as shown in Fig. 17.

Each auto-transformer has only one winding and it serves both as the primary and secondary windings of the ordinary two-coil transformer. This winding has a tap at about the center.

A fixed "stopping" condenser is mounted on the outside of the coil form. One terminal of this condenser is connected to the center-tap of the R. F. auto-transformer. The other terminal of the stopping condenser is connected to the plate circuit of the preceding tube, as indicated in Fig. 17.

The stopping condenser permits the R. F. currents in the plate circuit of the tube to flow through the auto-transformer, but it prevents short-circuiting of the plate-voltage supply.

The +B voltage is applied to the plates of the R. F. tubes through R. F. choke coils, R. F. C. No. 1, and R. F. C. No. 2. These chokes permit the flow of steady plate current but prevent the passage of R. F. current-variations, thus forcing them to flow through the auto-transformers.

The action of the auto-transformer circuit is very similar to that of the ordinary R. F. transformer circuit.

The local-distance switch in the auto-transformer coupled R. F. amplifier is arranged differently in order to secure a greater step-down in output volume when switching from the distance to the local position. The step-down of output volume in this case is intentionally designed to be much greater than in the early models.

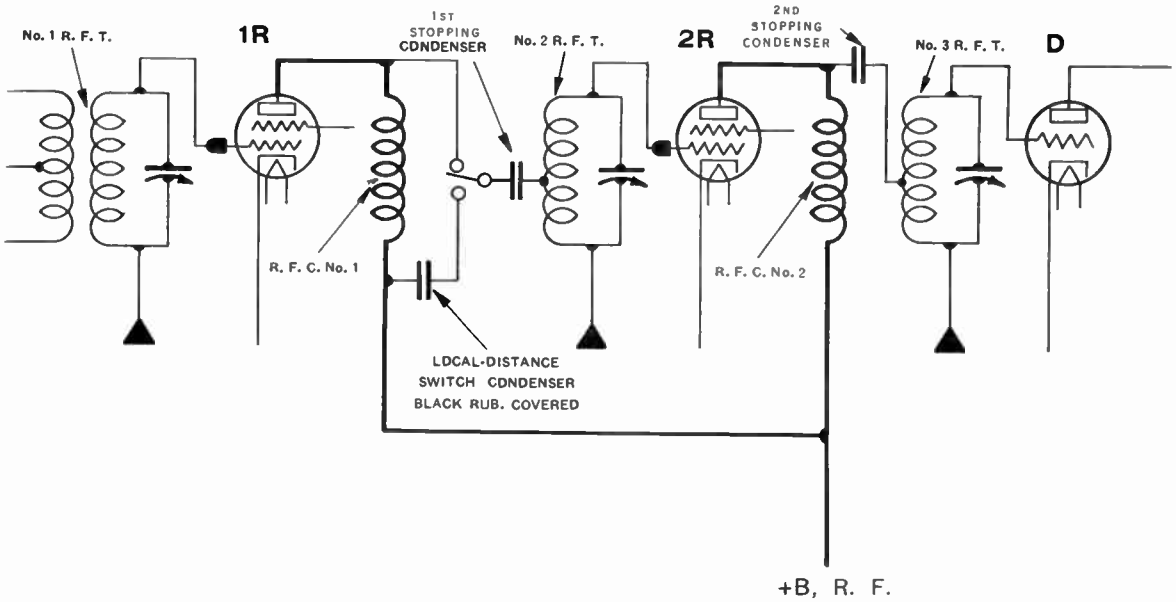


FIG. 17. ELEMENTARY CIRCUIT OF TWO-STAGE SCREEN-GRID RADIO-FREQUENCY AMPLIFIER USING AUTO-TRANSFORMER COUPLING.

Tuned-R. F. Screen-Grid Amplifier (Continued)

The connections of the local-distance switch in the auto-transformer coupled R. F. amplifier are shown in Fig. 17.

When the arm of the switch is turned clockwise to make contact with the plate side of R. F. C. No. 1, the plate of the 1st-R. F. tube is coupled to the grid circuit of the 2nd-R. F. tube through the 1st stopping condenser. This provides maximum amplification.

When the switch is turned anti-clockwise to the "local" position, the only coupling between the 1st- and 2nd-R. F. tubes is that provided by the slight capacity between the plate lead from the 1st-R. F. tube, and the lead from the 1st stopping condenser, as both of these leads run to the switch.

The local-distance-switch condenser (formed from two pieces of wire twisted together and covered with soft black rubber tubing) has a capacity approximately equal to that between the plate and screen electrodes and leads of the 1st-R. F. tube.

The local-distance switch condenser acts as a substitute for the plate-screen capacity of the 1st-R. F. tube when the switch is turned from the "distance" to the "local" position. This prevents detuning of the grid circuit of the 2nd-R. F. tube.

C. THE DETECTOR CIRCUIT

A greatly magnified reproduction of the received broadcast energy is delivered by the R. F. amplifier to the grid circuit of the detector tube.

This amplified energy, as previously described, consists of an R. F. alternating voltage which, of course, has positive and negative half cycles.

Each side (positive and negative) of the alternations is modulated, or varied in intensity, at an audio-frequency rate.

(This audio-frequency modulation corresponds to the sound waves of voice or music at the transmitter.)

It is the function of the detector tube to suppress the effects of one side of the R. F. alternations, and allow the A. F. modulation of the remaining side to produce A. F. current variations in the detector plate circuit.

The effects of either the negative or the positive side of the applied R. F. alternations may be suppressed.

There are two main types of three-element vacuum-tube detector circuits which are used to obtain the above results:

(a) **First, the "grid detection" method, using a grid condenser and leak,** as shown in Fig. 18. This method is used in Model 61 and 67. With this circuit, the plate current varies below normal when a signal is being received, indicating that the grid voltage becomes more negative.

The exact explanation of the action of this circuit is rather involved. For our purposes, it is sufficient to know that the grid, being isolated by the grid condenser from direct connection to the cathode circuit (except through the grid leak), accumulates a negative charge when the R. F. voltage variations are applied to the grid condenser. This charge leaks off, at the modulating frequency, through the grid leak, which has a resistance of several million ohms.

The result is that the electron flow between plate and cathode decreases below normal at a radio-frequency rate, and the amount of this decrease varies at an audio-frequency rate, corresponding to the modulation of one side of the applied R. F. voltage alternations in the grid circuit.

The A. F. variation of plate-circuit current sets up an A. F. voltage across the primary of No. 1 A. F. T., which has a high effective resistance (impedance, or opposition) to A. F. current variations. The A. F. voltage across the primary induces an A. F. voltage across the secondary; this A. F. voltage is fed into the audio-frequency amplifier.

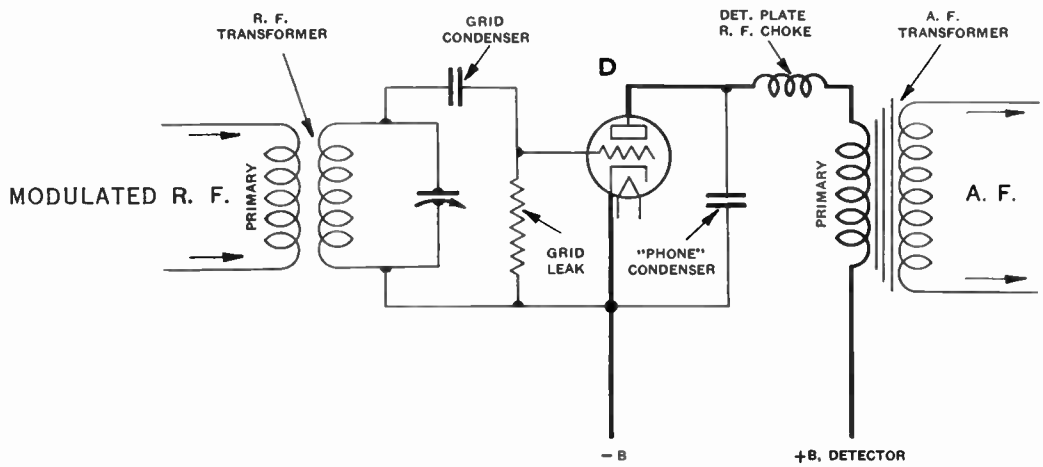


FIG. 18. CIRCUIT OF THREE-ELEMENT VACUUM-TUBE DETECTOR USING THE GRID-CONDENSER—GRID-LEAK METHOD OF DETECTION.

The Detector Circuit (Continued)

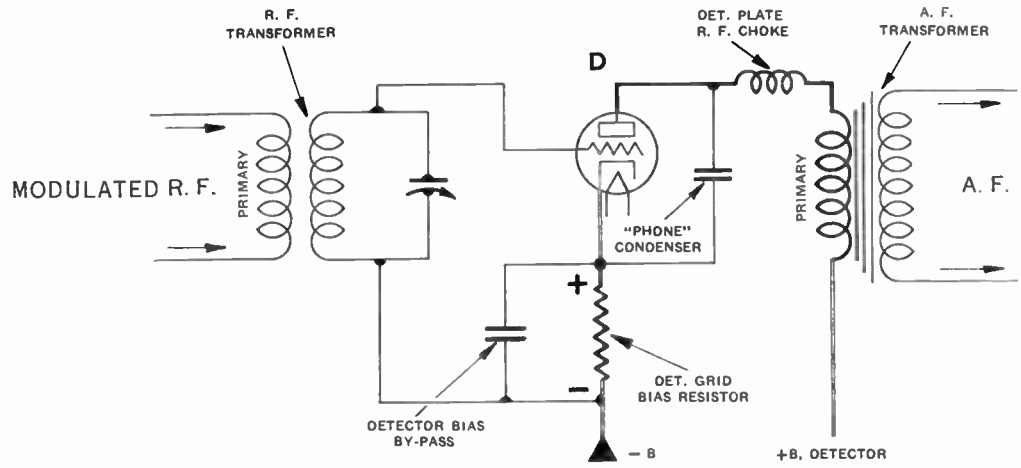


FIG. 19. CIRCUIT OF THREE-ELEMENT DETECTOR USING NEGATIVE BIAS ON GRID.
In the A. C.-operated screen-grid models, resistance coupling is used between the detector plate circuit and the 1st-A. F. grid circuit. However, for the sake of easy comparison with Fig. 18, A. F. transformer coupling is shown above.

(b) **The second method** of detection with a three-element vacuum-tube circuit **is termed "plate detection,"** and it is employed in the A. C.-operated screen-grid models.

In this circuit, Fig. 19, the grid of the tube is maintained at a relatively large negative voltage with respect to the cathode.

Because of this negative grid voltage, the plate-circuit current is extremely low.

When the modulated R. F. voltage supplied by the R. F. amplifier is impressed on the grid bias voltage, it makes the grid voltage alternately more negative and less negative than its normal bias value.

When the grid is more negative than its normal bias, the plate current, being already very low, cannot decrease appreciably.

However, when the grid voltage is less negative than its normal bias, it produces an increase in the plate-circuit current.

In other words, the effect of the negative half-cycles of the applied R. F. voltage alternations is suppressed, and the A. F. modulation of the positive half-cycles produces an A. F. variation in the plate-circuit current.

This A. F. current variation sets up an A. F. voltage across the primary of No. 1 A. F. T. The A. F. output of this transformer feeds the audio amplifier.

(This method of detection may also be described as operating the detector tube on the "bottom bend" of its plate-current—grid-voltage characteristic, at which point an increase of negative voltage on the grid does not decrease the plate current, but a decrease of negative voltage does increase the plate current.)

With this method of detection, the plate-circuit current increases when a signal is received.

D. THE AUDIO-FREQUENCY AMPLIFIER

As its name indicates, the audio-frequency amplifier is used to amplify the audio-frequency (A. F.) output of the detector tube.

The audio amplifier must be so designed that it will not alter the form or shape of the audio-frequency energy delivered to it by the detector tube. If any such alteration does occur, the reproduction will be distorted from its original form.

The amplification must be the same at all audio frequencies, otherwise some frequencies will be submerged, and other frequencies will be exaggerated, resulting in unnatural reproduction.

All Atwater Kent screen-grid receivers (prior to the introduction of the pentode tube in Model 84) have two stages of audio-frequency amplification. The 2nd, or output stage, has two tubes, which make available more than twice the output power of a single tube.

These audio amplifiers, in conjunction with the screen-grid R. F. tubes, have ample reserve power, which, as in the case of a high-powered automobile, is seldom used to its maximum capacity.

The audio-frequency amplifier in the A. C.-operated models is somewhat different from that used in Model 61 and 67. The latter two models are designed to have greater amplification for each audio stage in order to compensate for the necessarily lower plate voltages.

The principal difference between the two audio amplifying systems is in the method of coupling the detector to the 1st-A. F. tube.

In the battery-operated and direct-current receivers, Model 61 and 67, an audio-frequency transformer is used to couple the detector and 1st-A. F. tubes.

In the A. C.-operated models, "resistance coupling" is used between the detector and 1st-A. F. tubes.

A brief explanation of the action of these two methods of coupling is given on the next page.

The Audio-Frequency Amplifier (Continued)

(a) Transformer-Coupled 1st-Audio

In Fig. 19, the A. F. voltage which is set up across the primary of No. 1 A. F. T., as a result of A. F. variations in the detector plate-circuit current, induce a corresponding A. F. voltage across the secondary of No. 1 A. F. T. The voltage across the secondary is greater than the voltage across the primary because the transformer has a step-up ratio, that is, more turns in the secondary than in the primary.

The A. F. voltage across the secondary of No. 1 A. F. T. is impressed on the normal grid bias voltage of the 1st-A. F. tube.

As a result, the grid voltage becomes alternately less negative and more negative than its normal bias value, thus producing corresponding variations in the 1st-A. F. plate-circuit current equally above and below its normal value.

The current variations in the 1st-A. F. plate circuit are exactly similar to the A. F. current variations in the detector plate circuit, but of much greater amplitude or power owing to the amplification provided by No. 1 A. F. T. and the 1st-A. F. tube.

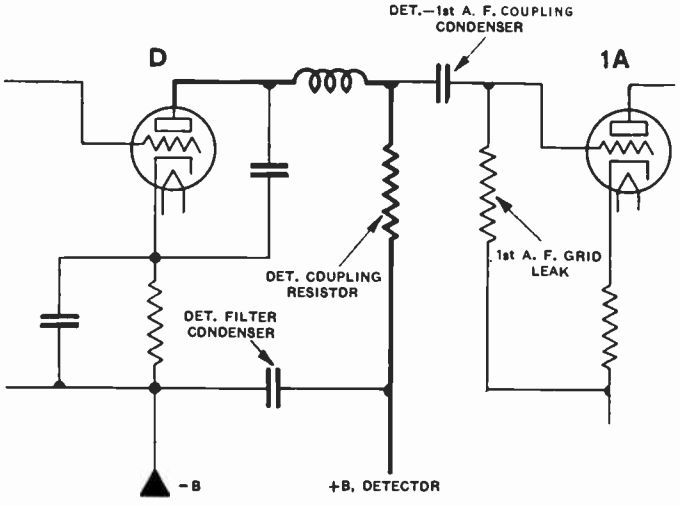


FIG. 20. DIAGRAM SHOWING RESISTANCE COUPLING BETWEEN DETECTOR AND 1ST-A. F. TUBES.

(b) Resistance-Coupled 1st-Audio

Fig. 20 shows resistance coupling between the detector and 1st-A. F. tubes.

In this circuit the grid of the 1st-A. F. tube is connected to the negative end of a bias resistor in its cathode circuit through a grid leak of about one-tenth of a megohm. This leak provides a path for the grid bias voltage to reach the grid, and it also prevents the accumulation of a negative charge on the grid.

The A. F. current variations in the detector plate circuit set up an A. F. voltage across the detector-coupling resistor. This A. F. voltage is fed to the grid of the 1st-A. F. tube through a fixed condenser of large capacity which has low effective resistance to A. F. current variations, but very high effective resistance to D. C.

The A. F. voltage which is fed through the coupling condenser is superimposed on the normal grid bias voltage of the 1st-A. F. tube.

As a result, the grid voltage becomes alternately less negative and more negative than its normal bias value, thus producing corresponding variations in the 1st-A. F. plate-circuit current equally above and below its normal value.

The current variations in the 1st-A. F. plate circuit are exactly similar to the A. F. current variations in the detector plate circuit, but of greater amplitude, owing to the amplification provided by the 1st-A. F. tube.

(c) The "Double-Audio" Output Stage

Except for the method of securing grid, plate, and filament voltages, the action of the double-audio output stage shown in Fig. 26 on Page 27 is typical of all double-audio output stages in Atwater Kent screen-grid receivers.

The A. F. variations in the plate-circuit current of the 1st-A. F. tube produce an A. F. voltage across the primary of the input A. F. transformer. This induces a corresponding A. F. voltage across the secondary.

A tap connection is made to the center of the secondary of the input A. F. transformer. This tap is connected to the negative end of a bias voltage. The positive end of the bias is connected to the filament circuit of the 2nd-A. F. tubes, thus maintaining the grids of both tubes at a negative voltage with respect to their filaments.

The plate of each 2nd-A. F. tube is connected to the primary of an output A. F. transformer. A center-tap on this primary is connected to the positive terminal of a high-voltage D. C. supply.

The A. F. voltage developed across each half of the secondary of the input A. F. transformer is superimposed on its normal grid bias voltage.

This makes the grid voltage of each tube alternately less negative and more negative than its normal bias voltage, and produces corresponding variations in the plate-circuit current of each tube equally above and below its normal value.

When the grid voltage of one 2nd-A. F. tube is becoming more negative, the grid voltage of the other 2nd-A. F. tube is becoming less negative; consequently, the plate-circuit current of one decreases as the plate-circuit current of the other increases.

This produces a co-operating A. F. variation of current through the primary of the output A. F. transformer. As the primary has a high opposition to A. F. current variations, an A. F. voltage is set up across the primary.

This A. F. voltage across the primary of the output transformer is similar in form to the A. F. voltage across the primary of the input A. F. transformer, but of much greater power owing to the amplification provided by the 2nd-A. F. tubes.

The advantages of the double-audio output stage are briefly as follows:

1. The two tubes acting together provide more than twice the available undistorted output power of one tube of the same type.

2. The double-audio output tubes balance out any variation or ripple in their plate-voltage or grid-voltage supply, thus reducing hum. In order to secure this balanced condition it is necessary to use matched tubes.

The Audio-Frequency Amplifier (Continued)

E. The Electro-Dynamic Speaker.

The Atwater Kent electro-dynamic speaker, which is used to convert the electrical output of the audio-frequency amplifier into audible energy, or sound waves, has a practically uniform response to all audio frequencies.

The A. F. voltage across the primary of the output transformer induces an A. F. voltage of much smaller value in the secondary (owing to the step-down ratio of this transformer). This low A. F. voltage is fed into the voice coil of the speaker. The voice coil has low resistance, consequently on a strong signal the A. F. current in the voice coil circuit is comparatively high. The magnetic field produced by flow of current through the voice coil reacts against the constant powerful field of the electro magnet, thus producing motion of the voice coil.

F. A Summary of the Action of the Receiving Circuit

We have now studied the action of the various sections of the receiving circuit, and before beginning to study the power supply system, it may be helpful briefly to review what we have read.

1. **The R. F. amplifier** selects the frequency of one broadcast station, excludes all other stations, and amplifies, without distortion, the energy received from the desired station.

2. **The detector circuit** rectifies the amplified R. F. energy and allows the modulation of this energy to affect the audio-frequency amplifier.

3. **The audio-frequency amplifier** increases the power of the audio-frequency energy delivered by the detector tube.

4. **The electro-dynamic speaker** converts the electrical output of the audio-frequency amplifier into audible energy or sound waves.

THE POWER SUPPLY SYSTEM IN A. C.-OPERATED MODELS

The power supply system must take the 110-volt A. C. (alternating-current) and from it produce high-voltage D. C. (direct-current) for the plate and screen circuits, low-voltage direct-current for the grid circuits, and low-voltage alternating-current for the filament circuits. This is done in this way:

A. The Power Transformer

The 110-volt A. C. supply is fed into the primary of a power transformer (see Fig. 21). There are four secondary windings on this transformer:

(a) The 2nd-A. F. filament winding provides 2.5 volts A. C. for the filaments of the 2nd-A. F. tubes.

(b) The R. F.—detector—1st-A. F. filament winding supplies 2.5 volts A.C. for the filaments of the R. F.—detector—1st-A. F. tubes.

(c) The rectifier filament winding supplies 5 volts A. C. for the filament of the rectifier tube.

(d) The high-voltage winding provides about 350 volts A. C. to each plate of the rectifier tube (measuring from the center tap of the high-voltage winding to each plate of the rectifier).

These values of secondary voltage are obtained by designing the transformer in accordance with a fundamental electrical principle that the ratio of primary voltage to secondary voltage is equal to the ratio of primary turns to secondary turns.

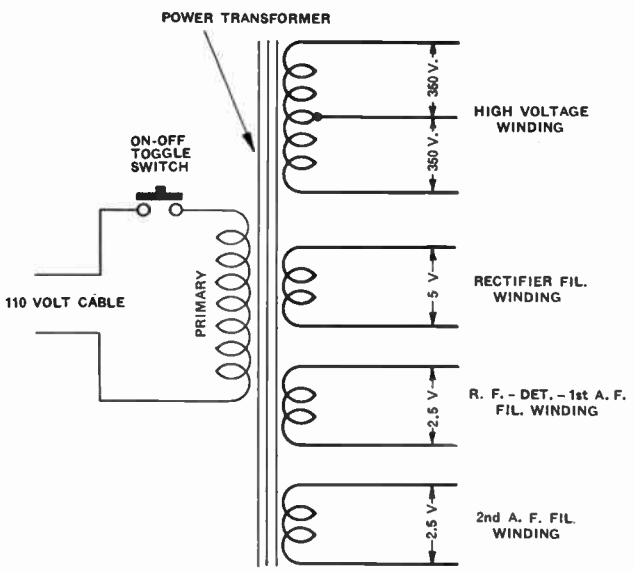


FIG. 21. THE POWER TRANSFORMER TAKES 110 VOLTS A. C. AND TRANSFORMS IT INTO HIGHER AND LOWER VALUES OF ALTERNATING CURRENT AS INDICATED ABOVE (EARLY MODEL 55).

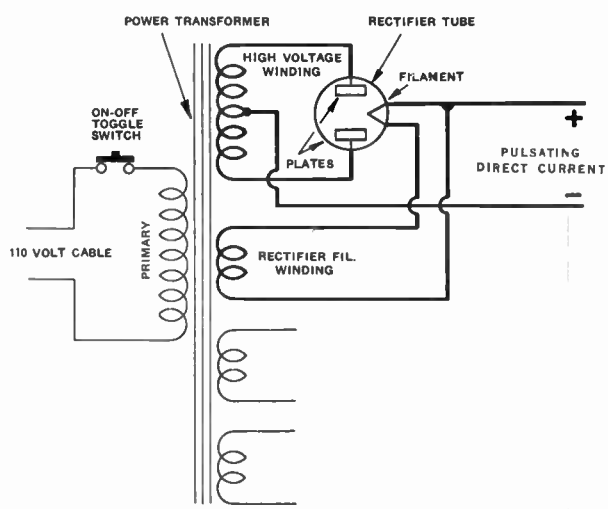


FIG. 22. THE HIGH-VOLTAGE A. C. IS CONVERTED INTO PULSATING D. C. BY A "FULL-WAVE" RECTIFYING TUBE, AS SHOWN ABOVE.

The Power Supply System (Continued)

B. Rectifying and Filtering the High-Voltage A. C.

The high-voltage A. C. must be converted into high-voltage D. C. before it can be used to supply the plate, screen, and grid circuits of the receiving tubes. This conversion is accomplished by rectifying the high-voltage A. C. (through use of a "full-wave" rectifying tube), as shown in Fig. 22, and feeding the resultant pulsating D. C. into a filter circuit which delivers a smooth high-voltage direct-current output, similar to that provided by "B" batteries.

The filter circuit, Fig. 23, contains audio-frequency chokes and large filter condensers.

The filter chokes, which are connected in series with the line, offer a high opposition to the alternating current component of the pulsating D. C. which is supplied by the rectifier tube. The chokes therefore tend to prevent passage of the pulsations in current, but offer only slight resistance to the direct-current portion of the current.

The filter condensers, connected across the supply lines, have low effective resistance to the A. C. component of the pulsating D. C. which is supplied by the rectifier tube. The filter condensers therefore tend to short-circuit the pulsations in the current, but as the condensers have a very high opposition to D. C., they do not affect the D. C. component of the pulsating D. C. supply.

The result of the action of the filter circuit is that the pulsations (in the direct-current furnished by the rectifier tube) are smoothed out, and after passing through the filter circuit, the current is practically pure D. C., and hence will not introduce any hum in the receiver. See Fig. 27 on Page 28.

(The detector and 1st-A. F. plate circuits have separate additional audio-frequency filters, comprising a filter resistor and filter condenser, which serve to prevent undesired reaction between the plate currents, which reaction has a tendency to occur owing to the coupling provided by the common supply.)

C. DISTRIBUTING THE HIGH-VOLTAGE D. C. TO MEET THE REQUIREMENTS OF THE RECEIVING TUBES

After the high-voltage A. C. has been rectified and filtered into pure D. C., it is distributed among the tubes in such a way as to meet the voltage requirements of each tube.

(a) Feeding the Plate Circuits

In order to understand how the correct voltages are applied to each tube, it is helpful to study the circuit of early Model 55 in Fig 15-A, and note that the negative line of the filter circuit goes through the speaker field coil to the chassis. Also, by tracing out the plate circuit of each tube, and the screen circuit of each R. F. tube, it will be found that these are all fed from the positive line of the filter circuit.

After entering the plate or screen circuit, how does the current get back to the negative side of the filter circuit?

The return path for each plate and screen circuit is across the electron-stream between plate and cathode, or screen and cathode, then through the bias resistor for that tube and back to the negative line (chassis) of the filter circuit.

(In the 2nd-A. F. tubes, the return path of the plate circuit is somewhat different, as will be described later.)

(b) How Grid Bias is Obtained

The plate current of each tube, or the plate and screen current of each R. F. tube, flows through the bias resistor.

This current produces a voltage across the bias resistor and, if the grid return of the tube is connected to the negative end of the resistor, the grid will be held at a negative voltage with respect to the cathode.

This voltage (across the bias resistor) constitutes the grid bias for the particular tube. The value of the bias voltage is governed by the resistance of the bias resistor, and by the value of the total current flowing through the bias resistor.

This may be understood more readily by studying Fig. 24 which shows the complete plate circuit of an R. F. tube. Here, as indicated by arrows, the current flows from the positive side of the filter circuit through the primary of the R. F. transformer, across the plate-

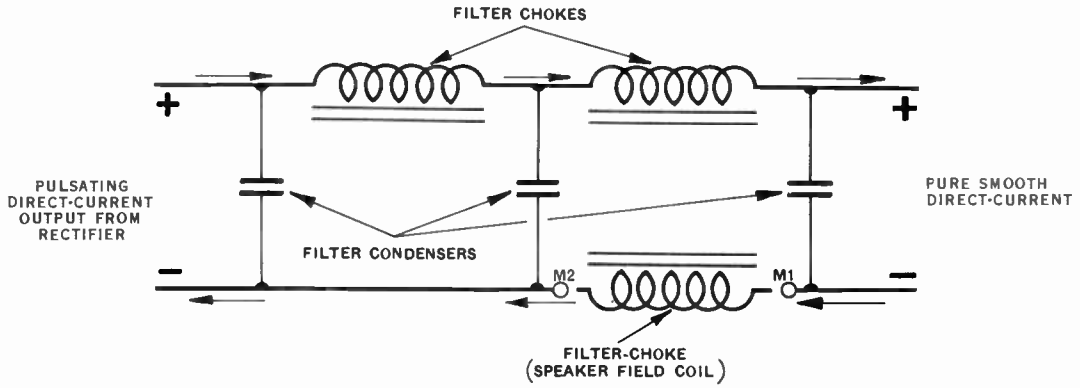


FIG. 23. THE PULSATING D. C. DELIVERED BY THE RECTIFIER CIRCUIT IS FILTERED INTO SMOOTH D. C. BY A COMBINATION OF AUDIO-FREQUENCY CHOKES AND LARGE FILTER CONDENSERS. THE FILTER CIRCUIT IS SHOWN ABOVE.
(Arrows indicate direction of current flow.)

The Power Supply System (Continued)

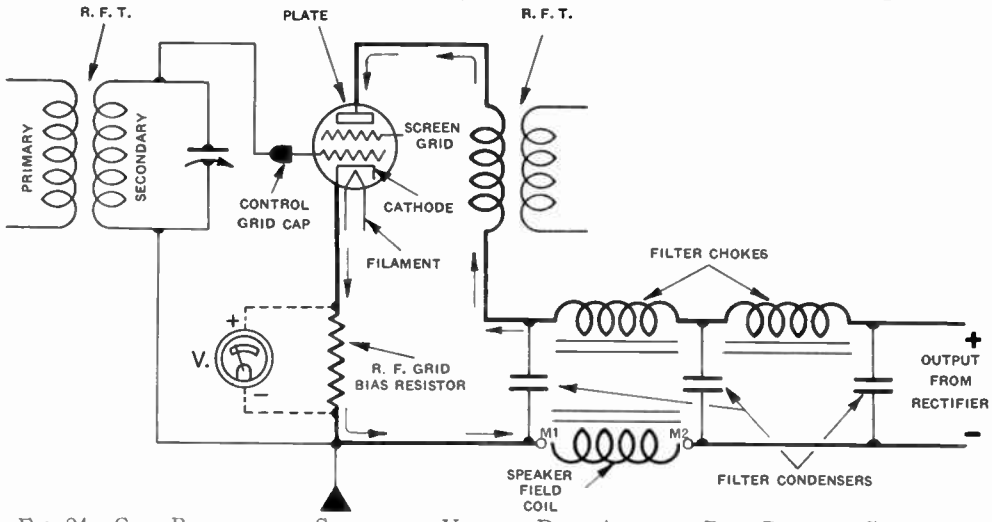


FIG. 24. GRID BIAS MAY BE SECURED BY VOLTAGE DROP ACROSS A BIAS RESISTOR CONNECTED BETWEEN CATHODE AND —B.

The plate-circuit current, flowing through the bias resistor, as indicated by arrows, causes a voltage drop across the resistor, thus making the cathode positive with respect to the grid-return lead, and therefore making the grid negative with respect to the cathode.

cathode electron path, through the bias resistor, and back to the negative side of the filter circuit.

The grid-return of the tube is through the secondary of the left-hand R. F. T. and thence to the negative end of the bias resistor. The voltage across the bias resistor (measured with a high-resistance D. C. voltmeter "V"), which is produced by the flow of plate and screen current, serves to make the grid negative with respect to the cathode.

(c) Measuring the Grid Bias

In actual measurement of the grid bias, we recommend measuring from the grid of the tube to the cathode, as shown in Fig. 25, in order to check the continuity of the grid circuit and measure the bias in one operation. However, in doing this, if the grid return path or the bias resistor has a high resistance in proportion to the resistance of the voltmeter, the measured voltage will be less than the voltage across the bias resistor. This is true when measuring the 1st-A. F. and the detector grid voltages in the A. C.-operated screen-grid models. In the voltage tables for these models we give the detector and 1st-A. F. grid voltages as measured from grid to cathode with the 0-50 scale of a one-thousand-ohm-per-volt meter. The actual normal bias voltage is higher.

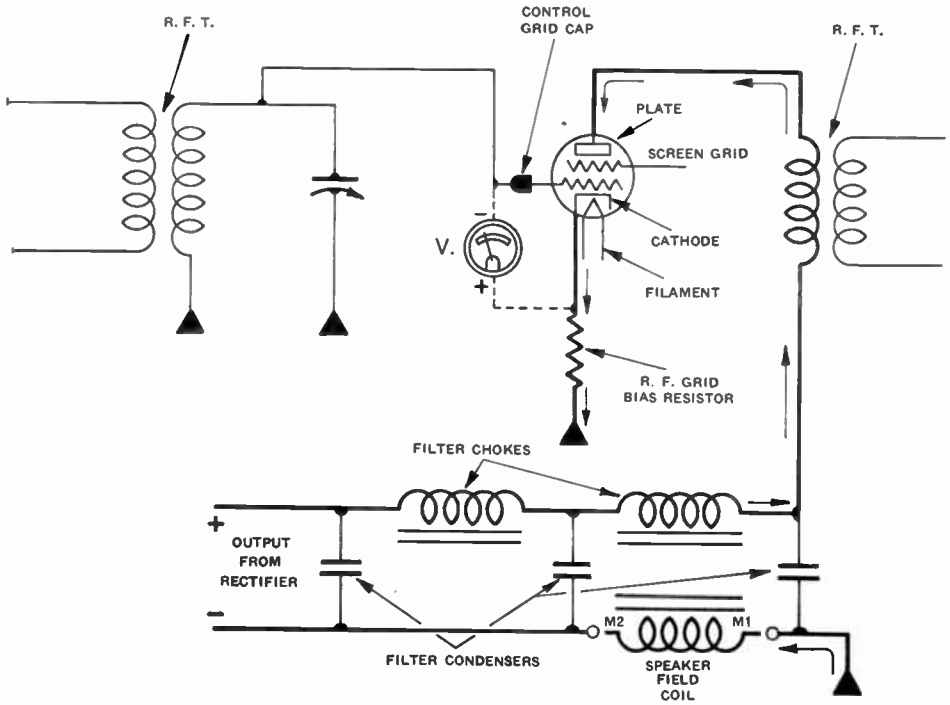


FIG. 25. THIS IS THE SAME CIRCUIT AS FIG. 24, BUT IT APPEARS DIFFERENT BECAUSE THE GRID-RETURN, CATHODE, AND —B, CHASSIS CONNECTIONS ARE SHOWN SEPARATELY.

The Power Supply System (Continued)

(d) Tracing the Bias Circuit

In the complete diagram of early Model 55, Fig 15-A, it is not as easy to trace out the complete plate-circuit path of each tube, as it is in Fig. 24. This is caused by the fact that in a desire to make the complete diagram (Fig. 15-A) follow the actual wiring of the set, so it will be most helpful in service work, we have shown separate chassis connections for the grid circuits, cathode circuits, and negative end of the main filter circuit.

This may be appreciated by comparing Figs. 24 and 25, which are identically the same electrically, but appear different because in Fig. 24 there is one chassis connection for all the circuits, while in Fig. 25 the chassis connections are shown separately.

(e) How Grid Bias is Obtained for 2nd-A. F. Tubes

The grid bias for the 2nd-A. F. tubes could be secured by connecting the filaments of these tubes to the negative end of the filter circuit through a suitable resistor, and connecting the grid return (center-tap of the secondary of the 2nd-A. F. in-put transformer) to the negative end of this resistor.

However, as the 2nd-A. F. bias voltage must be about 45 volts for the 245 tubes, and about 80 volts for the 250 tubes, it would not be economical to use this high voltage (which is subtracted from the total voltage available for the plates of the 2nd-A. F. tubes) merely for biasing the 2nd-A. F. tubes.

Therefore, a different method is used, as shown in Fig. 26. Here the speaker field coil is used as a filter choke and is connected in the negative line of the filter circuit. The field coil has resistance, and, as the D. C. currents of all plate and screen circuits flow through the negative line of the filter circuit, and therefore through the field coil, there is a D. C. voltage across this coil.

In Model 66, the voltage across the field coil is about 80 volts. Therefore, by connecting the filament circuit of the 2nd-A. F. tubes to the positive side (chassis) of the field coil, and connecting the grid return of the 2nd-A. F. tubes to the negative end of the coil, the grids of the 2nd-A. F. tubes are maintained at 80 volts negative with respect to their filaments.

The connection to the filament circuit is made through the center-tap of a filament-shunt resistor for the reason explained previously.

In the A. C.-operated models which employ 245 and 171-A tubes, requiring a grid bias of about 45 volts, a similar biasing system is used, but instead of using the entire voltage across the field coil, a potentiometer arrangement of resistors is connected across the field coil so that the correct portion of the total voltage is available for grid bias of the 2nd-A. F. tubes. This is shown in the diagram of early Model 55, Fig. 15-A, and also in Fig. 27.

Because of this careful engineering design, the speaker field coil serves three purposes:

1. It acts as a filter choke, thus helping to smooth out the plate-voltage supply.
2. The D. C. voltage across the field coil is used in whole or in part to bias the grids of the 2nd-A. F. tubes.
3. The total plate current of the tubes, flowing through the field coil, produces a strong magnetic field in the circular air-gap of the speaker magnet.

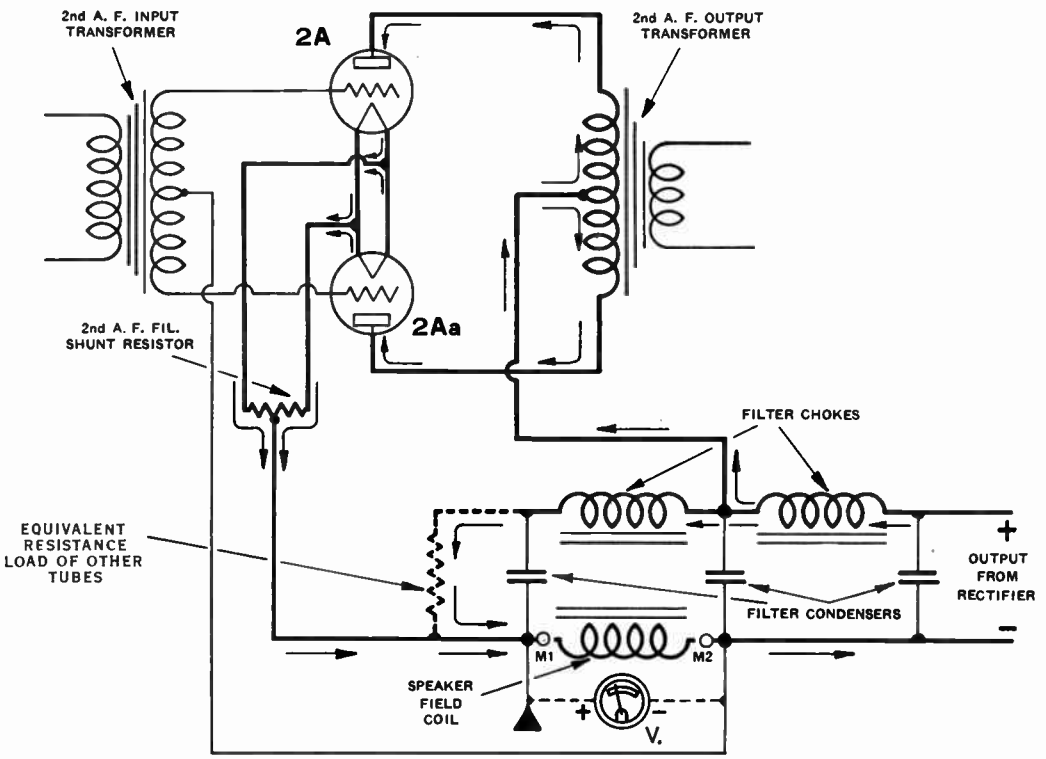


FIG. 26. THE 2ND-A. F. BIAS VOLTAGE IN MODEL 66 IS OBTAINED BY THE DROP ACROSS THE SPEAKER-FIELD COIL IN THE NEGATIVE SIDE OF THE FILTER CIRCUIT.

The filament circuit of the 2nd-A. F. tubes is connected to the positive side (chassis) of the field coil, and the grid-return (center-tap of the secondary of the input A. F. transformer) is connected to the negative side of the field coil. The bias voltage is measured with a high-resistance D. C. voltmeter "V."
The above diagram does not show the grid-filter resistor and condenser which are used in Model 66.

The Power Supply System (Continued)

(f) How the Screen-Grid Voltage is Controlled

The sensitivity of the R. F. amplifier, and consequently the output volume of the set, may be controlled by regulating the screen voltage.

When the screen voltage is adjusted to its maximum value, the R. F. amplifier has greatest sensitivity and amplification. Both of these factors decrease as the screen voltage is decreased.

For engineering and production reasons the circuit arrangement for securing the correct screen voltage varies in different models, and also in different types of the same model. The arrangement used in Model 55 and 55-C is shown in Figs. 28 and 29.

(g) The Complete D. C. Distributing System

Having now reviewed the rectifying and filtering circuit, and having described how the plate, grid, and screen voltages are obtained, it will prove helpful to study Fig. 27, which shows the complete D. C. distributing system for later Model 55.

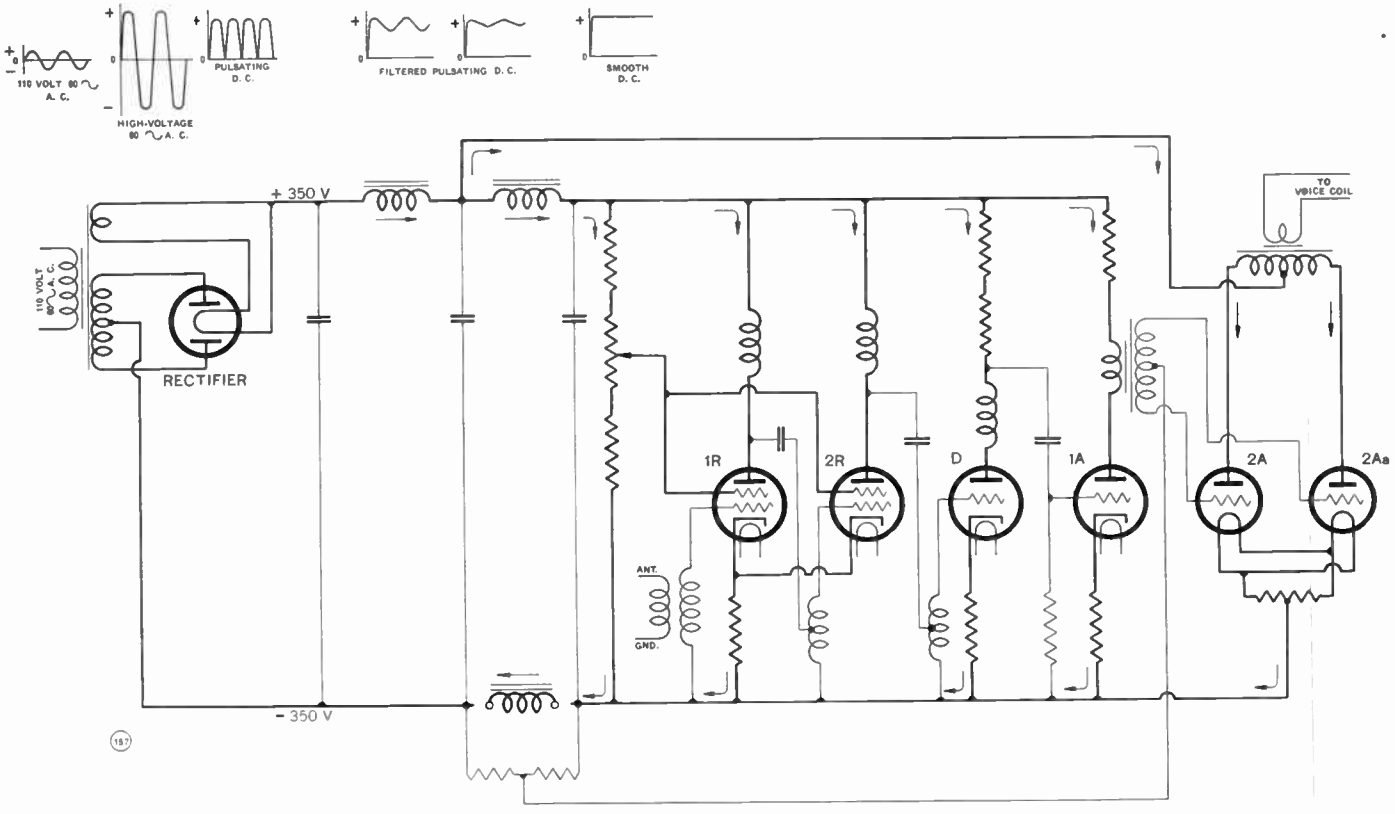


Fig. 27. D. C. Distributing System of Later 55 and 55-C.

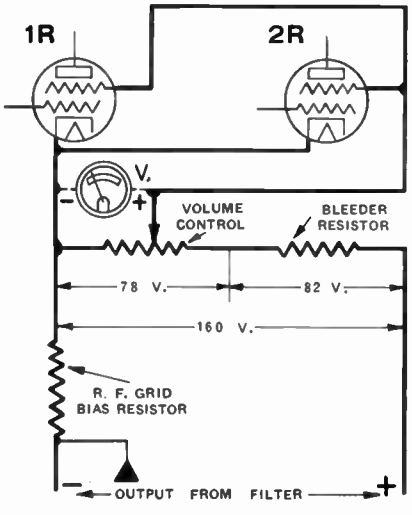
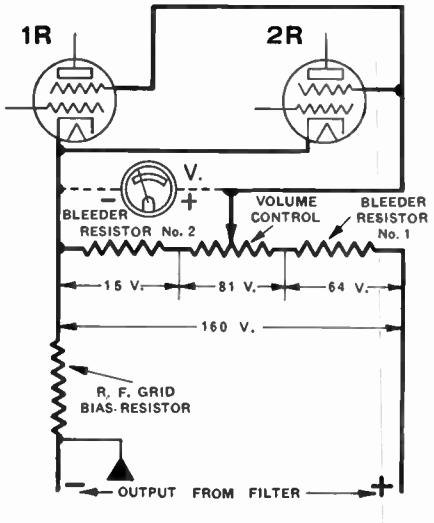


Fig. 28. In Early Model 55 and 55-C, the Screen Voltage is Adjustable From Zero to About 78 Volts, as Shown at Left.

Fig. 29. In Later Model 55 and 55-C, the Screen Voltage is Adjustable From About 15 to 96 Volts, as Shown at Right.

The screen voltage is measured with a high-resistance D. C. voltmeter "V."



IMPORTANT FACTS THE ATWATER KENT DEALER SHOULD KNOW

1. Replacing R. F. Transformers.

Atwater Kent dealers should keep constantly in mind this fact:

Single R. F. transformers are not sold separately.

When a single R. F. transformer in a set becomes burned out or damaged, it is necessary to replace the entire R. F. transformer group or assembly. This is due to the fact that these coils are matched in groups at the factory and sold from the factory in complete groups only.

If you do not have a replacement group in stock, return the group containing the damaged coil or coils to your distributor who will exchange it for a new group and charge you only for the coil or coils needing replacement. Refer to parts list for prices of replacements on each type of set.

2. Replacing Coils in Magnetic Speakers.

Coils for magnetic (horn or cone) type speakers are not sold separately.

This is due to the fact that when a new coil is installed it is necessary to remagnetize the poles which can only be done at the factory. When you have a speaker unit with burned out coil, return the unit to the distributor who will replace it and charge you only for the burned out coil plus a small labor charge.

3. Replacing Carbon-Type Volume Controls.

Parts for carbon-type volume controls (used in later screen-grid sets) are not sold separately.

Owing to the fact that special tools are required for assembling carbon-type volume controls, parts for this type control are not furnished separately. When one of these controls develops trouble, return it to your distributor for replacement at a charge for labor and material involved.

4. Operating 25-Cycle Sets on 60-Cycle Current.

A receiver designed for 25-cycle operation will function satisfactorily on 25-, 40- or 60-cycle current. However, a 60-cycle set must not be operated on 25-cycle or 40-cycle current, otherwise overheating and damage will result.

5. Converting D. C. Sets to A. C. and Vice-Versa.

The dealer may frequently be confronted with the question as to the possibility of changing over a D. C. set for use on A. C. or vice-versa. The cost of making any such change would be entirely prohibitive, consequently the only solution in a case of this kind (where the current is changed or customer moves to a location where current is different) is a trade-in for a model using the current called for. If the dealer can not handle the exchange himself he should take the matter up with his distributor. One exception to this may be mentioned in the case of an A. C. set which may be operated from a D. C. line by using a small motor generator—these can be purchased for as low as $50.00.

6. Operating a Radio on a 32-volt D. C. Lighting System.

Probably the most economical method of utilizing the 32-volt farm lighting system for radio is to use a standard A. C.-type receiver in connection with a small motor generator, designed to operate on 32-volts D. C. and deliver 110 volts A. C. There are several such generators available at reasonable prices.

A 6-volt battery-type receiver may be operated on 32 volts by using a suitable resistor (several commercial types are available) in series with the line, to reduce the voltage to that required for the filaments of the tubes. Resistors equipped with automatic cut-out to prevent overload are available.

The 32-volt system cannot be utilized to supply the plate or "B" voltage to a battery-type set. This must be supplied by dry "B" batteries. Storage "B" batteries which can be recharged (in sections) from the 32-volt system are also available.

7. Use of the Electro-Dynamic Speaker on Early-Type Sets.

We do not advise attempting to use an electro-dynamic speaker with our earlier type sets designed primarily for the use of a magnetic speaker. The dealer is advised to endeavor to sell the customer a complete new receiver in such cases, explaining to the customer the advantage of having an outfit in which the set and speaker were designed by the factory, to work together to give maximum performance.

8. Use of Screen-Grid Tubes in Early Models.

It is frequently asked if it is practical or advantageous to use screen-grid tubes in the early type electric or battery receivers which were manufactured before the screen-grid tubes were developed.

The answer to this question is that a receiver must be especially designed in order to use screen-grid tubes; owing to the peculiar nature of these tubes and their extreme sensitivity, they will not give best results in an ordinary tuned R. F. circuit of the early type. It can therefore be readily seen that it would be impractical to re-design an old set to permit using these tubes, owing to the expense and complications involved.

Here again the dealer is advised to urge the customer to trade-in his old set as part payment on an up-to-date model.

9. Adding Extra Speakers or Headphones to Various Atwater Kent Receivers.

Very often it is desired to use one or more additional speakers or headphones in other rooms, etc., the extra speakers being connected so that they can be switched on or off independently of the regular or original speaker. The method used for making connections of the additional speakers depends upon the type of set. An outline follows:

(1) *Magnetic Sets.*

One or several additional magnetic or inductor-type JB speakers or headphones may be used by simply connecting in parallel with the original speaker; that is, simply run leads from the output or speaker posts of the set to the additional speakers at their locations.

If more than two or three additional speakers are used a series-parallel connection is advisable. Headphones may be used in place of speakers if a suitable resistor is connected in series with one lead to regulate the volume.

A single-pole—single-throw switch in one lead to each extra speaker will permit it to be turned on at will.

Important Facts (Continued)

(2) *Early Electro-Dynamic Sets, Model 43, 46, 47 and 53.*

A small number of additional magnetic or inductor-type JB speakers or headphones may be used by making connection to the two terminals at the right-hand end of the rear row of terminals on top of the power unit. Simply solder two leads to these two terminals and bring the leads out through cover of set to the common leads of the additional speakers.

(3) *Screen-Grid Sets, Model 55, 60 or 66.*

In cases where more than one additional speaker or headphone are desired, we suggest the use of the special tapped output transformer (No. 15930), which we designed for this purpose. This transformer is simply substituted for the regular output transformer in the set and connection of the group of additional speakers made to whichever two of the five taps on the special transformer give the best results.

With this arrangement Model 55, 60 or 66 will handle up to 15 or 20 additional magnetic or inductor-type JB speakers satisfactorily.

We do not advise the use of additional electro-dynamic speakers, owing to the expense and difficulty of supplying direct current for the fields.

Where only one additional speaker or headphone is desired, we suggest an arrangement as shown in the illustration, which consists of tapping off the voice coil leads of the speaker cable, with a step-up transformer and connecting the extra speaker across half the secondary winding of this transformer. The use of switches so that either the regular or extra speaker may be cut out at will, is shown.

(4) *Model 67 Screen-Grid Battery-Type Receiver and Model 61 D. C. Receiver.*

A few extra magnetic or inductor-type JB speakers or sets of headphones may be used with these sets by running leads to them from the plates of the output tubes (171A) in the set.

(5) *1931 Models: Type L, F and P Chassis.*

The only satisfactory method of connecting additional magnetic or inductor-type JB speakers or headphones to these sets is by the use of our special output transformer, No. 17790, which is to be substituted for the regular transformer attached to the type N speaker. This special transformer is provided with 5 taps to permit best results with different numbers of speakers, up to 15 or 20 being practical. A connection is also provided in the transformer whereby the electro-dynamic speaker on the set may be shut off if desired.

(6) *1931 Models: Type D (D. C.) and Q (battery) Chassis.*

A few extra speakers or headphones may be used with these sets by making connection to the plates of the output (171A) tubes.

(7) *Model 84.*

No provision has been made for the use of additional speakers with this model; extra electro-dynamic speakers for this set are not sold separately.

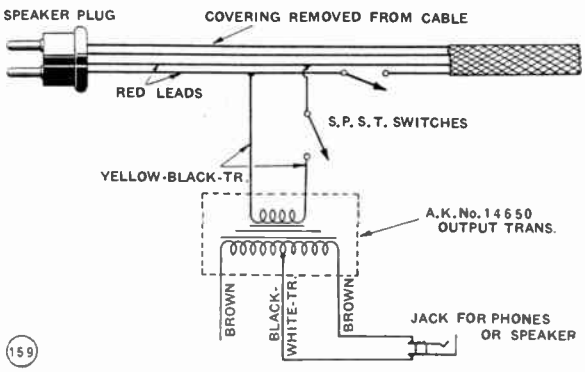


FIG. 32. CIRCUIT ARRANGEMENT FOR ADDING AN EXTRA SPEAKER TO MODEL 55, 60 OR 66.

SERVICE NOTES FOR SCREEN-GRID RECEIVERS

A. Replacing R. F. Transformers and Variable Condensers:

As in the other Atwater Kent single-dial receivers, if one R. F. transformer is defective or damaged, the entire group must be replaced. Likewise if one variable condenser is defective, all of the variable condensers must be replaced. Single R. F. coils or variable condensers are not furnished.

B. Replacing Eyeletted Parts:

The tube sockets, identifying plates and tube-shield bases are fastened with eyelets to the base-plate, and several parts are eyeletted to the main panel, but if any of these parts requires replacement, it may be removed by cutting out the eyelets, and the replacement part may then be mounted in position with short 6/32 or 8/32 screws and nuts.

C. Synchronizing Condensers:

When synchronizing the condensers, connect the oscillator pick-up lead to the Short-Antenna post, and place the local-distance switch in the "distance" position.

The bottom-plate should be screwed in position when testing any of the screen-grid models for output volume, or when synchronizing the condensers. However, in order to avoid the necessity of removing and replacing this plate a number of times, it will be found more convenient to cover the top of the test bench with a sheet of tin (about 20 gauge), which should be connected to ground. This sheet of metal acts as a shield in place of the bottom-plate.

In Model 61, the chassis must not be connected to ground, so in this case the ground connection to the sheet of tin should be opened. When testing both A. C. and D. C. receivers, an on-off toggle switch may be connected in the ground lead to the tin sheet. This switch should be opened when testing the screen-grid direct-current receivers.

D. Use Top Plate:

Owing to the design of the R. F. amplifying circuit in the screen-grid receivers, it is necessary to use a top shielding-plate when synchronizing the variable condensers. In the shield for three-condenser receivers, such as Model 55, it is necessary to cut a hole in the shield over the rotor of No. 1 condenser in order to make this rotor accessible for adjustment. This hole should be about 1½ inches in diameter with its center 2¼ inches from the left edge of the shield and about 1⅜ inches from the front edge. The rotor of No. 1 condenser may then be adjusted with one finger through this hole. No. 2 condenser rotor may be adjusted by turning the control knob, and No. 3 rotor may be reached from the right-hand side of the chassis.

In four-condenser screen-grid receivers, such as Model 60, a 1½ inch hole should be drilled in the shield over the rotors of No. 1, No. 3 and No. 4 condensers.

A top shield for the three-condenser type receivers, and a top shield for the four-condenser type receivers, with holes cut as mentioned above, should be available at each testing bench. These specially-drilled shields are NOT supplied from the factory.

E. Operating-Voltage Measurements:

One of the quickest methods of testing the screen-grid receivers is by measuring the voltage at each tube socket as indicated in the tables for each set. **Please note that the voltage values are approximate only.** These measurements must be made while the set is in operation, using either a commercial set-analyzer, with adapters which fit into the tube sockets, or using separate A. C. and D. C. voltmeters, making connection to the tube socket-contacts under the base plate. All of the socket-contacts may be exposed by inverting the set and removing the flat bottom-plate.

F. Continuity Testing:

Separate parts may be tested for continuity with a voltmeter and battery in the usual way. If there is any doubt as to whether a part is shorted, grounded, or open, it is advisable to remove all connecting leads to that part and test it separately.

When making continuity tests, see that the control-grid leads do not touch the chassis.

G. Antenna:

Two antenna posts are provided on the set, marked "Long Antenna" and "Short Antenna." The Long-Antenna post gives somewhat greater selectivity.

Indoor aerials for the screen-grid receivers should be erected as far as possible away from grounded metal, such as pipes, steel beams, electric wiring, etc. **A good outside antenna is recommended in preference to an indoor antenna.**

H. Ground:

It is necessary to use a good ground connection. In some cases, depending on the installation conditions, the sets will work satisfactorily without a ground, but for best results we strongly advise the use of a good ground connection.

I. Output Tubes:

The two A. F. output tubes (2A and 2Aa) should be matched on a tube tester, otherwise the set may hum.

The speaker-plug must not be removed from its socket while the set is in operation.

J. Local-Distance Switch:

The set should be operated with the local-distance switch in the local position when receiving near-by stations. Failure to do this may result in distortion when receiving near-by stations. This use of the local-distance switch should be explained to owners, in order to avoid unnecessary discussion.

K. Phonograph Adaptors:

Owing to the fact that resistance coupling is used between the detector and the 1st audio stage on Model 55, 55-F, 60 and 66, the usual type of phonograph pick-up may not give satisfactory volume on these receivers. However, some manufacturers have special pick-ups for these models.

PLANNING THE SERVICE DEPARTMENT

1. The Service Room

The first thought of the dealer, once he has been "sold on the idea" of rendering real service, will be a suitable workshop or service room in which to carry on this work, and also the tools and equipment he will require to perform radio service completely and efficiently.

In most cases it will be necessary for the dealer to utilize for his service room whatever location may be available for this purpose under the conditions of his present floor layout, but where there is a choice, or in case of the occupying of new quarters where any desired layout can be planned, it is suggested that the service and parts stock room be arranged adjoining or convenient to the rear of the sales and display room. With this arrangement, customers bringing sets in for service can be referred promptly to the "Service Department," which will avoid unnecessary delay and interference with the work of the floor salesman. The dealer's "outside service man" can, of course, enter the shop by the rear entrance.

The service room need not be very large, but should be well lighted. If possible to have outside light directly on the service bench or table from one side or the rear, it will enable the service man to work more efficiently and consequently to produce better results.

2. The Repair Bench

The service bench or "repair table" should be four or five feet long and about twenty inches deep. The height should be about thirty-six inches, so as to permit the repairman to work at it conveniently while standing. The top of the table should be of fairly heavy pine wood, and the legs should be heavy enough to insure the bench being absolutely firm and free from vibration. One or two round-topped stools can be provided for the men when working on jobs requiring considerable time.

3. Suggestions for Service Equipment

A reasonably complete outfit of meters and tools, which will cover the making of any ordinary tests and repairs, is suggested as an initial equipment for the dealer's service room, and consists of the following:

Voltmeter panel (see Page 39 for description).

Multi-wave oscillator covering the broadcast range and also 130 K. C.

Milliameter, 0-100 M. A.

A separate continuity testing meter or "ohmmeter."

Tube testing device (any standard make).

Hydrometer.

Soldering iron and equipment.

Testing prongs with cables (several pair).

Set of small open-end hex. wrenches.

Set of small socket type hex. wrenches.

Open end wrench for toggle switch (for 5/8-inch hex. nut).

Assortment of screw drivers, pliers and wire cutters.

Assortment of spring type clips for quick connections.

Assortment of small fuses (1 and 2 Amp. and 100 M. A.)

Pair of special wrenches for removing cone of E speaker (Part No. 9255).

Jig for setting volume-control contact (Part No. 15115).

Set of three shims for centering the voice coil in electro-dynamic speakers (Part No. 20171).

Three gauges for centering top-pole-piece in electro-dynamic speakers. Each gauge consists of a three-inch length of No. 54 drill rod.

Two specially-drilled top plates for use in synchronizing condensers in screen-grid receivers. See Page 31 for details.

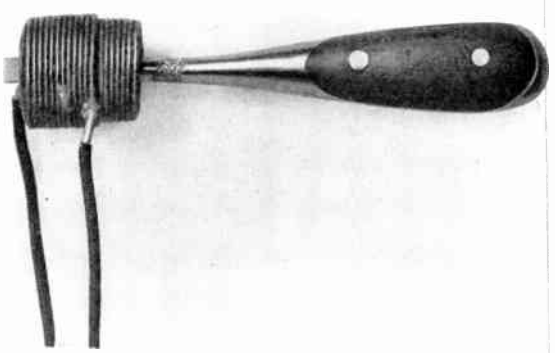


FIG. 33. MAGNETIZING A SCREW DRIVER.

A magnetized screw driver is of great assistance in removing and inserting screws in places which are ordinarily difficult to get at, and it is suggested the dealer prepare one. To magnetize a screw driver, simply insert the blade inside a coil about 50 turns of No. 18 or other insulated wire, the terminals of which are connected to a 6-volt battery and close the circuit for a moment.

4. Arranging the Equipment

All tools frequently used should be kept in a definite place where they will be accessible without delay. A row of hooks at one end of the work table or on the wall can be recommended for this.

The testing equipment may be arranged as shown on Page 38.

Planning the Service Department (Continued)

5. Locating Repair Parts Stock and Repair Material

The best method of arranging the stock of repair parts is to keep them in rows of small wooden bins or in glass jars on sets of shelves on the wall. Each bin or jar should be carefully labeled with the part number and name.

It will also be advisable to have an additional set of shelves for complete sets and speakers—for example a shelf for jobs "to be repaired," one for sets "ready for delivery," and one for sets "awaiting instructions" from the owner or waiting for parts which have been ordered.

6. Equipment for the Outside Service Man

The amount and type of equipment provided for the dealer's "outside service man" will depend on the total investment being made in service equipment, and the ability of the outside man in using meters, etc., to locate and perhaps repair minor troubles in the customer's home.

As a rule it is preferable to make only the external tests in the customer's home, and if trouble is found to be within the set or speaker they can be loaded into the service truck and brought to the shop. This avoids the bad psychological effect of making an actual set repair in the presence of the owner.

There are several complete set testing outfits or "analyzers" on the market made by reliable companies, ranging in price from $50.00 to $200.00 or more (retail price). These include all necessary voltmeters, ammeters, tube testers and, in some cases, an oscillator for use in synchronizing variable condensers.

If the dealer does not feel able to invest in one of these outfits, the following set of articles is suggested. Additions can be made as found advisable:

Soldering iron.
Screw drivers, several sizes.
Wrenches, hex., several sizes.
Combination pliers and wire cutters.
Hydrometer.
A. C. voltmeter, 4-8-150 volts.
0-50-250 D. C. voltmeter (1000-ohm-per-volt type).
Tubes—one or two of each type.
Headphones or speaker.
Continuity tester (described on Page 36).

The above equipment will provide for checking all batteries, tubes and the speaker, as well as the D. C. voltage of any circuit of set or power unit. Any troubles outside the set can thereby be immediately detected and if the difficulty is traced down to the set it can be disconnected and brought to the service shop for the usual routine circuit and voltage tests, and necessary repairs.

7. Keeping Records on Service

This feature is one which the dealer cannot afford to neglect if a smooth-running Service Department is to be maintained, and if the avoidance of misunderstandings with the customer and unnecessary correspondence with the distributor is desired.

Pads of printed forms, serially numbered and with sufficient copies for office records and the customer, should be used for handling repair jobs, and the date on which a set is brought in for repair, date repair is made, and also delivery date with customer's signature obtained, should be carefully entered.

It is extremely important for the dealer to fill out the warranty tag that accompanies each set and promptly return the post card section to his distributor. The dealer-record-card should be filed for reference in order to determine whether future repair jobs are in the warranty period.

If a repair "invoice" is made out separately, the number of the repair tag and all other data should be placed on the invoice.

All expenditures in the line of service should be recorded carefully in a suitable book, so that at the end of the year a comparison can be made between the cost of maintenance of the department and the total income from repair work done. The latter will, of course, be made up of the profit in repair parts and the amount charged for labor on repair work.

We also recommend the keeping of a careful "inventory" of the stock of repair parts. A "perpetual inventory" is the best if care is taken to keep it up to date. A record card should be maintained for each item kept in stock, and the quantity of this item and date received from the distributor recorded, as well as the date and repair number whenever one is used on a repair job. By going over the stock once a month or so, and checking the inventory, any items on which the stock is getting low can be ordered from the distributor and thus an adequate stock of all parts may be kept on hand at all times.

8. Service Personnel—the Psychology of Service

In the selection of a man or men to handle the Service Department of his store, the dealer should consider three main factors:

1—Education and experience.
2—Natural ability on radio repair work.
3—Ability to meet the customer.

It is self-evident that to perform satisfactory work as a radio service man, experience along radio lines and ability along the lines of electrical and mechanical repair

Planning the Service Department (Continued)

work are essential. The third factor, however, is not usually given due consideration, in fact too often it is sadly overlooked.

The Service Department, rather than being looked upon as a necessary evil (as it was several years ago before the dealer had been educated to its true value), is now considered one of the biggest factors for building good-will and indirectly increasing sales that the dealer can possibly have. But this is not possible unless the service man takes the proper attitude toward the customers and his own work. He should always assume the attitude that "the customer is right." He should listen politely to his story of his trouble and endeavor to assure him cheerfully and convincingly that his difficulty will soon be a thing of the past. Confidence in the product and in his own ability will be a powerful factor in the service man's favor in this connection. He should never argue with a customer and never make promises he cannot fulfill. All appointments made should be kept without fail.

All in all, a proper understanding of the psychology of service on the part of the service man will help to make the Service Department a great asset to the eventual success of the radio dealer's business.

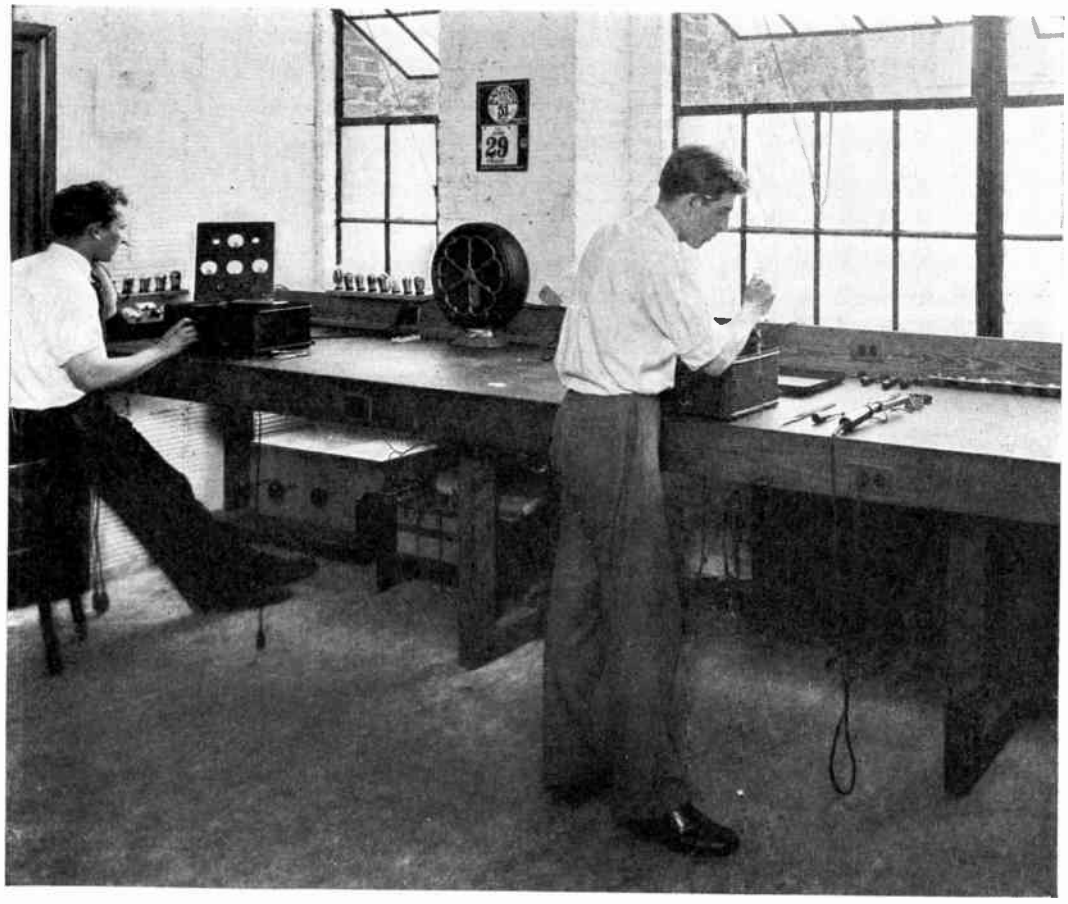


FIG. 34. TWO VIEWS OF A WELL-LAID-OUT SERVICE ROOM.

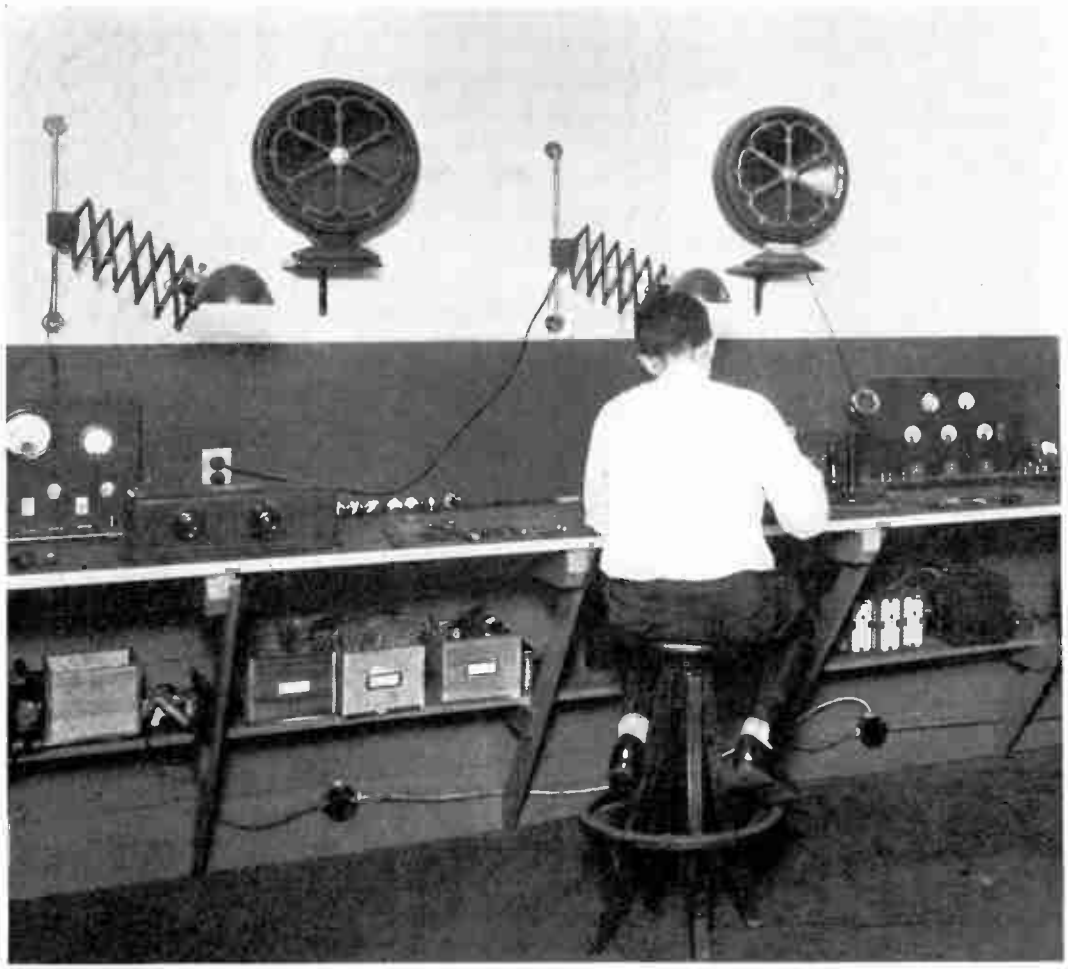


FIG. 35. ANOTHER WELL-ARRANGED SERVICE DEPARTMENT.

TESTING PROCEDURE

Points for Inspection

The following features should be given special attention in making the general visual inspection:

1—SOLDERED JOINTS—examine for firmness. A poor physical joint means a poor electrical connection. **Note especially ground lug connections.**

2—SCREWS, BOLTS AND NUTS—must be all tight.

3—INSULATION ON WIRING—must be perfect and not cut or frayed through where it passes metal edges of tube contacts, etc.

4—TUBE SOCKET CONTACTS—should be clean and tight.

5—SWITCHES—switch blades should be clean and make good contact. (Types other than toggle.)

6—DIAL KNOB—should operate smoothly and quietly.

7—RESISTORS—note if intact and tightly riveted or clamped in place.

8—R. F. TRANSFORMERS—examine for loose or damaged coils, or poor connections at terminals.

9—VARIABLE CONDENSERS—check for foreign particles between plates and note spacing between rotary and stationary plates.

10—RHEOSTATS or VOLUME CONTROL—must operate smoothly.

11—POWER SUPPLY CABLE—note condition of insulation on leads and condition of terminals at power end.

12—POWER UNIT (Early A. C. SETS)—cable connection panel must be bolted down tightly.

The set may then be tested in the following way:

(a) If there is no visible damage to the set (such as a shorted power unit with sealing-compound run over the edge, scratched R. F. transformers, broken tube sockets, etc.) it should be connected for operation, with all tubes in their sockets, and measurements should then be made of the plate, grid, and filament voltages. (Also check the volume control for smoothness of operation.)

These voltage measurements will usually indicate the exact source of trouble and the set may then be disassembled, if necessary, and repaired.

(b) After being repaired, and before reassembling in cabinet, it is advisable to apply continuity tests to the chassis and power unit. The continuity tests give a further check and minimize the possibility of delay in assembling the set before it is fully repaired.

(c) When repaired and assembled, the set should be connected to the output-measuring-circuit and oscillator and the variable condensers should be synchronized. Also again check the operation of the volume control. If a new power unit has been installed, the plate, grid-bias, and filament voltages should be measured. The set may then be switched over to an outside antenna and tested on broadcast signals.

(d) Before returning the set to the customer, a careful inspection should be made to make certain that all assembly screws are tight, that the tuning dial and volume-control knob are correctly adjusted, that the condenser-pulley set-screws are tight, that the cabinet is in good condition, etc.

CONTINUITY TESTS

All Atwater Kent receivers and power units may be tested for "grounds" and continuity of circuits, coils, resistors, etc., with a simple testing arrangement consisting of a voltmeter and battery connected as shown in Fig. 36. A 0-15 voltmeter with a 22½ volt "B" battery is recommended (the voltmeter should NOT be of a high-resistance type). In order to decrease the voltage across the meter to 15 volts, a volume control should be connected in series with the battery as shown in the diagram. The volume control may be adjusted occasionally to cut out resistance as the battery voltage drops off, thus bringing the voltmeter pointer to the 15 volt mark when the test prongs are touched together. Use the 18-volt tap on the battery.

Where the resistance of the circuit being tested is low, the meter should read practically 15 volts. In testing through the windings of a transformer or resistance unit, however, there will be a corresponding drop in voltage, and when testing across a condenser which is, of course, an insulator for D. C. (direct current) no reading should be obtained. If the results experienced on a certain test vary from the above general outline, trouble in the circuit or unit being tested is indicated.

In case there is any doubt as to whether a certain part has the correct resistance, it is desirable to compare its reading on the continuity meter with the reading secured on a new part of the same type.

A continuity meter is included in the meter panel described on Page 39.

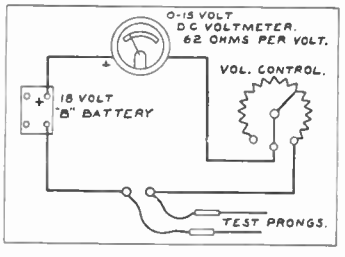


FIG. 36. DIAGRAM OF CONTINUITY TESTING CIRCUIT.

The volume control is part No. 9510.

SYNCHRONIZING VARIABLE CONDENSERS IN BELTED-TYPE RECEIVERS

In order to secure the best sensitivity, volume, and selectivity from a receiver of the single-dial type, it is extremely important that all the tuned circuits be synchronized at all settings of the tuning dial.

If the synchronism has been disturbed in a belted-type receiver, the condensers may be re-synchronized by loosening the pulley set-screws and adjusting the rotor of each condenser separately to give peak output on a constant-strength signal of 1000 kilocycles. The pulley screws are then tightened, and if the condensers and the R. F. transformers are matched, the synchronism should be good at all points on the dial. If the synchronism is not good at other points on the dial, as evidenced by weak reception, either the condensers or the R. F. coil group are not properly matched. In this case a new condenser group or a new transformer group (as necessary) should be installed and the condensers should be re-synchronized.

When synchronizing condensers, it is necessary to use a local oscillator to provide signals and a meter to indicate output volume.

The local oscillator is necessary in order to secure constant signal strength. Signals from broadcast stations are not sufficiently constant for this work.

An output meter is required to secure a reliable indication of output volume. The ear is not reliable for this purpose.

A suitable output measuring circuit is described on Page 41.

The oscillator feeds a weak signal into the receiver. The signal is amplified in the receiver and produces a reading on a meter that is connected to the output of the set. This meter indicates the strength of the output volume.

The reading on the output meter is greatest when all the tuned circuits in the set are adjusted to the same frequency as the oscillator signal. Therefore, if the variable condensers are adjusted separately to produce maximum output volume from the signal, each tuned circuit will be in resonance with the signal and in synchronism with each other.

It is necessary to check the variable condensers at three different broadcast frequencies in order to make certain that the tuned circuits are accurately synchronized at all settings of the tuning dial.

The oscillator must provide modulated signals at 1000, 800 and 600 kilocycles. The pick-up control or attenuator on the oscillator should be calibrated so that it may be re-set at any time to give the same output.

A No. 8112 grid condenser should be connected between the pick-up lead and the antenna post on the set.

The checking and synchronizing procedure is as follows:

Loosen the pulley set-screws on all condensers except the dial condenser. Adjust the rotor of each condenser separately to give peak output on the 600 K. C. signal. Note the position of the oscillator pick-up control and the peak reading of the output meter. Repeat this adjustment at 800 K. C. and finally at 1000 K. C.

Carefully tighten the pulley set-screws when the rotors are adjusted for peak output at 1000 K. C. The output reading at 1000 K. C. should be the same after the screws are tightened as before, otherwise the rotors have been disturbed while tightening the screws, and the operation must be repeated.

Now tune to 800 K. C. and readjust the oscillator pick-up to the same position it had when making the previous test at 800 K. C. The reading now, with the pulley screws tightened, should be at least 75% as much as the reading previously secured at this frequency when the rotors were adjusted separately.

The same comparison is made at 600 K. C.

If, with the pulley screws tightened, the output reading at 800 or at 600 K. C. is less than 75% of the reading that was secured when the rotors were adjusted separately, it indicates that either the R. F. transformers or the variable condensers are not matched, and a new group should be installed.

Note that the pulley set-screws are tightened when the rotors are adjusted for peak output at 1000 K. C. The set-screws should not be touched after that.

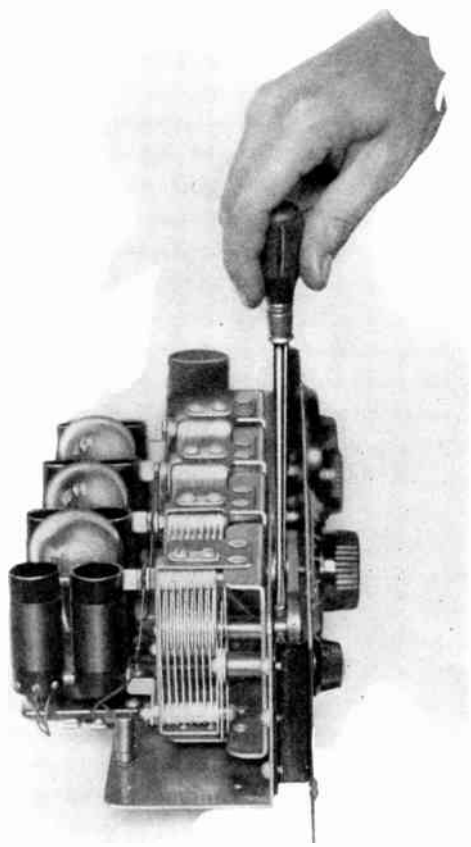


FIG. 37. TIGHTENING PULLEY SET SCREWS AFTER CONDENSERS HAVE BEEN SYNCHRONIZED AT 1,000 KILOCYCLES.

DESCRIPTION OF TESTING EQUIPMENT

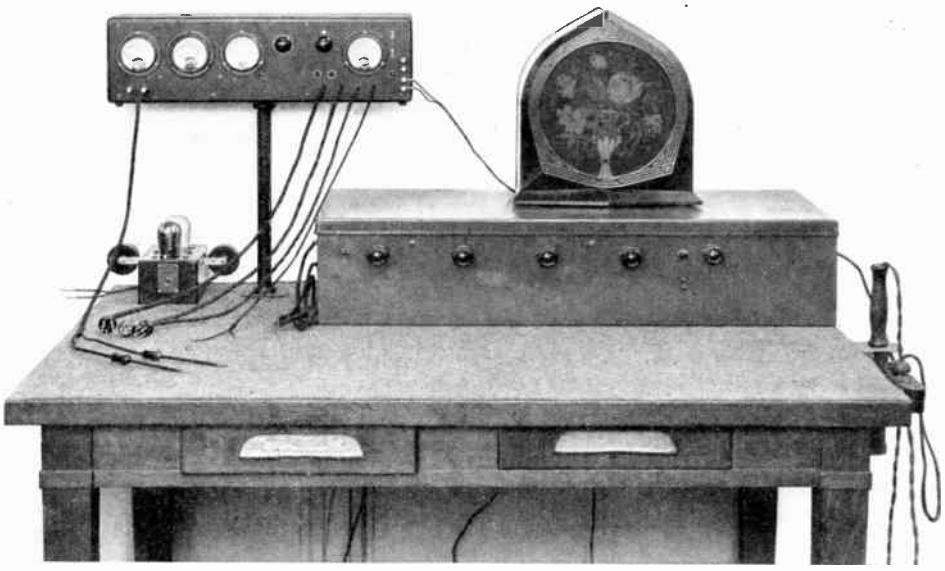


FIG. 38. SUGGESTED ARRANGEMENT FOR A TESTING BENCH.

The complete equipment we suggest for enabling a complete test of any Atwater Kent receiver, together with equipment for measuring the output, is illustrated above.

At the left, supported on the vertical metal stand, is the combination voltmeter testing panel, and output measuring circuit or equipment. Below this is pictured a 130-K. C. oscillator used in testing our superheterodyne models.

To the right is a large metal box housing the four-wave oscillator used to generate signals on four standard broadcast frequencies. On the top of this is shown the inductor type Model JB speaker used to test reception (volume and quality) of any set being tested. A soldering iron for use in repairs is pictured on the extreme right, as is also the plug for deriving power for the test equipment from the local A. C. line. The two drawers in the table are used for tubes and tools.

The four-wave oscillator and the 130-kilocycle oscillator shown in this view are especially constructed and can not be purchased. For dealer use, we recommend the purchase of a well-shielded battery-operated oscillator that covers the broadcast range of frequencies and also 130 kilocycles. The frequency controls should be accurately calibrated, and it should be possible to reduce the pick-up practically to zero or increase it to the equivalent of a strong local broadcast signal. The pick-up control or attenuator should be calibrated so that it may be re-set to give the same output at any time.

The voltmeter panel includes an A. C. voltmeter, a D. C. voltmeter, a continuity meter, and a switch to cut in the particular meter and voltage range that is required for a given test. There are only two leads from this meter circuit and these are at the left-hand end of the panel.

An output measuring circuit is provided at the right-hand end of the panel. This includes a thermo-coupled milliameter, three toggle switches, a four-point rotary switch, a special transformer, and other miscellaneous parts. The output circuit is described on Pages 41 and 42.

The voltmeter panel is designed to fit a Model 36 cabinet. The cabinet is mounted on a pipe with flanges at each end, forming a very neat and sturdy mounting.

The top of the test bench should be covered with a sheet of tin which should be grounded through a toggle switch. The switch should be closed when testing A. C. or battery-operated screen-grid receivers and opened when testing D. C.-operated receivers.

The test bench should be used only for testing. A separate bench should be provided for repair work.

Description of Testing Equipment (Continued)

The Voltmeter Panel

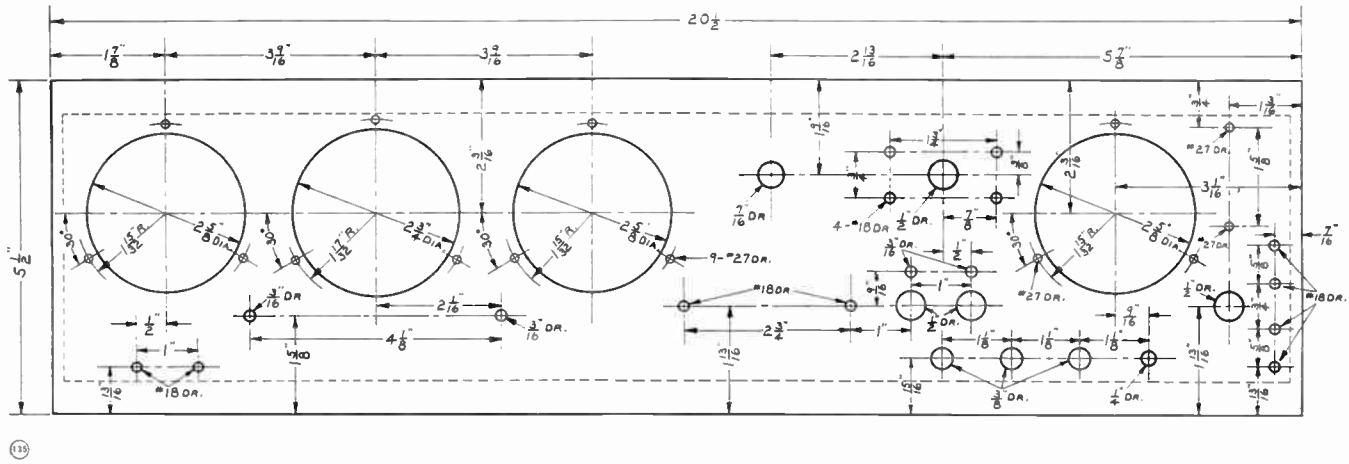


FIG. 39. SUGGESTED LAYOUT FOR VOLTMETER PANEL.
Clips for a fuse are mounted on the front of the panel, at right side of the thermo-galvanometer.

The three meters at the left of the voltmeter panel are connected as shown on Page 40. These meters are used in measuring the voltages and testing the continuity of any Atwater Kent receiver.

The meter at the right of the panel (Fig. 39) is a thermo-galvanometer used in an output measuring circuit described on Page 41.

The equipment required for the voltmeter circuit is as follows:

1 Phenolite panel 1/16 inch by 20½ inches by 5½ inches.
1 High-resistance D. C. voltmeter, 0-50-250 volts.
1 Accurate 200,000-ohm resistor for the 250-volt range of the meter.
1 Accurate 250,000-ohm resistor for the 500-volt range of the meter.
1 A. C. voltmeter 0-4-8-150 volts.
1 D. C. voltmeter, 62-ohms-per-volt, 0-15 volts.
1 Part No. 9510 volume control for the continuity circuit.
1 Part No. 9991 toggle switch.
1 Rotary switch, nine points.
1 22½-volt "B" battery. Use the 18-volt tap.
1 Pair of testing prongs with leads.
4 Part No. 8215 binding posts.

The above parts, except binding posts, toggle switch and volume control, can NOT be purchased from the factory.

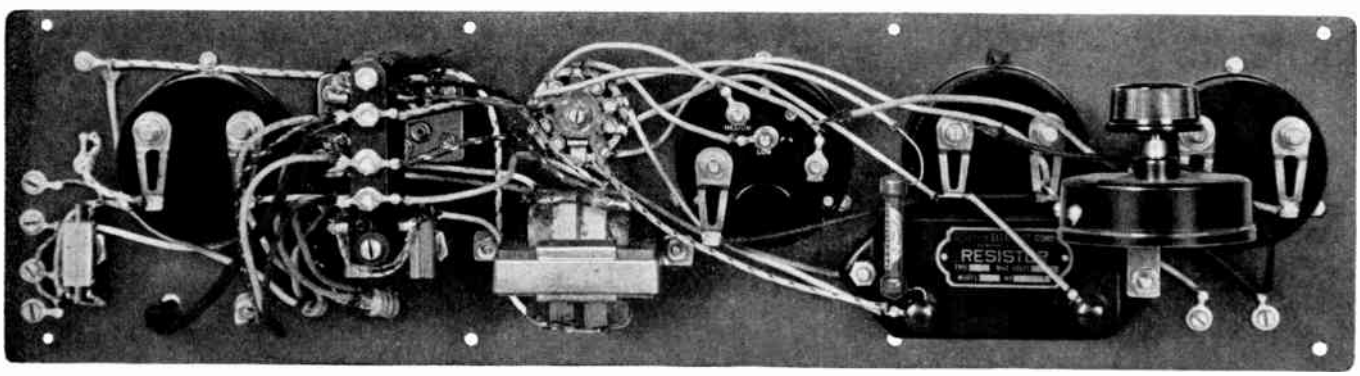


FIG. 39-A. REAR VIEW OF METER PANEL.

Description of Testing Equipment (Continued)

The Voltmeter Panel

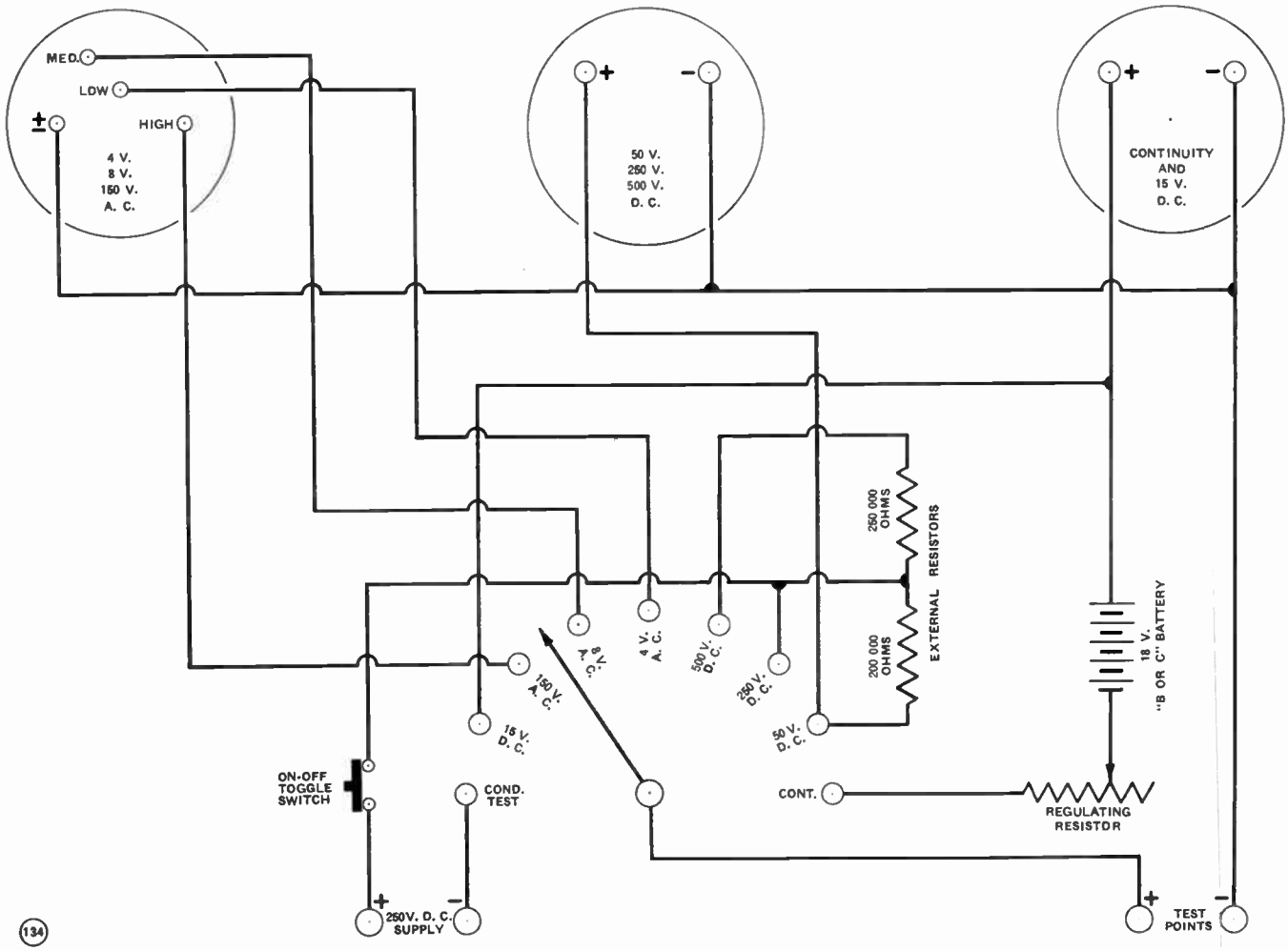


FIG. 40. DIAGRAM OF VOLTMETER TESTING CIRCUIT AS SEEN FROM REAR.

The high-resistance D. C. voltmeter has a scale reading of 0-50-250 volts, but utilizes external resistors for the 250 and 500 volt ranges. These resistors must be accurate.

The A. C. voltmeter is used for measuring line voltage, the filament voltage of A. C. receivers and all other circuits where A. C. is present and a measurement is required.

The high-resistance D. C. voltmeter is used to check plate and grid voltage, filament voltage on D. C. sets, battery voltage, "B" power units, etc. In general it is desirable to use the 250 or 500 volt scale when checking grid or plate voltage.

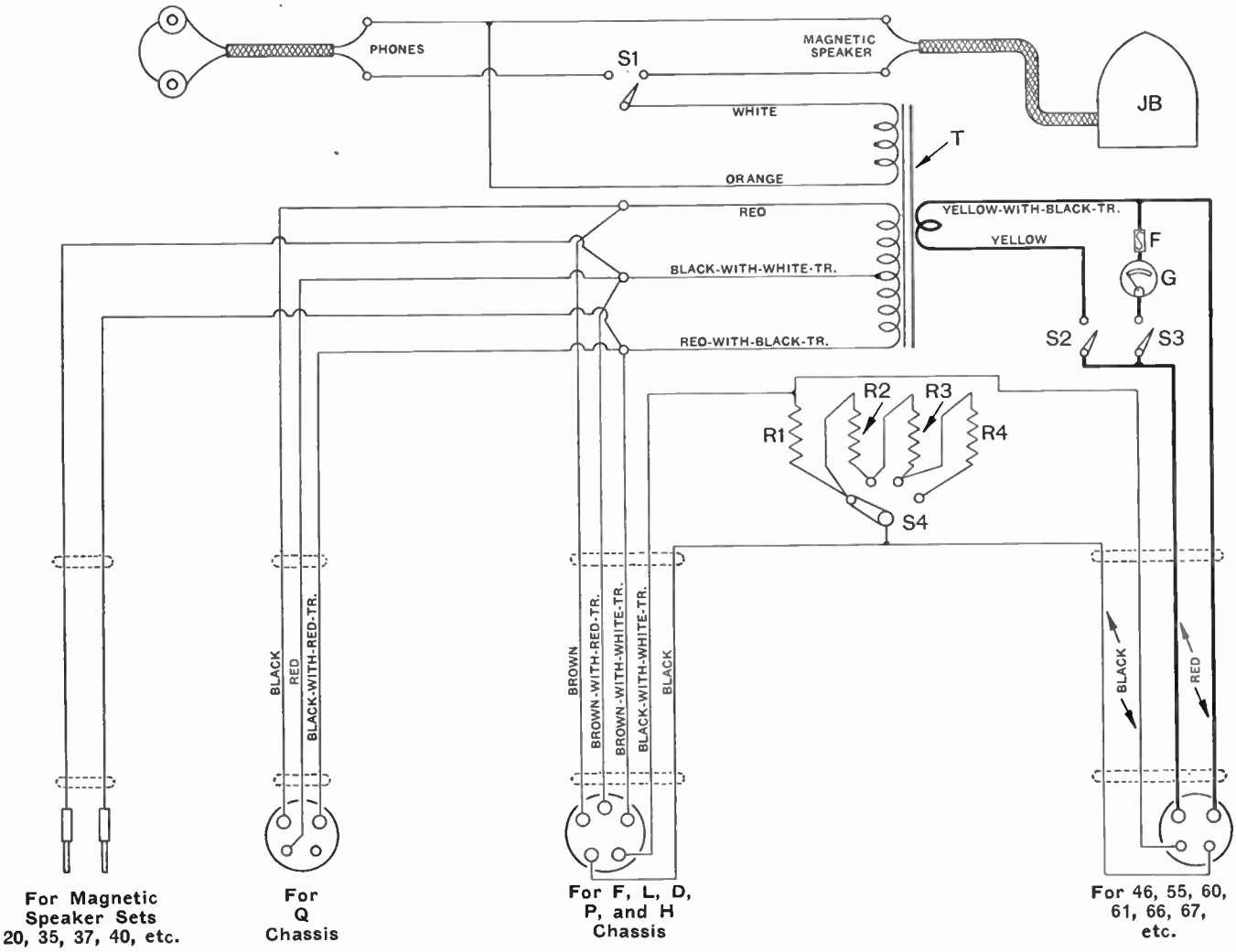
The continuity meter is used for checking resistors, transformers, chokes, condensers and other parts for open circuits or short circuits. The regulating resistor (volume control) should be adjusted to give full scale deflection when the test points are touched together.

The condenser test using 250 volts is for use in checking leakage in high-voltage paper-dielectric filter condensers. It should not be used in testing filament-circuit by-pass condensers; the latter should be tested with the continuity meter which employs only 18 volts.

The 250-volt supply for the condenser test may be secured from a "B" power unit or from a Model 42 power unit.

Description of Testing Equipment (Continued)

Output Measuring Circuit for Sets Prior to Model 84



CAUTION—USE ONLY ONE OF THESE FOUR CABLES AT ONE TIME

FIG. 41. DIAGRAM OF OUTPUT MEASURING CIRCUIT.

An output measuring circuit is provided at the right-hand end of the meter panel shown on Page 38. The output meter is used in synchronizing variable condensers as explained on Page 37.

The diagram of this output measuring circuit is shown above. Its main advantage is that only one speaker, a type JB, is required in testing any type of Atwater Kent receiver. This eliminates the necessity of tying up four or five electro-dynamic speakers. This improvement is made possible through the use of a special output transformer, and a series of resistors which take the place of the field coil in the various types of Atwater Kent electro-dynamic speakers.

(If it is not convenient to build an output measuring circuit of this type, we recommend the use of a multi-range rectifier-type 4000-ohm A. C. voltmeter with a full scale reading of about 150 volts. This forms a very satisfactory device and may be purchased from most service-instrument manufacturers. In order to use this meter with an electro-dynamic receiver, it is necessary to have the correct electro-dynamic speaker connected to the set. Follow the manufacturers instructions regarding the connections for meter.)

Operation of Output Circuit

(A) Throw S1 to the right to test for quality on the JB speaker.

Throw S1 to the left to pick up oscillator signals on the phones when synchronizing variable condensers.

(B) When testing an A. C.-operated electro-dynamic set, move S4 to the tap that gives the correct resistance to take the place of the field coil in the speaker for that particular set.

Tap 1 (left) takes place of F-6 field coil.
Tap 2 takes place of F-4 or N field coil.
Tap 3 takes place of F-2 field coil.
Tap 4 takes place of F field coil.

It is NOT necessary to use a "dummy" field load when testing a battery-operated or D. C.-operated electro-dynamic receiver. When testing such a receiver, S4 may be turned to the 4th tap (right).

(Continued on next page.)

Description of Testing Equipment (Continued)

Output Measuring Circuit

(C) MAGNETIC SETS. When testing a magnetic-type set, such as Model 20, 35, 37, 40, etc., connect the two-conductor cord to the speaker-posts on the set being tested. Close both S2 and S3 if a reading on the meter is desired; open either S2 or S3 to open the meter circuit.

(D) INDUCTOR SETS. In testing a Type Q chassis, insert the three-conductor plug in the speaker-plug socket on the Q Chassis. Close both S2 and S3 if a reading is desired on the output meter. Open either S2 or S3 to open the meter circuit.

(E) FIVE-PRONG ELECTRO-DYNAMIC SETS. In testing an L, P, D, F or H Chassis, insert the five-conductor plug in the speaker-plug socket on the chassis, and, if the chassis is A. C.-operated, set S4 at the correct tap. To get a reading on the meter, close S2 and S3; to open the meter circuit, open either S2 or S3.

(F) FOUR-PRONG ELECTRO-DYNAMIC SETS. In testing a Model 46, 55, 60, 61, 66, 67, etc., insert the four-conductor plug in the speaker-plug socket on the chassis. If the chassis is A. C.-operated, set S4 at the correct tap. To get a reading on the meter, close S3 and open S2. To operate the phones or JB speaker, close S2 and open S3. To operate both the phones and the meter, close both S2 and S3.

List of Parts

The meter "G" and the fuse "F" are NOT supplied from the factory.

(T) No. 18911 output transformer. This transformer has an extra winding which couples the speaker or phones to the output circuit of the particular set that is being tested.

S1—No. 13678 toggle switch.
S2, S3—No. 9991 toggle switches.
S4—No. 16430 switch.
R1—Four No. 16988 resistors in series.
R2—Three No. 16988 resistors in series.
R3—Four No. 16988 resistors in series.
R4—Five No. 16988 resistors in series.
F—¼ ampere fuse.
G—115 ma, thermo-coupled galvanometer.
I—No. 14169 double-conductor cord.
I—No. 17866 three-conductor cord-and-plug.
I—No. 17556 four-conductor cord-and-plug.
I—No. 17895 five-conductor cord-and-plug.
4—No. 8215 binding posts.

ABBREVIATIONS USED IN VOLTAGE TABLES

Abbreviation	Meaning
1 R	1st radio frequency socket
2 R	2nd radio frequency socket
3 R	3rd radio frequency socket
4 R	4th radio frequency socket
D	Detector socket
1 A	1st audio frequency socket
2 A	2nd audio frequency socket
2Aa	2nd audio frequency socket
3 A	3rd audio frequency socket
+ F	Positive filament contact
— F	Negative filament contact
G	Grid contact
P	Plate contact
S	Screen-grid contact
C (in A. C. sets)	Cathode contact
R. F. T.	Radio frequency transformer
A. F. T.	Audio frequency transformer

In the tables, to identify a certain contact of a certain socket, the abbreviation of the contact is combined with the abbreviation of the socket.

Thus the grid (G) contact of the third R. F. socket is referred to as G3R. The negative filament contact of the second A. F. socket is referred to as —F2A. The cathode of the detector socket (in A. C. sets) is CD. P2A means the plate contact of the second audio frequency socket, and so on.

The use of these symbols will enable the service man quickly to recognize the corresponding socket on the set without having to refer to the chart or wiring diagram.

In all cases where "—F" and "+F" appear on the diagrams and drawings of Atwater Kent A.-C.-operated receivers, these markings are used for identification purposes only, as the A. C.-operated filaments or heaters have no fixed polarity.

OPERATING VOLTAGE TESTS

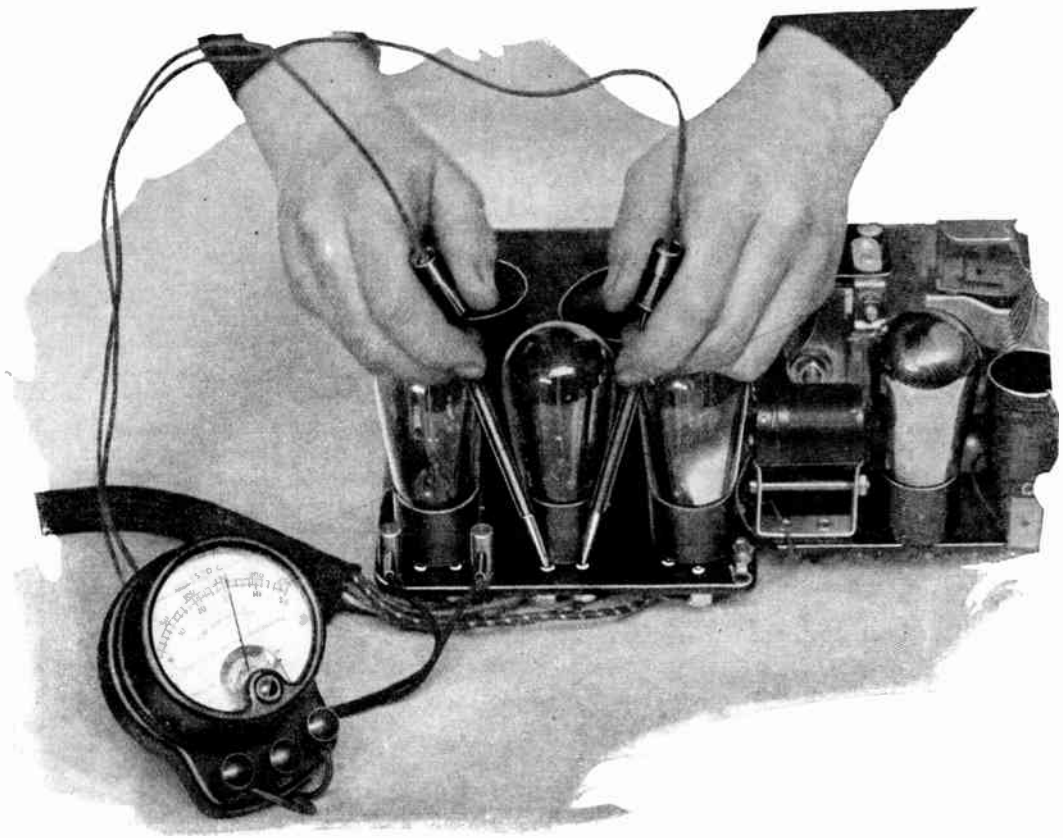


FIG. 42. BY MAKING CONTACT TO THE SOCKET EYELETS, IT IS POSSIBLE TO MEASURE VOLTAGES WITHOUT REMOVING THE CHASSIS FROM CABINET.

FIG. 42-A. MEASURING THE +B DETECTOR VOLTAGE AT THE POWER-UNIT TERMINALS.

Operating Voltage Tests (Continued)

The table of voltages (for A. C. receivers prior to screen-grid) on the facing page, is arranged logically to trace defects from the source of power, and it is advisable to follow the table as given. The sketch Fig. 42-B of the top view of Model 42 type of receiver shows clearly the identification of the various socket-contact eyelets in all Atwater Kent receivers of this general type. These eyelets are partly covered by the tube bases, when the tubes are in the sockets, but contact may be made to the eyelets through long, thin brass or steel test prongs, sharpened at the ends. The prongs should be pressed down on the eyelets and twisted in order to remove the insulating coating from the eyelets and make good contact. In screen-grid models, the socket-contact eyelets can not be reached from the top of the set, so it is necessary to invert the receiver and remove the bottom plate, thus exposing all socket-contacts, etc. A chart showing the identification of these contacts is given in the description of each screen-grid receiver.

If it is necessary to remove the chassis or power unit from the cabinet to make repairs, we suggest that the regular continuity tests be applied to these parts before reassembling in the cabinet.

In using the accompanying voltage table (for receivers prior to screen-grid) remember that the voltages listed are only approximate, being the average values for the various models.

When testing a defective set, many service men prefer to locate the defective part or circuit before removing the chassis or power unit from the cabinet. This may be done by measuring the plate, grid, and filament voltages at the power-unit terminals and at each tube socket while the set is connected for operation, with all tubes in their sockets and the 110-volt supply current turned on. If made systematically, the voltage measurements provide a quick method of locating defective parts. The voltages at the terminals of the power unit should be measured first, and then the voltages at the tube sockets, making contact through the eyelets that clamp the socket-contacts to the molded base. The illustrations, Figs. 42 and 42A show how the voltmeter leads are put in contact with the socket-eyelets, or with the power-unit terminals, when making measurements. In screen-grid type receivers, the set should be inverted, with bottom plate removed, and measurements made directly to the socket-contacts, as outlined in the voltage table which accompanies the description of each screen-grid receiver.

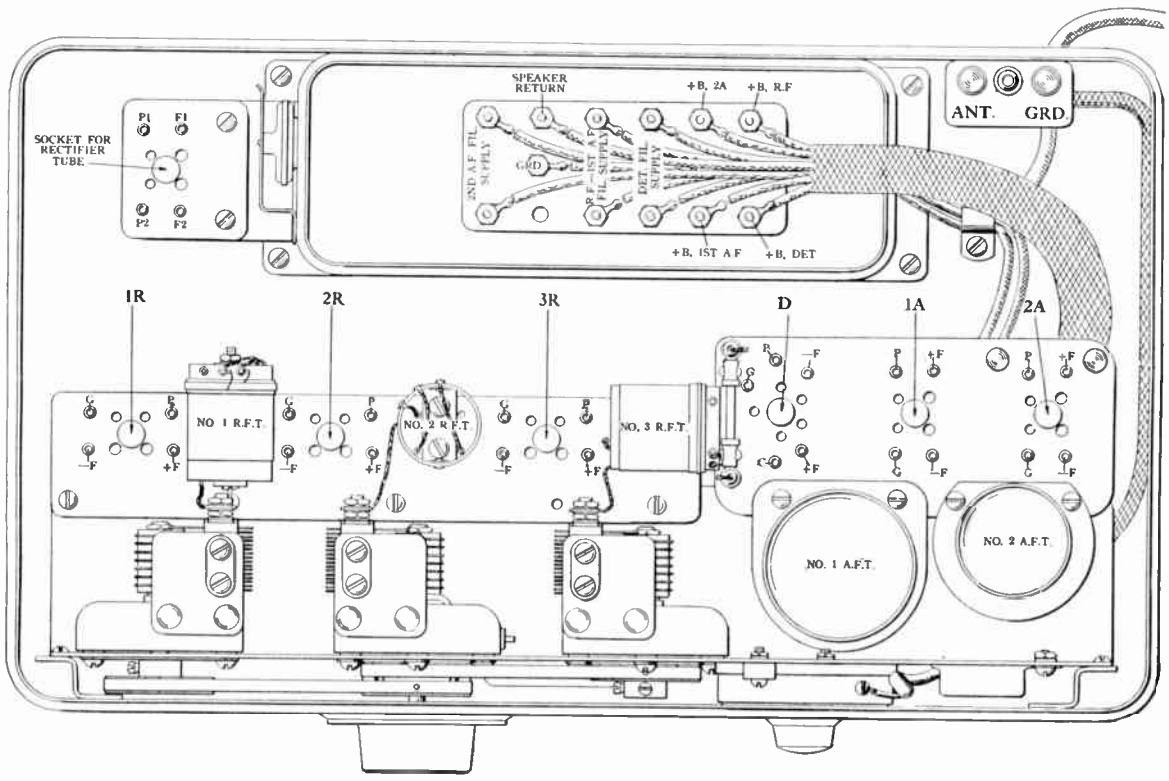


FIG. 42-B. TOP VIEW OF MODEL 42 RECEIVER.
The identification of socket-contact eyelets in this view may be applied to all Atwater Kent receivers of this general type.
The voltage of the three filament circuits are approximately as follows:
R. F.-1st-A. F. filament supply terminals=1.5 volts.
Detector filament supply terminals=2.5 volts.
2nd-A. F. filament supply terminals=5.0 volts.

VOLTAGE READINGS ON A. C. SETS (Prior to Screen-Grid)

TESTS MADE WITH SET IN OPERATION, ALL TUBES IN SOCKETS

Use High-Resistance D. C. Voltmeter (About 0-50-250) To Measure Plate and Grid Voltages. Use A. C. Voltmeter To Measure Filament Voltages.

MAKE TESTS IN ORDER LISTED

Voltages at Power Unit

	MEASURE ACROSS	Approx. Voltage	NO VOLTAGE INDICATES**	REMEDY
FILAMENT VOLTAGES	2.5V Fil. Supply Terminals.	2.4	Open filament winding or open connection in power transformer.	Replace power transformer assembly.
	1.5V Fil. Supply Terminals.	1.5		
	5V Fil. Supply Terminals.	4.9		
	F1 to F2 (on Rect. Socket).	4.9		
"B" VOLTAGES**	One 1.5V Fil. Supply Terminal to +B, R.F.	180	Open high-voltage winding, open filter choke or open R.F.-1st-A.F. bias resistor.	Apply continuity tests across filter and high-voltage winding. Repair as necessary.
	One 1.5V Fil. Supply Terminal to +B, 1st-A.F.	155	Open 1st-A.F. plate resistor.	Replace resistor.
	One 2.5V Fil. Supply Terminal to +B, Det.	45	Open Det. plate resistor.	Replace resistor.
	One 5V Fil. Supply Terminal to +B, 2A.	180	Open speaker-choke, open pri. of output trans., or open 2nd-A.F. bias resistor.	Replace defective assembly.
BIAS VOLTAGES	Ground to one 1.5V Fil. Supply Terminal.	13	Open R.F.-1st-A.F. grid-bias resistor.	Replace defective resistor.
	Ground to one 5V Fil. Supply Terminal.	45*	Open 2nd-A.F. grid-bias resistor.	

Voltages at Tube Sockets

	MEASURE ACROSS SOCKET EYELETS	Approx. Voltage	NO VOLTAGE INDICATES **	REMEDY
FILAMENT VOLTAGES	—F to +F on each R.F. Socket and on 1st-A.F. Socket.	1.4	Open fil. leads, cable or broken cable connection.	
	—FD to +FD.	2.3		
	—F2A to +F2A.	4.8		
PLATE VOLTAGES**	—F4R to P4R. (4th R.F. not used in all Models.)	160-180	Open white cable lead, open R.F. plates res. or open pri. No. 4 R.F.T.	Remove Chassis from cabinet. Apply continuity tests, and repair as necessary.
	—F3R to P3R.	160-180	Open white cable lead, open R.F. plate res., or open pri. No. 3 R.F.T.	
	—F2R to P2R.	160-180	Open primary circuit No. 2 R.F.T.	
	—F1R to P1R.	160-180	Open primary circuit No. 1 R.F.T.	
	—FD to PD.	45	Open yel. cable lead, open connection or open primary No. 1 A.F.T.	
	—F1A to P1A.	155	Open black-red-tracer cable or open pri. No. 2 A.F.T.	
	—F2A to P2A.	180	Open connection or open primary of output transformer.	Test output trans. and connections.
	—F2Aa to P2Aa. (2Aa tube used on electro-dynamic Sets.)	180		
GRID VOLTAGES	G1R to —F1R.	13	Open ant. coil (choke or secondary of antenna trans.).	Remove Chassis from cabinet. Apply continuity tests, and repair as necessary.
	G2R to —F2R.	13	Open sec. No. 1 R.F.T. or open No. 1 grid resistor.	
	G3R to —F3R.	13	Open sec. No. 2 R.F.T. or open No. 2 grid resistor.	
	G4R to —F4R. (4th R.F. not used in all Models.)	13	Open sec. No. 3 R.F.T. or open No. 3 grid resistor.	
	G1A to —F1A.	13	Open secondary No. 1 A.F.T.	
	G2A to —F2A.	45*	Open secondary No. 2 A.F.T.	
	G2Aa to —F2Aa. (2Aa tube used on electro-dynamic Sets.)	45*	Open secondary No. 2 A.F.T.	

* 15 volts on Model 43.

** Low plate voltage may indicate a leaky condenser. A shorted filter-condenser will cause overheating. The plate voltages in Model 36 and early 37 are lower than given in this table.

MODEL 10 AND 10B

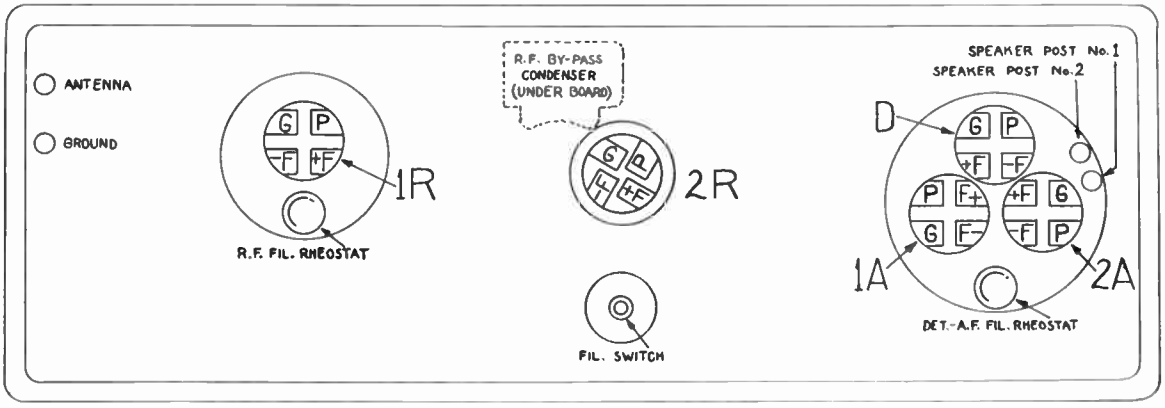


FIG. 43. TOP CHART OF MODEL 10.

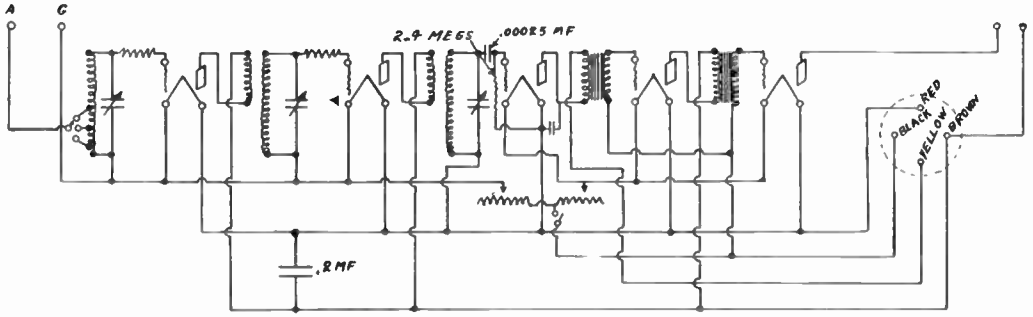


FIG. 44. SCHEMATIC DIAGRAM OF MODEL 10.

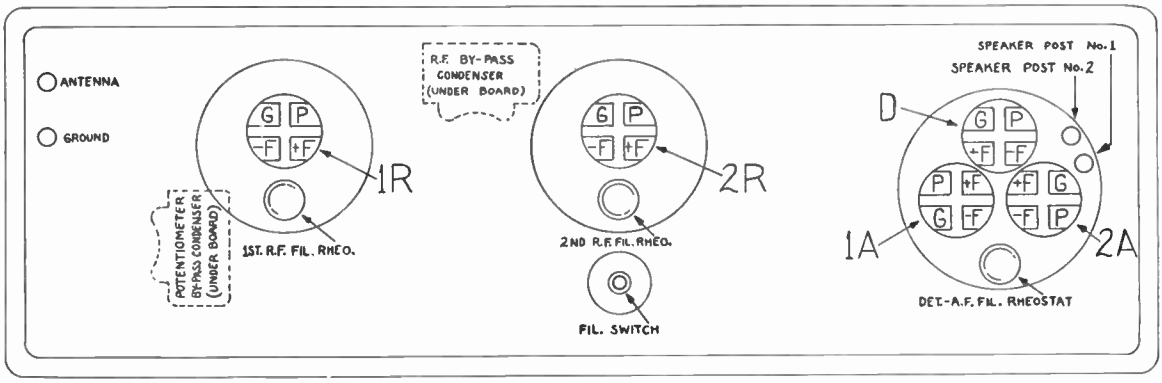


FIG. 45. TOP CHART OF MODEL 10B.

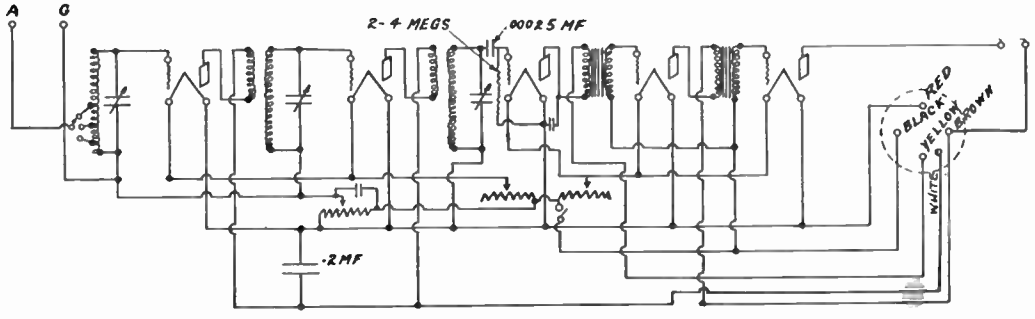


FIG. 46. SCHEMATIC DIAGRAM OF MODEL 10B.

This set has two R. F. rheostats (one for each R. F. tube). —F1R connects to the slider of the 1st R. F. rheostat instead of to —F2R.

MODEL 12, AND MODEL 20, No. 4640

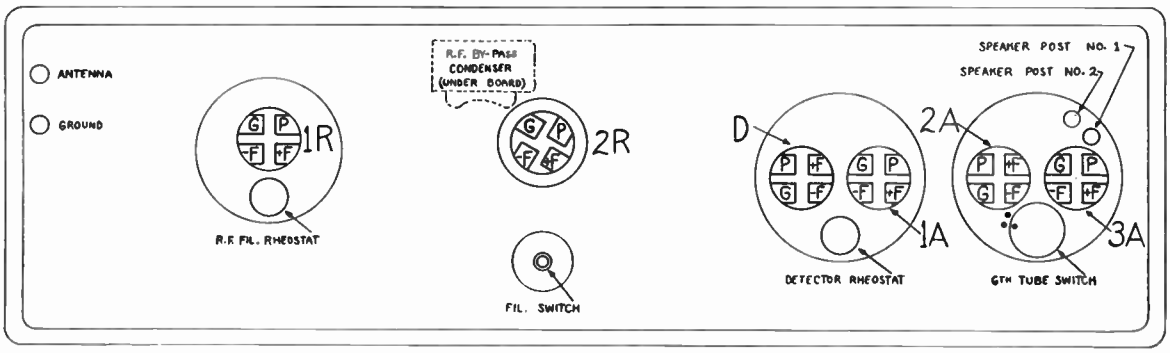


FIG. 47. TOP CHART OF MODEL 12.

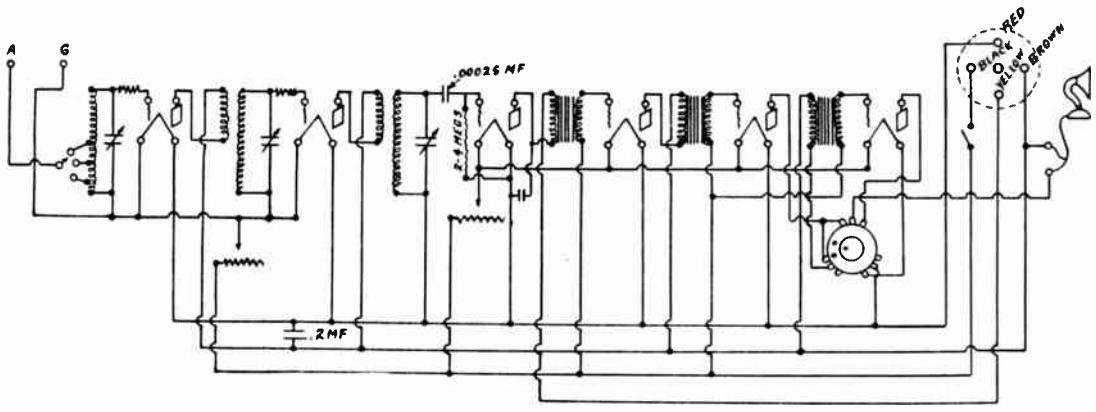


FIG. 48. SCHEMATIC DIAGRAM OF MODEL 12.

Diagram shows one rheostat controlling detector and all three A. F. tubes. In actual set, rheostat controls detector and 1st audio only, 2nd and 3rd audio tubes being on separate fixed resistors.

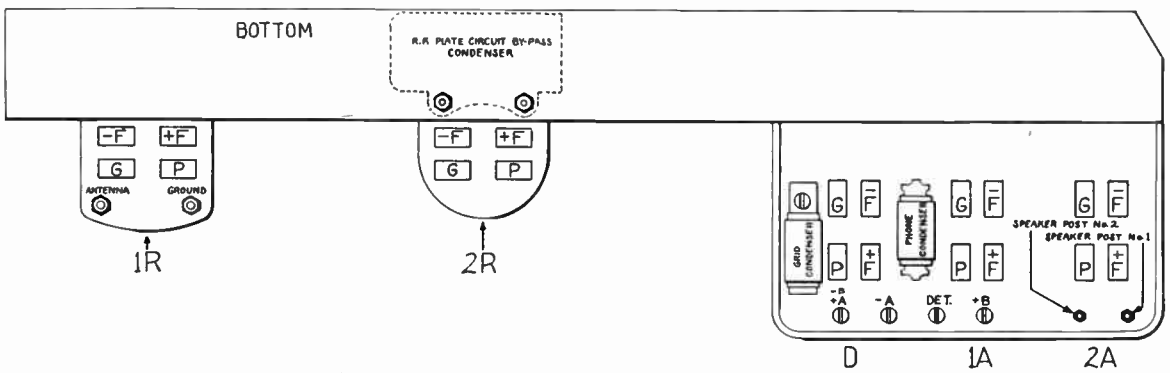


FIG. 49. BOTTOM CHART OF MODEL 20, No. 4640.

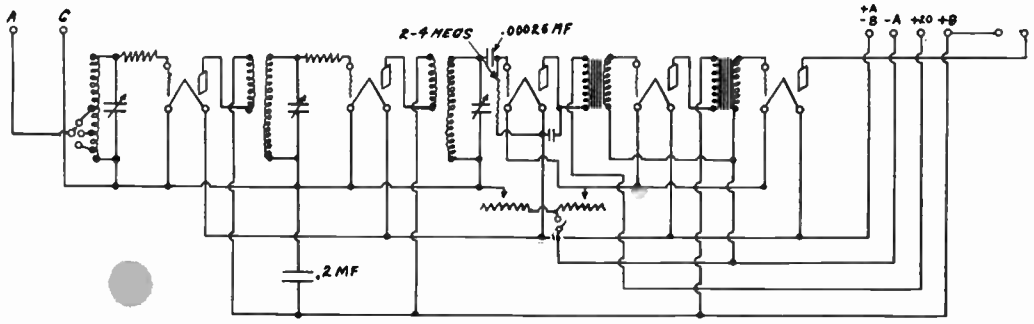


FIG. 50. SCHEMATIC DIAGRAM OF MODEL 20, No. 4640.

MODEL 20, No. 7570 AND No. 7960

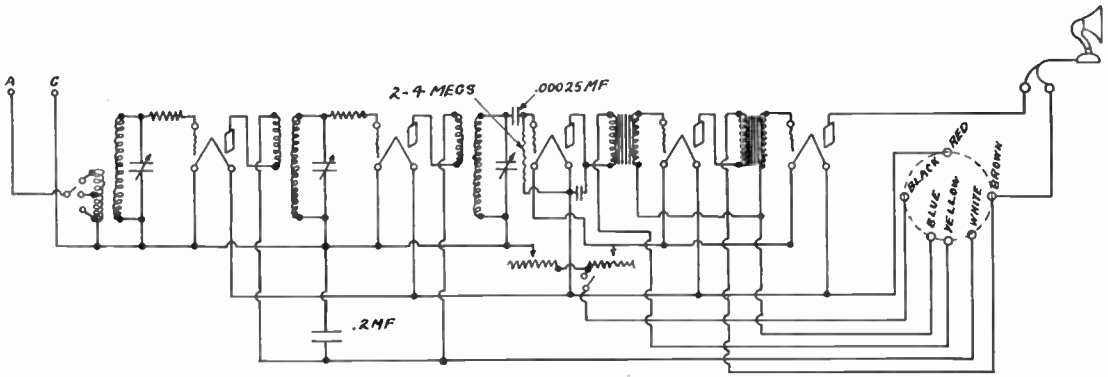


FIG. 51. DIAGRAM OF MODEL 20 COMPACT No. 7570.

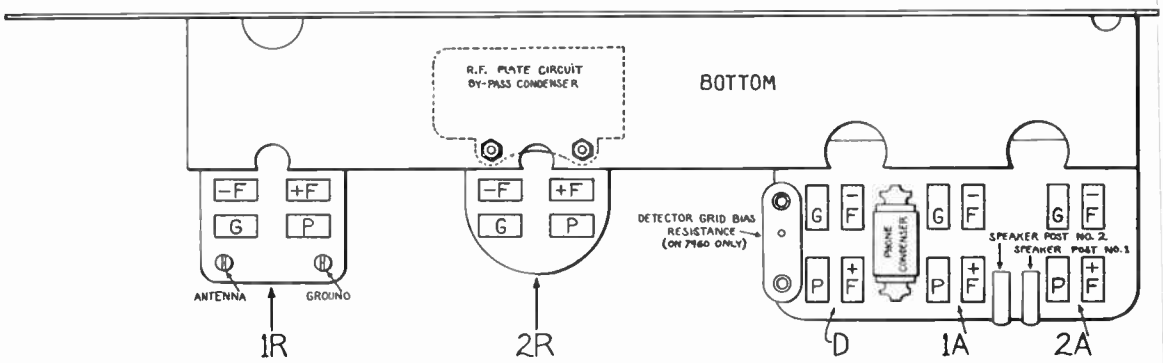


FIG. 52. CHART FOR MODEL 20 COMPACT (BOTH TYPES).

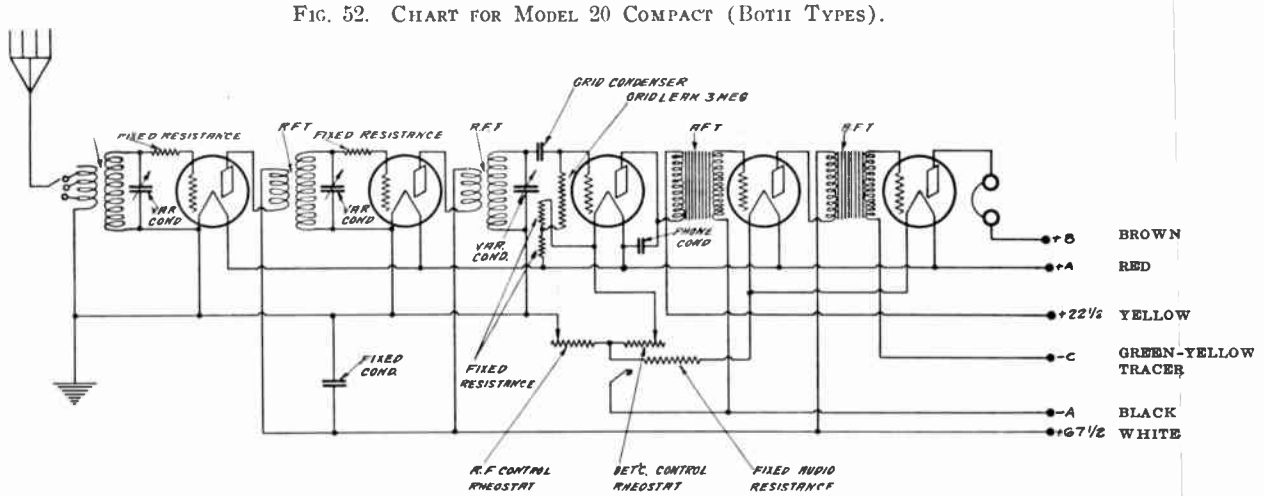


FIG. 53. DIAGRAM OF MODEL 20 COMPACT No. 7960.
See Fig. 66 for rheostat connections.

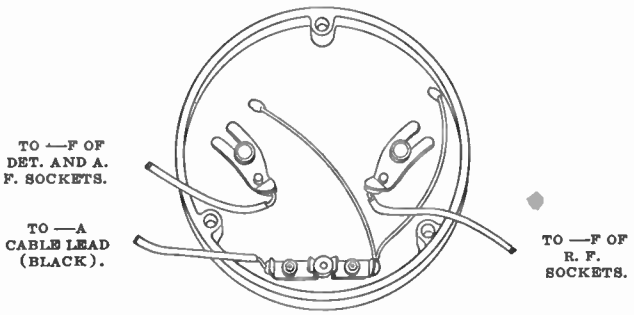


FIG. 54. REAR VIEW OF DOUBLE RHEOSTAT AND FILAMENT SWITCH ASSEMBLY USED IN MODEL 20 (No. 4640-7570), 19 AND 21.

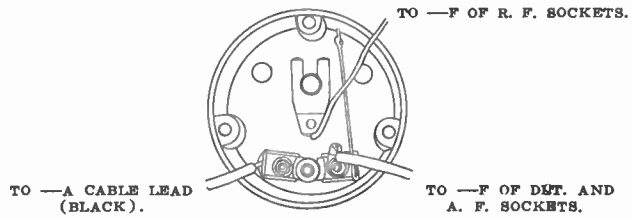


FIG. 55. REAR VIEW OF RHEOSTAT AND FILAMENT SWITCH ASSEMBLY USED IN MODEL 35.

R. F. ASSEMBLIES IN MODEL 30, 32, 35 AND 48

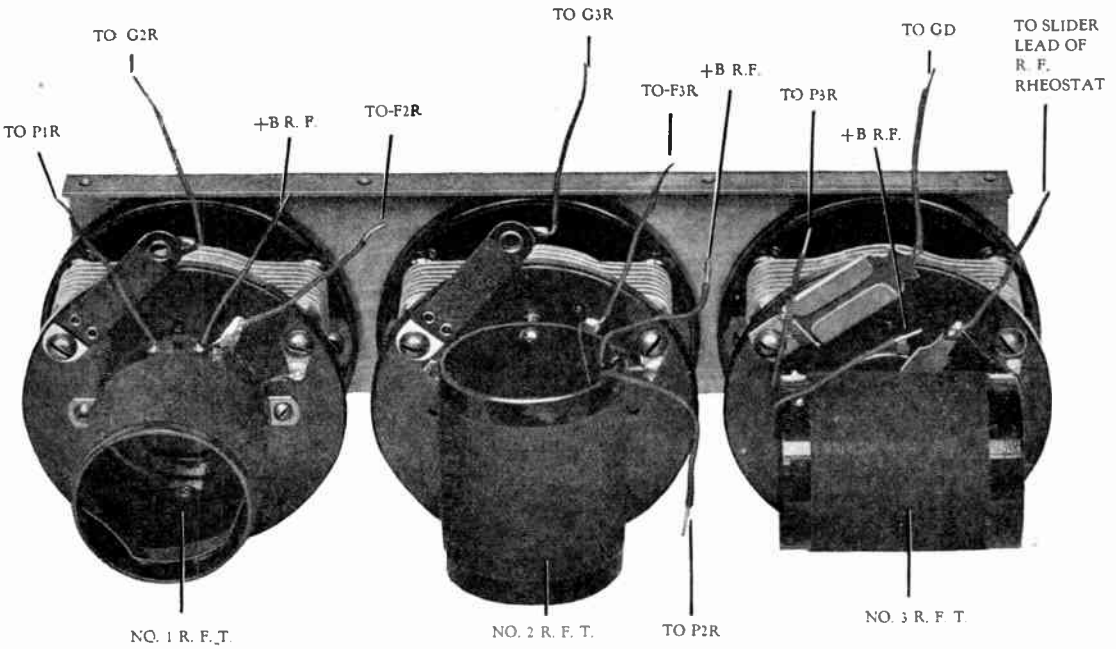


FIG. 56.
VIEW OF SUB-PANEL ASSEMBLY MODEL 30 (Early Type).

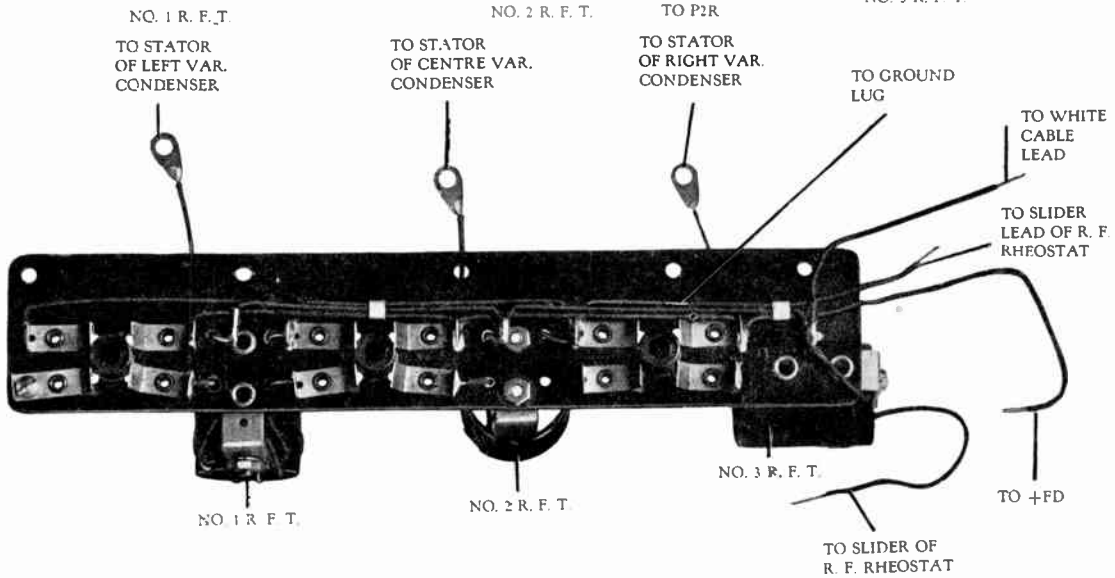


FIG. 57.
VIEW OF R. F. AMPLIFIER ASSEMBLY IN MODEL 30 (Later Type), 35 AND 48.

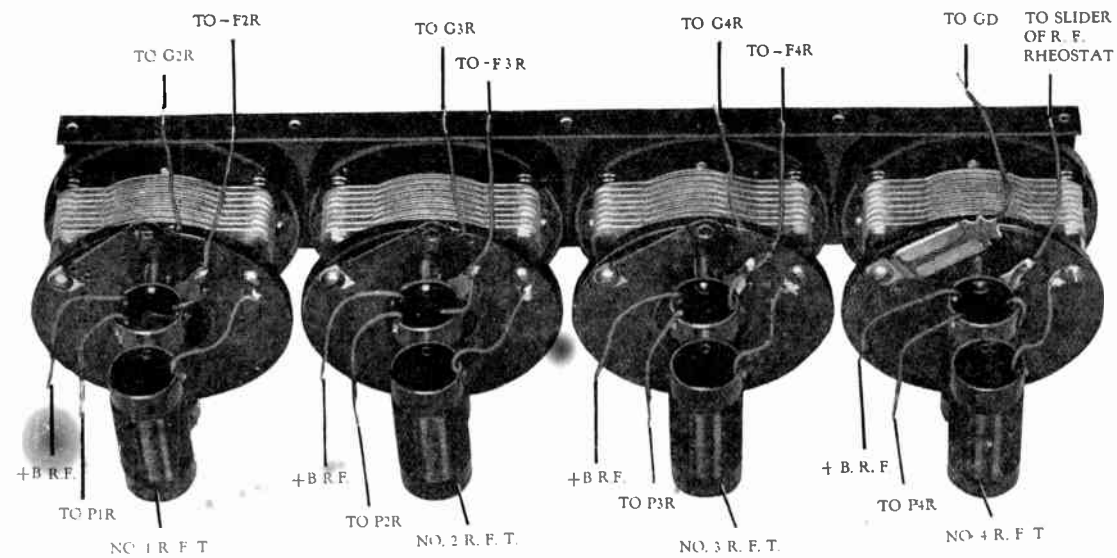


FIG. 58.
VIEW OF SUB-PANEL ASSEMBLY MODEL 32.

MODEL 30, 32, 35 AND 48

See Figs. 55 and 66 for rheostat connections.

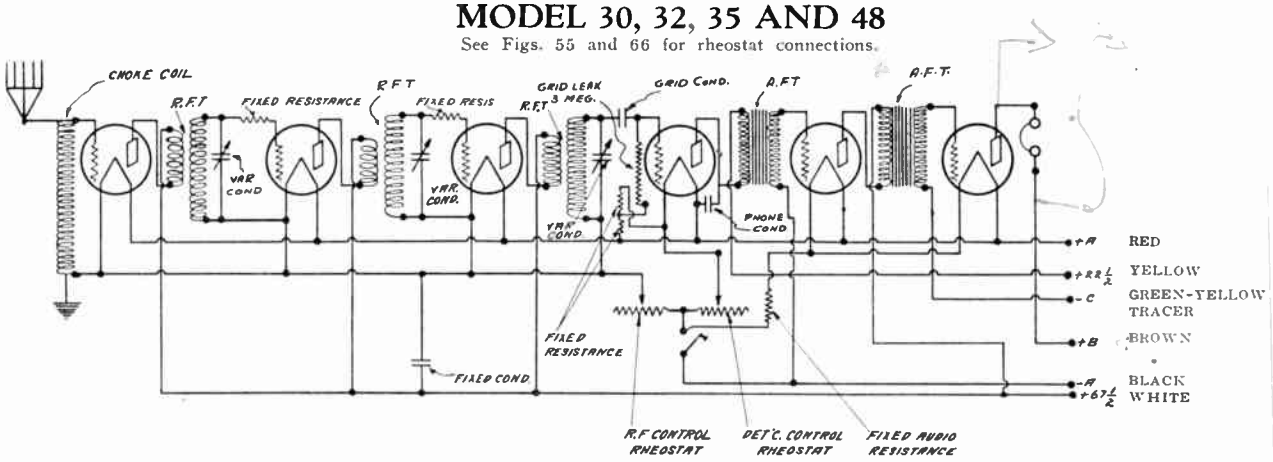


FIG. 59. WIRING DIAGRAM OF MODEL 30, 35 AND 48.

In Model 35, one rheostat controls the three R. F. filaments and a fixed resistor is connected in series with the detector and two A. F. filaments.

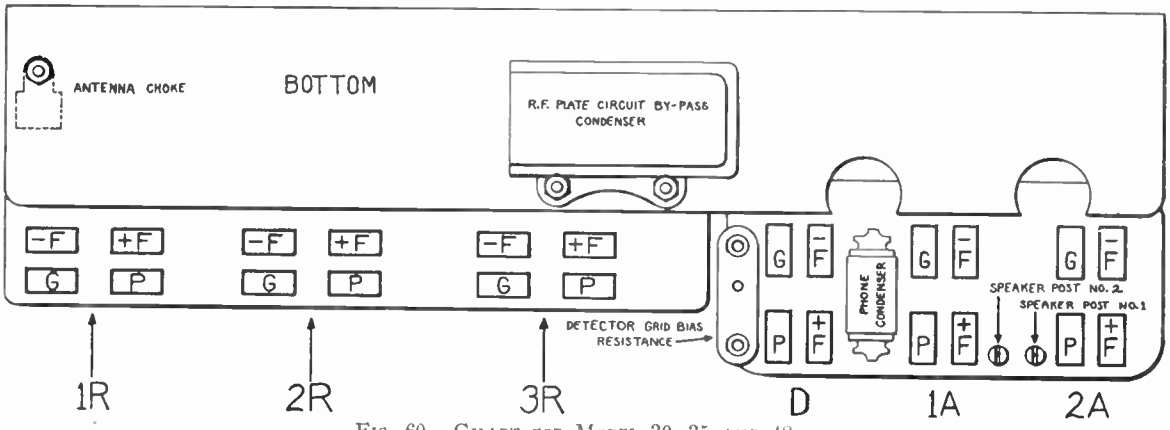


FIG. 60. CHART FOR MODEL 30, 35 AND 48.

Early Model 30 Sets have separate R. F. sockets, but the socket contacts are in same relative position as shown in above chart.

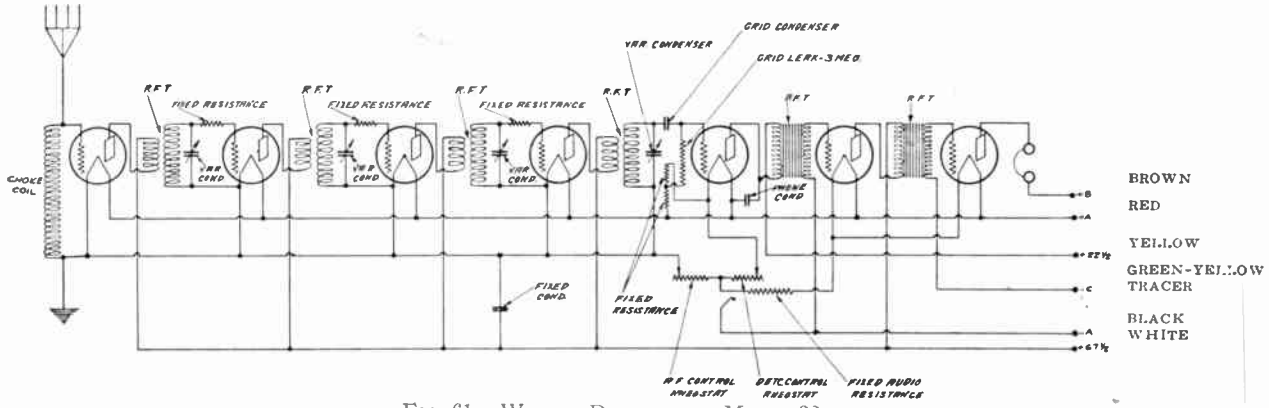


FIG. 61. WIRING DIAGRAM OF MODEL 32.

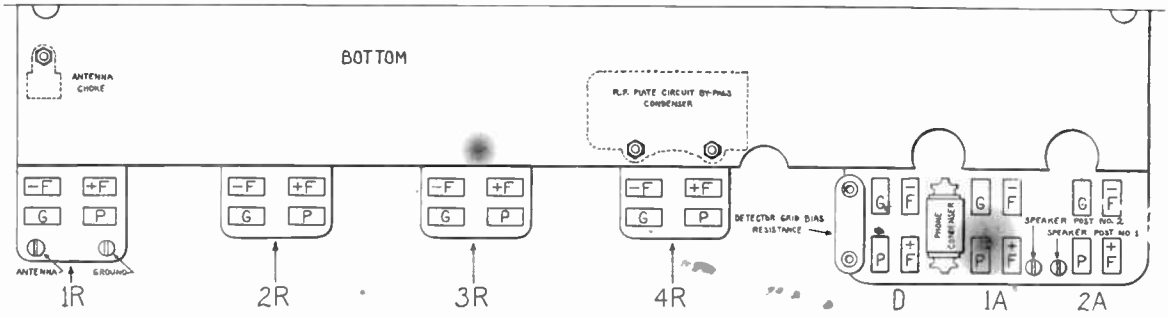


FIG. 62. CHART FOR MODEL 32.

MODEL 33 AND 49

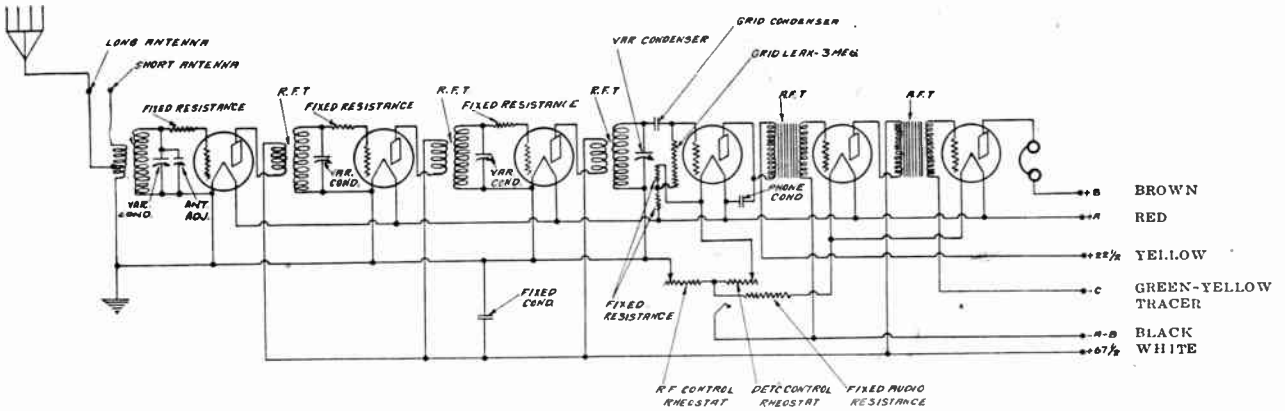


FIG. 63. WIRING DIAGRAM—MODEL 33 AND 49.

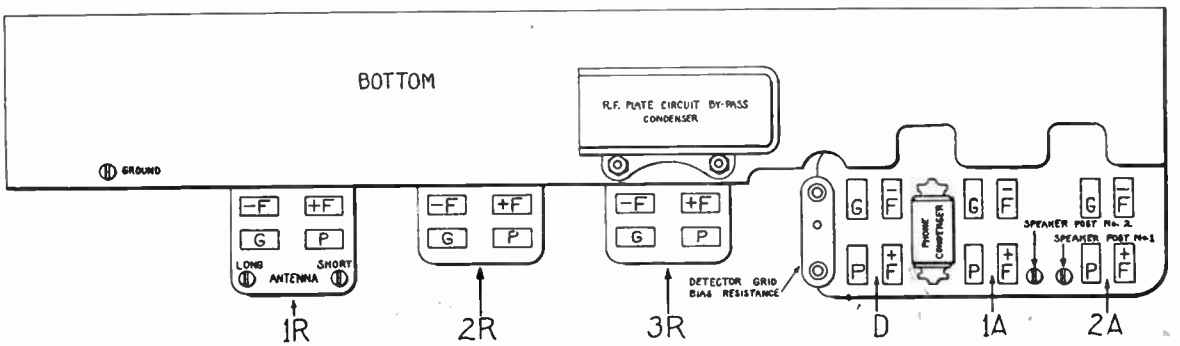


FIG. 64. TESTING CHART—MODEL 33 AND 49.

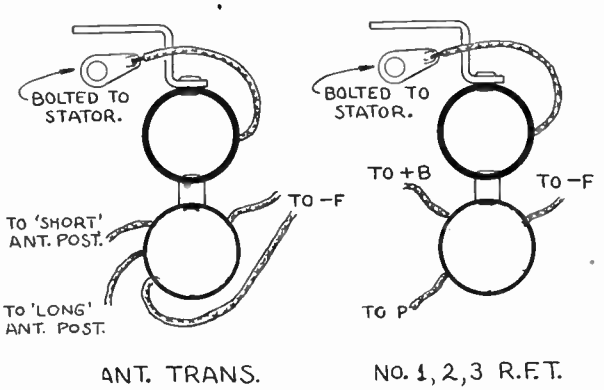


FIG. 65. SKETCH SHOWING HOW LEADS FROM ANTENNA TRANSFORMER AND FROM R.F. TRANSFORMERS ARE CONNECTED IN MODEL 33 AND 49.

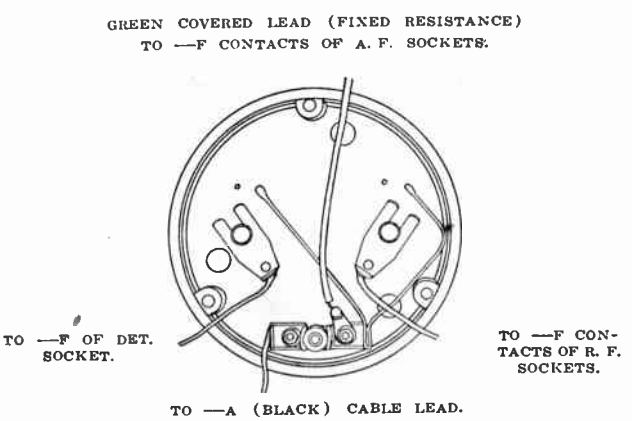


FIG. 66. REAR VIEW OF DOUBLE RHEOSTAT AND FILAMENT SWITCH ASSEMBLY USED IN MODEL 20 COMPACT (No. 7960), 30 (Early Type), 32, 33, 48, 49 AND 50.

The appearance of the rheostat in later Model 30 sets, and in Model 48 and 50, is slightly different from that shown above, but the connections are similar.

MODEL 36 BELOW SERIAL No. 2,610,000

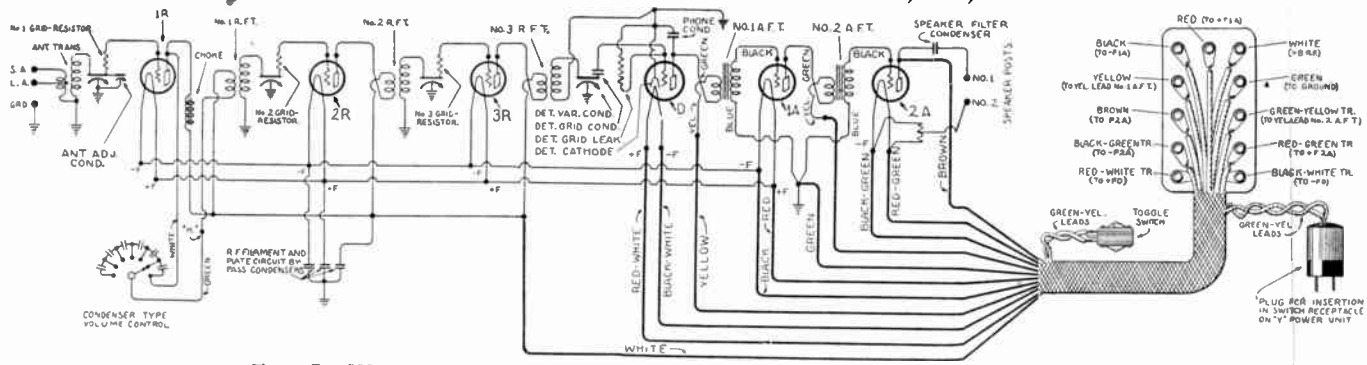


FIG. 67. WIRING DIAGRAM OF MODEL 36 WITH CONDENSER-TYPE VOLUME CONTROL.

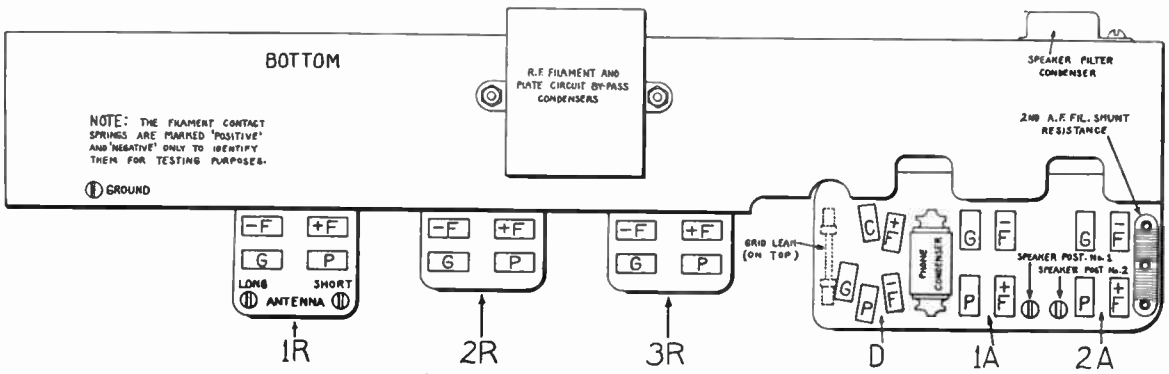


FIG. 68. CHART FOR MODEL 36.

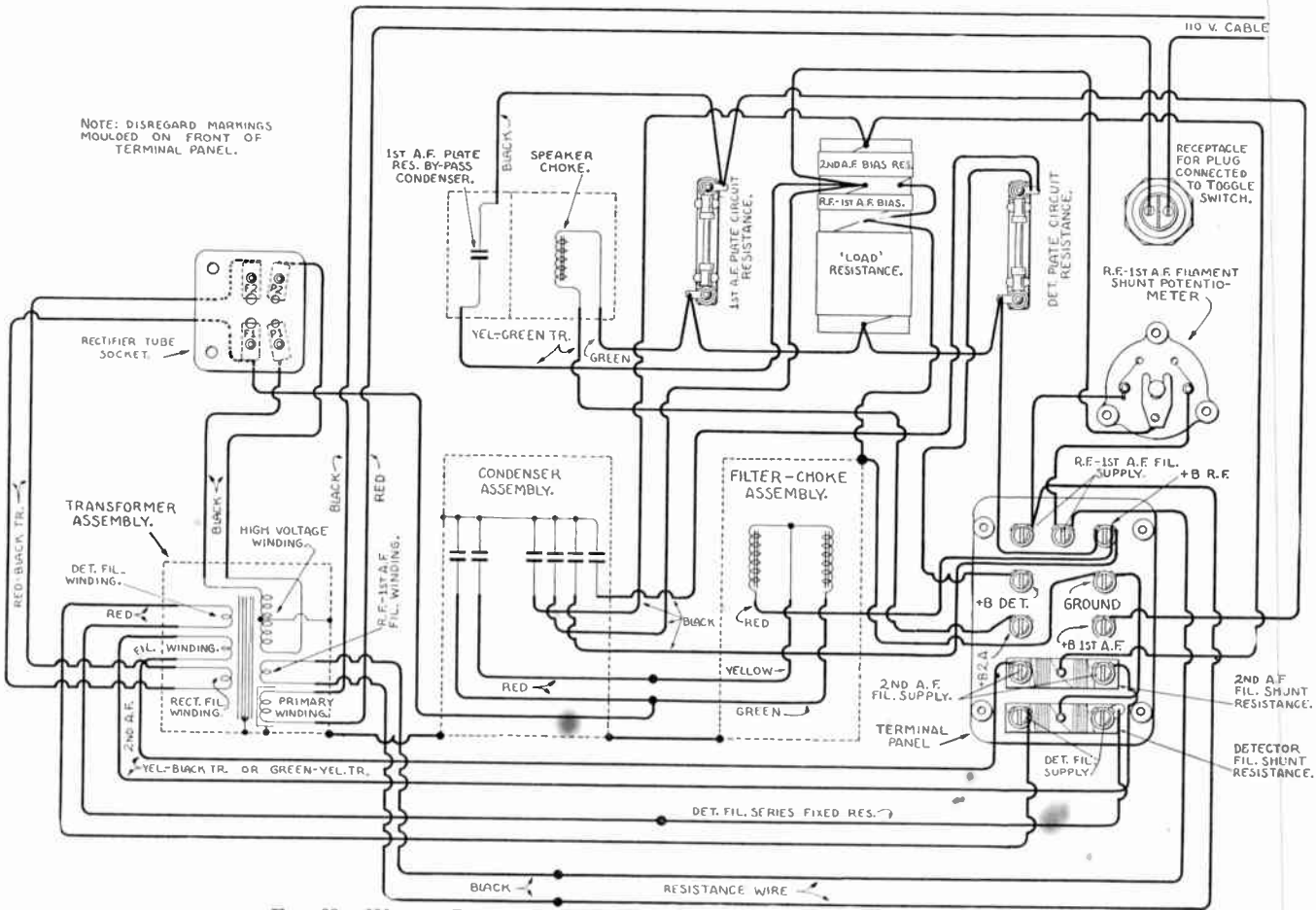


FIG. 69. WIRING DIAGRAM OF "Y" POWER UNIT BELOW SERIAL No. 260,000.

MODEL 36 ABOVE SERIAL No. 2,610,000

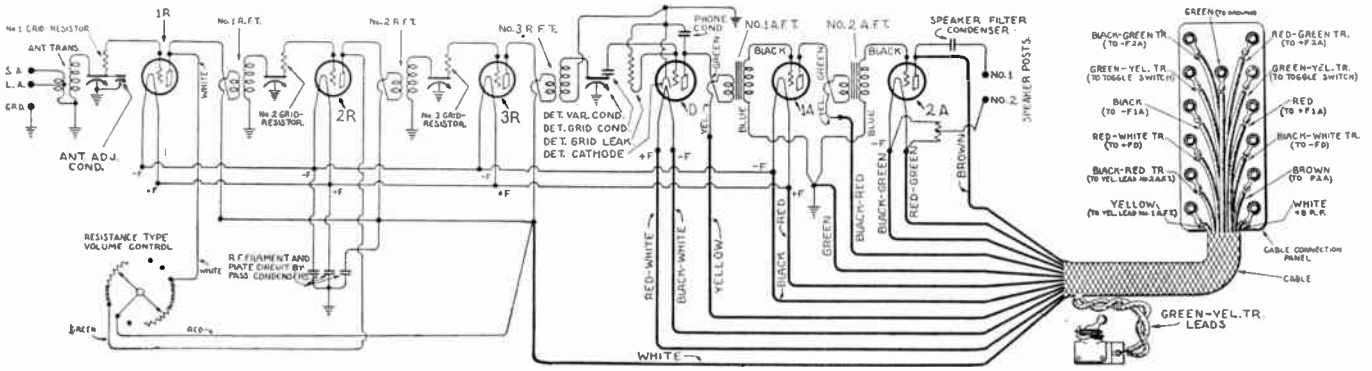


FIG. 70. WIRING DIAGRAM OF MODEL 36 WITH RESISTANCE-TYPE VOLUME CONTROL.

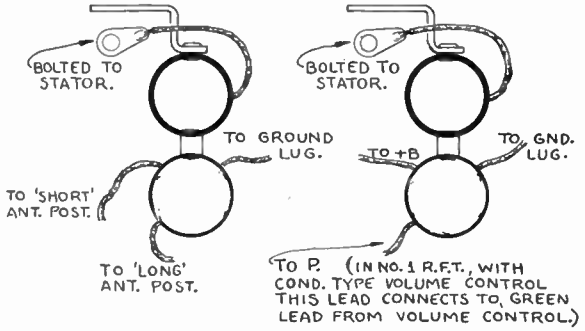


FIG. 71.
SKETCH SHOWING CONNECTIONS FROM ANTENNA TRANSFORMER AND FROM R. F. TRANSFORMERS IN MODEL 36.

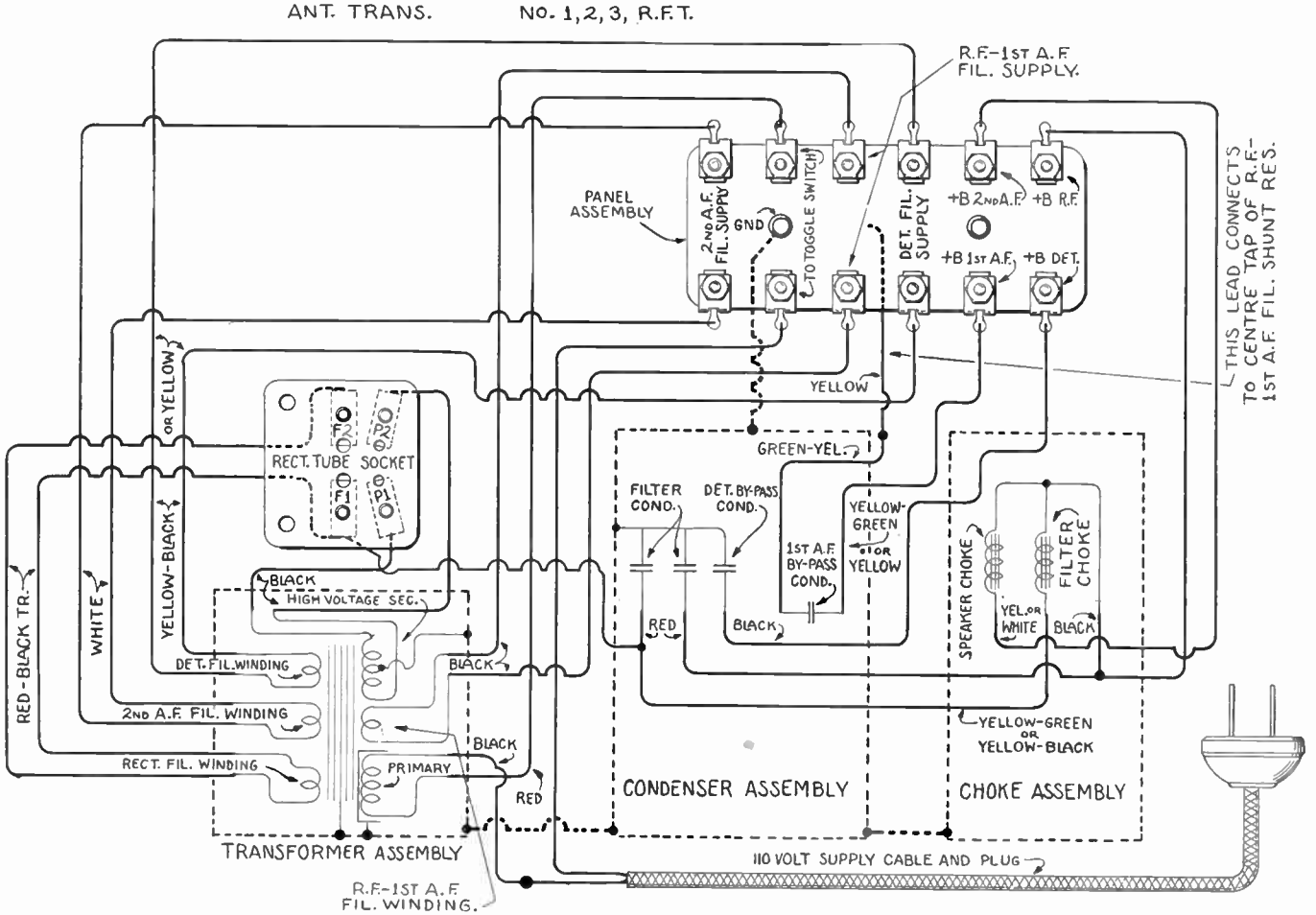


FIG. 72. WIRING DIAGRAM OF "Y" POWER UNIT ABOVE SERIAL No. 260,000.

MODEL 37, 37-F, 37-C CHASSIS

For Description of Power Unit, See Pages 56 and 57

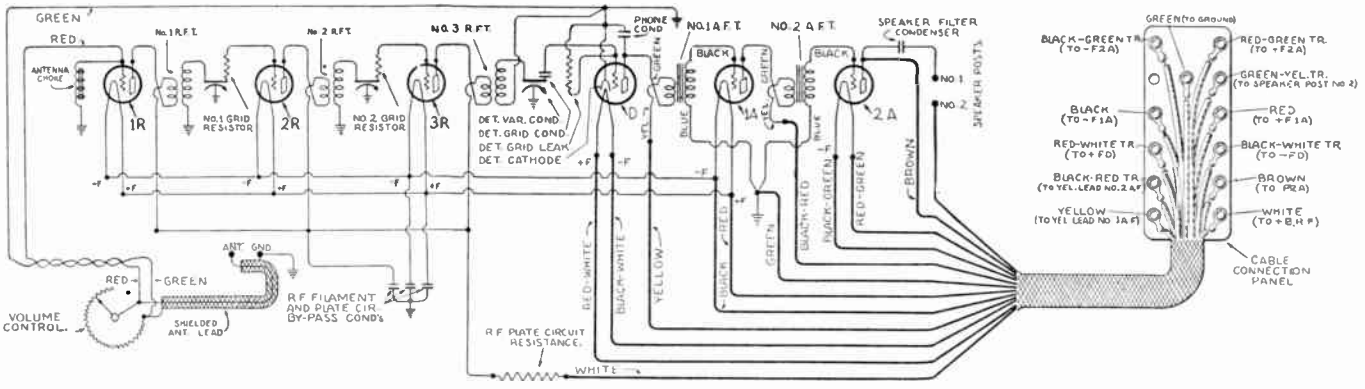


FIG. 73. WIRING DIAGRAM OF MODEL 37, 37-F, 37-C.

A 2nd-A. F. filament-shunt resistor is used before Serial No. 1,385,000, in which case speaker post No. 2 connects to the centre-tap of this resistor, and the green-yellow tracer lead is not used. The R. F. plate circuit resistor is used after Serial No. 1,385,000.

In Model 37-C the on-off switch is connected to the two terminals on either side of the ground eyelet. A 2nd-A. F. filament-shunt resistor is used in the chassis of all Model 37-C receivers.

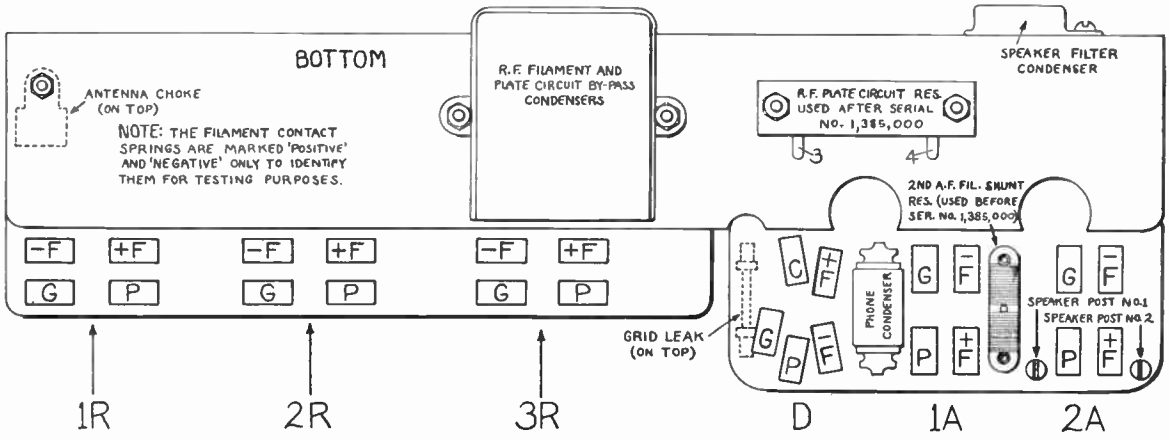


FIG. 74. CHART FOR MODEL 37, 37-F, 37-C.

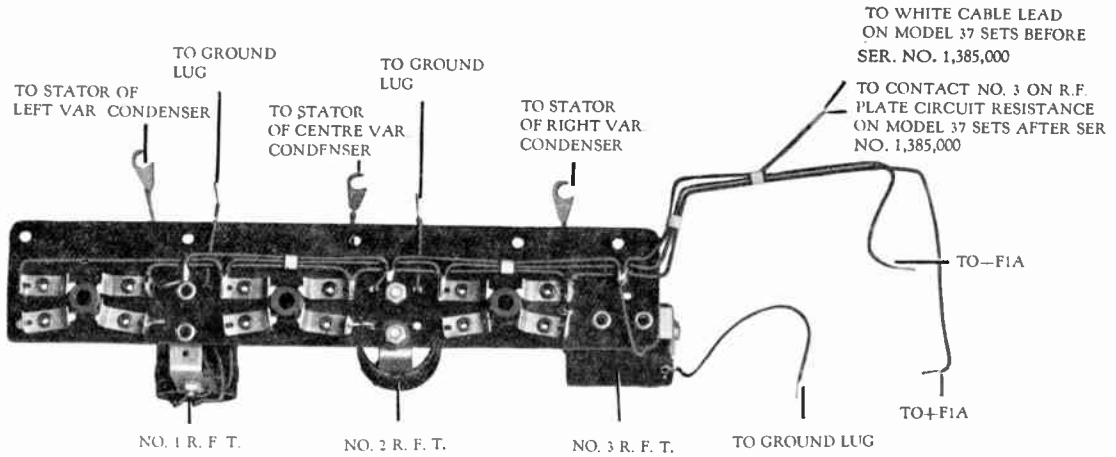


FIG. 75. VIEW OF R. F. AMPLIFIER.

MODEL 38 CHASSIS

For Description of Power Unit, See Pages 56 and 57

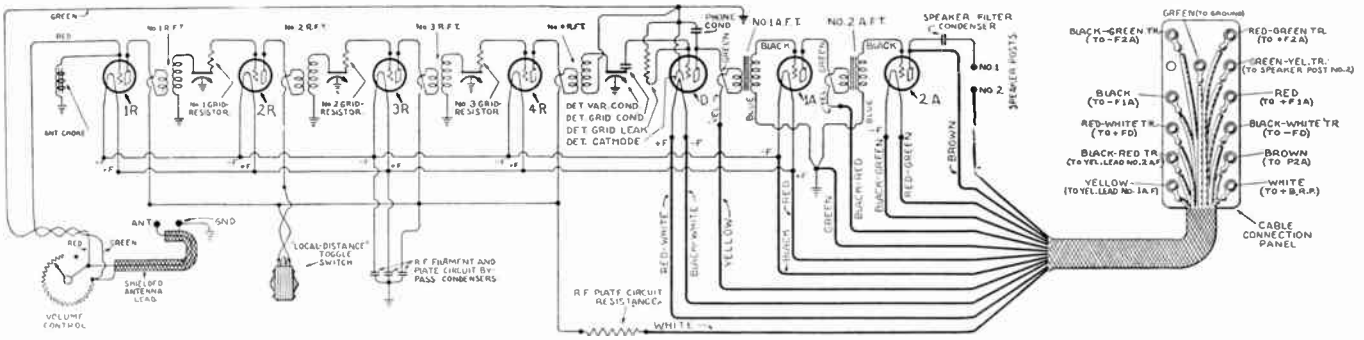


FIG. 76. WIRING DIAGRAM OF MODEL 38.

A 2nd-A. F. filament-shunt resistor is used before Serial No. 1,752,000 and the green-yellow tracer cable lead is not used. Connections for this resistor are shown in dotted lines in the diagram on page 61. A schematic diagram of the volume control is shown in Fig. 78.

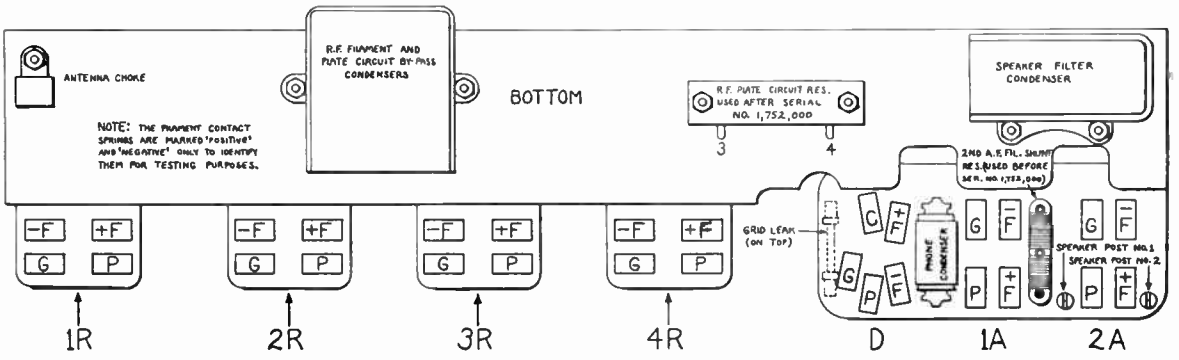


FIG. 77. CHART FOR MODEL 38.

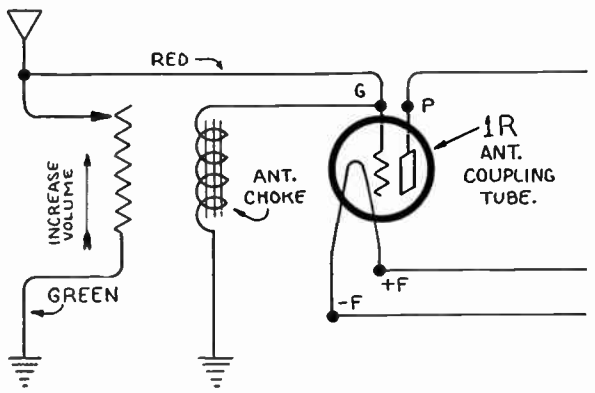


FIG. 78. SCHEMATIC DIAGRAM OF VOLUME CONTROL IN MODEL 37, 37-F, 37-C AND 38.

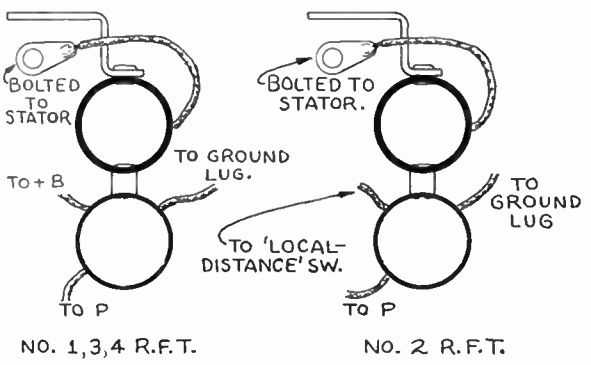


FIG. 79. SKETCH SHOWING CONNECTIONS FROM R. F. TRANSFORMERS, MODEL 38.

POWER UNIT IN MODEL 37, 37-F, 37-C AND 38

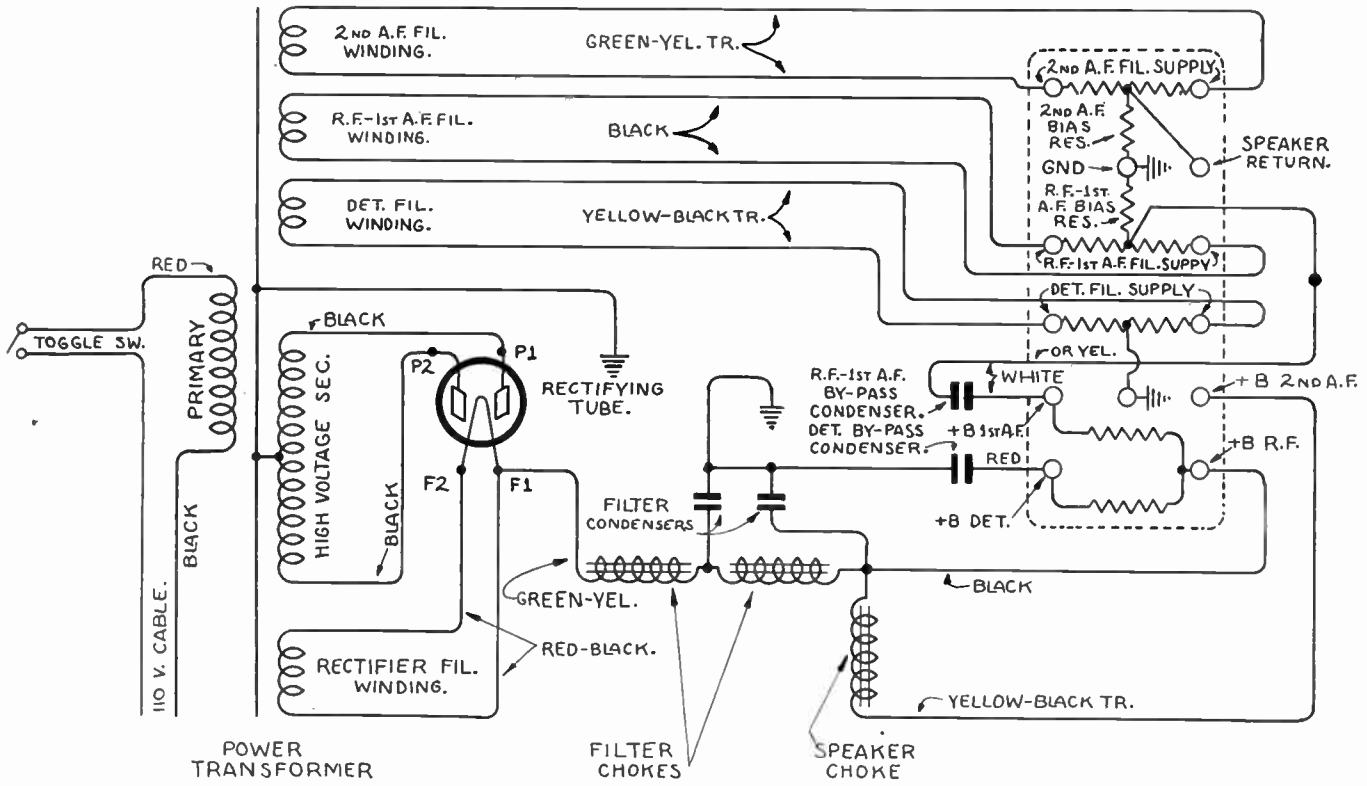


FIG. 80. DIAGRAM OF POWER UNIT IN MODEL 37, 37-F, 37-C AND 38.

In Model 37-C the on-off switch connections are made to the panel assembly as explained under Fig. 82.

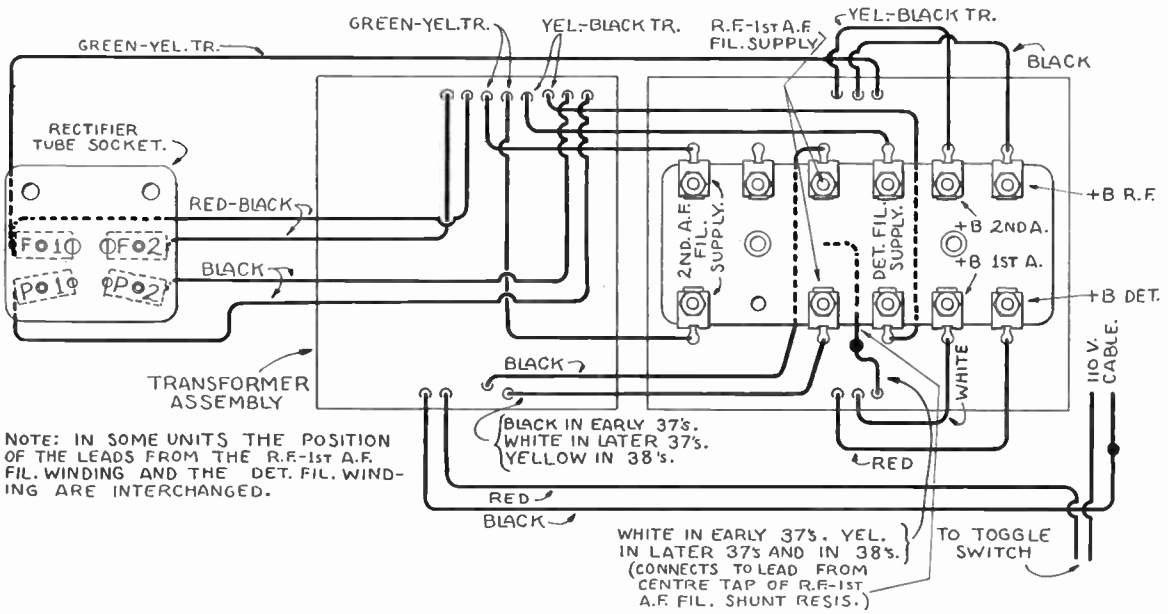


FIG. 81. SHOWING CONNECTIONS FROM TRANSFORMER AND CONDENSER-CHOKE ASSEMBLIES TO PANEL ASSEMBLY.

This view shows the approximate position of leads from the metal containers. In replacement condenser-choke assemblies for Model 38 the lead to +B 1st-A. F. terminal is sometimes black-red tracer instead of white.

PANEL ASSEMBLIES IN POWER UNITS

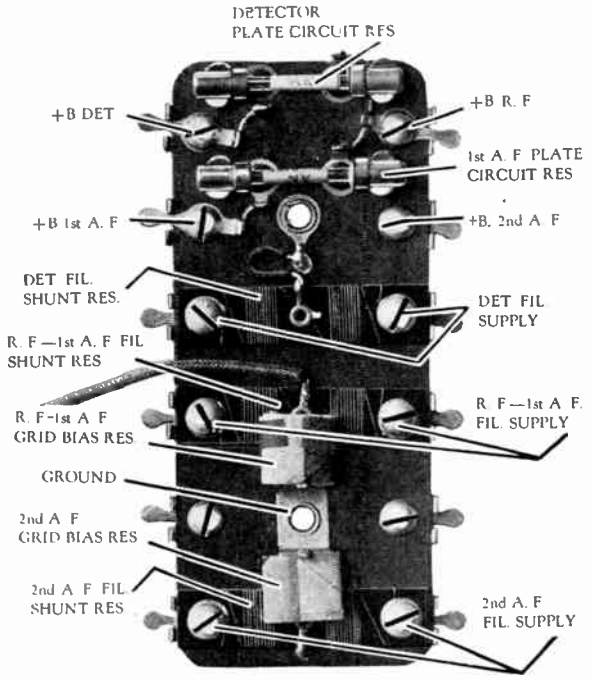


FIG. 82. REAR VIEW OF PANEL ASSEMBLY ON MODEL 37, 37-F, 37-C, 38 AND LATER TYPE "Y" POWER UNITS.

The terminal on the right hand side of the ground eyelet is used as "speaker-return" terminal on later Model 37 and 38 sets. In Model 37 Console sets, and in later type "Y" power units, the terminals on either side of the ground eyelet are used for toggle switch connection in the 110-volt line.

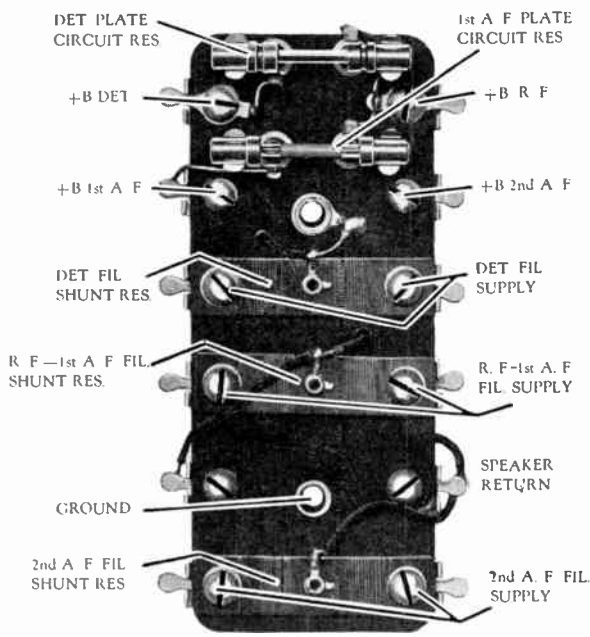


FIG. 85. BOTTOM VIEW OF PANEL ASSEMBLY USED IN POWER UNIT OF MODEL 40, 40-F, 42, 42-F, 43, 44, 44-F, 45, 46, 47, 52, 53, 56 AND 57.

The terminal at the left of the ground eyelet (in this view) is used as a junction point for the lead from the centre-tap of the R. F. 1st-A. F. filament-shunt resistor, and the blue (red in some models) lead from the 1st-A. F. by-pass condenser. This terminal is not connected to the set.

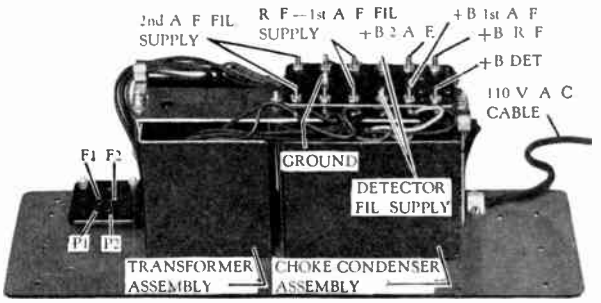


FIG. 83. POWER UNIT IN MODEL 37, 37-F, 37-C AND 38. COVER REMOVED.

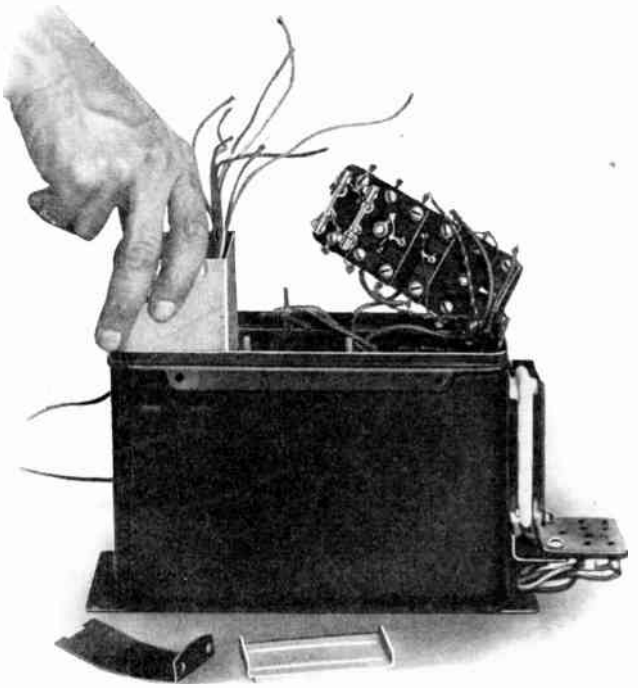


FIG. 84. REMOVING CONDENSER SECTION IN POWER UNIT FOR MODEL 40-F, 42-F, 44-F AND 2ND TYPE OF MODEL 44.

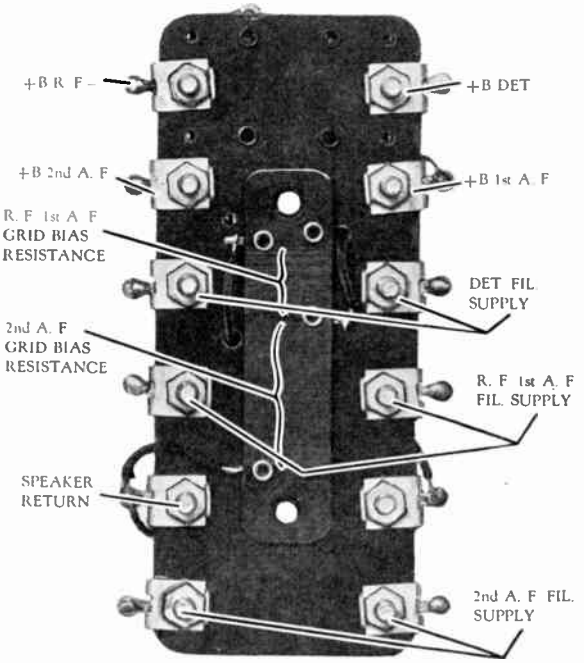


FIG. 86. TOP VIEW OF PANEL ASSEMBLY USED IN POWER UNIT OF MODEL 40, 40-F, 42, 42-F, 43, 44, 44-F, 45, 46, 47, 52, 53, 56 AND 57.

MODEL 40, 40-F, 42, 42-F, 44, 44-F, 45, 52, 56 AND 57 CHASSIS

For Description of Power Unit, see Page 60

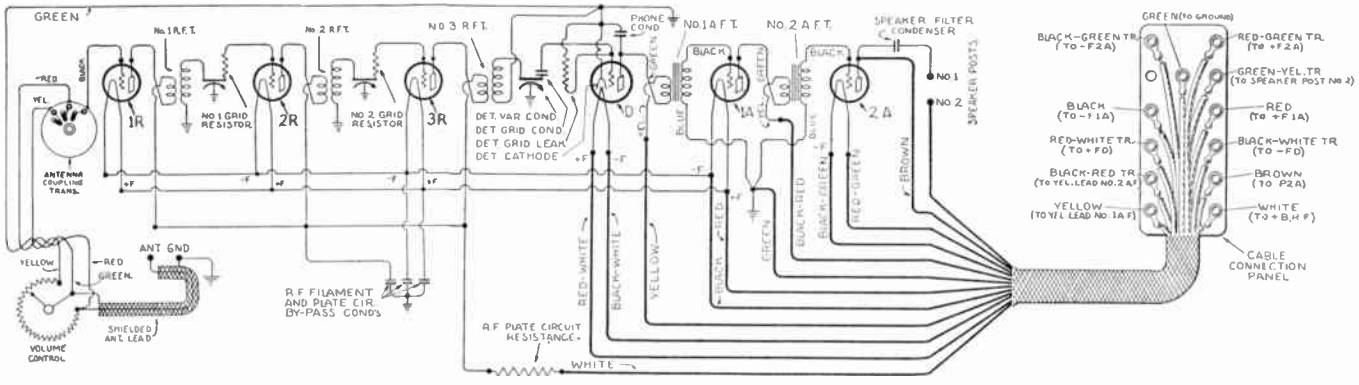


FIG. 87. WIRING DIAGRAM OF MODEL 40, 40-F, 42, 42-F, 52, 56 AND 57.

Model 52 does not have the shielded antenna lead, but is provided with two twenty-foot leads which are connected to the volume control, black for antenna and black-green tracer for ground. Model 56 and 57 have antenna and ground posts at the bottom of the cabinet.

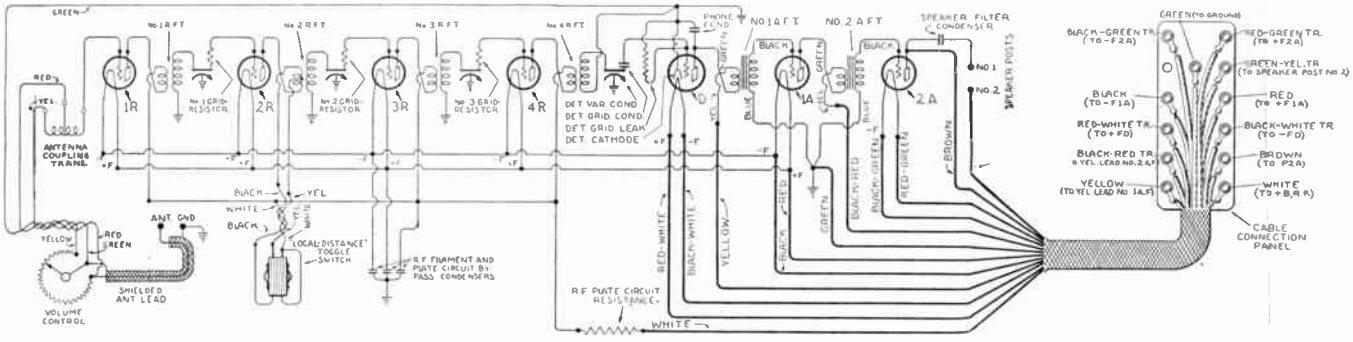


FIG. 88. WIRING DIAGRAM OF MODEL 41, 41-F AND 45.

A schematic diagram of the volume control is shown in Fig. 93. The ground connection to the R. F. by-pass condensers, in this and other models, is made through the metal container in which the condensers are sealed. A pictorial representation of the antenna coupling transformer is shown in Fig. 87.

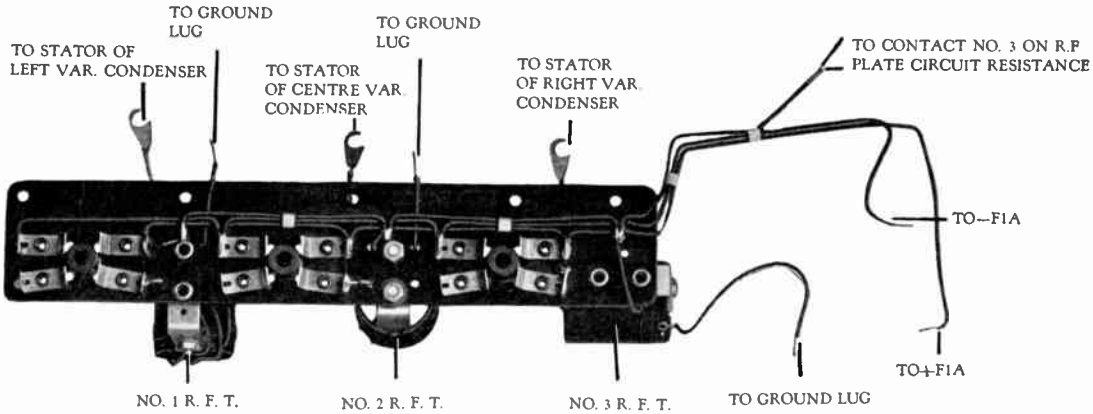


FIG. 89. VIEW OF R. F. AMPLIFIER ASSEMBLY IN MODEL 40, 40-F, 42, 42-F, 52, 56 AND 57.

MODEL 40, 40-F, 42, 42-F, 44, 44-F, 45, 52, 56 AND 57 CHASSIS

For Description of Power Unit, see Page 60

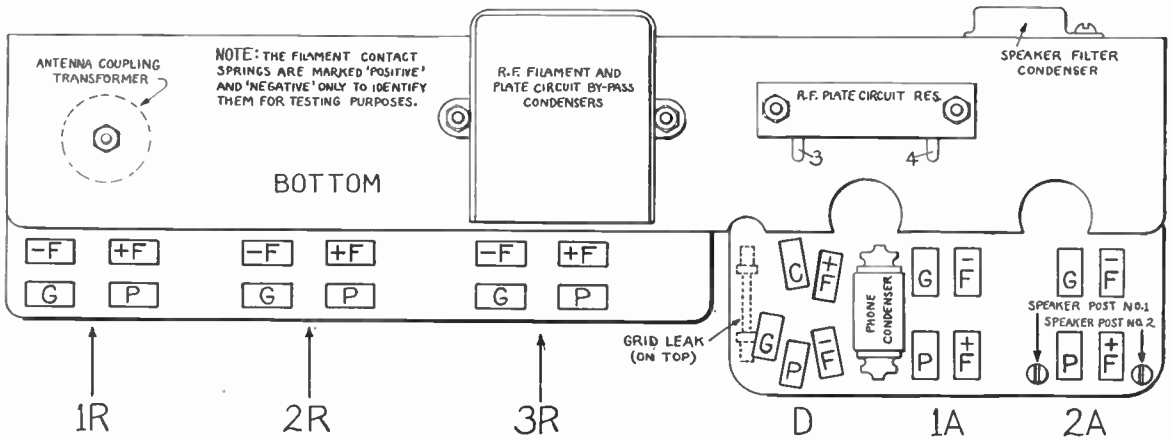


FIG. 90. CHART FOR MODEL 40, 40-F, 42, 42-F, 52, 56 AND 57.

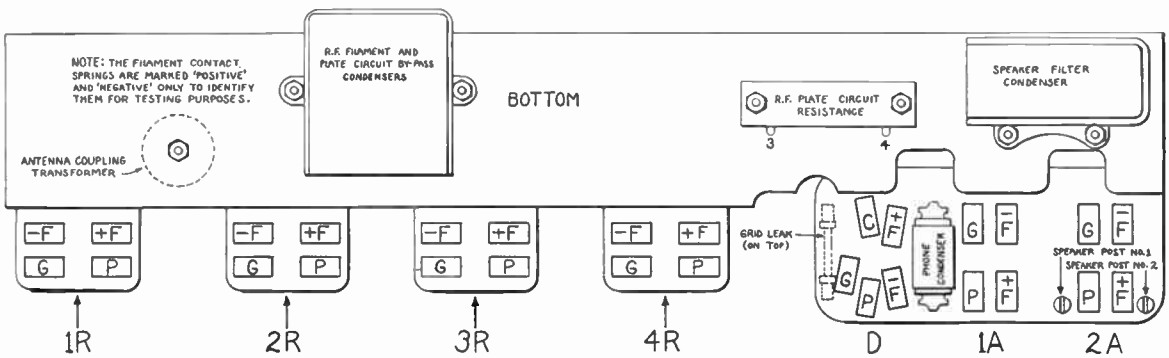


FIG. 91. CHART FOR MODEL 44, 44-F AND 45.

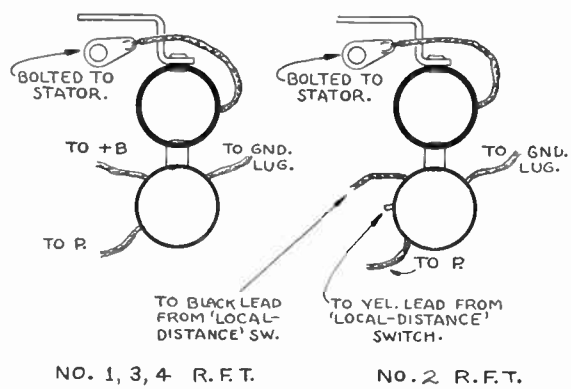


FIG. 92. SKETCH SHOWING CONNECTIONS FROM R. F. TRANSFORMERS IN MODEL 44, 44-F, 45 AND 47.

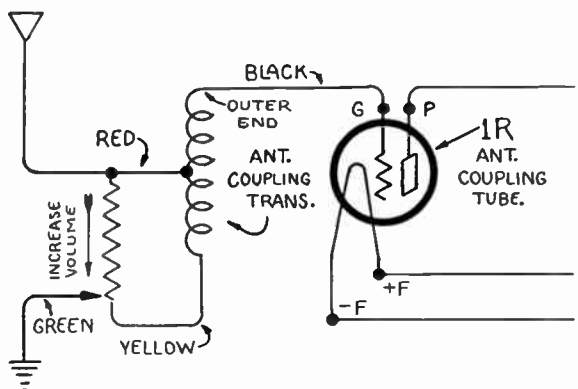


FIG. 93. SCHEMATIC DIAGRAM OF VOLUME CONTROL, MODEL 40, 40-F, 42, 42-F, 43, 44, 44-F, 45, 46, 47, 52, 53, 56 AND 57.

POWER UNIT IN MODEL 40, 42, 44, 45, 52, 56 AND 57

For Additional Information, see Pages 57, 61 and 62

Model 40-F, 42-F and 44-F Power Units are described on Page 62.

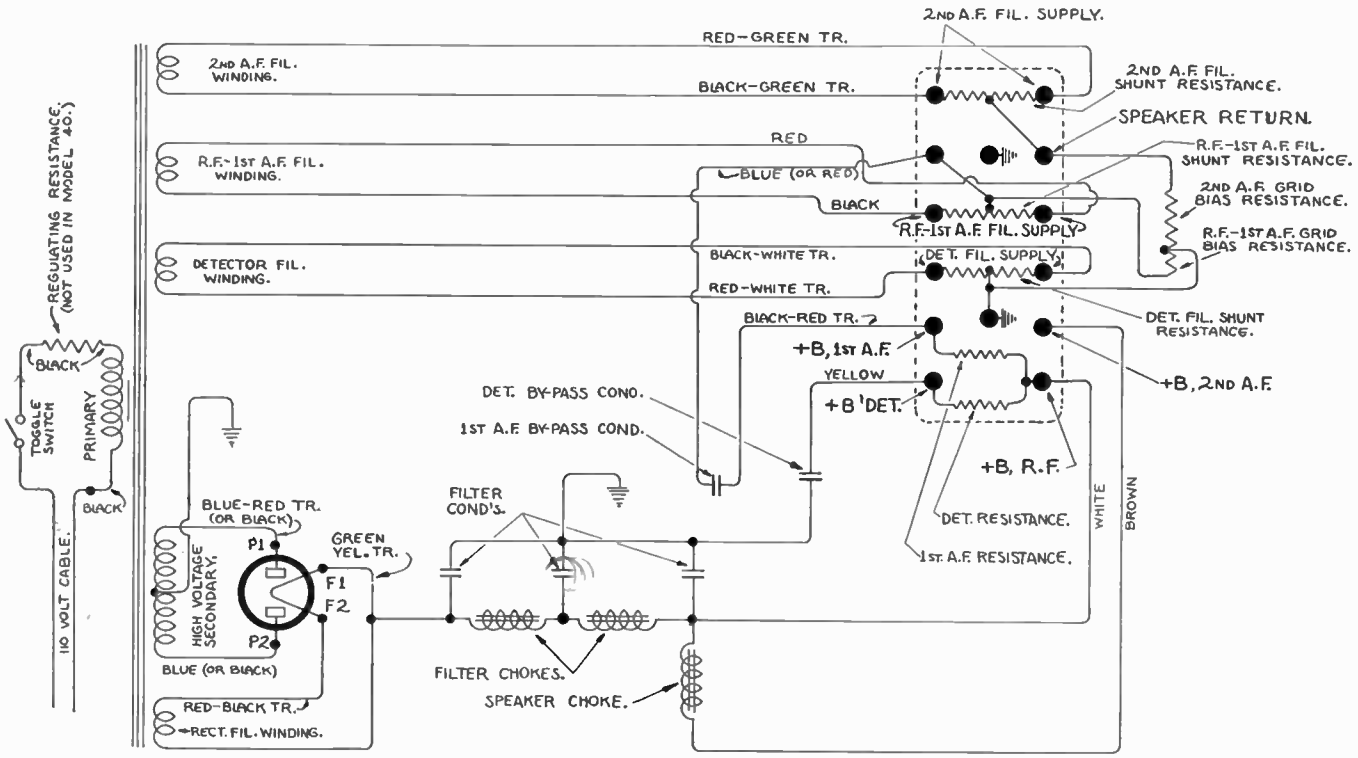


FIG. 94. SCHEMATIC DIAGRAM OF POWER UNIT IN MODEL 40, 42, 44, 45, 52, 56 AND 57.
The regulating resistor is used only in Model 42, 44 and 52.

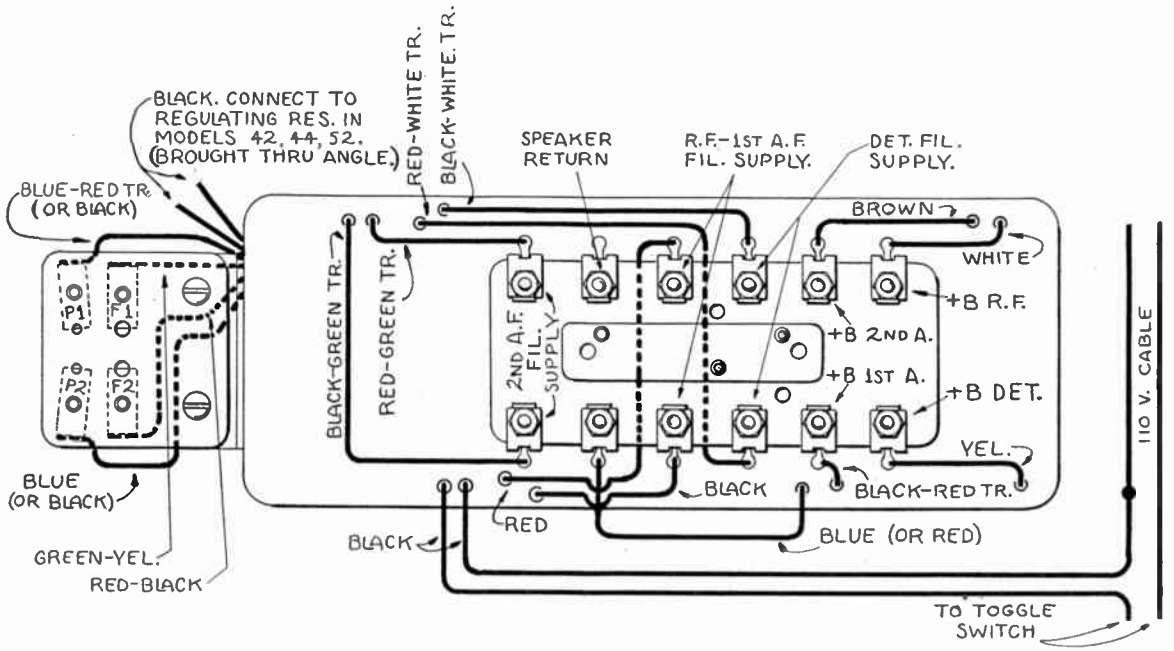


FIG. 95. POWER UNIT IN MODEL 40, 42, 44, 45, 52, 56 AND 57, SHOWING CONNECTIONS FROM SEALED CONTAINER TO PANEL ASSEMBLY, RECTIFIER SOCKET AND REGULATING RESISTANCE.

This view shows the approximate position of leads from sealed container. In Model 42, 44 and 52, a hole is cut in the rectifier-socket mounting angle and the two black leads are brought up through the hole and connect to the regulating resistor, which is mounted upright at the left-hand end of the sealed container.

2ND TYPE OF POWER UNIT IN MODEL 40, 56 AND 57

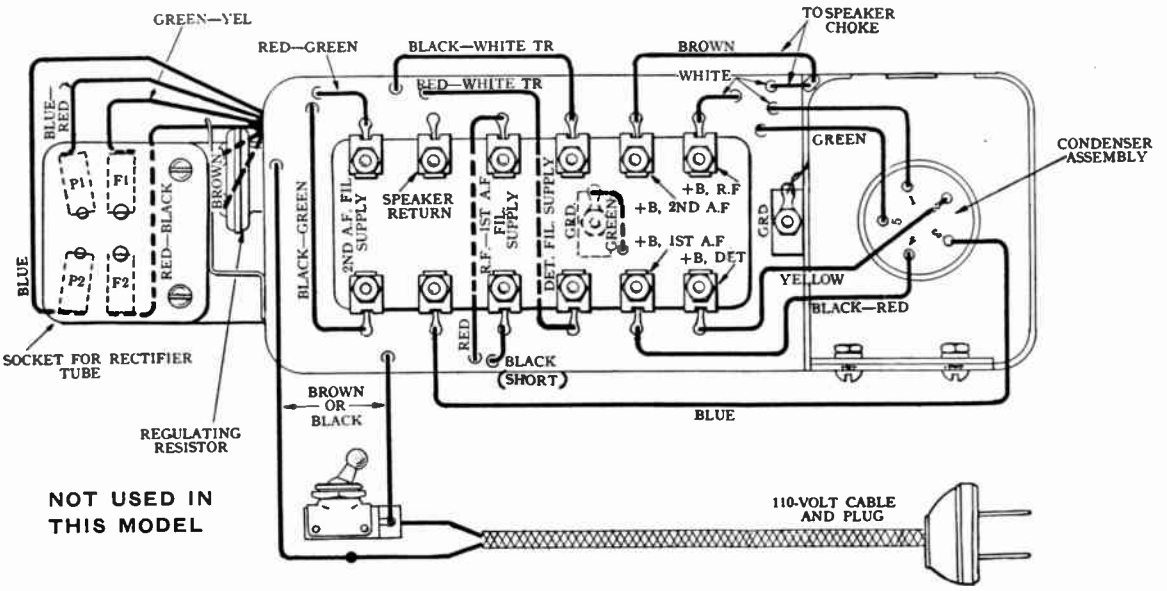


FIG. 96. VIEW SHOWING CONNECTIONS IN 2ND TYPE OF POWER UNIT FOR MODEL 40, 56 AND 57.

This view shows the panel assembly moved to left of normal position. The layout of the panel assembly is the same as shown in the illustrations on Page 57.

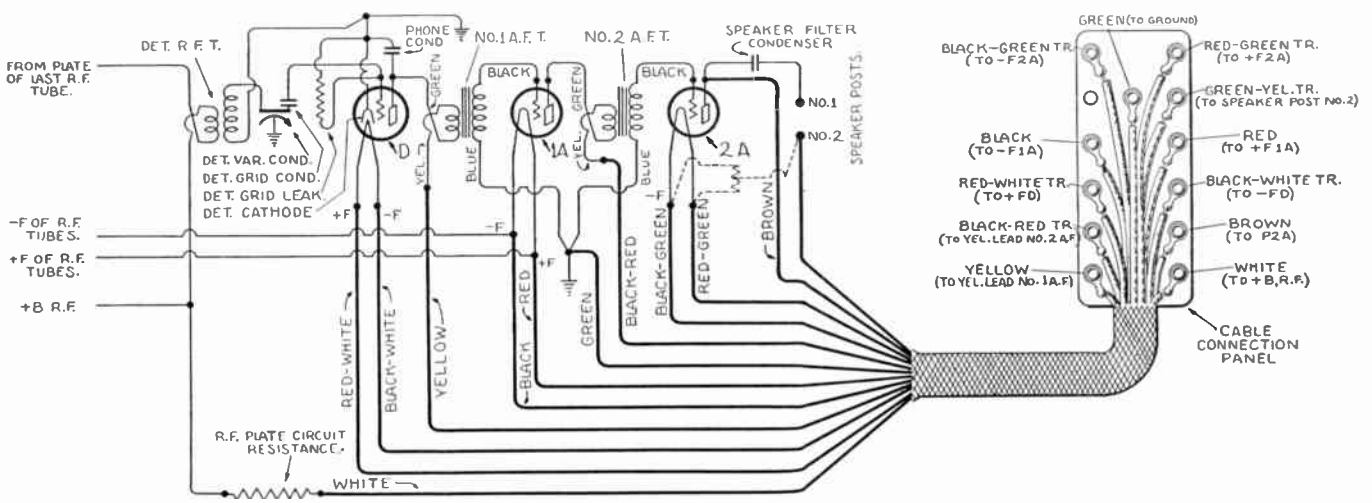


FIG. 97. DETECTOR AND TWO STAGE AUDIO FREQUENCY AMPLIFYING CIRCUIT USED IN LATER MODEL 36, AND IN MODEL 37, 37-F, 37-C, 38, 40, 40-F, 42, 42-F, 44, 44-F, 45, 52, 56 AND 57.

The 2nd-A. F. filament-shunt resistor (shown in dotted lines) is used in all Model 36 sets and in many Model 37 and 38. In later Model 37 and 38, and in Model 40, 42, 44, 45, 52, 56 and 57, this resistor is not used in set, but the 2nd-A. F. filament-shunt resistor in power unit is used for the same purpose, a green-yellow tracer lead connecting speaker post No. 2 to the centre tap of the 2nd-A. F. filament-shunt resistor in the power unit. In Model 36, and in Model 37 console sets, the two terminals on either side of the ground eyelet are used for toggle switch connection in the 110-volt line. In some Model 36 sets a green-yellow tracer lead is used instead of a black-red tracer lead for connection to the yellow lead of the 2nd-A. F. T. The R. F. plate-circuit resistor is not used in Model 36 nor in some 37 and 38 sets. Except for these minor variations, this circuit is standard in these sets, and the service man should remember the color scheme of A. F. transformers and the colors of cable leads and their location on the connection panel.

POWER UNIT IN MODEL 40-F, 42-F, 44-F AND 2ND TYPE OF MODEL 44

See Fig. 84 on Page 57.

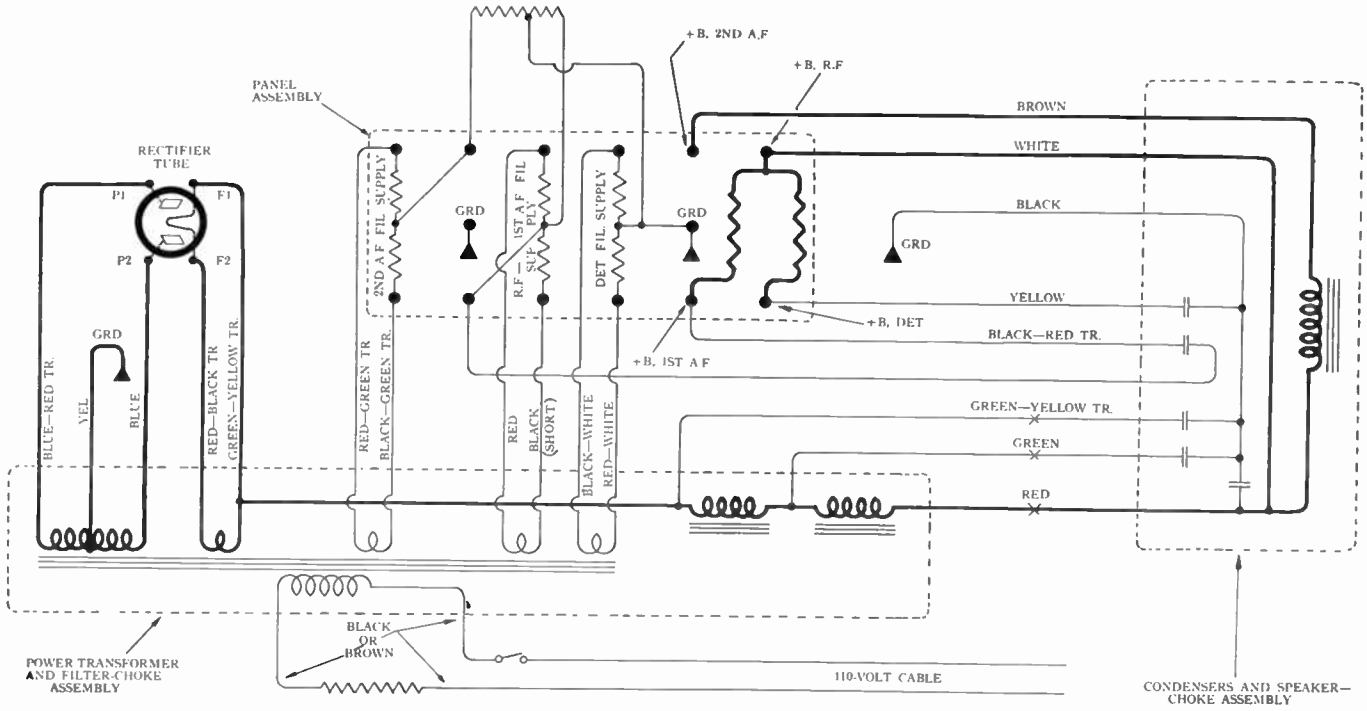


FIG. 98. WIRING DIAGRAM OF POWER UNIT FOR MODEL 40-F, 42-F, 44-F AND 2ND TYPE OF UNIT FOR MODEL 44.

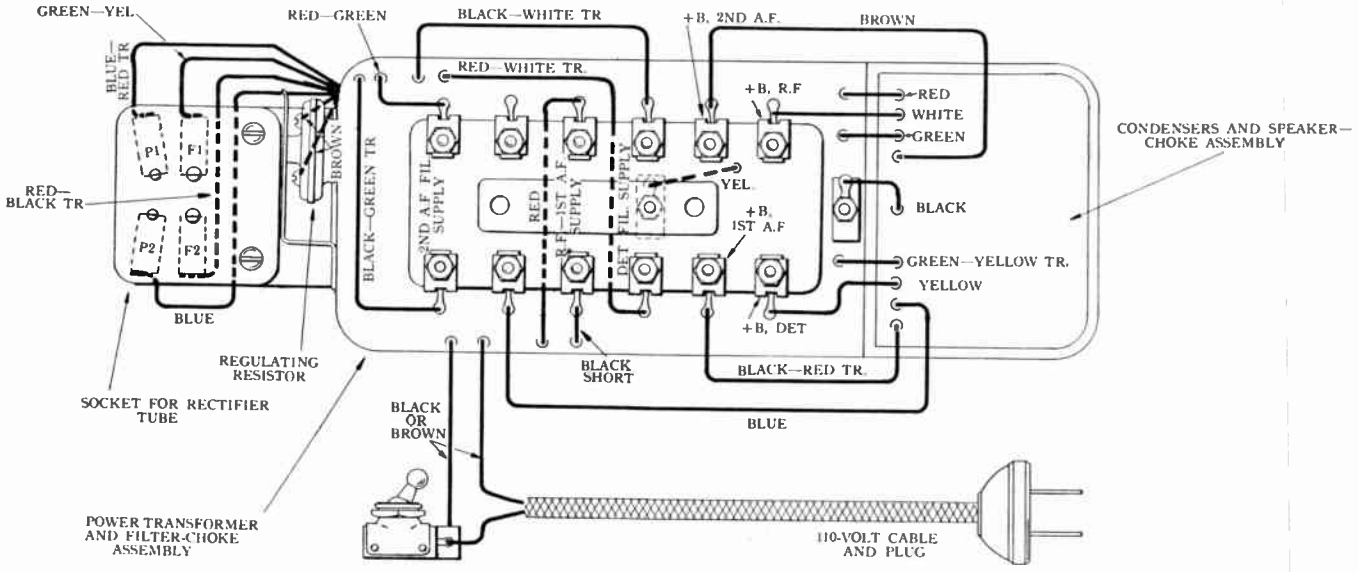


FIG. 99. SHOWING CONNECTIONS AND APPROXIMATE POSITION OF LEADS FROM SEALED CONTAINER POWER UNIT FOR MODEL 40-F, 42-F, 44-F AND 2ND TYPE OF MODEL 44.
This view shows panel assembly moved to left of normal position.

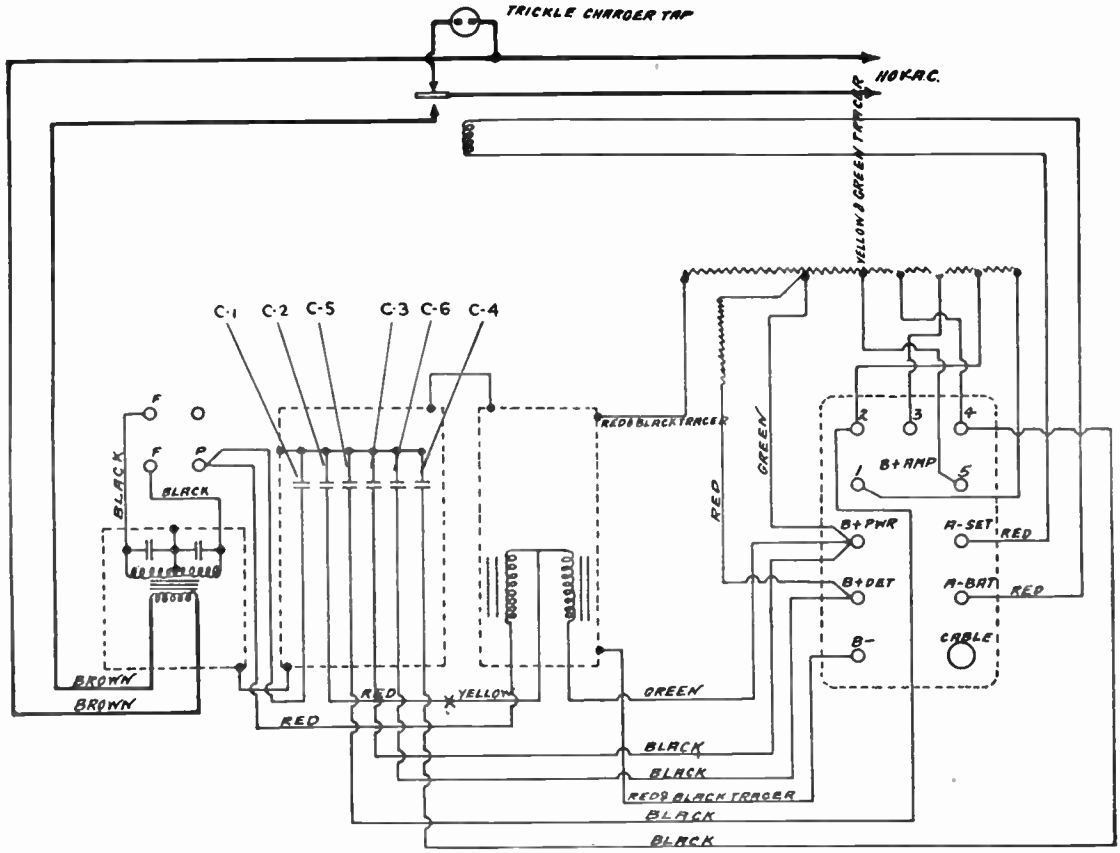


FIG. 100. B POWER UNIT. MODEL R No. 8800 (Wiring Diagram).

Note.—In Model "S" Unit for 25-cycle A. C. Power, Condenser C-5 is connected to Post 3 of "B + AMP," and Condenser C-4 is omitted.

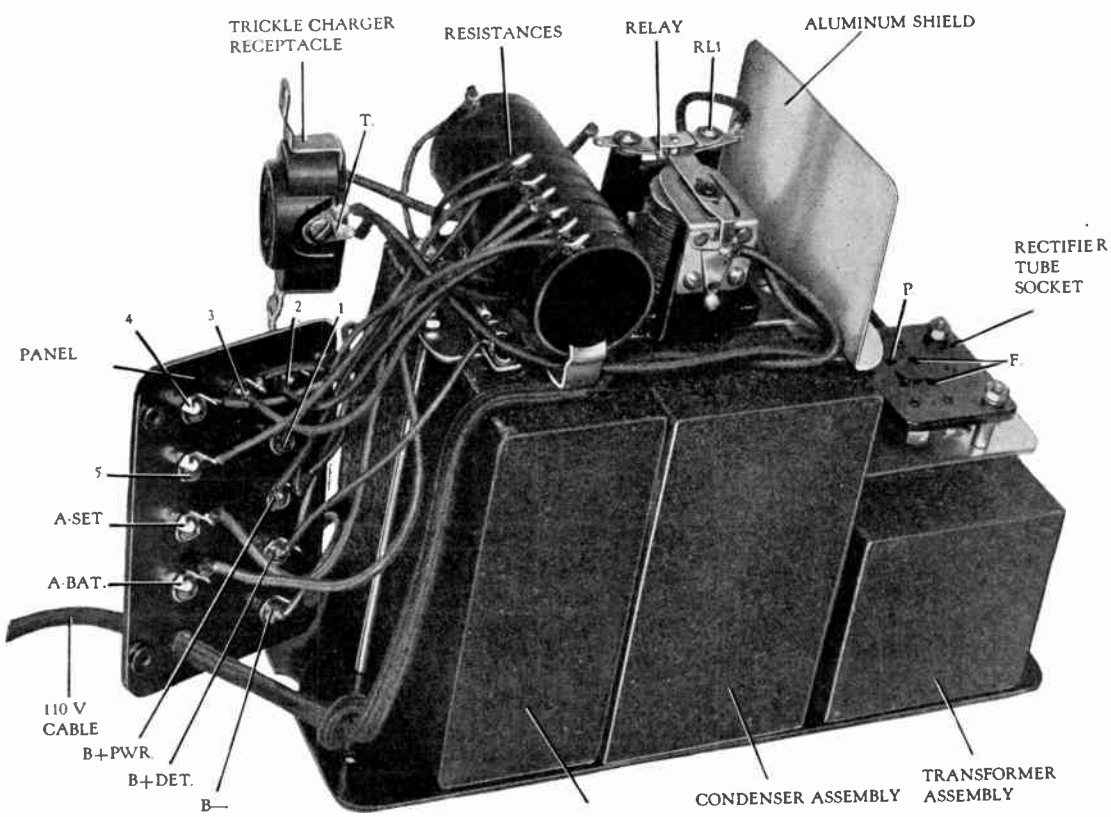


FIG. 101. VIEW OF B POWER UNIT.

Use Raytheon type BH rectifier tube for replacement.

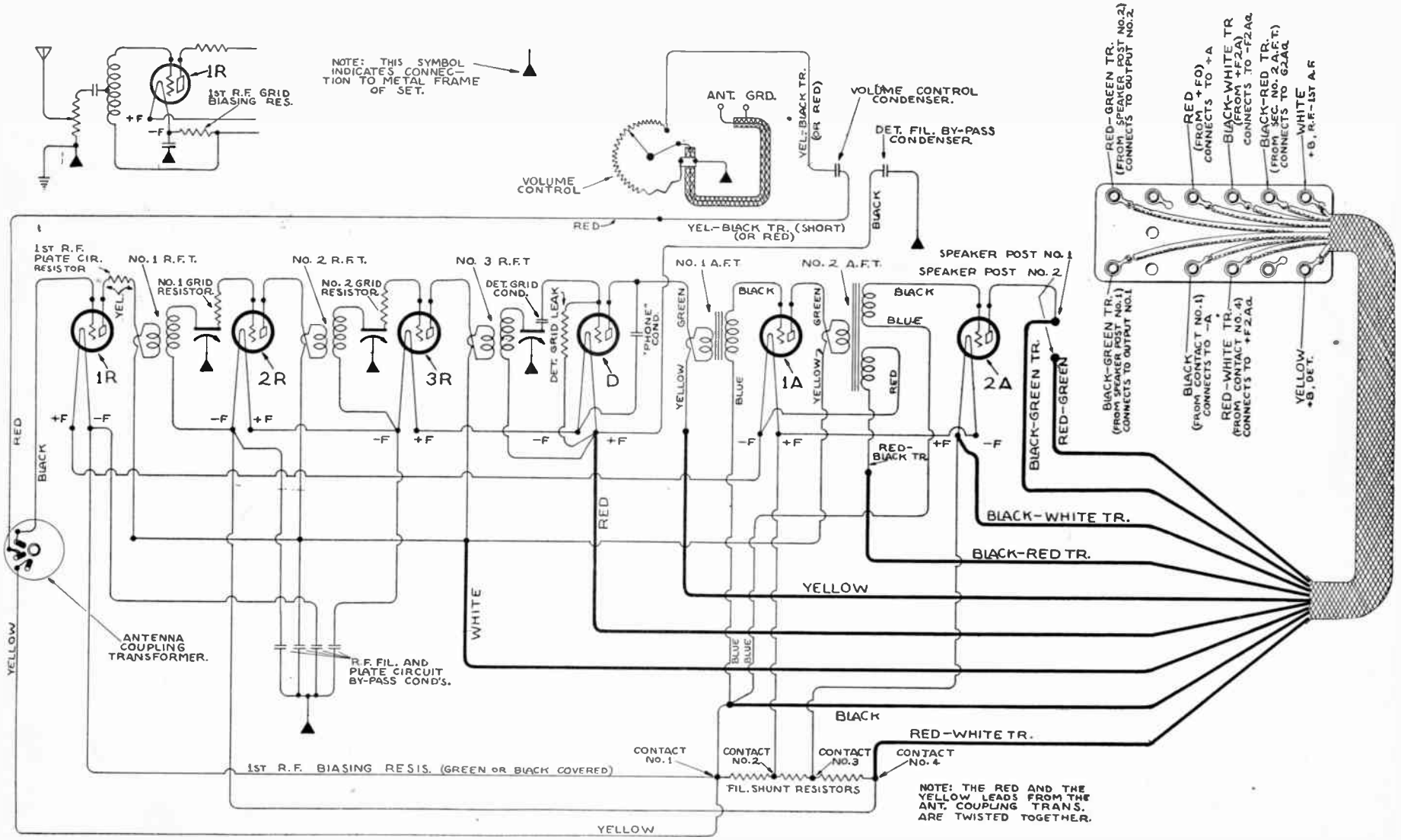


FIG. 102. DIAGRAM OF MODEL 41 CHASSIS.

MODEL 41 CHASSIS

For Voltage Table, See Page 106

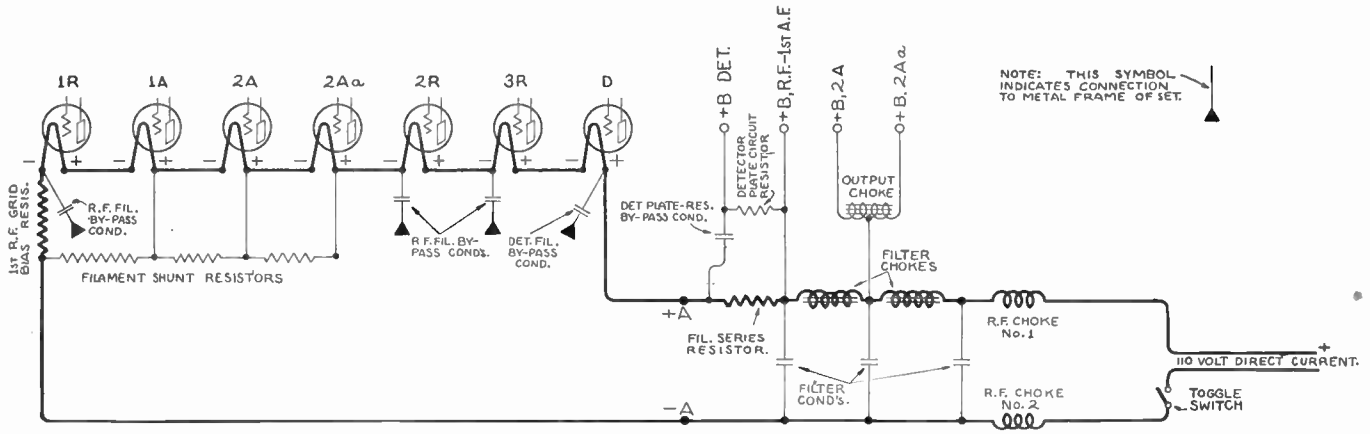


FIG. 103. SIMPLIFIED DIAGRAM OF POWER UNIT AND FILAMENT CIRCUIT IN MODEL 41 RECEIVER.
Tubes of the 112-A type are used in all sockets except 2A and 2Aa, which are the '71-A type.

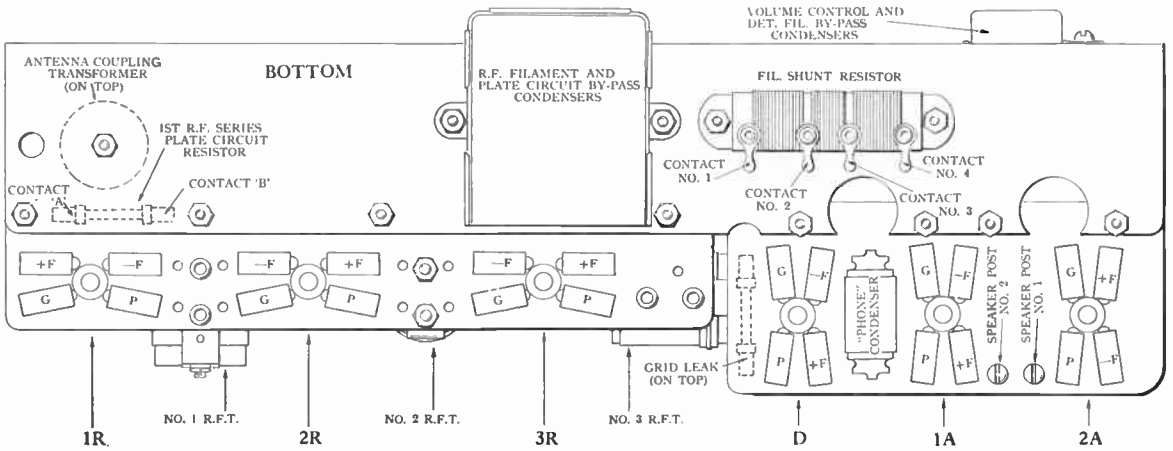


FIG. 104. CHART FOR MODEL 41.

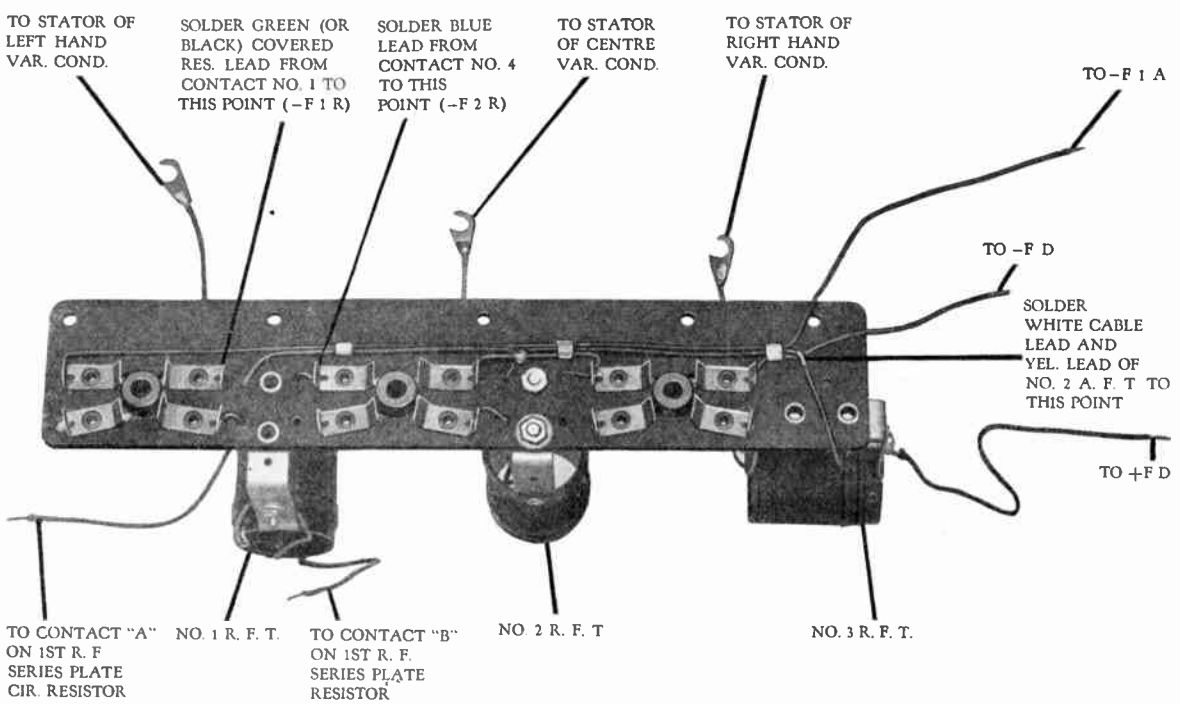


FIG. 105. VIEW OF R. F. AMPLIFIER ASSEMBLY.

MODEL 41 POWER UNIT (3rd Type)

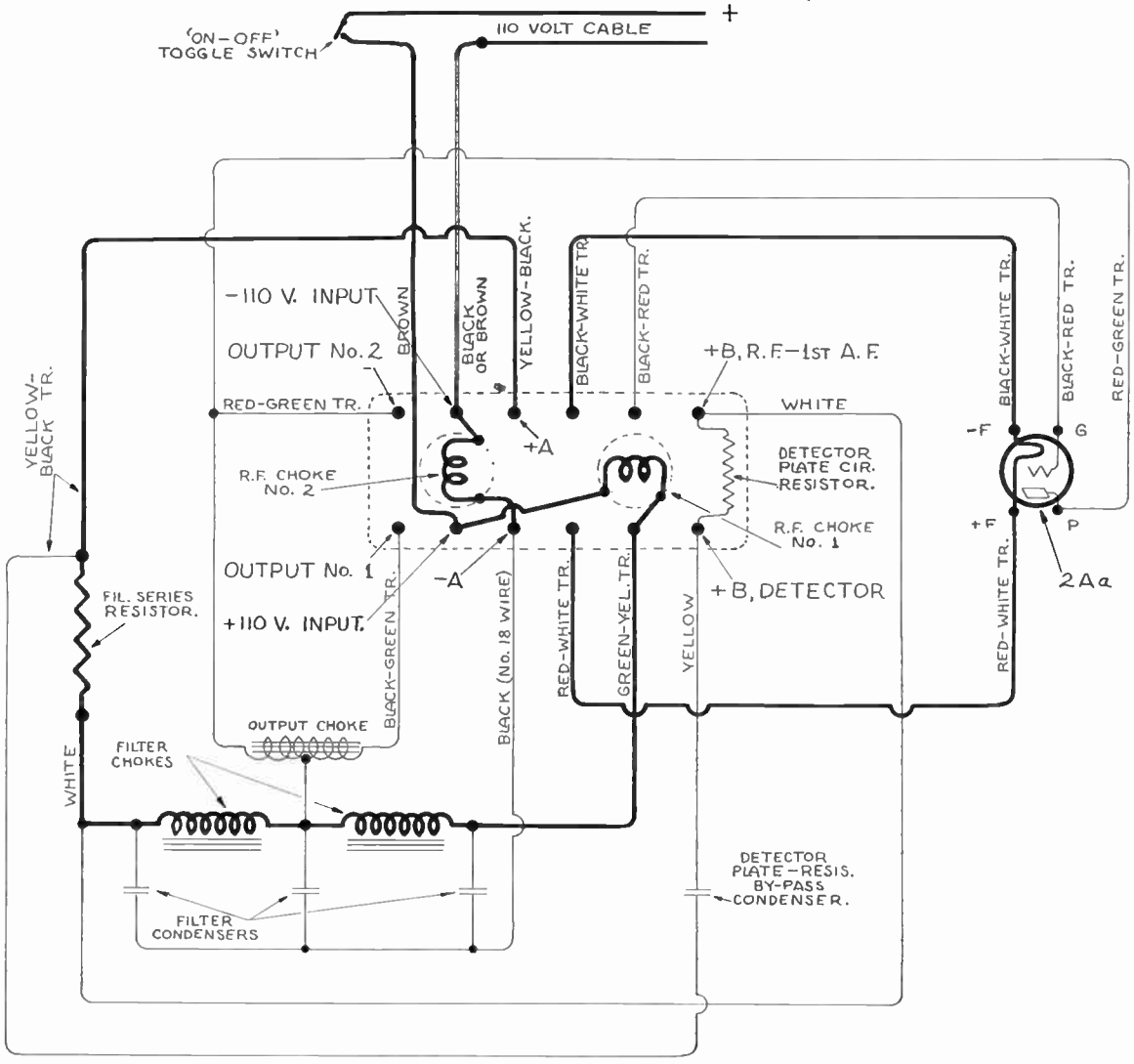


FIG. 106. WIRING DIAGRAM OF 3RD TYPE OF POWER UNIT FOR MODEL 41.

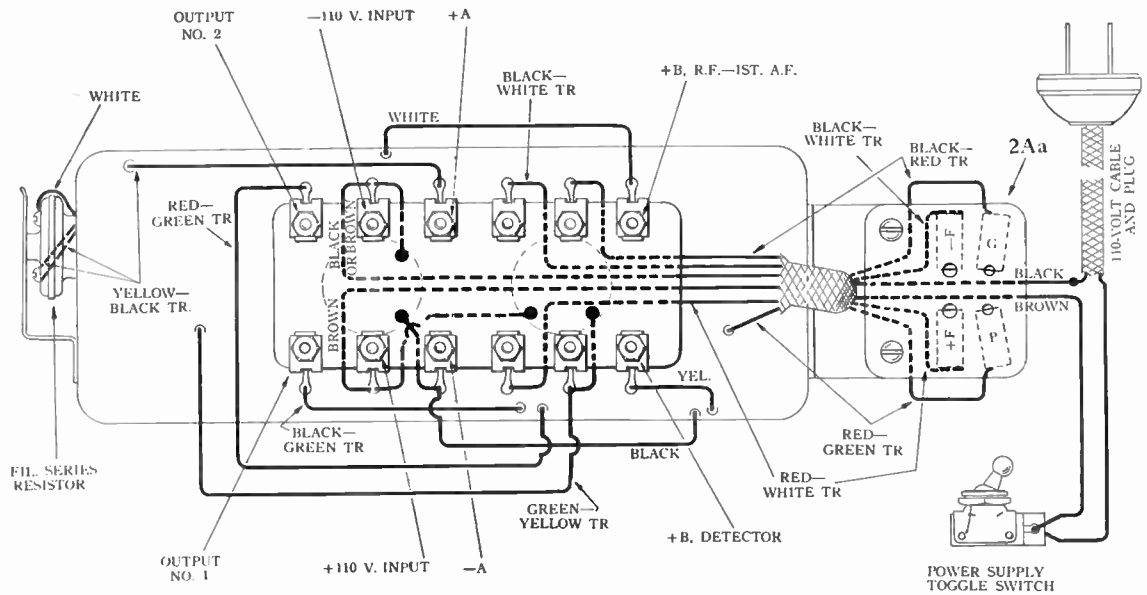


FIG. 107. SHOWING CONNECTIONS AND APPROXIMATE POSITION OF LEADS FROM SEALED CONTAINER IN 3RD TYPE OF POWER UNIT.

MODEL 81 MOTOR CAR RADIO

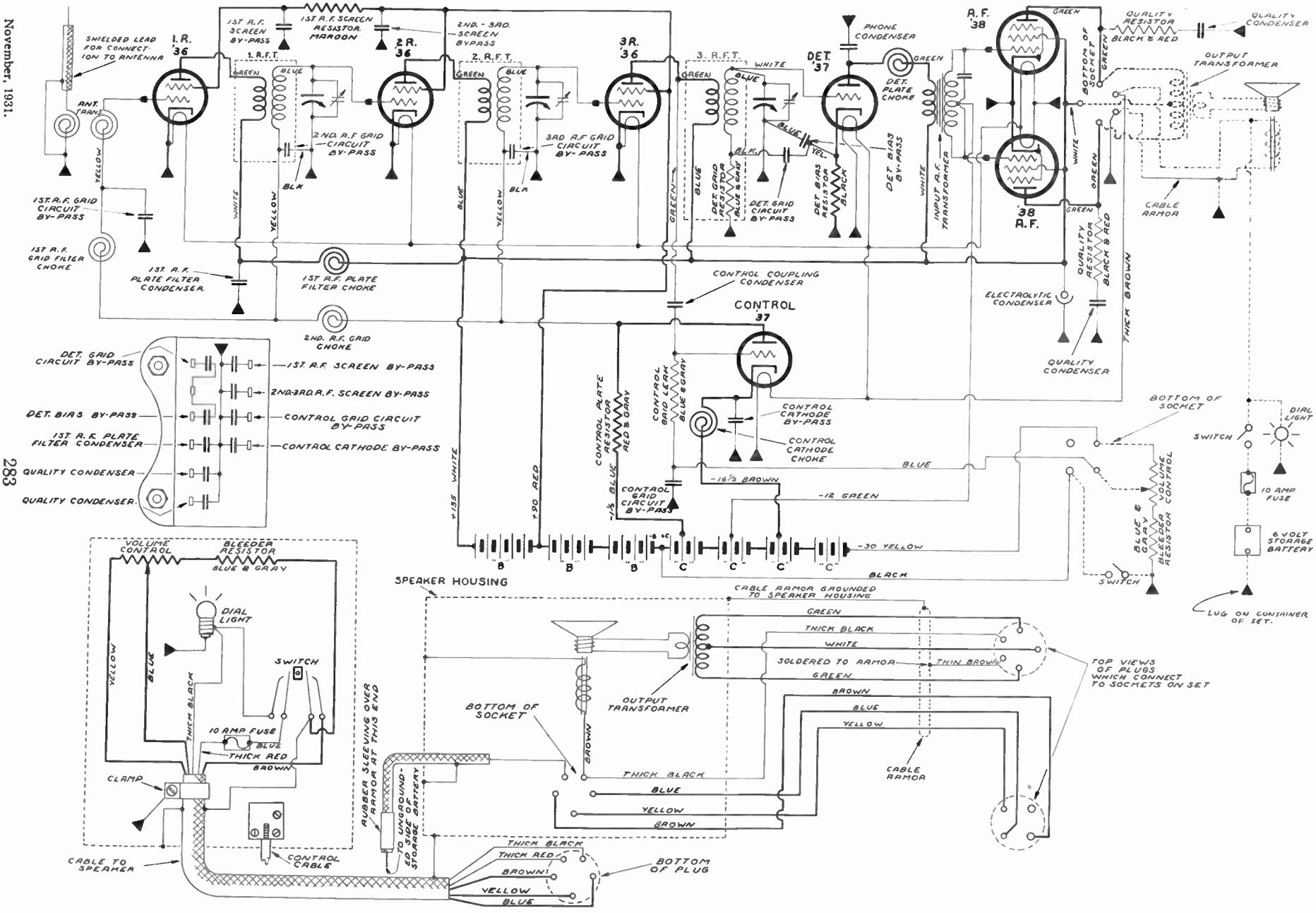


FIG. 282. DIAGRAM OF MODEL 81 MOTOR CAR RADIO (BATTERY-OPERATED).

This receiver consists of three units: (1st) the chassis and battery container, (2nd) the electro-dynamic speaker, (3rd) the remote-control unit.

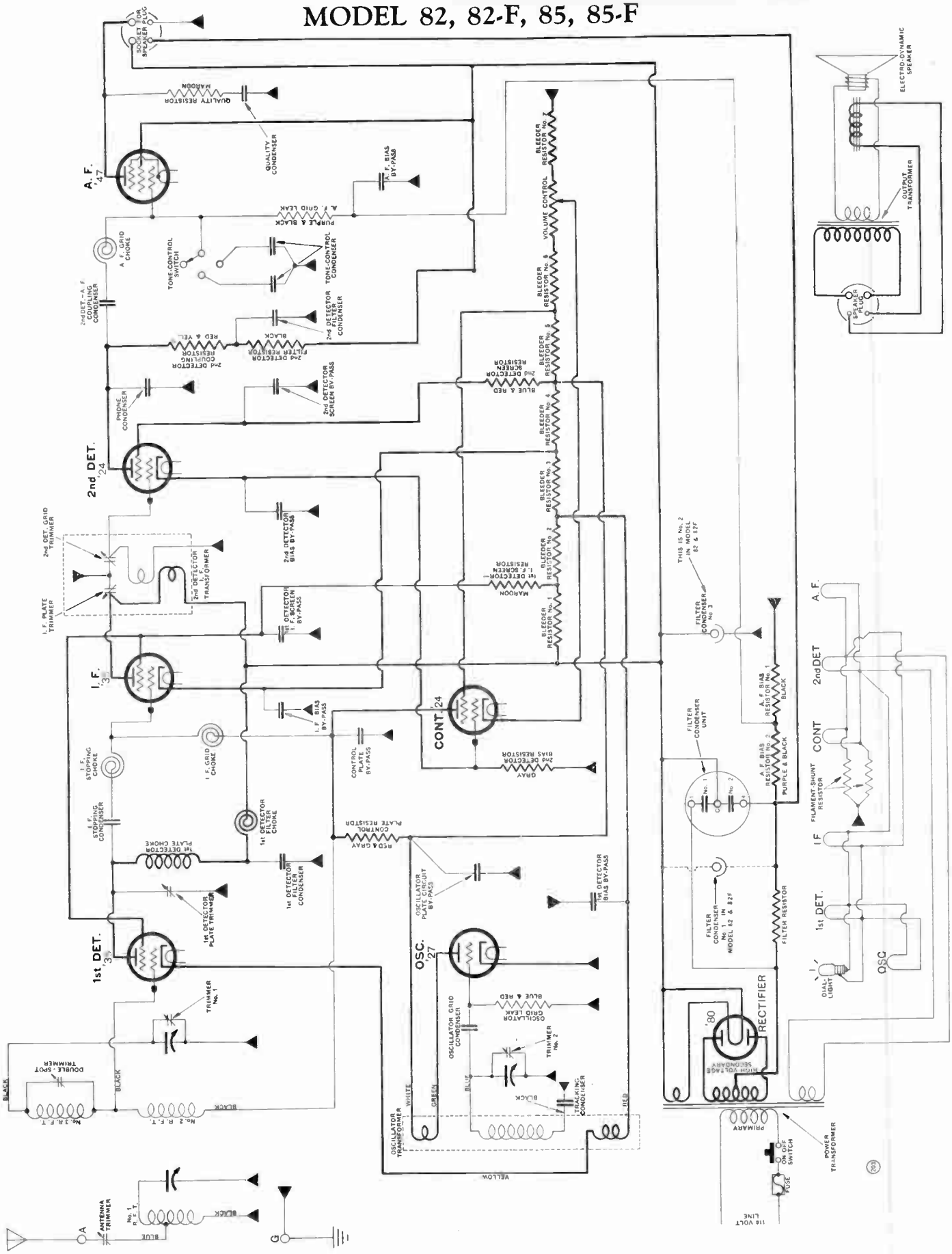


FIG. 283. DIAGRAM OF MODEL 82, 82-F, 85, AND 85-F (A. C.-OPERATED).

In Model 82 and 82-F, the filter-condenser unit is not used, but is replaced by an additional electrolytic condenser, which is shown above, connected in dotted lines. A few early-type Model 85 do not have automatic volume control; they have three electrolytic filter condensers; the circuit of these early Model 85 sets is similar to Model 80. The tracking condenser is mounted on the oscillator transformer in Model 82 and some 85 sets. The filament circuit of Model 82 is somewhat different from that shown above.

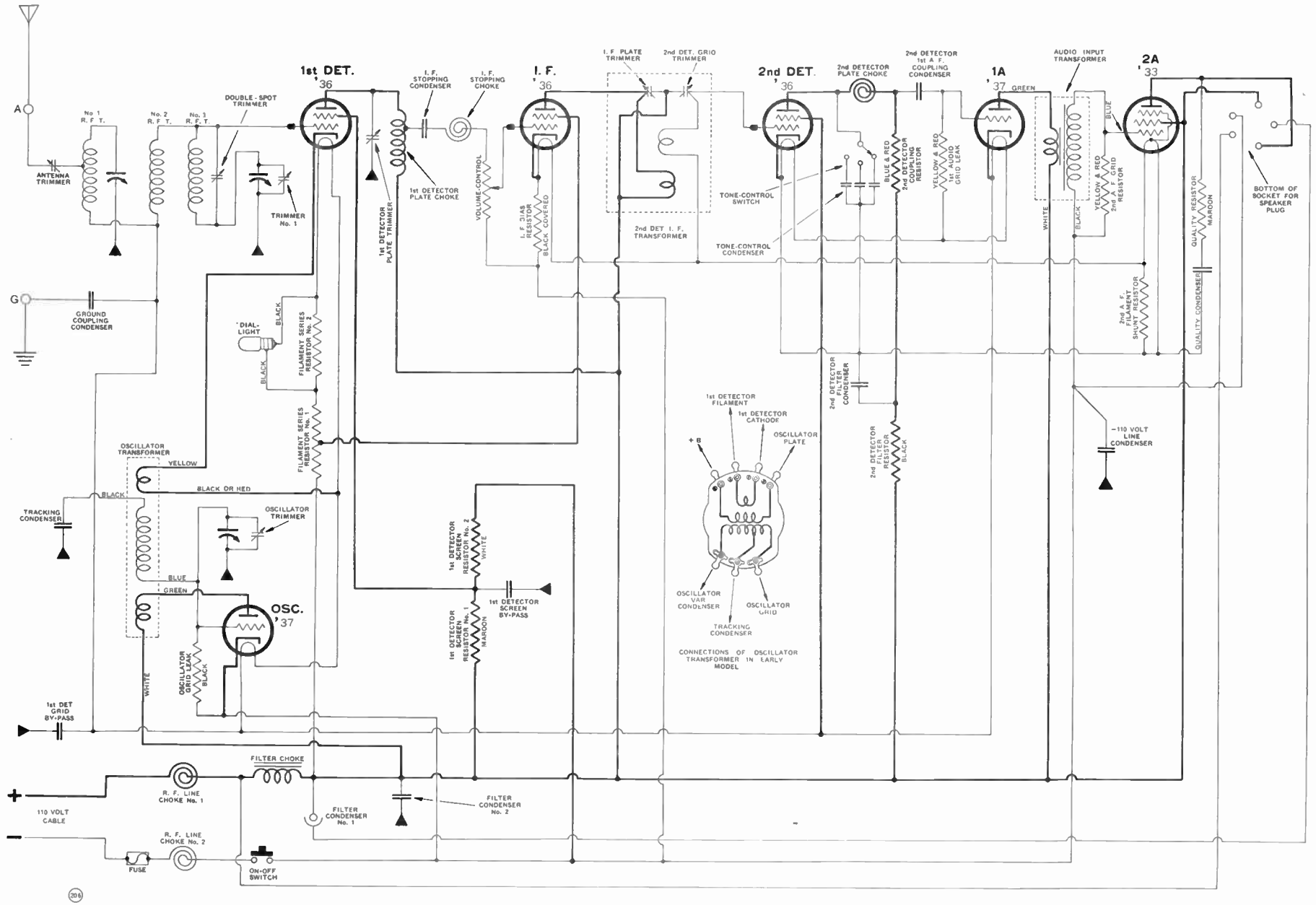


FIG. 284. DIAGRAM OF MODEL 82-D AND 84-D (D. C.-OPERATED).

Early Model 84-D does not have tone control; it has a condenser, instead of a resistor, across the secondary of the audio input transformer; it has a small phone condenser connected to the plate of the 2nd-detector, and it has an antenna choke connected between the antenna and ground posts. In 82-D, the oscillator-tracking condenser is mounted on the oscillator transformer. Connections to the oscillator transformer in early-type 84-D are shown in the separate drawing.

In 82-D, an extra-110-volt line condenser is connected from ground to a point between R. F. line choke No. 2 and the on-off switch.

MODEL 82-Q

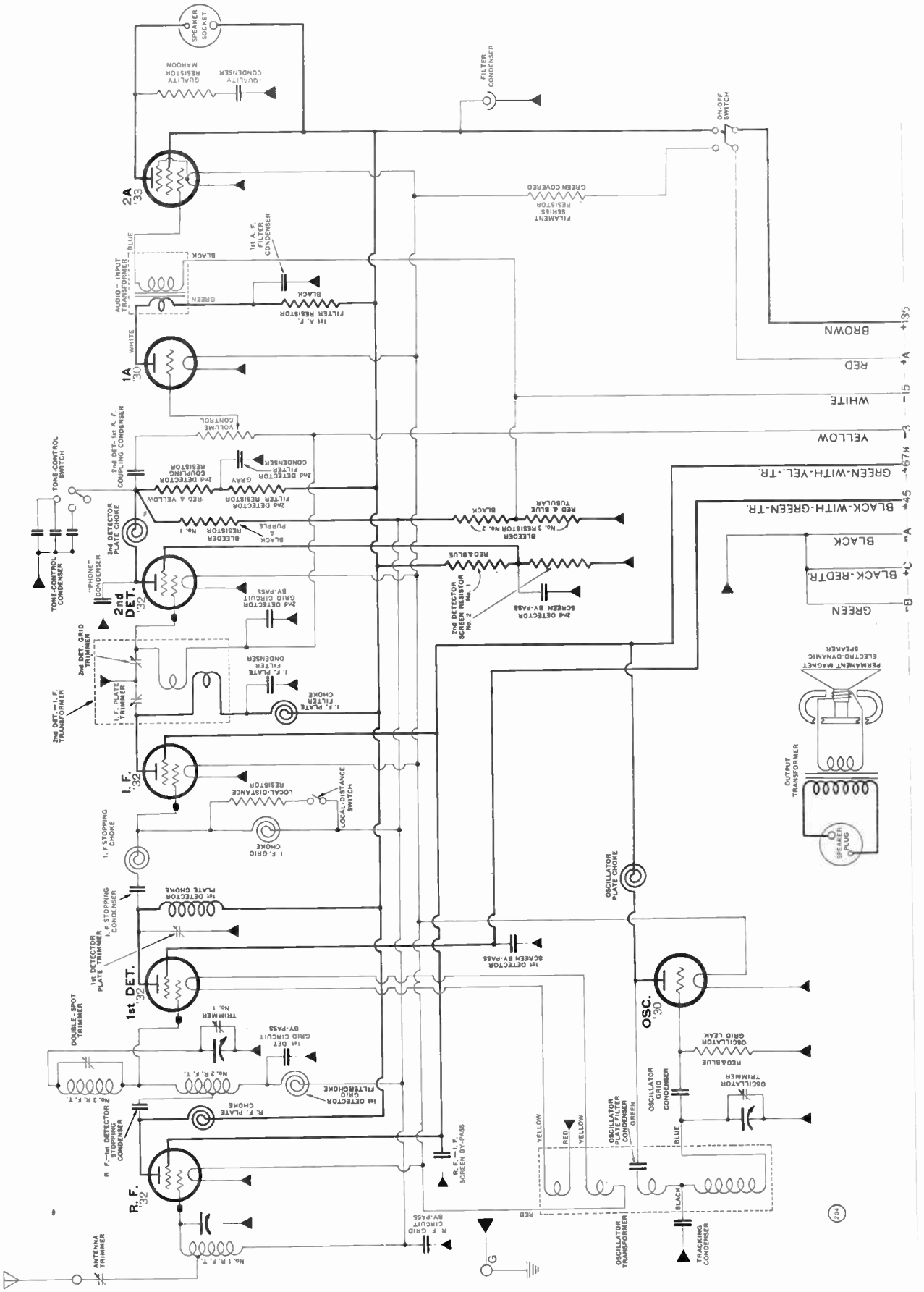


FIG. 285. DIAGRAM OF MODEL 82-Q (BATTERY-OPERATED).

In some 82-Q receivers, the primary of the audio input transformer is connected as follows: Green to the plate, and white to the 1st-A. F. filter resistor.

MODEL 84-Q

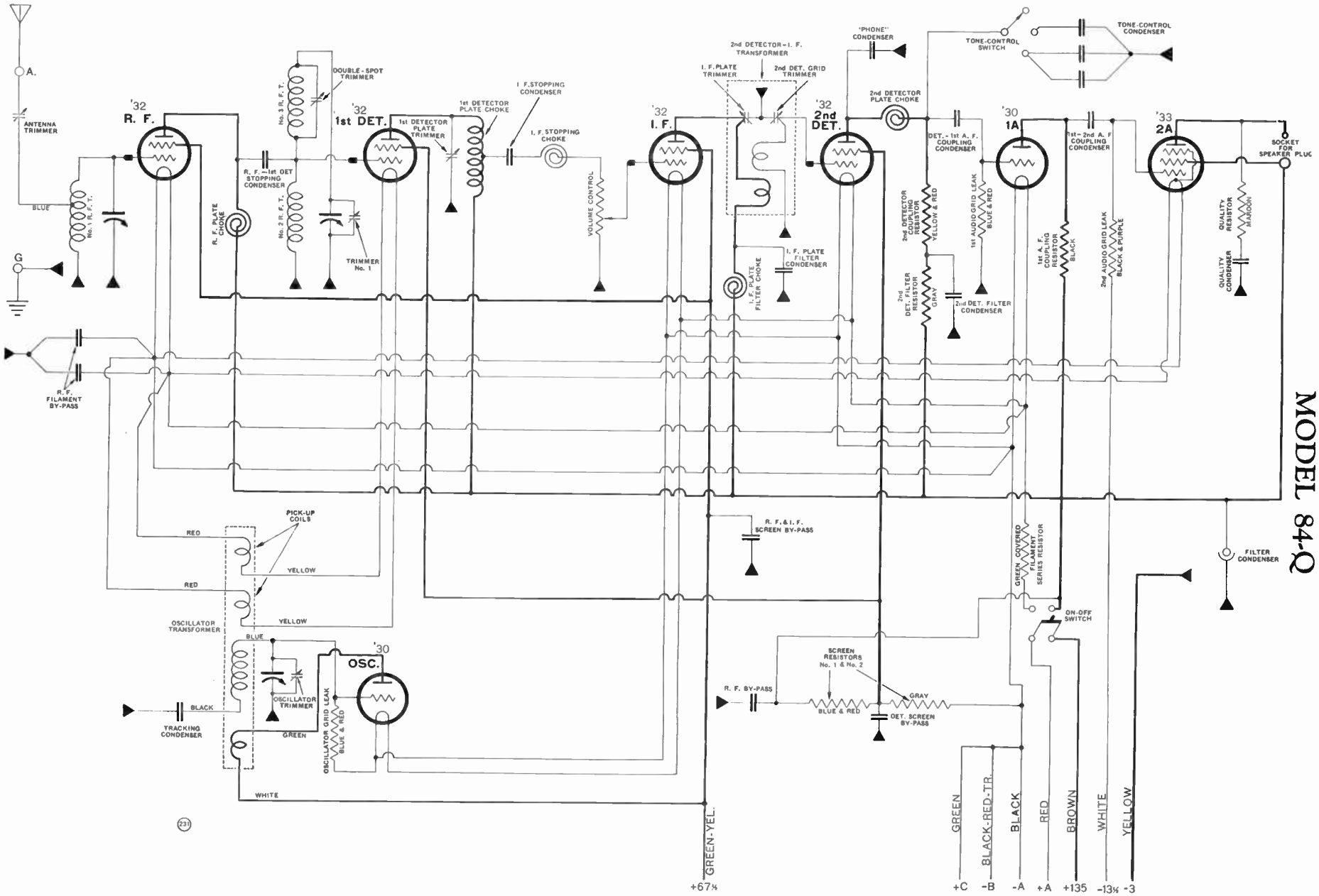


FIG. 286. DIAGRAM OF MODEL 84-Q (BATTERY-OPERATED).

A diagram of the speaker used with this set is shown in the diagram of Model 82-Q, Fig. 285.

Early-type 84-Q does not have tone control; it has a phone condenser in the 2nd-detector plate circuit; and it has an antenna choke connected across the antenna trimmer. The oscillator transformer in early-type Model 84-Q is different in this way: It has only one pick-up coil, which is connected in series with the screen of the 1st-detector. (The two filament-circuit pick-up coils are not used in the early model.)

MODEL 84, 84-F (Early Type)

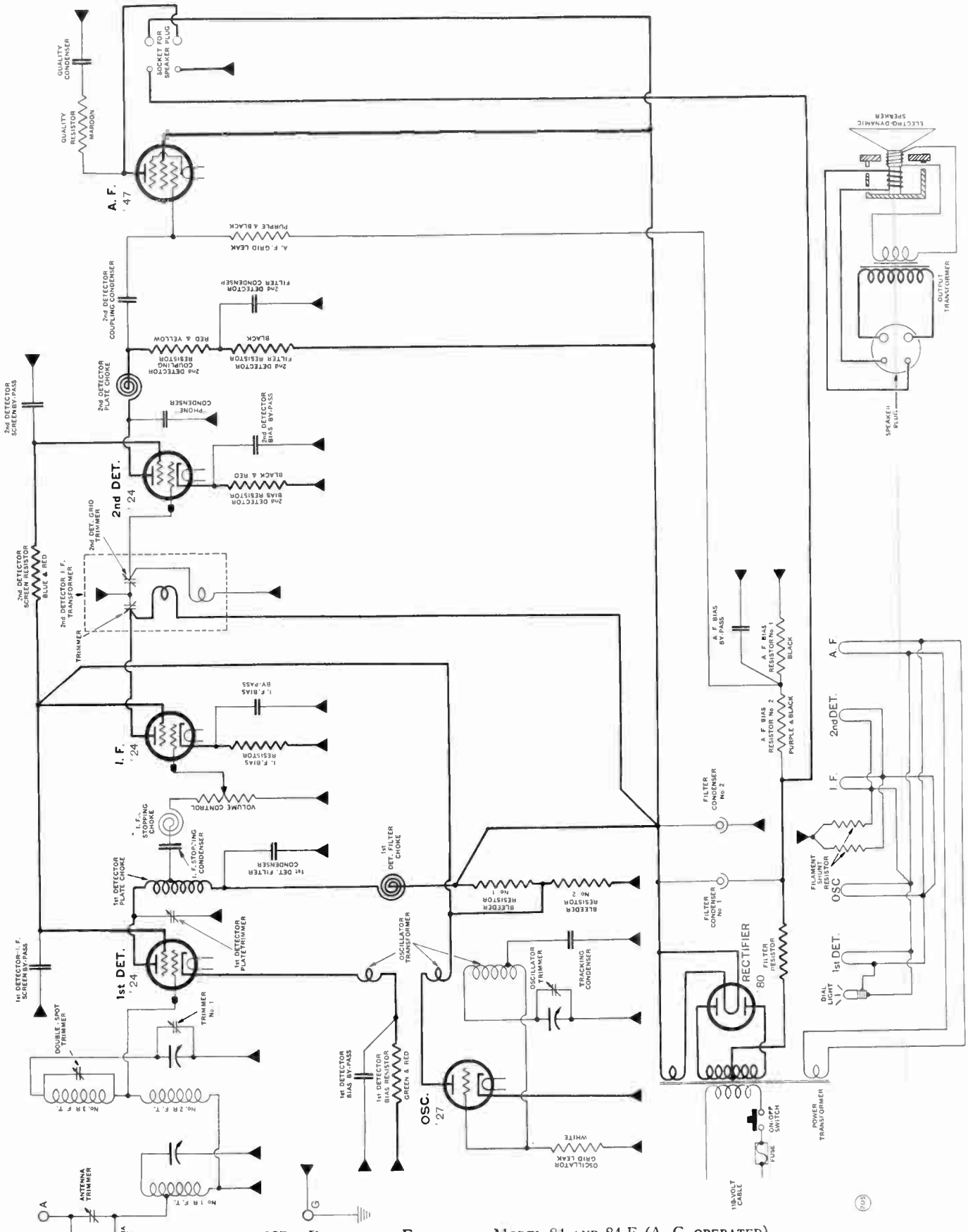


FIG. 287. DIAGRAM OF EARLY-TYPE MODEL 84 AND 84-F (A. C.-OPERATED).

In Model 84-F, the filter resistor (connected in series with the center-tap of the high-voltage winding) is NOT used.

MODEL 84, 84-F (Late Type)

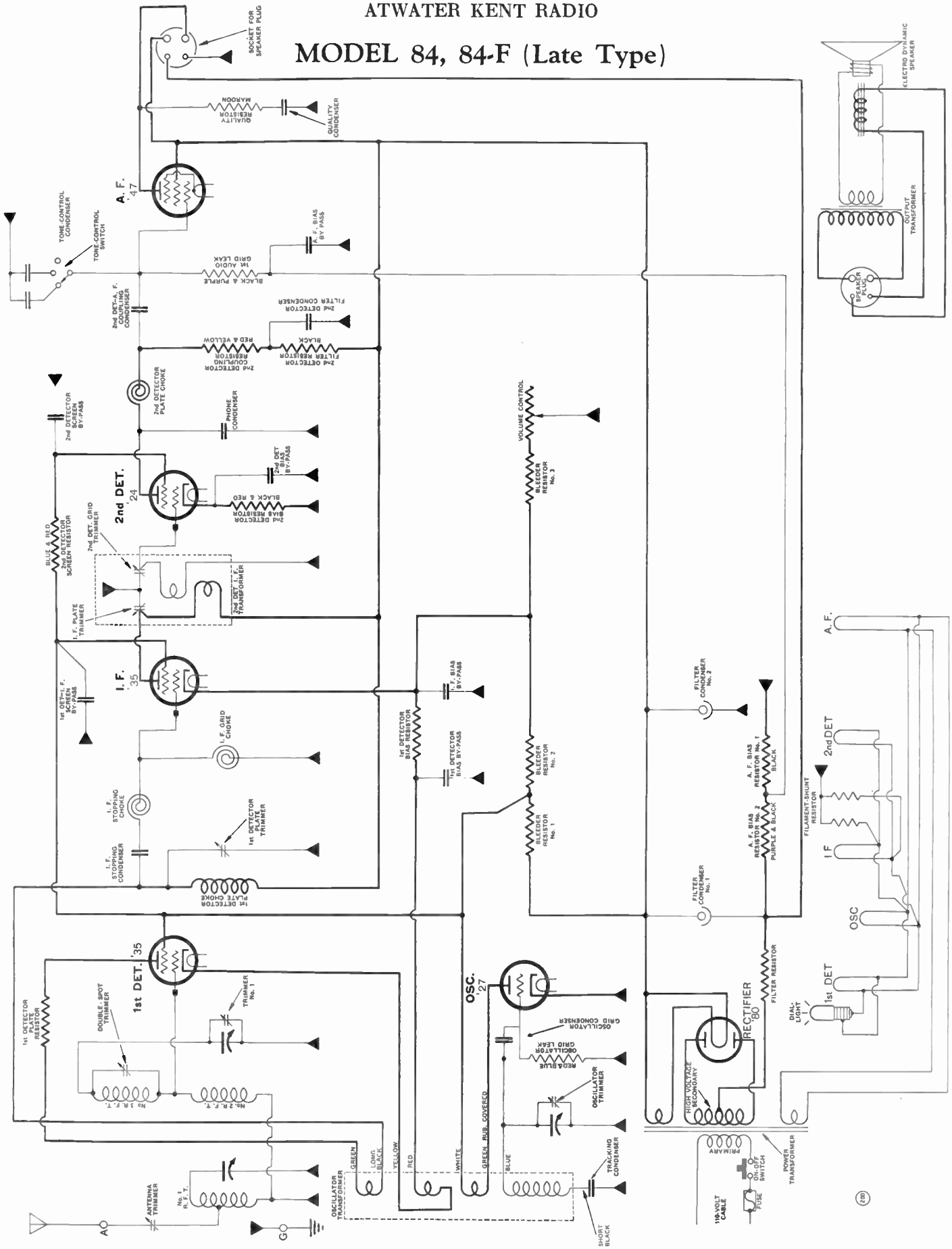


FIG. 288. DIAGRAM OF LATE-TYPE MODEL 84 AND 84-F (A. C.-OPERATED).

A few late-type Model 84 and 84-F receivers have slightly different oscillator transformers, as explained in the notes accompanying the parts list for these sets.
The filter resistor shown in the above diagram is NOT used in Model 84-F.
This set has a 1st-detector plate filter choke and condenser not shown in the diagram.

MODEL 85-Q

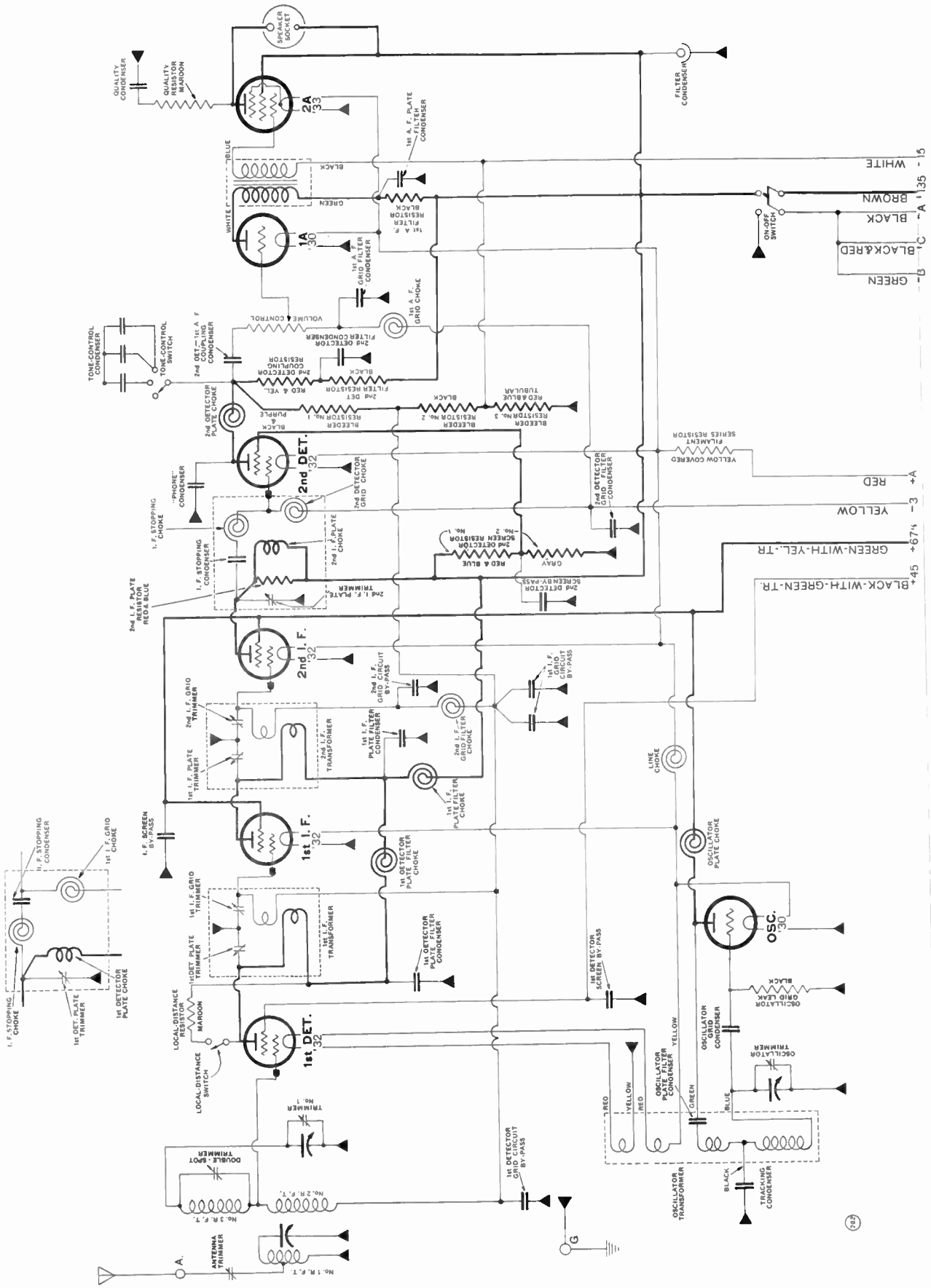


FIG. 289. DIAGRAM OF MODEL 85-Q (BATTERY-OPERATED).

In later-type Model 85-Q, the 1st-I. F. transformer is replaced by chokes and condensers, as shown in the separate drawing above the 1st-I. F. transformer. In some 85-Q sets, the colors of the primary leads of the audio input transformer are reversed.

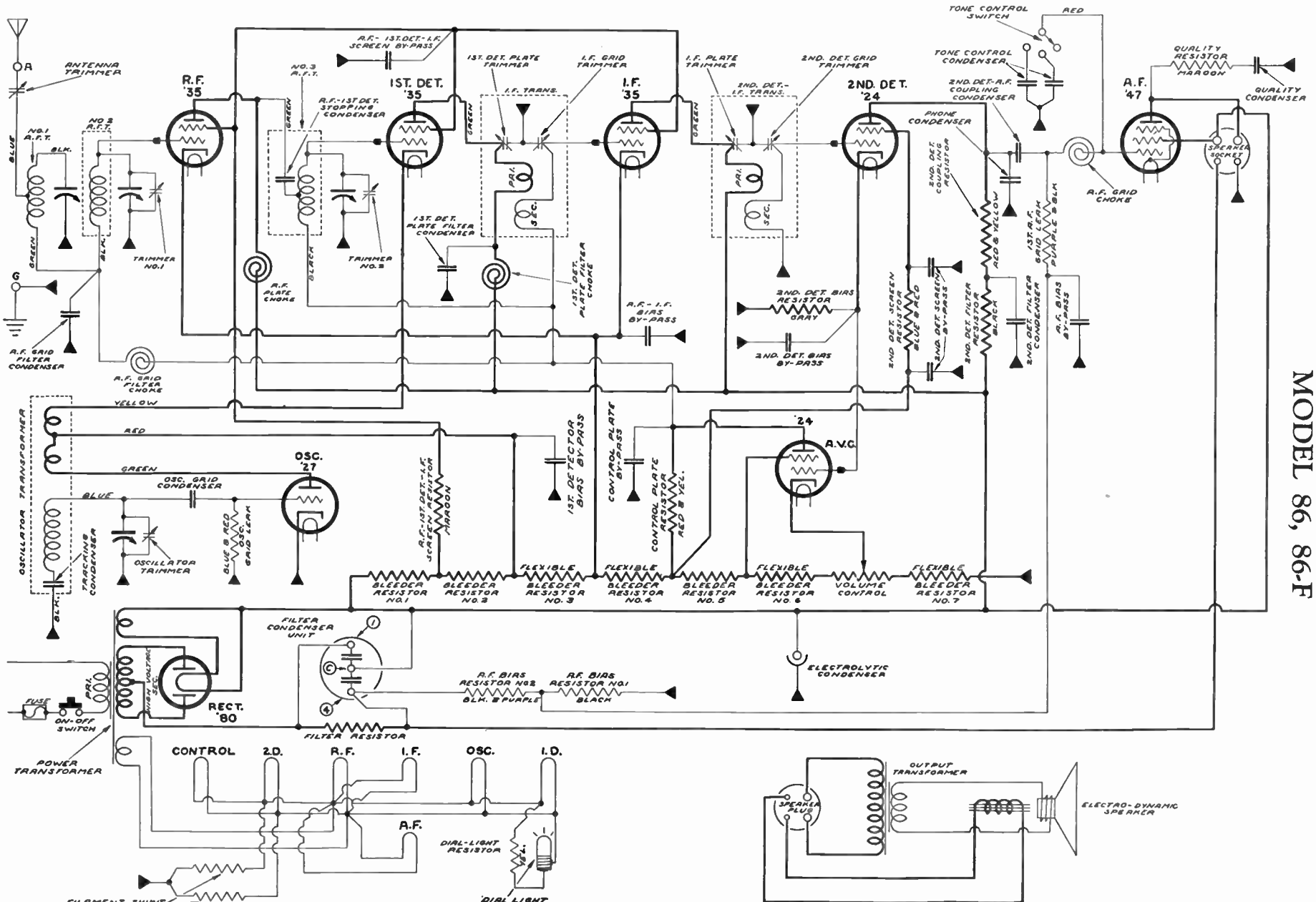


FIG. 290. DIAGRAM OF MODEL 86 AND 86-F (A. C.-OPERATED).

The filter resistor is not used in Model 86-F, and the control plate resistor is red and gray. The electrolytic condenser is listed in the Parts List as filter condenser No. 3.

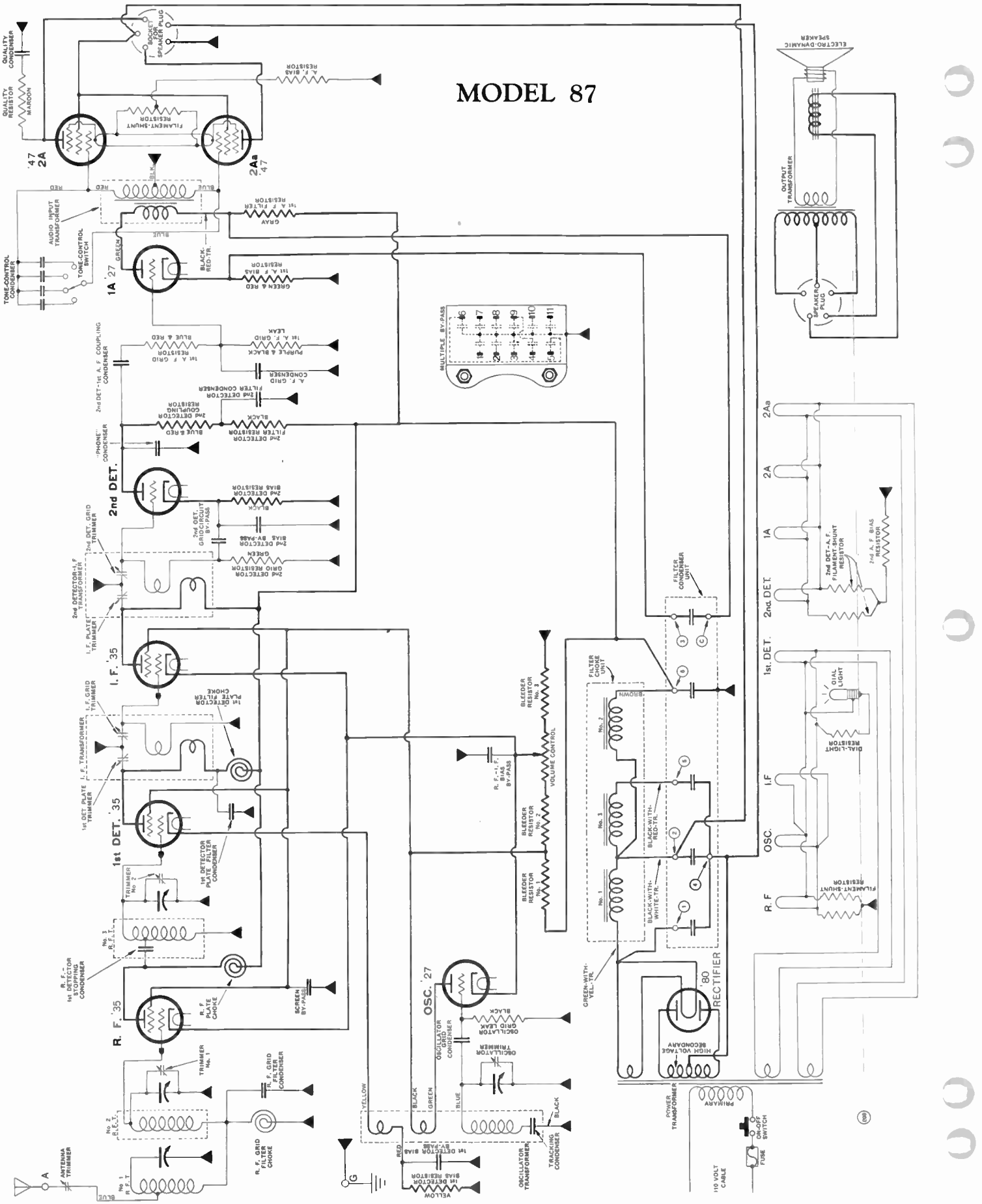


FIG. 291. DIAGRAM OF MODEL 87 (A. C.-OPERATED).

In a few early-type Model 87 receivers, No. 2 and No. 3 R. F. transformers are connected between the R. F. tube and the 1st-detector, similar to the arrangement used in early Model 89 shown in Fig. 292.

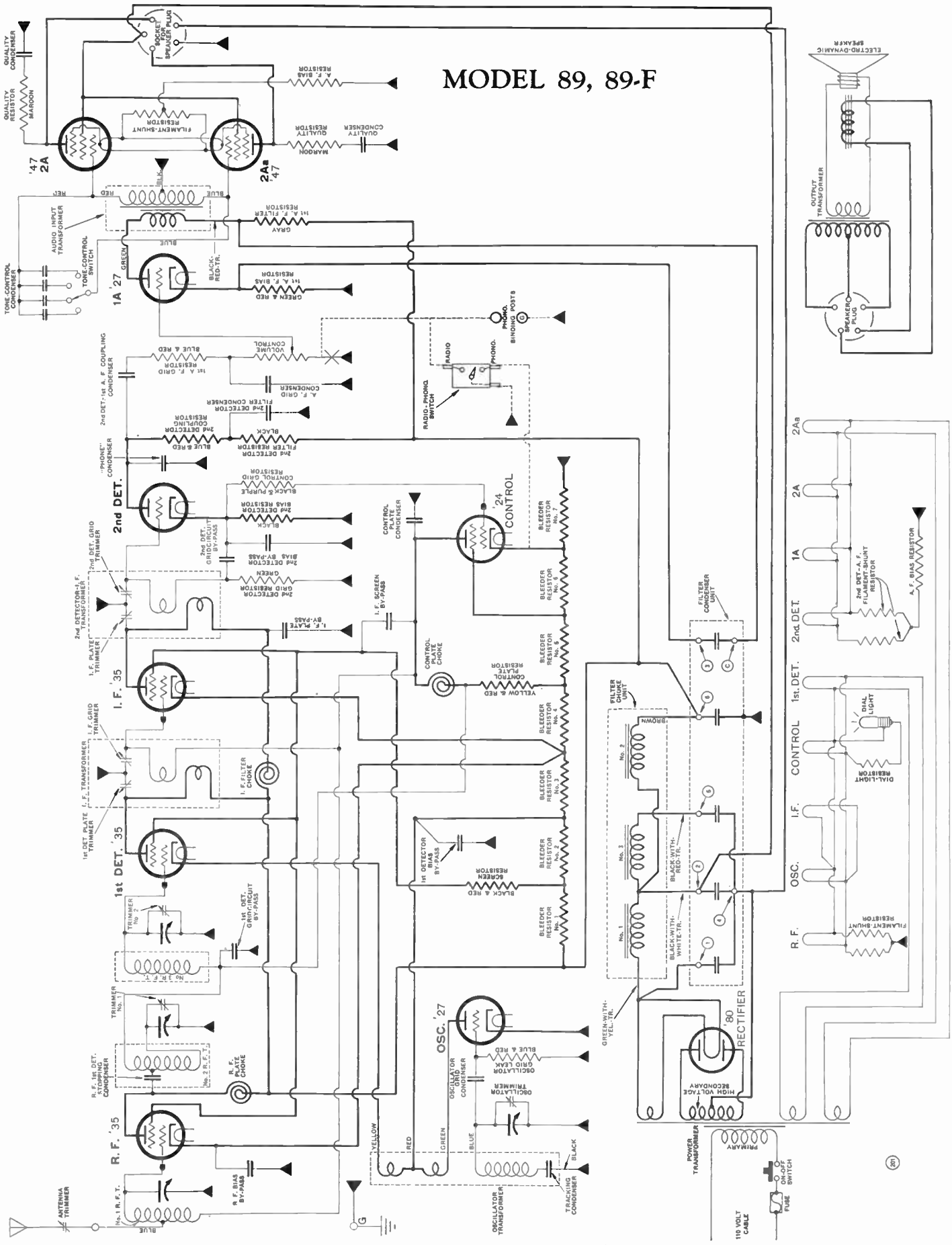


FIG. 292. DIAGRAM OF MODEL 89, 89-F, AND 89-P (A. C.-OPERATED).

IMPORTANT: The 2nd-detector grid resistor and the 2nd-detector grid-circuit by-pass are NOT used in this set, and the grid-return of the 2nd-detector connects directly to the chassis.

Later types of this Model have No. 1 and No. 2 R. F. transformers connected ahead of the R. F. tube, as shown in the diagram of Model 87 in Fig. 291.

The phonograph equipment, circuit, and parts in Model 89-P are the same as described on pages 236 to 240 of the Service Manual.

The phonograph-switching circuit in 89-P is shown above in dotted lines.

MODEL 80, 80-F, 82, 82-F TOP VIEW
MODEL 80, 80-F CHART

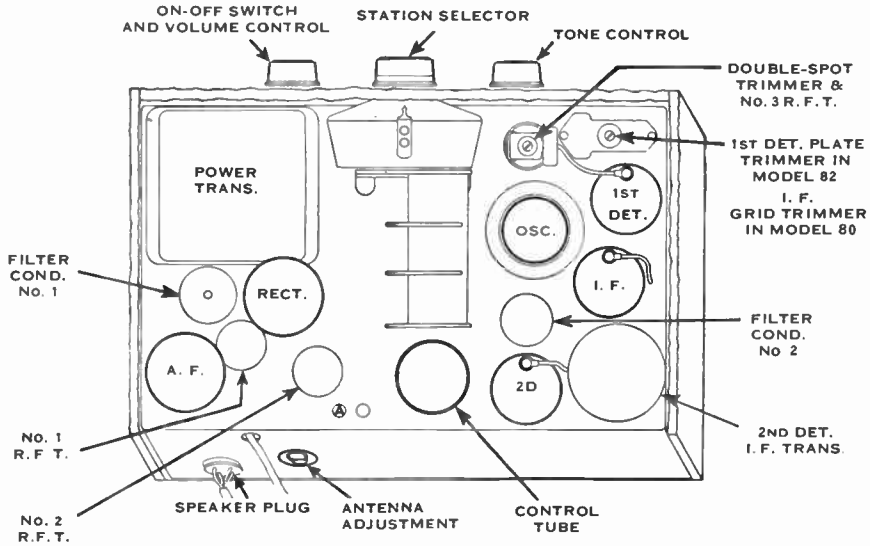


FIG. 293. TOP VIEW OF MODEL 82, 82-F.

The top view of Model 80, 80-F is similar except that it has no control tube and the position of No.1 and No. 2 R. F. T. is interchanged.

Condensers in Multiple By-pass Model 80, 80-F, 83, 83-F

1—Tone-control condenser.
2—Tone-control condenser.
3—1st-detector—I. F. screen by-pass.
4—I. F. bias by-pass.
5—2nd-detector bias by-pass.
6—Phone condenser.
7—2nd-detector—A. F. coupling condenser.
8—2nd-detector screen by-pass.
9—Quality condenser.
10—1st-detector plate filter condenser.
11—A. F. bias by-pass.
12—1st-detector bias by-pass.

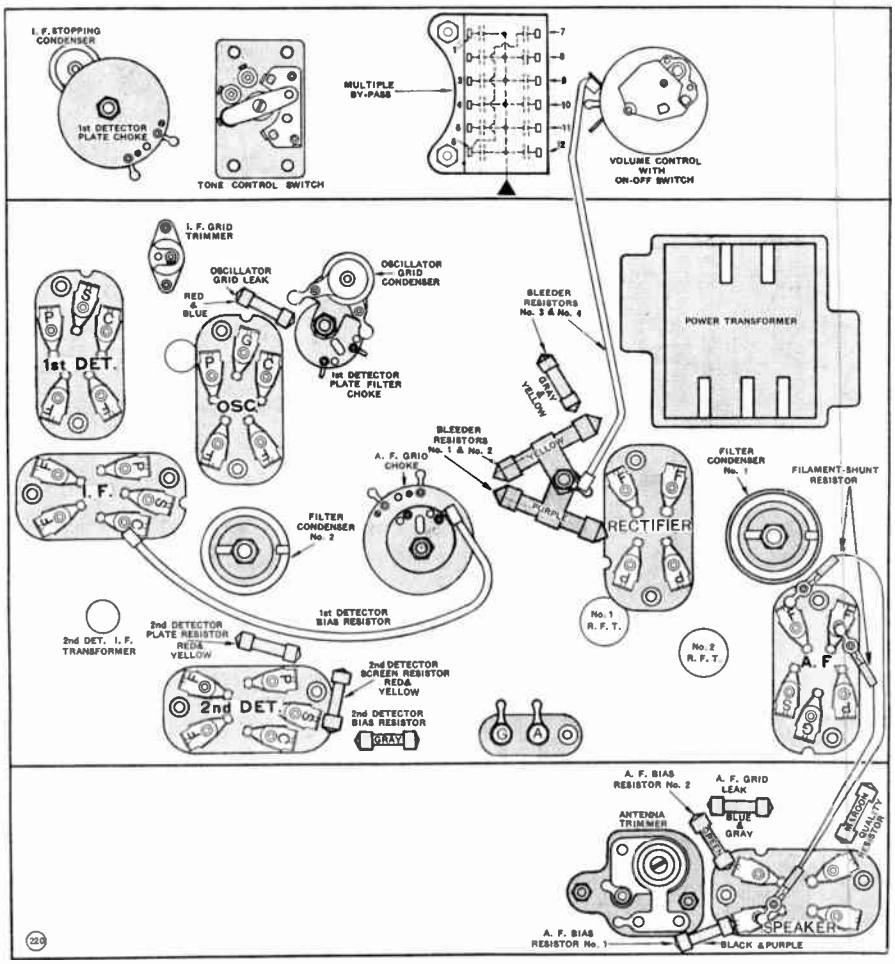


FIG. 294. CHART OF MODEL 80, 80-F.

The parts on Model 83, 83-F are similar except that Model 83, 83-F has a filter condenser unit and only one electrolytic condenser.

MODEL 83, 83-F TOP VIEW
MODEL 82, 82-F CHART

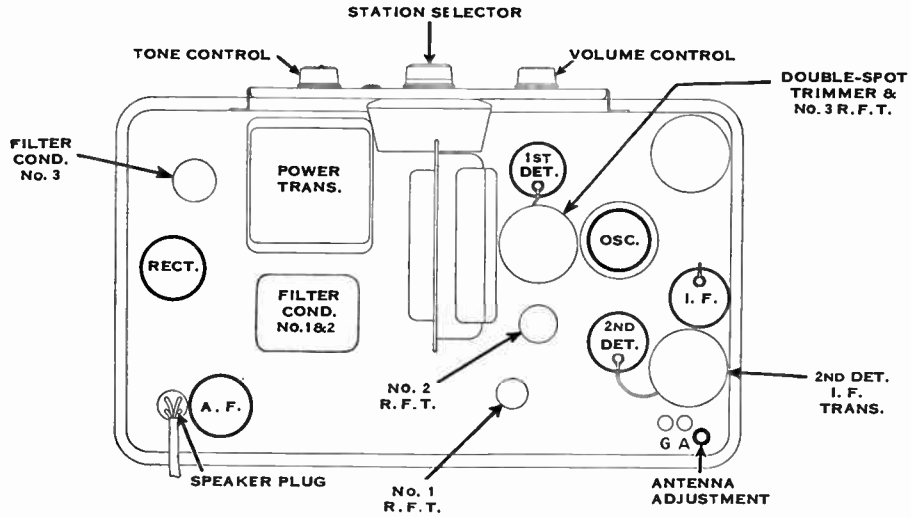
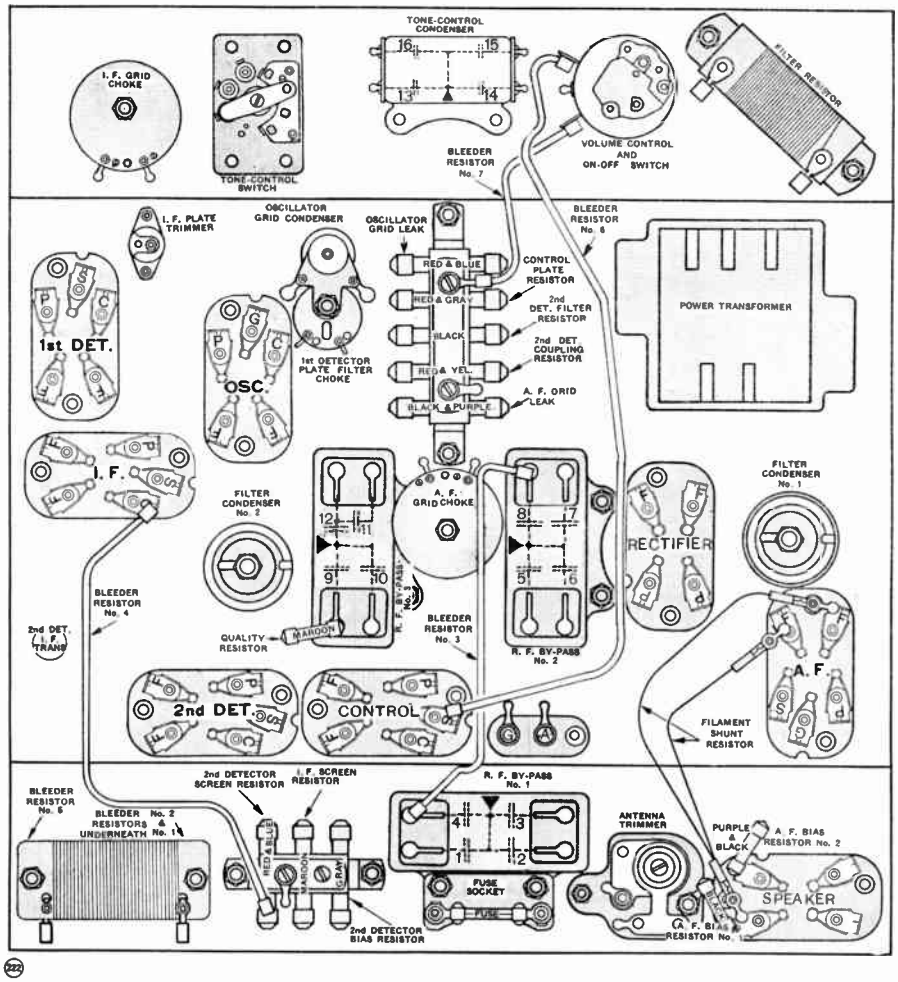


FIG. 295. TOP VIEW OF MODEL 83, 83-F.

The circle in the upper right-hand corner is the shield that covers the coupling unit between the 1st-detector and the I. F. tubes.



By-pass Condensers in Model 82, 82-F

R. F. By-pass No. 1

1—2nd-detector bias by pass.
2—Control plate by-pass.
3—Not used.
4—I. F. bias by-pass.

R. F. By-pass No. 2

5—1st-detector filter condenser.
6—1st-detector—I. F. screen by-pass.
7—2nd-detector filter condenser.
8—1st-detector bias by-pass.

R. F. By-pass No. 3

9—Quality condenser.
10—A. F. bias by-pass.
11—2nd-detector—A. F. coupling condenser.
12—Phone condenser.

Tone-control Condenser

13—Tone condenser.
14—2nd-detector screen by-pass.
15—Oscillator plate-circuit by-pass.
16—Tone condenser.

FIG. 296. CHART OF MODEL 82, 82-F.

The filter resistor is not used in Model 82-F.

MODEL 82-D TOP VIEW AND CHART

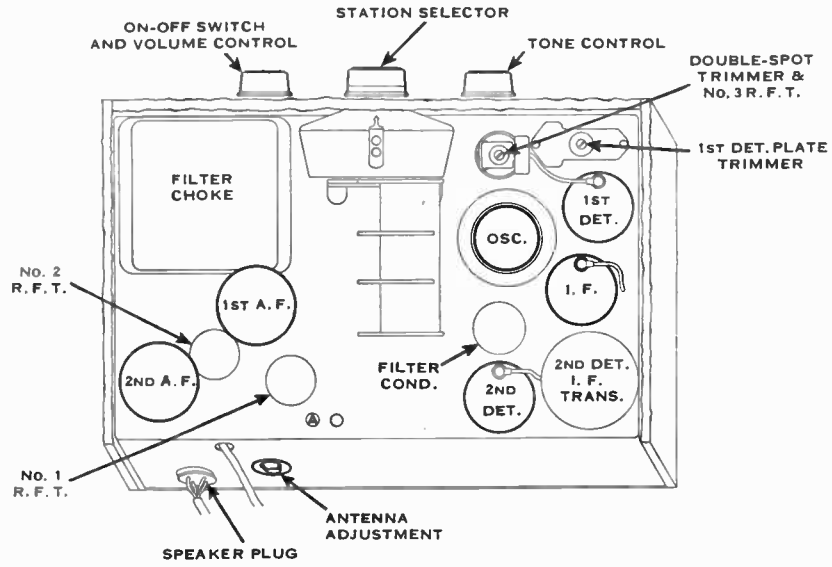


FIG. 297. TOP VIEW OF MODEL 82-D.

By-pass Condensers in Model 82-D

R. F. By-pass No. 1

1—Ground coupling condenser.
2—1st-detector screen by-pass.
3—110-volt line condenser.
4—1st-detector grid by-pass.

R. F. By-pass No. 2

5—2nd-detector—1st-A.F. coupling condenser.
6—Filter condenser No. 2.
7—Not used.

R. F. By-pass No. 3

8—Quality condenser.
9—2nd-detector filter condenser.
10—110-volt line by-pass.

Tone-control Condenser

11—Not used.
12—Tone condenser.
13—Tone condenser.
14—Tone condenser.

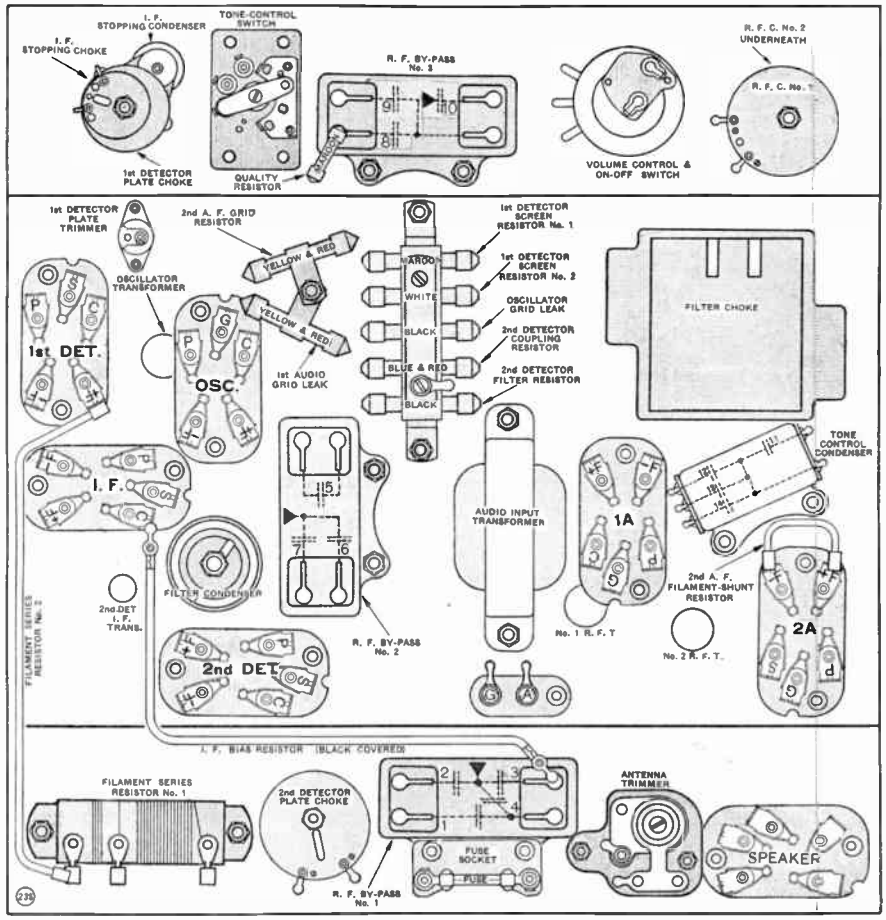


FIG. 298. CHART OF MODEL 82-D.

MODEL 82-Q TOP VIEW AND CHART

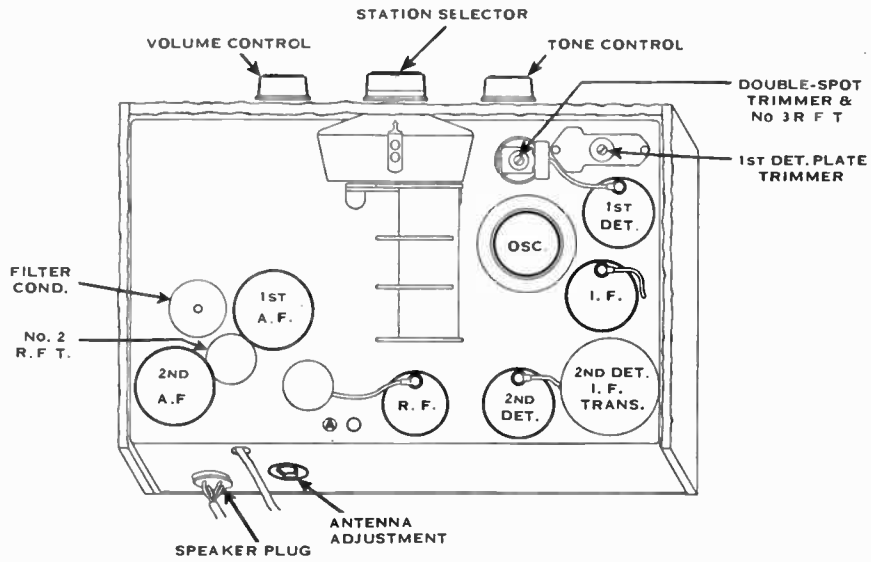


FIG. 299. TOP VIEW OF MODEL 82-Q.

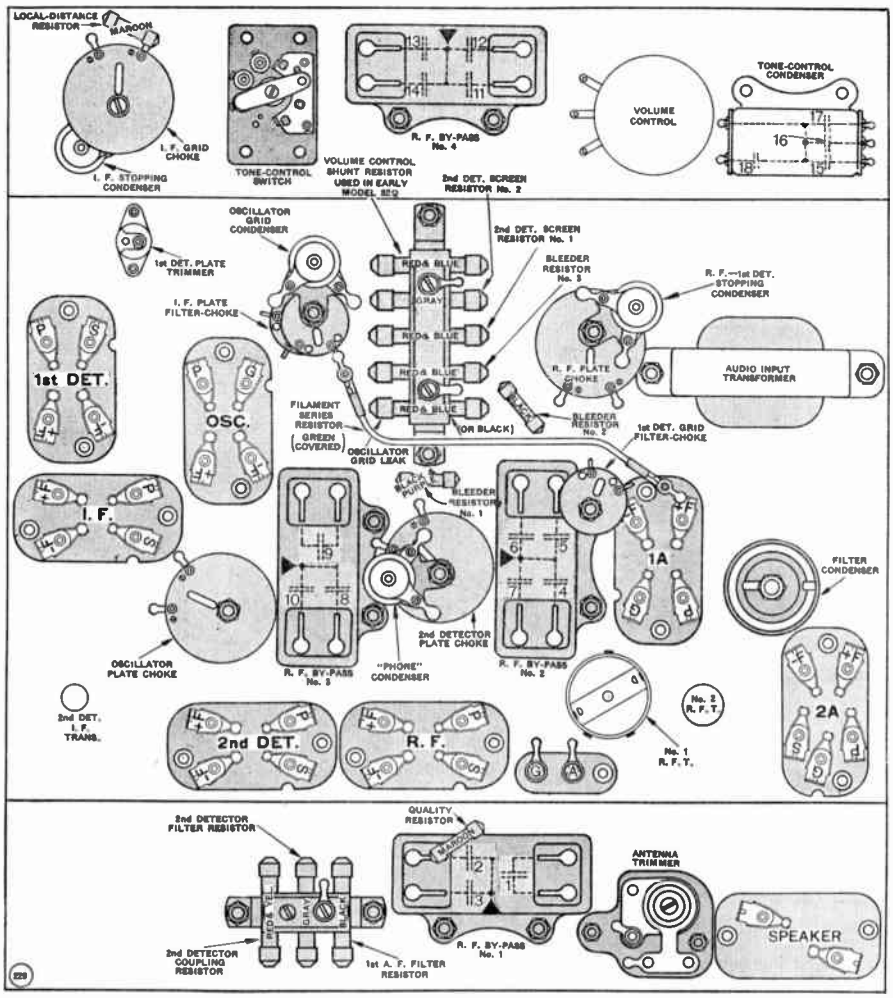


FIG. 300. CHART OF MODEL 82-Q.

By-pass Condensers in Model 82-Q

R. F. By-pass No. 1

1—Not used.
2—Quality condenser.
3—2nd-detector grid-circuit by-pass.

R. F. By-pass No. 2

4—+B filter condenser.
5—R. F. grid-circuit by-pass.
6—R. F.—I. F. screen by-pass.
7—1st-detector grid-circuit by-pass.

R. F. By-pass No. 3

8—2nd-detector filter condenser.
9—2nd-detector—1st-A. F. coupling condenser.
10—Tracking condenser.

R. F. By-pass No. 4

11—2nd-detector screen by-pass.
12—1st-A. F. filter condenser.
13—1st-detector screen by-pass.
14—I. F. plate filter condenser.

Tone-control Condenser

15—Tone condenser.
16—Tone condenser.
17—Tone condenser.
18—Not used.

MODEL 84, 84-F—TOP VIEW

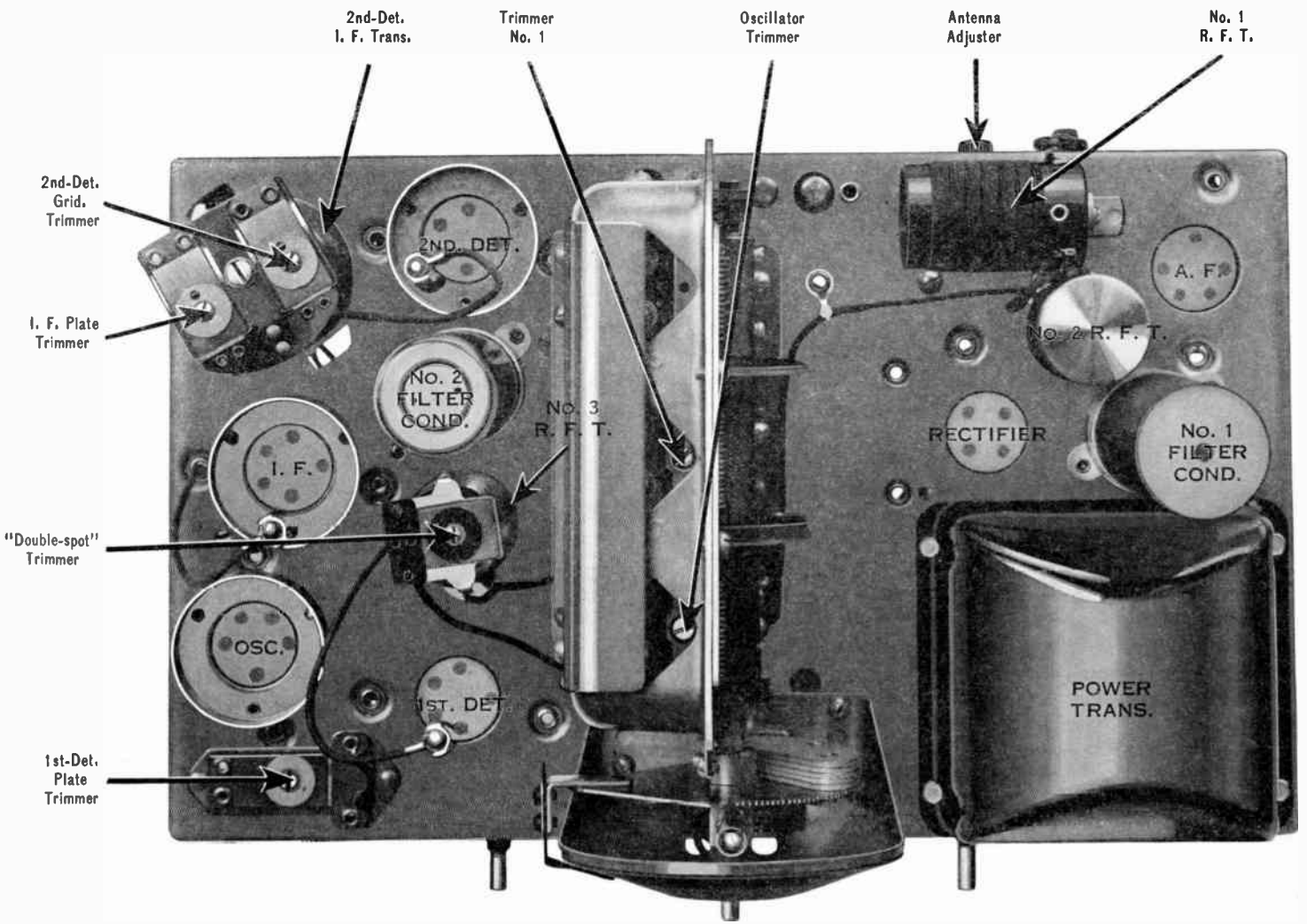


FIG. 301. TOP VIEW OF MODEL 84, 84-F CHASSIS.

MODEL 84, 84-F CHARTS

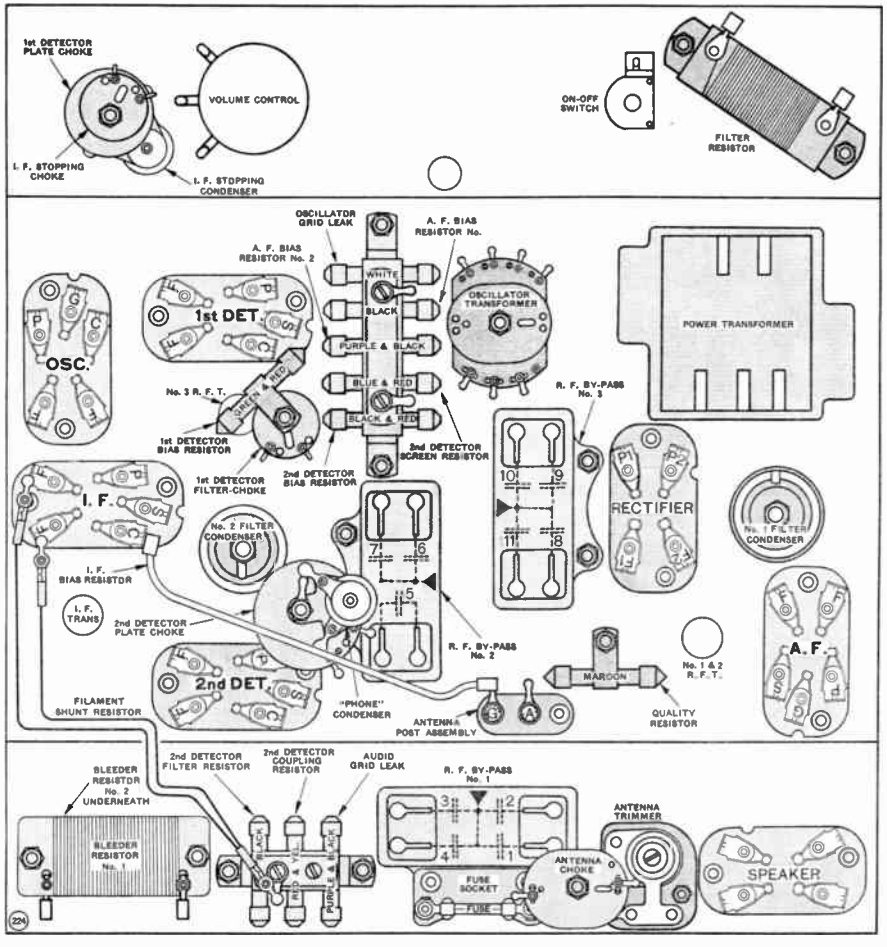


FIG. 302. CHART OF EARLY-TYPE MODEL 84, 84-F.

In some early-type Model 84, 84-F, the 1st-detector bias resistor is a flexible type, and the quality resistor is wire-wound. These are both superseded by the tubular resistors indicated above.
The filter-resistor at top-right is NOT used in any Model 84-F.

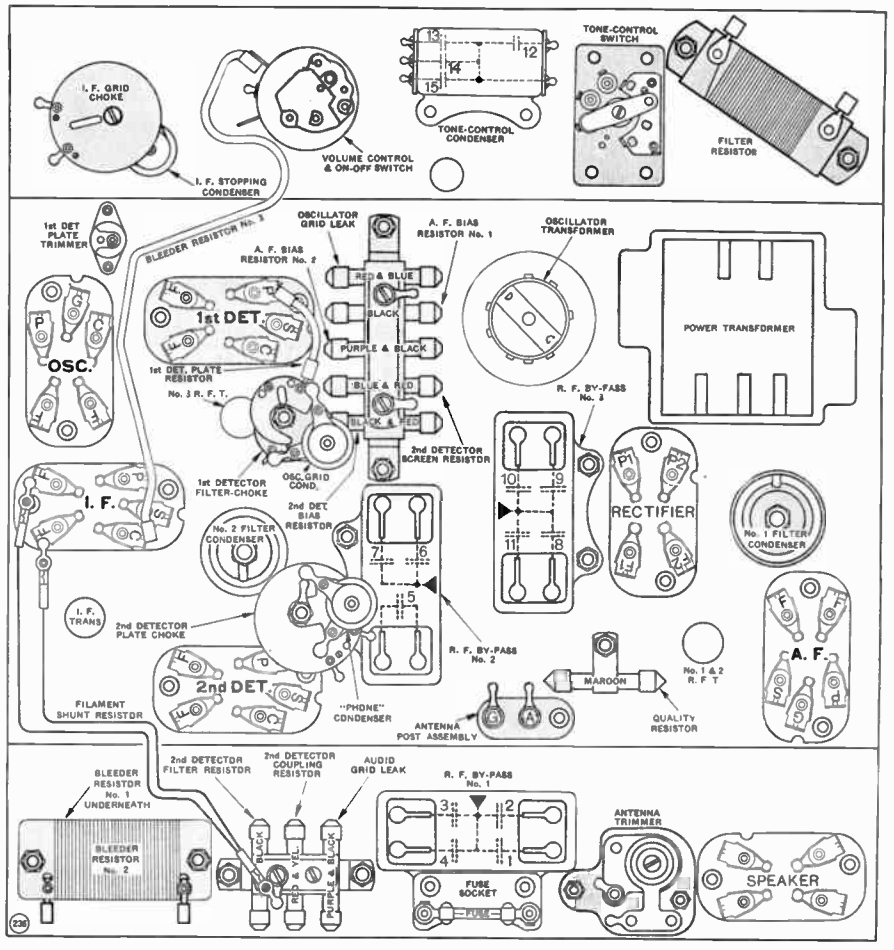


FIG. 303. CHART OF LATE-TYPE MODEL 84, 84-F.

Some late-type Model 84, 84-F receivers have slightly different oscillator transformers and connections than indicated in the diagram Fig. 288. When servicing such sets, carefully note and adhere to the original method of wiring. A flexible type 1st-detector bias resistor (not shown above) is connected from condenser 9 to condenser 3.

By-pass Condensers in Model 84, 84-F.

R. F. By-pass No. 1

1—2nd-detector filter condenser.
2—Quality condenser.
3—I. F. bias by-pass.
4—A. F. bias by-pass.

R. F. By-pass No. 2

5—2nd-detector—A. F. coupling condenser.
6—Tracking condenser.
7—2nd-detector bias by-pass.

R. F. By-pass No. 3

8—1st-detector filter condenser.
9—1st-detector bias by-pass.
10—1st-detector—I. F. screen by-pass.
11—2nd-detector screen by-pass.

Tone-control Condenser
(used only in late type)

12—Not used.
13—Tone-control condenser.
14—Not used.
15—Tone-control condenser.

MODEL 84-D TOP VIEW AND CHART

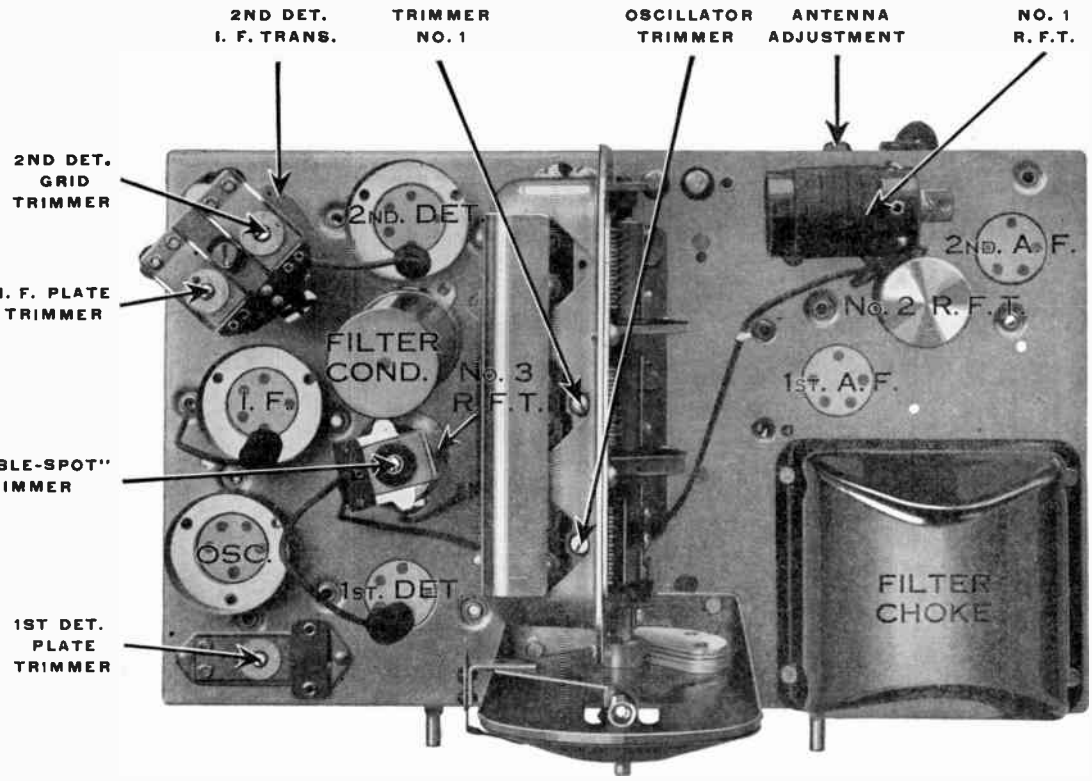


FIG. 304. TOP VIEW OF MODEL 84-D.

By-pass Condensers in Model 84-D

Condensers in R. F. By-pass No. 1

1—Ground coupling condenser.
2—1st-detector screen by-pass.
3—110-volt line condenser.
4—1st-detector grid by-pass.

R. F. By-pass No. 2

5—2nd-detector—1st-A. F. coupling condenser.
6—Filter condenser No. 2.
7—Tracking condenser.

R. F. By-pass No. 3

8—Quality condenser.
9—2nd-detector filter condenser.
10—2nd-A. F. grid condenser in early-type sets, 2nd-detector phone condenser in later-type sets.

Tone-control Condenser (Late-type sets only)

11—Not used.
12—Tone condenser.
13—Tone condenser.
14—Tone condenser.

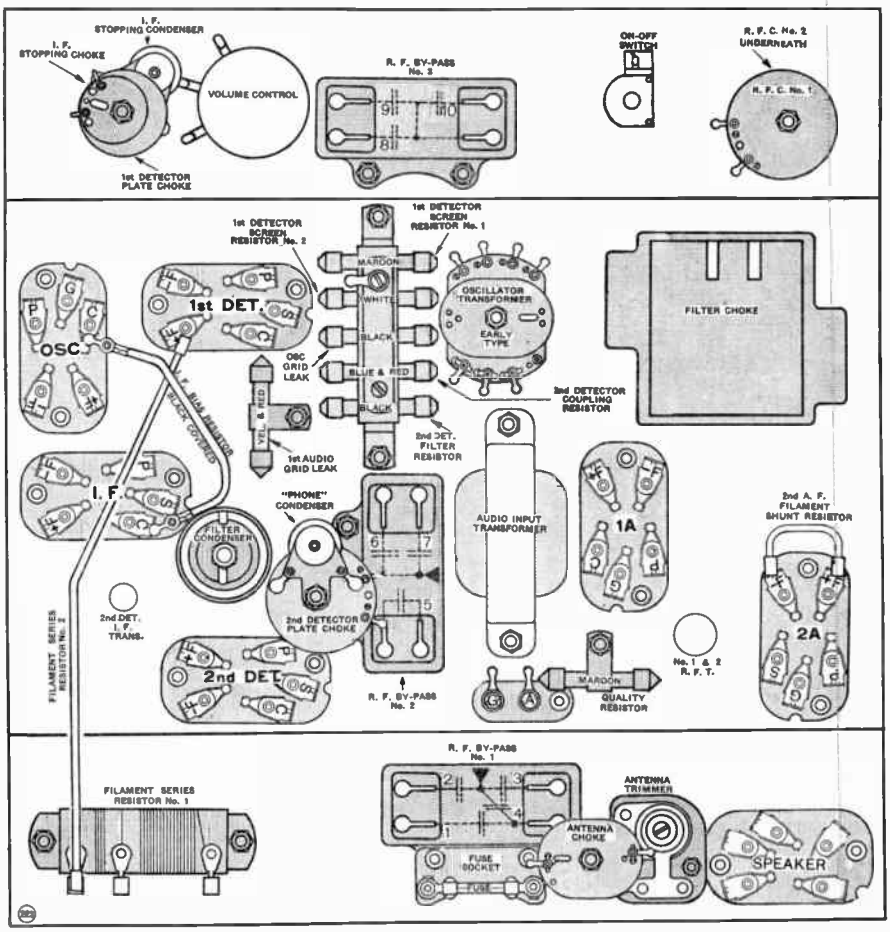


FIG. 305. CHART OF MODEL 84-D. (EARLY TYPE WITHOUT TONE CONTROL.)

MODEL 84-Q TOP VIEW AND CHART

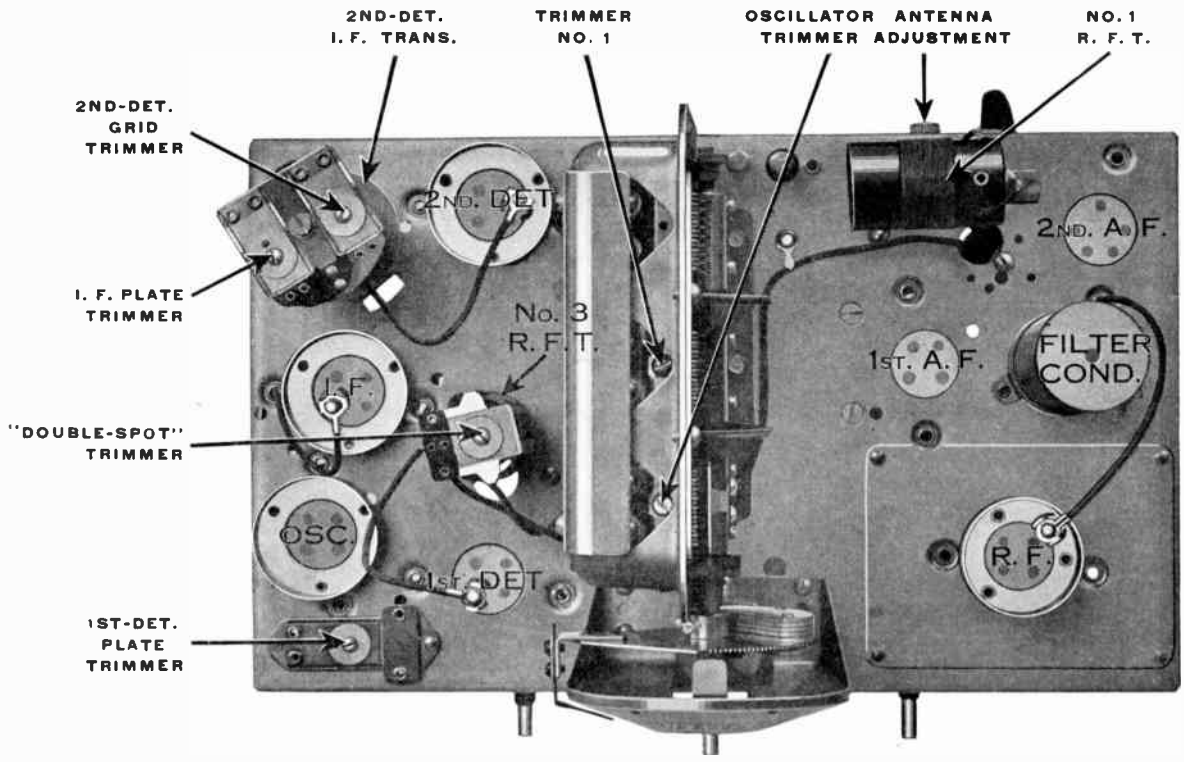


FIG. 306. TOP VIEW OF MODEL 84-Q.

In a few early-model 84-Q receivers, the position of the R. F. and the 1st-A. F. socket is interchanged.

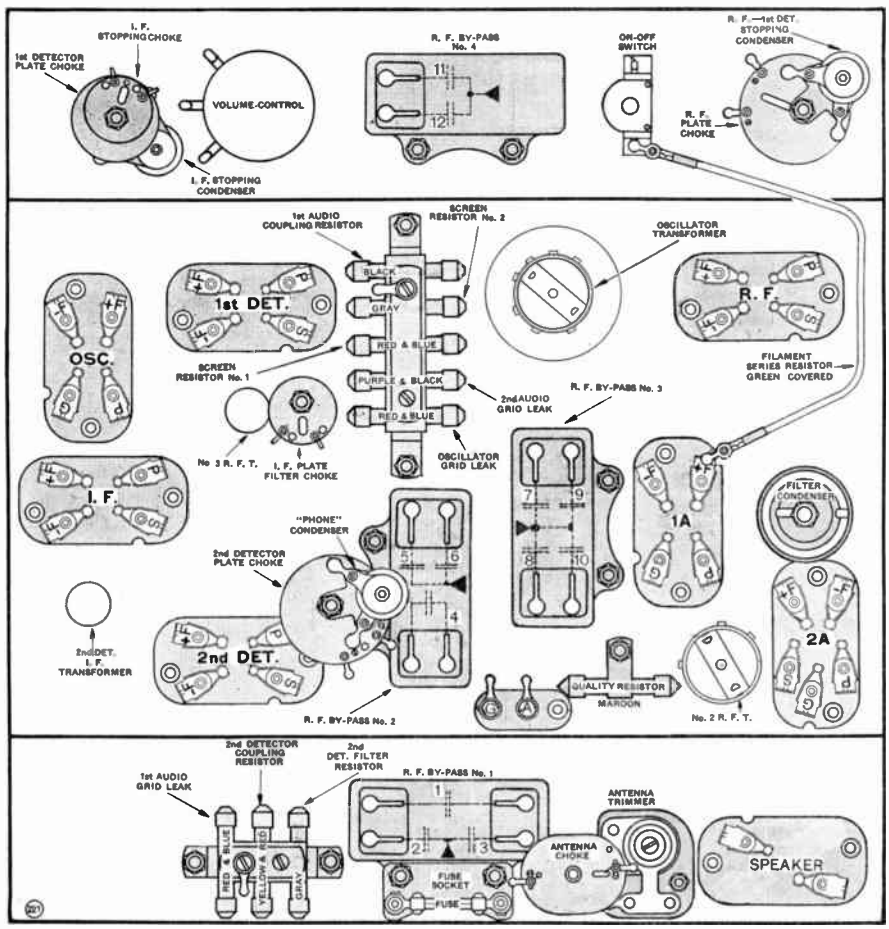


FIG. 307. CHART OF MODEL 84-Q. (EARLY TYPE WITHOUT TONE CONTROL.)

By-pass Condensers in Model 84-Q

R. F. By-pass No. 1

1—1st-2nd A. F. coupling condenser.
2—Phone condenser.
3—Quality condenser.

R. F. By-pass No. 2

4—2nd-detector—1st-A. F. coupling condenser.
5—2nd-detector filter condenser.
6—Tracking condenser.

R. F. By-pass No. 3

7—R. F.-I. F. screen by-pass.
8—I. F. plate filter condenser.
9—1st-detector—2nd-detector screen by-pass.
10—+B filter condenser.

R. F. By-pass No. 4 (Later 84-Q only)

11—R. F. filament by-pass.
12—R. F. filament by-pass.

MODEL 85, 85-F TOP VIEW AND CHART

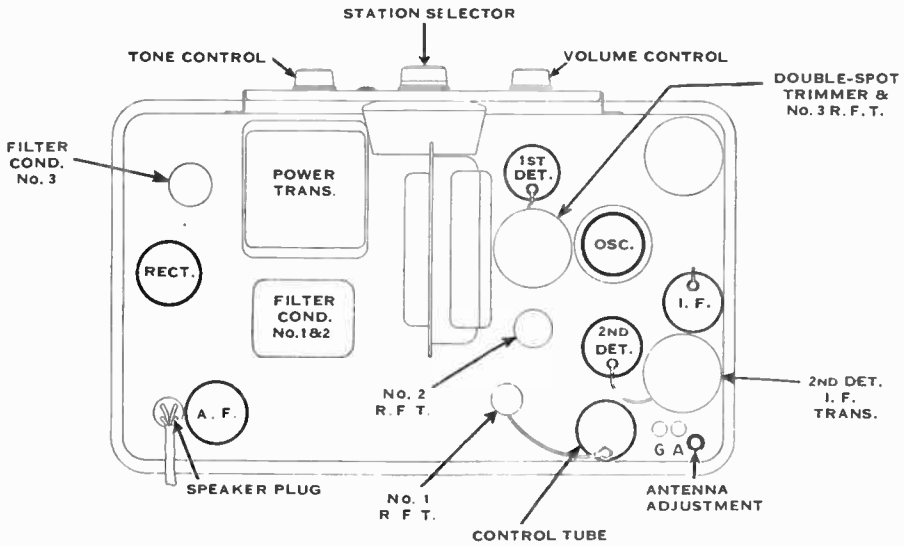


FIG. 308. TOP VIEW OF MODEL 85, 85-F.

The circle in the top right corner represents the shield for the coupling unit between the 1st-detector and I. F. tubes.

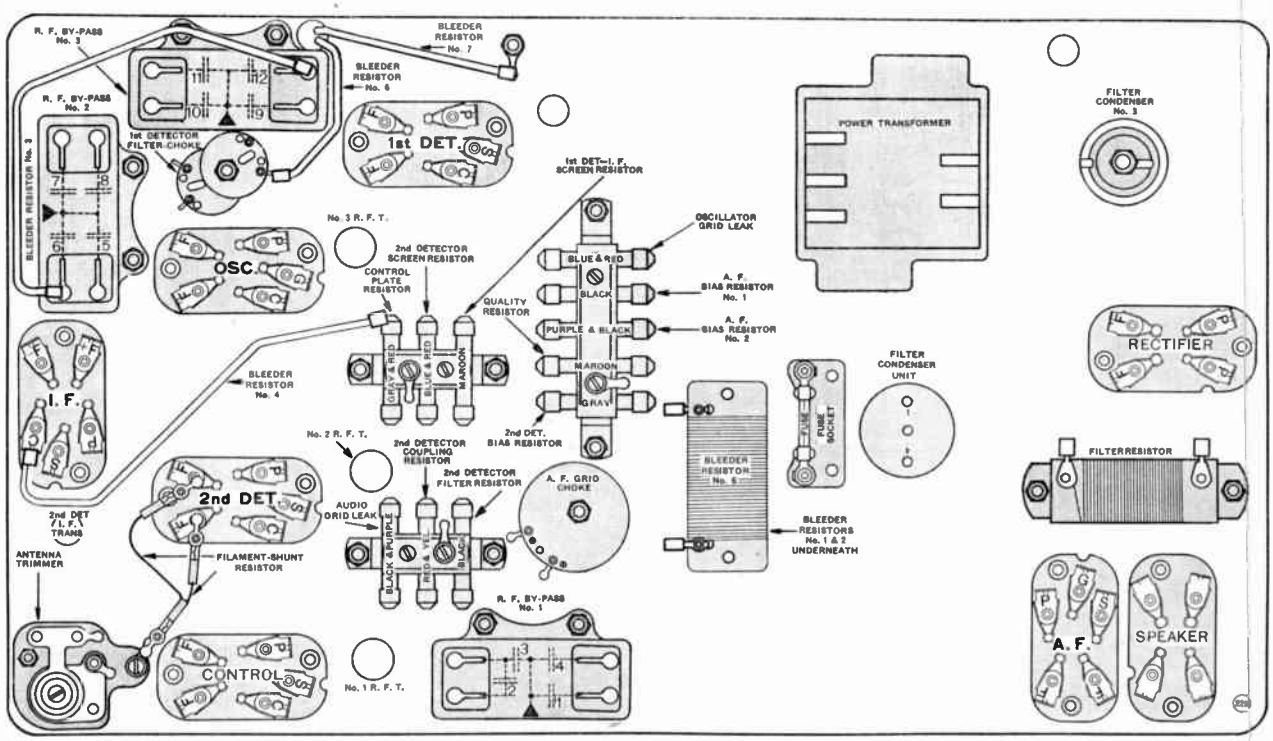


FIG. 309. CHART OF MODEL 85, 85-F.

The filter resistor is not used in Model 85-F.

By-pass Condensers in Model 85, 85-F

R. F. By-pass No. 1

1—Quality condenser.
2—2nd-detector—A. F. coupling condenser.
3—Phone condenser.
4—2nd-detector bias by-pass.

R. F. By-pass No. 2

5—A. F. bias by-pass.
6—I. F. bias by-pass.
7—Tracking condenser.
8—Control-plate by-pass.

R. F. By-pass No. 3

9—1st-detector—I. F. screen by-pass.
10—2nd-detector filter condenser.
11—1st-detector filter condenser
12—1st-detector bias by-pass.

Tone-control Condenser (on front panel)

Two top contacts—2nd-detector screen by-pass and oscillator plate-circuit by-pass.
Two bottom contacts—tone-control condensers.

MODEL 85-Q TOP VIEW AND CHART

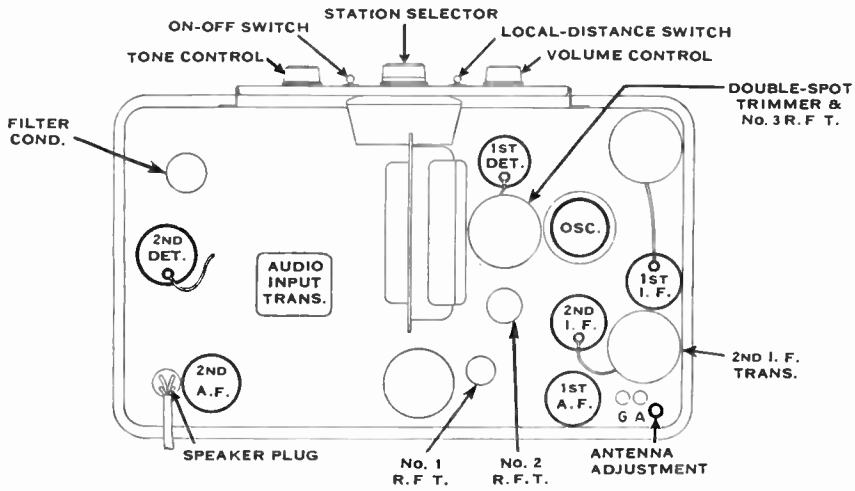


FIG. 310. TOP VIEW OF MODEL 85-Q.

The circle in the top right corner indicates the shield for the coupling unit between the 1st-detector and the 1st-I. F. tubes. The circle in the bottom center is the shield covering the coupling unit between the 2nd-I. F. and the 2nd-detector tubes.

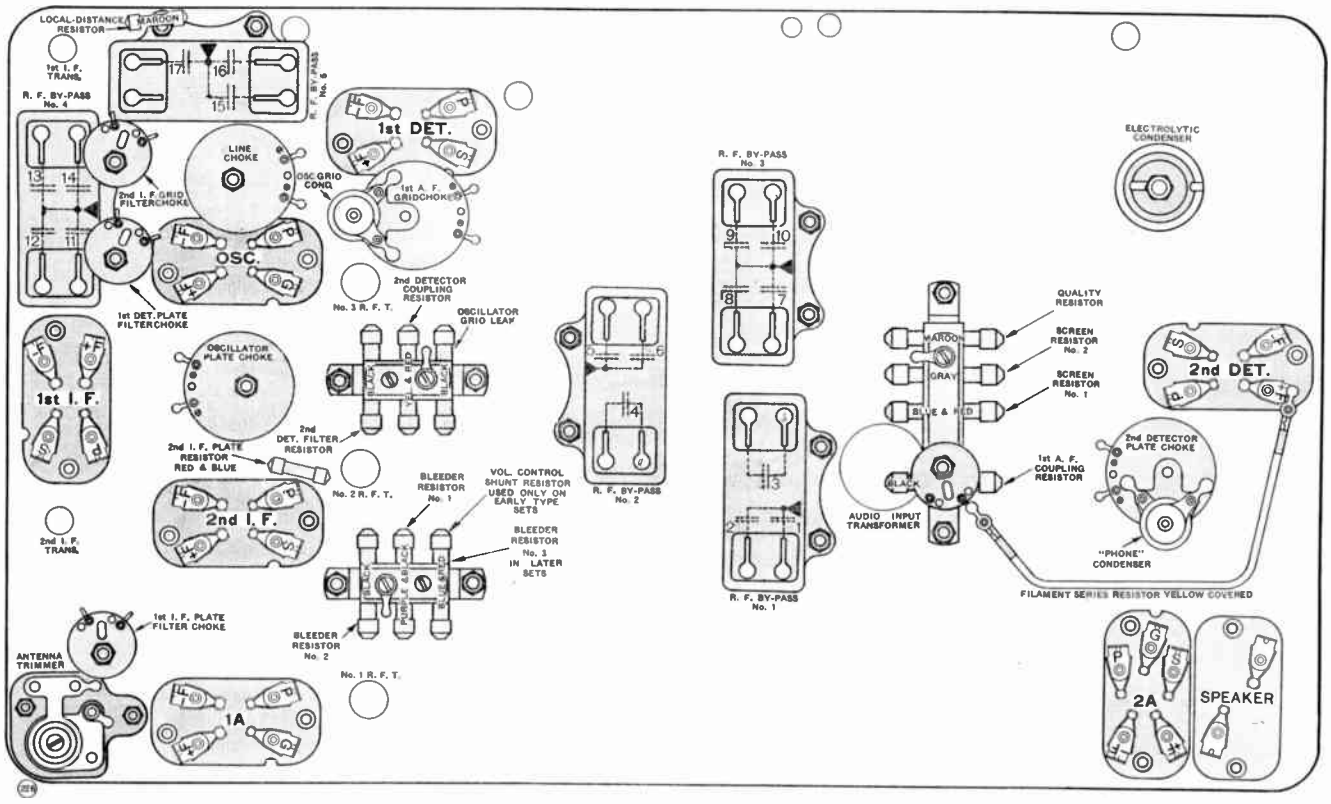


FIG. 311. CHART OF MODEL 85-Q.

By-pass Condensers in Model 85-Q.

R. F. By-pass No. 1

1—1st-detector grid-circuit by-pass.
2—Quality condenser.
3—Not used.

R. F. By-pass No. 2

4—2nd-detector—1st-A. F. coupling condenser.
5—1st-A. F. grid filter condenser.
6—Tracking condenser.

R. F. By-pass No. 3

7—2nd-detector grid filter condenser.
8—2nd-detector screen by-pass.
9—2nd-detector filter condenser.
10—1st-A. F. plate filter condenser.

R. F. By-pass No. 4

11—1st-I. F. plate filter condenser.
12—I. F. screen by-pass.
13—2nd-I. F. grid-circuit by-pass.
14—1st-I. F. grid-circuit by-pass.

R. F By-pass No. 5

15—1st-detector screen by-pass.
16—1st-I. F. grid-circuit by-pass.
17—1st-detector plate filter condenser.

MODEL 86, 86-F TOP VIEW AND CHART

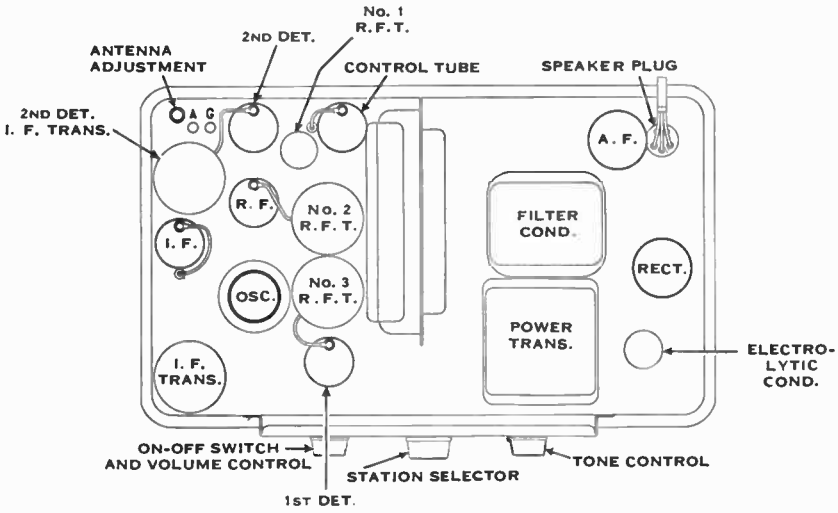


FIG. 312. TOP VIEW OF MODEL 86, 86-F.

The speaker plug has only four prongs instead of five, as indicated above.

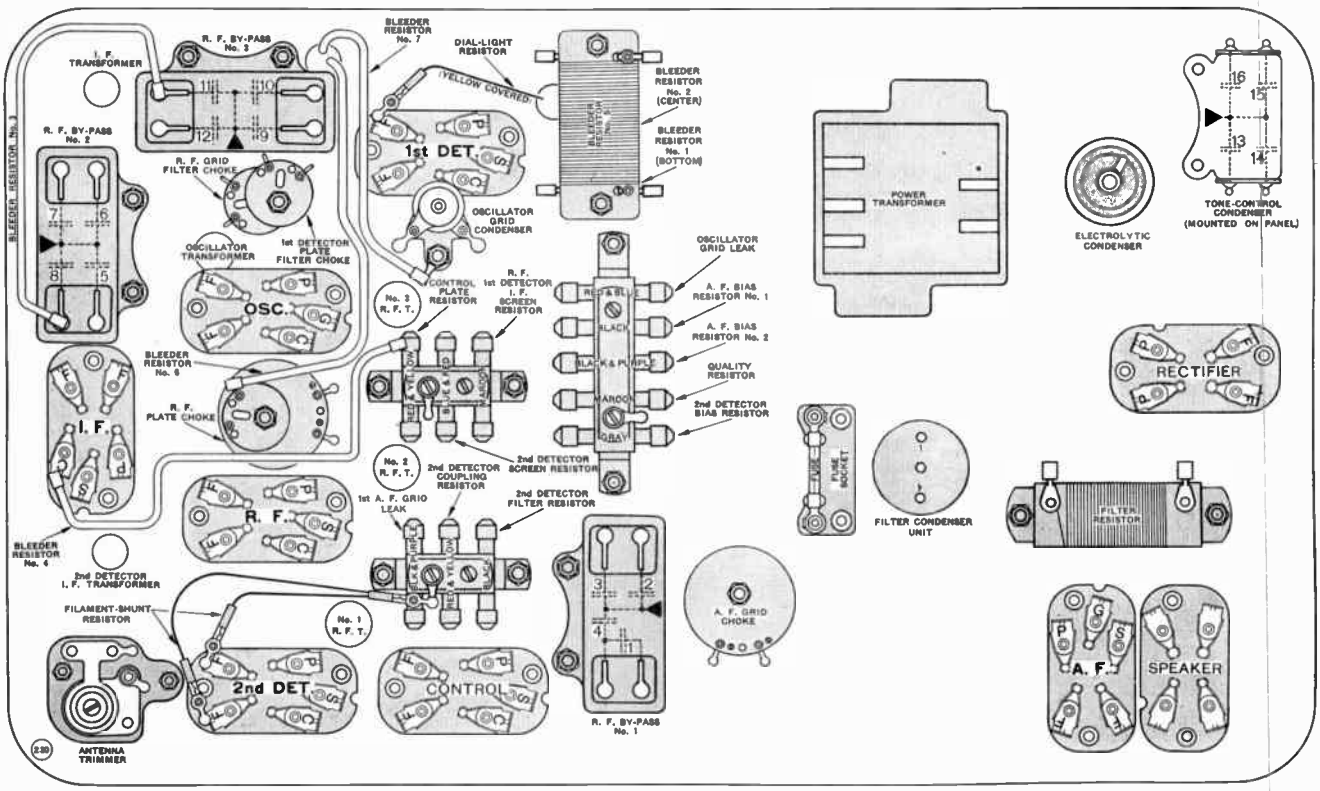


FIG. 313. CHART OF MODEL 86, 86-F.

The filter resistor is not used in Model 86-F.

By-pass Condensers in Model 86, 86-F

R. F. By-pass No. 1

1—2nd-detector—A. F. coupling condenser.
2—Quality condenser.
3—2nd-detector bias by-pass.
4—Phone condenser.

R. F. By-pass No. 2

5—A. F. bias by-pass.
6—R. F. grid filter condenser.
7—Control plate by-pass.
8—R. F.—I. F. bias by-pass.

R. F. By-pass No. 3

9—1st-detector plate filter condenser.
10—R. F.-1st-detector—I. F. screen by-pass.
11—1st-detector bias by-pass.
12—2nd-detector filter condenser.

Tone-control Condenser

13—Tone-control condenser.
14—Tone-control condenser.
15—2nd-detector screen by-pass.
16—2nd-detector screen by-pass.

MODEL 87 TOP VIEW AND CHART

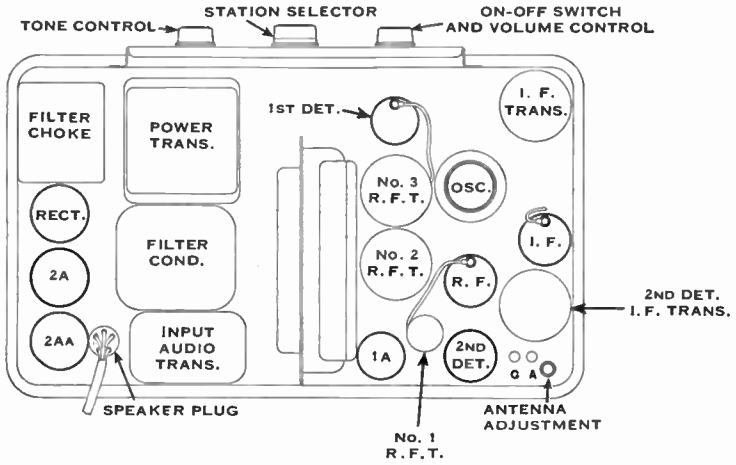


Fig. 314. Top View of Model 87.

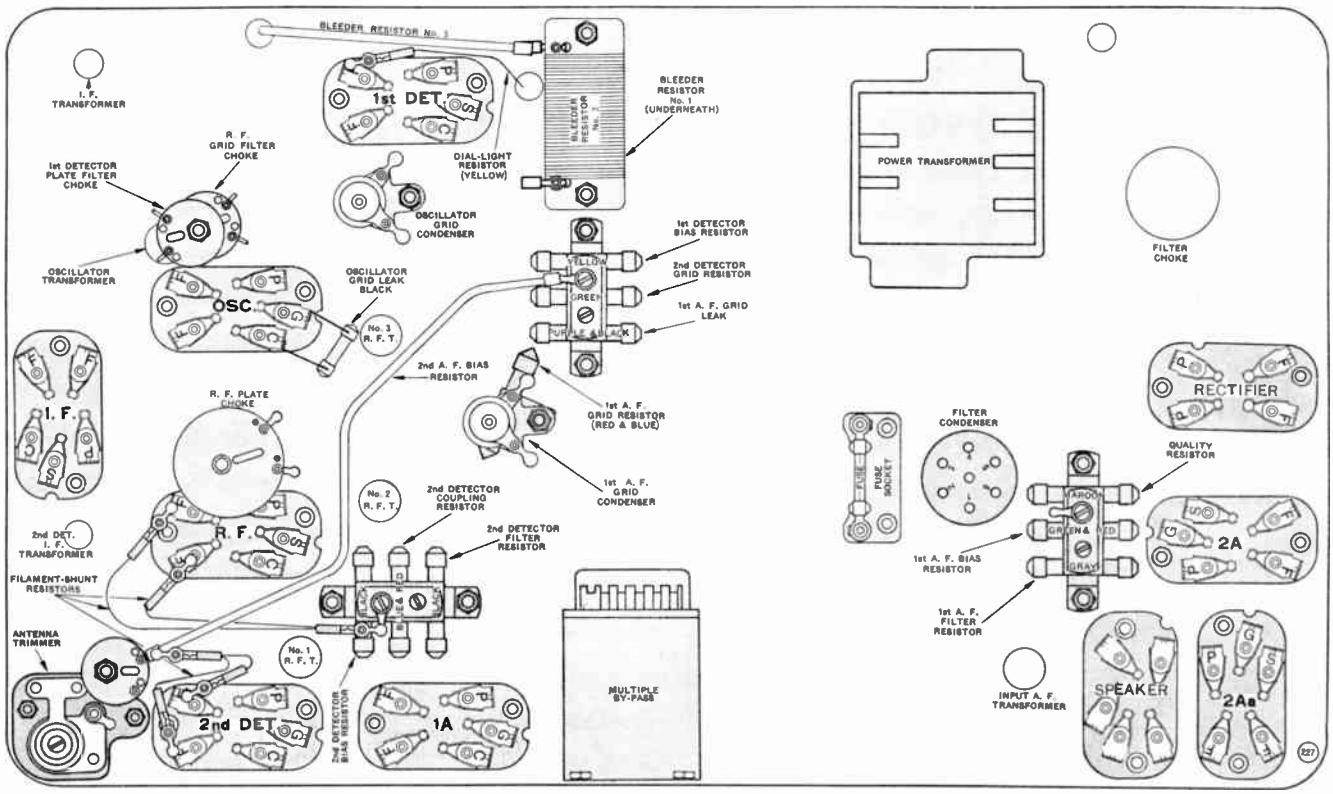


Fig. 315. Chart of Model 87.

Condensers in Multiple By-pass Model 87

The internal connections of the multiple by-pass are shown on page 292.

1—1st-detector plate filter condenser.
2—1st-detector bias by-pass.
3—R. F.—1. F. bias by-pass.
4—2nd-detector grid-circuit by-pass.
5—2nd-detector—1st-A. F. coupling condenser.
6—Phone condenser.
7—R. F. grid filter condenser.
8—Quality condenser.
9—2nd-detector bias by-pass.
10—2nd-detector filter condenser.
11—R. F.—1st-detector—I. F. screen by-pass.

MODEL 89, 89-F TOP VIEW AND CHART

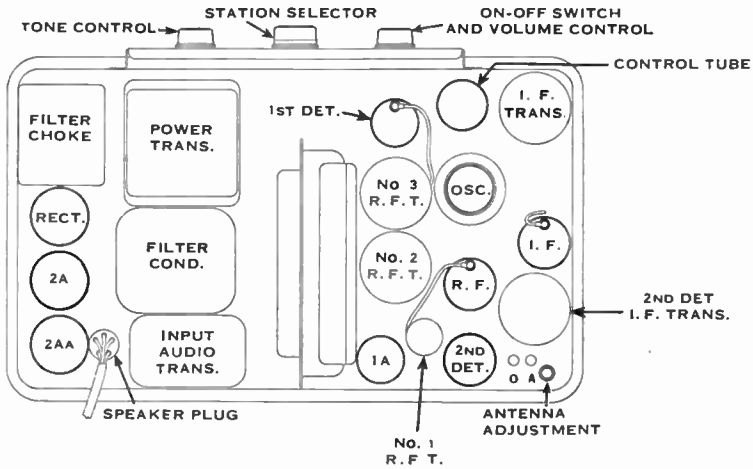


FIG. 316. TOP VIEW OF MODEL 89, 89-F.

Model 89-P has two binding posts for pick-up connection at the rear of the chassis, and a radio-phono toggle switch is mounted on the front panel.

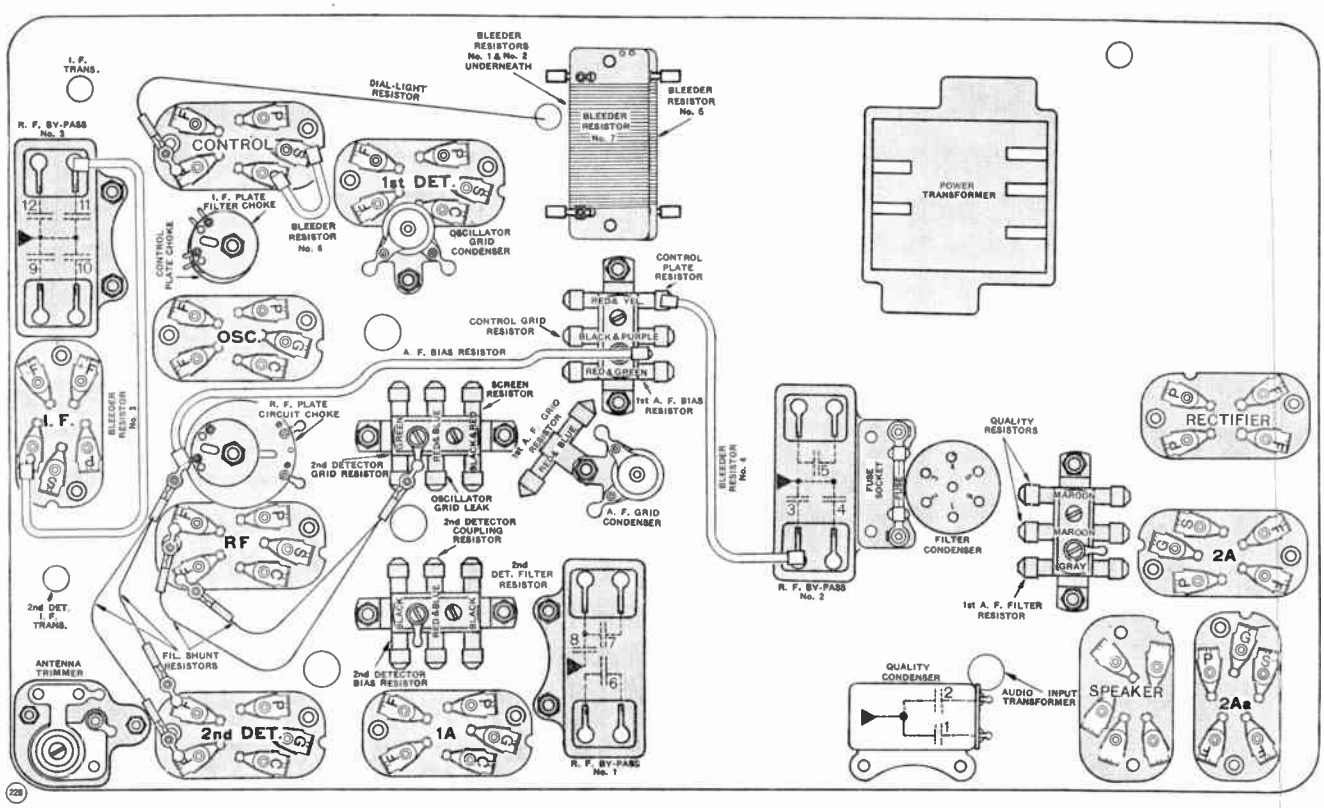


FIG. 317. CHART OF MODEL 89, 89-F.

The 2nd-detector grid resistor is not used in late-type Model 89, 89-F, 89-P.

By-pass Condensers in Model 89, 89-F, 89-P

Quality Condenser

1—Quality condenser.
2—Quality condenser.

R. F. By-pass No. 1

6—2nd-detector—1st-A. F. coupling condenser.
7—2nd-detector grid-circuit by-pass.
8—2nd-detector bias by-pass.
(A small "phone" condenser, not shown, is connected internally to the lower-left terminal of by-pass No. 1.)

R. F. By-pass No. 2

3—R. F. bias-by-pass.
4—2nd-detector filter condenser.
5—I. F. screen by-pass.

R. F. By-pass No. 3

9—I. F. plate by-pass.
10—1st-detector grid-circuit by-pass.
11—1st-detector bias by-pass.
12—Control-plate condenser.

ILLUSTRATIONS OF SPEAKERS IN A. C.- AND BATTERY-OPERATED COMPACT MODELS

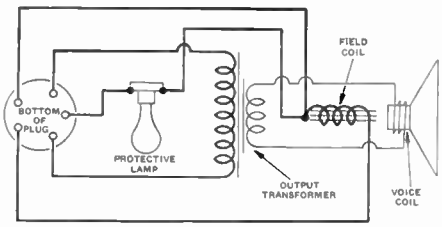


FIG. 318. CIRCUIT OF SPEAKER USED IN MODEL 82-D, 84-D.

The protective lamp (75 watts) is connected in series with the electrolytic filter condenser in the chassis. If the 110-volt D. C. supply plug is reversed, the lamp will light. When the 110-volt plug is properly inserted, the lamp does not light. This action is due to the fact that the electrolytic condenser passes current if the polarity of the applied D. C. voltage is not correct.

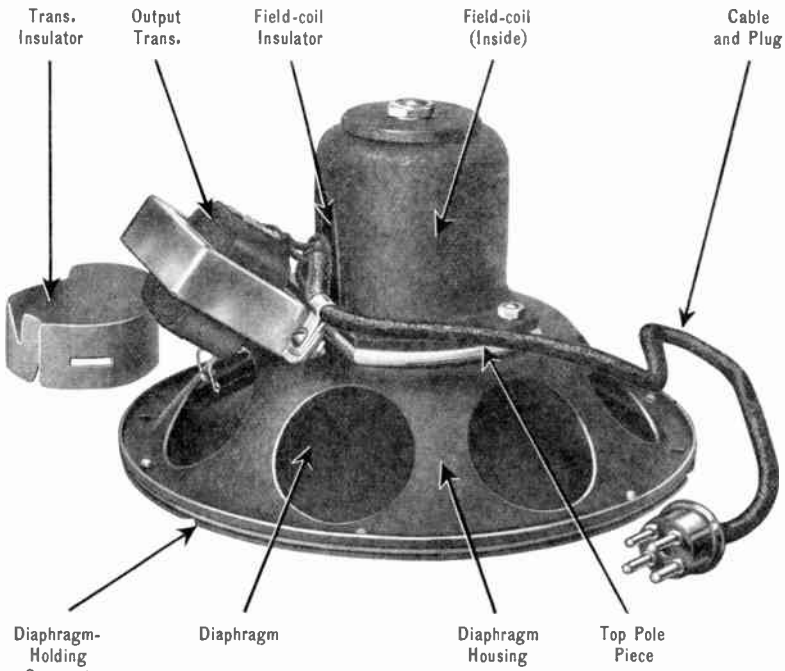


FIG. 319. TYPE S SPEAKER USED IN MODEL 80, 80-F, 82, 82-F, 84 AND 84-F.

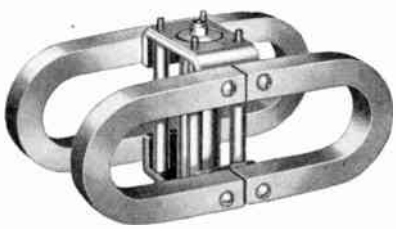


FIG. 320. No. 19918 MAGNET ASSEMBLY USED IN PERMANENT-MAGNET ELECTRO-DYNAMIC SPEAKER.

IMPORTANT.—No separate parts are furnished for the No. 19918 magnet assembly in the permanent-magnet electro-dynamic speakers. If any part of the magnet assembly requires replacement or adjustment, return the complete unit, exactly as shown, to your distributor.

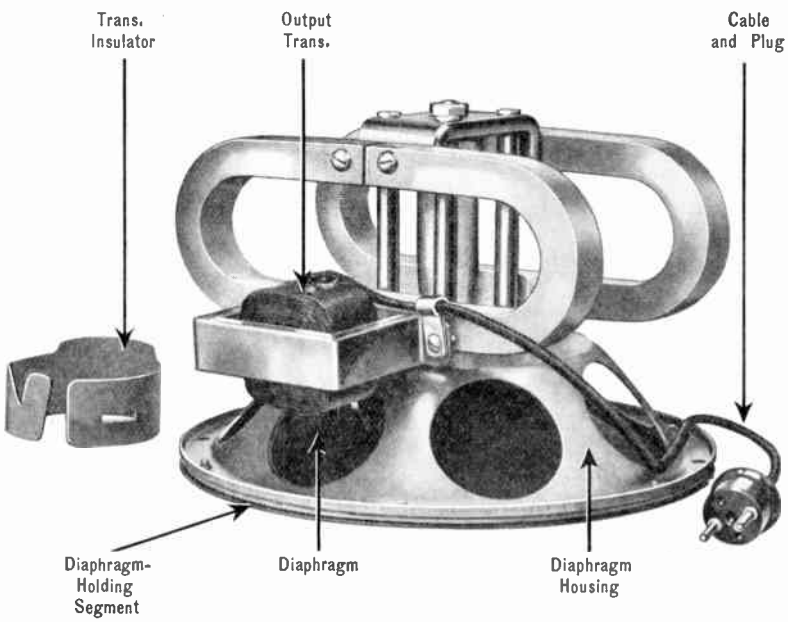


FIG. 321. PERMANENT-MAGNET-TYPE ELECTRO-DYNAMIC SPEAKER USED IN BATTERY-OPERATED MODELS.

PARTS AND PRICE LIST FOR MODEL 81, No. 20300 MOTOR CAR RADIO

Part No.	Name of Part	List Price
21048	CHASSIS AND BATTERY CONTAINER (less lid)	$ 3.00
21049	Container lid	1.00
21148	Battery container cardboard	Net .25
21331	Battery top pad	" .03
21061	Mounting bolt 13" long	.10
21142	Mounting bolt washer	.01
21141	Mounting bolt lockwasher	.70/c
21064	Wing nut	.05
21399	VARIABLE CONDENSER STATOR ROTOR & FRAME WITH LEADS	6.00
4887	Variable condenser mounting screw	.30/c
18844	Rotor connection (long)	.10
20119	Trimmer mica	.03
21126	Control pulley	.75
21583	Control pulley set screw	.05
21479	Control pulley clamp screw	.02
21582	Control pulley clamp washer	.01
21127	Control pulley spring	.55
20928	Spring centering ring	.05
19060	ELECTROLYTIC CONDENSER	2.50
19716	Clamp for electrolytic without case	.10
17068	Electrolytic clamp rivet	.01
19543	Clamp screw	.25/c
19784	Clamp nut	.01
	FIXED CONDENSERS	
23140	Multiple by-pass condenser	2.00
23250	1st R. F. grid circuit by-pass cond.	.35
21160	Phone condenser	.50
21160	Control coupling condenser	.50
	TRANSFORMERS	
21398	Antenna transformer	.60
21397	R. F. Transformer Group	3.75
21045	R. F. Transformer shield	.50
22810	Audio transformer	4.50
19623	Grid lead and cap	.12
	CHOKES	
19210	Detector plate choke	.25
19210	1st R. F. grid choke	.25
19210	Control cathode choke	.25
19210	2nd R. F. grid choke	.25
19210	1st R. F. plate filter choke	.25
	TUBULAR RESISTORS	
20950	1st R. F. screen resistor (maroon)	.25
21040	Detector grid bias resistor (black)	.25
21050	Control grid leak (blue and gray)	.25
23120	Quality resistor (red and black)	.25
23130	Control plate resistor (red and gray)	.25
	SOCKETS	
21396	Socket bracket	.35
19547	Self-tapping screw 3/8" long	.02
21041	Tube sockets (7 used)	.35
21336	Socket (4 prongs)	.30
21337	Socket (5 prongs)	.35
17377	Socket insulator	.25/c
8249	Socket mounting rivet	.50/c
9678	Solder clip	.50/c

Part No.	Name of Part	List Price
	MODEL 81 SPEAKER NO. 22600	
21161	Diaphragm assembly	$ 2.25
19469	Diaphragm holding segment	.15
14394	Diaphragm holding segment screw	.30/c
4795	Diaphragm spider screw	.30/c
19471	Diaphragm spider washer (fibre)	.30/c
19459	Diaphragm spider washer (hex. metal)	.02
21165	Speaker housing with socket	2.00
21337	Socket (5 prongs)	.35
17377	Socket insulator	.25/c
8249	Socket rivet	.50/c
21053	Grill	1.00
19484	Cone housing	1.75
14842	Cone housing mounting screw	.01
8188	Cone housing mounting nut	.01
19475	Cardboard ring	.10
22440	Field coil	3.00
21508	Field coil insulator	.02
20147	Field coil insulating washer (front)	.05
19479	Field coil insulating washer (back)	.50/c
19454	Top pole plate	.65
19538	Pole plate mounting screw	.03
17433	Pole plate mounting lock washer	.50/c
14367	Pole plate mounting nut	.02
22830	Output transformer	3.00
19463	Output transformer strap	.10
4214	Output transformer mounting screw	.30/c
17432	Output transformer mounting lock-washer	.50/c
8188	Output transformer mounting nut	.01
21128	Speaker-to-chassis cable & plugs, 10'	4.80
15739	Cable clamp	.02
21132	Cable insulating sleeve	.05
21059	Rubber bushing	.05
21315	Cable clamp	.05
15079	Cable plug (4 prong)	.65
18582	Cable plug (5 prong)	.65
21164	Armored lead to ungrounded side of battery (5 ft. long)	.50
21162	Armored lead clamp	.05
21263	Dash rubber bushing	.10
21062	Speaker mounting bolt	.10
21141	Speaker mounting bolt lockwasher	.70/c
21142	Speaker mounting bolt washer	.01
23180	CONTROL UNIT COMPLETE SUPERSEDED BY 21492	
21492	Control unit complete	13.75
20873	Model nameplate	.05
9206	Nameplate rivet	.20/c
21323	Dial knob	.30
21478	Dial knob shaft and gear	.60
21479	Dial knob shaft screw	.02
21481	Dial knob shaft spring washer	.01
21579	Dial strip	.25
21482	Dial gear	.80
21479	Dial gear bearing screw	.02
21483	Dial gear washer	.01
21484	Station selector cable 9' 11" (less sheathing)	.60
21851	Station selector cable sheathing 9'	2.15
21485	Station selector cable clamping plate	.10
21486	Station selector cable clamping screw	.02

November, 1931. THESE PRICES SUPERSEDE ALL PREVIOUS PRICES AND ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PARTS AND PRICE LIST FOR MODEL 81 (Continued)

Part No.	Name of Part	List Price
21487	Station selector cable chuck complete	$ .60
21147	Station selector cable staple	.50/c
21488	Control unit-to-speaker cable and plug (5′ 2″)	2.40
18582	Plug (5 prong)	.65
21489	Cable clamp	.05
21486	Cable clamp screw	.02
21491	Lock switch	.75
21585	Lock switch lock washer	.02
21584	Lock switch mounting nut	.10
20976	Switch key	.10
21406	Fuse 10 amp	.15
21493	Fuse socket	.35
21495	Fuse socket mounting screw	.02
21495	Dial lamp socket mounting screw	.02
21496	Volume control	1.10
21325	Volume control knob	.30
21497	Volume control mounting nut	.05
21498	Volume control fibre washer (large)	.05
21586	Volume control fibre washer (small)	.02
21050	Bleeder resistor (blue-gray)	.25
21499	Control unit base	1.00
21501	Control case	1.00
21502	Control case insulation	.10
21495	Control case mounting screw	.02
21503	Steering column clamp	.45
21504	Leather for steering column clamp	.20
21505	Steering column clamp screw	.05
17432	Steering column clamp lock washer	.50/c
21507	Steering column clamp set screw	.05
21324	Steering column cable strap	.05
21494	Dial lamp socket	.25
21407	Dial lamp	.25

MISCELLANEOUS PARTS

21153	Lead to grounded side of battery 36″ long	$ .15
21151	Terminal	$ .06
23260	Generator condenser	1.25
21144	Distributor suppressor (long)	.60
21143	Plug suppressor (short)	.60
21065	Gasket for chassis & battery container	.30
21069	Shielded antenna lead	.15
21068	Antenna lead rubber bushing	.05
22530	Fibre disc (1″ diam.) with 2 lugs, used as a terminal block	.05
21149	Shipping container	Net .65
21333	Instructions	" .10
23450	PLATE ANTENNA (Complete)	4.00
21557	Antenna plate	3.25
21559	Antenna plate mounting bolt	.10
21558	Porcelain insulator	.12
21561	Wood spacing block	.01
21369	Insulating washer	.03
21562	Iron washer	.01
21141	Lock washer	.70/c
21563	Nut	.02
21442	Instruction sheet	Net .50/c
21565	Shipping container	" .20
23520	IGNITION FILTER (furnished only when defective filter is returned to distributor)	4.25
21624	Condenser for ignition filter No. 23520 (furnished only when defective condenser is returned to distributor)	2.00
23530	Choke for ignition filter	2.00

EXTRA-LENGTH CABLES

21652	Station selector cable, per foot	.06
21653	Station selector cable sheathing, per ft.	.25
21654	Speaker-to-chassis cable, per foot	.35
21655	Control unit-to-speaker cable, per foot	.35
21656	Speaker-to-chassis cable (with plugs) 15 ft. long	6.55

BY-PASS AND TONE-CONTROL CONDENSERS USED IN SCREEN-GRID AND PENTODE-TYPE RECEIVERS

Part No.	*Code Markings	Type of Cond.	List Price
15262	B-1, H-1, H-9, H-20	By-pass	$1.00
15263	B-2, H-2	By-pass	.90
15640	H-16	By-pass	1.00
15770	H-15	By-pass	1.00
15780	H-17	By-pass	1.10
15790	H-18, H-21	By-pass	1.00
15837	B-3 (superseded by 16233)	By-pass	....
15870	B-7, L-28	Tone	1.00
16060	H-24, L-29 (304) Superseded by 18350	By-pass	....
16233	H-4, H-10	By-pass	.90
16461	H-6, H-12	By-pass	.75
16462	H-5, H-11	By-pass	1.00
16490	B-6, L-12	Tone	1.00
16745	H-7, H-8, H-13	By-pass	1.00
16828	B-5	Line	.50
16880	H-23, L-26 (439)	By-pass	1.10
16940	H-22, L-10	By-pass	1.10
17360	H-27, L-32	By-pass	1.10
17370	H-25, H-26, L-3, L-39	By-pass	1.10
18350	H-28, L-49	By-pass	1.10
19150	H-29	By-pass	1.00
19160	H-30	By-pass	$1.00
19560	H-31	By-pass	1.00
19690	H-32	By-pass	1.00
19710	H-33	By-pass	1.00
19980	H-34	By-pass	1.00
19990	H-35	By-pass	1.00
20010	B-8	Tone	1.00
20350	H-36	By-pass	1.00
20830	L-B-9, J-2, J-1	Multiple	2.00
21170	H-37	By-pass	1.00
21180	H-38	By-pass	1.00
21250	B-9	Tone	1.00
21430	H-39, L-37-A	By-pass	1.00
21440	H-40, L-44-A	By-pass	1.00
21450	B-10, L-36-A	Quality	.50
21530	L-42-A, B-11	Tone	1.00
22050	H-41	By-pass	1.00
22570	J-3	Multiple	2.00
23140	J-4	Multiple	2.00
23310	H-42 (superseded by 21180)**		
23330	H-43	By-pass	1.00

*For information about code markings, see Page 253 in the Service Manual.

**Do not use 23310 in place of 21180.

November, 1931. THESE PRICES SUPERSEDE ALL PREVIOUS PRICES AND ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PARTS AND PRICE LIST

FOR MODEL 80, 82, 82-D, 82-Q, 83, 84, 84-D, 84-Q, 85, 85-Q, 86, 87 and 89

(Numbers in Circles Refer to Notes on Page 317)

NAME OF PART	Model 84, 84F Early Type①	Model 84, 84F Later Type	Model 84 D Early Type①	Model 84 D Later Type	Model 84 Q Early Type①	Model 84 Q Later Type	Model 85, 85F Early②Later Type①	Model 85, 85F Later Type	Model 80, 80F	Model 82, 82F	Model 82Q	Model 82D	Model 83, 83F	Model 85Q ㉔	Model 86, 86-F ㉕	Model 87	Model 89, 89F 89P ㉕
CABINET, Complete	19862 $7.60	19862 $7.60	19862 $7.60	19862 $7.60	19862 $7.60	19862 $7.60			21234 $7.60	21235 $7.60	21235 $7.60	21235 $7.60					
Cloth Screen	19691 .75	19691 .75	19691 .75	19691 .75	19691 .75	19691 .75	18959 1.00	18959 1.00	20596 .75	20601 .75	20601 .75	20601 .75	18959 $1.00	18959 $1.00	18959 $1.00	18959 $1.00	18959 $1.00
Cabinet feet	19527 .12	19527 .12	19527 .12	19527 .12	19527 .12	19527 .12			19527 .12	19527 .12	19527 .12	19527 .12					
FRONT PANEL with braces and escutcheon							21316 2.50	21317 2.50					21238 2.50	21237 2.50	21669 2.50	23280 2.50	21239③ 2.50
Front-Panel brace							17224 .10	17224 .10					17224 .10	17224 .10	17224 .10	17224 .10	17224 .10
ESCUTCHEON	19511 .65	19511 .65	19511 .65	19511 .65	19511 .65	19511 .65	18816 1.00	21438 1.00	20443 .65	19511 .65	19511 .65	19511 .65	21437 1.00	21438 1.00	21532 1.00	21439 1.00	21441 1.00
Escutcheon rivet	19552 .50/c	19552 .50/c	19552 .50/c	19552 .50/c	19552 .50/c	19552 .50/c	8272 .02	8272 .02	19552 .50/c	19552 .50/c	19552 .50/c	19552 .50/c	8272 .02	8272 .02	8272 .02	8272 .02	8272 .02
DIAL PLATE AND BRACKET ASSEMBLY	19750 .65	19750 .65	19750 .65	19750 .65	19590 .50	19590 .50	19750 .65	19750 .65	19750 .65	19750 .65	19590 .50	19750 .65	19750 .65	19590 .50			
Dial-light socket and reflector															16420A .40	16420A .40	16420A .40
Dial plate	18882 .30	18882 .30	18882 .30	18882 .30	19932 .30	19932 .30	18882 .30	18882 .30	18882 .30	18882 .30	19932 .30	18882 .30	18882 .30	19932 .30			
Dial-plate rivet	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c	15734 .30/c			
Dial lamp	19644 .25	19644 .25	16099 .25	16099 .25			19644 .25	19644 .25	19644 .25	19644 .25		16099 .25	19644 .25		19644 .25	19644 .25	19644 .25
Dial knob	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30	17814 .30
VOLUME CONTROL, complete less leads④	19040 2.45	20180 2.90	19040 2.45	20389⑤ 3.45	19040 2.45	19040 2.45	19040 2.45	20030⑦ 2.75	20840⑦ 2.75	20990⑦ 2.75	16122㉑ 3.00	20389⑤ 3.45	22330⑦ 2.75	16122 ㉑ 3.00	23410⑦ 2.75	22650⑦ 2.75	20389⑤ 3.45
Volume-control mounting bracket							19777 .20	20646 .30					20646 .30	21236 .30	20646 .30	20646 .30	20646 .30
Volume-control mounting insulation								20135 .05	20135 .05	20135 .05	20135 .05	20135 .05	20135 .05	20135 .05	20135 .05	20135 .05	20135 .05
Volume-control mounting nut	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03	20093 .03
TONE-CONTROL Condenser		16490 1.00		16490 1.00		16490 1.00	16490 1.00	20010 1.00		21250 1.00	16490 1.00	16490 1.00		16490 1.00	20010 1.00	21530 1.00	21530 1.00
Tone-control condenser clamp							18223 .05	18223 .05						18223 .05	18223 .05	18223 .05	18223 .05
Tone-control switch, complete		20730 .75		20730 .75		20730 .75	16430 .75	20730 .75	20730 .75	20730 .75	20730 .75	20730 .75	20730 .75	20730 .75	20730 .75	16430 .75	16430 .75
Tone-control-switch base							18148 .60									18148 .60	18148 .60
Tone-control-switch shaft							18146 .12									18146 .12	18146 .12

Tone-control-switch blade							18112 .03									18112 .03	18112 .03
ON-OFF SWITCH	19050 1.10	(7)	19050 1.10	(6)	19902 1.50	20420 1.50	19480 1.10	(7)	(7)	(7)	20420 1.50	(6)	(7)	22010 1.50	(7)	(7)	(6)
On-off switch nut	19546 .03		19546 .03														
LOCAL-DISTANCE SWITCH (Phonograph switch in 89P)											22590 1.50			13664 1.00			17461 1.00
KNOB for switch or volume control	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30	17244 .30
POWER TRANSFORMER, 60 Cycle	19070 7.50	19070 7.50					19420 7.50	19420 7.50	20890 7.50	21140 7.50			22680 7.50		23430 7.50	21660 8.25	21660 8.25
Power Transformer, 25 Cycle	19290 9.50	19290 9.50						22060 9.50	23190 9.50	23110 9.50			22470 9.50		23560 9.50		22610 10.75
Power Transformer, 220 Volts									23040 11.50	23060 11.50							
Power-transformer cover or lid, 60 cycle	17824 .50	17824 .50					17824 .50	17824 .50	20469 .50	17824 .50			17824 .50		17824 .50	17824 .50	17824 .50
Power-transformer-cover spring, 60 cycle	17825 .10	17825 .10					17825 .10	17825 .10	17825 .10	17825 .10			17825 .10		17825 .10	17825 .10	17825 .10
Power-transformer cover or lid, 25 cycle	17824 .50	17824 .50						17824 .50	20469 .50	20469 .50			20469 .50		20469 .59		21032 .50
AUDIO INPUT TRANSFORMER			19870 4.00	19870 4.00							23510 4.00	19870 4.00		23440 4.00		21670 3.75	21670 3.75
Audio-transformer or choke strap			19463 .10	19463 .10							19463 .10	19463 .10					
R. F. TRANSFORMER group (9)	19797 3.00	19797 3.00	20165 3.00	20165 3.00	20407 3.00	20406 3.00	20361 3.00	20361 3.00	21241 3.00	21242 3.00	21274 3.00	21243 3.00	20361 3.00	21244 3.00	21436 3.00	21245 (12) 3.00	21246 (12) 3.00
R. F. Transformer cap (aluminum)	19443 .05	19443 .05	19443 .05	19443 .05			19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05	19443 .05
OSCILLATOR TRANSFORMER	19260 1.00	20210 (10) 1.25	19260 1.00	19920 1.25	19660 1.00	19970 1.25	19260 1.00	20270 (20) 1.25	20910 1.25	20910 1.25	22150 1.25	22110 1.00	22670 1.25	22150 1.25	21580 1.25	22240 1.25	21580 1.25
Oscillator-transformer shield		20348 .30		20127 .30		20127 .30		20313 .50	20313 .50	20313 .50	20313 .50	20906 .50	20313 .50	20313 .50	20313 .50	20313 .50	20313 .50
1st-I. F. Transformer, less trimmers														20713 (11) 2.00	20713 2.00	20713 2.00	20713 2.00
2nd-I. F. transformer, less trimmers														20963 (11) 2.00			
2nd-detector I. F. transformer, less trimmers	19573 2.00	19573 2.00	19573 2.00	19573 2.00	19573 2.00	19573 2.00	19573 2.00	19573 2.00	20621 2.00	19573 2.00	21031 2.00	19573 2.00	19573 2.00		20716 2.00	20716 2.00	20716 2.00
SHIELD for R. F. or I. F. transformer	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50	17295 .50
FILTER-CHOKE UNIT			19770 5.00	19770 5.00								19770 5.00				21680 5.75	21680 5.75
Filter-choke cover or lid			17824 .50	17824 .50								17824 .50				17302 .20	17302 .20
Filter-choke cover spring			17825 .10	17825 .10								17825 .10					
Antenna choke	19250 .60		19250 .60		19250 .60		19250 .60										
R. F. line choke No. 1 or No. 2			17254 .50	17254 .50								17254 .50		17254 .50			
R. F. plate choke					(15)	17015 .50					17015 .50				17015 .50	17015 .50	17015 .50

THIS LIST SUPERSEDES ALL PREVIOUS LISTS. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PARTS AND PRICE LIST (Continued)

FOR MODEL 80, 82, 82-D, 82-Q, 83, 84, 84-D, 84-Q, 85, 85-Q, 86, 87 and 89

(Numbers in Circles Refer to Notes on Page 317)

NAME OF PART	Model 84, 84F Early Type①	Model 84, 84F Later Type	Model 84 D Early Type①	Model 84 D Later Type	Model 84 Q Early Type①	Model 84 Q Later Type	Model 85, 85F Early①② Later Type	Model 85, 85F Later Type	Model 80, 80F	Model 82, 82F	Model 82Q	Model 82D	Model 83, 83F	㉔ Model 85Q	㉕ Model 86, 86F	Model 87	㉕ Model 89, 89F 89P
1st-detector plate choke	19571 1.00	20331 1.00	19571 1.00	19571 1.00	19571 1.00	19571 1.00	19571 1.00	20307 1.00	17390 1.00	20307 1.00	20307 1.00	19571 1.00	20307 1.00	⑪			
1st-detector filter choke	19210 .25				19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25		19210 .25	19210 .25	19210 .25	19210 .25	
I. F. stopping choke	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25	19210 .25			
I. F. filter choke											19210 .25			19210 .25			19210 .25
1st-I. F. grid choke		17390 .60						17390 .60	20307 .60	17390 .60	17390 .60		17390 .60	⑪			
2nd-I. F. plate choke														20307 1.00			
2nd-detector plate or pentode grid choke	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60	17390 .60			
2nd-detector grid, or 1st-A. F. grid, choke														17390 .60	17390 .60		
Oscillator plate choke											17015 .50			17015 .50			
Control plate choke (R. F. grid choke in 86)															19210 .25		19210 .25
FLEXIBLE AND WIRE-WOUND RESISTORS (for tubular resistors, see Page 317).																	
1st-detector bias resistor	19190 ⑬ .20	20380 .20							21030 .20				21030 .20				
I. F. bias resistor	16320 .20		19830 .15	19830 .15			16320 .20					19830 .15					
A. F. bias resistor																21420 .20	21420 .20
Filament-shunt resistor	17077 .15	17077 .15					17077 .15	17077 .15	17077 .15	17077 .15			17077 .15		17077 .15	17077 .15	17077 .15
2nd-A. F. filament shunt resistor			19820 .20	19820 .20								19820 .20					
Filament-series resistor No. 1			19850 1.00	19850 1.00	19610 .15	19610 .15					19610 .15	19850 1.00		19610 .15			
Filament-series resistor No. 2			19840 .20	19840 .20								19840 .20					
Bleeder resistor No. 1	16330 .40	16330 .40					16330 .40	20150 .40		20150 .40					20150 .40	22660 .40	21050 .40
Bleeder Resistor No. 2	16330 .40	17610 .40					16330 .40	16330 .40		20140 .40					20140 .40	22660 .40	20150 .40

Bleeder resistor No. 3	18520 .20							20050 .20		20050 .20					16320 .20	20040 .20	21030 .20
Bleeder resistor No. 4								20040 .20	20040 .20	20040 .20			20040 .20		17380 .20		17380 .20
Bleeder resistor No. 5								20150 .40		20150 .40					20150 .40		20150 .40
Bleeder resistor No. 6								20120 .20		20120 .20					20120 .20		20120 .20
Bleeder resistor No. 7								20520 .20		20520 .20					20520 .20		17610 .40
1st-detector plate resistor	20320 .20																
Filter resistor	19180 ⑭ 1.00	19180 ⑭ 1.00					19180 1.00	19180 ⑭ 1.00		19180 ⑭ 1.00					19180 ⑭ 1.00		
Dial-light resistor															18236 .15	18236 .15	18236 .15
VARIABLE CONDENSER ROTOR, STATOR AND FRAME	19861 6.00	19861 6.00	19861 6.00	19861 6.00	19861 6.00	19861 6.00	19861 6.00	19861 6.00	21252 5.00	21252 5.00	21252 5.00	21252 5.00	19861 6.00	19861 6.00	21358 9.60	20794 ⑫ 9.60	20794 ⑫ 9.60
Rotor connection, long	18844 .10	18844 .10	18844 .10	18844 .10	18844 .10	18844 .10	18844 .10	18844 .10	20235 .10	20235 .10	20235 .10	20235 .10	18844 .10	18844 .10	20795 .10	20795 .10	20795 .10
Rotor connection, short	19554 .10	19554 .10	19554 .10	19554 .10	19554 .10	19554 .10	19554 .10	19554 .10					19554 .10	19554 .10	20796 .10	20796 .10	20796 .10
Stopping spring	19968 .12	19968 .12	20065 .12	20065 .12	20065 .12	20065 .12	19968 .12	19968 .12					19968 .12	19968 .12	19968 .12	19968 .12	19968 .12
Dial-knob shaft	18809 .05	18809 .05	18809 .05	18809 .05	18809 .05	18809 .05	19751 .05	19751 .05	18809 .05	18809 .05	18809 .05	18809 .05	19751 .05	19751 .05	17941 .05	17941 .05	17941 .05
Dial-knob shaft bracket	19505 .30	19505 .30	19505 .30	19505 .30	19505 .30	19505 .30	19505 .30	19505 .30	20116 .30	20116 .30	20116 .30	20116 .30	19505 .30	19505 .30	18144 .30	18144 .35	18144 .35
Dial-knob-shaft-bracket support	17935 .03	17935 .03	17935 .03	17935 .03	17935 .03	17935 .03	17935 .03	17935 .03					17935 .03	17935 .03	17935 .03	17935 .03	17935 .03
Dial rubber and bushing	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15	17961 .15
Dial pointer	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05	17959 .05
Dial-pointer shim	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02	18823 .02
Dial gear and balance weight	19529 .75	19529 .75	19529 .75	19529 .75	19529 .75	19529 .75	19529 .75	19529 .75	20149 .75	20149 .75	20149 .75	20149 .75	19529 .75	19529 .75			
Dial gear															18615 .40	18615 .40	18615 .40
Balance weight															18117 .35	18117 .35	18117 .35
Pointer control arm															17962 .30	17962 .30	17962 .30
Trimmer mica	17062 .03	17062 .03	17062 .03	17062 .03	17062 .03	17062 .03	17062 .03	17062 .03	20119 .03	20119 .03	20119 .03	20119 .03	17062 .03	17062 .03	17062 .03	17062 .03	17062 .03
MULTIPLE-TYPE BY-PASS CONDENSER (Other by-pass condensers are listed on Page 309)									20830 2.00				20830 2.00			22570 2.00	

PARTS AND PRICE LIST (Continued)

FOR MODEL 80, 82, 82-D, 82-Q, 83, 84, 84-D, 84-Q, 85, 85-Q, 86, 87 and 89

(Numbers in Circles Refer to Notes on Page 317)

NAME OF PART	Model 84, 84F Early Type①	Model 84, 84F Later Type	Model 84 D Early Type①	Model 84 D Later Type	Model 84 Q Early Type①	Model 84 Q Later Type	Model 85, 85F Early① Later Type②	Model 80, 80F	Model 82, 82F	Model 82Q	Model 82D	Model 83, 83F	㉔ Model 85Q	㉕ Model 86, 86-F	Model 87	㉕ Model 89, 89F 89P
FILTER CONDENSER UNIT, paper and foil type							20370 $7.50					20370 $7.50		20370 $7.50	21520 $7.95	21520 $7.95
Filter-condenser cover and spring							20398 .45					20398 .45		20398 .45	18188 .45	18188 .45
Filter condenser No. 1 (Electrolytic)	19728 $2.60	19728 $2.60	20049 $2.60	20049 $2.60	19728 $2.60	19728 $2.60	19728 $2.60	19728 2.60	19728 $2.60	19728 $2.60	20049 $2.60		19060 $2.50			
Filter condenser No. 2 (Electrolytic)	19060 2.50	19060 2.50					19728 2.60	19060 2.50	19060 2.50							
Filter condenser No. 3 (Electrolytic)							19060 2.50	19060 2.50				19060 2.50		19060 2.50		
Fibre insulating case for electrolytics	19551 .10	19551 .10	19551 .10	19551 .10	19551 .10	19551 .10	19551 .10		19551 .10	19551 .10	19551 .10	19551 .10				
MOUNTING ACCESSORIES FOR EARLY-TYPE ELECTROLYTICS																
Case solder clip	19559 .01	19729 .02	19559 .01	19729 .02	19559 .01	19729 .02	19559 .01		19729 .02	19729 .02	19729 .02	19729 .02				
Base insulator	19558 .20		19558 .20		19558 .20		19558 .20									
Mounting nut	19556 .05		19556 .05		19556 .05		19556 .05									
Mounting lockwasher	19557 .03		19557 .03		19557 .03		19557 .03									
MOUNTING ACCESSORIES FOR LATER-TYPE ELECTROLYTICS																
Clamp for electrolytics with fibre case		19936 .10		19936 .10		19936 .10			19936 .10	19936 .10	19936 .10	19936 .10				
Clamp for electrolytics without fibre case		19716 .10					19716 .10	19716 .10	19716 .10			19716 .10	19716 .10	19716 .10		
Clamp screw		19543 .25/c		19543 .25/c		19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c	19543 .25/c		
Clamp nut		19784 .01		19784 .01		19784 .01	19784 .01	19784 .01	19784 .01	19784 .01	19784 .01	19784 .01	19784 .01	19784 .01		
Clamp rivet		17068 .01		17068 .01		17068 .01	17068 .10	17068 .01	17068 .01	17068 .01	17068 .01	17068 .01	17068 .01	17068 .01		
TRIMMER CONDENSERS																
Antenna trimmer	20340 .60	20340 .60	20340 .60	20340 .60	20340 .60	20340 .60	19326 .60	19326 .60	20340 .60	20340 .60	20340 .60	20340 .60	19326 .60	19326 .60	19326 .60	19326 .60
Antenna-trimmer mounting bushing	19501 .03	19501 .03	19501 .03	19501 .03	19501 .03	19501 .03			19501 .03	19501 .03	19501 .03	19501 .03				
Antenna-adjustment instruction-tag	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F 859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02	20753 F-859 .02
Single I. F. trimmer	17240 .50	17240 .50	17240 .50	17240 .50	17240 .50	17240 .50	19330 .70	19330 .70	17240 .50	17240 .50	17240 .50	17240 .50	19330 .70	19330 .70		

Double I. F. trimmer	18150 .95	18150 .95	19910 1.10	19910 1.10	18150 .95	18150 .95	18150 .95	18150 .95	18150 .95	18150 .95	18150 .95	19910 1.10	18150 .95	18150 .95	18150 .95	18150 .95	18150 .95
Double-spot trimmer	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35	17230 .35			
Trimmer-condenser sealing wax (used in all sets)	.50 lb.																
SMALL FIXED CONDENSERS (See Page 317 for identification.)																	
R. F.-1st detector stopping condenser						17974 .35					21160 .35				⑯	⑯	⑯
Oscillator grid condenser		17470 .35						21160 .35	21160 .35	21160 .35	21160 .35		21160 .35	21160 .35	21160 .35	21160 .35	21160 .35
I. F. stopping condenser	17440 .50	17440 .50	17440 .50	17440 .50	17440 .50	17440 .50	17440 .50	21160 .35	21160 .35	21160 .35	21160 .35	21160 .35	21160 .35	21160 .35			
Phone condenser	17440 .50	17440 .50	17440 .50		17440 .50	17440 .50	17440 .50	17440 .50			17440 .50			17440 .50			
A. F. Grid condenser															22220 .35	22220 .35	
SOCKETS																	
R. F. Socket					19962 .25	19958 .25					20237 .25				20236 .30	20236 .30	20236 .30
1st-detector socket	17518 .30	20306 .30	20025 .30	20025 .30	19958 .25	19958 .25	17518 .30	20236 .30	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20236 .30
I. F. Socket	17518 .30	20306 .30	20025 .30	20025 .30	19958 .25	19958 .25	18774 .30	20236 .30	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20236 .30
2nd-detector socket	17518 .30	17518 .30	20025 .30	20025 .30	19958 .25	19958 .25	17518 .30	20236 .30	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20236 .30
1st-A. F. socket			20026 .30	20026 .30	19959 .25	20184 .25					20237 .25	20236 .30		20237 .25		20236 .30	20236 .30
Pentode socket	19955 .30	19955 .30	19964 .30	19964 .30	19964 .30	19964 .30	19955 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30	20236 .30
Rectifier socket	18813 .25	18813 .25					17508 .25	20237 .25	20237 .25	20237 .25			20237 .25		21448 .30	20237 .25	20237 .25
Speaker socket	19648 .25	19648 .25	18007 .30	18007 .30	19963 .25	19963 .25	17512 .25	20329 .25	20329 .25	20329 .25	20665 .25	20664 .30	20329 .25	20665 .25	21336 .30	20664 .30	20664 .30
Oscillator socket	19533 .30	19533 .30	20026 .30	20026 .30	19961 .25	19961 .25	17519 .30	20236 .30	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20237 .25	20236 .30	20236 .30	20236 .30
Automatic volume control socket								20236 .30		20236 .30					20236 .30		20236 .30
Socket insulator (fibre sheet)	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377 .25/c	17377⑯ .25/c	17377⑯ .25/c	17377⑯ .25/c
Socket eyelet	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c	8249 .50/c
Fuse socket	18449 .15	18449 .15	18449 .15	18449 .15	18449 .15		18449 .15	18449 .15		18449 .15		18449 .15	18449 .15		18449 .15	18449 .15	18449 .15
TUBE SHIELD	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15	15213 .15
Tube-shield base	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03	15214 .03
Tube-shield base rivet	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c	16771 .30/c
BATTERY CABLE					19939 3.50	19939 3.50					21665 3.75			21664 3.50			
Battery-cable clamp					15739 .02	15739 .02					15739 .02			15739 .02			

THIS LIST SUPERSEDES ALL PREVIOUS LISTS. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PARTS AND PRICE LIST (Continued)

FOR MODEL 80, 82, 82-D, 82-Q, 83, 84, 84-D, 84-Q, 85, 85-Q, 86, 87 and 89

(Numbers in Circles Refer to Notes on Page 317)

NAME OF PART	Model 84, 84F Early Type①	Model 84, 84F Later Type	Model 84 D Early Type①	Model 84 D Later Type	Model 84 Q Early Type①	Model 84 Q Later Type	Model 85, 85F Early①② Later Type	Model 80, 80F	Model 82, 82F	Model 82Q	Model 82D	Model 83, 83F	Model 85Q ㉔	Model 86, 86-F ㉕	Model 87	Model 89, 89F 89P ㉕
Battery-cable terminal-clip					8352 $.06	8352 $.06				8352 $.06			8352 $.06			
Battery-cable instruction tag					19941 F-772 .02	19941 F-772 .02				21625 F-855 .02			21625 F-855 .02			
110-VOLT DOUBLE-CONDUCTOR CABLE AND PLUG	19566 $1.90	19566 $1.90	19566 $1.90	19566 $1.90			19566 $1.90	19566 $1.90	19566 $1.90	19566 $1.90	19566 $1.90	19566 $1.90		19566 $1.90	19566 $1.90	19566 $1.90 ㉓
110-volt-cable instruction tag			20073 .02	20073 .02							20073 .02					
110-volt plug (male)	18897 .15	18897 .15	18897 .15	18897 .15			18897 .15	18897 .15	18897 .15	18897 .15	18897 .15	18897 .15		18897 .15	18897 .15	18897 .15
110-volt cable bushing	16741 .05	16741 .05	16741 .05	16741 .05			16741 .05	16741 .05	16741 .05	16741 .05	16741 .05	16741 .05		16741 .05	16741 .05	16741 .05
Bushing retaining spring	16742 .05	16742 .05	16742 .05	16742 .05			16742 .05	16742 .05	16742 .05	16742 .05	16742 .05	16742 .05		16742 .05	16742 .05	16742 .05
BINDING-POST BASE	18363 .05	18363 .05	18363 .05	18363 .05	18363 .05	18363 .05		18363 .05	18363 .05	18363 .05	18363 .05			18363 .05		18363 .05
Binding post, marked "A"	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20	19536 .20
Binding post, ground	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	8215 .20	18546 .20
Miscellaneous Parts																
Self-tapping screw (3/8" long)⑰	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02	19547 .02
Line fuse (2 amperes)	18534 .05	18534 .05	18534 .05	18534 .05	18534 .05		18534 .05	18534 .05		18534 .05	18534 .05	18534 .05		18534 .05	18534 .05	18534 .05
Control-grid lead and cap	19623 .12	19623 .12	21108 .15	21108 .15	19623 .12	19623 .12	19623 .12	19623 .12	19623 .12	19623 .12	19623 .12	21108 .15	19623 .12	19623 .12	21555 .12	19623 .12
Fibre disc (1" dia.) with two lugs (used as a terminal block for wire connections)	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05	22530 .05
Bottom plate							19869 1.30	19869 1.30				19869 1.30	19869 1.30	19869 1.30	19869 1.30	19869 1.30
Ground clamp assembly	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30	13989 .30
Cardboard packing tube (fits on speaker field case)	19699 .10	19699 .10	19699 .10	19699 .10				19699 .10	19699 .10		19699 .10					
Instruction and log card for 60-cycle, battery and D. C. models	19542 F-755 .01 Net	20339 F-795 .01 Net	19995 F-777 .01 Net	20395 F-793 .01 Net	19934 F-774 .01 Net	20374 F-792 .01 Net	19858 F-767 .01 Net	20565 F-808㉖ .01 Net	20608 F-805㉖ .01 Net	21626 F-853 .01 Net	20877 F-817 .01 Net	20875 F-811 .01 Net	21627 F-854 .01 Net	21549 F-850 .01 Net	20923 F-812 .01 Net	20729 F-813⑱ .01 Net
Instruction and log card for 25-cycle models	19851 F-766 .01 Net	20405 F-797 .01 Net					19875 F-771 .01 Net	20948 F-820 .01 Net	20949 F-821 .01 Net			20951 F-822 .01 Net		21603 F-857 .01 Net		20991 F-826 .01 Net
Shipping container for 60-cycle, battery and D. C. models	19541 .55 Net	20337 .55 Net	20003 .55 Net	20394 .55 Net	19935 .55 Net	20373 .55 Net	19863 .65 Net	19863 .65 Net	20457 .55 Net	20559 .55 Net	21187 .55 Net	21122 .55 Net	21046 .65 Net	20966 .65 Net	21517 .65 Net	21526 .65 Net	20724⑱ .65 Net
Shipping container for 25-cycle models	19541 .55 Net	20422 .55 Net					19876 .65 Net	21353 .55 Net	21365 .55 Net			21368 .65 Net		21651 .65 Net		21374 .65 Net

THIS LIST SUPERSEDES ALL PREVIOUS LISTS. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

NOTES

Figures in circles in the parts list refer to the corresponding notes listed below. It is important to read these notes before ordering parts.

① Changes from early type to late type were not made all at one time.

② 85-F was made only in later type.

③ Front panel in 89-P is No. 21318.

④ Salvage and use leads from the original control.

⑤⑥ Control No. 20389 includes the on-off switch which is NOT sold separately.

⑦ The on-off switch (on back of volume control) is NOT sold separately. Replace the complete volume control unit.

⑨ R. F. transformers are not sold separately.

⑩ No. 20210 has 8 leads. Some 84 (A. C.) sets have a 19920 cylindrical transformer with 6 leads, requiring a No. 20127 shield. A few late 84 (A. C.) sets have a 20210A transformer with 6 leads and a mica condenser mounted on the side. This requires a No. 20348 shield.

⑪ In late-type Model 85-Q, the 1st-I. F. transformer is not used; the 2nd-I. F. transformer is No. 20713, and the following additional parts are used: 1st-detector plate choke No. 20307, and 1st-I. F. grid choke No. 17390.

⑫ In Model 87 after 2525451, 89 after 6743355, 89-F after 1585176, and 89-P after 1935231, the R. F. transformer group is No. 21436, and the variable condenser unit is No. 21358.

⑬ No. 19190 is superseded by 19346.

⑭ No. 19180 resistor is not used in 84-F, 82-F, 85-F, 86-F.

⑮ Sold only as part of the R. F. Trans. group.

⑯ Speaker socket insulator is No. 18016.

⑰ Used also are No. 21007 (⅞″) and No. 19717 (1″) self-tapping screws.

⑱ Log card in 89-P is 21025. Shipping container in 89-P is 21273.

⑲ Screen in 80 is 20596. Screen in 82, 82-D, 82-Q is 20601.

⑳ In late-type Model 85, after serial No. 4998356, and Model 85-F after No. 5055609, the oscillator transformer is No. 22670.

㉑ In a few early-type Model 82-Q and 85-Q, the volume control is No. 19040 and a blue-and-red resistor is shunted across the control. In all other 82-Q and 85-Q, the volume control is No. 16122 and the red-and-blue resistor is not used.

㉒ In late-type Model 87, 89, 89-F and 89-P, the output transformer has a metal cover. This transformer, less cover is No. 21693. The insulator for this transformer is No. 21424, list price $.02.

㉓ In 89-P, the 110-volt cable is No. 18589, list price $1.00.

㉔ The list of parts for Model 85-Q apply only to sets having serial numbers below 163767.

㉕ The list of parts for Model 86, 89, 89-F, and 89-P apply only to sets having serial numbers as follows: Model 86 below 5876861. Model 89 below 6755181. Model 89-P below 1935904. Model 89-F below 1585395.

㉖ Instruction and log card for Model 80 (220-volt type) is No. 20904, F-823, $.01 net. The log card for Model 82 (220-volt type) is No. 20905, F-824, $.01 net.

IDENTIFICATION OF SMALL FIXED CONDENSERS OF TYPE ILLUSTRATED AT LEFT

Part No.	*Identification*
17440	Copper washers, 7 plates.
17470	"X" scratched on fibre, 4 plates.
17974	Aluminum washers, 4 plates.
21160	Black-finished washers, 4 plates.
22220	Brass-washers, 2 plates.

TUBULAR RESISTORS (Large Size, 1¾ inches long) USED IN PENTODE-TYPE RECEIVERS

Part No.	**Identifying Color*	*List Price*
15285	Gray	$ .50
15544	Yellow	.25
15545	Maroon	.25
15592	Black	.25
15891	Black-red	.25
15892	Green	.25
16282	Blue-red	.25
16724	White	.25
19346	Green-red	.30
19581	Red-yellow	.25
19649	Black-purple	.25
20151	Purple	.25
20223	Red-gray	.25

MOUNTING ACCESSORIES FOR LARGE-SIZE TUBULAR RESISTORS

Part No.	*Name*	*List Price*
19508	Single-resistor clamp	$ .05
17341	Three-resistor bracket	.05
17342	Three-resistor pad	.25/c
17345	Three-resistor clamp	.02
17118	Five-resistor bracket	.05
17117	Five-resistor pad	.25/c
17119	Five-resistor clamp	.02

TUBULAR RESISTORS (Small Size, 1 inch long) USED IN PENTODE-TYPE RECEIVERS

Part No.	**Identifying Color*	*List Price*
20920	Red-yellow	$ .25
20930	Black-purple	.25
20940	Green	.25
20950	Maroon	.25
20960	Gray-yellow	.25
20970	Gray	.25
20980	Red-blue	.25
21040	Black	.25
21050	Blue-gray	.25
23120	Red-black	.25
23130	Red-gray	.25

*When replacing a tubular resistor, use a resistor of the same identifying color and size. The background color of the resistor is disregarded in the identification except in the case of the all-white or all black resistors. If a resistor has black-and-red coloring on a white base, the identification is black and red, not black, white and red.

November, 1931. THESE PRICES SUPERSEDE ALL PREVIOUS PRICES AND ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PARTS AND PRICE LIST FOR SPEAKERS IN PENTODE-TYPE RECEIVERS

Numbers in circles refer to notes on Page 317.

NAME OF PART	No. 17300 Compact Speaker in MODEL 80, 82, 84	No. 18600 Compact Speaker MODEL 82-D, 84-D	No. 18400 Compact Speaker MODEL 82-Q, 84-Q	No. 18500 Compact Speaker with output trans. sealed in cylindrical container	No. 18100 Console Speaker MODEL 83, 85 (Early Type)	No. 20500 Console Speaker with output trans. sealed in cylindrical container	No. 19900 Console Speaker in Model 85-Q	No. 24600 Console Speaker in Model 86 and late Models 83 and 85	No. 19800 Console Speaker in Model 87, 89, 89-F, 89-P
DIAPHRAGM	19465 $2.25	19465 $2.25	19465 $2.25	19465 $2.25	19465 $2.25	19465 $2.25	19465 $2.25	20737 $3.25	20737 $3.25
Diaphragm-holding segment (3 used)	19469 .15	19469 .15	19469 .15	19469 .15				14382 $1 set	14382 $1 set
Diaphragm-holding segment screw	14394 .30/c	14394 .30/c	14394 .30/c	14394 .30/c				14394 .30/c	14394 .30/c
Diaphragm-spider screw	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c	4795N .30/c
Diaphragm-spider washer (hex. metal)	19459 .02	19459 .02	19459 .02	19459 .02	19459 .02	19459 .02	19459 .02	19459 .02	19459 .02
Diaphragm-spider washer (fibre)	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c	19471 .30/c
Diaphragm (or cone) housing	19484 1.75	20008 1.75	20231 1.75	19909 1.75	19484 1.75	19909 1.75	20231 1.75	20894 2.50	20894 2.50
FIELD COIL	18870 3.00	19860 3.00		18870 3.00	18870 3.00	18870 3.00		18870 3.00	21260 3.00
Field-coil insulator	19458 .02	19458 .02		19911 .05	19458 .02	19911 .05		19458 .02	19458 .02
Field-coil washer back (2⅛" dia.)	19479 .50/c	19479 .50/c		19479 .50/c	19479 .50/c	19479 .50/c		19479 .50/c	19479 .50/c
Field-coil washer front (2⅜" dia. padded)	20147 .05	20147 .05		20147 .05	20147 .05	20147 .05		20147 .05	20147 .05
TOP POLE PIECE	19454 .65	19454 .65		19454 .65	19454 .65	19454 .65		19454 .65	19454 .65
Top-pole-piece mounting screw	19538 .03	19538 .03		19538 .03	19538 .03	19538 .03		19538 .03	19538 .03
Top-pole-piece mounting nut	14367 .02	14367 .02		14367 .02	14367 .02	14367 .02		14367 .02	14367 .02
MAGNET ASSEMBLY COMPLETE			19918 6.00				19918 6.00		
OUTPUT TRANSFORMER, with strap	19697 2.25	19697 2.25	19697 2.25	19670 3.00	19697 2.25	19670 3.00	19697 2.25		21370 3.00
Output-transformer strap	19463 .10	19463 .10	19463 .10		19463 .10		19463 .10		19463 .10
Output-transformer (less case) (22)								21672 3.00	21693 3.00

Output-transformer case								21417 .40	21418 .40
Output-transformer fibre insulator	19478 .02	19478 .02	19478 .02		19478 .02		19478 .02	21424 .02	19478 (22) .02
Output-transformer mounting screw	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c	7697 .30/c
Output-transformer mounting nut	8188 .01	8188 .01	8188 .01	8188 .01	8188 .01	8188 .01	8188 .01	8188 .01	8188 .01
CABLE AND PLUG ASSEMBLY	19487 1.60	20012 1.65	19916 1.40	19487 1.60	19789 1.65	19789 1.65	20889 1.50	19789 1.65	20657 1.65
Plug only	15079 .65	18582 .65	19884A .40	15079 .65	15079 .65	15079 .65	19884A .40	15079 .65	18582 .65
Cable Clamp	19508 .05	19508 .05	19508 .05	19508 .05	19508 .05	19508 .05	19508 .05	19508 .05	19508 .05
PROTECTIVE LAMP (75 watts)		20075 .35 net							
Lamp socket		20014 .50							
Lamp socket screw		20136 .25/c							
Miscellaneous									
Speaker-mounting screw	19526 .01	19526 .01	19526 .01	19526 .01					
Speaker-mounting nut	15006 .02	15006 .02	15006 .02	15006 .02					
Speaker-mounting plate					19755 .75	19755 .75	19755 .75		
Speaker-mounting-plate screw					19882 .01	19882 .01	19882 .01		
CLOTH SCREEN	19691 (19) .75	19691 (19) .75	19691 (19) .75	19691 .75	18959 1.00	18959 1.00	18959 1.00	18959 1.00	18959 1.00
GAUGES centering voice coil (set of 3)	20171 .10	20171 .10	20171 .10	20171 .10	20171 .10	20171 .10	20171 .10	20171 .10	20171 .10
SHIPPING CONTAINER					19837 .35 Net	20493 .35 Net	20806 .35 Net	20739 .35 Net	20739 .35 Net
Instruction Sheet						19868 .02 Net			
Speaker Packing Tube						20447 .10			

NOTE: No. 20171 Centering Gauges supersede No. 14622. The No. 20171 gauges are "double-ended," one end being used for type F, N and J speakers, and the other end is used for the speakers in Model 84 and 85, etc.
The top pole piece may be centered by use of three lengths of 3/64 inch drill rod.

THIS LIST SUPERSEDES ALL PREVIOUS LISTS. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

SERVICE NOTES

With the exception of Model 81 Motor Car Radio, which has a tuned-radio-frequency circuit, all the receivers described in this supplement employ the super-heterodyne circuit and utilize a frequency of 130 kilocycles for intermediate-frequency amplification.

A general description of the super-heterodyne system appears on page 258 of the Service Manual. A description of the pentode tube is given on page 17. Service notes covering the general adjustment of trimmer condensers, double-spot reception, and testing equipment, are given on pages 259, 260, 261, 262 and 275. Much of this information may be applied in servicing Models 80, 82, 83, 84, 85, 86, 87 and 89.

We want to emphasize the following points:

1. The antenna adjustment must be correctly adjusted in accordance with the instructions accompanying each set.
2. The tube shields and transformer shields must be tightly seated.
3. Try new tubes before attempting any adjustments or repairs.
4. When replacing a tubular resistor, use a resistor of the same identifying color. In a few cases, owing to engineering changes, the color of a resistor in a chassis may not agree with the color specified in the diagram. In such a case, disregard the diagram and use a replacement resistor having the same color as the defective unit. However, if a resistor has been removed, or its identification destroyed, replace it with a resistor having the color that is specified in the diagram for that set. A list of tubular resistors is given on page 317.

VOLTAGE TABLE

FOR MODEL 80, 81, 82, 82-D, 82-Q, 83, 84, 84-D, 84-Q, 85, 85-Q, 86, 87 and 89

The voltages listed in this table are only approximate, and are measured values, not actual operating values. Turn volume control to maximum.

Use 250-volt scale of a 1000-ohm-per-volt D. C. voltmeter.

All plate, screen and grid measurements are made from cathode in heater-type tube, and from —F in plain-filament-type tube.

		MODEL 80	MODEL 81	MODEL 82	MODEL 82-D	MODEL 82-Q	MODEL 83	MODEL 84	MODEL 84-D	MODEL 84-Q	MODEL 85	MODEL 85-Q	MODEL 86	MODEL 87	MODEL 89
	LINE VOLTAGE	110	—	110	112	—	110	110	120	—	110	—	115	110	110
	TOTAL "B" VOLTAGE	—	125	—	—	125	—	—	—	125	—	125	—	—	—
R. F. TUBE**	FILAMENT	—	5.5	—	—	2	—	—	—	2	—	—	2.4	2.4	2.4
	PLATE	—	125	—	—	125	—	—	—	125	—	—	125	170	125
	SCREEN	—	75	—	—	60	—	—	—	65	—	—	40	80	50
	GRID	—	SMALL	—	—	3	—	—	—	3	—	—	2	2	2
1ST DET. TUBE†	FILAMENT	2.4	5.5	2.4	5.5	2	2.4	2.4	5.7	2	2.4	2	2.4	2.4	2.4
	PLATE	225	95	135	70	125	225	205	80	125	135	125	125	160	120
	SCREEN	90	—	50	50	40	90	65	50	25	50	40	35	70	45
	GRID	5	7	4	5	3	5	6	5	3	3	3	4	11	4
I. F. TUBE	FILAMENT	2.4	—	2.4	6	2	2.4	2.4	6.5	2	2.4	2	2.4	2.4	2.4
	PLATE	230	—	140	95	125	230	215	105	125	135	125	125	170	125
	SCREEN	95	—	50	50	60	95	65	55	65	50	65	40	80	50
	GRID	2	—	SMALL	SMALL	3	2	3	SMALL	SMALL	2	3	2	2	2
2ND DET. TUBE	FILAMENT	2.4	—	2.4	5.5	2	2.4	2.4	5	2	2.4	2	2.4	2.4	2.4
	PLATE	110	—	105	55	45	110	90	55	60	100	40	95	90	120
	SCREEN	45	—	65	10	25	45	45	10	25	65	25	60	—	—
	GRID	5	—	8	2	3	5	6	1	3	7	3	8	SMALL	15
1ST A. F. TUBE	FILAMENT	2.4	5.5	2.4	5.5	2	2.4	2.4	6	2	2.4	2	2.4	2.4	2.4
	PLATE	230	120	230	75	55	230	205	80	55	215	55	210	90	120
	SCREEN	240	123	240	—	—	240	215	—	—	225	—	220	—	—
	GRID	4	11	5	3	3	4	5	2.5	3	5	3	5	3	4
2ND A. F. TUBE	FILAMENT	—	—	—	2	2	—	—	2	2	—	2	—	2.4	2.4
	PLATE	—	—	—	85	120	—	—	90	120	—	120	—	200	225
	SCREEN	—	—	—	90	125	—	—	95	125	—	125	—	210	230
	GRID	—	—	—	7	15	—	—	7	5	—	15	—	14	—
OSC. TUBE	FILAMENT	2.4	—	2.4	5	2	2.4	2.4	6	2	2.4	2	2.4	2.4	2.4
	PLATE	95	—	95	100	60	100	70	110	60	100	40	95	85	100
	GRID	*	—	*	*	*	*	*	*	*	*	*	*	*	*
CONTROL TUBE	FILAMENT	—	5.5	2.4	—	—	—	—	—	—	2.4	—	2.4	—	2.4
	PLATE	—	3	15	—	—	—	—	—	—	15	—	30	—	25
	SCREEN	—	—	8	—	—	—	—	—	—	7	—	7	—	5
	GRID	—	2	4	—	—	—	—	—	—	5	—	4	—	3

* The measured oscillator grid voltage will vary dependent on the capacity of the voltmeter leads. In some cases, the presence of the leads will stop oscillation and no reading will be secured for grid bias. In other cases, the reading will be only slight, or it may be as high as 10 volts.

**This includes the 1st, 2nd and 3rd R. F. tubes in Model 81. †This is the detector tube in Model 81.

ATWATER KENT RADIO

Service Data

PARTS LIST AND PRICE LIST FOR

TYPE L, F, P, Q AND D CHASSIS RECEIVERS

AND

TYPE N, N-3, J AND JB SPEAKERS

INDEX OF CONTENTS

GENERAL SERVICE DATA

CHASSIS DATA

PHONOGRAPH DATA

SPEAKER DATA

For Screws, Nuts and Small Parts in Sets and Speakers, See Page 229.

ATWATER KENT RADIO

TABLE OF PRICES, TUBE EQUIPMENT, AND OTHER DATA FOR MODELS 70, 72, 74, 75 AND 76

	Power Source	Price Complete Less Tubes	Type Chassis	Part No.	Type Speaker	Part No.	Color Code	Tubes	Shipping Weight Chassis	Shipping Weight Spkr.	Shipping Weight Cab.
Model 70 Low-boy 24¾" wide 15¼" deep 38¾" high	60 cycles 110 volts A. C.	$119.	L	16000	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	47 lbs.	21¼ lbs.	54 lbs.
	25 cycles 110 volts A. C.	129.	F	16100	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	51¼ lbs.	21¼ lbs.	
	110 volts Direct Current	129	D	16700	N-3	16900	Blue	3-UX-222 2-UX-112A 2-UX-171A	44½ lbs.	22½ lbs.	
	Battery	99.	Q	16800	J	15920	Orange	3-UX-222 2-UX-112A 2-UX-171A	36 lbs.	10¾ lbs.	
Model 72 (Super-Heterodyne) Low High-boy	60 cycles 110 volts A. C.	133.	H	16500	N	16400	Green	3-UY-224 3-UY-227 2-UX-245 1-UX-280	47 lbs.	21¼ lbs.	26½ lbs.
Model 74 Table 24½" wide 16½" deep 30¼" high	60 cycles 110 volts A. C.	125.	L	16000	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	47 lbs.	21¼ lbs.	51 lbs.
	25 cycles 110 volts A. C.	135.	F	16100	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	51¼ lbs.	21¼ lbs.	
	110 volts Direct Current	135.	D	16700	N-3	16900	Blue	3-UX-222 2-UX-112A 2-UX-171A	44½ lbs.	22½ lbs.	
Model 75 Phonograph-Combination 26¾" wide 17" deep 40¼" high	60 cycles 110 volts A. C.	195.	P	16600	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	45¾ lbs.	21¼ lbs.	85 lbs.
Model 76 High-boy 26" wide 16¼" deep 45¾" high	60 cycles 110 volts A. C.	145.	L	16000	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	47 lbs.	21¼ lbs.	78½ lbs.
	25 cycles 110 volts A. C.	155.	F	16100	N	16400	Green	3-UY-224 2-UY-227 2-UX-245 1-UX-280	51¼ lbs.	21¼ lbs.	
	110 volts Direct Current	155.	D	16700	N-3	16900	Blue	3-UX-222 2-UX-112A 2-UX-171A	44½ lbs.	22½ lbs.	
	Battery	125.	Q	16800	J	15920	Orange	3-UX-222 2-UX-112A 2-UX-171A	36 lbs.	10¾ lbs.	
Inductor Type Speaker	(Price $28.00)	For use as additional speaker or in multiple-speaker installation.			JB	17010	Black			20¼ lbs.	

December, 1930. These prices are subject to change without notice. WEST COAST PRICES SLIGHTLY HIGHER.

SYNCHRONIZING CONDENSERS

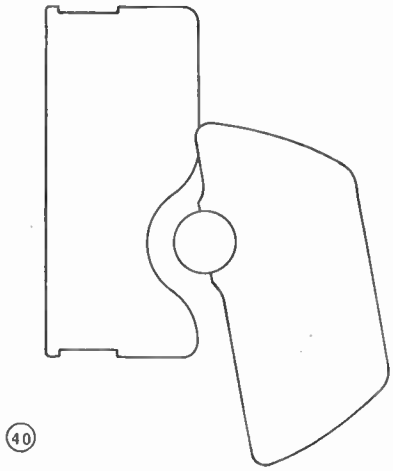


FIG. 218. POSITION OF ROTOR BLADES FOR 1500 K. C.

When the variable-condenser unit has been replaced or adjusted in any way, it is necessary to check the alignment as follows:—

(1) Loosen the pointer set-screws.

(2) Move the rotor plates to the position shown in Figure 218.

(3) With the rotor in this position, adjust the pointer to the 1500 K. C. position and tighten the pointer set screws.

(4) Note how far down on the 1500 K. C. mark the pointer comes, then turn the condenser knob to the 550 K. C. mark. The pointer should come down on this mark approximately the same as on the 1500 K. C. mark. If it does not, it is an indication that the front panel is not centered

(5) If the front panel is not centered, loosen the screw at each end of the bottom of the front panel and shift the panel one way or another as necessary. Tighten the panel screws and then reset the pointer accurately.

ADJUSTING TRIMMER CONDENSERS

When adjusting the trimmer condensers, it is necessary to have a four-wave oscillator, providing modulated signals at 1500, 1000, 800 and 600 kilocycles. The oscillator signals should come in at exactly these settings on two or more Type L sets THAT HAVE THE ORIGINAL FACTORY SYNCHRONISM.

1. Connect the common pick-up lead from the four R. F. oscillators to one end of a No. 8112 condenser. Connect the other end of this condenser to the Long-Antenna post. Connect the oscillator container to the Ground post.

2. Connect the output measuring circuit shown in Figure 259 to the speaker-plug socket on the set. Close S2 and S3. Throw S1 to the left.

3. Put all tubes in the set; power switch on; volume control at maximum; local-distance switch at distance. Break away the sealing wax on the trimmer-condenser screws.

4. Turn pointer exactly to the 1500 K. C. mark. Reduce or increase the amount of pick-up from the 1500 K. C. oscillator to secure a reading of about 20 on the output meter.

5. With a screw-driver, turn the pressure screw of the 4th trimmer condenser (on front variable condenser) one way or the other, as necessary, to the point where the reading on the output meter is greatest. Repeat this process on the 3rd trimmer, then on the 2nd, and finally on the 1st. Reduce the pick-up from the 1st oscillator if necessary in order to keep the needle of the galvanometer near the centre of its scale.

This adjustment of the trimmer-condenser screws is termed the CORRECT POSITION.

IMPORTANT SERVICE NOTES

1. In the Types L, F, P, D and Q chassis receivers, it is very important to arrange the three control-grid leads to the screen-grid tubes exactly parallel to each other. If these leads are not parallel, and two of them come close together, the dial readings will not be accurate, especially at the high-frequency end of the scale.

2. When replacing a flexible resistor, care must be taken to use a resistor having the same value. In the event of any uncertainty, make a continuity meter reading of a good resistor of the same type in a stock set, and then use a replacement resistor that gives the same reading on the continuity meter.

3. A number of different code markings may be used to identify by-pass condensers that have the same part number. If the part number is the same, the condensers are interchangeable, even though the code markings are different. (See Page 253.)

TYPE L-1 CHASSIS, VOLTAGE TABLE AND DIAGRAM

VOLTAGE TABLE FOR TYPE L-1 CHASSIS

Set in operation. Volume control at maximum.
L-D Switch at distance.

Use High Resistance D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages.
Use A. C. Voltmeter to Measure Filament Voltages.

APPROX. VOLTAGES, USING 120 V LINE

TUBE	FILAMENT VOLTAGE	PLATE VOLTAGE	CONTROL-GRID VOLTAGE	SCREEN VOLTAGE
1st-R.F.	2.4	185	6	85
2nd-R.F.	2.35	185	4.5	86
3rd-R.F.	2.35	185	4.5	86
Detector	2.35	120	12**	—
1st-A.F.	2.35	75	3.5	—
2A	2.45	265	55*	—
2Aa	2.45	265	55*	—
Rectifier	5.	—	—	—

* Use 250-volt scale.
** This is the voltage across the detector bias resistor; when measuring from grid to cathode, the voltage reading is only 2.
All readings made from cathode in heater-type tubes, and from —F in plain-filament-type tubes.

In order to identify modifications of each chassis, where such modifications require new part numbers, a numeral is used after the type letter. Thus the 1st style of Type L chassis (below No. 6,234,881) is termed Type L-1, and the 2nd style (above No. 6,234,881) is termed Type L-2. This marking is for use only in Service literature and will not appear on the serial-number plates.

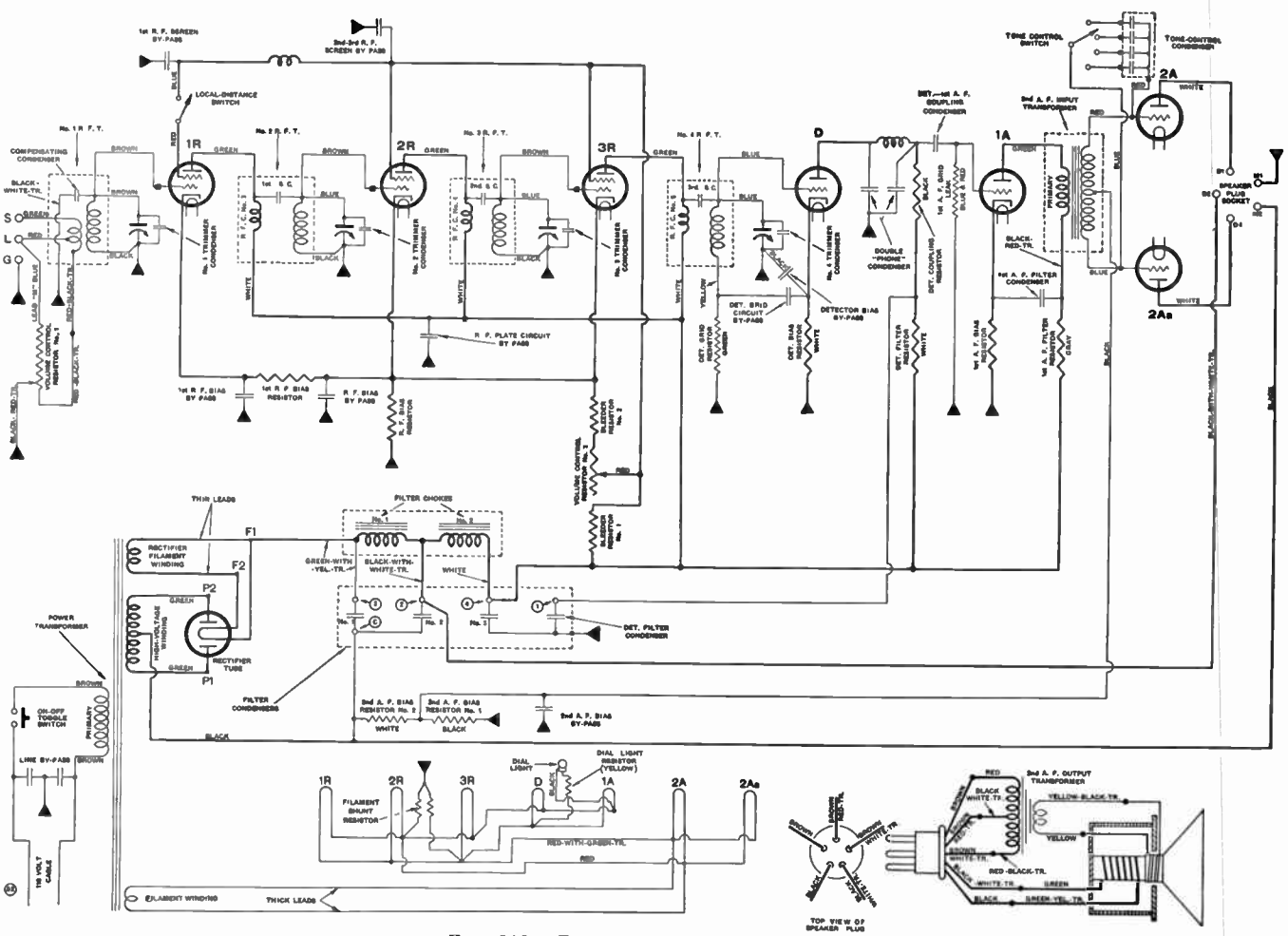


FIG. 219. DIAGRAM OF L-1 CHASSIS.

December, 1930.

TYPE L-2 CHASSIS, VOLTAGE TABLE AND DIAGRAM

The Type L Chassis has three stages of screen-grid radio-frequency amplification, plate detection, one stage of resistance-coupled audio, and a "double-audio" output stage. It is designed for 110-120-volt, 50-60-cycle alternating-current operation.

Type F Chassis is similar to Type L, but it is designed for operation on 25-cycle alternating current. The filter circuit is different from the L.

Type P Chassis is similar to Type L, but instead of a "local-distance" switch, it has a "radio-phonograph" switch.

VOLTAGE TABLE FOR TYPE L-2 AND P CHASSIS

Set in operation. Volume control at maximum. L-D (or 'phono) switch up.

Use High Resistance D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages.
Use A. C. Voltmeter to Measure Filament Voltages.

APPROX. VOLTAGES, USING 120 V. LINE

TUBE	FILAMENT VOLTAGE	PLATE VOLTAGE	CONTROL-GRID VOLTAGE	SCREEN VOLTAGE
1st-R.F.	2.4	180	5	85
2nd-R.F.	2.35	180	4.5	86
3rd-R.F.	2.35	180	4.5	86
Detector	2.35	110	14**	—
1st-A.F.	2.35	70	2	—
2A	2.45	250	55*	—
2Aa	2.45	250	55*	—
Rectifier	5.	—	—	—

* Use 250-volt scale.
** This is the voltage across the detector bias resistor; when measuring from grid to cathode, the voltage reading is only 2.
All readings made from cathode in heater-type tubes, and from —F in plain-filament-type tubes.

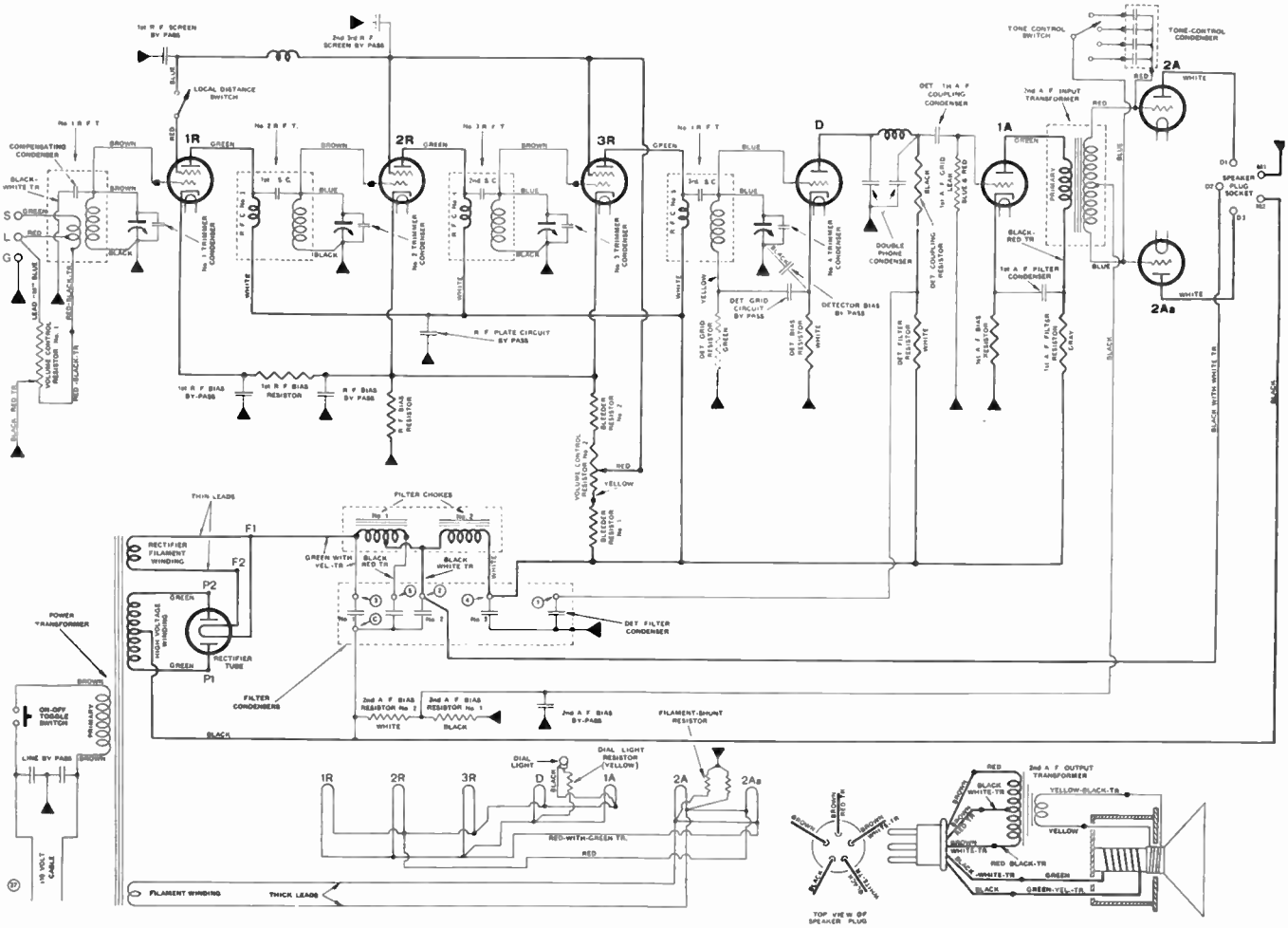


FIG. 220. DIAGRAM OF L-2 CHASSIS.

In the majority of L-2 sets, the filament shunt resistor is connected across the R.F. filaments, as shown in Fig. 219. Also, a 2-ampere fuse is connected in one side of the 110-volt line.

TYPE L-1 CHASSIS RECEIVER

Condensers in R.F. By-Pass No. 1

L—Line by-pass.
L—Line by-pass.
C—2nd-A.F. bias by-pass.
E—1st-R.F. screen by-pass.

Condensers in R.F. By-Pass No. 2

A—1st-R.F. bias by-pass.
B—R.F. bias by-pass.
U—1st-A.F. filter condenser.

Condensers in R.F. By-Pass No. 3

D—Detector bias by-pass.
H—R F. plate-circuit by-pass.
T—Detector grid-circuit by-pass.

Condensers in Detector By-Pass

F—2nd-3rd R.F. screen by-pass.
M—Detector-1st A.F. coupling condenser.
P—Phone condenser.
P—Phone condenser.

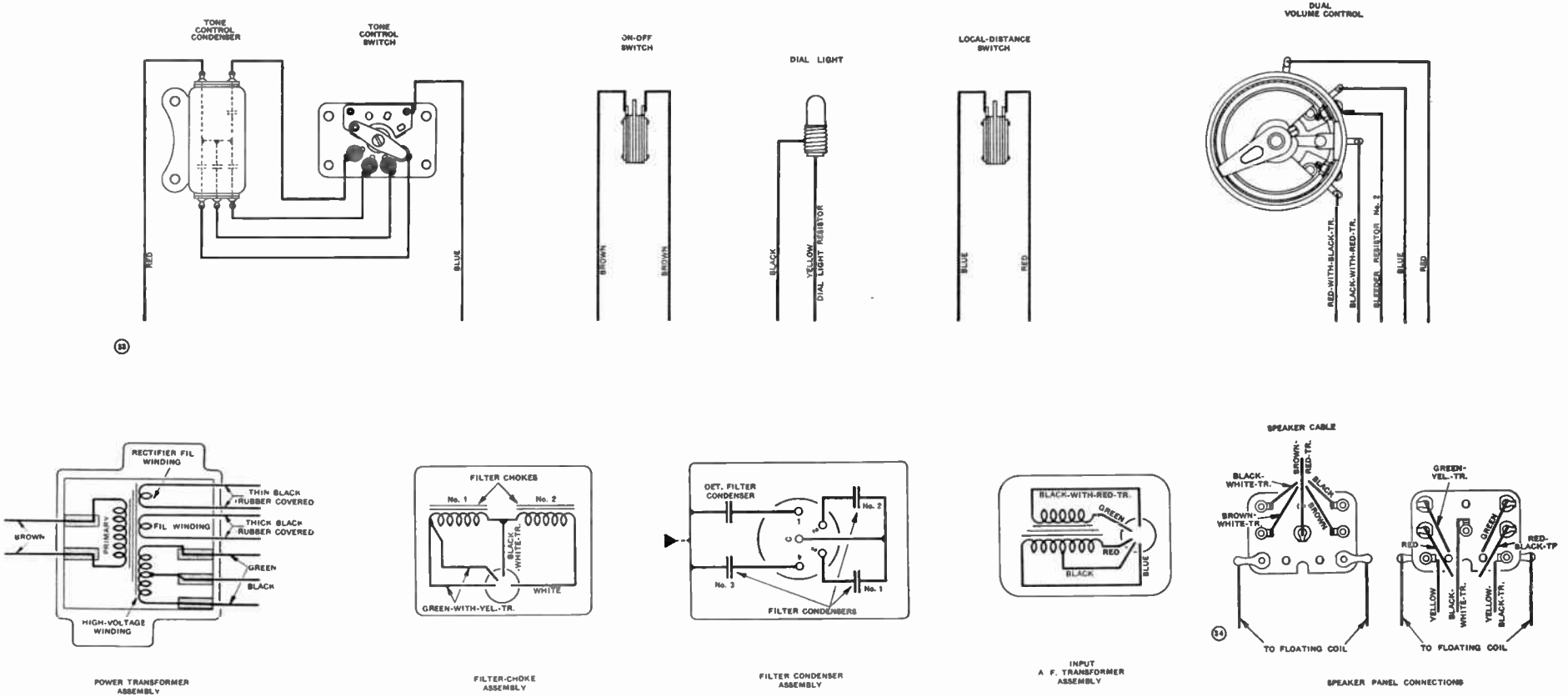


FIG. 221. CONNECTION OF UNITS IN TYPE L-1 CHASSIS, AND, AT RIGHT, CONNECTIONS TO TERMINAL PANEL OF TYPE N SPEAKER.

The rectifier filament winding leads come out the left-hand side of the power transformer; these are thin leads covered with black sleeving. The filament winding has thick leads covered with black sleeving.

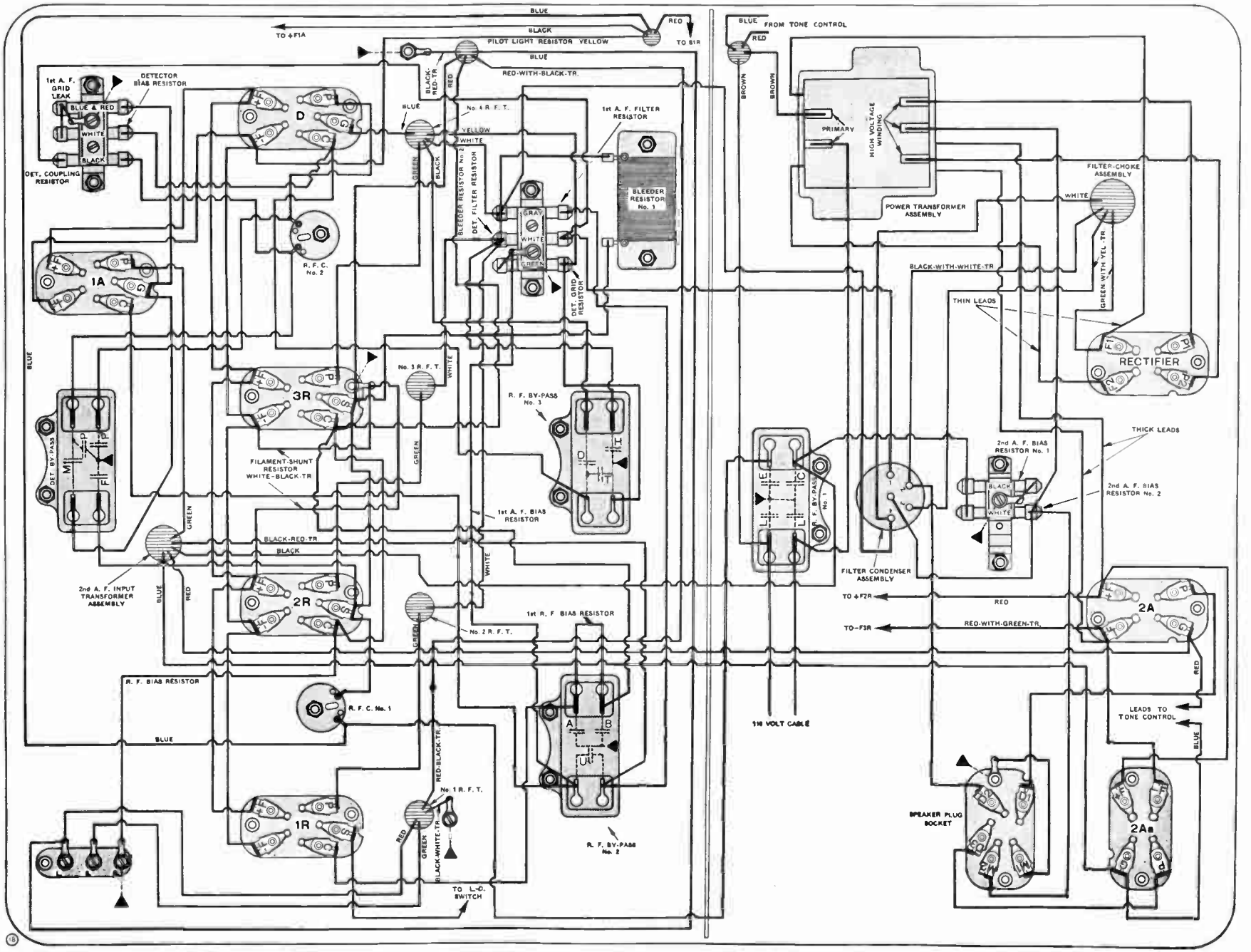


FIG. 222. BOTTOM WIRING OF TYPE L-1 CHASSIS.

TYPE L-2 CHASSIS RECEIVER

Condensers in R.F. By-Pass No. 1

L—Line by-pass.
L—Line by-pass.
C—2nd-A.F. bias by-pass.
E—1st-R.F. screen by-pass.

Condensers in R.F. By-Pass No. 2

A—1st-R.F. bias by-pass.
B—R.F. bias by-pass.
U—1st-A.F. filter condenser.

Condensers in R.F. By-Pass No. 3

D—Detector bias by-pass.
H—R.F. plate-circuit by-pass.
T—Detector grid-circuit by-pass.

Condensers in Detector By-Pass

F—2nd-3rd R.F. screen by-pass.
M—Detector-1st A.F. coupling condenser.
P—Phone condenser.
P—Phone condenser.

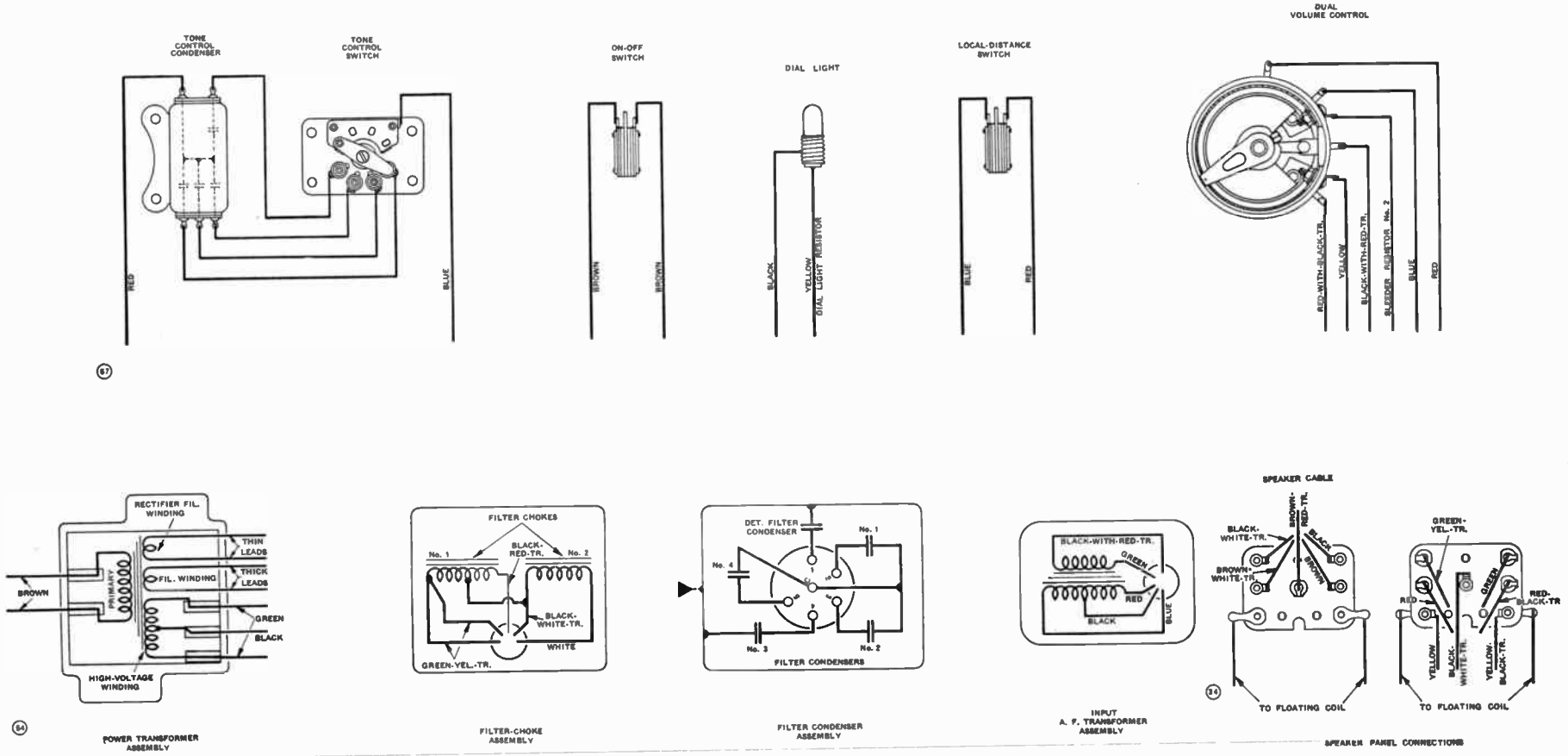


FIG. 223. CONNECTION OF UNITS IN TYPE L-2 CHASSIS, AND, AT RIGHT, CONNECTIONS TO TERMINAL PANEL OF TYPE N SPEAKER.

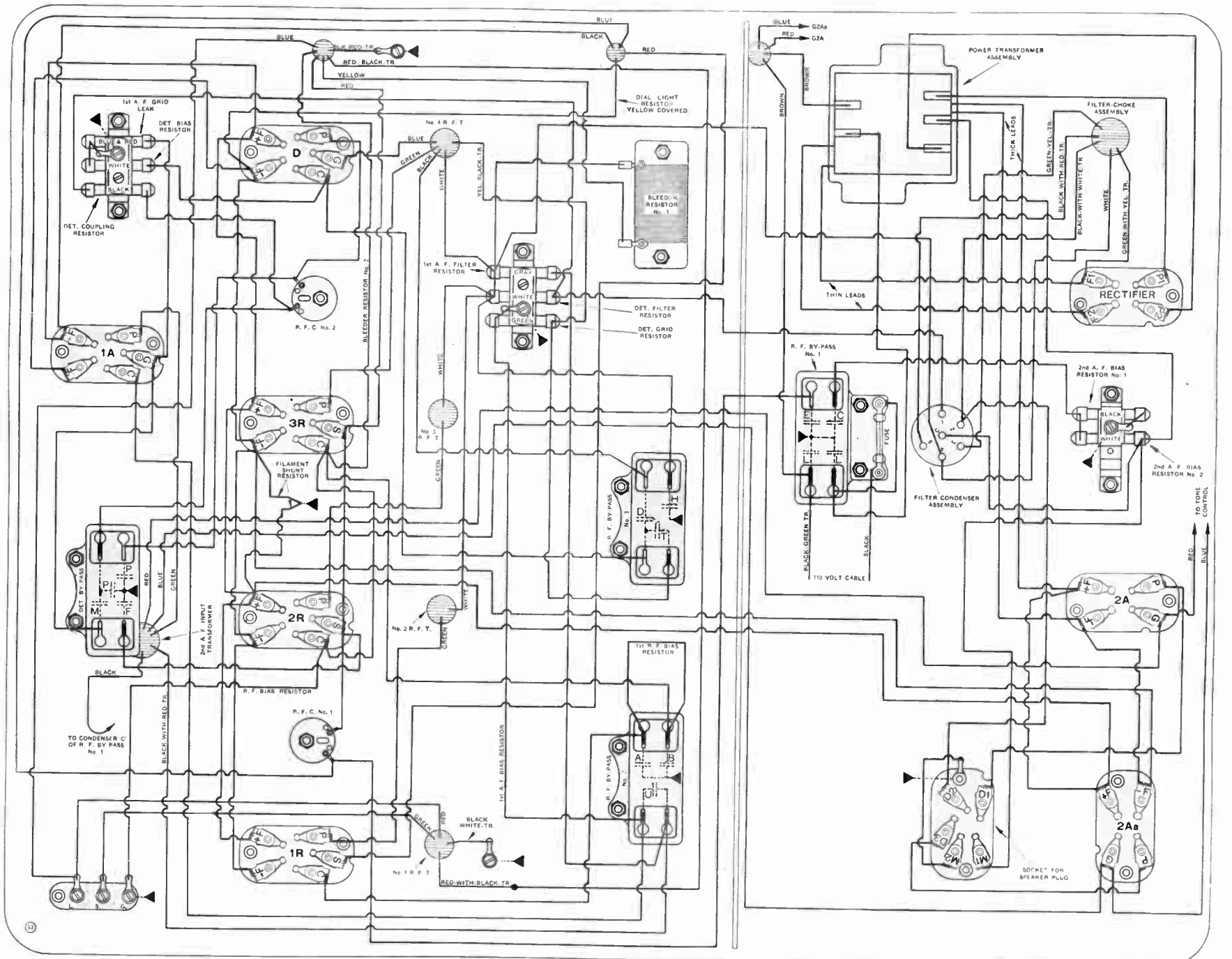


FIG. 224. BOTTOM WIRING OF TYPE L-2 CHASSIS RECEIVER.

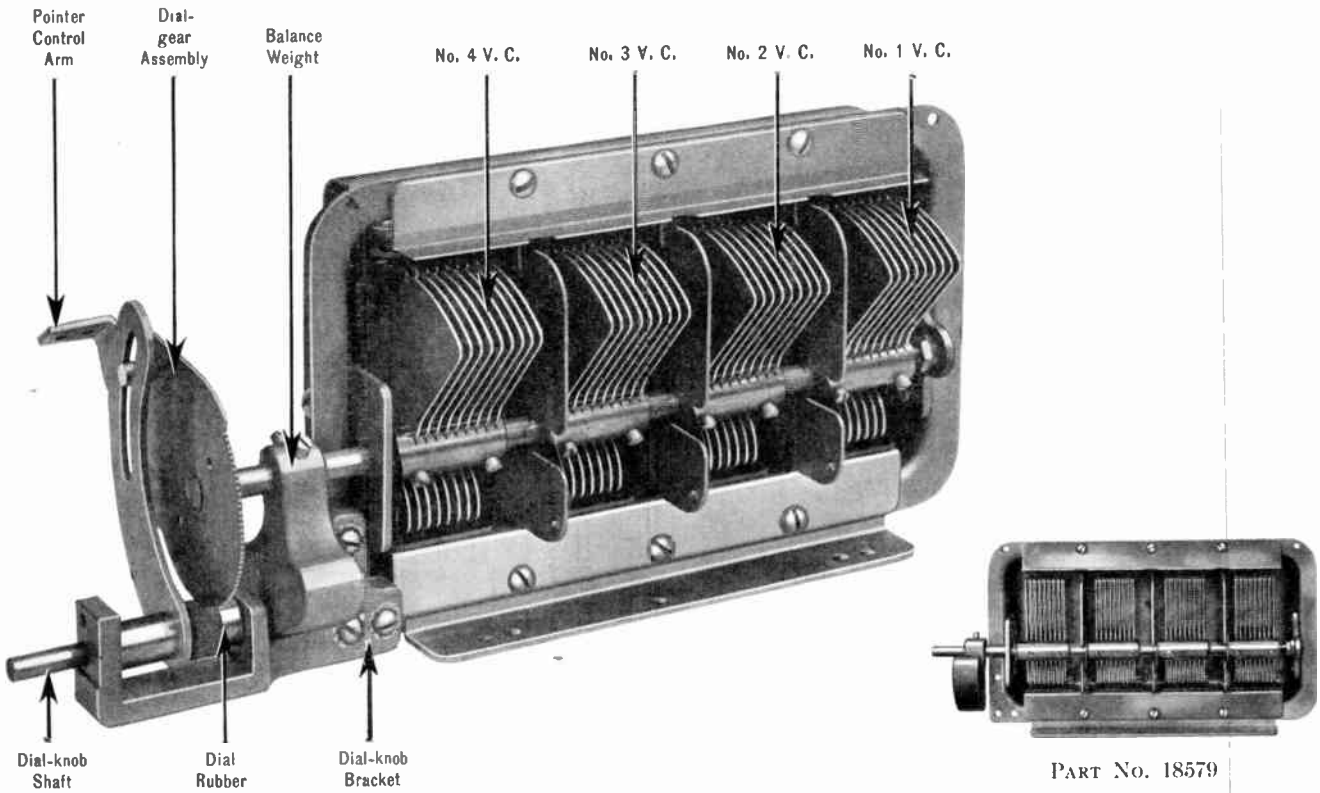


FIG. 225. VARIABLE-CONDENSER ASSEMBLY.

If any section of this condenser is seriously damaged, the stator, rotor and frame (with balance weight) unit (No. 18579) should be replaced.

IMPORTANT: DO NOT disturb the adjustment of the rotor set-screws nor the bearing screw at the rear end of the shaft.

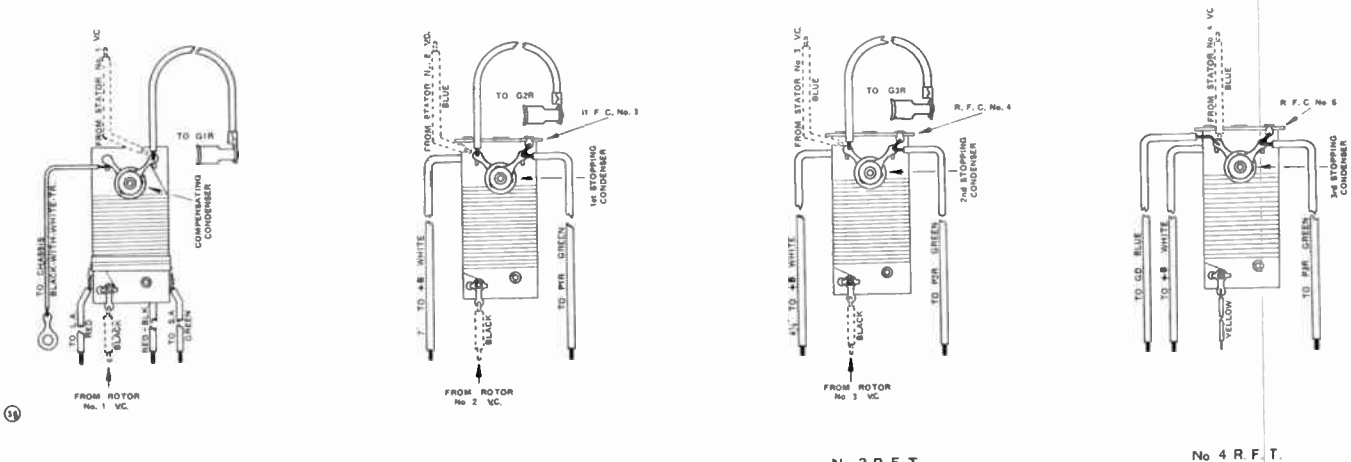


FIG. 226. CONNECTIONS OF R. F. COIL GROUP IN L-2 AND F CHASSIS.

If one R. F. coil or R. F. C. Nos. 3, 4 or 5, is defective, the complete coil group must be replaced. If the compensating condenser or one of the stopping condensers is defective, it may be replaced without changing anything else.

PARTS AND PRICE LIST—TYPE L, No. 16000, CHASSIS

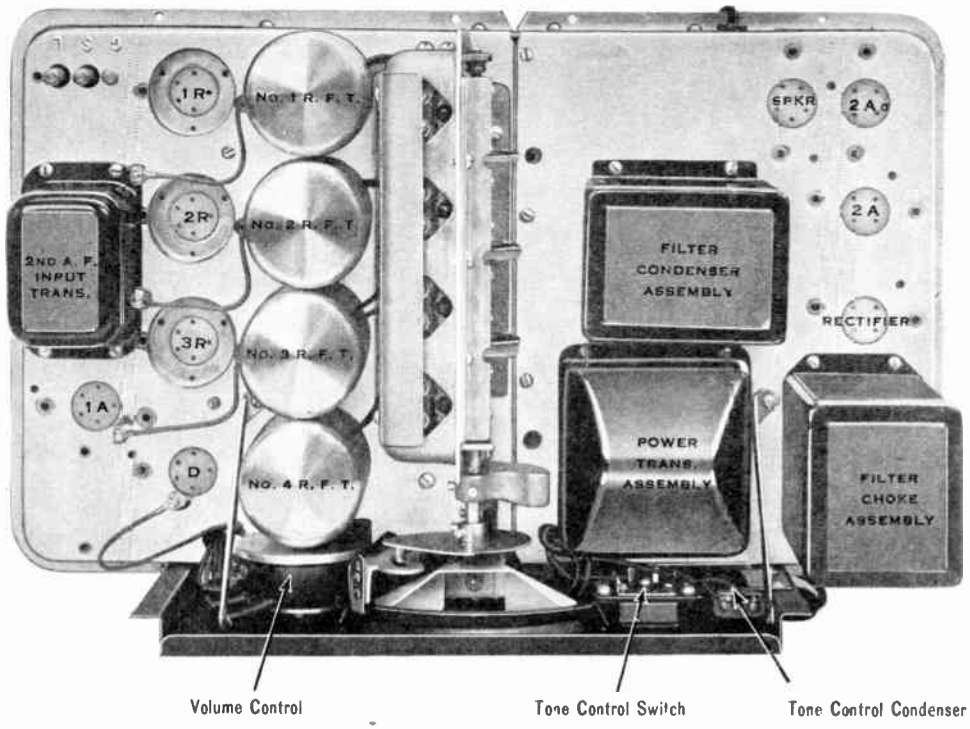


FIG. 227.

TOP VIEW OF TYPE L CHASSIS.

Type P Chassis is similar except for the addition of two binding posts at the rear of the front panel for connection to the pick-up transformer.

Type F Chassis has a different style of power transformer.

Part No.	FRONT PANEL ASSEMBLY	*Price*
18085	Front panel with dial plate	$1.25
18581	Front panel complete	2.50
17224	Front panel brace (2 used)	.10
17985	Escutcheon	1.00
17244	Volume-control or tone-control knob	.30
16370	On-off switch complete	1.10
16380	Local-distance switch	1.25
16270	Volume-control	3.70
17876	Volume-control bracket	.20
16576	Volume-control cover	.05
18223	Tone-control condenser clamp	.05
17814	Dial knob	.30
17959	Dial pointer	.05

Part No.	POWER UNITS	*Price*
16660	Power-transformer	$7.50
17825	Power-transformer spring	.10
17824	Power-transformer cover	.50
17563	Power-transformer insulating sheet	.02
	Filter Condenser Unit For L-1	
15480	Filter-condenser (5 taps)	7.95
17429	Filter-condenser cover	.40
17534	Filter-condenser spacer (fibre)	.25/c
	Filter Condenser Unit For L-2	
15850	Filter-condenser (6 taps)	7.95
18188	Filter-condenser case	.45
17534	Filter-condenser spacer (fibre)	.25/c
16680	Filter-choke (5 leads)*	5.75
17302	Filter-choke lid	.20
15520	2nd-A. F. input transformer	3.75

*No. 16680 choke assembly is for use in Type L-2 chassis, but it may be used in Type L-1 chassis by cutting off the black-with-red-tracer lead.

Part No.		*Price*
18579	VARIABLE-CONDENSER STATOR, ROTOR AND FRAME (WITH LEADS AND BALANCE WEIGHT)	$9.60
17107	Rotor-connection (long)	.10
17291	Rotor-connection (short)	.10
15404	Dial light	.25
16420	Dial-light socket and reflector, one-hole mounting (less lead and resistor)	.40
16420-A	Dial-light socket and reflector, two-hole mounting (less lead and resistor)	.40
18615	Dial-gear	.40
17936	Dial-knob bracket (one-hole mounting)	.35
18144	Dial-knob bracket (two-hole mounting)	.35
17935	Dial-knob bracket support (threaded)	.03
17961	Dial-rubber assembly	.15
17941	Dial-knob shaft	.05
17962	Pointer-control arm	.30

No separate parts, except those listed above, will be supplied for the variable-condenser unit.

16430	TONE-CONTROL SWITCH COMPLETE	.75
18148	Base	.60
18146	Shaft	.12
18112	Contact blade	.03

Part No.	COIL GROUP	*Price*
18327	R. F. coil group	$4.00
15540	Stopping condenser (3 used)	.10
15540	Compensating condenser (1 used)	.10
17295	R. F. coil shield (4 used)	.50

If one R. F. coil, or R. F. C. No. 3, No. 4, or No. 5 is defective, the ENTIRE coil group must be replaced.

December, 1930. These prices supersede all previous prices and are subject to change without notice.

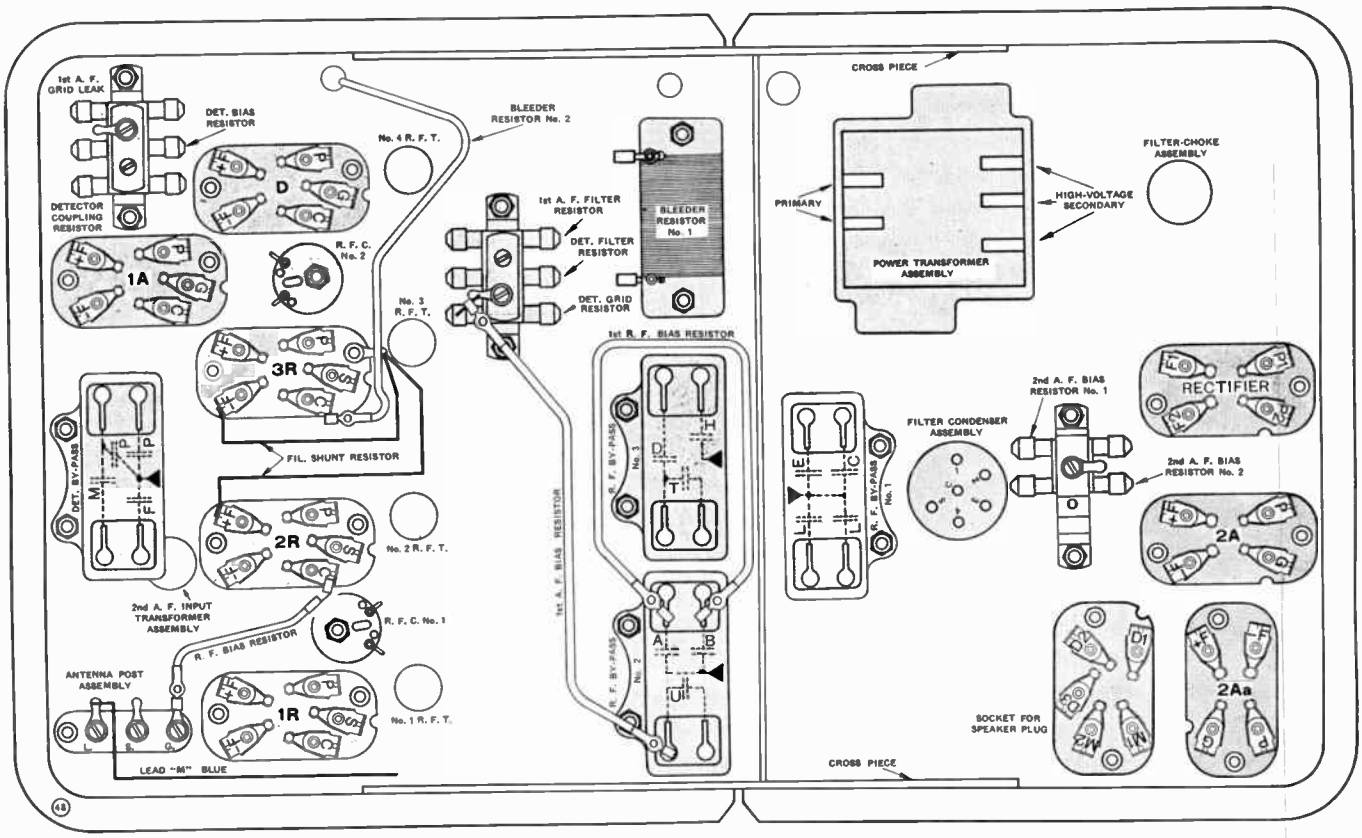


FIG. 228. BOTTOM VIEW OF TYPE L-2 AND P CHASSIS.

A line fuse (2-amperes) and fuse holder are mounted at the right of R.F. by-pass No. 1 in later-type sets.
In L-1 chassis, the filter condenser assembly has five contacts instead of six as shown.

TUBULAR RESISTORS
TWO-RESISTOR GROUP

Part No.		*Price*
15592	2nd-A.F. bias resis. No. 1 (black)	$ .25
16724	2nd-A.F. bias resis. No. 2 (white)	.25
17341	Mounting bracket	.05
17344	Fibre pad	.25/c
17343	Metal clamping strip	.02

THREE-RESISTOR-GROUPS

Part No.		*Price*
16282	1st-A.F. grid leak (blue or blue and red)	$ .25
16724	Detector bias resistor (white)	.25
15592	Detector coupling resistor (black)	.25
15285	1st-A.F. filter resistor (gray)	.50
16724	Detector filter resistor (white)	.25
15892	Detector grid resistor (green)	.25
17341	Mounting bracket	.05
17342	Fibre pad	.25/c
17345	Metal clamping strip	.02

FLEXIBLE RESISTORS

Part No.		*Price*
16350	R.F. bias resistor	$ .20
16320	1st-R.F. bias resistor	.20
16320	1st-A.F. bias resistor	.20
17090	Bleeder resistor No. 2	.20
18236	Dial light resistor (yellow)	.15
17077	Filament shunt resistor	.15
16330	Bleeder resistor No. 1 (flat type)	$ .40
13306	Insulator (1½" x 3")	.25/c
15271-A	R. F. CHOKE No. 1, NO. 2 (2 used)	.25

FIXED CONDENSERS

Part No.		*Price*
15790	R.F. by-pass No. 1	$1.00
15770	R.F. by-pass No. 2	1.00
15780	R.F. by-pass No. 3	1.10
15640	Detector by-pass	1.00
16490	Tone-control condenser	1.00

SOCKETS

Part No.		*Price*
17518	R.F. sockets (3 used)	$ .30
17519	Detector or 1st-A.F. socket (2 used)	.30
17511	2Aa socket	.25
17509	2A socket	.25
17508	Rectifier socket	.25
18007	Speaker-plug socket	.30
17377	Socket insulator (fibre sheet) (5 used)	.25/c
18016	Speaker-plug-socket insulator	.25/c
18449	Fuse socket	.15
16420	Dial-light socket and reflector, one-hole mounting (less leads)	.40
16420-A	Dial-light socket and reflector, two-hole mounting (less leads)	.40

December, 1930. These prices supersede all previous prices and are subject to change without notice.

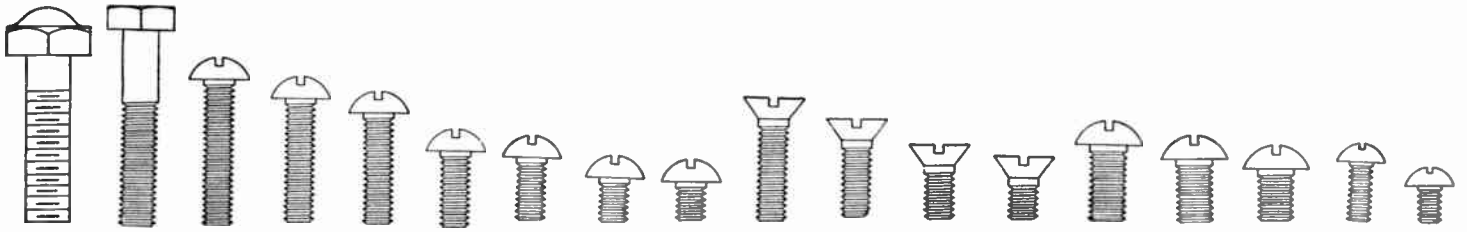
PARTS AND PRICE LIST—TYPE L, No. 16000, CHASSIS (Cont'd)

MISCELLANEOUS PARTS

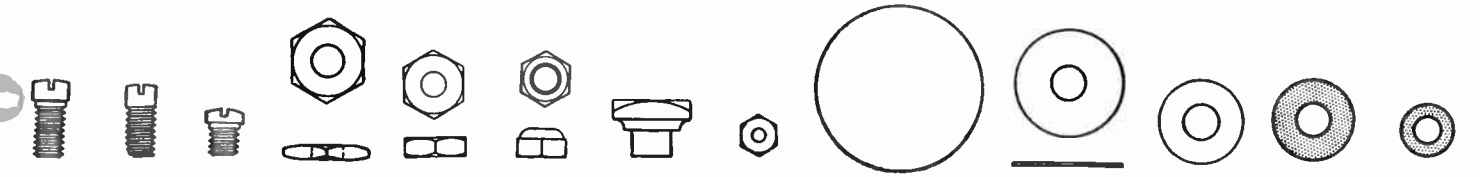
Part No.		Price
17524	110-volt cable with plug	$1.90
8956	110-volt plug only	.30
16741	Insulating bushing for 110-volt cable	.05
16742	Bushing-retaining spring	.05
17521	Antenna binding posts and base	.45
17323	Antenna and ground post base	.05
8215	Binding post	.20
17536	Bottom plate	1.30
18117	Balance weight for variable condenser	.35
13989	Ground clamp	.30
15213	Tube-shield (3 used)	.15
15214	Tube-shield base (3 used)	$ .03
17326	Detector cap	.30
17223	Cross piece (10″ x 7/8″—2 used)	.25
17632	Detector-cap lead (brown)	.10
	Trimmer-condenser sealing wax	.50 lb.
18118	"Guide" Card (form F-680)	.75/c net
18119	Log Card (form F-681)	.75/c net
17989	Tuned-radio-frequency name-plate	.06
18534	Line fuse (2-ampere)	.05
16220	Literature assembly	.20 net
18122	Instruction book	.10 "
18123	Shipping container	.65 "

SMALL PARTS ON L, F, P, Q, D RECEIVERS, AND J, JB, N, N-3 SPEAKERS

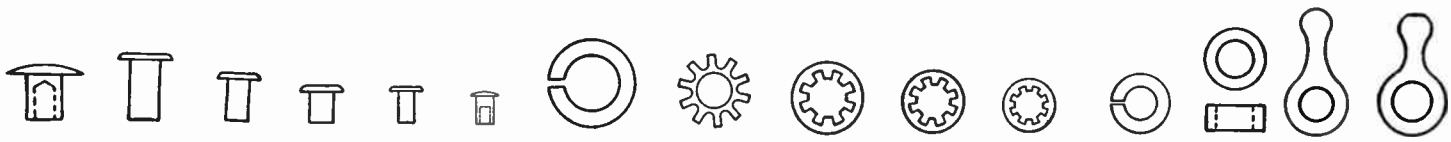
ILLUSTRATIONS ARE FULL SIZE



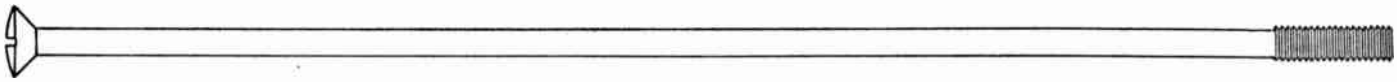
18092 $ .04 | 18391 $ .02 | 3718 $ .02 | 13052 $ .30/c | 9689 $ .30/c | 8221 $ .30/c | 9274 $ .30/c | 7697 $ .30/c | 8106 $ .30/c | 16158 $ .30/c | 15283 $ .30/c | 17516 $ .30/c | 14394 $ .30/c | 14379 $ .35/c | 15766 $ .35/c | 9209 $ .35/c | 14788 $ .20/c | 969 $ .30/c



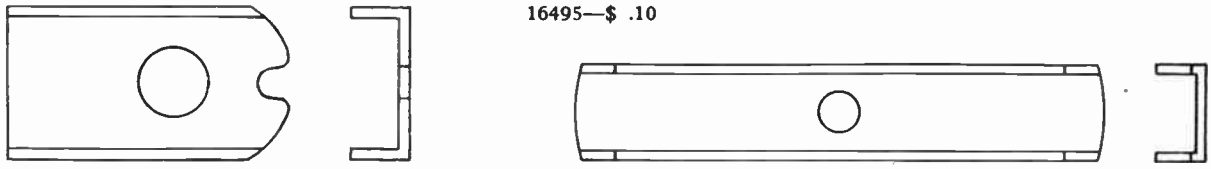
7977 $ .50/c | 15562 $ .30/c | 14687 $ .50/c | 15133 $ .04 | 8188 $ .01 | 15006 $ .02 | 17507 $ .05 | 17868 $ .02 | 16492 (Felt) $ .04—3/8″ thick | 15134 (Leather) $ .01 | 13928 $ .01 | 13145 (Fibre) $ .25/c | 3419 (Fibre) $ .15/c



17679 $ .01 | 8249 $ .50/c | 16771 $ .30/c | 9128 $ .30/c | 9206 $ .20/c | 8272 $ .02 | 18095 $ .40/c | 17204 $ .40/c | 17433 $ .50/c | 17432 $ .50/c | 18127 $ .45/c | 8220 $ .10/c | 17775 $ .02 | 9678 $ .50/c | 9675 $ .50/c



16495—$ .10



16512—Clamp—$ .05

18389—Strap—$ .05

17827 $ .05 | 16168—Rubber $ .02 | 16499 $ .15 | 15414—Foot $ .08 | 18388 $ .25

December, 1930. These prices supersede all previous prices and are subject to change without notice.

TYPE F CHASSIS, DIAGRAM AND PARTS LIST

(For Voltage Table, See Page 253)

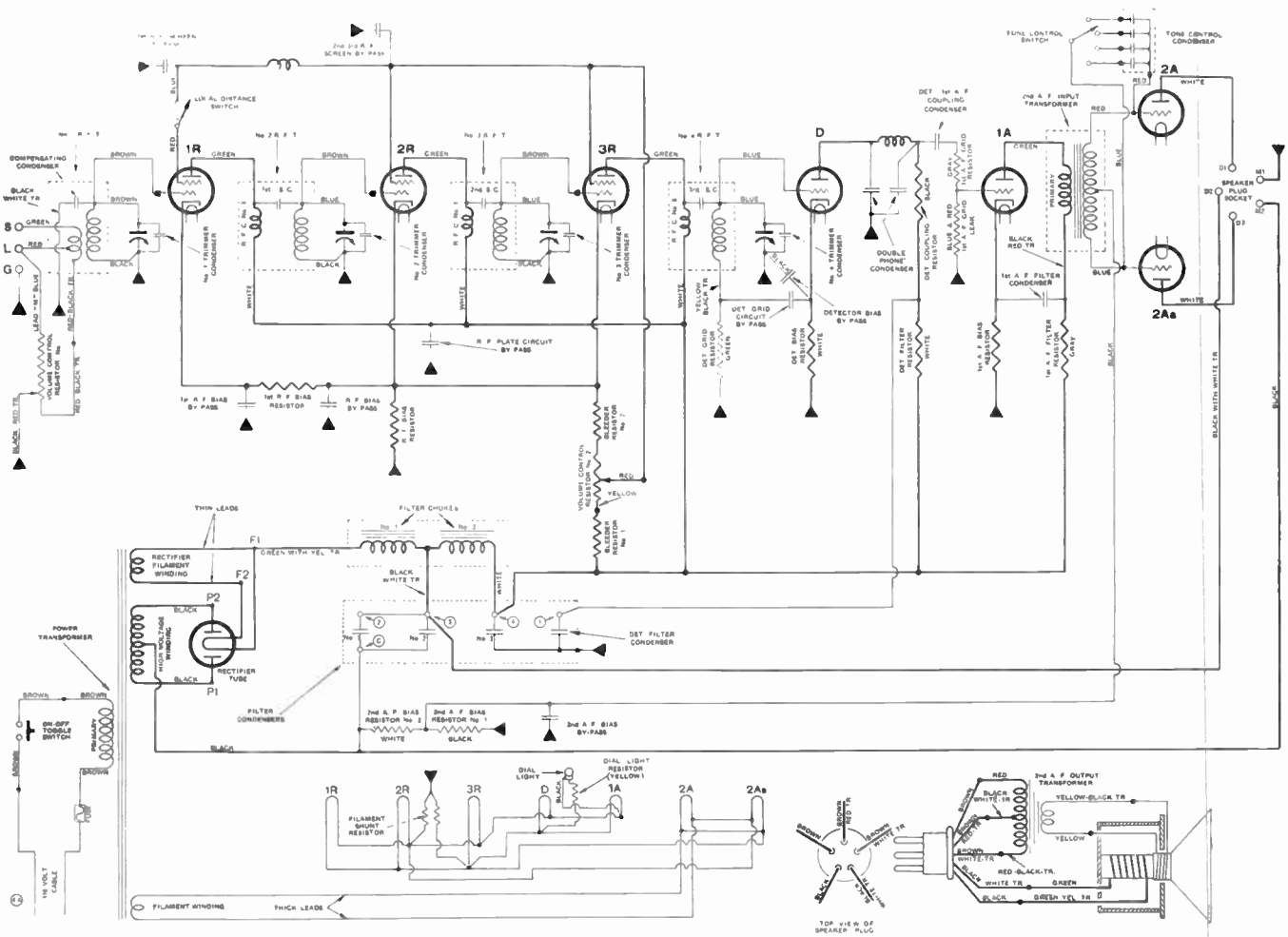


FIG. 229. WIRING DIAGRAM OF TYPE F CHASSIS.

In some early-type F chassis, a line by-pass condenser is used and the 1st-A. F. grid resistor (gray) is omitted. In later-type F chassis, the filter condenser has only four contacts, as shown on Page 232, and the top of the 1st-A.F. grid leak is connected to the opposite end of the 1st-A.F. grid resistor, as shown on Page 233.

PARTS AND PRICE LIST—TYPE F, No. 16100, CHASSIS

All parts not listed below are same as those used in Type L, No. 16000, Chassis, on Pages 227, 228 and 229.

Part No.		*Price*
15880	Power-transformer	$12.00
18645	Power-transformer lid with name-plate	.20
16520	Filter-condenser assembly	7.95
18188	Filter-condenser case	.45
17534	Filter-condenser spacer (fibre)	.25 /c
16260	Filter-choke	7.50
17302	Filter-choke lid	.20
15790	R.F. by-pass No. 1 (before No. 5802566)	$1.00
15262	R.F. by-pass No. 1 (after No. 5802566)	1.00
15285	1st-A.F. grid resistor, gray (after No. 5802566)	.50
16590	Literature assembly	.20 net
18256	Instruction book	.10 "
18257	Shipping container	.65 "

December, 1930. These prices supersede all previous prices and are subject to change without notice.

TYPE P CHASSIS, DIAGRAM AND PARTS LIST

(For Voltage Table, See Page 221.)

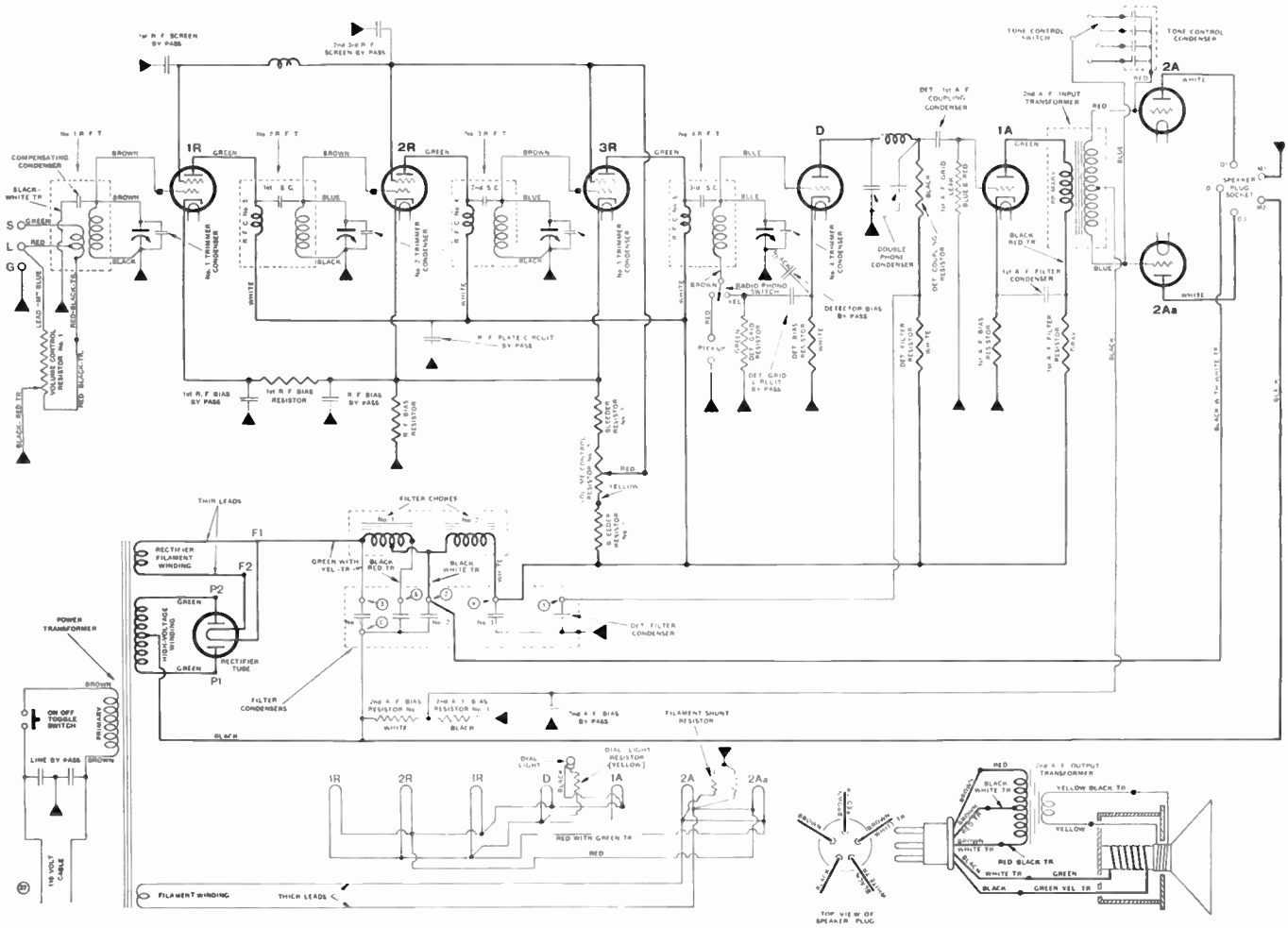


FIG. 230. WIRING DIAGRAM OF TYPE P CHASSIS.

In later-type P sets, the filament shunt resistor is connected across the R.F. filaments, as shown in Fig. 229. Also, a 2-ampere fuse is connected in one side of the 110-volt line.

PARTS AND PRICE LIST—TYPE P, No. 16600, CHASSIS

All parts not listed below are same as those used in Type L, No. 16000, Chassis, on Pages 227, 228 and 229.

Part No.		*Price*
18544	Phono-radio switch	$1.25
17040	Phonograph post assembly	.45
18546	Binding post (marked G)	.20
8215	Binding post (plain)	.20

Part No.		*Price*
18548	Instruction sheet	$ .10 net
17060	Literature assembly	.20 "
18547	Shipping container	.65 "

For phonograph parts, see Page 239.

December, 1930. These prices supersede all previous prices and are subject to change without notice.

TYPE F CHASSIS RECEIVER

Condensers in R.F. By-Pass No. 1

C—2nd-A.F. bias by-pass.
E—1st-R.F. screen by-pass.
F—2nd-3rd-R. F. screen by-pass.

Condensers in R.F. By-Pass No. 2

A—1st-R.F. bias by-pass.
B—R.F. bias by-pass.
U—1st-A.F. filter condenser.

Condensers in R.F. By-Pass No. 3

D—Detector bias by-pass.
H—R.F. plate-circuit by-pass.
T—Detector grid-circuit by-pass.

Condensers in Detector By-Pass

M—Detector-1st A.F. coupling condenser.
P—"Phone" condenser.
P—"Phone" condenser.
R—Filament by-pass.

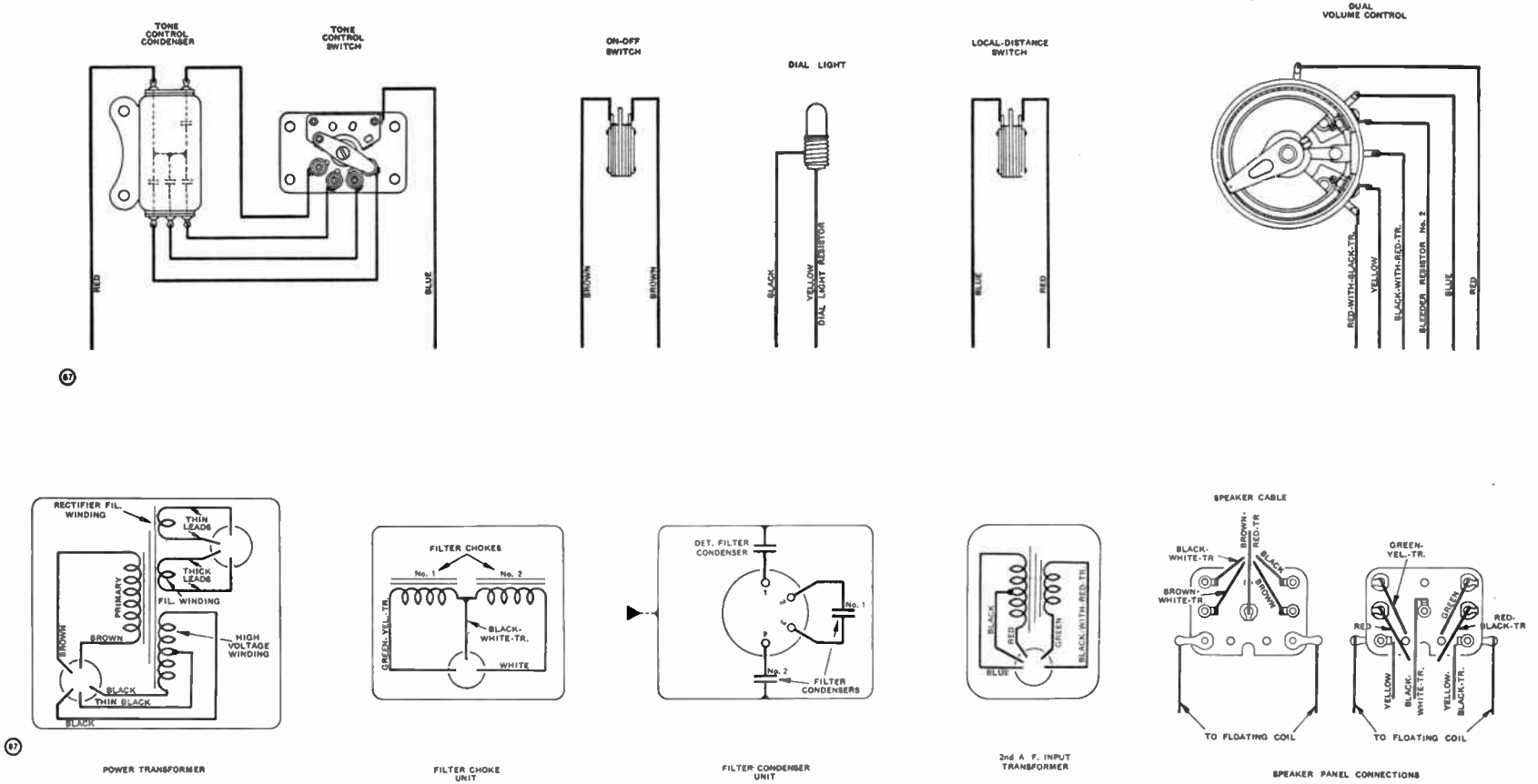


FIG. 231. CONNECTIONS OF UNITS IN TYPE F CHASSIS.

In some early Type F Chassis, the filter condenser has five contacts, as shown on Page 230.

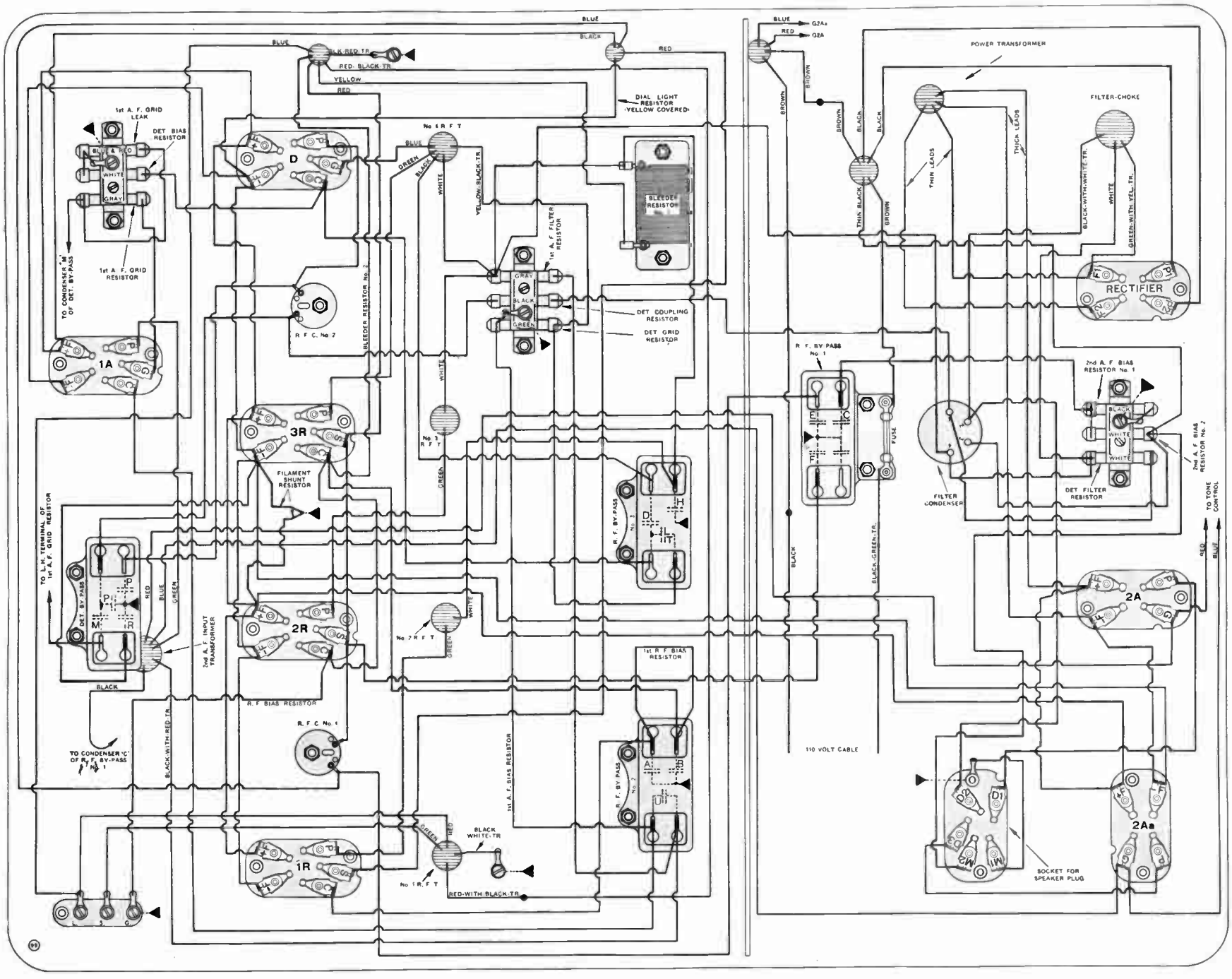


FIG. 232. BOTTOM WIRING OF TYPE F CHASSIS RECEIVER.

In some early Type F Chassis, a line by-pass condenser is used, and the 1st-A. F. grid resistor (gray) is omitted. Also, the filter condenser has five contacts, as shown on Page 230.

TYPE P CHASSIS RECEIVER

Condensers in R.F. By-Pass No. 1

L—Line by-pass.
L—Line by-pass.
C—2nd-A.F. bias by-pass.
E—1st-R.F. screen by-pass.

Condensers in R.F. By-Pass No. 2

A—1st-R.F. bias by-pass.
B—R.F. bias by-pass.
U—1st-A.F. filter condenser.

Condensers in R.F. By-Pass No. 3

D—Detector bias by-pass.
H—R.F. plate-circuit by-pass.
T—Detector grid-circuit by-pass.

Condensers in Detector By-Pass

F—2nd-3rd R.F. screen by-pass.
M—Detector-1st A.F. coupling condenser.
P—Phone condenser.
P—Phone condenser.

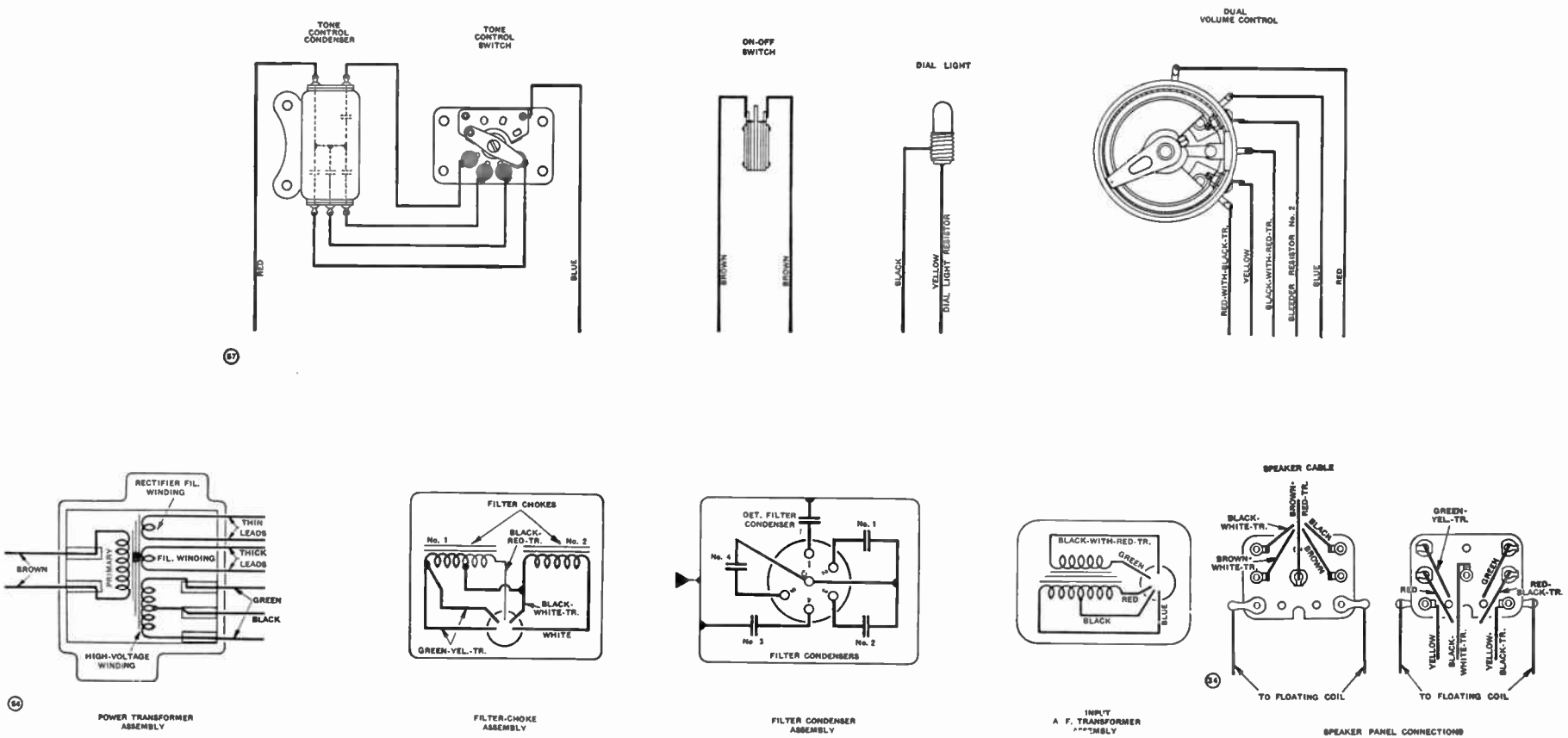


FIG. 233. CONNECTION OF UNITS IN TYPE P CHASSIS, AND, AT RIGHT, CONNECTIONS TO TERMINAL PANEL OF TYPE N SPEAKER.

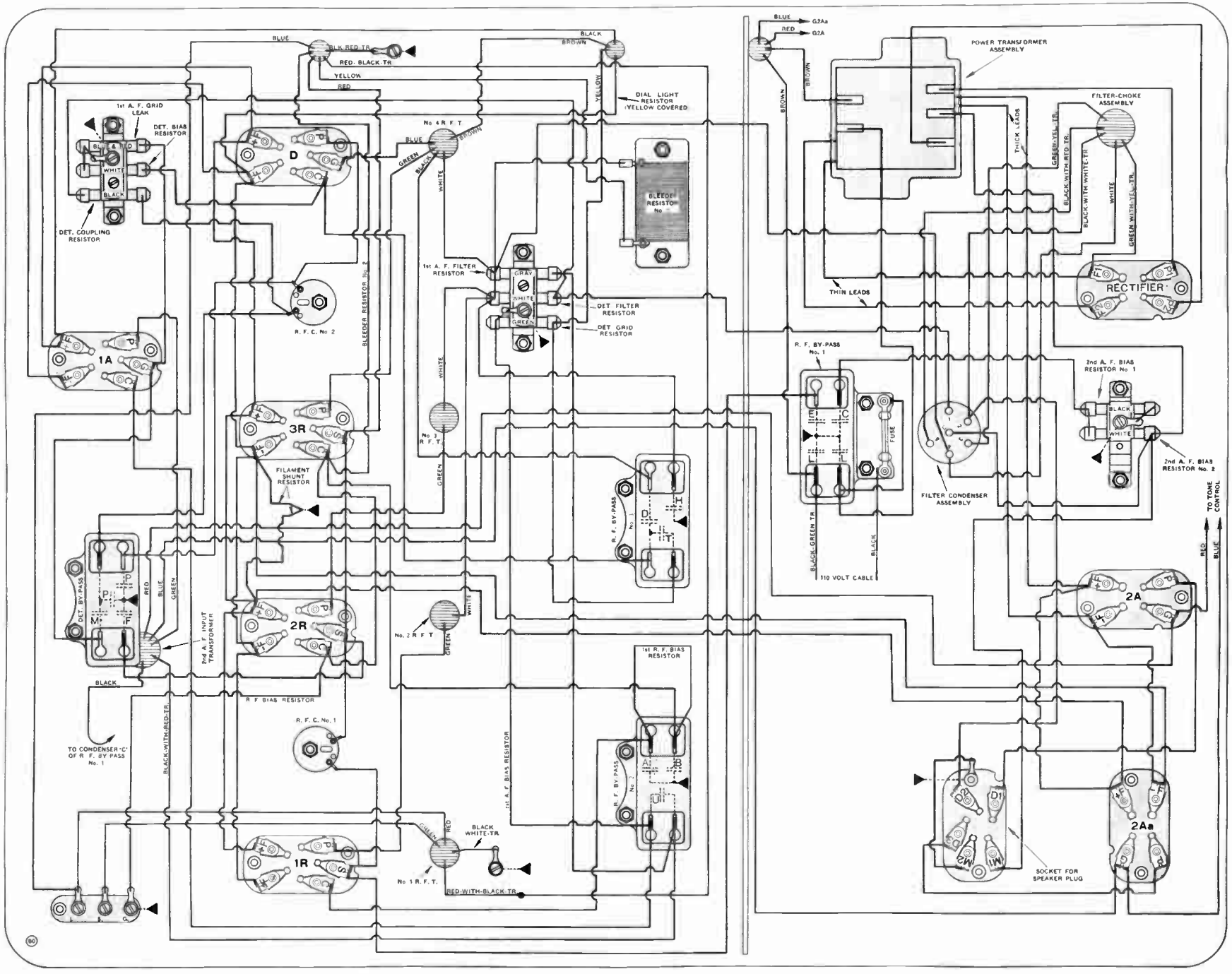


FIG. 234. BOTTOM WIRING OF TYPE P CHASSIS.

PHONOGRAPH PICK-UP

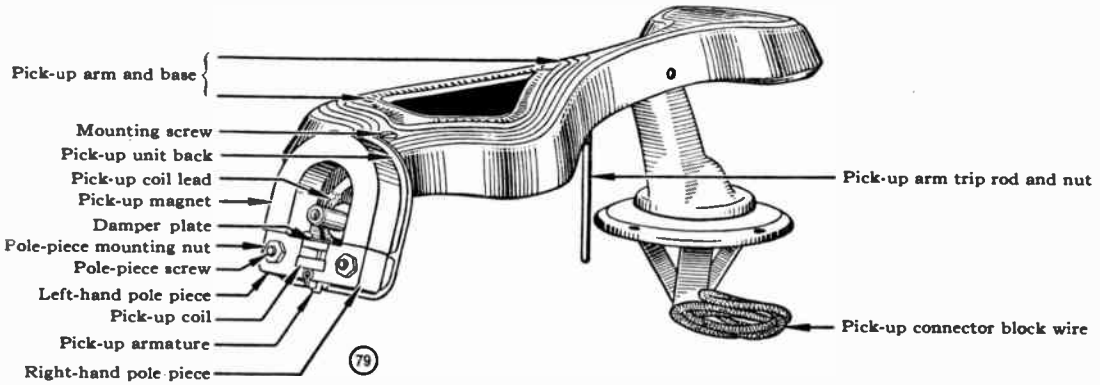


FIG. 235. DRAWING OF PHONOGRAPH PICK-UP AND ARM USED IN MODEL 75.

ACTION OF PICK-UP

The phonograph pick-up is a miniature alternating-current generator, but instead of having a rotating armature, it has a vibrating armature. The vibrations of the armature are produced by the movement of the pick-up needle in the grooves on a phonograph record.

The armature vibrates in a narrow gap between the pole pieces of a strong permanent magnet, thus causing a variation of the magnetic field in the gap. This variation of the magnetic field "cuts" the turns of a small pick-up coil which is also mounted in the field of the magnet, thus generating a weak alternating current in the pick-up coil.

The weak alternating current generated in the pick-up coil is passed through a volume control into the primary (small winding) of a step-up transformer.

The resultant voltage developed across the secondary of this transformer is impressed on the grid circuit of the detector tube in the P Chassis. The signal is amplified to loud-speaker volume by the audio amplifier in the P Chassis, and then reproduced by the speaker.

Thus the image of sound waves cut in the grooves in a phonograph record generates similar audio-frequency electrical impulses in the pick-up. These impulses are amplified in the radio set and then converted into sound waves by the speaker.

ARMATURE ADJUSTMENT

The armature-pivot bearings consist of two small strips of rubber (armature spacing cushions) which space the armature from the bearing surfaces on each pole piece.

The top end of the armature fits in a slit in a flat rubber damper. The damper is fastened to a small brass plate that may be adjusted to the right or to the left, in order to center the armature in the magnet gap.

If the armature is off center, as indicated by erratic reproduction, loosen the two round-head screws that hold the damper plate, and move the plate slightly to the right or left to a point where the armature is centered. Tighten the two screws.

When the armature is correctly centered, it should take as much force to move the needle to the left as to the right.

If the rubber damper plate or armature spacing cushions are dried out, or lack life, replace them with new pieces of rubber, which may be secured from your distributor.

USE KEEPER ON PICK-UP MAGNET

If the pick-up magnet must be removed from the pick-up, *FIRST* place a steel or iron keeper (a large nail will do) across the sides of the magnet poles, *THEN* remove the magnet.

Do *NOT* take off the keeper until *AFTER* the magnet is placed back on its pole pieces in the pick-up.

If the magnet is weak, have it re-magnetized, but be sure to place a keeper across the sides of the magnet poles before removing it from the magnetizer, and do not remove the keeper until after the magnet is placed back on its pole pieces in the pick-up.

CONTINUITY TESTS

Test across the two contacts on the neck of the molded pick-up back. The continuity reading should be nearly full. No reading indicates an open pick-up coil or leads.

Test from either contact on the pick-up to each pole piece, and to the armature. If there is any reading, it indicates that the pick-up coil or leads are grounded. This must be eliminated. Use two small pieces of thin cambric cloth to insulate the pick-up coil from the pole pieces.

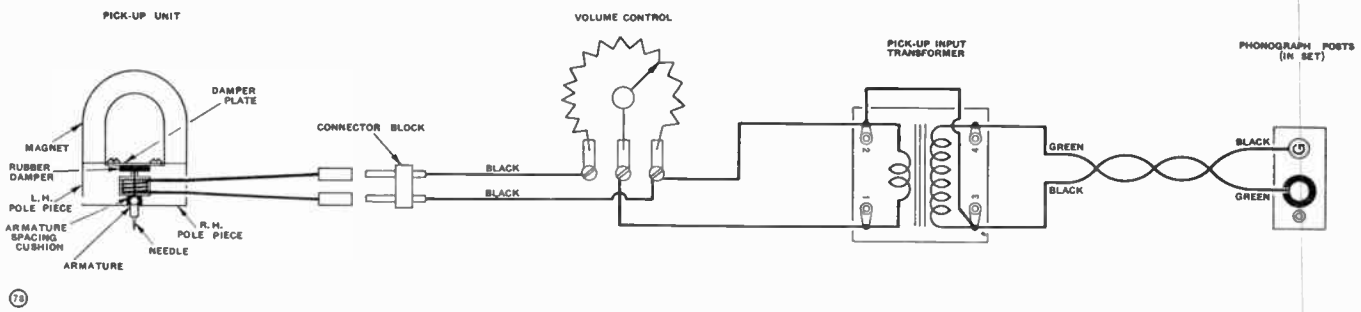


FIG. 236. ELECTRICAL CONNECTIONS OF PICK-UP, VOLUME CONTROL AND INPUT TRANSFORMER.

INDUCTION DISC PHONOGRAPH MOTOR

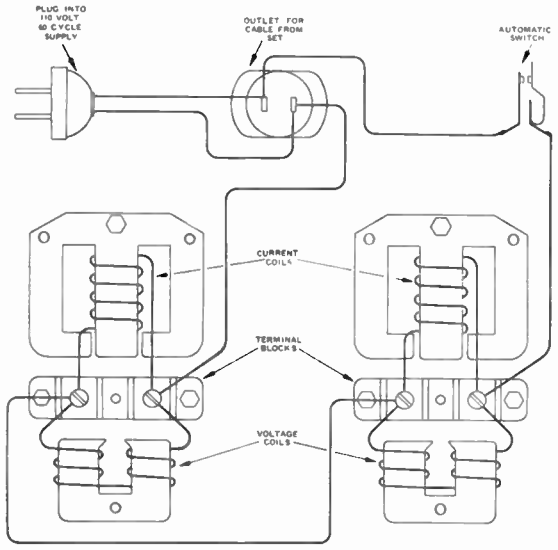


FIG. 237. ELECTRICAL CONNECTIONS OF THE INDUCTION-DISC PHONOGRAPH MOTOR.

The induction-disc phonograph motor has two sets of field coils or "inductors." Each inductor has three coils and five "poles." A magnetic field is produced between the poles by the alternating current flowing through the three coils.

The edge of a non-magnetic rotor disc fits in the narrow gap between the poles on each inductor. The magnetic field between the poles causes the disc to rotate.

The rotor disc itself has no coils, and there are no electrical connections to it.

The speed of the rotor disc is controlled by a governor and a regulating screw device. The correct speed is 78 revolutions per minute (with pick-up on record). The speed may be determined by counting the number of revolutions made by the turntable in one minute. It is preferable, however, to regulate the speed with the aid of a stroboscope disc, which may be purchased from your distributor. Simple instructions for the use of this inexpensive device are printed on the back of the stroboscope disc. The speed should be checked at least twice a year.

The motor and governor bearings and gears must be kept well greased at all times. See chart on bottom of motor board.

When an induction-disc motor requires repair, it is advisable to tear it down completely, replace the defective parts, clean and grease all parts, and reassemble correctly.

AUTOMATIC ELECTRIC SWITCH and FRICTION BRAKE

GENERAL DESCRIPTION

A trip rod on the pick-up arm engages with the slot between the brake and switch levers on the automatic brake illustrated below. As the arm moves toward the center of the record, the trip rod swings these two levers and the brake-latch trip anti-clockwise. As the needle nears the end of the record, the brake-latch trip engages with the toothed edge of the latch plate, as shown. When the record is finished, the needle runs into an eccentric groove that swings the pick-up arm *away* from the center of the record. This movement pushes the trip against the latch plate, and frees the latch from the hand lever at point "A." This opens the A. C. switch and throws the friction leather against the inside edge of the turntable, thus stopping the motor and turntable.

ADJUSTMENTS

(1) If the latch does not trip, or trips before completion of a record, bend the hand-lever stop slightly to the right or left, as necessary.

(2) If the latch trip does not engage correctly with the latch-plate, loosen the two latch-plate screws and shift the plate one way or the other, as necessary. Re-tighten the screws. Remove any burrs from the teeth of the latch plate with fine emery paper.

(3) If the electric switch does not make and break contact when the hand-lever is turned on and off, it may be necessary to bend the long contact spring, or loosen the two switch screws and move the switch until the correct position is found. In the off position, there should be at least $\frac{1}{16}$" gap between the contact points.

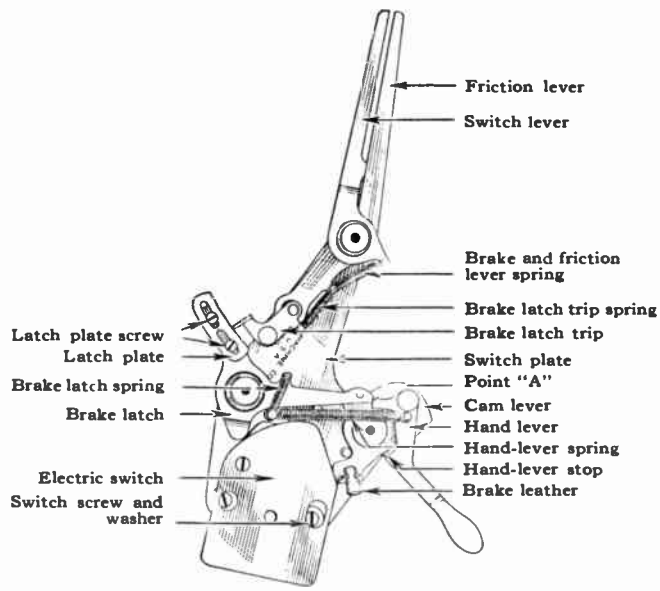
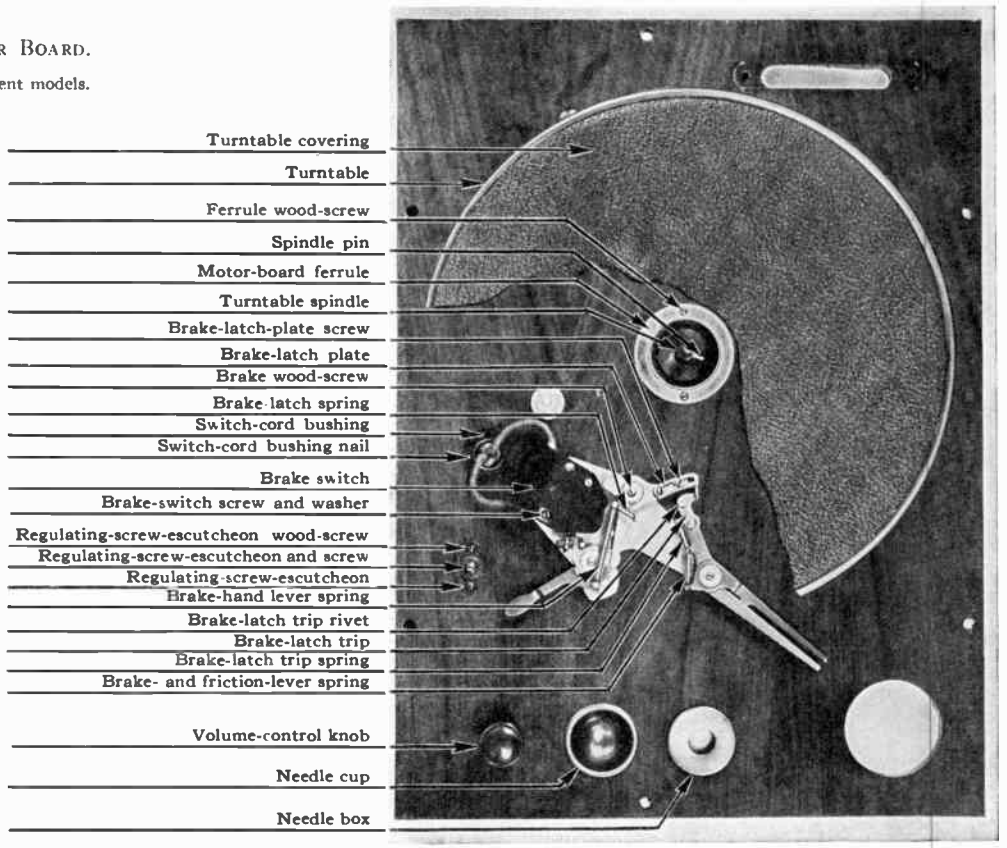


FIG. 238. DETAILED VIEW OF THE AUTOMATIC SWITCH AND BRAKE.

PHONOGRAPH MOTOR BOARD

FIG. 239. TOP VIEW OF MOTOR BOARD.

The slot in the board is not used in current models.



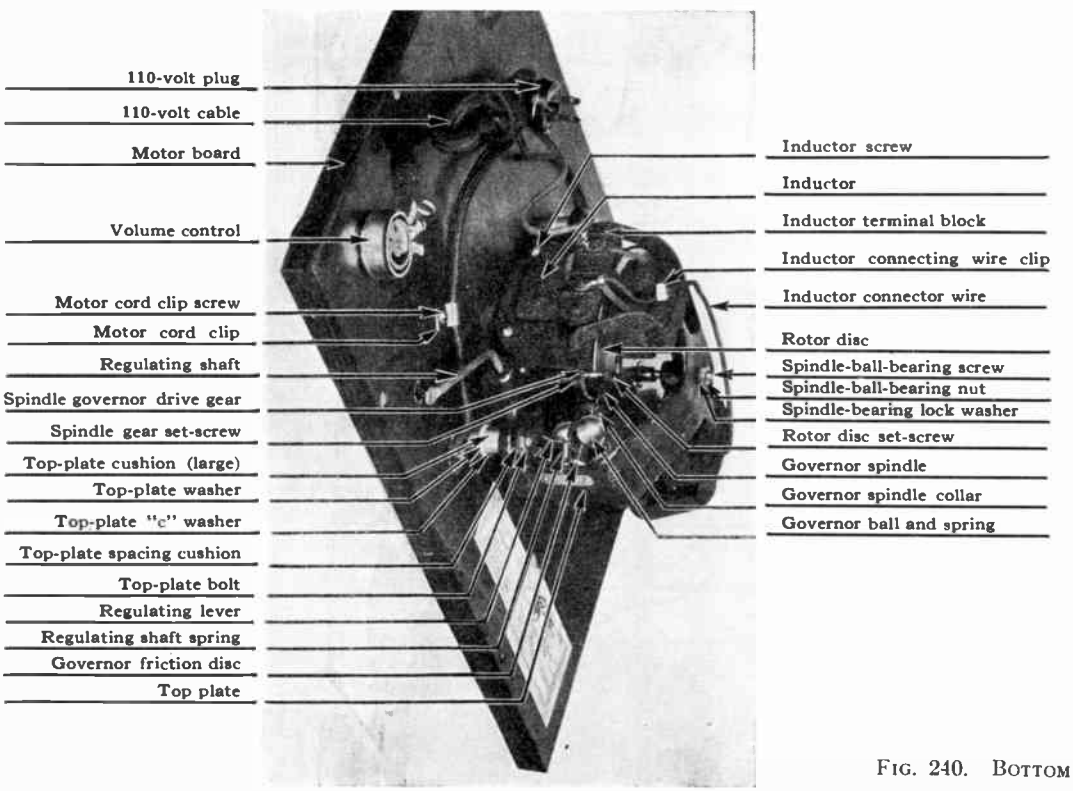


FIG. 240. BOTTOM VIEW OF MOTOR BOARD.

PARTS AND PRICE LIST — MODEL 75
PHONOGRAPH PARTS

Part No.	PICK-UP UNIT	Price
19056	Pick-up unit, complete, less arm	$12.50
19057	Pick-up coil	.50
19101	Pick-up-coil insulator	.05/doz.
19061	Pick-up magnet	2.60
19094	Pick-up-magnet spring (flat)	.10/doz.
19059	Pick-up pole piece (left-hand)	.40
19065	Pick-up pole piece (right-hand)	.40
19095	Pick-up-pole-piece nut	.12/doz.
19058	Pick-up armature	.30
19358	Armature spacing cushion	.12/doz.
19066	Pick-up needle screw	.08
19365	Damper plate	.10
19387	Damper-plate screw	.14/doz.
19364	Pick-up rubber damper	.06
19063	Pick-up cover	.50
19093	Pick-up-cover screw	.03
19102	Pick-up-unit back	.50
19096	Pick-up mounting screw	.02
19098	Pick-up mounting lock-washer	.06/doz.
19097	Pick-up mounting nut	.04

Part No.	PICK-UP ARM AND BASE	Price
19068	Pick-up arm and base, less unit	$ 5.50
19067	Pick-up connector block and wire	1.10
19069	Pick-up-arm trip rod and nut	.04
19092	Pick-up-arm trip-rod nut	.01
19099	Pick-up-arm wood-screw	.20/doz.
19087	PICK-UP INPUT TRANSFORMER	5.50
19353	Transformer leads	.30

Part No.	VOLUME CONTROL	Price
19077	Volume control, complete, less knob	$ 1.40
19079	Volume-control knob	.30
19146	Volume-control-knob set-screw	.06/doz.
19141	Volume-control connection screw	.06/doz.
19138	Volume-control washer	.12/doz.
19139	Volume-control nut	.08
19078	Volume-control cord	.25

Part No.	INDUCTION DISC MOTOR	Price
19071	60-cycle motor	$36.50
19073	60-cycle inductor	10.00
19104	Inductor terminal block	.20
19103	Inductor screw	.25/doz.
19106	Inductor connector wire	.20
19105	Inductor-connector-wire clip	.08/doz.
19072	Rotor disc	4.00
19109	Rotor-disc set-screw	.15/doz.

Part No.	GOVERNOR	Price
19074	Governor, complete	$ 2.50
19111	Governor spindle	.75
19112	Governor-spindle collar	.20
19113	Governor-spindle-collar set-screw	.12/doz.
19075	Governor ball and spring	.10
19115	Governor-ball-and-spring washer	.03/doz.
19114	Governor-ball-and-spring screw	.12/doz.
19121	Governor friction	.75
19076	Governor bearing	.03
19116	Governor bearing (grooved)	.03
19117	Governor-bearing ball	.01
19118	Governor-bearing set-screw	.12/doz.

Part No.	TURNTABLE SPINDLE	Price
19164	Turntable spindle	$ .75
19166	Turntable-spindle pin	.02
19082	Turntable-spindle ball-bearing	.01
19086	Turntable-spindle ball-bearing screw	.36/doz.
19108	Turntable-spindle ball-bearing lock-washer	.02
19107	Turntable-spindle ball-bearing nut	.01
19133	Turntable-spindle governor drive gear	.30
19109	Governor-drive-gear set-screw	.15/doz.

Part No.	SPEED REGULATOR	Price
19134	Regulating shaft	$ .12
19122	Regulating-shaft spring	.02
19123	Regulating lever	.15
19125	Regulating-lever leather	.01
19124	Regulating-lever set-screw	.02
19153	Regulating-screw escutcheon and screw	.23
19154	Escutcheon wood screw	.12/doz.

Part No.	BRAKE	Price
19145	Brake, complete	$ 3.40
19081	Brake switch	1.50
19155	Brake-switch screw	.02
19156	Brake-switch washer	.04
19161	Brake wood-screw	.10/doz.
19158	Brake-switch-cord bushing	.12
19157	Brake-switch-bushing nail	.08/doz.
19152	Brake hand-lever spring	.05
19147	Brake and friction lever spring	.05
19149	Brake-latch trip	.20
19151	Brake-latch-trip rivet	.02
19148	Brake-latch-trip spring	.06
19162	Brake-latch plate	.06
19163	Brake-latch-plate screw	.08/doz.
19159	Brake-latch spring	.06

Part No.	TOP PLATE	Price
19119	Top plate	$ 5.00
19126	Top-plate bolt	.10
19131	Top-plate bolt "C" washer	.03
19107	Top-plate nut	.01
19085	Top plate-washer	.01
19128	Top-plate lock-washer	.10/doz.
19127	Top-plate spacing cushion	.06
19143	Top-plate rubber cushion (small)	.06

Part No.	MISCELLANEOUS	Price
19135	Motor-cord clip	$ .04
19136	Motor-cord-clip wood-screw	.04/doz.
19137	Motor-cord eyelet	.16/doz.
19144	Motor-cord outlet	.60
19168	Turntable (with covering)	4.00
19169	Turntable covering	1.50
19083	Needle box	.30
19084	Needle cup	.15
19165	Motor-board ferrule	.10
19167	Motor-board-ferrule wood-screw	.08/doz.
19359	Light grease (can)	.25
19361	Heavy grease (tube)	.25
19362	Stroboscope disc	.05
19354	Speed tag	.01
19355	60-cycle tag	.01

December, 1930. These prices supersede all previous prices and are subject to change without notice.

Tabulated Service Data for Phonograph

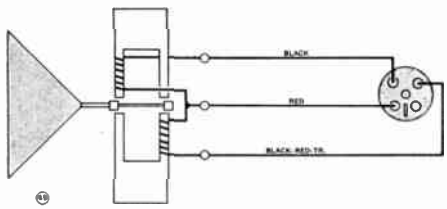
Important. It is advisable for the dealer to inspect and adjust radio-phonograph combinations at least twice a year. Clean off the old grease, put fresh grease and oil on the bearings, and regulate the motor speed to 78 revolutions per minute. If necessary, install a new rubber damper and armature spacing cushions in the pick-up. Tighten all screws and bolts. Finally, check over the radio set and tubes.

TROUBLE	PROBABLE CAUSE
No reproduction.	Defective volume control, input transformer, or pick-up coil.
Weak reproduction.	Weak magnet, shorted pick-up coil, or armature off center.
Distortion.	Loose or worn needle, defective rubber damper or armature spacing cushions, dirt in magnet gap, or needle screw touching pick-up cover.
Motor fails to operate.	Defective automatic switch, wrong or open connections in motor circuit, defective inductor, or jammed motor.
Irregular speed.	Poor lubrication, defective governor, improperly mounted motor, weak inductor, worn bearings.
60-cycle hum.	Loose inductor coils (use wedges to tighten) or loose laminations in inductor cores (tighten bolts).
Wabbling turntable.	Bent turntable spindle.
Noise.	Bent rotor disc-touching inductors, broken governor springs, defective or improperly lubricated gears or bearings, or bent governor spindle.

TYPE Q CHASSIS, VOLTAGE TABLE AND DIAGRAM

Type Q Chassis (battery operated) has three stages of screen-grid R. F. amplification, grid detection, one stage of transformer-coupled audio, and a double-audio output stage.

An output filter choke and condenser are used in the Q-2 (above Serial No. 5704025), as shown in the diagram below. The Q-1 Chassis does not have these two parts.



CONNECTIONS OF INDUCTOR TYPE J SPEAKER.

VOLTAGE TABLE FOR TYPE Q CHASSIS

Set in operation. Volume control at maximum. L-D switch at distance.

Use High Resistance D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages. Use A. C. Voltmeter to Measure Filament Voltages.

TUBE	FILAMENT VOLTAGE	PLATE VOLTAGE	CONTROL-GRID VOLTAGE	SCREEN VOLTAGE
	180 VOLTS "B" BATTERY			
1st-R.F.	3.3	135	1.5	45
2nd-R.F.	3.3	135	1.5	45
3rd-R.F.	3.3	135	2.5	45
Detector	5.0	70	—	—
1st-A.F.	5.0	67	45	—
2A	5.0	180	45	—
2Aa	5.0	180	45	—

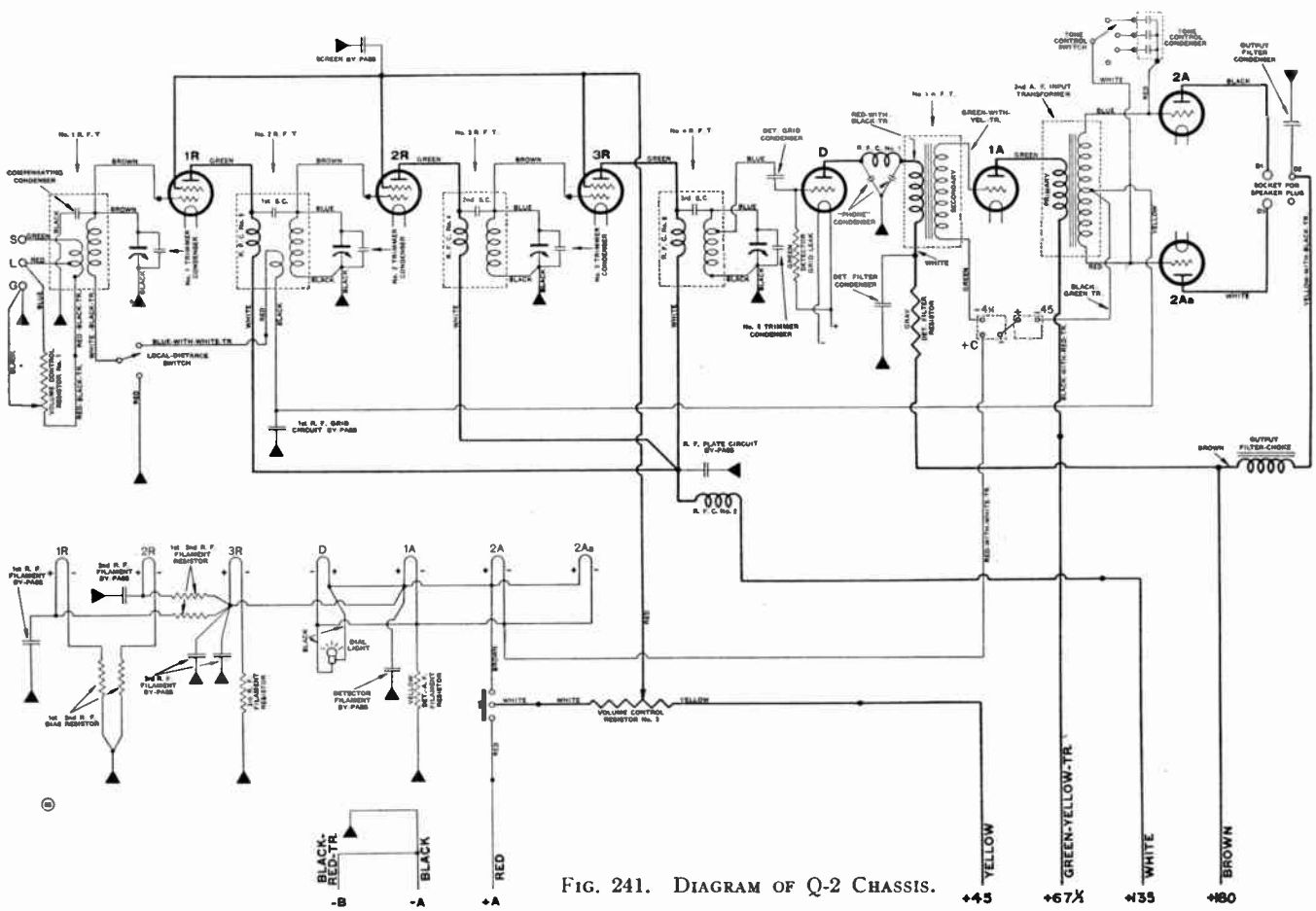


FIG. 241. DIAGRAM OF Q-2 CHASSIS.

The output filter choke and filter condenser are used only in Type Q-2 Chassis. The choke is mounted in the 2nd-A. F. input transformer container. Type Q-1 Chassis may be converted to Q-2 by installing this unit (No. 18020) and connecting it as shown above and on Page 243.

December, 1930.

TYPE Q CHASSIS RECEIVER

R.F. By-Pass No. 1

G—R.F. screen by-pass.
V—1st-R.F. grid-circuit by-pass.
Y—Output filter condenser.
N—1st-R.F. filament by-pass.

R.F. By-Pass No. 2*

H—R.F. plate-circuit by-pass.
T—Detector filter condenser.
P—"Phone" condenser.
P—"Phone" condenser.

R.F. By-Pass No. 3

S—Detector filament by-pass.
R—3rd-R.F. filament by-pass.
R—3rd-R.F. filament by-pass.
O—2nd-R.F. filament by-pass.

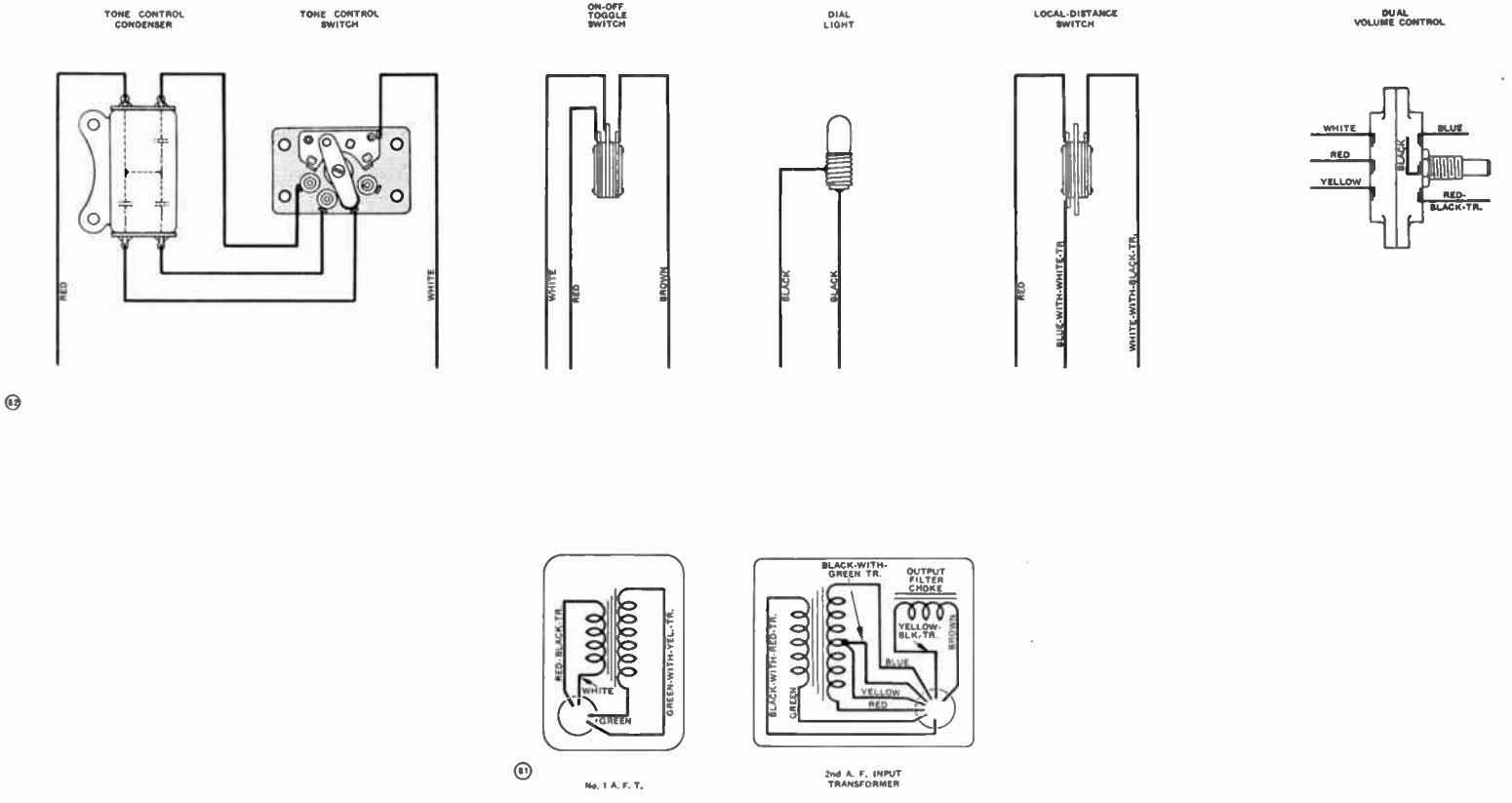


FIG. 242. CONNECTIONS OF UNITS IN Q-1 AND Q-2 CHASSIS.

The output filter choke is not used in the Q-1 chassis.

*The connections shown in Fig. 243 for R. F. by-pass No. 2 are correct when this part is No. 16060 (H-24). However, if a No. 18350 (H-28) is used, "P" and "P" are at top, and "H" and "T" are at bottom; therefore, the connections to this condenser are correspondingly changed.

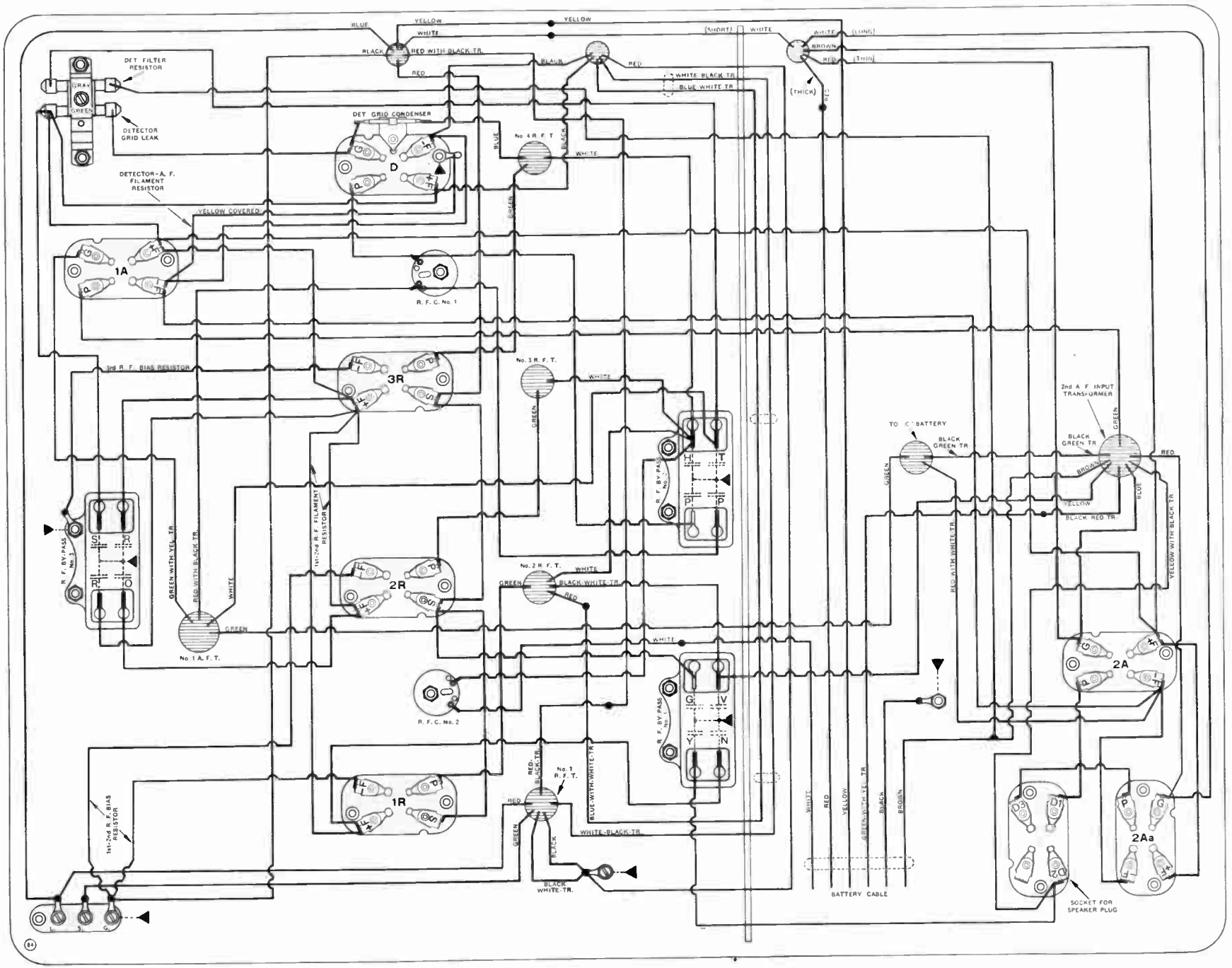


FIG. 243. BOTTOM WIRING OF TYPE Q-2 CHASSIS.

IMPORTANT. The connections of R. F. by-pass No. 2 are shown correctly when this condenser is Part No. 16060, Code II-24. If this condenser is No. 18350, Code II-28, P and P are at the top, and [illegible] the battery, and the leads to this condenser are correspondingly changed.

PARTS AND PRICE LIST—TYPE Q, No. 16800, CHASSIS

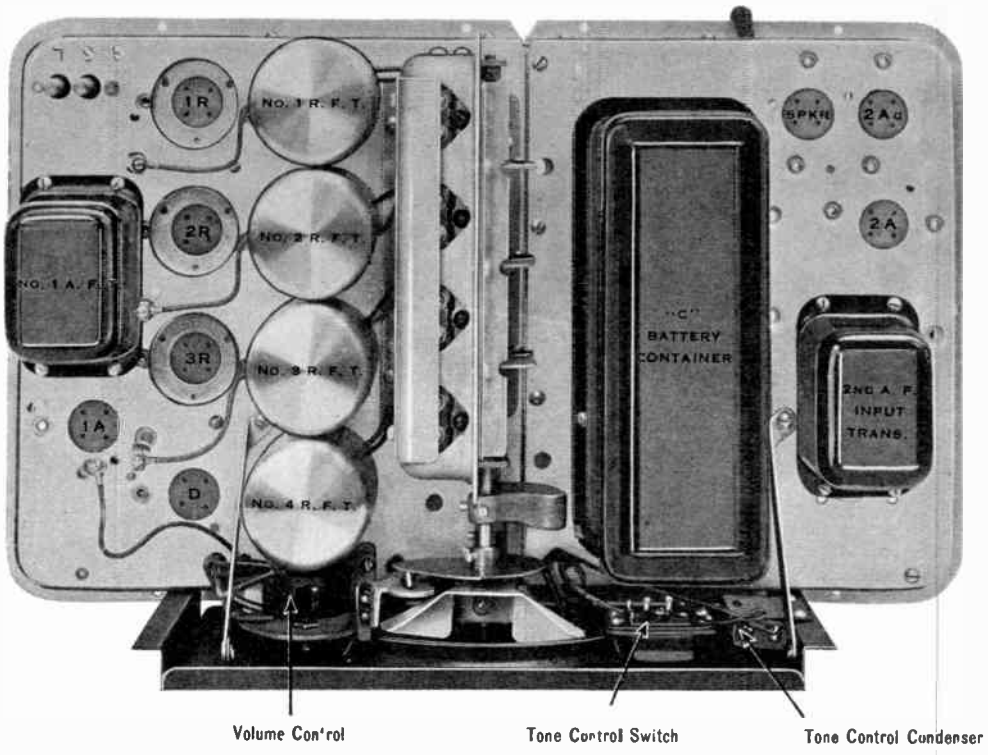


FIG. 244.
TOP VIEW OF TYPE Q CHASSIS.

FRONT PANEL ASSEMBLY

Part No.		Price
18085	Front panel with dial plate	$1.25
18581	Front panel complete	2.50
17985	Escutcheon	1.00
17224	Front panel brace (2 used)	.10
17244	Volume-control or tone-control knob	.30
17814	Dial knob	.30
16770	On-off switch	1.60
16760	Local-distance switch	1.25
16010	Volume-control (less bracket)	5.25
18259	Volume-control bracket	.20
18223	Tone-control condenser clamp	.05
17959	Dial pointer	.05
16430	TONE-CONTROL SWITCH COMPLETE	.75
18148	Base	.60
18146	Shaft	.12
18112	Contact blade	.03

AUDIO TRANSFORMERS

Part No.		Price
15960	No. 1 A. F. transformer	$4.00
18020	No. 2 A. F. transformer (18020 supersedes No. 15970)	5.25
15978	"C" battery container	1.30
16103	"C" battery container lid	.50
16104	Connection card	.06

Part No.		Price
18579	VARIABLE-CONDENSER STATOR, ROTOR AND FRAME (with leads and balance weight)	$9.60
18615	Dial gear	.40
17962	Pointer control arm	.30
17961	Dial-rubber assembly	.15
17941	Dial-knob shaft	.05
16420	Dial-light socket and reflector, one-hole mounting (less leads)	.40
16420-A	Dial-light socket and reflector, two-hole mounting (less leads)	.40
17936	Dial-knob bracket (one-hole mounting)	.35
18144	Dial-knob bracket (two-hole mounting)	.35
17935	Dial-knob bracket support (threaded)	.03
17107	Rotor-connection (long)	.10
17291	Rotor-connection (short)	.10
16099	Dial light	.25

No separate parts, except those listed above, will be supplied for the variable-condenser unit.

COIL GROUP

Part No.		Price
17510	R. F. coil group	$4.00
16360	Stopping condenser (3 used)	.10
16360	Compensating condenser (1 used)	.10
17295	R. F. coil shield (4 used)	.50

If one R. F. coil, or R. F. C. No. 3, No. 4, or No. 5, is defective, the ENTIRE coil group must be replaced.

December, 1930. These prices supersede all previous prices and are subject to change without notice.

PARTS AND PRICE LIST—TYPE Q, No. 16800, CHASSIS

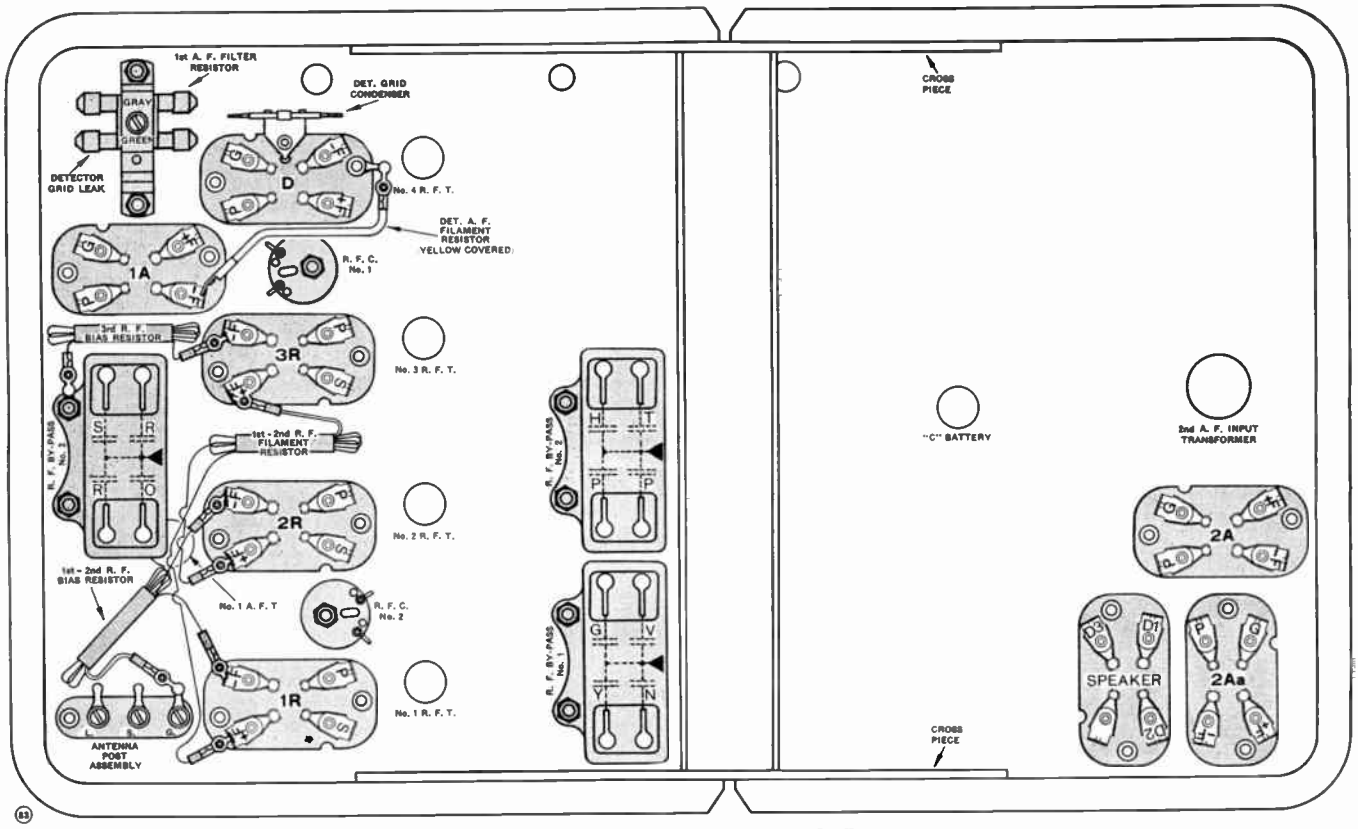


FIG. 245. BOTTOM VIEW OF TYPE Q CHASSIS.

TUBULAR RESISTORS

Part No.		Price
15285	Det. filter resistor (gray)	$ .50
15892	Detector grid-leak (green)	.25
17341	Resistor bracket	.05
17344	Fibre resistor pad	.25/c
17343	Metal clamping strip	.02

FLEXIBLE RESISTORS

Part No.		Price
16081	Detector-A.F. filament resistor	$ .15
16290	1st-2nd R.F. bias resistor (each leg 14" long)	.20
16610	3rd-R.F. bias resistor	.20
16280	1st-2nd R.F. filament resistor (each leg 10" long)	.20
15271-A	R. F. CHOKE NO. 1, No. 2	.25

SOCKETS

Part No.		Price
18417	1R, 2R, 3R tube sockets	$ .25
18418	D, 1A tube sockets	.25
18419	Detector tube socket, and grid cond. assembly	.65
18398	2A tube socket	.25
18399	2Aa tube socket	.25
17512	Speaker plug socket	.25
17377	Socket insulator (8 used)	.25/c

FIXED CONDENSERS

Part No.		Price
15262	R. F. by-pass No. 1	$1.00
18350	R. F. by-pass No. 2	1.10
15262	R. F. by-pass No. 3	1.00
15870	Tone control condenser	1.00
16088	Grid condenser	.20
18419	Grid condenser and det. socket assembly	.65

MISCELLANEOUS PARTS

(Screws, nuts, washers, and small parts—see page 229)

Part No.		Price
16165	Battery cable	$3.50
15739-A	Cable clamp	.02
17521	Antenna binding posts and base	.45
17323	Antenna and ground base	.05
8215	Binding post	.20
18493	Bottom plate	1.30
13989	Ground clamp	.30
15213	Tube-shield (3 used)	.15
15214	Tube-shield base (3 used)	.03
17326	Detector cap	.30
18117	Balance-weight for variable condenser	.35
18118	"Guide" card (form F-680)	.75/c net
18119	Log card (form F-681)	.75/c net
17223	Cross piece (10" x 7/8"—2 used)	.25
17632	Detector cap lead (brown)	.10
	Trimmer-condenser sealing wax	.50 lb.
18114	Tuned-radio frequency name-plate	.06
15990	Literature assembly	.20 net
17885	Instruction book	.10 "
18485	Shipping container	.65 "

December, 1930. These prices supersede all previous prices and are subject to change without notice.

TYPE D-1 CHASSIS, VOLTAGE TABLE AND DIAGRAM

VOLTAGE TABLE FOR TYPE D CHASSIS

Set in operation. Volume control at maximum.
L-D switch at distance.

Use High Resistance D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages.
Use A. C. Voltmeter to Measure Filament Voltages.

APPROX. VOLTAGES, USING 120 V. LINE

TUBE	FILAMENT VOLTAGE	PLATE VOLTAGE	CONTROL-GRID VOLTAGE	SCREEN VOLTAGE
1st-R.F.	3.3	75	4.2	60*
2nd-R.F.	3.3	75	1.3	50
3rd-R.F.	3.3	75	1	50
Detector	5	20	—	—
1st-A.F.	5	45	6	—
2A	5	75	10	—
2Aa	5	80	10	—

All readings made from cathode in heater-type tubes, and from —F in plain-filament-type tubes.
Use 250-volt scale to measure 2nd A. F. grid voltage.
*This is 50 volts in D-2 chassis.

Type D Chassis (D. C. operated) has three stages of screen-grid R. F. amplification, detector, one stage of transformer—coupled A. F., and a "double-audio" output stage.

This set is designed for use with an electro-dynamic type N-3 speaker.

The early Type D Chassis is known as the D-1. A later modification is known as the D-2. For an explanation of the difference between these two types, see Page 249.

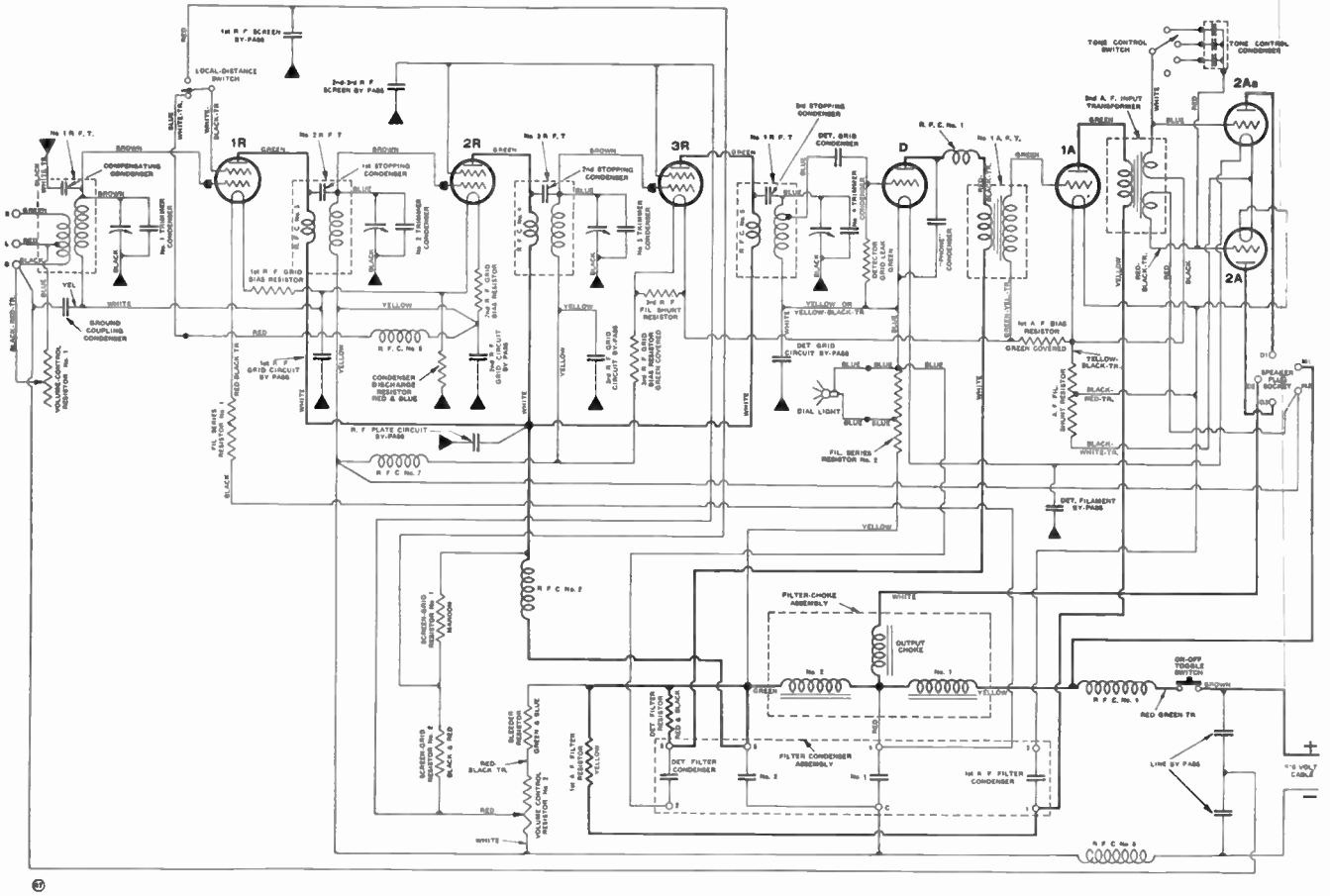


FIG. 246. DIAGRAM OF D-1 CHASSIS.

TYPE D-2 CHASSIS

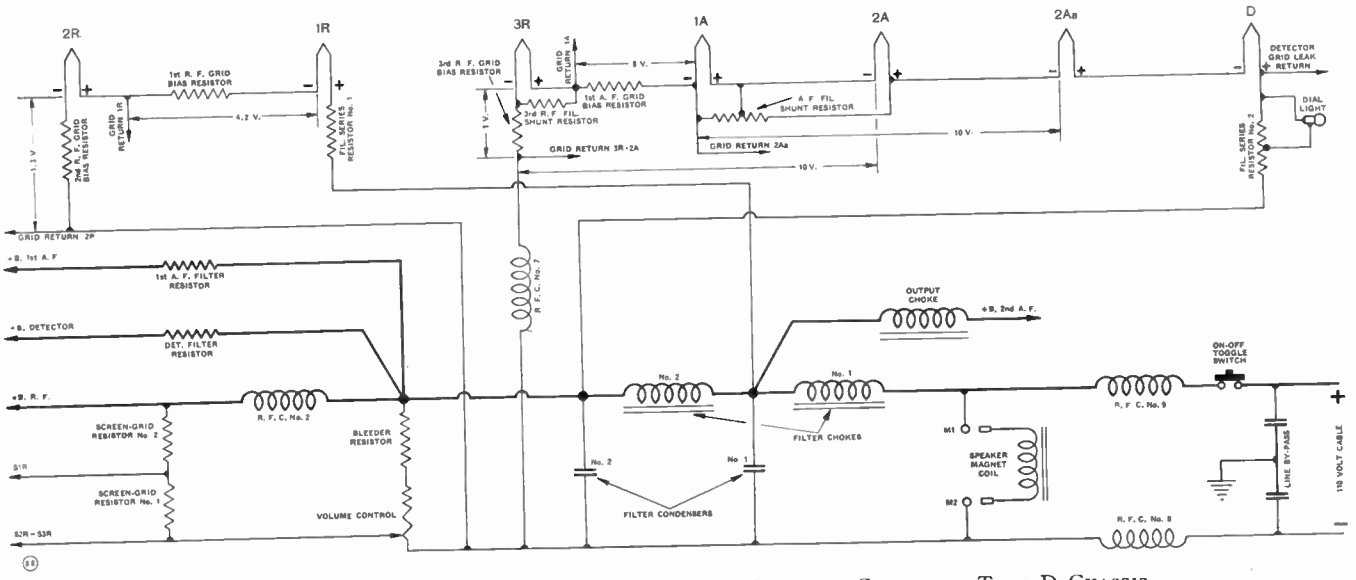


FIG. 247. SIMPLIFIED DIAGRAM OF POWER UNIT AND FILAMENT CIRCUIT IN TYPE D CHASSIS.

The grid bias voltage for any one tube is secured by bringing the grid-return lead of the tube to a point in the filament circuit that has the correct negative voltage with respect to the negative filament terminal of the same tube. This is clearly indicated in the above diagram.

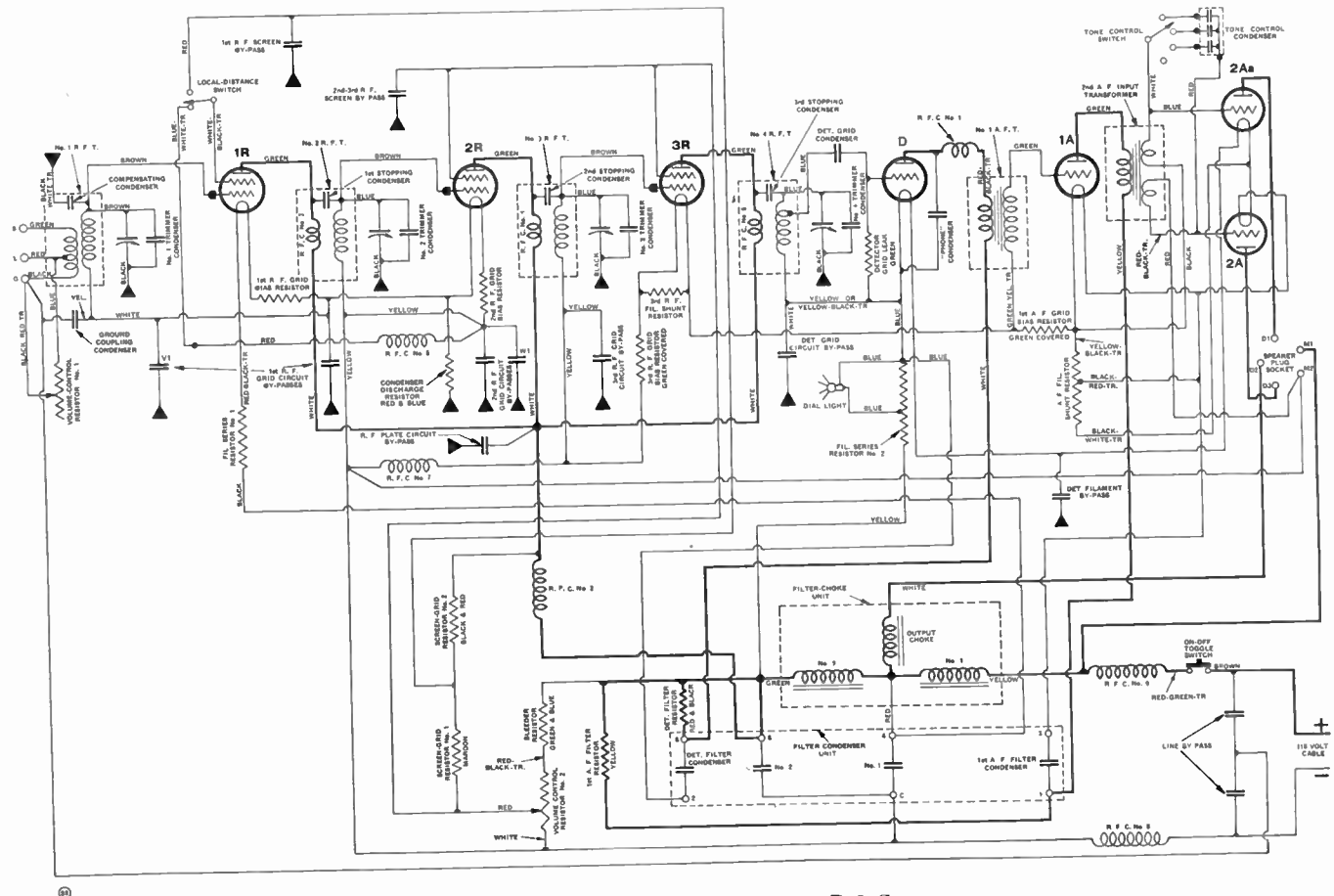


FIG. 248. SCHEMATIC DIAGRAM OF TYPE D-2 CHASSIS.

Note the addition of by-pass condensers V-1 and W-1 and the reversal of screen-grid resistors No. 1 and No. 2.

TYPE D CHASSIS RECEIVER

Condensers in R.F. By-Pass No. 1

L—Line by-pass.
L—Line by-pass.
U—Ground coupling condenser.

Condensers in R.F. By-Pass No. 2

E—1st-R.F. screen by-pass.
F—2nd-3rd-R.F. screen by-pass.
V1—1st-R.F. grid-circuit by-pass.
W1—2nd-R.F. grid-circuit by-pass.

Condensers in R.F. By-Pass No. 3

H—R.F. plate-circuit by-pass.
S—Detector filament by-pass.
P—"Phone" condenser.

Condensers in R.F. By-Pass No. 4

D—Detector grid-circuit by-pass.
V—1st-R.F. grid-circuit by-pass.
W—2nd-R.F. grid-circuit by-pass.
X—3rd-R.F. grid-circuit by-pass.

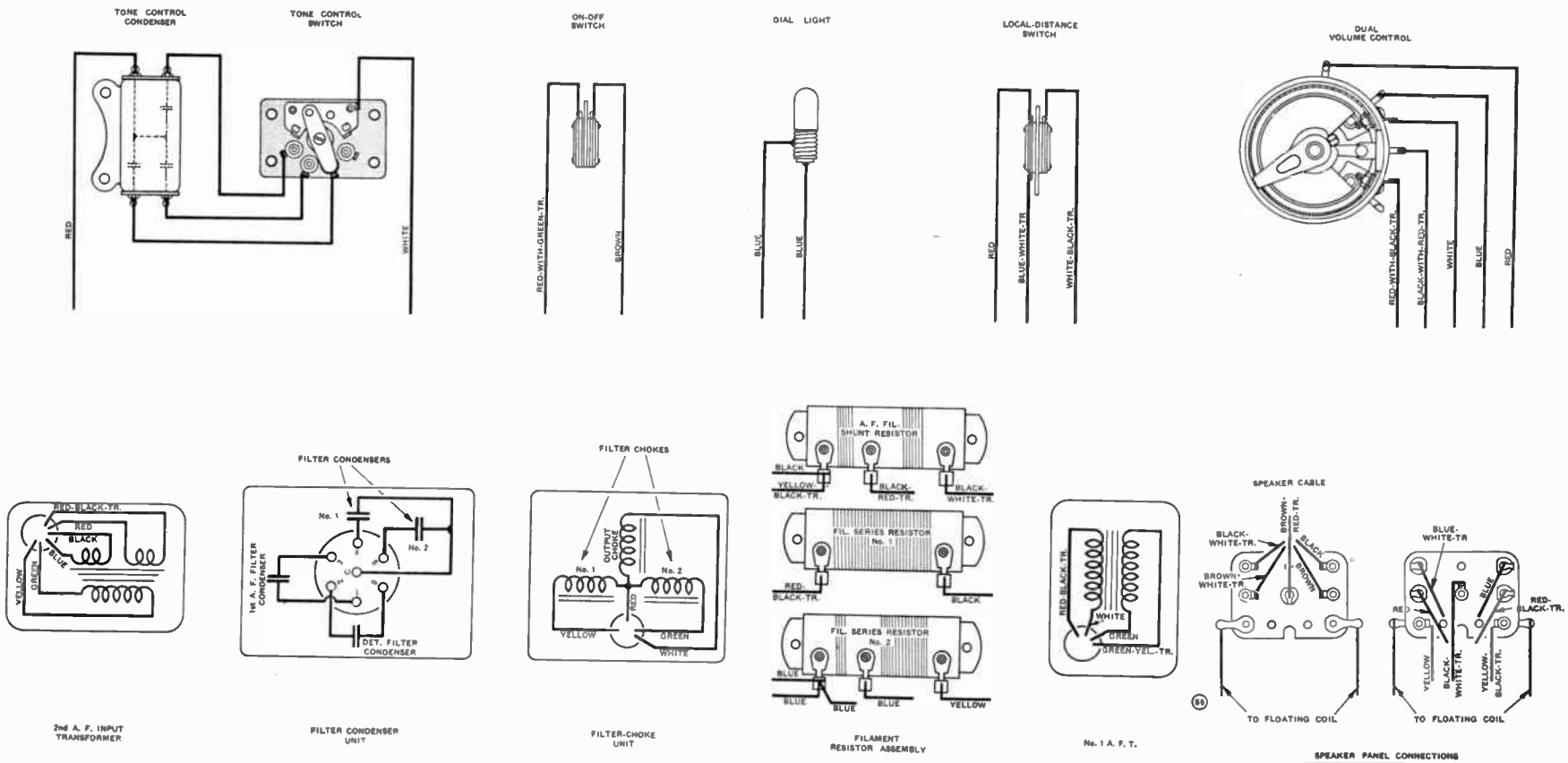


FIG. 249. CONNECTIONS OF UNITS IN TYPE D-1 AND D-2 CHASSIS.

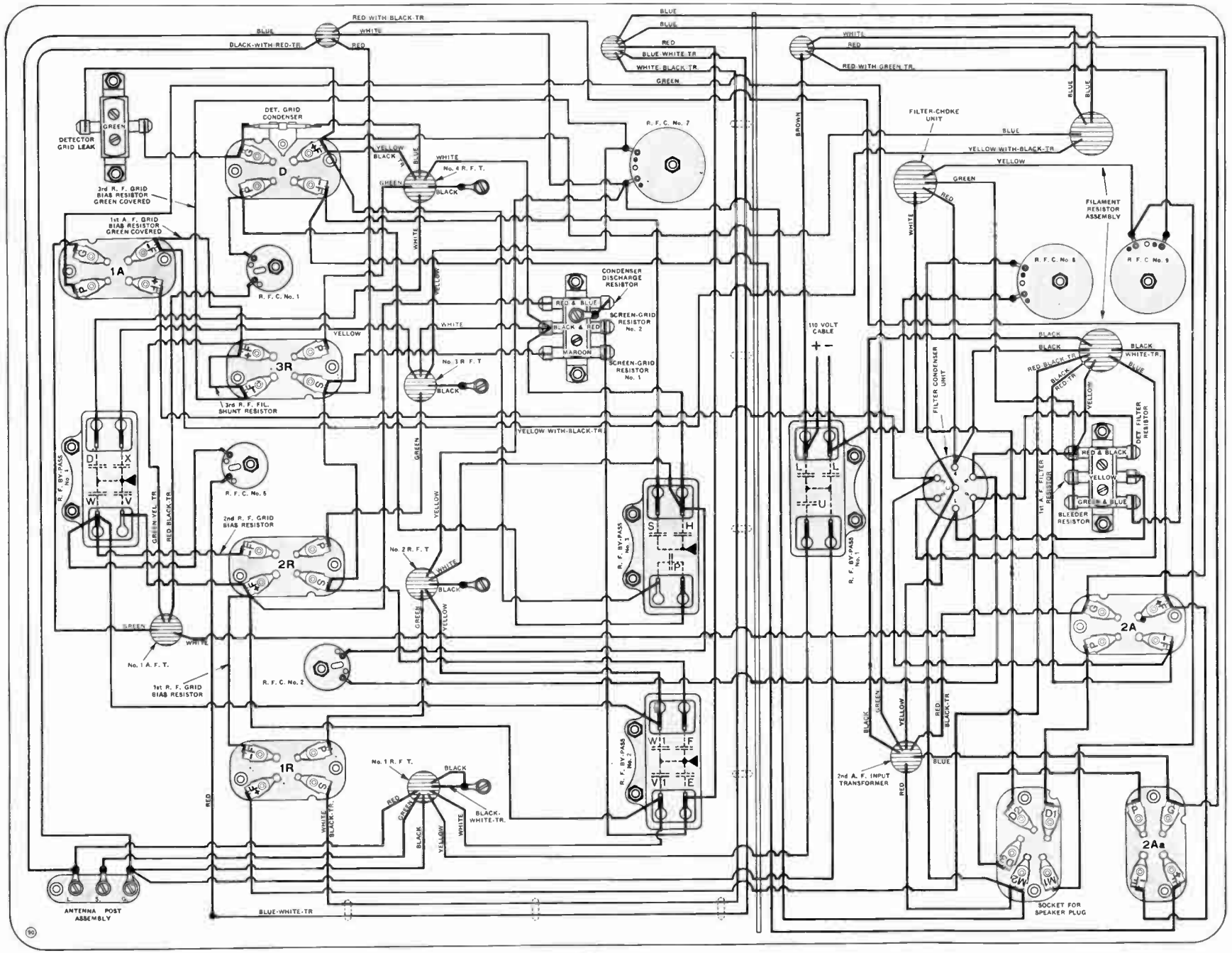


FIG. 250. BOTTOM WIRING OF TYPE D-2 CHASSIS.

The parts in the D-2 are exactly the same as the parts in the D-1. The only difference is in the wiring arrangement and reversal of screen-grid resistors No. 1 and No. 2. The D-1 Chassis may be changed into the D-2 by connecting exactly as shown above.

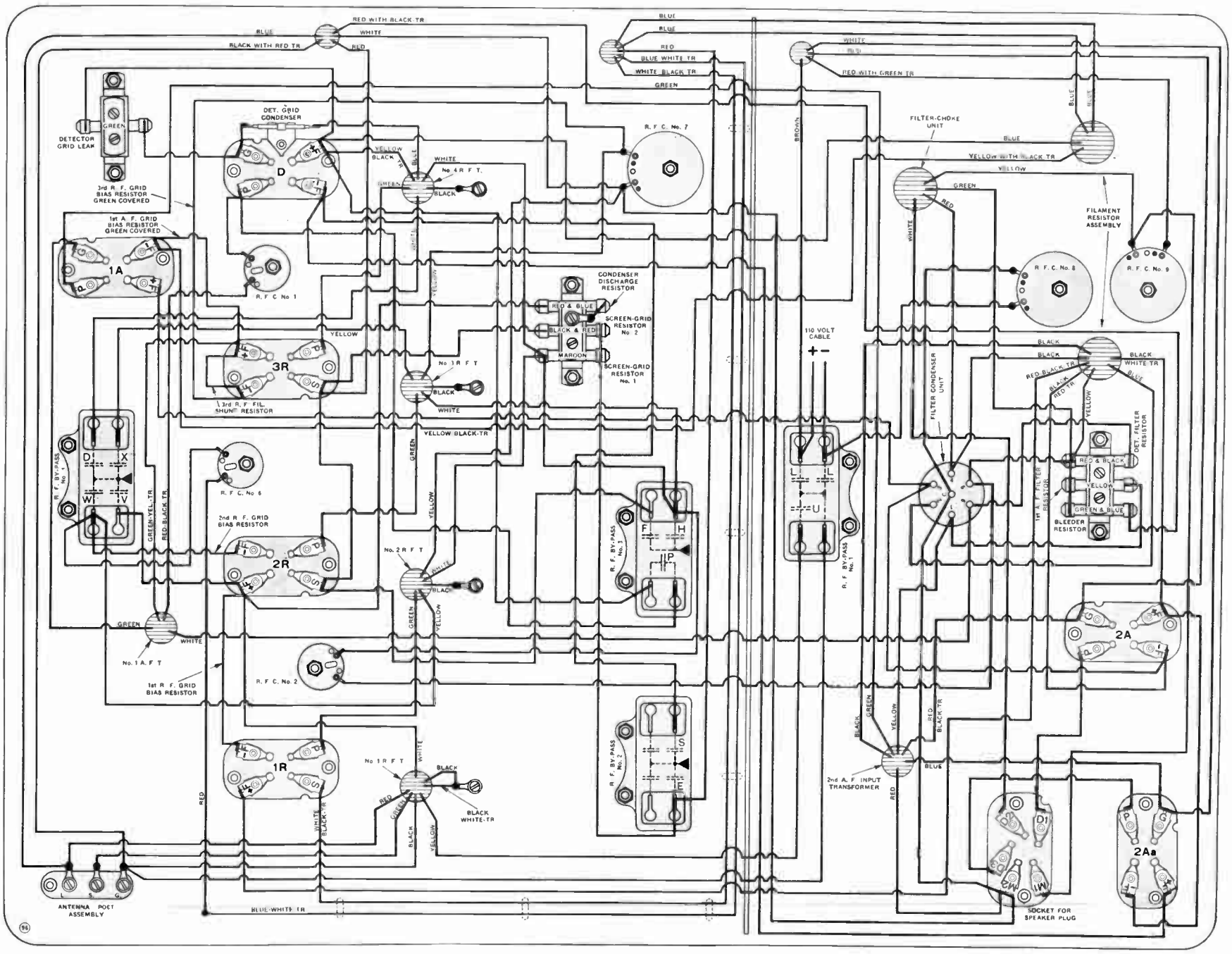


FIG. 251. BOTTOM WIRING OF TYPE D-1 CHASSIS. SEE CAPTION OF FIG. 250.

PARTS AND PRICE LIST—TYPE D, No. 16700, CHASSIS

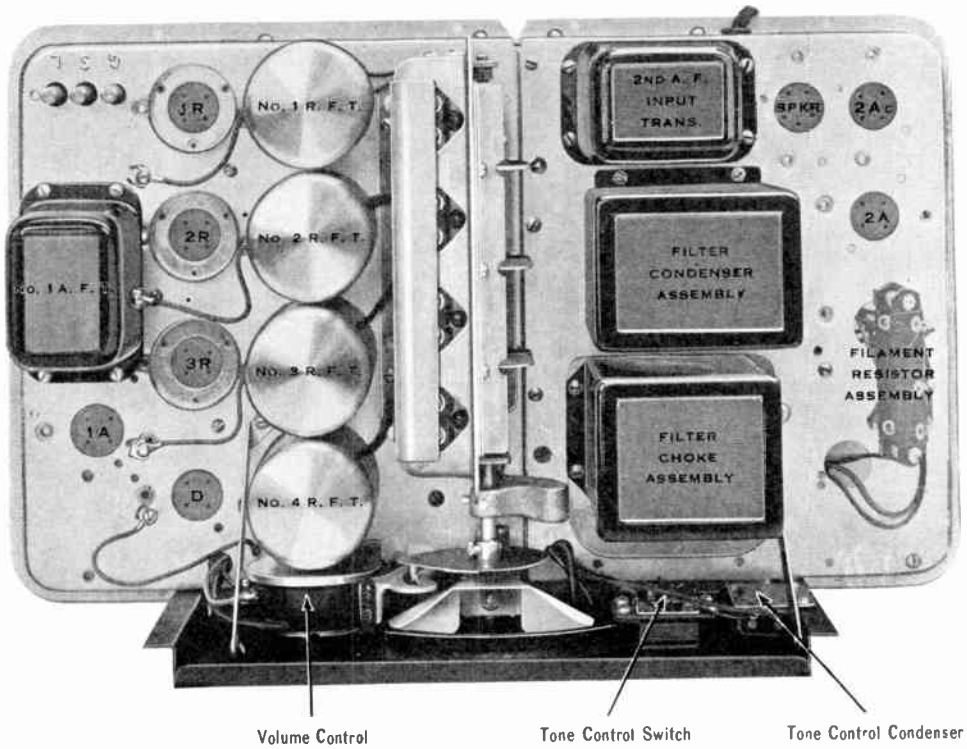


FIG. 252.

TOP VIEW OF TYPE D CHASSIS.

FRONT PANEL ASSEMBLY

Part No.		*Price*
18085	Front panel with dial plate	$1.25
18581	Front panel complete	2.50
17224	Front panel brace (2 used)	.10
17985	Escutcheon	1.00
17244	Volume-control or tone-control knob	.30
16760	Local-distance switch	1.25
16740	On-off switch	1.10
16630	Volume-control	4.50
17876	Volume-control bracket	.20
16576	Volume-control cover	.05
17814	Dial knob	.30
18223	Tone-control condenser clamp	.05
17959	Dial pointer	.05

POWER UNITS

Part No.		*Price*
16890	Filter-choke	$8.60
18232	Filter-choke base plate	.10
18638	Filter-choke lid and name-plate	.20
14710	Filter-condenser	9.70
18188	Filter-condenser case	.45
17534	Filter-condenser spacer (fibre)	.25/c
17070	No. 1 A. F. transformer	4.50
16640	2nd-A. F. input transformer	4.50
16430	TONE-CONTROL SWITCH COMPLETE	.75
18148	Base	.60
18146	Shaft	.12
18112	Contact blade	.03

Part No.		*Price*
18579	VARIABLE CONDENSER STATOR, ROTOR AND FRAME (WITH LEADS AND BALANCE WEIGHT)	$9.60
17107	Rotor-connection (long)	.10
17291	Rotor-connection (short)	.10
16099	Dial light	.25
16420	Dial-light socket and reflector, one-hole mounting (less leads)	.40
16420-A	Dial-light socket and reflector two-hole mounting (less leads)	.40
18615	Dial-gear	.40
17936	Dial-knob bracket (one-hole mounting)	.35
18144	Dial-knob bracket (two-hole mounting)	.35
17935	Dial-knob bracket support (threaded)	.03
17941	Dial-knob shaft	.05
17961	Dial-rubber assembly	.15
17962	Pointer control arm	.30

No separate parts, except those listed above, will be supplied for variable-condenser unit.

COIL GROUP

Part No.		*Price*
17490	R.F. coil group	$4.00
16360	Stopping condenser (3 used)	.10
16360	Compensating condenser (1 used)	.10
17295	R.F. coil shield (4 used)	.50

If one R.F. coil or R.F.C. No. 3, No. 4, No. 5, is defective, the ENTIRE coil group must be replaced.

December, 1930. These prices supersede all previous prices and are subject to change without notice.

PARTS AND PRICE LIST—TYPE D, No. 16700, CHASSIS

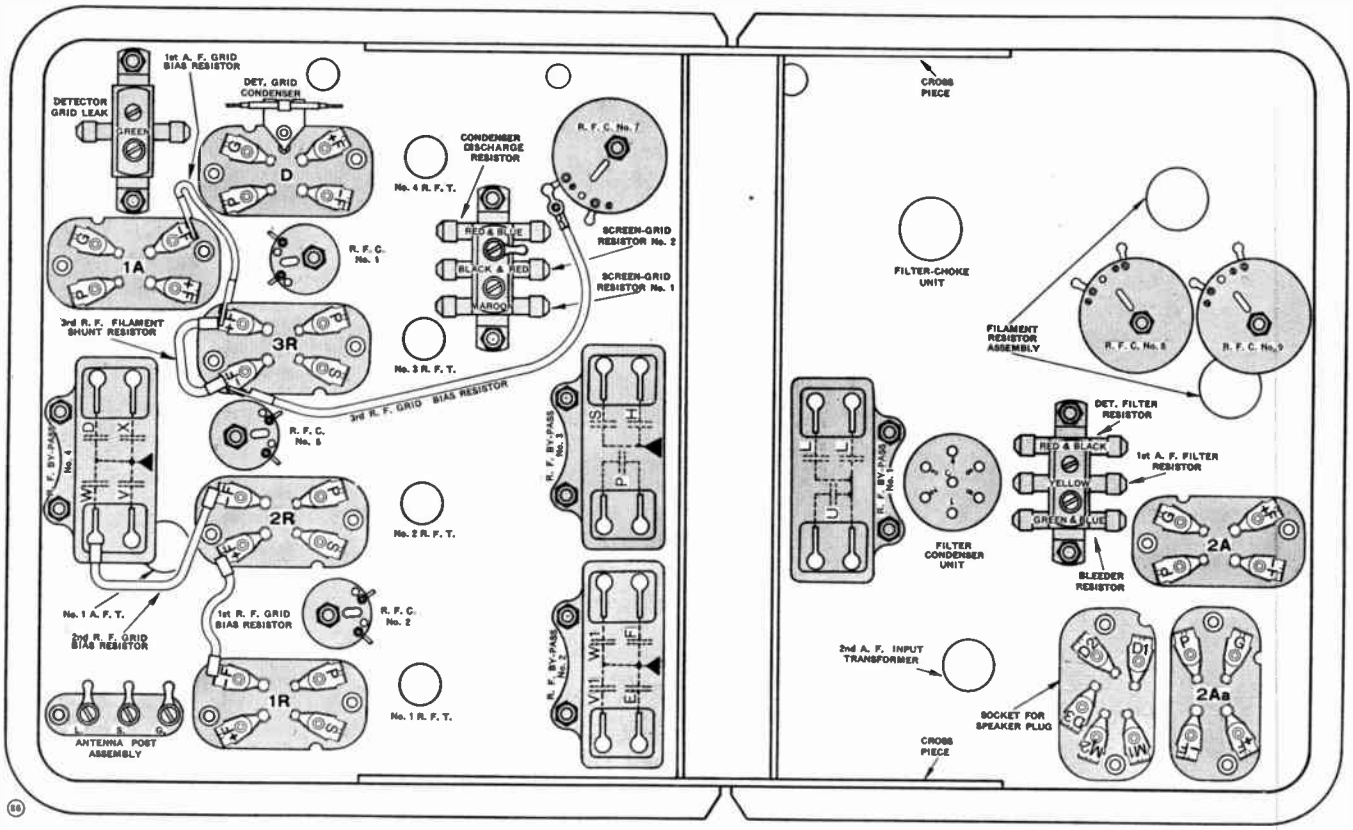


FIG. 253. BOTTOM VIEW OF TYPE D CHASSIS.
In later-type D chassis, a line fuse (2 amperes) is mounted at the right of R. F. by-pass No. 1.

TUBULAR RESISTORS

Part No.		Price
15892	Detector grid leak (green)	$ .25
16282	Condenser discharge resistor (blue and red)	.25
15891	Screen grid resistor No. 2 (black and red)	.25
15545	Screen grid resistor No. 1 (maroon)	.25
15891	Det. filter resistor (red and black)	.25
15544	1st-A.F. filter resistor (yellow)	.25
18049	Bleeder resistor (green and blue)	.30
17341	Mounting bracket	.05
17342	Fibre resistor pad	.25/c
17345	Metal clamping strip	.02

FLEXIBLE RESISTORS

Part No.		Price
16322	1st-A.F. grid bias resistor	$ .20
16322	3rd-R.F. grid bias resistor	.20
16850	2nd-R.F. grid bias resistor	.20
16860	1st-R.F. grid bias resistor	.20
16840	3rd-R.F. filament shunt resistor	.20

WIRE-WOUND RESISTORS

Part No.		Price
18354	Filament series resistor No. 2	$1.00
18355	Filament series resistor No. 1	1.00
18356	A.F. filament shunt resistor	1.00
15972	Mounting bracket (2 used)	.10

FIXED CONDENSERS

Part No.		Price
15870	Tone-control condenser	$1.00
16940	R.F. by-pass No. 1	1.10
15262	R.F. by-pass No. 2	1.00
16880	R.F. by-pass No. 3	1.10
15262	R.F. by-pass No. 4	1.00
18419	Grid-condenser assembly (includes detector socket)	.65
16088	Grid condenser	.20
17254	R.F. CHOKE No. 7, No. 8, No. 9	.50
15271-A	R.F. CHOKE No. 1, No. 2, No. 6	.25

SOCKETS

Part No.		Price
18417	1R, 2R, 3R tube sockets	$ .25
18418	Det. or 1st A.F. sockets	.25
18419	Det. socket and grid condenser assembly	.65
18398	2A socket	.25
18399	2Aa socket	.25
17377	Socket insulator (7 used)	.25/c
18007	Speaker-plug socket	.30
18016	Socket insulator	.25/c
18449	Fuse socket	.15
16420	Dial-light socket and reflector, one-hole mounting (less leads)	.40
16420-A	Dial-light socket and reflector, two-hole mounting (less leads)	.40

December, 1930. These prices supersede all previous prices and are subject to change without notice.

MISCELLANEOUS PARTS

(For screws, nuts, washers and small parts—see page 229.)

Part No.		Price
17524	110-volt cable, with plug	$1.90
8956	110-volt plug only	.30
16741	Insulation bushing for 110-volt cable	.05
16742	Retaining spring	.05
17521	Antenna binding posts and base	.45
17323	Antenna and ground post base	.05
8215	Binding Post	.20
17536	Bottom Plate	1.30
13989	Ground-clamp	.30
15213	Tube-shield (3 used)	.15
15214	Tube-shield base (3 used)	.03
17326	Detector cap	.30
17223	Cross piece (10" x 7/8"—2 used)	$ .25
17632	Detector cap lead (brown)	.10
	Trimmer-condenser sealing wax	.50 lb.
18118	"Guide" card (form F-680)	.75/c net
18119	Log card (form F-681)	.75/c net
18113	Tuned radio-frequency name-plate	.06
18534	Fuse (2 amperes)	.05
18051	Instruction book	.10 net
15910	Literature assembly	.20 "
18489	Shipping container	.65 "
18117	Balance weight for variable condenser	.35

VOLTAGE TABLE FOR TYPE F CHASSIS

Set in operation. Volume control at maximum.
L-D switch at distance.

Use High Resistance D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages.
Use A. C. Voltmeter to Measure Filament Voltages.

APPROX. VOLTAGES, USING 120 V. LINE

TUBE	FILAMENT VOLTAGE	PLATE VOLTAGE	CONTROL-GRID VOLTAGE	SCREEN VOLTAGE
1st-R.F.	2.5	180	6	92
2nd-R.F.	2.5	180	4	93
3rd-R.F.	2.5	180	4	93
Detector	2.5	117	30**	—
1st-A.F.	2.4	70	2	—
2A	2.7	250	55*	—
2Aa	2.7	250	55*	—

All readings made from cathode in heater-type tubes, and from —F in plain-filament-type tubes.
* Use 250-volt scale.
** This is the voltage across the detector bias resistor; when measuring from grid to cathode, the voltage reading is only 2.

IDENTIFICATION OF BY-PASS CONDENSERS IN SCREEN-GRID RECEIVERS

The following list gives the identifying markings that are stamped on each by-pass condenser.

Note that by-pass condensers of one part number may have one of several code markings. Thus No. 15262 may be marked B-1, H-1, H-9 or H-20. As these markings are all for the same part number, the condensers so marked are interchangeable—that is, H-20 may be used in place of B-1, H-1 or H-9; or H-1 may be used in place of B-1, H-9, H-20, and so on.

In many cases the code marking is preceded by a numeral such as 1-H-20 or 2-H-20. In all cases the first numeral should be disregarded.

PART NO.	CODE MARKING
15262	B-1, H-1, H-9, H-20
15263	B-2, H-2
15640	H-16
15770	H-15
15780	H-17
15790	H-18, H-21
15837	B-3 (superseded by 16233)
15870	B-7, L-28
16060	H-24, L-29, (304) superseded by 18350

PART NO.	CODE MARKING
16233	H-4, H-10
16461	H-6, H-12
16462	H-5, H-11
16490	B-6, L-12
16745	H-7, H-8, H-13
16828	B-5
16880	H-23, L-26, (439)
16940	H-22, L-10
17360	H-27, L-32
17370	H-25, H-26, L-3 L-39
18350	H-28, L-49

December, 1930. These prices supersede all previous prices and are subject to change without notice.

Centering Top Pole Piece in Electro-Dynamic Speakers

In later-type electro-dynamic speakers, the top pole piece does not have a centering disc. For this reason it is necessary to center the top pole piece whenever this part is replaced or adjusted. This centering requires three gauges. Each gauge may be a three-inch length of No. 54 drill-rod, or if desired the shanks of three No. 54 drills may be used for the same purpose.

Procedure: (1) Loosen the nuts that clamp the top pole piece, the cone housing, and the field-coil case.

(2) Insert the three gauges in the magnet gap, as illustrated in Figure 254. Tighten the bolts very securely and then remove the gauges.

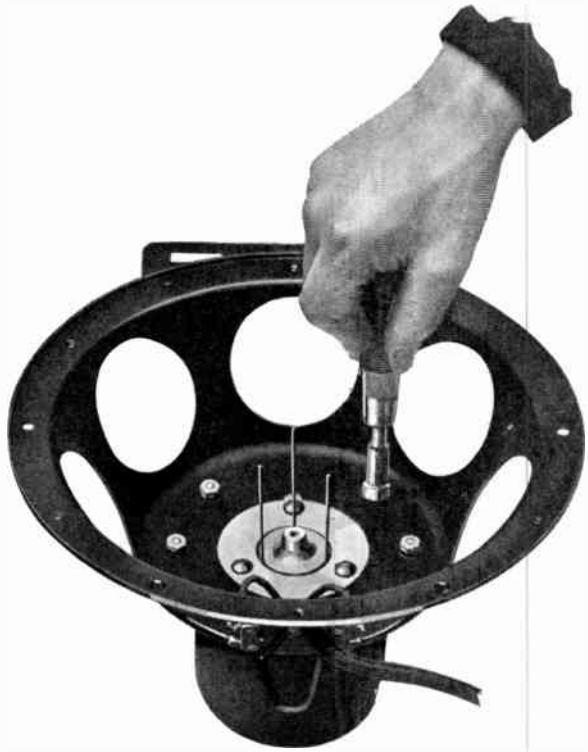


FIG. 254. (AT RIGHT.)
SHOWING GAUGES IN POSITION WHILE TIGHTENING TOP POLE PIECE.

PARTS AND PRICE LIST—TYPE N, N-3, CHASSIS SPEAKERS

(For screws, nuts, and small parts, see Page 229.)

TYPE N, No. 16400

Part No.		Price
18081	Diaphragm	$3.25
16410	Field coil	5.00
18093	Field-coil insulator	.02
18075	Field-coil spacer	.09
18055	Top pole piece	1.25

TYPE N, No. 16400 (Cont'd)

Part No.		Price
18073	Cone-housing with terminal card	$2.60
17889	Terminal card	.12
17796	Terminal-card insulator	.02
17803	Terminal-card cover	.12
17895	Cable and plug assembly	1.65
18582	Plug only	.65
14382	Steel ring (3 segments)	1.00
16390	Output transformer (before No. 6852901 and from 6938001 to 6943001)	3.25
16390-A	Output transformer (from 6852901 to 6937000, and above 6943001)	3.25
	5-Conductor Cable	.14/ft.
18068	Instruction sheet	.02 net
15578-N	Shipping container	.35 "

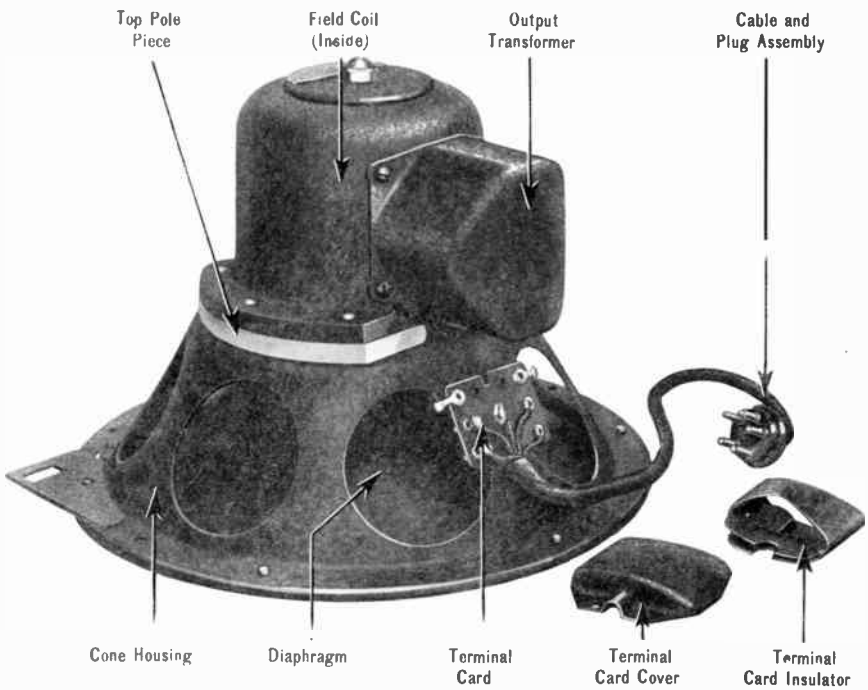


FIG. 255. N OR N-3 SPEAKER.

TYPE N-3, No. 16900

Parts not listed below are same as those used in "N" No. 16400 Chassis speaker.

Part No.		Price
17020	Field coil	$8.00
16390	Output transformer (before No. 7477302)	3.25
16390-A	Output transformer (after No. 7477302)	3.25
	5-Conductor cable	.14/ft.
18542	Instruction sheet	.02 net
15578-N-3	Shipping container	.35 "

December, 1930. These prices supersede all previous prices and are subject to change without notice.

PARTS AND PRICE LIST—TYPES J AND JB INDUCTOR SPEAKERS

(For screws, nuts, and small parts, see Page 229.)

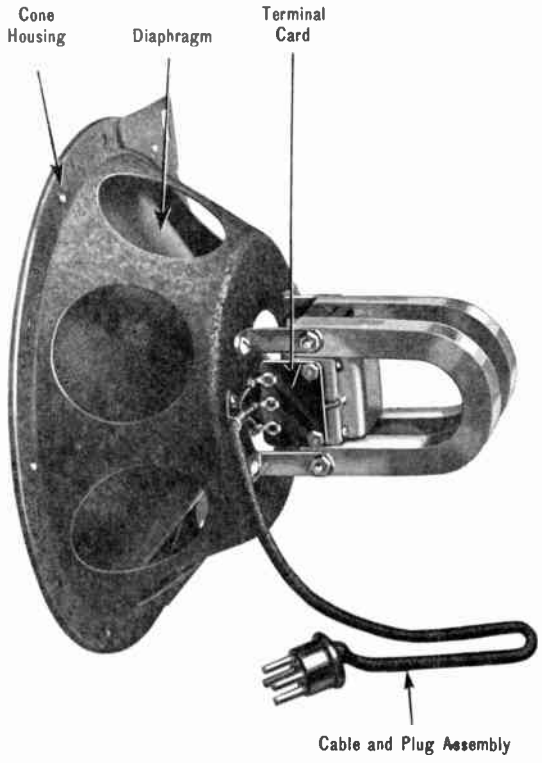


FIG. 256. TYPE J SPEAKER.

TYPE J, No. 15920, CHASSIS SPEAKER

Part No.		*Price*
17856	Diaphragm	$ 1.50
17864	Sound unit complete	10.90
17862	Terminal card	.20
17858	Cone housing	2.60
17866	Cable and plug assembly	1.60
15079	Plug only	.65
17827	Cable clamp	.05
14382	Steel ring (3 segments)	1.00
	3-Conductor cable	.10/ft.
17872	Instruction sheet	.02 net
19336	Shipping container	.35 "

IMPORTANT

No separate parts are furnished for the No. 17864 and 17864-B sound units in the type J and JB inductor speakers.

If any part of the sound unit (illustrated at right) requires replacement or adjustment, return the complete unit, exactly as shown, to the factory.

FIG. 257. No. 17864, SOUND UNIT, COMPLETE.

TYPE "JB" SPEAKER, No. 17010

NOTE:—All parts not listed below are same as used in Type "J" No. 16920 Chassis Speaker.

Part No.		*Price*
17847	Cone housing	$ 2.60
17864-B	Sound unit, less resistor	10.90
19345	Terminal card, less resistor	.20
19346	Resistor (green and red)	.30
18577	Frame	3.75
18578	Felt pad (1 used)	.75/c
16734	Front frame	5.50
16735	Front screen	2.10
4259	Cord	.80
	2-Conductor Cable	.08/ft.
18573	Instruction sheet	.02 net
16695	Shipping container	.35 "

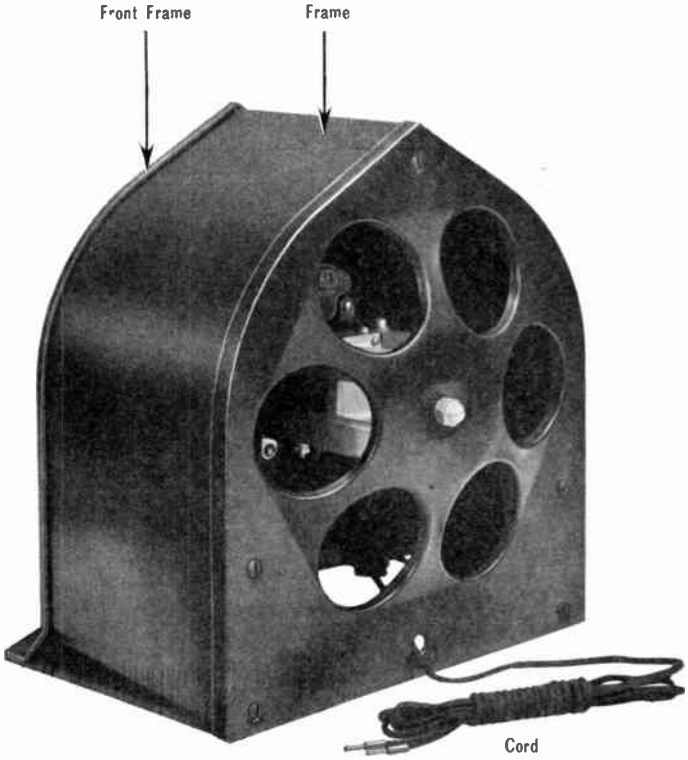


FIG. 258. TYPE JB SPEAKER (REAR VIEW).

Output Measuring Circuit for All Types of Atwater Kent Receivers

In the output measuring circuit, shown in Figure 259, only one speaker, a Type JB, is required in testing any type of Atwater Kent receiver. This eliminates the necessity of tying up four or five electro-dynamic speakers.

This improvement is made possible through the use of a special output transformer, and a series of resistors which take the place of the field coil in the various types of Atwater Kent electro-dynamic speakers.

OPERATION

(A) Throw S1 to the right to test for quality on the JB speaker. Throw S1 to the left to pick up oscillator signals on the phones when synchronizing variable condensers.

(B) When testing an A. C.-operated electro-dynamic set, move S4 to the tap that gives the correct resistance to take the place of the field coil in the speaker for that particular set.

Tap 1 (left) takes place of F-6 field coil.
Tap 2 takes place of F-4 or N field coil.
Tap 3 takes place of F-2 field coil.
Tap 4 takes place of F field coil.

It is NOT necessary to use a "dummy" field load when testing a battery-operated or D. C.-operated electro-dynamic receiver. When testing such a receiver, S4 may be turned to the 4th tap (right).

(C) MAGNETIC SETS. When testing a magnetic-type set, such as Models 20, 35, 37, 40, etc., connect the two-conductor cord to the speaker-posts on the set being tested. Close both S2 and S3 if a reading on the meter is desired; open either S2 or S3 to open the meter circuit.

(D) INDUCTOR SETS. In testing a Type Q Chassis, insert the three-conductor plug in the speaker-plug socket on the Q Chassis. Close both S2 and S3 if a reading is desired on the output meter. Open either S2 or S3 to open the meter circuit.

(E) FIVE-PRONG ELECTRO-DYNAMIC SETS. In testing an L, P, D, F or H Chassis, insert the five-conductor plug in the speaker-plug socket on the chassis, and, if the chassis is A. C.-operated, set S4 at the correct tap. To get a reading on the meter, close S2 and S3; to open the meter circuit, open either S2 or S3.

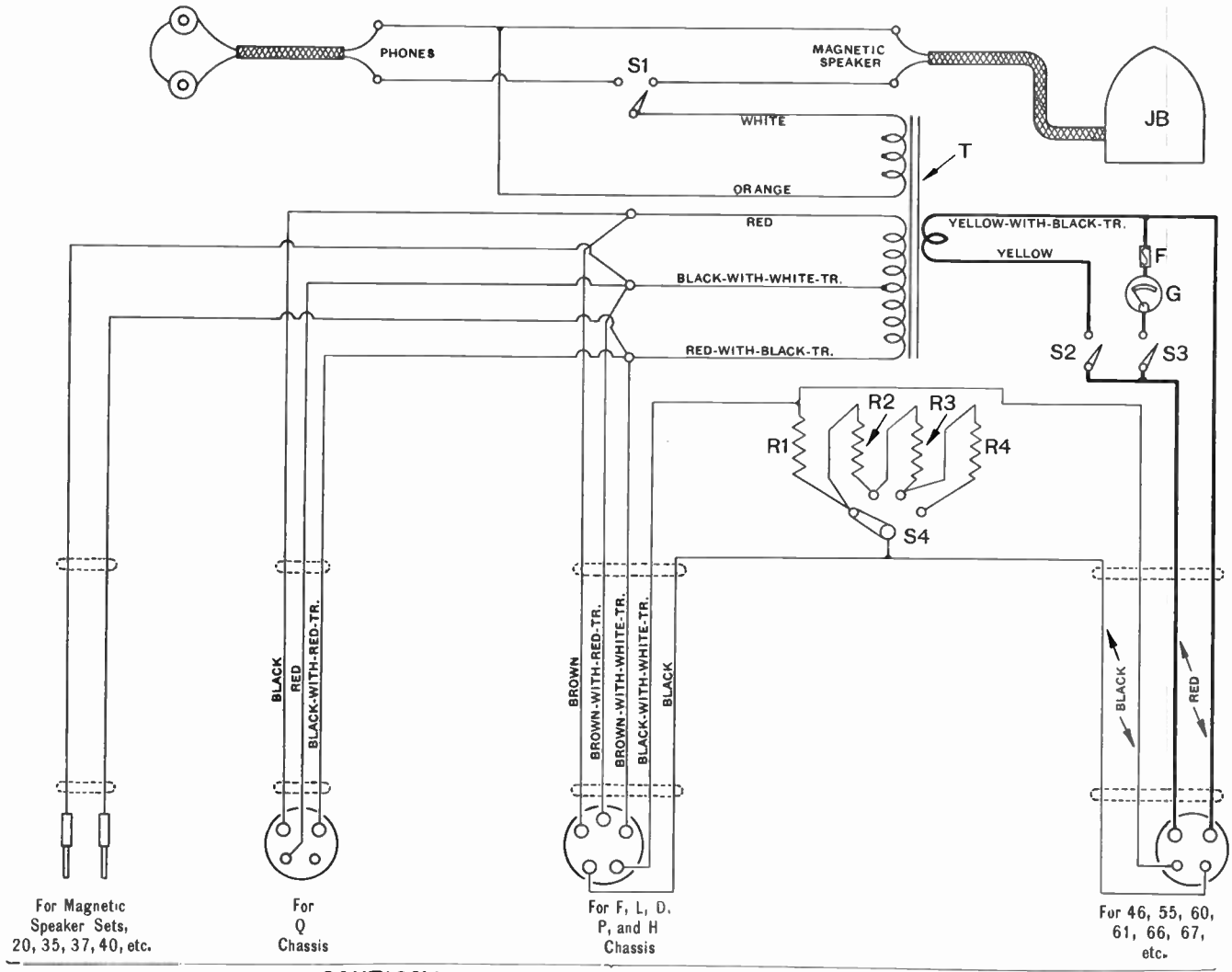
(F) FOUR-PRONG ELECTRO-DYNAMIC SETS. In testing a Model 46, 55, 60, 61, 66, 67, etc., insert the four-conductor plug in the speaker-plug socket on the chassis. If the chassis is A. C.-operated, set S4 at the correct tap. To get a reading on the meter, close S3 and open S2. To operate the phones or JB speaker, close S2 and open S3. To operate both the phones and the meter, close both S2 and S3.

LIST OF PARTS

(With the exception of fuse ("F") and meter ("G") only standard Atwater Kent parts are used in this circuit.)

T—No. 18911 output transformer. This transformer has an extra winding which couples the speaker or phones to the output circuit of the particular set that is being tested.

S1—No. 13678 toggle switch.
S2, S3—No. 9991 toggle switches.
S4—No. 16430 switch.
R1—Four No. 16988 resistors in series.
R2—Three No. 16988 resistors in series.
R3—Four No. 16988 resistors in series.
R4—Five No. 16988 resistors in series.
F—¼ ampere fuse.
G—115 ma, thermo-coupled galvanometer.
1—No. 14169 double-conductor cord.
1—No. 17866 three-conductor cord-and-plug.
1—No. 17556 four-conductor cord-and-plug.
1—No. 17895 five-conductor cord-and-plug.



CAUTION: USE ONLY ONE OF THESE FOUR CABLES AT ONE TIME.

FIG. 259. UNIVERSAL OUTPUT MEASURING CIRCUIT FOR ALL TYPES OF ATWATER KENT RECEIVERS.

ATWATER KENT RADIO

SERVICE DATA

With

PARTS AND PRICE LISTS FOR

MODEL 80, 80-F, 81, 82, 82-F, 82-D, 82-Q, 83, 83-F, 84, 84-F, 84-D, 84-Q 85, 85-F, 85-Q, 86, 86-F, 87, 89, 89-F, 89-P

TABULATED DATA FOR MODELS DESCRIBED IN THIS SUPPLEMENT

Model Number	Power Supply	Part Number Complete	Part Number Chassis	Part Number Speaker	Cabinet	Automatic Vol. Control	Tone Cont.	Local-Dist. Switch	TUBES R.F.	1st Det.	1st I. F.	2nd I. F.	2nd Det.	1st A. F.	2nd A.F.	Osc.	Control Tube	Rect.
80	110-V., 60-C.	20900	20820	17300	*	No	Yes	No	—	35	35	—	24	47	—	27	—	80
80-F	110-V., 25-C.	21400	21710	17300	*	No	Yes	No	—	35	35	—	24	47	—	27	—	80
82	110-V., 60-C.	21000	21090	17300	**	Yes	Yes	No	—	35	35	—	24	47	—	27	24	80
82-F	110-V., 25-C.	21700	21740	17300	**	Yes	Yes	No	—	35	35	—	24	47	—	27	24	80
82-D	110-V., D. C.	21800	21750	18600	**	No	Yes	No	—	36	36	—	36	37	33	37	—	—
82-Q	Battery	21900	21760	18400	**	Yes	Yes	Yes	32	32	32	—	32	30	33	30	—	—
83	110-V., 60-C.	21100	——	18100 24600†	Lowboy	No	Yes	No	—	35	35	—	24	47	—	27	—	80
83-F	110-V., 25-C.	22000	——	18100 24600†	Lowboy	No	Yes	No	—	35	35	—	24	47	—	27	—	80
84 (Early)	110-V., 60-C.	17500	18930	17300	***	No	No	No	—	24	24	—	24	47	—	27	—	80
84 (Late)	110-V., 60-C.	19000	20060	17300	***	No	Yes	No	—	35	35	—	24	47	—	27	—	80
84-F (Early)	110-V., 25-C.	17600	19270	17300	***	No	No	No	—	24	24	—	24	47	—	27	—	80
84-F (Late)	110-V., 25-C.	19200	20070	17300	***	No	Yes	No	—	35	35	—	24	47	—	27	—	80
84-D (Early)	110-V., D. C.	17800	19680	18600	***	No	No	No	—	36	36	—	36	37	33	37	—	—
84-D (Late)	110-V., D. C.	19300	20080	18600	***	No	Yes	No	—	36	36	—	36	37	33	37	—	—
84-Q (Early)	Battery	18300	19550	18400	***	No	No	No	32	32	32	—	32	30	33	30	—	—
84-Q (Late)	Battery	19400	20090	18400	***	No	Yes	No	32	32	32	—	32	30	33	30	—	—
85 (Early)	110-V., 60-C.	17900	——	18100	Lowboy	No	Yes	No	—	24	24	—	24	47	—	27	—	80
85 (Late)	110-V., 60-C.	17900	——	18100 24600†	Lowboy	Yes	Yes	No	—	35	35	—	24	47	—	27	24	80
85-F	110-V., 25-C.	18200	——	18100 24600†	Lowboy	Yes	Yes	No	—	35	35	—	24	47	—	27	24	80
85-Q	Battery	22200	——	19900	Lowboy	Yes	Yes	Yes	—	32	32	32	32	30	33	30	—	—
86	110-V., 60-C.	23000	——	24600	Low-Highboy	Yes	Yes	No	35	35	35	—	24	47	—	27	24	80
86-F	110-V., 25-C.	24700	——	24600	Low-Highboy	Yes	Yes	No	35	35	35	—	24	47	—	27	24	80
87	110-V., 60-C.	21200	——	19800	Lowboy or Highboy	No	Yes	No	35	35	35	—	27	27	47 (2)	27	—	80
89	110-V., 60-C.	21300	——	19800	Lowboy or Highboy	Yes	Yes	No	35	35	35	—	27	27	47 (2)	27	24	80
89-F	110-V., 25-C.	22400	——	19800	Lowboy or Highboy	Yes	Yes	No	35	35	35	—	27	27	47 (2)	27	24	80
89-P	110-V., 60-C.	20000	——	19800	Phono. Comb.	Yes	Yes	No	35	35	35	—	27	27	47 (2)	27	24	80
81	Battery	20300	22750	22600	Model 81 has seven tubes: Three '36s as 1st, 2nd and 3rd R. F., one '37 as detector, two '38s as push-pull A. F., and one '37 as automatic volume control tube.													

*Compact type. Rounded arch of zebra wood. Matched butt walnut panel. Rope carved pilasters. 19¼" high, 15⅞" wide, 9⅞" deep.
**Compact type. Gothic arch of zebra wood. Matched butt walnut panel. Carved twist pilasters. 19¼" high, 15⅞" wide, 9⅞" deep.
***Compact type. Gothic arch. 19¼" high, 15⅞" wide, 9⅞" deep.
†The two part numbers for speakers in 83, 83-F, 85, 85-F indicate early- and late-type speakers.
LOWBOY. Finished in American walnut with matched butt walnut front panels. 23¾" wide, 15¼" deep, 38¾" high.
HIGHBOY with sliding doors. Finished in hand-rubbed American walnut. Matched butt walnut front panels and doors. 26" wide, 16¼" deep, 45¾" high.
LOW-HIGHBOY. Finished in American walnut with matched butt walnut front panels and apron, and rubbed top.
PHONOGRAPH COMBINATION CABINET. Finished in American walnut with rubbed top. Matched butt walnut front panels and apron. Top piano-hinged and with automatic support.

MODEL 80, 80-F, 83, 83-F

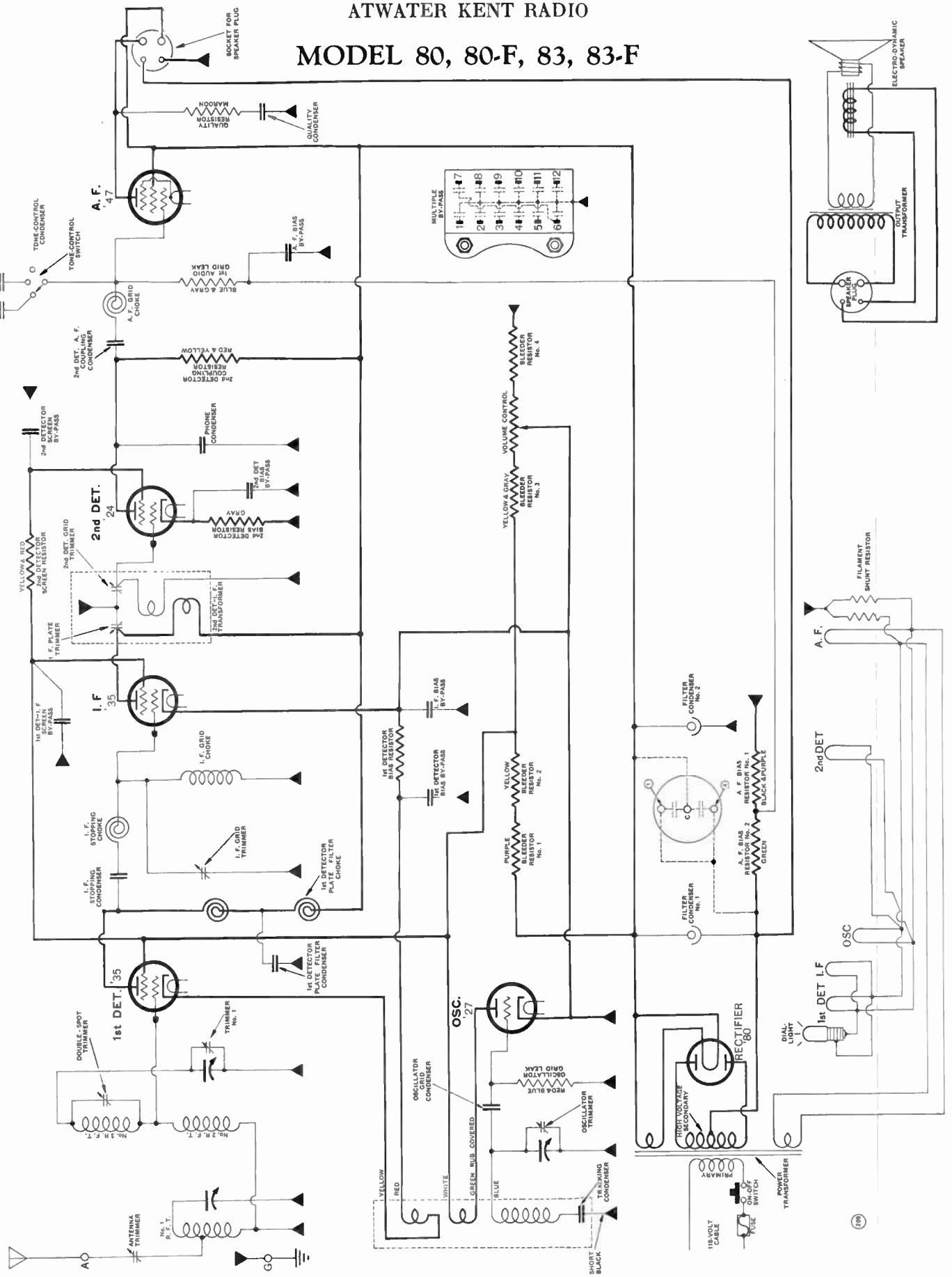


FIG. 281. DIAGRAM OF MODEL 80, 80-F, 83, AND 83-F (A. C.-OPERATED).

In Model 83 and 83-F, a filter-condenser unit is used and it is connected as shown in dotted lines. This unit is NOT used in Model 80 and 80-F. In Model 83, 83-F, the electrolytic filter condenser No. 1 is not used, and the filament circuit is slightly different.

ATWATER KENT RADIO

Service Data, Parts List, and Price List for

MODEL 60-C [3RD TYPE]

Serial No. 5,670,001 to 5,684,000

Model 60-C is a chassis-type, screen-grid, electro-dynamic radio receiver, designed for 110-120 volt, 50-60 cycle, A. C. operation

As a result of the adoption of numerous laboratory developments which have been rigorously checked by extensive preliminary trials, the 3rd type of Model 60-C possesses many electrical and mechanical refinements which give to this model a number of very desirable improvements.

Electrically, the principal difference is in the arrangement of the R. F. amplifying circuit. Mechanically, the principal difference is in the design of the variable-condenser unit. These differences are tabulated on Page 202.

The improvements resulting from these changes are summarized below. It is important to remember that the following list gives only the improvements; in addition to these improvements, the 3rd type of Model 60-C has all the features of superiority which are described on Page 115 of this manual.

1. EXACT SYNCHRONISM. This is due to the exact mechanical construction of the variable-condenser unit.

2. UNIFORM SENSITIVITY.

3. UNIFORM SELECTIVITY.

4. UNIFORM DIAL SETTINGS. The same station is tuned in at almost identically the same dial number on all 3rd-type Model 60-C receivers. This feature is secured by strict uniformity of R. F. transformers and by the great accuracy in condenser construction.

5. EASILY ACCESSIBLE PARTS. The simple mechanical construction, quickly removable plug-in-type R. F. coil shields, one-bolt R. F. transformer-mounting brackets, air-cooled power transformer, separate tube sockets, direct wiring, complete service information with "picture drawings"—all these help to make servicing easy, quick and certain.

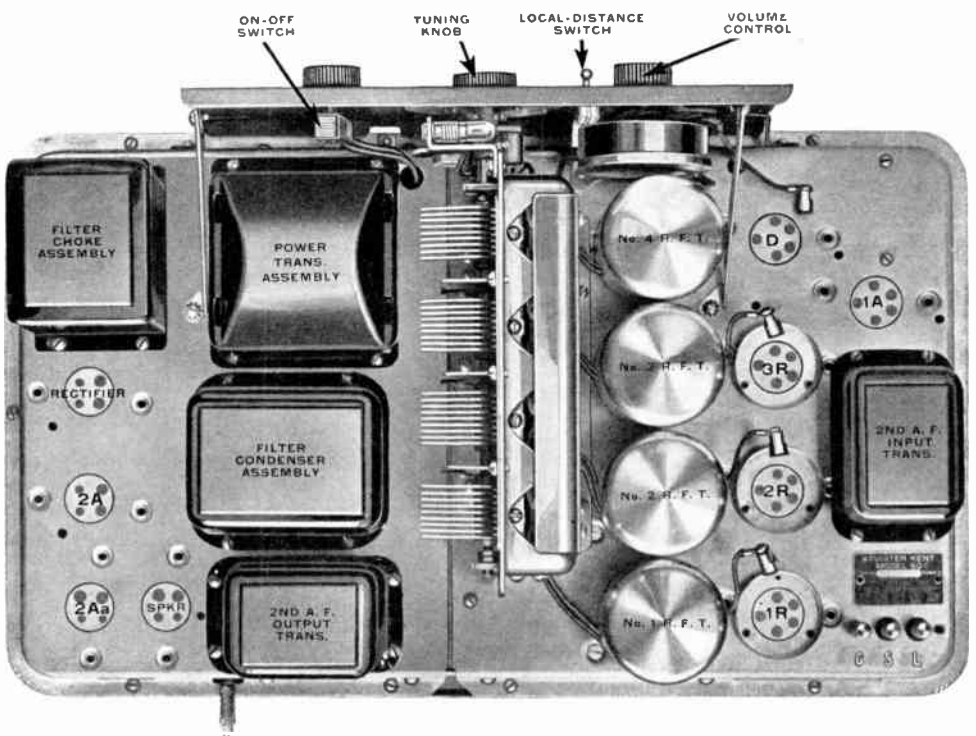


FIG. 201. TOP VIEW OF 3RD TYPE OF MODEL 60-C.

Comparison of the Three Types of Model 60-C

Like the two preceding types of Model 60-C, the 3rd type has three stages of screen-grid radio-frequency amplification, a detector, one stage of resistance-coupled audio-frequency amplification, and a "double-audio" output stage.

The principal differences between the three types are as follows:—

	IN THE FIRST TYPE	IN THE SECOND TYPE	IN THE THIRD TYPE
VOLUME CONTROL	A **single** volume control regulates the screen-voltage.	A **dual-type** volume control— 1. Regulates the amount of R.F. energy transferred from the 1st- to the 2nd-R.F. tube. 2. Regulates the screen-voltage.	A **dual-type** volume control— 1. Regulates the amount of R.F. energy transferred from the antenna circuit to the 1st-R.F. tube. 2. Regulates the R.F. control-grid voltage.
LOCAL-DISTANCE SWITCH	The local-distance switch is connected to the primary of No. 2 R.F.T. **(between the 1st and 2nd R.F. tubes).** In the distance position, the switch cuts in the entire primary of No. 2 R.F.T., thus giving three straight stages of R.F. amplification. In the local position, the switch cuts out a part of the primary of No. 2 R.F.T., thus reducing the total R.F. amplification.	The local-distance switch is connected to the 2nd stopping condenser **(between the 2nd- and 3rd-R.F. tubes).** In the distance position, the switch connects the 2nd stopping condenser to the plate of the 2nd-R.F. tube, thus giving three straight stages of R.F. amplification. In the local position, the switch connects the 2nd stopping condenser to the +B side of the plate-circuit of the 2nd-R.F. tube, thus reducing the total R.F. amplification.	The local-distance switch is connected to the secondary of No. 1 R.F.T. **(ahead of the 1st-R.F. tube).** In the distance position, the switch connects the grid-return lead of the 1st-R.F. tube to the chassis, thus giving three straight stages of R.F. amplification. In the local position,* the switch connects the grid-return lead of the 1st-R.F. tube to a coupling coil (on the 2nd-R.F. transformer) and then to the bias circuit of the 2nd-A.F. tubes. The coupling coil provides coupling between the 1st and 2nd tuned circuits, and the high negative grid bias makes the 1st-R.F. tube inoperative, thus reducing the total R.F. amplification.
R.F. TRANSFORMERS	The R.F. transformers are **inductively coupled.**	The R.F. transformers are **auto-transformer coupled.**	The R.F. transformers are **auto-transformer coupled.**
VARIABLE CONDENSERS	Both the 1st and 2nd types have four separate variable condensers controlled by pulleys and belts.		The variable condensers are of the "multiple" type, with the four rotors mounted on a common shaft.

* If, in the "local" position, the volume is not sufficiently reduced, the 1st-R.F. tube should be changed.

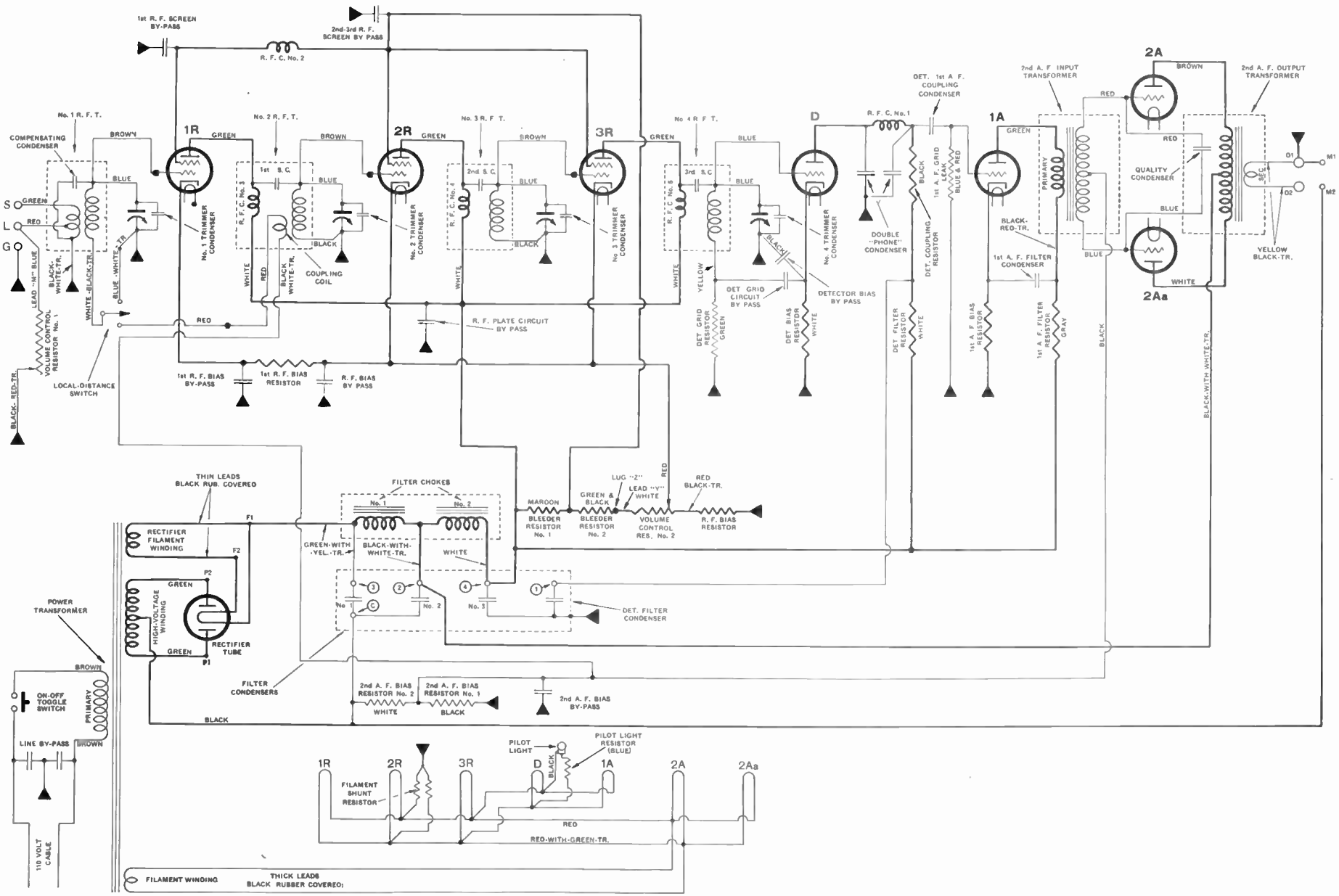


FIG. 202. SCHEMATIC DIAGRAM OF 3RD TYPE OF MODEL 60-C.

In the above diagram, "S.C." means stopping condenser.
In later types of this model, the leads from the filament winding are covered with light gray rubber or black sleeving, and the grid-return of No. 4 R F.T. is yellow-with-black-tracer instead of yellow.
In a few of these models, the quality condenser is connected across the primary of the output transformer, the connections being made inside the unit:
In these sets, the output transformer has five leads instead of seven.

3rd Type Model 60-C

(Serial No. 5,670,001 to 5,684,000)

Condensers in R.F. By-Pass No. 1

L—Line by-pass.
L—Line by-pass.
C—2nd-A.F. bias by-pass.
E—1st-R.F. screen by-pass.

Condensers in R.F. By-Pass No. 2

A—1st-R.F. bias by-pass.
B—R.F. bias by-pass.
U—1st-A.F. filter condenser.

Condensers in R.F. By-Pass No. 3

D—Detector bias by-pass.
H—R.F. plate-circuit by-pass.
T—Detector grid-circuit by-pass.

Condensers in Detector By-Pass.

F—2nd-3rd R.F. screen by-pass.
M—Detector-1st A.F. coupling condenser.
P—Phone condenser.
P—Phone condenser.

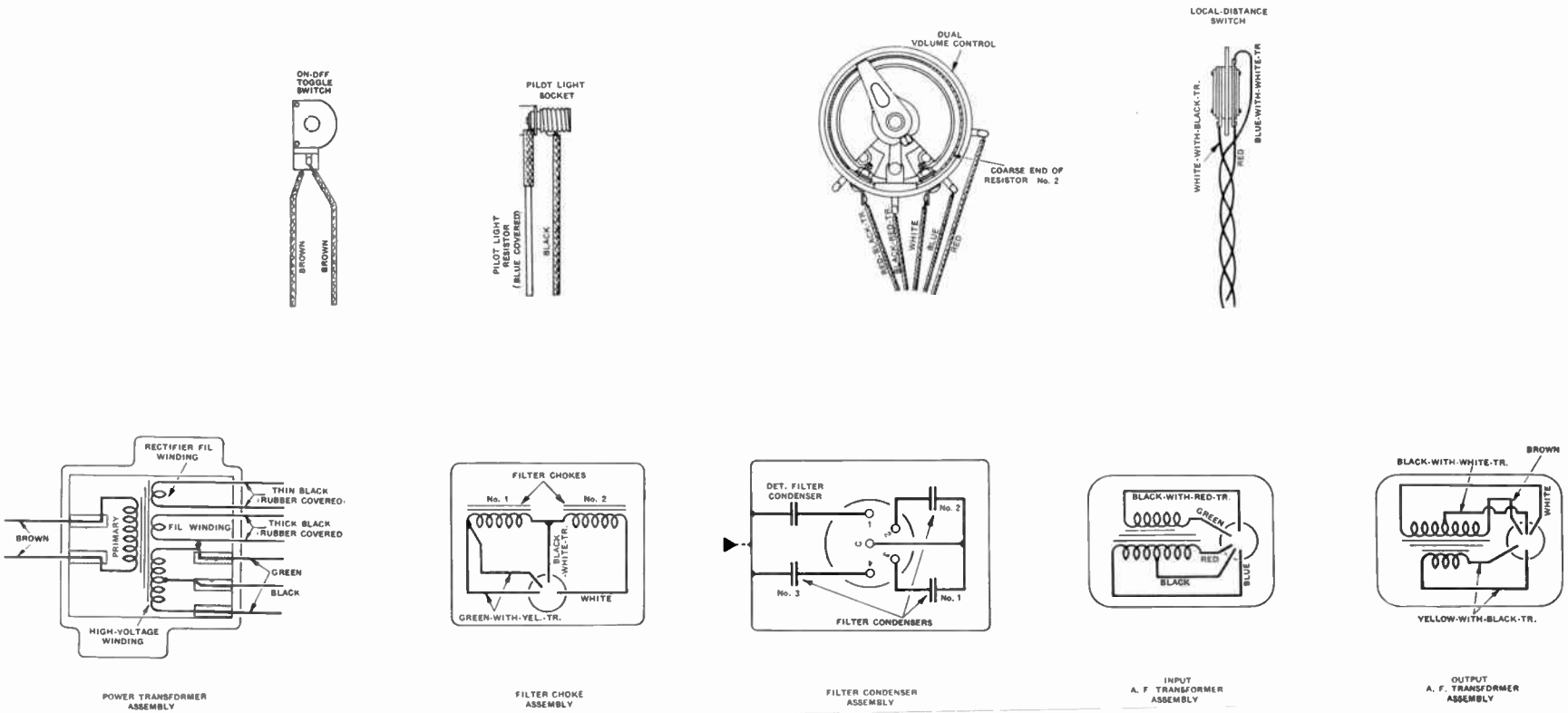


FIG. 203. CONNECTIONS OF UNITS IN 3RD TYPE OF MODEL 60-C

In later types of this Model, the red-with-black tracer lead on the volume control is replaced by a brown-with-white-diagonal-tracer lead which is the R.F. bias resistor. The bottom wiring connections for this later-type Model 60-C are shown on Page 207. Connections of the R.F. coil group are given on Page 212.

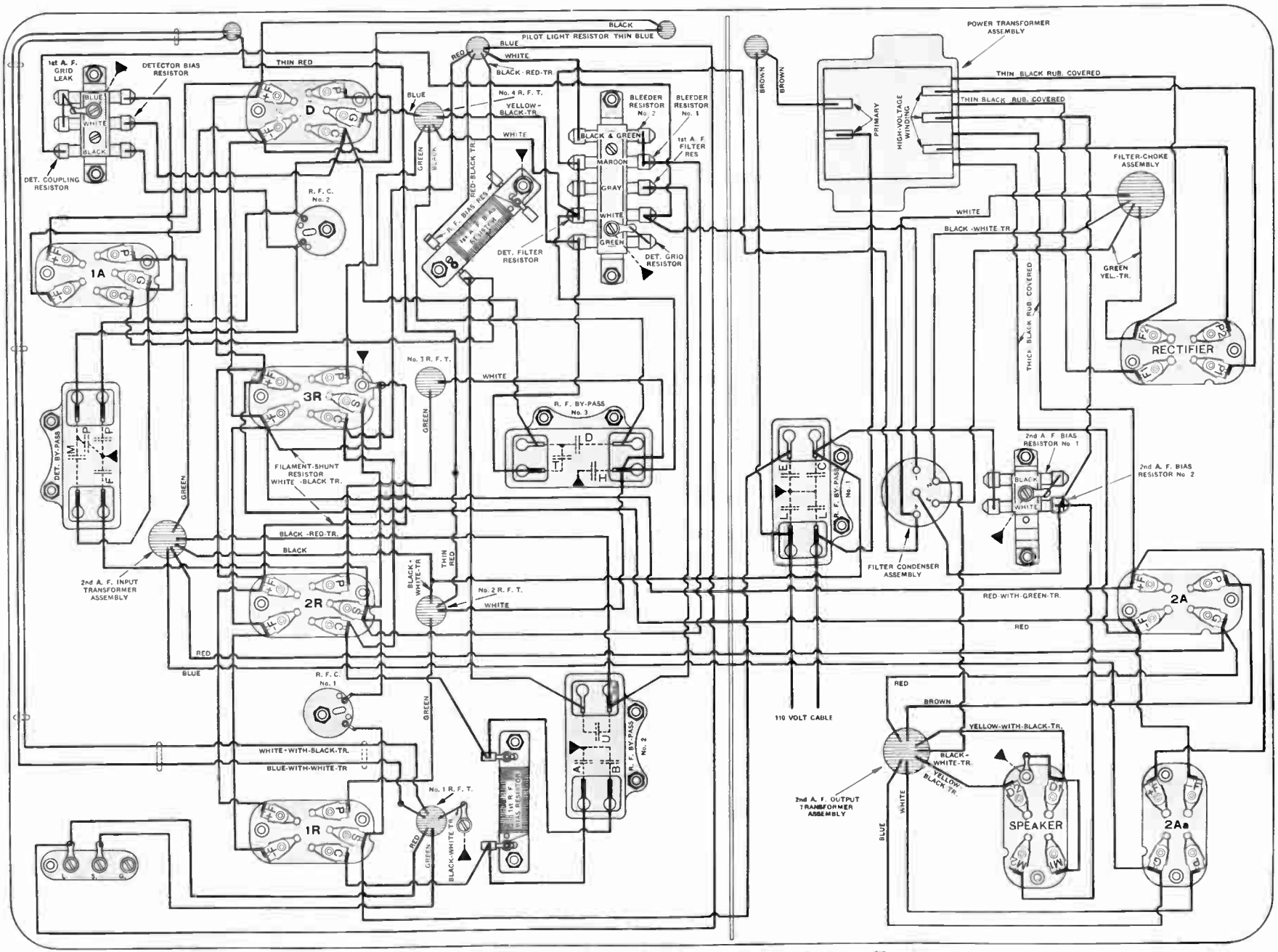


FIG. 204. BOTTOM WIRING OF 3RD TYPE OF MODEL 60-C (EARLY TYPE).

The R.F. bias resistor is mounted under the 1st-A.F. bias resistor with a sheet of insulating fibre between the two resistors. In later types of this model, the 1st-A.F. grid leak is blue and red instead of blue. The blue-with-white-tracer lead from the local-distance switch is connected to the black lead from the rotor of No. 1 V. C.

VOLTAGE TESTS

Operating voltage tests provide a quick and accurate method of checking circuit continuity and finding the general location of any defect. Then, if necessary, continuity tests may be used to narrow down the search to the specific part or connection that is causing trouble.

Procedure: Connect the set for operation, with all tubes and the speaker-plug in their sockets, and measure the voltages at the tube sockets as outlined on Page 208.

The voltage table on Page 208 lists the parts that may possibly be "open" if there is a lack of voltage on any circuit. HOWEVER, IT IS IMPORTANT TO REALIZE THAT LOW VOLTAGE, OR NO VOLTAGE, MAY BE CAUSED BY A SHORTED FILTER, BY-PASS, COUPLING, OR STOPPING CONDENSER, OR BY A GROUNDED CIRCUIT.

The voltage values given in the table on Page 208 were taken with the volume control turned to the position of minimum volume (anti-clockwise). Turning the volume control to the maximum-volume position reduces the R.F. control-grid voltage, and this reduces the R.F. plate and screen voltages. The voltages for maximum volume are approximately as follows (for a 120-volt line):

TUBE	CONTROL-GRID VOLTAGE	PLATE VOLTAGE	SCREEN VOLTAGE
1st-R.F.	8	145	110
2nd-R.F.	5	145	110
3rd-R.F.	5	145	110
Detector	0.8	95	...
1st-A.F.	1	60	...

The voltages on the other tubes remain practically the same as the values given in the table on Page 208.

CONTINUITY TESTS

After making operating-voltage tests, continuity tests may be used if necessary to locate the exact cause of trouble in a set.

The continuity tests given in the table on Page 209 were made with the testing circuit shown in Figure 209. The readings given in the table will be somewhat different if a meter is used having a resistance other than that specified.

BEFORE MAKING ANY CONTINUITY TESTS, IT IS ADVISABLE TO CHECK EACH CONDENSER IN THE SET FOR SHORT CIRCUITS.

When lead "Y" is unsoldered from lug "Z," the +B circuit is isolated from the chassis. Therefore, by testing from the filament of the rectifier tube (F1), to the chassis, there should be no reading on the continuity meter. If there is any reading, either some part of the +B circuit is grounded, or one or more of the following condensers is shorted: Filter condenser No. 1, 2, or 3, R.F. plate-circuit by-pass, 1st or 2nd stopping condensers, 1st-R.F. screen by-pass, 2nd — 3rd-R.F. screen by-pass, detector filter condenser, "phone" condenser, detector—1st-A.F. coupling condenser, or 1st-A.F. filter condenser.

The other condensers in the set may be checked, if necessary, by unsoldering all leads to their terminals and testing across each condenser separately.

TABLE OF CONDENSERS, WHICH, IF SHORTED, MAY CAUSE LOW PLATE, SCREEN, OR GRID VOLTAGE IN 3rd TYPE MODEL 60-C.

	LOW VOLTAGE, OR NO VOLTAGE ON—	MAY BE CAUSED BY A SHORTED—	OR BY A GROUNDED—
ALL TUBES	Plates, screens, and grids of ALL tubes.	Filter condenser No. 1, No. 2, or No. 3, R.F. plate-circuit by-pass, 1st stopping condenser, or 2nd stopping condenser.	Filter choke, 2nd-A.F. plate circuit, or R.F. plate circuit.
R.F. TUBES ONLY	R.F. screens and grid.	1st-R.F. screen by-pass, or 2nd-3rd-R.F. screen by-pass.	R.F.C. No. 2, or screen circuit.
	1st-R.F. grid.	1st-R.F. bias by-pass.*	1st-R.F. cathode circuit.
	2nd- and 3rd-R.F. grids.	R.F. bias by-pass.	2nd—3rd-R.F. cathode circuit.
DET. TUBE ONLY	Detector plate and grid.	Detector filter condenser, or "phone" condenser.	R.F.C. No. 1, or detector plate circuit.
	Detector grid.	Detector grid-circuit by-pass, or detector bias by-pass.**	Detector cathode circuit.
A.F. TUBES	1st-A.F. plate.	1st-A.F. filter condenser.***	1st-A.F. plate circuit.
	1st-A.F. grid.	(If the 1st-A.F. grid is positive, the detector-1st-A.F. coupling condenser may be shorted.)	1st-A.F. cathode circuit.
	2nd-A.F. grids.	2nd-A.F. bias by-pass.	2nd-A.F. grid circuit.

* With the switch at local, if the 1st-R.F. and the 2nd-A.F. grid bias is low, the compensating condenser may be shorted.
** If the detector grid is positive, the 3rd stopping condenser may be shorted.
*** If the 1st-A.F. filter condenser is shorted, the 1st-A.F. bias will be high.

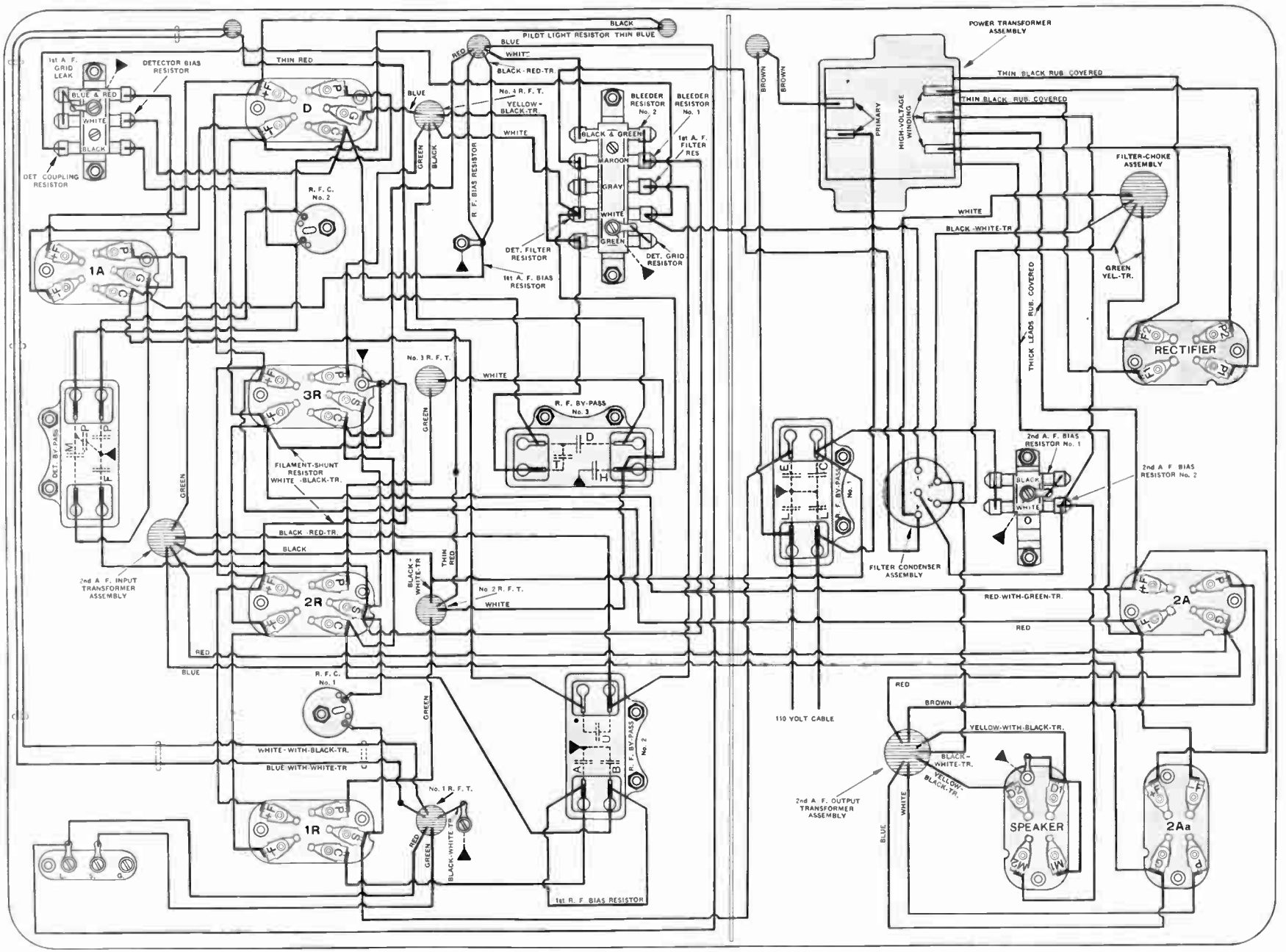


FIG. 205. BOTTOM WIRING OF THE 3RD TYPE OF MODEL 60-C (LATER STYLE).

In the 1st style of this model, the R.F. bias resistor, the 1st-R.F. bias resistor and the 1st-A.F. bias resistor are wire-wound on bakelite strips about 3 inches by 5/8 inch. In the 2nd style of this model, these resistors are replaced by "flexible" resistors which resemble ordinary insulated leads, except that each resistor has a die-cast or molded metal lug at each end. The identification of these resistors is as follows:—The R.F. bias resistor, No. 15830, is brown-with-white-diagonal-tracer. The 1st-R.F. bias resistor, No. 15810, is brown-with-white-straight-stripes; it has no chassis-lug. The 1st-A.F. bias resistor, No. 15820 is brown-with-white-straight-stripes; it has one chassis-lug. (Nos. 15810 and 15820 are electrically interchangeable.)

VOLTAGE TABLE FOR 3rd TYPE MODEL 60-C

Set in operation. Volume control at MINIMUM. Test in order listed. **(See Page 206.)**

Use 1000-ohm-per-volt D. C. Voltmeter (about 0-50-250) to Measure Plate and Grid Voltages. Use A. C. Voltmeter to Measure Filament Voltages.

CIRCUIT	MEASURE ACROSS	APPROX. VOLTAGE *		NO READING INDICATES
		110 V. Line	120 V. Line	
FILAMENT	—F to +F on each socket.	2.3	2.4	Open filament winding or connection.
	F1 to F2 on rectifier socket.	4.5	4.7	Open rectifier filament winding.
PLATE	C1R to P1R.	170	185	Open high voltage winding, filter choke, R.F.C. No. 3, 1st-R.F. bias resis., volume control resis. No. 2, R.F. bias resis., or speaker magnet coil.
	C1R to P2R, P3R.	170	185	Open R.F.C. No. 4, or R.F.C. No. 5.
	CD to PD.	119	130	Open detector filter resis., coupling resis., R.F.C. No. 1, or det. bias resis.
	C1A to P1A.	73	80	Open 1st-A.F. filter resis., primary of A.F. input transformer, or 1st-A.F. bias resis.
	—F2A to P2A, P2Aa.	224	250	Open primary of output transformer.
GRID	C1R to G1R (switch at distance).	16.5	18	Open secondary No. 1, R.F.T. or defective L-D sw.
	C2R to G2R, G3R.	16.5	18	Open secondary No. 2, No. 3 R.F.T.
	CD to GD.	1.5	1.8	Open secondary No. 4 R.F.T., or det. grid resis.
	C1A to G1A.	1.9	1.9	Open 1st-A.F. grid leak.
	—F2A to G2A, G2Aa.	36**	40**	Open 2nd-A.F. bias No. 2, or sec. of input trans.
	C1R to G1R (switch at local).	45	50	Open coupling coil, or defective L-D switch.
SCREEN	C1R to S3R, S2R, S1R.	142	155	Open bleeder resis. No. 1, or R.F.C. No. 2.

*These are the measured voltages, not the actual operating voltages. **If 2nd-A.F. bias resis. No. 1 is open, the grid voltage will be approx. 85.

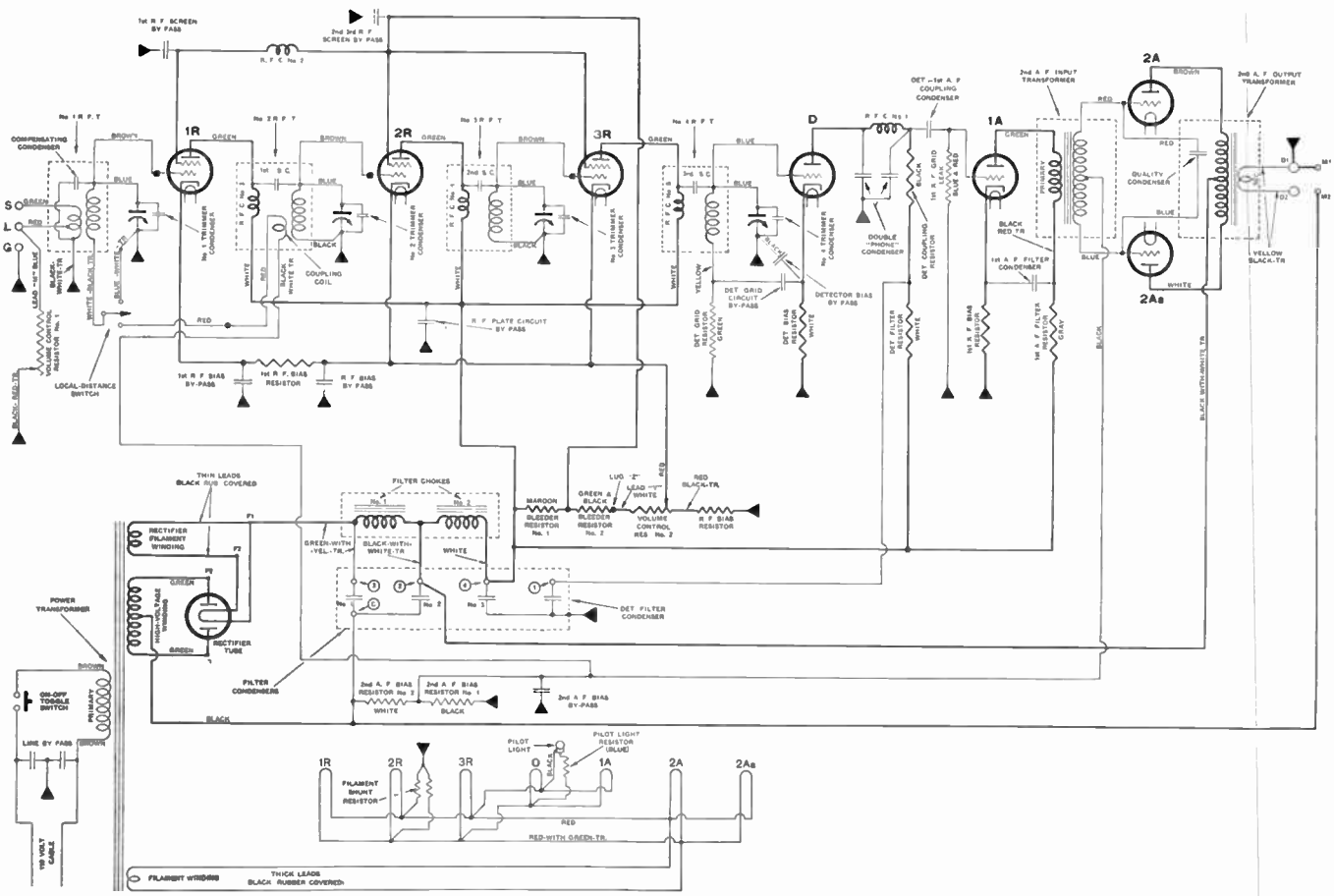


FIG. 206. DIAGRAM OF 3RD TYPE OF MODEL 60-C. "S.C." MEANS STOPPING CONDENSER. THIS DIAGRAM IS THE SAME AS FIG. 202.

May, 1930.

CONTINUITY TEST TABLE FOR 3rd TYPE MODEL 60-C

Unsolder leads "M" and "Y." Remove speaker and 110-V. plugs. Set volume control at minimum. Make tests in order listed. **(See Page 206.)**

	Test	Approx. Correct Reading	Wrong Reading Indicates
Test From F1 To	Contact No. 4 on condenser assembly.	2.2	None—Open No. 1 or 2 filter choke.
	P_1R, P_2R, P_3R.	2.2	None—Open R.F.C. No. 3, 4, or 5.
	S_2R, S_3R.	1.0	None—Open bleeder resistor No. 1.
	S_1R.	1.0	None—Open R.F.C. No. 2.
	Lug "Z."	0.2	None—Open bleeder resistor No. 2.
	PD.	0.1	None—Open detector filter resistor, coupling resistor, or R.F.C. No. 1.
	P_1A.	0.4	None—Open 1st-A.F. filter resistor, or primary of A.F. input transformer.
	P_2A, P_2Aa.	9	None—Open primary of A.F. output transformer.
Test From Chassis To	CD.	0.4	None—Open detector bias resistor.
	C_1A.	7.8	None—Open 1st-A.F. bias resistor.
	G_2A, G_2Aa.	0.2	None—Open secondary of A.F. input trans., or open 2nd-A.F. bias resis. No. 1.
	P_1, P_2.	0.2	None—Open 2nd-A.F. bias resis. No. 2, or open high-voltage winding.
	F_1.	None	Grounded filter chokes, or plate circuits (see page 206).
	Each side of 110-v. plug.	None	Full—Grounded primary circuit of power transformer.
	Each antenna post.	Full	None—Open primary No. 1 R.F.T.
	Lead "M."	1.5	None—Open volume control resis. No. 1. (Vol. control at max. for this test.)
	C_2R, C_3R.	2.3	None—Open R.F. bias resis., or open volume control resis. No. 2.
	C_1R.	2	None—Open 1st-R.F. bias resistor.
	Stator No. 2, 3 V.C.	Full	None—Open secondary No. 2, or 3 R.F.T.
	G_1A.	0.2	None—Open 1st-A.F. grid leak.
Other Tests	D_1 to D_2.	Full	None—Open secondary circuit A.F. output transformer.
	F_1 to F_2.	Full	None—Open rectifier filament winding.
	Across 110-volt plug.	Full	None—Open primary circuit of power transformer. (Pwr. switch "on.")
	GD to by-pass T.	Full	None—Open secondary No. 4 R.F.T.
	Stator No. 1 variable condenser to chassis.	Full (with switch at distance)	None—Open sec. No. 1 R.F.T. or open switch.
		0.2 (with switch at local)	None—Open coupling coil or switch.

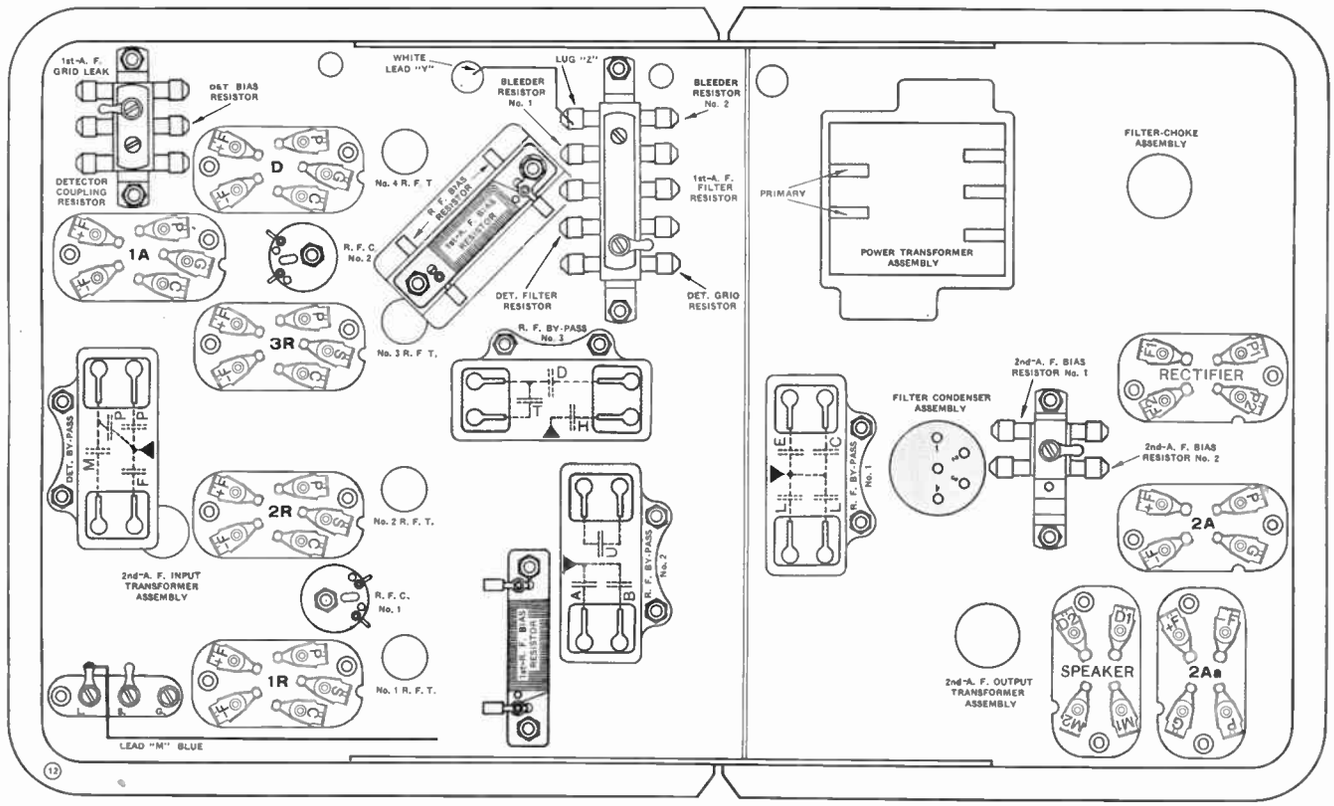


FIG. 207. TEST CHART FOR 3RD TYPE OF MODEL 60-C.

The 1st-R.F. bias resistor, the R.F. bias resistor, and the 1st.-A.F. bias resistor are of a different style in later types of this model. See Page 207.

DESCRIPTION OF THE VARIABLE-CONDENSER UNIT

The condenser group in the 3rd type of Model 60-C consists of four variable condensers and four adjustable "trimmer" condensers. One trimmer condenser is connected in parallel to each variable condenser.

The four stators, or groups of stationary plates, are insulated from each other and from the chassis. A blue lead is soldered to each stator.

The four rotors, or groups of rotary plates, are mounted on a common shaft. Each rotor is held in the correct position on the shaft by two set-screws. *The adjustment of the rotors on the shaft is made at the factory and must not be disturbed under any condition. Also, do not disturb the adjustment of the bearing screw at the rear end of the shaft.*

Four rotor-connection means provide electrical connection to the four rotors. A black lead is soldered to each rotor-connection.

A counter-weight is used to balance the weight of the rotors. The counter-weight does three things:

1. It balances the condenser shaft and thus eliminates any tendency that might otherwise exist for the shaft to turn away from a given dial setting.
2. By its balancing action, the counter-weight makes possible an extremely light and smooth adjustment of the control knob.
3. The counter-weight is limited in its motion by the pilot-light mounting bracket. This limits movement of the shaft between the positions of maximum and minimum capacity value, corresponding respectively to 100 and to zero on the dial.

If the counter-weight should require resetting, proceed as follows:—

1. Loosen the set-screws on the counter-weight.
2. Turn the shaft so the rotors are at maximum, with the straight edge of the rotor plates exactly even with the straight edge of the stator plates.
3. Hold the shaft in this position and turn the counter-weight so that it hits against the right-hand edge of the pilot-light bracket.
   The counter-weight should be about 1-16 inch away from the front edge of the condenser frame so that it will not scrape against the frame.
4. Tighten the counter-weight set-screws.
5. Turn the shaft in order to see that the counter-weight does not touch the frame of the condenser.

The dial and dial gear is arranged with the front side of the scale exactly flush with the front end of the shaft.

When the rotors are set at maximum, with the straight edge of the rotor plates exactly even with the straight edge of the stator plates, the dial should be set exactly at 100 with reference to the indicating point on the escutcheon.

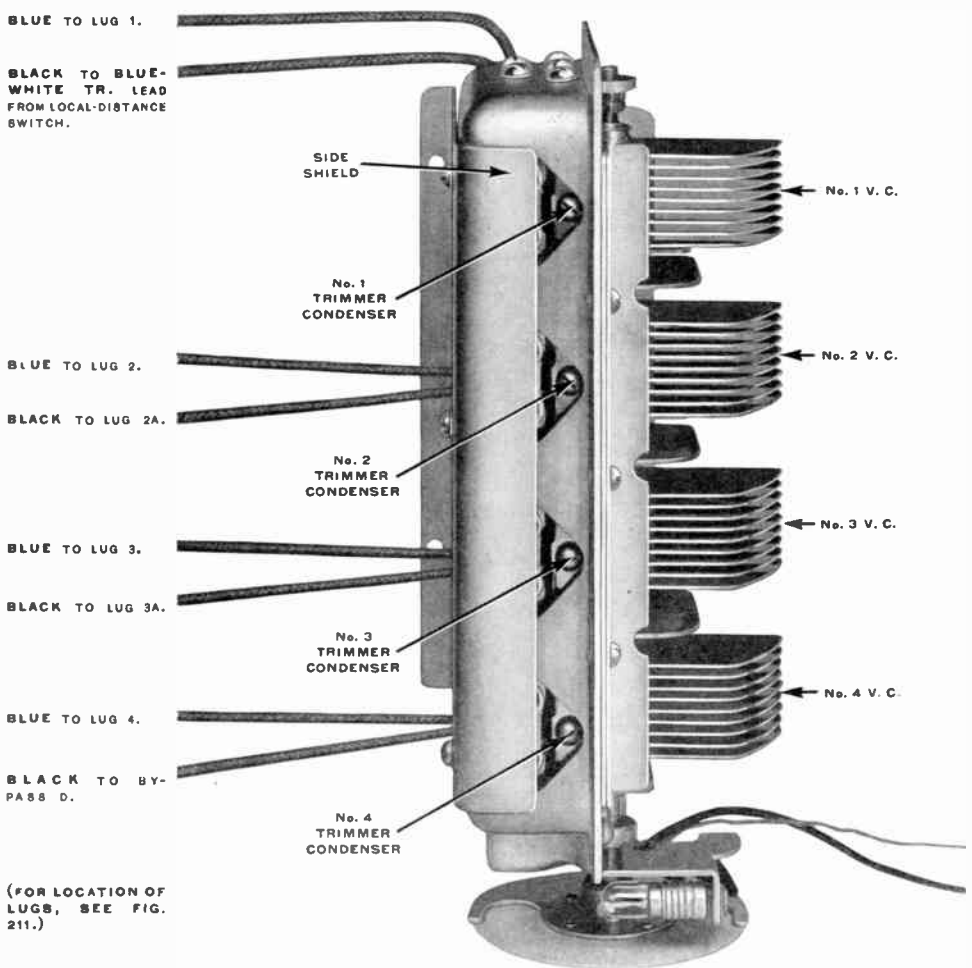


FIG. 208. VIEW OF VARIABLE CONDENSER UNIT

The front and rear bearings of the condenser shaft may be lubricated with "Nujol," and a light film of Nujol may be spread on the rotor-connections.

When handling the set, ALWAYS KEEP THE ROTOR PLATES TURNED INSIDE THE STATOR PLATES in order to prevent accidental bending of the rotor plates.

In order to synchronize the four R. F. circuits accurately at the high-frequency end of the broadcast range (below 10 on the dial) an independently-adjustable trimmer condenser of low value is connected in parallel to each of the four variable condensers.

Each trimmer condenser consists of two plates separated by a piece of mica. The value of each trimmer is regulated by the pressure of a screw which governs the distance between the two plates. The location of these screws is shown in Figure 208.

The adjusting screw on each trimmer condenser is sealed with wax at the factory, but this wax may be easily broken away from the screws when adjustment of the trimmer condensers is necessary.

Checking Sensitivity of Set

After inspecting, testing, and repairing a set, connect it for operation and measure the plate, grid, screen and filament voltages. If these voltages check satisfactorily, test the receiver on broadcast reception for sensitivity and output volume at different points on the dial.

Lack of sensitivity or volume at certain sections of the tuning dial may be a result of damage to one of the R. F. transformers, or to the variable-condenser unit. Damage to these parts will throw the tuned R. F. circuits out of synchronism.

The initial synchronism of the R. F. circuits is built into the set by rigid uniformity of the R. F. transformers, and by the extremely accurate design of the variable-condenser unit. Owing to the rugged construction of these parts, the built-in factory synchronism should remain constant indefinitely.

However, if through rough handling the R. F. transformers have been damaged, or the rotor plates of the variable-condenser unit have been bent out of their manufactured alignment, the defective part should be repaired or replaced.

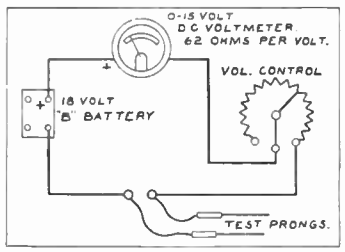


FIG. 209. DIAGRAM OF CONTINUITY TESTING CIRCUIT.

The voltage control is part No. 13320.

Equipment Required

When checking the sensitivity of the set, it is necessary to use an oscillator, and a meter to indicate maximum output volume.

A local oscillator is necessary to ensure constancy of signal strength; signals from broadcast stations are not sufficiently constant for this work.

An output meter is necessary to ensure a reliable indication of output volume; the ear is not reliable enough for this purpose.

The oscillator feeds a weak signal into the receiver. The signal is amplified in the receiver and produces a reading on a meter which is connected to the output of the set. This meter indicates the strength of output volume. The reading on the output meter is greatest when all the tuned circuits in the set are adjusted to the same frequency as the oscillator signal.

1. *Oscillator.*

The oscillator must provide modulated R. F. signals at four different frequencies in the broadcast range. *These four frequencies should correspond to dial settings of 5, 45, 65 and 95 on the dial of a 3rd type Model 60-C* ***which has the original factory synchronism.***

Each of the four R. F. oscillators should have an adjustable pick-up so that the strength of each oscillator may be controlled independently of the other three.

2. *Output Measuring Circuit.*

The output measuring circuit is shown and described in Figure 210.

Adjusting Trimmer Condensers

1. Connect the common pick-up lead from the four R. F. oscillators to one end of a No. 8112 condenser. Connect the other end of this condenser to the Long-Antenna post. Connect the oscillator container to the Ground post.
2. Put plug "A" of the output measuring circuit in the speaker-plug socket on the set. Plug an F-4 type speaker in socket "B." Throw switch "D" to the right.
3. Put all tubes in the set; power switch on; volume control at maximum; local-distance switch at distance. Break away the sealing wax on the trimmer-condenser screws
4. *Tune set exactly to 5 on dial.* Reduce or increase the amount of pick-up from the 1st oscillator to secure a reading of about 20 on the output meter.
5. With a screw-driver, turn the pressure screw of the 4th trimmer condenser one way or the other, as necessary, to the point where the reading on the output meter is greatest. Repeat this process on the 3rd trimmer, then on the 2nd, and finally on the 1st. Reduce the pick-up from the 1st oscillator if necessary in order to keep the needle of the galvanometer near the centre of its scale.

This adjustment of the trimmer-condenser screws is termed the CORRECT POSITION.

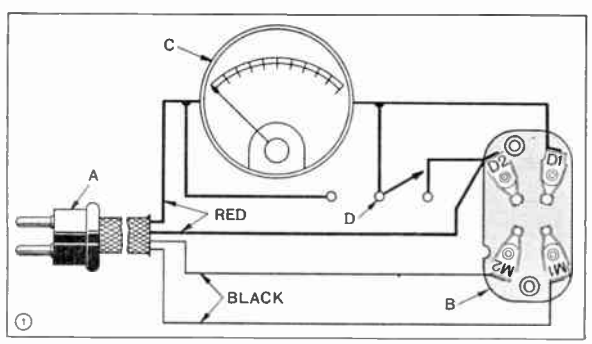
Fig. 210. Output Measuring Circuit for Electro-Dynamic Receivers.

A—Plug-and-cord No. 14537. This is to be inserted in the speaker-plug socket of set that is being tested.

B—Speaker-plug socket No. 17512. Insert plug of correct type of electro-dynamic speaker in this socket.

C—Thermo-coupled galvanometer (115 milliamperes). This meter gives an indication of the amount of A. F. current that is flowing through the voice-coil circuit.

D—Single-pole—double-throw toggle switch No. 13678. With this switch, either the voice coil or the galvanometer may be shorted out of the circuit.



THE CONNECTIONS SHOWN IN HEAVY LINES MUST BE SHORT AND OF LOW RESISTANCE.

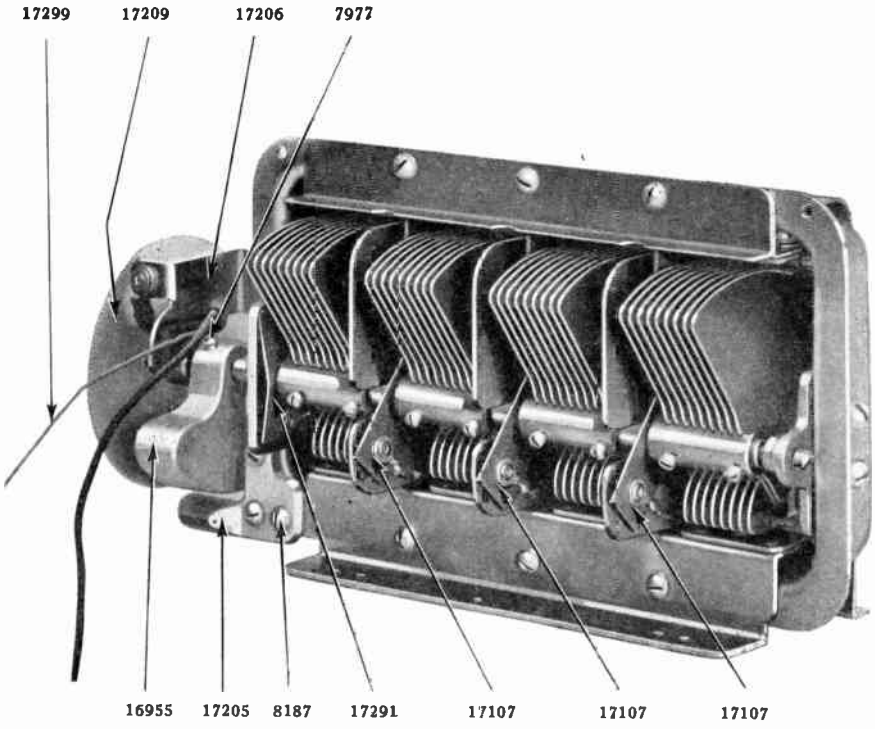


Fig. 211. (Above) View of Variable-Condenser Unit.

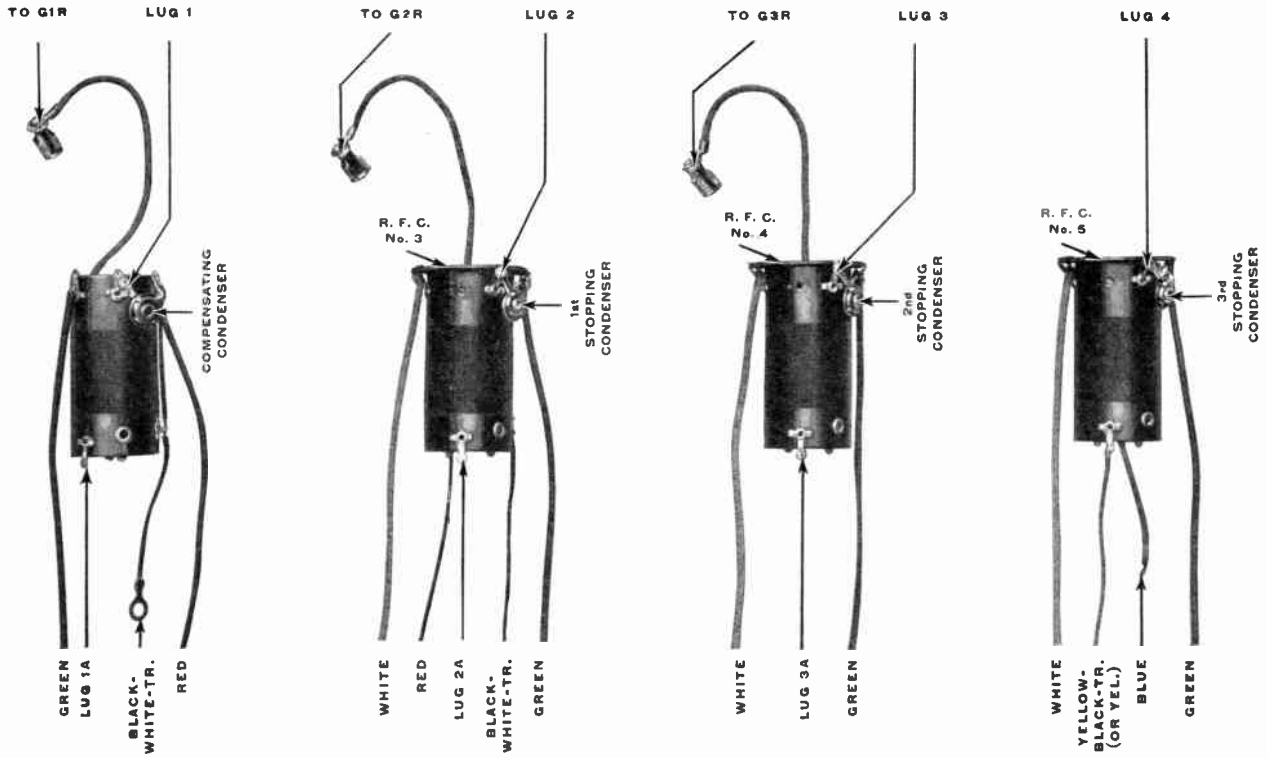
(See Pages 210 and 211 for further information.)

IMPORTANT—Do not disturb the adjustment of the rotor set-screws, nor the bearing-screw at the rear end of the shaft.

If any section of this unit is seriously damaged, the entire unit should be replaced.

Fig. 212. (Below) Coil Group, Showing Location of Parts and Connections of Leads.

If one R. F. coil, or R. F. C. No. 3, No. 4, or No. 5 is defective, the entire coil group must be replaced. If the compensating condenser or one of the stopping condensers is defective, it may be replaced without changing anything else.



No. 1 R.F.T.

Brown, with cap, to control-grid of 1R.
Green to S.
Red to L.
Black-white-tr. to chassis.
Connect **white-black tr.** lead from local-distance switch to lug 1A.
Connect **blue** lead from stator No. 1 V.C. to lug 1.
Connect **black** lead from rotor No. 1 V.C. to **blue-white-tr.** lead from local-distance switch.

No. 2 R.F.T.

Brown, with cap, to control-grid of 2R.
Green to P1R.
White to by-pass H.
Black-white-tr. to lead from by-pass C.
Red to lead of same color from local-distance switch.
Connect **blue** lead from stator No. 2 V.C., and **black** lead from rotor No. 2 V.C. to lugs 2 and 2A respectively.

No. 3 R.F.T.

Brown, with cap, to control grid of 3R.
Green to P2R.
White to by-pass H.
Connect **blue** lead from stator No. 3 V.C., and **black** lead from rotor No. 3 V.C. to lugs 3 and 3A respectively.

No. 4 R.F.T.

Blue, short, to GD.
Green to P3R.
White to left-hand end of detector filter resistor.
Yellow or yellow-black-tr. to left-hand end of detector grid-circuit resistor.
Connect **blue** lead from stator No. 4 V.C., to lug 4.
Connect **black** lead from rotor No. 4 V.C. to by-pass D.

PARTS AND PRICE LIST

MODEL 60-C, No. 15100, RECEIVING SET (SERIAL No. 5,670,001 to 5,684,000)

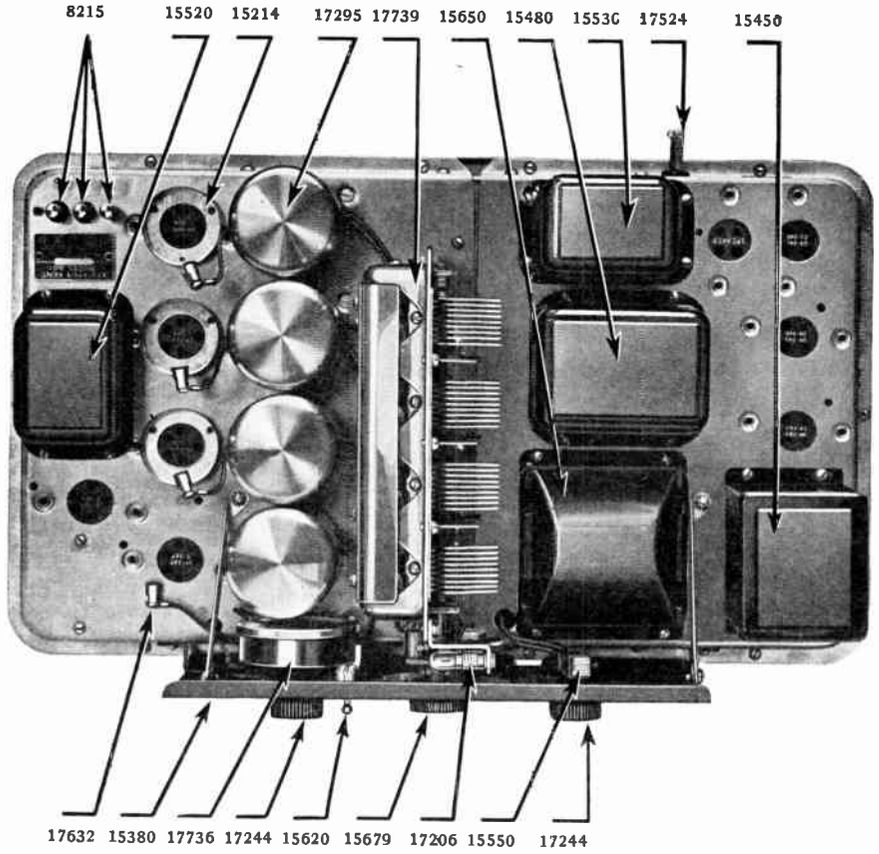


FIG. 213.
TOP VIEW.

FRONT PANEL ASSEMBLY

Part No.		*Price*
15380	Front panel only	$1.50
17224	Front-panel brace (2 used)	.10
17679	Rivets for panel braces	.01
16236	Escutcheon	.50
8272	Rivet for escutcheon	.02
17244	Volume-cont. or on-off switch knob	.30
15562	Set-screw	.50/c
15550	On-off switch complete	1.10
15620	Local-distance switch complete	.90
17736	Volume-control (less bracket)	3.70
17219	Volume-control bracket	.20
16576	Volume-control cover	.05
15679	Dial-knob assembly	.30
15678	Dial knob only	.25
15681	Dial-knob rubber	.02
15682	Dial-knob screw	.06

POWER UNITS

Part No.		*Price*
15450	Filter-choke assembly	$5.75
15331	Filter-choke lid	.20
15650	Power-transformer assembly	7.50
17268	Power-transformer cover	.50
17563	Power-trans. insulating sheet	.02
15480	Filter-condenser assembly	7.95
17429	Filter-condenser cover	.40
17534	Filter-condenser spacing pad	.25/c
17602	Red lead for filament circuit	.08
17603	Red-green-tracer lead for fil. circuit	.08

AUDIO-FREQUENCY TRANSFORMERS

Part No.		*Price*
15520	Input A. F. transformer	$3.75
15530	Output A. F. transformer	3.25

Part No.		*Price*
17739	VARIABLE-CONDENSER ASSEMBLY COMPLETE	$10.95
17738	VARIABLE-CONDENSER STATOR, ROTOR AND FRAME ASSEM. (With leads)	9.25
16955	Balance weight	.35
17209	Dial assembly	.60
17107	Rotor-connection (long)	.10
17291	Rotor-connection (short)	.10
15404	Pilot light	.25
17206	Pilot-light socket	.30
17299	Pilot-light resistor (blue)	.15
17205	Dial-knob bracket	.15

No separate parts, except those listed above, will be supplied for the variable-condenser unit.

COIL GROUP

Part No.		*Price*
17737	R. F. coil group	$4.00
15540	Stopping condenser (3 used)	.10
15540	Compensating condenser (1 used)	.10
17295	R. F. coil shield (4 used)	.50

If one R. F. coil, or R. F. C. No. 3, No. 4, or No. 5 is defective, the ENTIRE coil group must be replaced.

PARTS AND PRICE LIST (Cont'd)

MODEL 60-C, No. 15100, RECEIVING SET (SERIAL No. 5,670,001 to 5,684,000)

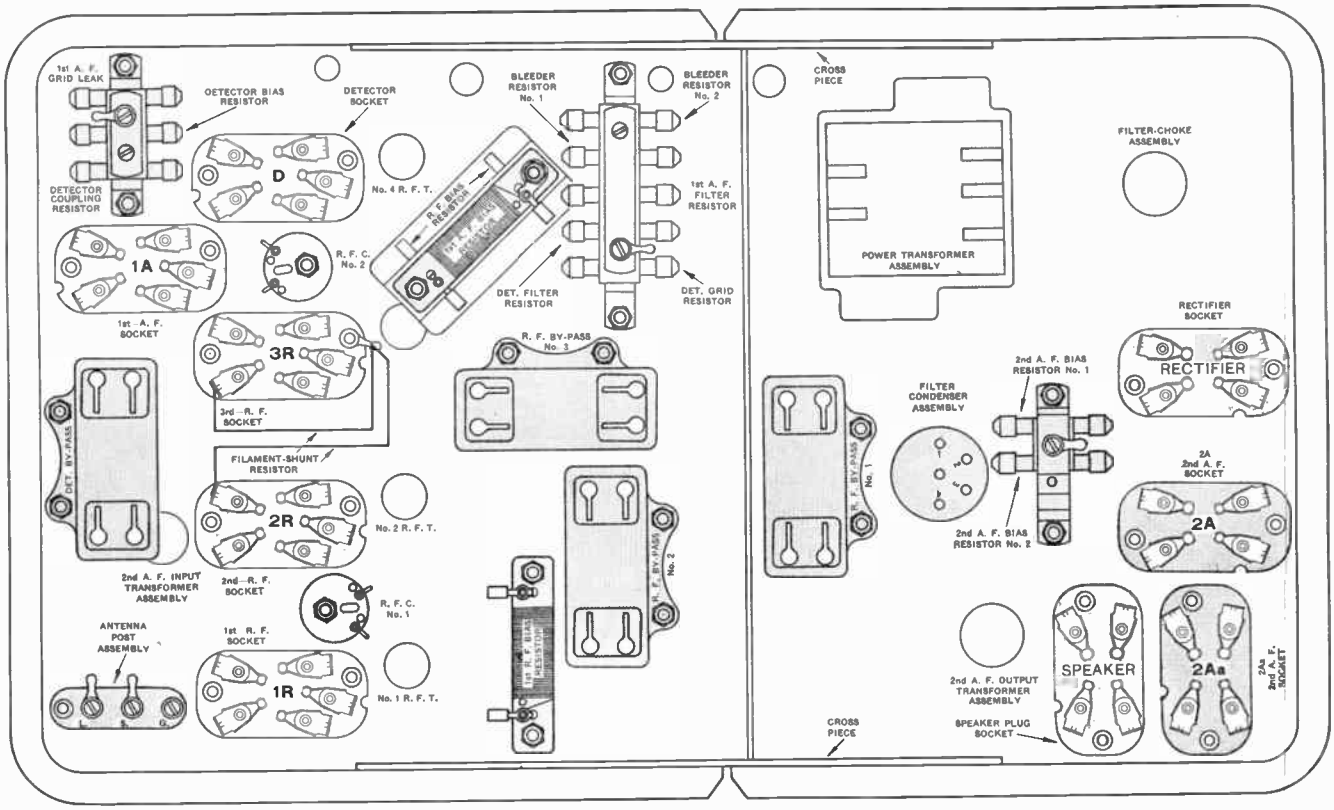


FIG. 214. BOTTOM VIEW. (See Page 216.)

TUBULAR RESISTORS
TWO-RESISTOR GROUP

Part No.		Price
15592	2nd-A.F. bias res. No. 1 (black)	$ .25
16724	2nd-A.F. bias res. No. 2 (white)	.25
17341	Mounting bracket	.05
17344	Fiber resistor pad	.25/c
17343	Metal clamping strip	.02

THREE-RESISTOR GROUP

Part No.		Price
16282	1st-A.F. grid leak (blue, or blue and red)	$ .25
16724	Detector bias resistor (white)	.25
15592	Detector coupling res. (black)	.25
17341	Mounting bracket	.05
17342	Fibre resistor pad	.25/c
17345	Metal clamping strip	.02

FIVE-RESISTOR GROUP

Part No.		Price
15545	Bleeder resistor No. 1 (maroon)	$ .25
17558	Bleeder res. No. 2 (black and green)	.25
15285	1st-A.F. filter resistor (gray)	.50
16724	Detector filter resistor (white)	.25
15892	Detector grid resistor (green)	.25
17118	Mounting bracket	.05
17117	Fibre pad	.25/c
17119	Metal clamping strip	.02

WIRE-WOUND RESISTORS

Part No.		Price
15720	R. F. bias res. (superseded by No. 15830)	
15670	1st-A.F. bias res. (superseded by No. 15820)	
15660	1st-R.F. bias res. (superseded by No. 15810)	
15830	R. F. bias res.	$ .15
15820	1st-A.F. bias res.	.15
15810	1st-R.F. bias res.	.15
17077	Filament-shunt res. (black-white-tr.)	.15
17299	Pilot-light resistor (blue)	.15
13306	Sheet-fiber insulator 1½" x 3"	.25/c
17232	Sheet-fiber insulator ¾" x 3"	.25/c
15271-A	R. F. CHOKE, No. 1, No. 2 (2 used)	$ .25

BY-PASS CONDENSERS

Part No.		Price
15790	R.F. by-pass No. 1 (H-18)	$1.00
15770	R.F. by-pass No. 2 (H-15)	1.00
15780	R.F. by-pass No. 3 (H-17)	1.10
15640	Detector by-pass (H-16)	1.00

SOCKETS

Part No.		Price
17518	R.F. socket (3 used)	$ .30
17519	Detector or 1st-A.F. socket	.30
17511	2Aa socket	.25
17509	2A socket	.25
17508	Rectifier socket	.25
17512	Speaker-plug socket	.25
17377	Socket insulator (fibre-sheet)	.25/c
8249	Socket-fastening eyelet	.50/c

PARTS AND PRICE LIST (Cont'd)

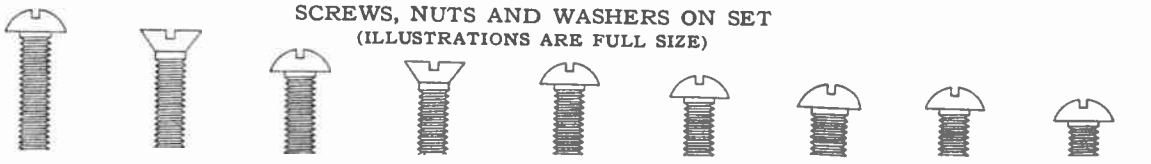
MODEL 60-C, No. 15100, RECEIVING SET (SERIAL No. 5,670,001 to 5,684,000)

MISCELLANEOUS PARTS

Part No.		Price
17524	110-volt cable, with plug	$1.90
8956	110-volt plug only	.30
16741	Insul. bushing for 110-volt cable	.05
16742	Bushing-retaining spring	.05
17521	Antenna binding posts and base	.45
8215	Binding post	.20
17536	Bottom plate	1.30
16508	Fibre wire - clamp	.50/c
13989	Ground-clamp assembly	.30

Part No.		Price
15213	Tube-shield (3 used)	$0.15
15214	Tube-shield base (3 used)	.03
17326	Detector cap	.30
15410	Literature assembly	.35 net
17332	Instruction book	.10 "
17527	Shipping container	.65 "
17223	Cross piece (10" x 7/8"—2 used)	.25
17632	Detector-cap lead (brown)	.10
———	Trimmer-condenser sealing wax	.50 lb.

SCREWS, NUTS AND WASHERS ON SET
(ILLUSTRATIONS ARE FULL SIZE)



Part No.	13052	16158	8221	15283	8187	9274	9209	7697	8106
Price	$0.30/c	$0.30/c	$0.30/c	$0.30/c	$0.30/c	$0.30/c	$0.35/c	$0.30/c	$0.30/c

Part No.	14687	7977	8220	17432	15643	17433	8188	9678
Price	$0.50/c	$0.50/c	$0.10/c	$0.50c	$0.30/c	$0.50/c	$0.01	$0.50/c

FIG. 215.

MODEL F-4-C, No. 14410, POWER SPEAKER (AFTER SERIAL No. 6,155,001)

Part No.		Price
17547	Cone-housing assembly	$2.60
17546	Terminal-card assembly	.20
7637	Mounting eyelets	.40/c
17392	Name plate	.25
9206	Mounting eyelets	.20/c
17551	Field coil only	8.00
17515	Field-coil insulator	.02
17552	Field-coil spacer	.09
17553	Top pole piece	2.75
17557	Diaphragm assembly	3.25
17556	Cable and plug assembly	1.65
15079	Plug	.65
13499	Cable clamp	.05
14382	Steel ring (3 segments)	1.00
15604	Instruction sheet	.02 net
15578	Shipping container	.35 "
14622	Voice-coil centering gauge (3 used)	.10 set

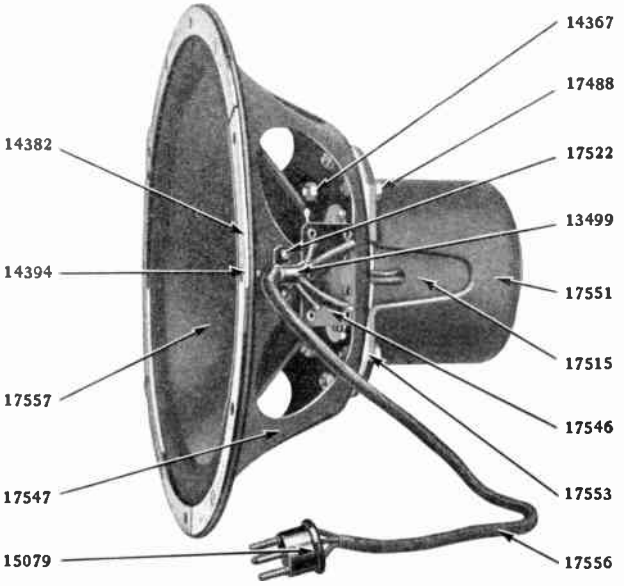
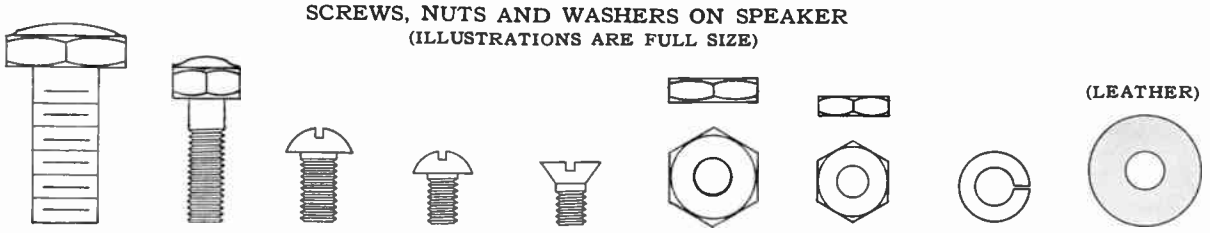


FIG. 216.

SCREWS, NUTS AND WASHERS ON SPEAKER
(ILLUSTRATIONS ARE FULL SIZE)



Part No.	15572	17488	14379	17522	14394	15133	14367	15643	15134
Price	$0.06	$0.03	$0.35/c	$0.30/c	$0.30/c	$0.04	$0.02	$0.30/c	$0.01

FIG. 217.