1932
Official Radio Service Manual

Vol. No. 2

Complete Directory
of all
1931-1932 Radio Receivers

Full Radio Service Guide

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TEXT INDEX

Circuits listed in italic type are in the 1931 issue of the Manual. Circuits listed in italic type, with the page number followed by an asterisk, are in the supplements to the 1931 Manual.*

Trade Name Index

INTRODUCTION

IN compiling the new 1932 edition of the OFFICIAL RADIO SERVICE MANUAL, the editors have been inspired by the tremendous interest shown by Service Men all over the country.

Of the first edition, a total of 38,000 copies have been sold, and many more thousands will be sold in the future for the reason that there is no duplication between the information published in the first issue and the material published in the 1932 issue, or subsequent volumes.

The thousands of letters filled with helpful suggestions, criticisms, and praise, have been all carefully read, and the many ideas which, in the opinion of the editors, would enhance the value of the new volume, have been included in the present Manual.

The editors take this occasion to thank all of their many friends for the letters submitted during the year.

The electrical circuits of the most modern types of receivers naturally take up the major portion of the Manual. Radio Service Men will, no doubt, appreciate the increased information about the resistance, capacity and voltage values, which is so essential today, when time-saving and accurate knowledge are such important considerations to the Service Man.

The inclusion of the graphs on the characteristics of the various types of tubes now standard in the market, we are certain, will interest all radio men. The heart of the modern radio receiver is the vacuum tube, and no one can afford to ignore this information, which has never before been available in such compact and usable form.

For the radio Service Man just starting in the field, the section devoted to "Analysis of a Typical Receiver" will be of extreme helpfulness. No single receiver on the market contains every important feature of interest to the Service Man; for that reason, the presentation of a hypothetical radio receiver was considered necessary. This receiver embraces the outstanding variations, sectionalized into the radio-frequency, detector, and audio-frequency circuits. The various types of power supplies, automatic volume controls, and remote controls receive sufficient treatment so that the underlying theory covering the function of the various components employed will be clearly understood.

A new section in the back of the book covers the circuits, with data, on sound-picture and public-address systems. This is in answer to the many inquiries on this subject.

While it is true that not every Service Man will have occasion to use such information, it often happens that he may be called in to service such apparatus, and then this information will prove invaluable.

It has been a source of great satisfaction to the editors to welcome the change of policy by the radio set manufacturers. Only a year ago, it was most difficult for the editors to procure all the available data on manufactured sets. This year, with practically no exception, set manufacturers have vied with each other to cooperate with the editors to make this Manual the outstanding one in print. The reason, of course, is that the set manufacturers realize today the great and growing importance of the Service Man who makes the actual, and often the only, personal contact with the set owner. Then, too, the opinion of the Service Man, as a rule, makes a lasting impression on the ultimate consumer as to the relative merits of a radio set or other radio equipment.

We will be pleased to receive suggestions and criticisms from the men in the field as to how this Manual can be further improved. This Manual has been created for the Service Man, and the editors naturally feel that he is the one who can best tell what would be necessary to enhance the value of the book to them.

It should be noted that there is not a line of duplication between the 1931 Manual and the present one. All the material published in the 1932 Manual is original, and new. It is the intention of the Publishers to bring out a new Manual every year, and every Manual will be new from start to finish.

To the radio set manufacturers and radio equipment manufacturers who have so generously furnished service data and information on their respective products, and to the thousands of well-wishers who have written in during the course of the year. we wish to extend our sincere thanks, with the hope that the present volume will be of growing usefulness to the radio industry, and particularly to the radio Service Man.

New York, October, 1931.

THE EDITORS.

ELEMENTARY RADIO SERVICING

FIRST PRINCIPLES

IT is not essential that we delve into the scientific reasons for various phenomena—merely that we gain a clear idea of the inter-relation of electrical units so that we may more readily picture what is going on behind the scenes in a radio receiver and attack our service problems in a sane manner.

Electrical quantities are expressed in *volts* or *amperes.* If we were to draw an analogy from hydraulics we might say that voltage corresponds to the water pressure in a pipe or tank expressed in pounds per square inch and that the amperage corresponds to the rate of flow through a pipe in gallons per minute. It is obvious that in order to force a large quantity of water through a small pipe in a given time a large pressure must be developed. If, for example, we were to block the flow of water by shutting a valve, the pressure would still remain—but the rate of flow would drop to zero—likewise, if we were to open the valve but slightly the pressure would still be the same but the rate of flow would be small. There is, therefore, some other factor which determines the rate of flow as compared with the pressure and this is the "resistance" of the pipe line.

RESISTANCE

One Ohm of resistance has been defined as the resistance of a circuit in which a pressure of one volt develops a rate of flow of one ampere. Calculations in circuits where the units are expressed in Ohms, Volts, and Amperes are dependent upon the simple relations laid down in Ohm's Law. Accordingly the following relations are evolved from the expression E=IR which means that the voltage (E) is equal to the Current in Amperes (I) times the resistance in Ohms (R):

$$E=IR$$
$$I=E/R$$
$$R=E/I$$

From these three equations we may determine the unknown quantity where two quantities are known. Example: Determine the resistance of a 201A filament when it is known that the current is .25-ampere when 5 volts are across the terminals. If R=E/I we must divide 5 by .25 and we obtain 20 ohms for our answer.

Example: A resistor of 20 ohms is connected across a 6-volt storage battery. What will be the current flow in amperes? If I=E/R we simply divide the value of the resistor in ohms into the voltage of the battery which is 6 volts thus: 6/20 equals .3-ampere, the current flowing in the circuit.

VOLTAGE DROP

There is a difference in voltage between any two points on a circuit having resistance and this difference is known as the Voltage Drop. The difference in voltage is determined by the resistance between the two points and the current flowing. If we desire to know the value of resistance to place in series with a 201A tube in order to operate its filament from a 6-volt battery we first determine the voltage drop required between the battery and the filament of the tube—namely, 1 volt. We therefore know the voltage (1 volt), the current (.25-ampere), and may find the resistance required by resorting to the equation once more that R=E/I and discover that the resistance must be 4 ohms.

COMBINATIONS OF RESISTANCES
RESISTANCES IN SERIES

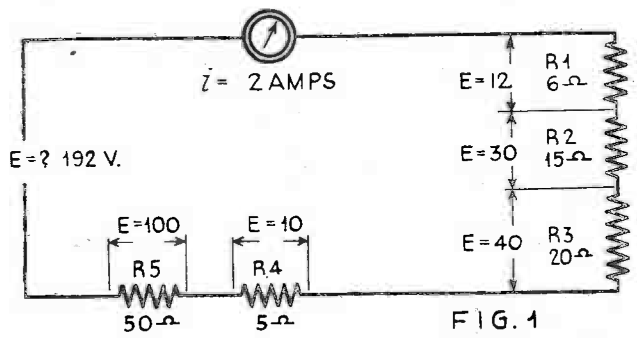


FIG. 1

If resistances are connected in series the total resistance is the sum of all the resistors in the circuit. See Fig. 1. Thus the equation may be written

$$R\ \text{eff.}=R_1+R_2+R_3+R_4+R_5\ \text{etc.}$$

It will be noted on examination of the diagram that in series circuits the current is the same through all of the resistors but that the voltage drop across the resistors depends upon the value of the individual resistor.

RESISTORS IN PARALLEL
EQUAL VALUES OF RESISTANCES IN PARALLEL

In many circuits there are combinations of resistors in parallel. That is to say, the current path is divided through two or more resistors. If the numerical values of the resistances are equal then the effective circuit resistance can be obtained from the following equation:

$$R\ eff = \frac{R}{N}$$

wherein R is the value of one of the resistors and N is the number of resistors in the circuit.
Example: There are 6 resistors in a circuit and they are in parallel. The resistance of each one is 12 ohms. Then by dividing by 6 we have the effective resistance which is 2 ohms.

The solution of equal values of resistance in parallel is an extremely simple operation but it must be remembered that the formula is useful only when the resistors are equal in value.

UNEQUAL VALUES OF RESISTANCES IN PARALLEL
(Two Resistors)

Many times we will come across resistances in parallel which are unequal in value. This is shown in Fig. 2. If there are but two resistances in the circuit as shown then we can use the following formula:

$$R\ eff. = \frac{R_1 \times R_2}{R_1 + R_2}$$

Example: We have two resistors of 5 and 10 ohms value, respectively. What is the effective value of resistance? 5 times 10 is 50; 5 plus 10 is 15; 50 divided by 15 gives us the effective value of resistance which

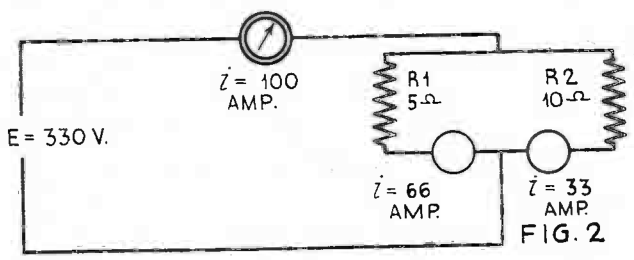


FIG. 2

is 3.3-ohms.

It will be noted in circuits with resistances in parallel that the same voltage will appear across the resistors but the current through the resistors will vary with the value of the individual resistor.

Mention should be made of the fact that when we have resistors of equal value in parallel that the current will be the same in all the resistors and that the same voltage will appear across all of the resistors.

UNEQUAL VALUES OF RESISTANCES IN PARALLEL
(Two or More Resistors)

Fig. 3 shows a circuit in which there are four resistors in parallel and unequal in value. In this

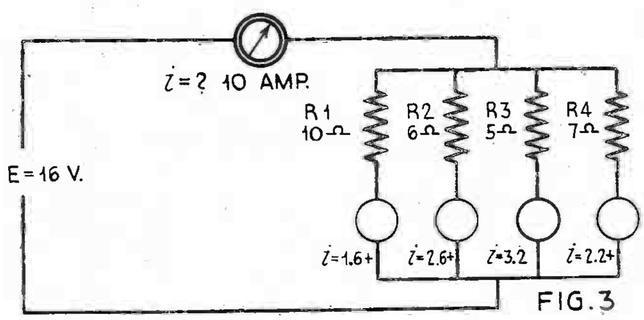


FIG. 3

case we would use the formula commonly known as the "Reciprocal of the sums of the reciprocals" Thus

$$R\ effective = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\ \text{etc.}}$$

$$\text{Substituting: } \frac{1}{\frac{1}{10} + \frac{1}{6} + \frac{1}{5} + \frac{1}{7}}$$

$$\text{Solving: } \frac{1}{10} = .1;\ \frac{1}{6} = .166;\ \frac{1}{5} = .2;\ \frac{1}{7} = .14$$

Adding: $.1 + .166 + .2 + .14 = .606.$

$$\text{Finding the reciprocal } \frac{1}{.606} = 1.6\text{-ohms effective.}$$

Proof: The sum of the currents in the branches of a parallel circuit will equal the total current flowing into the circuit. From examination of the circuit we find that the sum of the currents is 9.6 plus amperes. The answer would have come out exactly 10 amperes if we had carried the solution of the various reciprocals to more than four places beyond the decimal point.

The complete solution of a problem is carried out above so that any one desiring to do so can use it as a model to aid him in studying just how the formula is handled. The author has gone to some lengths here in the solution of the problem but his experience as an instructor of servicemen indicates that there is never enough said on this phase of the study of electrical circuits.

RESISTANCE NETWORKS WITH RESISTORS IN SERIES AND IN PARALLEL

Circuits often have combinations of resistors in series and in parallel. The solution of the effective value of resistance is obtained by breaking up the circuit into its local circuits, solving each portion consisting of parallel circuits and then resolving them into simple series circuits. Fig. 4 shows a circuit along with the values for the various resistors.

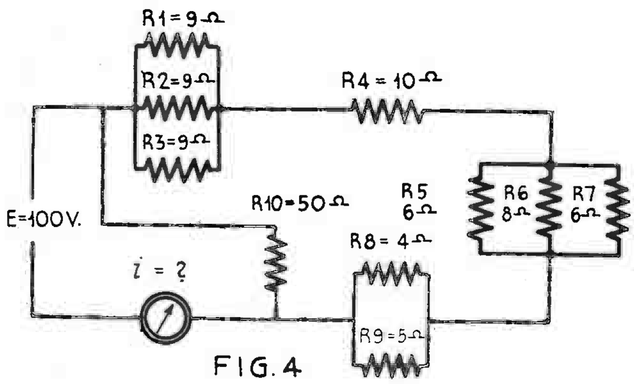


FIG. 4

Solution: The first thing to do is to solve all of the branch circuits.

Circuit R_1; R_2; R_3 has an effective resistance of 3 ohms.

Circuit R_5; R_6; R_7 has an effective resistance of 2.5-ohms.

Circuit R_8; R_9 has an effective resistance of 2.2-ohms.

As the above parallel circuits are in series with resistor R_4 we find the effective value of resistance by adding 10, 3, 2.5, and 2.2 together. This totals 17.7-ohms.

Resistor R_{10} is connected across the voltage supply and the effective value of the resistance network R_1 to R_9 is in turn connected across R_{10}. Thus R_{10} is in parallel to the 17.7-ohm resistance of the network.

Solving for parallel circuits $50 \times 17.7/50+17.7$ we have the effective total circuit resistance of 12.8-ohms.

Knowing that the voltage applied is 100 volts and the effective resistance is 12.8-ohms and using the rule "I" equals "E" over "R"; then 100 divided by 12.8 is 7.8 or the current flowing in the circuit.

CONDUCTANCE

It seems peculiar that we have dealt with resistances when in reality the thing that we require of any portion of an electrical circuit is conductance—*the ability* and not *the inability* with which it carries electricity is the important factor. The unit of Conductance is the Mho and the Conductance of a circuit is

$$G=1/R.$$

It is thus that a Resistance of 2 ohms has a conductance of ½ Mho. In operating upon parallel circuits it is much simpler to employ conductances in our calculations so as to avoid the many reciprocal factors involved. This may be seen readily from the comparison of the two equations

$$R.\ eff.=\frac{1}{1/R_1+1/R_2+1/R_3}$$

$$G\ eff.=G_1+G_2+G_3$$

POWER

The power consumed in a circuit is equal to the product of the voltage and the current thus

$$P\ (watts)=E \times I$$

or it may be expressed by the product of the current squared and the resistance

$$P=I^2R$$

This latter relation is useful in determining the power rating requirements of a resistor. Thus a resistance of 10 ohms having a current of 2 amperes flowing through it must be rated at 40 watts at least if overheating is to be avoided.

ALTERNATING CURRENTS

A Direct Current has a definite polarity—that is the current flow is always in one direction. Alternating currents are employed commercially because of economies which can be gained in the transmission of current over long distances. An alternating current has its polarity or direction of flow constantly changing. The frequency of the current is determined by the time required for each complete alternation or change of direction. In Fig. 5 this is shown

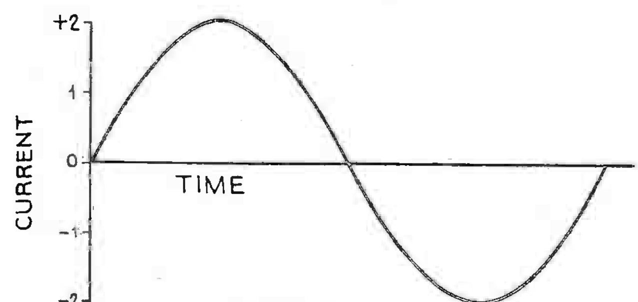


FIG. 5

graphically and it may be seen that over a period of time equal to 1/60th second corresponding to a 60 cycle current the current direction starts at zero—rises to a maximum positive value of 2 amperes—falls to zero again and passes through a maximum negative value of 2 amperes to return to a zero again.

The peak or maximum value is seen to be 2 amperes—but the effective value is not 2 amperes but the "root mean square" or r.m.s. value which is the value read from an alternating current meter in the circuit. This value is calculated from the maximum value by the equation

$$I_{r.m.s.}=I_{peak} \times .707 \text{ or conversely}$$

$$I_{peak}=I_{r.m.s.} \times 1.414$$

How these factors are arrived at is immaterial to our purposes. The voltage in A.C. circuits will follow exactly the same laws and the Ohm's Law for alternating currents is expressed by

$$E=IZ$$

IMPEDANCE AND REACTANCE

The alternating counterpart of Resistance is the Impedance (Z), which is the effective resistance of the circuit. "Z" is the resultant effect of pure resistance, capacitance, and inductance in a circuit. The effect of inducance or capacitance alone in a circuit is "X", the Reactance.

The reactance of a circuit is dependent upon the frequency of the alternating current flowing and the reactance of a condenser is equal to

$$Xc = \frac{1000000}{6.28\ f\ C}\ \text{Ohms.}$$

Condenser Capacity in Mfds.	Reactance in Ohms at Various Frequencies							
	60	100	250	500	1000	10,000	100,000	1,000,000
0.001	2666000	1600000	640000	320000	160000	16000	1600	160
0.005	533200	320000	128000	64000	32000	3200	320	32
0.01	266600	160000	64000	32000	16000	1600	160	16
0.1	26660	16000	6400	3200	1600	160	16	1.6
0.5	5332	3200	1280	640	320	32	3.2	.32
1.0	2666	1600	640	320	160	16	1.6	0.16
2.0	1333	800	320	160	80	8	0.8	0.08
4.0	666	400	160	80	40	4	0.4	0.04
8.0	333	200	80	40	20	2	0.2	0.02
10.0	267	160	64	32	16	1.6	0.16	0.016

FIG 6

From examination of the chart in Fig. 6 it may be seen that the reactance decreases with increasing frequency. The capacity in the above formula is stated in microfarads.

The reactance of an inductance is determined by the equation

$$X_1 = 6.28\ f\ L\ \text{Ohms.}$$

Coil Inductance in Henries	Reactance in Ohms at Various Frequencies						
	60	100	250	500	1000	10,000	100,000
0.01	3.77	6.28	15.7	31.4	62.8	628	6,280
0.05	18.8	31.4	78.5	157	314	3,140	31,400
0.1	37.7	62.8	157	314	628	6,280	62,800
0.5	188.5	314	785	1,570	3,140	31,400	314,000
1.0	377	628	1,570	3,140	6,280	62,800	628,000
2.0	754	1,256	3,140	6,280	12,560	125,600	1,256,000
5.0	1,885	3,140	7,850	15,700	31,400	314,000	3,140,000
10.0	3,770	6,280	15,700	31,400	62,800	628,000	6,280,000
20.0	7,540	12,360	31,400	62,800	123,600	1,236,000	12,360,000
30.0	11,310	18,840	47,200	94,200	188,400	1,884,000	18,840,000
40.0	15,080	24,720	61,800	123,600	247,200	2,472,000	24,720,000
50.0	18,850	31,400	78,500	157,000	314,000	3,140,000	31,400,000
100.0	37,700	62,800	157,000	314,000	628,000	6,280,000	62,800,000

FIG 7

That the reactance of the inducance increases with the increase in frequency is apparent from Fig. 7. This is an important point to keep in mind. In the above equation L is in henries.

Inductive and capacitative reactances differ in their relative effects upon the circuits in which they occur and a combination of the two has an effect determined by the equation.

$$X = X_L - X_C$$

Circuits containing both Reactance and Resistance—and no circuit can be said to be purely reactive with no resistance effects—have an effective resistance noted as their impedance (Z) and the equation for this quantity is

$$Z = \sqrt{R^2 + (X_1 - Xc)^2}$$

Such a quantity is known as the "square root of the sum of the squares."

RESONANCE

You may already have asked yourselves what would happen if the reactance due to inductance were equal to that due to capacitance and you may have answered the question in a manner satisfactory to yourself—that the resistance of the circuit alone would remain. In a measure this would be correct —but in an important sense it would fail.

When a circuit is tuned to resonance the two reactances are equal and cancel and the frequency at which any combination achieves this condition may be determined from the equation

$$f = \frac{1}{\sqrt{L \times C}}$$

where f is the frequency in cycles per second, L the inductance of the coil measured in a unit termed the "henry", and C the capacitance of the condenser measured in a unit termed the "farad." In radio work it is more convenient to speak of a smaller unit than the "henry," thus a unit known as the "microhenry," or μ h, is used, one million of which when added together make a henry. It is also more convenient to speak of a smaller unit than the farad, known as the "microfarad," or mf., thus a unit is used, one million of which when added together make a farad. The formula just quoted then becomes

$$f = \frac{159{,}200}{\sqrt{L \text{ in microhenries} \times C \text{ in microfarads}}}\ \text{c.p.s.}$$

As an example, a coil having an inductance of 203 microhenries is tuned with a condenser set at 0.0005-microfarad. To what frequency does the combination tune?

$$f = \frac{159{,}200}{\sqrt{203 \times 0.0005}}\ \text{c.p.s.}$$
$$= 500{,}000.$$

Instead of saying "five hundred thousand cycles per second," the term five hundred kilocycles is often used. A "kilocycle" (abbreviated "kc.") is one thousand cycles.

Sometimes the term "wavelength" symbolized by the Greek letter λ (lambda) is used in place of the term frequency, and vice versa. In the case of an electric wave sent through free space, its velocity is constant, and is equal to that of light. The product of the wavelength and the frequency equals this velocity, for the wavelength is the distance a given point in the wave travels during one cycle, or

$$\lambda \times f = 299{,}800{,}000 \text{ meters per second}$$

or (very nearly) 300,000,000

where is the wavelength measured in meters and f is the frequency in cycles per second. Thus if it is desired to know the wavelength of a radio wave of a frequency of 500,000 c.p.s.

$$= \frac{300{,}000{,}000}{f} = \frac{300{,}000{,}000}{500{,}000} = 600 \text{ meters}$$

Instead of calculating the wavelength every time it is necessary, the chart shown in Fig. 8 may be referred to.

In circuits consisting of Inductance, Capacitance, and Resistance in a series combination such as is shown in Fig. 9, the term within the parenthesis in the equation

KILOCYCLES (kc) TO METERS (m), OR METERS TO KILOCYCLES

[COLUMNS ARE INTERCHANGEABLE]

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29,982	1,010	296.9	2,010	149.2	3,010	99.61	4,010	74.77	5,010	59.84	6,010	49.89	7,010	42.77	8,010	37.43	9,010	33.28
20	14,991	1,020	293.9	2,020	148.4	3,020	99.28	4,020	74.58	5,020	59.73	6,020	49.80	7,020	42.71	8,020	37.38	9,020	33.24
30	9,994	1,030	291.1	2,030	147.7	3,030	98.95	4,030	74.40	5,030	59.61	6,030	49.72	7,030	42.65	8,030	37.34	9,030	33.20
40	7,496	1,040	288.3	2,040	147.0	3,040	98.62	4,040	74.21	5,040	59.49	6,040	49.64	7,040	42.59	8,040	37.29	9,040	33.17
50	5,996	1,050	285.5	2,050	146.3	3,050	98.30	4,050	74.03	5,050	59.37	6,050	49.56	7,050	42.53	8,050	37.24	9,050	33.13
60	4,997	1,060	282.8	2,060	145.5	3,060	97.98	4,060	73.85	5,060	59.25	6,060	49.48	7,060	42.47	8,060	37.20	9,060	33.09
70	4,283	1,070	280.2	2,070	144.8	3,070	97.66	4,070	73.67	5,070	59.13	6,070	49.39	7,070	42.41	8,070	37.15	9,070	33.06
80	3,748	1,080	277.6	2,080	144.1	3,080	97.34	4,080	73.49	5,080	59.02	6,080	49.31	7,080	42.35	8,080	37.11	9,080	33.02
90	3,331	1,090	275.1	2,090	143.5	3,090	97.03	4,090	73.31	5,090	58.90	6,090	49.23	7,090	42.29	8,090	37.06	9,090	32.98
100	2,998	1,100	272.6	2,100	142.8	3,100	96.72	4,100	73.13	5,100	58.79	6,100	49.15	7,100	42.23	8,100	37.01	9,100	32.95
110	2,726	1,110	270.1	2,110	142.1	3,110	96.41	4,110	72.95	5,110	58.67	6,110	49.07	7,110	42.17	8,110	36.97	9,110	32.91
120	2,499	1,120	267.7	2,120	141.4	3,120	96.10	4,120	72.77	5,120	58.56	6,120	48.99	7,120	42.11	8,120	36.92	9,120	32.88
130	2,306	1,130	265.3	2,130	140.8	3,130	95.79	4,130	72.60	5,130	58.44	6,130	48.91	7,130	42.05	8,130	36.88	9,130	32.84
140	2,142	1,140	263.0	2,140	140.1	3,140	95.48	4,140	72.42	5,140	58.33	6,140	48.83	7,140	41.99	8,140	36.83	9,140	32.80
150	1,999	1,150	260.7	2,150	139.5	3,150	95.18	4,150	72.25	5,150	58.22	6,150	48.75	7,150	41.93	8,150	36.79	9,150	32.77
160	1,874	1,160	258.5	2,160	138.8	3,160	94.88	4,160	72.07	5,160	58.10	6,160	48.67	7,160	41.87	8,160	36.74	9,160	32.73
170	1,764	1,170	256.3	2,170	138.1	3,170	94.58	4,170	71.90	5,170	57.99	6,170	48.59	7,170	41.82	8,170	36.70	9,170	32.70
180	1,666	1,180	254.1	2,180	137.5	3,180	94.28	4,180	71.73	5,180	57.88	6,180	48.51	7,180	41.76	8,180	36.65	9,180	32.66
190	1,578	1,190	252.0	2,190	136.9	3,190	93.99	4,190	71.56	5,190	57.77	6,190	48.44	7,190	41.70	8,190	36.61	9,190	32.62
200	1,499	1,200	249.9	2,200	136.3	3,200	93.69	4,200	71.39	5,200	57.66	6,200	48.36	7,200	41.64	8,200	36.56	9,200	32.59
210	1,428	1,210	247.8	2,210	135.7	3,210	93.40	4,210	71.22	5,210	57.55	6,210	48.28	7,210	41.58	8,210	36.52	9,210	32.55
220	1,363	1,220	245.8	2,220	135.1	3,220	93.11	4,220	71.05	5,220	57.44	6,220	48.20	7,220	41.53	8,220	36.47	9,220	32.52
230	1,304	1,230	243.8	2,230	134.4	3,230	92.82	4,230	70.88	5,230	57.33	6,230	48.13	7,230	41.47	8,230	36.43	9,230	32.48
240	1,249	1,240	241.8	2,240	133.8	3,240	92.54	4,240	70.71	5,240	57.22	6,240	48.05	7,240	41.41	8,240	36.39	9,240	32.45
250	1,199	1,250	239.9	2,250	133.3	3,250	92.25	4,250	70.55	5,250	57.11	6,250	47.97	7,250	41.35	8,250	36.34	9,250	32.41
260	1,153	1,260	238.0	2,260	132.7	3,260	91.97	4,260	70.38	5,260	57.00	6,260	47.89	7,260	41.30	8,260	36.30	9,260	32.38
270	1,110	1,270	236.1	2,270	132.1	3,270	91.69	4,270	70.22	5,270	56.89	6,270	47.82	7,270	41.24	8,270	36.25	9,270	32.34
280	1,071	1,280	234.2	2,280	131.5	3,280	91.41	4,280	70.05	5,280	56.78	6,280	47.74	7,280	41.18	8,280	36.21	9,280	32.31
290	1,034	1,290	232.4	2,290	130.9	3,290	91.13	4,290	69.89	5,290	56.68	6,290	47.67	7,290	41.13	8,290	36.17	9,290	32.27
300	999.4	1,300	230.6	2,300	130.4	3,300	90.86	4,300	69.73	5,300	56.57	6,300	47.59	7,300	41.07	8,300	36.12	9,300	32.24
310	967.2	1,310	228.9	2,310	129.8	3,310	90.58	4,310	69.56	5,310	56.46	6,310	47.52	7,310	41.02	8,310	36.08	9,310	32.20
320	936.9	1,320	227.1	2,320	129.2	3,320	90.31	4,320	69.40	5,320	56.36	6,320	47.44	7,320	40.96	8,320	36.04	9,320	32.17
330	908.6	1,330	225.4	2,330	128.7	3,330	90.04	4,330	69.24	5,330	56.25	6,330	47.36	7,330	40.90	8,330	35.99	9,330	32.14
340	881.8	1,340	223.7	2,340	128.1	3,340	89.77	4,340	69.08	5,340	55.15	6,340	47.29	7,340	40.85	8,340	35.95	9,340	32.10
350	856.6	1,350	222.1	2,350	127.6	3,350	89.50	4,350	68.92	5,350	56.04	6,350	47.22	7,350	40.79	8,350	35.91	9,350	32.07
360	832.8	1,360	220.4	2,360	127.0	3,360	89.23	4,360	68.77	5,360	55.94	6,360	47.14	7,360	40.74	8,360	35.86	9,360	32.03
370	810.3	1,370	218.8	2,370	126.5	3,370	88.97	4,370	68.61	5,370	55.83	6,370	47.07	7,370	40.68	8,370	35.82	9,370	32.00
380	789.0	1,380	217.3	2,380	126.0	3,380	88.70	4,380	68.45	5,380	55.73	6,380	46.99	7,380	40.63	8,380	35.78	9,380	31.96
390	768.8	1,390	215.7	2,390	125.4	3,390	88.44	4,390	68.30	5,390	55.63	6,390	46.92	7,390	40.57	8,390	35.74	9,390	31.93
400	749.6	1,400	214.2	2,400	124.9	3,400	88.18	4,400	68.14	5,400	55.52	6,400	46.85	7,400	40.52	8,400	35.69	9,400	31.90
410	731.3	1,410	212.6	2,410	124.4	3,410	87.92	4,410	67.99	5,410	55.42	6,410	46.77	7,410	40.46	8,410	35.65	9,410	31.86
420	713.9	1,420	211.1	2,420	123.9	3,420	87.67	4,420	67.83	5,420	55.32	6,420	46.70	7,420	40.41	8,420	35.61	9,420	31.83
430	697.3	1,430	209.7	2,430	123.4	3,430	87.41	4,430	67.68	5,430	55.22	6,430	46.63	7,430	40.35	8,430	35.57	9,430	31.79
440	681.4	1,440	208.2	2,440	122.9	3,440	87.16	4,440	67.53	5,440	55.11	6,440	46.56	7,440	40.30	8,440	35.52	9,440	31.76
450	666.3	1,450	206.8	2,450	122.4	3,450	86.90	4,450	67.38	5,450	55.01	6,450	46.48	7,450	40.24	8,450	35.48	9,450	31.73
460	651.8	1,460	205.4	2,460	121.9	3,460	86.65	4,460	67.22	5,460	54.91	6,460	46.41	7,460	40.19	8,460	35.44	9,460	31.69
470	637.9	1,470	204.0	2,470	121.4	3,470	86.40	4,470	67.07	5,470	54.81	6,470	46.34	7,470	40.14	8,470	35.40	9,470	31.66
480	624.6	1,480	202.6	2,480	120.9	3,480	86.16	4,480	66.92	5,480	54.71	6,480	46.27	7,480	40.08	8,480	35.36	9,480	31.63
490	611.9	1,490	201.2	2,490	120.4	3,490	85.91	4,490	66.78	5,490	54.61	6,490	46.20	7,490	40.03	8,490	35.31	9,490	31.59
500	599.6	1,500	199.9	2,500	119.9	3,500	85.66	4,500	66.63	5,500	54.51	6,500	46.13	7,500	39.98	8,500	35.27	9,500	31.56
510	587.9	1,510	198.6	2,510	119.5	3,510	85.42	4,510	66.48	5,510	54.41	6,510	46.06	7,510	39.92	8,510	35.23	9,510	31.53
520	576.6	1,520	197.2	2,520	119.0	3,520	85.18	4,520	66.33	5,520	54.32	6,520	45.98	7,520	39.87	8,520	35.19	9,520	31.49
530	565.7	1,530	196.0	2,530	118.5	3,530	84.94	4,530	66.19	5,530	54.22	6,530	45.91	7,530	39.82	8,530	35.15	9,530	31.46
540	555.2	1,540	194.7	2,540	118.0	3,540	84.70	4,540	66.04	5,540	54.12	6,540	45.84	7,540	39.76	8,540	35.11	9,540	31.43
550	545.1	1,550	193.4	2,550	117.6	3,550	84.46	4,550	65.89	5,550	54.02	6,550	45.77	7,550	39.71	8,550	35.07	9,550	31.39
560	535.4	1,560	192.2	2,560	117.1	3,560	84.22	4,560	65.75	5,560	53.92	6,560	45.70	7,560	39.66	8,560	35.03	9,560	31.36
570	526.0	1,570	191.0	2,570	116.7	3,570	83.98	4,570	65.61	5,570	53.83	6,570	45.63	7,570	39.61	8,570	34.98	9,570	31.33
580	516.9	1,580	189.8	2,580	116.2	3,580	83.75	4,580	65.46	5,580	53.73	6,580	45.57	7,580	39.55	8,580	34.94	9,580	31.30
590	508.2	1,590	188.6	2,590	115.8	3,590	83.52	4,590	65.32	5,590	53.64	6,590	45.50	7,590	39.50	8,590	34.90	9,590	31.26
600	499.7	1,600	187.4	2,600	115.3	3,600	83.28	4,600	65.18	5,600	53.54	6,600	45.43	7,600	39.45	8,600	34.86	9,600	31.23
610	491.5	1,610	186.2	2,610	114.9	3,610	83.05	4,610	65.04	5,610	53.44	6,610	45.36	7,610	39.40	8,610	34.82	9,610	31.20
620	483.6	1,620	185.1	2,620	114.4	3,620	82.82	4,620	64.90	5,620	53.35	6,620	45.29	7,620	39.35	8,620	34.78	9,620	31.17
630	475.9	1,630	183.9	2,630	114.0	3,630	82.60	4,630	64.76	5,630	53.25	6,630	45.22	7,630	39.29	8,630	34.74	9,630	31.13
640	468.5	1,640	182.8	2,640	113.6	3,640	82.37	4,640	64.62	5,640	53.16	6,640	45.15	7,640	39.24	8,640	34.70	9,640	31.10
650	461.3	1,650	181.7	2,650	113.1	3,650	82.14	4,650	64.48	5,650	53.07	6,650	45.09	7,650	39.19	8,650	34.66	9,650	31.07
660	454.3	1,660	180.6	2,660	112.7	3,660	81.92	4,660	64.34	5,660	52.97	6,660	45.02	7,650	39.14	8,650	34.62	9,660	31.04
670	447.5	1,670	179.5	2,670	112.3	3,670	81.70	4,670	64.20	5,670	52.88	6,670	44.95	7,670	39.09	8,670	34.58	9,670	31.01
680	440.9	1,680	178.5	2,680	111.9	3,680	81.47	4,680	64.06	5,680	52.79	6,680	44.88	7,680	39.04	8,680	34.54	9,680	30.97
690	434.5	1,690	177.4	2,690	111.5	3,690	81.25	4,690	63.93	5,690	52.69	6,690	44.82	7,690	38.99	8,690	34.50	9,690	30.94
700	428.3	1,700	176.4	2,700	111.0	3,700	81.03	4,700	63.79	5,700	52.60	6,700	44.75	7,700	38.94	8,700	34.46	9,700	30.91
710	422.3	1,710	175.3	2,710	110.6	3,710	80.81	4,710	63.66	5,710	52.51	6,710	44.68	7,710	38.89	8,710	34.42	9,710	30.88
720	416.4	1,720	174.3	2,720	110.2	3,720	80.60	4,720	63.52	5,720	52.42	6,720	44.62	7,720	38.84	8,720	34.38	9,720	30.85
730	410.7	1,730	173.3	2,730	109.8	3,730	80.38	4,730	63.39	5,730	52.32	6,730	44.55	7,730	38.79	8,730	34.34	9,730	30.81
740	405.2	1,740	172.3	2,740	109.4	3,740	80.17	4,740	63.25	5,740	52.23	6,740	44.48	7,740	38.74	8,740	34.30	9,740	30.78
750	399.8	1,750	171.3	2,750	109.0	3,750	79.95	4,750	63.12	5,750	52.14	6,750	44.42	7,750	38.69	8,750	34.27	9,750	30.75
760	394.5	1,760	170.4	2,760	108.6	3,760	79.74	4,760	62.99	5,760	52.05	6,760	44.35	7,760	38.64	8,760	34.23	9,760	30.72
770	389.4	1,770	169.4	2,770	108.2	3,770	79.53	4,770	62.86	5,770	51.96	6,770	44.29	7,770	38.59	8,770	34.19	9,770	30.69
780	384.4	1,780	168.4	2,780	107.8	3,780	79.32	4,780	62.72	5,780	51.87	6,780	44.22	7,780	38.54	8,780	34.15	9,780	30.66
790	379.5	1,790	167.5	2,790	107.5	3,790	79.11	4,790	62.59	5,790	51.78	6,790	44.16	7,790	38.49	8,790	34.11	9,790	30.63
800	374.8	1,800	166.6	2,800	107.1	3,800	78.90	4,800	62.46	5,800	51.69	6,800	44.09	7,800	38.44	8,800	34.07	9,800	30.59
810	370.2	1,810	165.6	2,810	106.7	3,810	78.69	4,810	62.33	5,810	51.60	6,810	44.03	7,810	38.39	8,810	34.03	9,810	30.56
820	365.6	1,820	164.7	2,820	106.3	3,820	78.49	4,820	62.20	5,820	51.52	6,820	43.96	7,820	38.34	8,820	33.99	9,820	30.53
830	361.2	1,830	163.8	2,830	105.9	3,830	78.28	4,830	62.07	5,830	51.43	6,830	43.90	7,830	38.29	8,830	33.95	9,830	30.50
840	356.9	1,840	162.9	2,840	105.6	3,840	78.08	4,840	61.95	5,840	51.34	6,840	43.83	7,840	38.24	8,840	33.92	9,840	30.47
850	352.7	1,850	162.1	2,850	105.2	3,850	77.88	4,850	61.82	5,850	51.25	6,850	43.77	7,850	38.19	8,850	33.88	9,850	30.44
860	348.6	1,860	161.2	2,860	104.8	3,860	77.67	4,860	61.69	5,860	51.16	6,860	43.71	7,860	38.14	8,860	33.84	9,860	30.41
870	344.6	1,870	160.3	2,870	104.5	3,870	77.47	4,870	61.56	5,870	51.08	6,870	43.64	7,870	38.10	8,870	33.80	9,870	30.38
880	340.7	1,880	159.5	2,880	104.1	3,880	77.27	4,880	61.44	5,880	50.99	6,880	43.58	7,880	38.05	8,880	33.76	9,880	30.35
890	336.9	1,890	158.6	2,890	103.7	3,890	77.07	4,890	61.31	5,890	50.90	6,890	43.52	7,890	38.00	8,890	33.73	9,890	30.32
900	333.1	1,900	157.8	2,900	103.4	3,900	76.88	4,900	61.19	5,900	50.82	6,900	43.45	7,900	37.95	8,900	33.69	9,900	30.28
910	329.5	1,910	157.0	2,910	103.0	3,910	76.68	4,910	61.06	5,910	50.73	6,910	43.39	7,910	37.90	8,910	33.65	9,910	30.25
920	325.9	1,920	156.2	2,920	102.7	3,920	76.48	4,920	60.94	5,920	50.65	6,920	43.33	7,920	37.86	8,920	33.61	9,920	30.22
930	322.4	1,930	155.3	2,930	102.3	3,930	76.29	4,930	60.82	5,930	50.56	6,930	43.26	7,930	37.81	8,930	33.57	9,930	30.19
940	319.0	1,940	154.5	2,940	102.0	3,940	76.10	4,940	60.69	5,940	50.47	6,940	43.20	7,940	37.76	8,940	33.54	9,940	30.16
950	315.6	1,950	153.8	2,950	101.6	3,950	75.90	4,950	60.57	5,950	50.39	6,950	43.14	7,950	37.71	8,950	33.50	9,950	30.13
960	312.3	1,960	153.0	2,960	101.3	3,960	75.71	4,960	60.45	5,960	50.31	6,960	43.08	7,960	37.67	8,960	33.46	9,960	30.10
970	309.1	1,970	152.2	2,970	100.9	3,970	75.52	4,970	60.33	5,970	50.22	6,970	43.02	7,970	37.62	8,970	33.42	9,970	30.07
980	303.9	1,980	151.4	2,980	100.6	3,980	75.33	4,980	60.20	5,980	50.14	6,980	42.95	7,980	37.57	8,980	33.39	9,980	30.04
990	302.8	1,990	150.7	2,990	100.3	3,990	75.14	4,990	60.08	5,990	50.05	6,990	42.89	7,990	37.52	8,990	33.35	9,990	30.01
1,000	299.8	2,000	149.9	3,000	99.94	4,000	74.96	5,000	59.96	6,000	49.97	7,000	42.83	8,000	37.48	9,000	33.31	10,000	29.98

FIG 8

(OVER)

$$Z=\sqrt{R^2+(X_l-X_c)^2}$$

is equal to zero and the impedance of the circuit is simply

$$Z=\sqrt{R^2}$$

or $Z=R$

In a series circuit comprising inductance and capacitance only the current could rise to large proportions at resonance—it being effectively a short circuit across the supply. This effect is held in check by the fact that some resistance is always in the circuit.

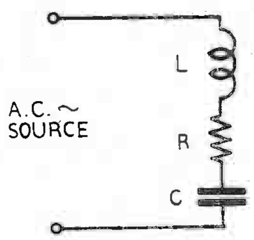


FIG. 9

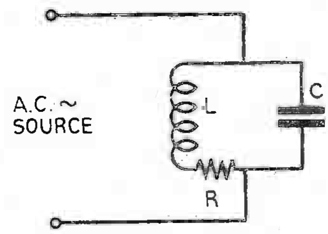


FIG. 10

In a parallel circuit a somewhat different effect occurs. Here we have a circuit arrangement substantially as shown in Figure 10. In such a circuit the current does not pass through both elements but is divided between the two as was the case in parallel resistance circuits carrying direct current.

Without resistance in the circuit the currents flowing in the two branches would counteract each other because of the opposing effects of the capacitance and the inductance and the current flowing through the circuit would be zero. This would correspond to an infinite impedance across the line.

As your studies become more advanced it is well to bear in mind that though the current through the circuit be zero relatively large currents may be flowing in the two branches. The presence of resistance modifies this idea of an infinite Impedance and we find that the effective Impedance of a parallel resonant circuit is equal to

$$\frac{L}{C}\ \frac{I}{R}=Z$$

L is in henries
C is in farads
R is in ohms
Z is in ohms

Let us consider that the coil has an inductance of 250 microhenries and a radio frequency resistance of 15 ohms and that the condenser shunted across the coil has a capacity of 102 micromicrofarads. This is the value of capacity to tune the circuit to a frequency of 1000 K.C.

Substituting the above value in the equation we have

$$\frac{.00025}{.000000000102}\times\frac{1}{15}=163333 \text{ ohms.}$$

The resistance in the circuit is the effective resistance of the coil at radio frequencies which is usually a figure somewhat larger than the direct current resistance. It can be seen that the lower the resistance the higher will be the impedance of the circuit.

The important difference between series and parallel circuits at resonance is obviously that the one has an impedance approaching zero but limited by the resistance while the other has an impedance which would be infinitely high—were it not for the effects of resistance.

In the series circuits the current flowing is large and although the voltage developed across the whole is small the voltage across any one element may rise to unprecedented heights as we shall later find.

In all the above equations solution may be obtained only where the Resistance is expressed in ohms, Frequency in cycles per second, the Capacitance in Farads and the Inductance in Henries.

We must therefore reduce all values to these terms. To this end it is worth noting that the familiar prefixes milli, micro, micromicro denote that the term indicated must be multiplied by .001, .000,001 and .000,000,000,001 in order to change them into fractional parts of the Henry or Farad as the case may be. Thus 250 micromicrofarads will become .000,000,000,250 Farads before insertion into the above equations as 200 microhenries must become .0002 Henries.

No mention of "phase relations" or other complex factors has been made as these interpretations were thought to involve too great a degree of mathematics to warrant their inclusion.

SERVICING RADIO RECEIVERS

The Service Man's Tools.

THERE is nothing that will tend to create in the mind of the customer a feeling of confidence as much as a well chosen kit of tools, which should be carried to the job in a convenient bag. This, along with the test kit gives the desired impression of completeness which goes for rapid and accurate work.

The usual tools other than the special measuring instruments which should be a part of the portable equipment are as follows:

Diagonal Pliers
Long Nose Pliers
Side Cutting Pliers
Spintite Wrench Set
Electricians' Knife
Insulated Test Probes
Neutralizing Tool
Alcohol Torch
Soldering Iron
Self Fluxing Solder—Rosin Cored
Heavy Screw Driver
Long Thin Screw Driver
Hand Drill and Drill Set
Friction Tape
Set of Files
Polishing Cloth and a small quantity of Furniture Polish
Emery Cloth
Hydrometer
Large Piece of Canvas
Flash Light

In addition to the above the technician should carry an assortment of fixed resistances of the values found to be most useful in service work, replacement A.F. transformer, spare pilot lights, set of R.F. coils, howl arrester, complete set of tubes, such batteries as may be necessary, spare power switch, aerial and lead wire, insulators, lead-in strips, lightning arrester, screws, etc.

Testing Instruments.

Confident and rapid servicing of the modern radio receiver requires the intelligent use of the following instruments:

Set Analyzer
Ohmmeter
Modulated Oscillator
Output Meter or Resonance Indicator.

Too great stress cannot be laid upon the necessity for clean cut and accurate equipment. Not only does this save time but it creates a confidence which is likely to result in a return call. The modern receiver is so constructed that servicing is virtually impossible without the apparatus noted.

The Set Analyzer.

The radio set analyzer is an instrument so constructed that the conditions under which any one of the tubes in the receiver operates can be readily determined at a glance. There are of course certain conditions which cannot be localized by this means—these will be taken up later—but in the majority of cases the analyzer will give a thorough diagnosis of the trouble.

The analyzer may be constructed in many ways—it may have a number of meters or it may be so constituted as to require but a single meter with a number of push buttons to make the required connections in the tube circuit and to rearrange the internal circuit of the analyzer so as to cope with the changing conditions.

Many of the more recent analyzers employ rectifier type meters so that a single D.C. meter with the proper shunts and series resistances will be operative over all required ranges of direct and alternating currents and voltages. This effects a saving in the initial cost of the apparatus without affecting the accuracy of the equipment in any way. The majority of the models now on the market use at least two meters, the one being for A.C. measurements and the other for D.C.

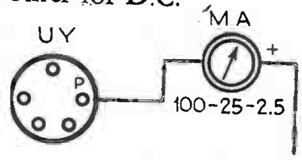


FIG. 11

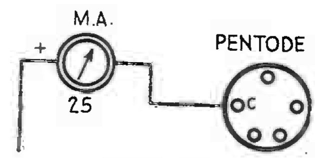


FIG. 12

The schematic circuits shown in the text give an idea as to how the meter ranges are shifted and the internal changes made by means of the push buttons. Figs. 11, 12 and 13.

The instruments are so arranged that the various meter ranges are available for separate external measurements by means of binding post connections and test probes and in some cases provision is made for the use of the equipment as an ohmmeter or as a capacity meter. Instruction pamphlets obtainable from the manufacturers of the various equipment give these details.

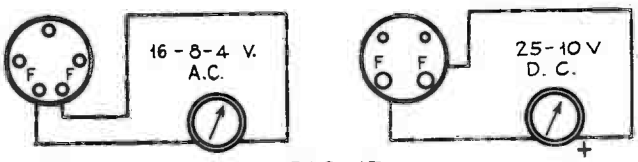


FIG. 13

Testing the Receiver Circuits.

Set analyzers are provided with adapters which make the necessary connections automatically. This is of course necessary when we intend to test circuits involving rectifier tubes or tubes with four and five prong bases. Modern testers are now so complete that it is seldom necessary to use special adapters except for the change from five to four prong plugs.

Selecting the proper adapter we remove the tube from the socket and replace it by the adapter. The tube is then placed in the socket provided in the analyzer.

You will note that the meter will have various ranges of voltage and current reading scales and it is important not only that the correct button be pressed but that the reading be taken from the proper scale. This is in no way confusing but demands a certain degree of alertness on the part of the technician.

The accompanying Fig. 14 shows the correct readings to be obtained in the analysis of the Radiola 64. This data is available from the manufacturer of the particular test set for which these readings hold good. Charts such as that shown in the figure are available and it is a good idea to fill out the chart as you go along so that even though no trouble may be found in the receiver you may hold the chart for future reference. A file of such charts giving a case history of a particular receiver is sometimes a valu-

RADIOLA—Model 64
Line Voltage 112—Volume Control Full

Tube No. in Order	Type of Tube	Position of Tube 1st. R.F., Det., etc.	Readings, Plug in Socket of Set — Tube Out: A Volts	Tube Out: B Volts	Tube in Tester: A Volts	B Volts	C Volts	Cathode Volts	Normal Plate M.A.	Plate M.A. Grid Test	Plate M.A. Change
1	227	Ant.Coup.St.	2.5	128	2.4	124	25	13.5	3.4	7.8	4.4
2	227	Tuned R.F.	2.5	128	2.4	124	25	16.0	3.3	7.1	3.8
3	227	Tuned 1stDet.	2.5	80	2.4	75	25	16.0	.2	2.9	2.7
4	227	1st. I.F.	2.5	128	2.4	124	9	13.5	3.4	7.8	4.5
5	227	2nd. I.F.	2.5	128	2.4	124	9	13.5	3.4	7.8	4.5
6	227	Oscillator	2.5	80	2.4	75	25	13.5	7.0	7.6	.6
7	227	2nd. Det.	2.5	180	2.4	176	25	13.5	-	-	-
8	227	Vol. Control	2.5	80	2.4	75	4	-	-	-	-
9	250	Power	7.5	584	7.2	392	65	-	52	55	3.0
10	281	Rectifier			7.4				50		
11	281	Rectifier			7.4				50		

FIG 14

able thing in that it will indicate the fact that tubes are not quite up to scratch and that new ones should be taken on the call. The reverse of the chart will serve to record the work done on each visit. A reference to the chapter bearing upon the analysis of a complete receiver circuit will indicate the possible causes of trouble where the readings taken are not up to standard.

There are of course certain points where the analyzer will fail and it is these exceptions which make necessary the use of other apparatus in testing.

This statement must not be construed as an indictment of the analyzer as having failed in its purpose for the technician cannot possibly render efficient service without it. At times the very failure of the analyzer to point out the fault may lead to its detection.

When the Analyzer Fails.

As we noted there are certain conditions in the radio receiver which defy detection by means of the analyzer. As an example of this, the analyzer cannot detect a shorted variable condenser as the path from grid to ground remains substantially unchanged. In Fig. 15 the voltmeter is connected so

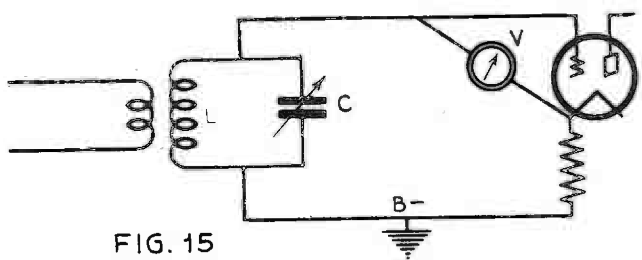


FIG. 15

as to measure the value of the bias. It can be seen that a shorted condenser (C) will have no effect on the reading of the voltmeter (VM) because of the extremely low coil (L) resistance.

In general, short circuits in the antenna coupling circuit or in the R.F. transformers do not affect the meter readings as these are low resistance circuits and the change in constants due to the short circuit will have no effect on the voltages or current in the tube circuit. Short circuits to ground in the plate circuits of the tubes naturally cause a loss of plate voltage accompanied by high plate currents and in cases where the bias is obtained from the voltage divider in the manner described in another section such a short circuit of the R.F. transformer secondary or of the variable condenser would result in a loss of bias, Fig. 16.

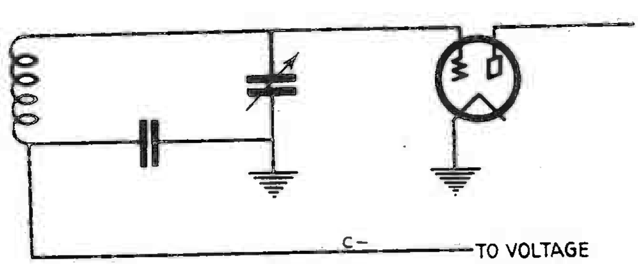


FIG. 16

Open condensers do not in any way affect the voltage readings as they do not offer a direct current path at any time. Resistances connected across transformer windings either as stabilizing agents limiting the amplification or as volume controls will show no changes in applied voltages whether they are open or short-circuited. The center tapped resistances across the filament or heater circuits will cause hum if open or short-circuited in one section. These defects will not show up, however, in the meter readings.

Then why—you ask—is the set analyzer so necessary a piece of apparatus? The answer is that in the majority of cases the trouble is shown up by the analyzer readings—if not we may resort to the manner of deduction employed by the late Sherlock Holmes and rest assured that the trouble lies in some circuit defect not noted in the analyzer readings. Troubles are evidenced by the following conditions:

Excessive and uncontrollable volume.

Regeneration.

Failure of one or more of the tuned circuits to tune sharply to resonance.

Hum or noise.

Audio howl or acoustic regeneration.

No signal.

Excessively broad or sharp tuning.

Tunable hum appearing on station carrier but when no signal is received.

Most of these conditions may be checked by the use of the other apparatus listed and will be taken up in turn.

A note of the fact that an open grid biasing resistance in series with the cathode of the tube will not be evidenced by zero voltage and zero bias together with a high plate current when checked with the analyzer should be made. The reason for this is that when the analyzer is switched so as to measure the voltage between cathode and ground a high resistance is placed across this circuit. With the biasing resistance intact this high resistance has little effect but if the biasing resistance be open the meter resistance will fill the gap with the result that the tube receives a high grid bias. Fig. 17. The plate

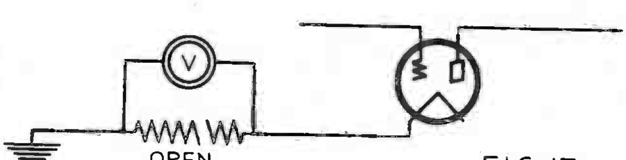


FIG.17

voltage will then be relatively low and the current will be close to zero while the meter is across the cathode and ground. These facts need nothing but a little study to fix them firmly in the technician's mind so that he can recognize them at a glance.

Open or shorted neutralizing condensers will have no effect upon the meter readings except where the circuit arrangement is such that a short circuit results in a connection between the grid and plate through

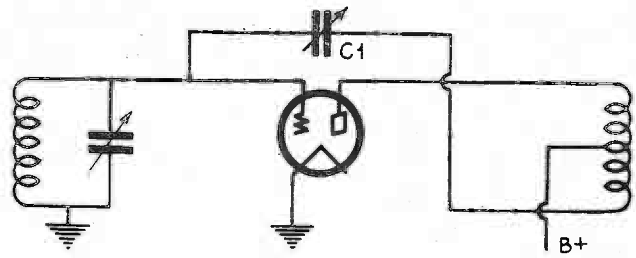


FIG. 18

capacity C_1. Fig. 18.

Continuity Testing.

The Ohmmeter listed as among the equipment desirable is useful not only in the measurement of resistance values but in checking receiver troubles not noticeable through changes in the operating voltages. Many manufacturers give routine data charts on the servicing of their receivers with the ohmmeter. These charts give the points between which the tests should be made and the correct resistance reading.

An ohmmeter is a milliammeter in series with a resistance and a battery with the scale so calibrated as to read directly in the effective ohms resistance between the test prods. A variable resistance is included so that adjustment can be made for variations in the battery voltage.

The Figs. 19, 20, 21 and 22 show the circuit arrangements of a Brunswick receiver which is typical of modern design practice. The power supply and the receiver chassis are separate units but this has no effect on the adaptability of the procedure to other sets. We have also reproduced here the continuity test chart of the receiver as recommended by the manufacturer. This chart indicates the correct effect and the possible incorrect effects which may be apparent together with their probable cause.

A check of any receiver by means of the analyzer —which failing in diagnosis can be followed by a continuity test of the circuits—will undoubtedly result in a discovery of the trouble.

Continued oscillation or lack of sensitivity through disalignment of the circuits may be checked by the use of the modulated oscillator to be described. This is particularly necessary in the case of the superheterodyne receiver and also with neutrodyne receivers. The manner of operation in checking neutralization and alignment of circuits follows:

The Modulated Oscillator and Its Uses.

The modulated oscillator is in reality a miniature and portable broadcast transmitter which places a controllable signal in the hands of the technician at all times. The instrument is to be operated in conjunction with an output meter or a resonance indicator such as will be described.

The oscillator should be tunable over the entire broadcast band and should have a second range of from about 100 to 200 kc, for checking the character-

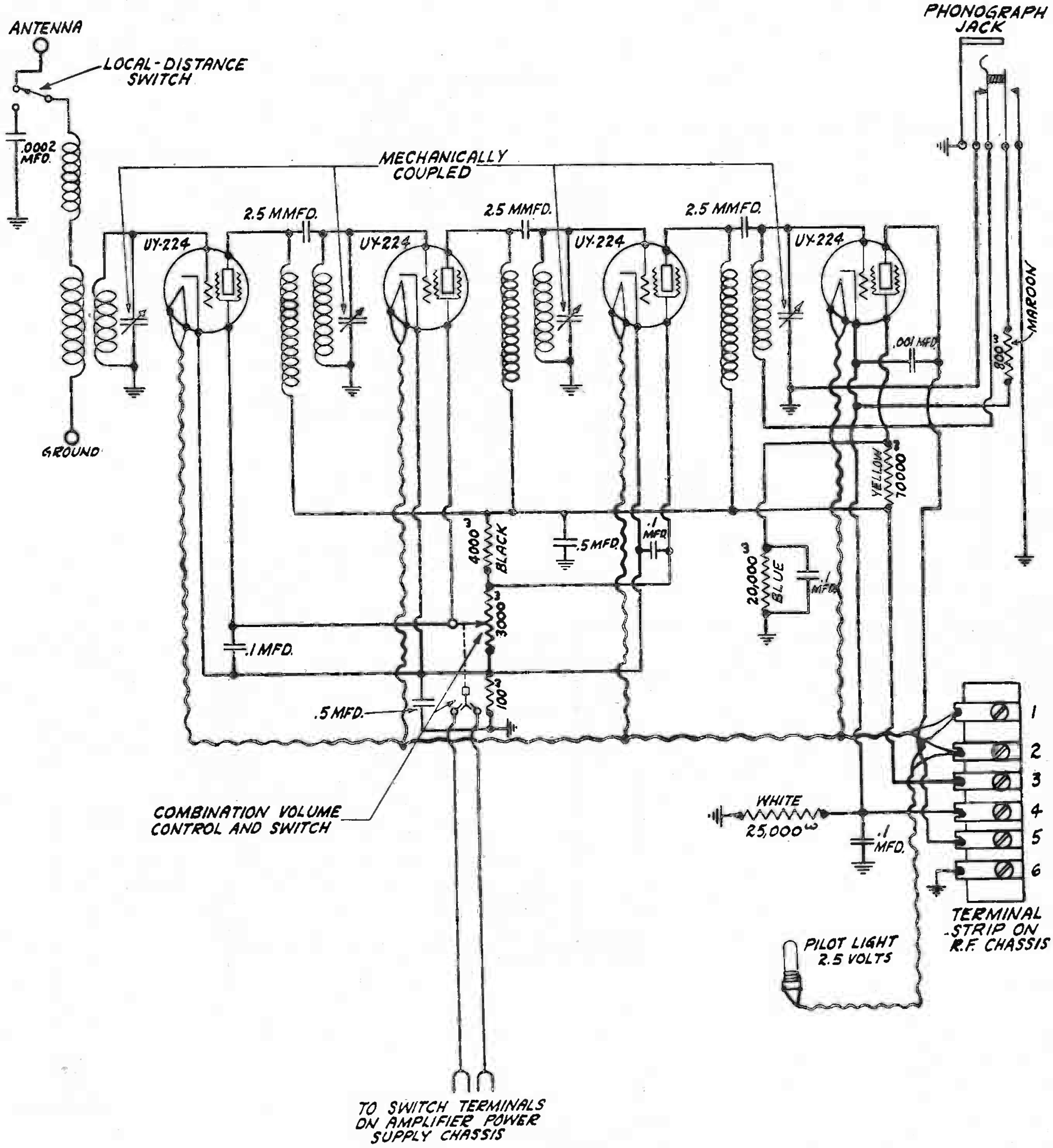


FIG. 19

SCHEMATIC CIRCUIT OF RADIO CHASSIS

7003

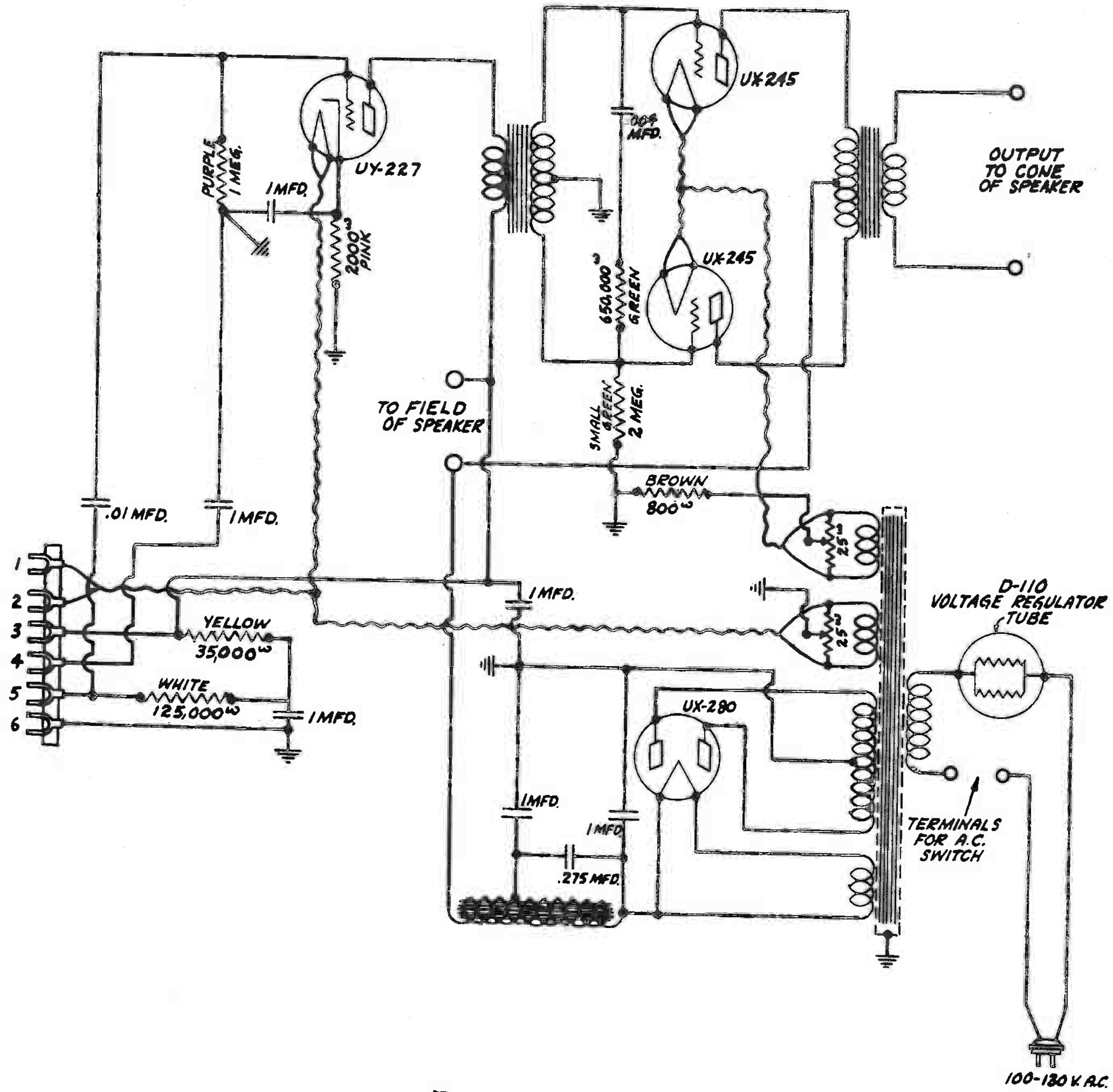


FIG. 20

SCHEMATIC CIRCUIT OF AUDIO AMPLIFIER POWER SUPPLY CHASSIS USED ON STRAIGHT RADIO-60 CYCLE

7004

CONTINUITY TEST CHART

Test No.	Under Test	Test Positions	Correct Effect	Probable Incorrect Effect	Caused By
1	R. F. Grid Circuits	Ground to 1st, 2nd and 3rd grid caps	Closed thru 4Ω (B1.3)	Open or shorted	Open in flexible lead Open in R. F. coil Bent condenser plate
2	Detector Grid circuit	Ground to detector grid cap	Closed thru 4Ω (B1.3)	Open Shorted	Open in flexible lead Defective phonograph jack Open in R. F. coil Bent condenser plate
3	1st A. F. grid circuit	Ground to 1st A. F. socket grid contact	Closed thru 1 meg (A0)	Shorted thru 165,000 Ω (A.02)	Shorted .01 mfd. coupling condenser
4	Power tube grid circuits	Ground to alternate power tube socket grid contacts	Closed thru 6000 Ω (A0.7)	Shorted Open	Filter resistance lead touching hum potentiometer frame Shorted .004 cond. Open transformer winding
5	Antenna circuit	Ground to ant. post (switch set for distance)	Closed thru 30 Ω (B3.6)	Closed thru 5Ω (B1.6) Open	Shorted antenna loading coil Open antenna loading coil Open transformer primary Defective switch
6	Antenna circuit	Ground to high side ant. primary coil	Closed thru 5Ω (B1.6)	Open	Open primary
7	Antenna circuit	Ground to ant. post (switch set for local)	Open	Closed thru 30Ω (B3.6)	Defective switch
8	Phonograph jack	Ground to cathode contact of detector socket (open plug inserted in jack)	Closed thru 800Ω (A3.3)	Closed thru 25,000Ω (A0.17)	Open connection or defective jack
9	Phonograph jack	Ground to grid cap of detector (open plug inserted in jack)	Open	Closed thru 4Ω (B1.3)	Defective jack
10	Radio Frequency plate circuit	Ground to 1st, 2nd and 3rd R. F. socket plate contacts (Volume control at maximum)	Closed thru 7000Ω (A0.6)	Closed thru 60Ω (B4.2) Closed thru 4100Ω (A0.9) Closed thru 100,000Ω (A0)	Shorted .5 mfd. by-pass condenser R. F. choke lug shorted to antenna wire shielding Shorted coupling condenser Shorted screen-grid by-pass condenser Open volume control Open 100Ω grid bias resistor
11	Detector plate circuit	Ground to detector plate	Closed thru 165,000Ω (A0.02)	Closed thru 25,000Ω (A.17)	Shorted .001 mfd. by-pass condenser
12	1st A. F. plate circuit	Ground to plate contact 1st A. F. tube	Closed thru 9800Ω (A0.4)	Closed thru 2700Ω (A1.3) Short Open	Shorted condenser in filter block Shorted .5 mfd. condenser in radio chassis Plate connections touching potentiometer frame Open primary in transformer Open volume control Open 100Ω grid bias resistor

FIG 21

CONTINUITY TEST CHART—*Continued*

Test No.	Under Test	Test Positions	Correct Effect	Probable Incorrect Effect	Caused By
13	Power tube plate circuit	Ground to alternate power tube socket plate contacts	Closed thru 12,300Ω (A0.3)	Open Closed thru 600Ω (A3.0) 750Ω (A3.3) 5200Ω (A0.7)	Open field coil Open primary windings Shorted condensers in filter block
14	Screen-grid circuits	Ground to 1st, 2nd and 3rd R. F. socket grid contacts (Volume control at max.)	Closed thru 3100Ω (A1.2)	Short Closed thru 100Ω (A4.5)	Grounded volume control Shorted.1 mfd. by-pass. cond.
15		Ground to 1st and 2nd R. F. socket grid contacts (Volume control at minimum	Closed thru 100Ω (A4.5)	Closed thru 100,000Ω (A.05) Short	Open 100Ω grid bias resistor Defective volume control Shorted .5 mfd. cathode by-pass condenser Grounded volume control
16	Detector Screen-grid circuit	Ground to detector socket grid contact	Closed thru 17,000Ω (A0.25)	Short	Shorted .1 by-pass condenser
17	R. F. return circuit	Ground to 1st, 2nd and 3rd R. F. socket cathode contacts	Closed thru 100Ω (A4.5)	Short Closed thru 100,000Ω (A.05)	Shorted .5 mfd. cathode by-pass condenser Open 100Ω resistor
18	Detector return circuit	Ground to detector socket cathode contact	Closed thru 25,000Ω (A.17)	Short Closed thru 800Ω(A2.7)	Shorted .1 mfd. by-pass cond. Defective phonograph jack
19	1st A. F. return circuit	Ground to 1st A. F. socket cathode contact	Closed thru 2000Ω(A1.5)	Short	Shorted condenser in filter block
20	Power tube return	Ground to filament contact both power tube sockets	Closed thru 800Ω (A2.7)	Short	Grounded hum potentiometer Grounded filament winding on power transformer
21	Plate supply	Ground to rectifier socket filament contact	Closed thru 11,000Ω (A.37)	Short Closed thru 150Ω (A4.3) Open	Shorted 1st condenser in filter Shorted 2d condenser in filter Open choke coil Open field coil
22	High voltage secondary of power trans.	Ground to alternate rectifier socket plate contacts	Closed thru 250Ω (A3.9)	Open	Open high voltage secondary winding
23	Primary of power trans.	Ground to side of primary winding	Open	Short	Grounded power switch Grounded transform.primary
24	Speaker field	Across terminals of plug	Closed thru 4750Ω(A0.8)	Open Short	Open field coil Shorted field coil
25	Choke coil	Rectifier filament to blue or maroon wire on field	Closed thru 160Ω(A4.2)	Closed thru 20Ω (B3.2)	Shorted .275 cond. in block

Note—

FIG.22

istics of the intermediate frequency amplifier of a superheterodyne receiver. This may be a commercial item or it may be a home-made job. The main difficulty in the home-made oscillator lies in the inability of the average technician to effect a calibration of the intermediate frequency circuit.

It is of course possible to construct all service apparatus but the difficulties attendant upon the construction of a really good analyzer are so manifold as to make it a momentous undertaking for any but the most skilled craftsmen.

Resonance indicators and output meters are readily home constructed and they will be described in detail as will the various service tools necessary in conjunction with the oscillator.

Trouble and Causes.

Before going into detail in the use and construction of these items we will review the possible troubles in Radio Receivers and the causes which may be connected therewith.

Dead Receiver.

Power off due to switch not on, blown fuse, open cord, or power line dead.
Tube not in socket.
Antenna shorted to ground.
Broken lead-in.
Grounded lightning arrester.
Shorted variable condenser or equalizer.
Open or short circuits within receiver.
Defective tubes.
Polarity reversed (D.C. receivers only).
Open R.F. coils.

Weak Signals.

Defective tubes.
Defective antenna.
Loose or poor ground connection.
Aligning trimmers out of adjustment.
Oscillator alignment out (superheterodyne only)
Intermediate frequency amplifiers improperly tuned.
Open or short circuits within the receiver.
Incorrect line voltage (low).
Antenna connected to wrong input post (receivers with long and short antenna connections only).
Defective audio transformer.

Hum.

Defective detector or power tubes.
Weak rectifier tube.
Shorted filter choke.
Open filter condenser.
Open or shorted center tap resistance.
Unmatched push-pull tubes.
Improper bias on tubes.
Cathode to heater short circuit in detector tube.
Heater voltage grounded.
Frozen or inoperative elctrolytic condenser.
Defective audio transformers.
Poor ground connection.
Loose laminations in power transformers.
Hum on broadcast carrier.
Tunable hum due to oscillation in power transformer secondary.

Fading or Intermittent Operation.

Atmospheric conditions which are unavoidable.
Thermostatic short or open circuit in tube.
Swinging ground in antenna circuit.
Extreme fluctuation in line voltage.
Excessive heater voltage.
Dirty tube prongs.

Distortion.

Receiver improperly tuned to signal.
Defective output tubes.
Mismatched push-pull tubes.
Defective audio transformers.
Detector overloaded.
Incorrect grid bias on audio tubes.
Defective speaker.
Improper detector bias.
Oscillation in R.F. amplifier.

Noise (Outside Receiver).

Atmospheric conditions.
Elevators in building.
Antenna shorting on grounded objects such as roof, etc.
Defective electrical or electromedical appliances nearby.
Poor antenna contact where lead-in joins antenna.

Noise (Inside Receiver).

Defective tubes.
Loose contact in tube sockets.
Intermittent short circuits.
Dirty variable condensers.
Defective by-pass condenser.
Loose dial light.
Poor resistors.

Audio Howl or Acoustic Feed-Back.

Microphonic tube.
Loose speaker (not properly fastened in cabinet).
Open circuit in A.F. transformers.
Open by-pass condensers.
Weak batteries (battery receivers only).

High resistance soldered joints in A.F. circuits.

Oscillation.

Circuit not neutralized.
Interaction between two stations on adjacent channels.
Antenna lead run too close to unshielded receiver.
Open by-pass condenser.
Shorted R.F choke.
Incorrect voltages on tubes.
Loose shields.
Open or reversed R.F. transformer winding.
Poor ground connection.
Defective tubes.
Loose tube shield.

Motor Boating.

Defective output tube.
Open grid in output circuit.
Defective transformer.
Open by-pass condenser.

Broad Tuning.

Improper coupling in band-selector circuits.
Trimmers out of alignment.
Condenser loose on shaft.
Unmatched coils.
Too long antenna.
No ground connection or long ground lead.
Defective tube.
Antenna connected to wrong input point.

Hot Rectifier Tube.

Shorted filter condenser.
Internal short in power transformer primary.
Filter choke coil winding shorted to iron core.

Most of these pointers suggest their own remedies. We will, however, recapitulate so as to be certain that we have covered every point.

Dead Receiver.

Check power supply to see that the tubes are receiving their proper voltages. Test tubes and circuits with analyzer. Check antenna system and disconnect lightning arrester. Check circuit noted with continuity tester if analyzer fails to points out trouble.

Weak Signals.

Check antenna system. Check tubes and circuits with analyzer for improper voltages and check tuning circuits for alignment.

Hum.

Check all circuits noted. Change tubes. Inoperative electrolytic condensers can be repaired by removing all tubes but the rectifier leaving the set turned on for fifteen minutes or so. The excess voltage delivered under these conditions will but put the condensers back into operating shape. Tunable hum can be cured by placing small (.01-mf.) condensers across the two halves of the high voltage winding. This is due to oscillation in this circuit and is evidenced by hum appearing only when a station is tuned in. Be sure that the hum is not on the station carrier before resorting to this expedient.

Fading.

If fading is on all stations it is probably not due to atmospheric conditions and the circuits mentioned above should be checked. Tubes are often found with shorts or opens which do not appear until the tube heats thoroughly. Operation of the heaters at an excessive voltage results in "paralysis" of the tube.

Distortion.

Volume control should be effected by means of the control provided—not by detuning the receiver. In some cases this practice results in distortion. Check voltages and tubes. Look for oscillation in R.F. stages and check loud speaker.

Noise (Outside Receiver).

This may be checked by removing the antenna. If the receiver is now quiet the noise is due to some external condition. If elevators are noisy suggest that they be overhauled. A line filter in the receiver power supply is often effective but in most cases the filter *must be placed at the source of the disturbance* if it is to be cured.

Noise (Within Receiver).

Check all circuits mentioned for loose contacts or dirty joints. Check variable condensers for dust which can be removed with a pipe cleaner. Some condensers are cadmium plated and the plating has been known to "grow" under certain conditions. If the condenser cannot be replaced you may remove it from the set and connect it to the terminals of a six volt battery. Rotating the condenser will cause the fuzz to arc and burn off.

Audio Howl.

This is in most cases due to the feeding back of acoustic energy from the speaker to the detector tube which is very sensitive to mechanical vibration. Replacing the detector tube may effect a cure or the tube may be covered with a lead shield to weight it against vibration. A piece of Ford lower radiator coupling hose will fit over a '27 or '24 and is ideal for the purpose. Failing in this manner the mounting of the receiver chassis on sponge rubber might effect a cure. See also that the cover of the set is not vibrating. Sometimes a first A.F. tube causes this type of howl also.

Oscillation.

Oscillation may not exist in the receiver but may be due to the heterodyne whistle of two stations close together in the broadcast frequency spectrum. This will be immediately noticeable to the technician but he may have to explain the fact to his customer. Oscillation in screen grid receivers is usually due to loose shielding or incorrect voltages. Open by-pass condensers or shorted R.F. chokes may also result in feed-back between stages. In the case of neutralized receivers every possible cause should be checked before attempting to adjust the neutralizing condensers. If the cause is in a reversed coil winding it will not be possible to neutralize the set. The process of neutralization will be described shortly in the section covering the use of the service oscillator.

Motorboating.

This is usually due to feed-back between stages due to a high impedance circuit common to two or more stages. In battery receivers this often occurs when the batteries lose their voltage and develop a high internal resistance. It is characterized by a slow putt-putt or a howl which may be differentiated from acoustic feed-back by the fact that tapping the tubes does not greatly aggravate the condition. In A.C. receivers look for open by-pass condensers, defective transformers, or defective output tubes.

Broad Tuning.

This may result from the use of too long an antenna or through the lack of a proper ground connection. It may also result from improper coupling in band-selector circuits. This is mentioned in detail in the section describing a typical receiver. Improper voltages on screen grid tubes may also have this result as well as disaligned trimmers or a loose condenser rotor. High resistance connections in one of the R.F. circuits must be watched for. A high resistance connection is due to poor soldering—the flux coating the joint so that the solder cannot make a good contact.

Coils improperly matched may also have this result. To be sure of this in making a replacement it is well to employ an entire new set of coils as matched at the factory except in the cases of certain receivers where the coils are all matched with extreme accuracy. The new RCA and Victor sets are in this class as a special method of coil matching is used at the factory and all coils are uniform within narrow limits. Alignment of the tuning elements should be carried out with an oscillator and output meter or by the use of the output meter or resonance indicator alone where a station can be tuned in. The process is described in the section devoted to the operation of the service oscillator.

Overheated Rectifier.

If the receiver is inoperative and it is seen that the rectifier tube plates are red hot the probable trouble is a shorted filter condenser. A primary short circuit in the power transformer will result in an excessively high secondary voltage which may also have this effect but this is doubtful as the new rectifiers are rated at an extremely high voltage as compared with the earlier types.

Careful study of these pages should enable the technician to spot trouble not evidenced by off readings on the analyzer. These analyzers are required equipment by all the larger service organizations and while no doubt the technician can effectively service a receiver without one it is certain that the necessity for getting into awkward positions to obtain readings with a simple voltmeter will slow up the work tremendously. Manufacturers of such apparatus have made arrangements for partial payment plans which place the equipment within the reach of all and there is now no reason why the service technician should be without proper equipment.

The Service Oscillator and Its Use.

We noted before that the service oscillator is nothing more than a miniature radio transmitter giving a modulated signal output of any desired frequency. It is possible to build such an oscillator with a grid leak and condenser combination which gives a modulated signal due to rapid blocking of the grid circuit. This occurs through the use of such a combination of resistance and capacitance that the charge on the grid does not leak away rapidly but builds up and discharges in such a manner as to modulate the signal.

This is an excellent simplification of the apparatus but does not give as flexible a piece of apparatus as would be the case where the modulation is obtained from a separate source as in the case of a broadcast transmitter.

An oscillator of the first type is shown in schematic in Fig. 23. The equipment should be completely shielded in an aluminum case such as is obtainable on the open market so that the signal can be picked up only at the terminals provided. In the circuit shown the 125-ohm resistor effects the required variation of the signal output in accordance with the signal strength desired. The grid leak should be varied over a range between .5 and 10 megohms until the value giving the desired modulation tone is obtained. The batteries should be enclosed di-

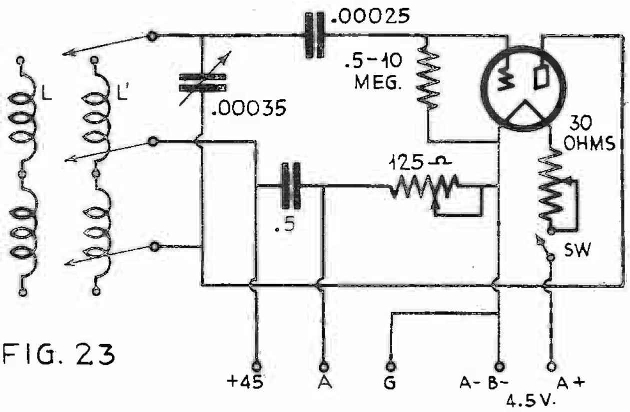


FIG. 23

rectly in the shield so that no pick-up in the receiver from stray signals in the battery leads will affect the adjustment of the receiver. This is important.

The values of the various parts are given directly on the schematic circuit diagram. It will be noted that by simply throwing an anti-capacity key switch the range of the signal may be either in the broadcast band or in the range of the intermediate frequency amplifier of a superheterodyne receiver. This is the simplest form of oscillator which can be effectively used in service work and we will continue our notes on the use of the apparatus with this type of oscillator in mind. Later we will take up the construction of a more complex device and its calibration.

Inasmuch as we will not use the receiver antenna during operations with the test oscillator it will be necessary to replace it with a device known as a "Dummy Antenna" and having equivalent characteristics—except in its capabilities of picking up a signal. In Fig. 24 there is a sketch of a "dummy antenna" together with data on the parts going into its structure.

DUMMY ANTENNA

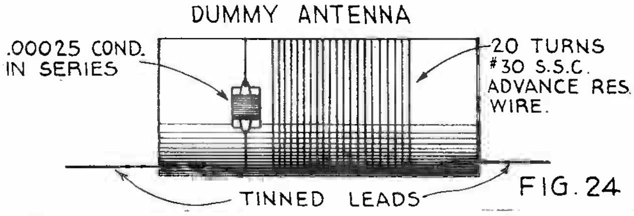


FIG. 24

Output meters are available on the market for connection in place of the loud speaker so that a visible indication of the output is obtained. Such an indication is necessary in all operations with the service oscillator. A satisfactory output meter for most service work may be made by employing a '12A tube with the grid and plate tied together in the manner shown in Fig. 25. The filament battery may be two 4.5-volt "C" batteries in parallel.

Maximum output is indicated by the maximum deflection on the milliammeter scale. Such a meter may be connected directly across the loud speaker windings. It is a simple matter to mount a meter of this type in a small aluminum shield together with the necessary batteries so that it becomes a permanent part of the technician's equipment.

A second type of output meter is the "resonance indicator" which consists of a milliammeter in series with the detector plate lead. An adapter is made from an old tube base and a socket in such a manner that two leads are brought out for the insertion of a 0-1 milliampere meter. Fig. 26. When used with a "bias" detector the maximum signal will be indicated by the maximum reading on the milliammeter.

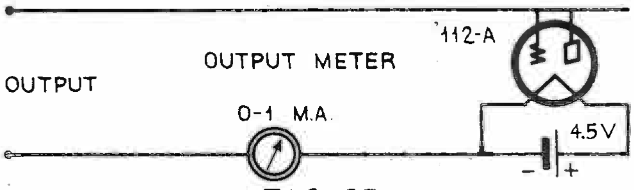


FIG. 25

Alignment of Radio Frequency Amplifiers.

In aligning a receiver by means of the oscillator and the output meter or by means of the resonance indicator it is necessary to connect the dummy antenna between the oscillator antenna post and the antenna input of the receiver as shown in Fig. 27.

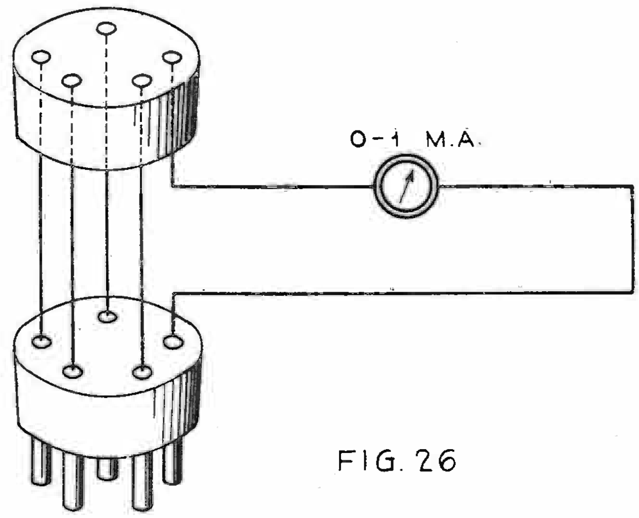


FIG. 26

The oscillator is set to some high frequency within the broadcast range and the output of the oscillator is adjusted so that with the volume control of the receiver set at about 50% of the maximum output the reading on the output meter is something less than the maximum.

Now starting with the trimmer condenser in the detector circuit each trimmer should be adjusted so that the maximum reading is obtained in the output. Use a bakelite or other non-metallic screw driver in making this adjustment.

If at any time during the process the output meter runs off scale readjust the output of the oscillator to bring it back into the range of the meter. Once having completed the adjustments of the trimmers, the oscillator output should be shifted to some lower frequency and the adjustments of the trimmers checked again. The receiver will now be in correct alignment but if the receiver dial is calibrated directly in kilocycles you may have disturbed this calibration. If so tune in a station of known frequency, release the dial mechanism and shift it so that the calibration is correct.

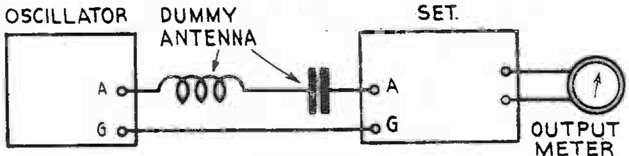


FIG.27

Aligning the Intermediate Frequency Amplifier in a Superheterodyne.

To effect an alignment of the intermediate frequency stages of a superheterodyne receiver the procedure is not dissimilar to that just described.

Connect the antenna post of the oscillator directly to the grid of the first detector tube. Connect the ground terminal of the oscillator to the receiver ground. In order to be certain that no broadcast interference is picked up it is necessary to ground the antenna post of the receiver.

Now with the oscillator tuned to the correct intermediate frequency as ascertained from the manufacturer's data adjust the output of the oscillator so as to give a convenient reading at the output meter with the receiver volume control at about mid-range. The adjustment is now continued in the same manner as in the case of the radio frequency stages. In the superheterodyne it is best to complete the alignment of the intermediate frequency before attempting any adjustment of the R.F. or oscillator.

Neutralizing a Receiver.

In neutralizing a receiver by means of the oscillator we require a dummy tube. This dummy is made by taking a *good* tube and cutting off one filament or heater terminal at the base so that the tube is inoperative.

An easy way to insulate the filament prong from the socket is to slip a short piece of soda straw over one of the prongs and exercise a little care in inserting the tube in the socket. This does not spoil the tube.

Connect up the oscillator with the dummy antenna as described and place the dummy tube in the first socket. Shift the neutralizing condenser with an insulated tool or screw driver so that it is completely off neutralization and tune in the signal from the oscillator so that a good, strong indication is evident in the output meter. Now adjust the neutralizing condenser until no signal comes through. With the condenser off neutralization a certain amount of the signal is passed through the dummy tube through the capacitance between the electrodes. When neutralization is complete this tube capacitance is balanced out and no signal passes through the dummy tube. Having completed the balancing of the first stage replace the dummy tube with one known to be good and repeat the process from stage to stage until all of the circuits are balanced. The receiver is now completely neutralized and any oscillation taking place is due to other causes. If the primary coil wiring is reversed you will not be able to effect a complete neutralization of the receiver. Be careful in making changes in wiring of neutralizing windings and replace wires in proper positions.

Balancing the Oscillator of a Superheterodyne.

Some superheterodyne receivers employ a bridge type of circuit in the oscillator tuning condenser system. This consists of a unit of the gang condenser—a large fixed condenser and two trimmers. After having effected alignment of both the R.F. and intermediate frequency stages continued insensitivity is possible due to this circuit being out of alignment.

With the output meter in place and the oscillator connected to the receiver through the dummy antenna tune the oscillator to about 1400 kc. and adjust the receiver so as to obtain a reading at the output meter of about half scale. Now adjust the trimmer across the portion of the gang condenser which tunes the oscillator for maximum output at high frequencies. Now retune the oscillator and receiver to 600 kc. and adjust the trimmer across the oscillator fixed condenser for maximum output at the low frequencies. Return again to the 1400 kc. position and make any final corrections necessary.

Certain superheterodyne receivers have one section of the gang condenser cut to the proper shape for tuning the oscillator and do not employ the bridge circuit arrangement. Alignment of the oscillator in such receivers is carried out at the same time and in the same manner as the R.F. alignment.

Special Tool for R.F. Alignment.

A special tool for alignment of R.F. circuits is shown in Fig. 28. This is called a balancing ring. It consists of a ring of No. 14 wire covered with spaghetti tubing mounted on the end of a bakelite rod.

BALANCING RING

FIG. 28

In aligning the tuning circuit press gently on each tuning condenser rotor end plate. If the output reading increases it indicates that insufficient capacity is in the circuit and the trimmer should be tightened. If the ring is placed over each R.F. coil in turn and the reading increases, too much capacity is in the circuit and the trimmer should be loosened. This test is only of value in those receivers where the coils are open for test by placing the ring over one end of the coil and the test cannot be used where the coils are shielded completely. If both these tests result in a decreased output reading it indicates that the adjustment is already correct and that stage needs no adjustment.

The end of the bakelite tool may be ground down so that the tool may be used also as an insulated screw driver for trimmer adjustment. The use of a metallic screw driver for such a purpose throws everything out of balance.

Making an Ohmmeter for Resistance and Continuity Tests.

Through the courtesy of the International Resistance Company we are including two sketches for the adaptation of 0-1 ma. meters to use as ohmmeters. These two scales shown in Fig. 29A may be cut out and pasted over the original scale of the meters indicated in Fig. 29B.

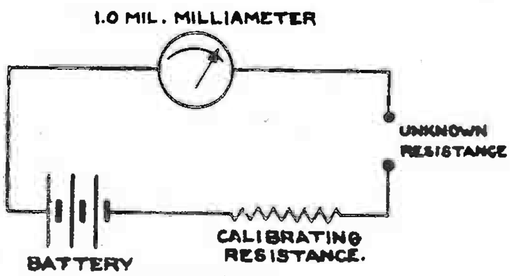
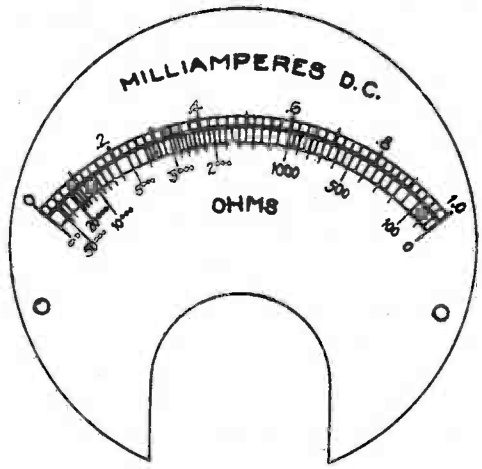


FIG. 29 B

The following chart gives the values for the series resistance and the battery. The scale may be extended to 3 and 15 times the value shown by using the higher battery voltages and higher series resistances. This means that with the multiplying factor of 3 the reading of 100 ohms will be really 300 ohms and the reading of 2000 ohms—6000. Use of the factor of 15 would mean that 100 ohms on the scale would correspond to a resistance across the terminals of 1500 ohms, and 2000 ohms—30,000.

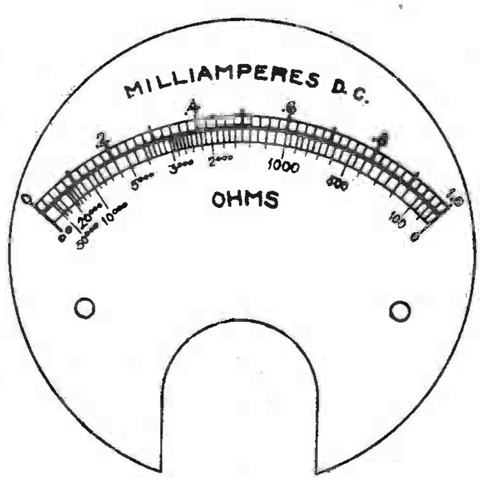
Battery Voltage	Series Resistance	Scale Multiplying Factor
1.5	1,500	1
4.5	4,500	3
22.5	22,500	15

In each case prior to use the test prods should be shorted and the zero adjustment of the meter set so that the reading is zero resistance. This compensates for loss of battery voltage through service. When the setting can no longer be made at zero the battery should be replaced. The two ranges having the 1 and 3 factors are the most useful for our purpose and the meter can be set up in a cabinet with a change-over switch and a tapped "C" battery so as to cover both ranges at will.



ADAPTED FOR WESTON METER, MODEL 301.

FIG. 29 A



ADAPTED FOR JEWELL METER PATTERN 88.

DIRECTIONS FOR USE OF OHMMETER SCALES.

REMOVE METER FROM CASE BY LOOSENING THE THREE MOUNTING SCREWS. REMOVE THE TWO SCREWS HOLDING THE MILLIAMMETER SCALE IN POSITION. PLACE OHMMETER SCALE ON TOP OF OLD SCALE, FASTENING WITH A FEW SPOTS OF GLUE IF DESIRED, AND REPLACE SCALE MOUNTING SCREWS. CONNECT METER, BATTERY AND CALIBRATING RESISTANCE IN SERIES, AS IN DIAGRAM, AND SHORT-CIRCUIT "UNKNOWN" TERMINALS. METER SHOULD READ ZERO ON OHMMETER SCALE. IF NOT, ADJUST POINTER WITH ZERO SET SCREW. REPLACE METER IN CASE.

ANALYSIS OF TYPICAL RECEIVER

We are going to learn how to service radio sets in an entirely unorthodox fashion. By this is meant that we are going to assume a hypothetical receiver —one not of any particular type or design and give it all the features found in the most modern radio sets. We will then analyze this imaginary set step by step, learning what each part contributes to the over-all efficiency of the receiver and in what manner the failure of that part might affect the operation of the receiver as a whole.

The average receiver of today has two screen-grid radio frequency amplifying tubes, a detector, a first A.F. stage and a second A.F. stage which may employ one or more tubes. There is also a rectifier tube which serves to convert high voltage alternating current into a pulsating direct current which is smoothed out by means of filter circuits and furnishes the necessary operating voltages for the receiver.

We will design our receiver along these lines—analyze its structure and then retrace our steps to see what possible variations might be found in manufacturers' designs and how they might affect the operation of the receiver. These variations involve the use of unusual forms of coupling between tubes —resistance coupling in amplifiers—unusual volume controls—special types of detectors—automatic volume controls—etc.

Of course no one treatise can hope to cover in detail the foibles and fancies of all the radio engineers at large in the country, for each man has pet ideas which he incorporates in receivers of his design—ideas based on personal likes and dislikes and upon the necessity for avoiding patent infringement. We will, however, take into consideration the more usual arrangements of various radio circuits in a manner calculated to aid in service work.

Analysis of a Radio Receiver.

In Fig. 30 we find a receiver in schematic which incorporates in a good measure the best features of everyday engineering practice. Peculiar and involved circuit arrangements have been avoided entirely but will be taken up later.

You will note that three input terminals are provided. In using a fairly short antenna, connection should be made to the S.A. binding post. If a long or low antenna is used, the L.A. post should be employed so that the fact that C_1 is in series with the antenna will effectively shorten it and prevent the large antenna capacitance from affecting the tuning of the first condenser and coil.

If C_1 were shorted the use of a long antenna would broaden the tuning of the receiver as a whole and considerable interference would result. The same effect would be true if we connected an antenna of too high capacitance to the S.A. post. Connecting any antenna to the L.A. post with the condenser unsoldered or open would result in no signal whatever or at best a very weak one.

In this receiver a portion of the volume control is in the antenna circuit, its adjustment affecting the amount of signal voltage furnished across the terminals of the primary winding L_1. Even with such a volume control in its minimum signal position a certain amount of signal will get through by capacity coupling unintentionally introduced through the proximity of the two windings, L_1, L_2, and we must include another volume control at some point in the receiver if a true *zero volume* setting is desired.

This second control is labelled R_2 and the two may be coupled to the same shaft for simplicity of operation. Another reason for the use of the two controls will be shown in another section of this book under the heading of "Cross Modulation."

If R_1 were open-circuited we would find that the volume was not changed in the normal manner as we rotated the control knob and that extremely loud signals resulted when the knob was in the "maximum" position. Derangement of R_2 has similar effects which will be noted a bit further on.

The peculiar circuit structure between the antenna and the grid of the first R.F. tube constitutes a "band-selector" or "band-pass filter" arrangement. Theoretically, a radio signal consists of a carrier wave and two *side-bands,* the width of which depends upon the modulation impressed upon the carrier. If two circuits be coupled so that a common impedance exists between the two, a double-peaked response will be obtained. In Fig. 31, there are shown the response characteristics of two tuned circuits coupled in a normal fashion as with a tube; the same two circuits coupled by means of an impedance common to both circuits are shown in comparison

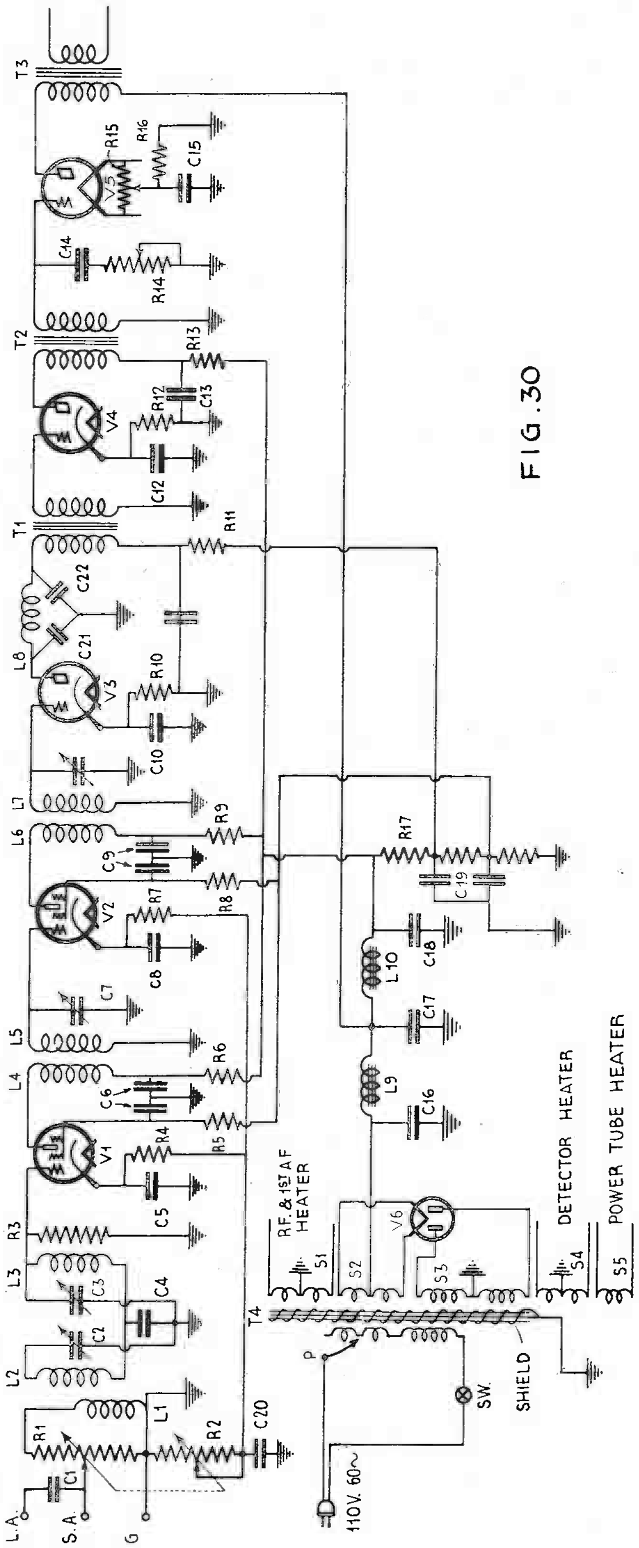


FIG. 30

with the double peak characteristic readily noticeable.

The manner in which the double-peak or "band-pass" circuit approaches the ideal square response curve is obvious. Another and more important use for the band-selector is described later under the heading of "cross-modulation." This peak separation does not remain constant over the tuning range and a value of C_4 (the coupling impedance) should be chosen such as to give the best effect over the entire band. With capacitative coupling as shown in Fig. 30, a condenser in the neighborhood of .01-mf. is usual. The short-circuiting of C_4 will result in no signal.

The resistance R_3 has no effect upon the circuit operation and is there merely to provide a return path for the grid circuit. Its value is usually about 3 megohms. Normally the resistance measured to ground from the grid of the first tube would be 3 megohms but with C_4 short-circuited the reading would indicate zero resistance.

An open circuit at C_4 results in loss of signal strength while an improper value of capacitance at this point will result in too broad tuning either at one portion or throughout the tuning range— or in excessively sharp tuning at one end.

The tuned circuits L_2C_2 and L_3C_3 are to all intents identical with the circuits employed in coupling the radio frequency amplifier stages except that they lack the primary circuits. The usual value for the maximum capacitance of each section of the gang tuning condenser is about .00035-mf. This calls for a tuning inductance of about 240 microhenries for covering the broadcast band.

Open or short circuits at any of these points will cause loss or weakening of the signal.

The Radio Frequency Amplifier Stages.

Plate voltages from the power supply are furnished to each tube by taking taps off at the proper point on the voltage divider. As is the common practice the grid circuits are returned directly to ground. Seemingly this would mean that the grids did not obtain a negative bias such as is required for the correct operation of the tubes. The bias is obtained by means of a resistance in the cathode circuit of each tube through which the plate current of the tube must flow.

Operation of the tube requires that the grid should always have a negative potential with respect to the cathode circuit. The true meaning is not distorted if we say that the cathode should be positive with respect to the grid. The current flowing through the resistance creates a voltage drop according to Ohm's Law and makes the cathode positive with respect to ground (and the grid) by that amount.

In determining the voltage characteristics of each R.F. stage we must first set the volume control at its maximum position. This short-circuits R_2 and leaves R_4 between the cathode of V_1 and ground. The condenser C_5 is in shunt across R_4 so as to effectively short circuit it as far as R.F. is concerned. This assures us that the biasing resistance has no effect on the signals.

The value of the by-pass condenser should be large enough that its reactance is substantially lower than the resistance of R_4 at all frequencies within the broadcast band.

The gain through the tube and consequently the "volume" can be controlled by varying the bias of the grid. This is done by increasing the resistance of R_2.

The resistances R_4 and R_7 provide a minimum bias for the tubes below which excessive plate current would be drawn. Increasing the resistance of R_2 increases the bias of the tubes and thus decreases their amplification. Short-circuiting of R_2 would mean that neither tube would vary in amplification with rotation of the volume control knob. This would be shown by means of a set analyzer if the plate current of the tubes failed to change when the volume control was rotated.

Open circuits in R_2, R_4, or R_7 would be indicated by no plate current flowing in one or both tubes. Short-circuiting of either R_4 or R_7 causes excessive current to flow in the plate circuit of the tube involved, since no bias would be applied to the grid of that tube at maximum volume setting.

An open resistance R_3 would result in loss of bias for the first grid and V_1 would consequently draw excess current. Short-circuiting of C_5 or C_8 also removes the biasing potential from the grids of their respective tubes and allows excess current to flow.

R_5, R_6, R_8, and R_9 are what is known as isolating resistances. C_6 and C_9 are each double condenser units by-passing the isolating resistance to which they are connected. The capacitance is made large enough so that it presents a lower impedance path to ground for stray R.F. voltages than do the resistances.

These circuits are another means of assurance that the radio frequency voltages stay in the circuits provided for them. Their failure to stay "put" results in oscillation. Short circuits at these points will result in loss of voltages on the tubes. Open condensers will cause loss of signal or oscillation.

Shielding of the individual stages has not been indicated in the sketch but it is necessary in all screen-grid stages and is preferable even in circuits employing three element tubes. The two coils L_2 and L_3 should be shielded one from the other. Individual shields or partial shields should be over the screen-grid tubes.

It is also desirable that the filtering resistances and condensers pertaining to each stage be shielded within the same enclosures as the coils.

The R.F. transformers consist of a primary (L4 and L6) and a secondary (L5 and L7). Design factors attendant upon the use of the screen-grid tube call for a primary with often as many or more turns than are on the secondary winding if the maximum available gain is to be realized.

The windings may be one over the other or the primary may be wound with fine wire on a small bobbin at the end of secondary or placed within the coil form. Open circuits in the primaries are readily traced by loss of plate voltage while open secondaries result in loss of grid bias and consequent heavy plate current. Poor connections may cause broadness of tuning and short circuits in either winding will result in loss of signal.

The Bias Detector.

The function of the detector is one of converting modulated R.F. signals into a direct current pulsating at the modulation frequency. In bias detectors such as that shown the tube is operated on a portion of its characteristic curve so that changes in the signal occurring in the negative sense have no effect while changes in the positive direction cause plate current to flow.

The choice of the resistance R_{10} is such that the plate current is close to zero when no signal is impressed on the grid. Fig. 32 shows this effect

FIG. 32

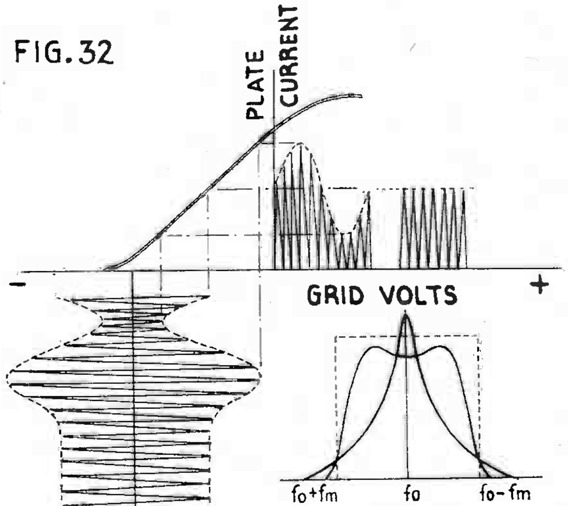


FIG. 31

graphically. It is essential that enough signal be impressed on the detector grid that changes under modulation occur only upon the straight portion of the characteristic curve of the tube. Otherwise the variations in plate current will not be images of the corresponding changes in the signal applied to the grid.

The by-pass condenser across R_{10} must be of sufficient capacitance to effectively by-pass the resistor at audio frequencies. This means that a capacitance of from .5 to 2 mf. must be used at C_{10}.

The plate impedance of tubes biased close to the plate current cut-off region is high and if the lower modulation frequencies are to be passed, the primary of the transformer T_1 must have a high value of inductance if it is to present a favorable load to the detector.

The system C_{21}, L_8, C_{22} represents a low pass filter which allows the passage of currents of audio frequencies but by-passes to ground all R.F. energy. C_{22} might well be omitted from the circuit but C_{21} may not be omitted without severe loss of signal energy and the possibility of a portion of the R.F. energy in the plate circuit of the detector tube being fed back to the R.F. amplifiers where it might cause serious oscillation problems. If we employ C_{21} only it must be of about .001-mf. or .002-mf. in which case a slightly deleterious effect on the high frequencies may be noted. Careful design of a system as shown permits the use of relatively small condensers —about .0005-mf. with a 10 millihenry choke having but little effect upon the higher frequencies of modulation. Total exclusion of any such arrangement results in choking of the detector tube at high volume due to the R.F. energy in its plate circuit as well as the possibility of regeneration.

A short circuit in L_8 may be detected by means of an ohmmeter but its effects will be rather obscure. An open R.F. choke will be instantly noted by loss of detector plate voltage. Short circuits in either of the two condensers will be obvious as they will result in loss of plate voltage and a drop in voltage across the lower portion of R_{17}. Opens in these circuits will necessitate a bit of trouble-shooting on the part of the service man as they will not be apparent on any set testers, and in cases of weak signals and regeneration they will probably escape attention except as a last resort.

R_{11} and C_{11} constitute another isolating filter and need little mention except that the condenser reactance should be small compared with the resistance at all audio frequencies. Open circuits in the condenser leads may mean poor quality and a short circuit will result in loss of plate voltage for all tubes obtaining voltage from a common tap on the voltage divider. An open resistance R_{11} will result in loss of the detector plate voltage and a shorted resistance at this point will cause excessive voltage to be applied.

Normally T_1 will be a low ratio transformer because of the requirement of high primary inductance. With the higher ratios the large primary would call for an excessively bulky secondary winding and one having a large self-capacitance. This latter fact would result in loss of the high audio frequencies. The circuit fed by this transformer needs little said about it as the effects of the various circuit elements normally and abnormally have been covered. T_2 may be of higher ratio than T_1 as its primary inductance need not be so high.

The circuit across the secondary of the transformer C_{14}, R_{14} constitutes a tone control. With the maximum resistance in the circuit the high frequencies would be transmitted undiminished while gradual decrease of the resistance permits the condenser to be more and more effectively in shunt across the secondary of the transformer. An open or short circuited resistance would be evidenced by the fact that the tone was either high or low pitched regardless of the setting of the resistance. An open condenser would show itself by constant passage of the highs regardless of the control setting. A shorted condenser in the tone control circuit would be indicated by the fact that the tone control would become a volume control with no signal passing when the control was in the "bass" position.

V_5 is the power output tube which differs but little from the circuit arrangement of the stage previous. The output tubes available are of the filament type and not indirectly heated as in V_4.

A center tapped resistance (R_{15}) provides a balanced point for taking off the filament end of the biasing resistance. This center tapped resistance should be large enough so as not to affect the regulation of the filament supply winding of the transformer by adding an appreciable load but should be small in comparison with R_{16}. Failure of R_{15} due to short circuit of one portion or open circuit of one side will result in excessive hum.

Opening of the biasing resistor will result in loss of plate current while a short circuit of either the resistance or its by-passing condenser (C_{15}) will result in the removal of the grid biasing potential with consequent dangerous increase in plate current.

It might be noted here that low output impedance tubes such as are employed in output circuits *must not be operated without* sufficient bias on the grid. *Total destruction of the tube will* result if the biasing potential is removed for even a few moments. Neither may tubes of this class be employed as resistance coupled amplifiers with the grid return path provided by a resistance of high value. Any slight overloading which causes grid current to flow will create a voltage drop across the grid leak resistance which will lower the effective grid bias and may result in the destruction of the tube. Where the bias is provided by the means shown in Fig. 30, this cannot occur since the increasing plate current will also increase the bias in a manner such as to bring conditions quickly back to normal.

The output transformer (T_3) serves to couple the output tube to the loud speaker which may be of any type—the ratio of the transformer being adjusted to match the impedance of the tube to that of the speaker winding. Open circuits in the primary of the output transformer result in loss of plate voltage.

The Power Supply System.

The primary winding of the power transformer (T_4) is shown with taps taken out so that the transformation ratio of the transformer may be adjusted to compensate for abnormally high or low line voltages such as are encountered in many districts. The higher the line voltage the greater should be the number of active turns in the primary.

Most modern power transformers are equipped with an electrostatic shield between the primary and secondary of the transformer which is either a thin sheet of copper foil or a winding of fine wire. This is grounded to the chassis and aids in reducing the effect of line noises on the output of the receiver.

If the primary winding has a number of short-circuited turns they will act as a shorted secondary and the power drawn from the line will be increased —the increased drain may not be great enough to blow the line fuses and the fault may be discovered but with great difficulty. Shorted turns in the primary circuit will, however, increase the ratio of transformation by lowering the number of active primary turns and the result will be evident in increased secondary voltages. An open primary will result in a completely dead receiver and the fault will be obvious. Open secondary or shorted secondary windings will result respectively in zero or low voltage readings. Short-circuited turns are usually evidenced by excessive heating and the service man should familiarize himself to the "feel" of transformers under operating conditions so that overheating may be recognizable.

In cases where all tubes operate at a single voltage —2.5 volts for example—many designers use a single secondary winding for all heaters and filaments. This will work out well in most cases although some stubborn cases of oscillation and hum have been traced to this source. In our receiver the secondary windings are provided so that the R.F. and first A.F. heaters operate from S_1, the detector from S_4 and the output tube from S_5.

The heaters are kept at ground potential by center-tapping the windings of the first two named directly to the chassis. The power tube winding is not center-tapped—the electrical center of the system being obtained by means of a center-tapped resistance R_{15}.

The biasing resistance can just as well be connected between the center tap of the transformer winding as in the manner shown. Short-circuiting of either half of any of these windings will result in a half-voltage reading at the heaters. S_2 and S_3 are the rectifier filament and high voltage windings feeding the rectifier tube (V_6).

Partial short-circuiting of one half of the high voltage winding will result in a lowered output voltage and excessive hum. An open circuit in one half will result in reduced output and hum. Either condition may be readily recognized by measuring the voltage across each half with an A.C. voltmeter.

The negative leg of the rectifier circuit is taken off at the center tap of the transformer and the positive terminal is at the mid-tap of the rectifier filament winding. The positive side may be taken off at either side, as well as at the center, as the voltage drop across the rectifier filament is so small as to create but slight unbalance of the circuit.

The ripple in a full-wave rectifier circuit such as is shown is a 120 cycle pulsation if a 60 cycle supply is used. In consequence, a low pass filter system designed to cut off all frequencies from 120 cycles up is employed in filtering out this ripple.

This is the simplest type of filter where design considerations are taken into account and employs two inductances and three condensers arranged as shown in the circuit. The output stage does not require a great deal of filtration because of the fact that the hum voltages in its plate supply are not large and are not subject to any amplification before reaching the speaker.

The inductance of a choke varies with the D.C. flowing through it and for this reason we effect a better over-all filtration by taking off the voltage supply for the power stage after it has been passed through but one section of the filter. The added inductance gained in the second choke by not passing the full load through it aids in the perfect filtration of the detector and other plate voltages where freedom from ripple is most demanded. Short-circuited condensers may be readily noted by the overheating of the rectifier tube and by loss of plate voltage in all circuits. Open condensers may be noted by added hum. Shorted turns in chokes are also noticeable because of increased hum and by slightly higher filter output voltages.

The total value of the resistance across the filter output depends upon the load of the various tubes brought to bear on the power supply and upon the desired output voltage. This is covered fully in the section on Vacuum Tubes. The voltage taken off for the plate voltage of the amplifier tubes is determined by the values of the isolating resistances in series with the plate leads. The voltage taken off at the power supply must be high enough to compensate for the voltage drop through these resistances. So also must the voltages tapped off for the detector and screen-grid circuits be correspondingly higher so as to compensate for this voltage drop.

In all the circuits the voltage at the plate must be high enough to compensate for the loss in voltage due to the fact that the grid biasing potential is, in each case, subtractive from the plate voltage. Thus, if the power tube is a '45 designed to operate with a plate voltage of 250 and a grid bias of -50 volts the voltage at the junction between the two chokes must be slightly over 300,—slightly over 300 because we must also compensate for the drop in voltage through the primary of the output transformer.

An open circuit in the most positive section of R_{17} would result in a higher voltage on all amplifier plates and a loss of screen-grid and detector plate voltage. A short circuit in this section would result in an excessive screen-grid potential on the R.F. tubes and a high plate voltage on the detector. Similar faults in the other sections of the resistance would have like effects depending upon the location of the fault. Breakdown of the resistance to ground would cause loss or gain in voltage in certain circuits dependent upon the location of the fault.

The by-pass condenser unit C_{19} is a further precaution against interstage reaction due to an impedance common to two or more circuits. This is a precaution made fairly unnecessary by the use of the isolating filters.

This is about all as far as our particular circuit is concerned, and we may now go on to discuss more specialized circuit arrangements. It should be borne in mind throughout the study of this section that our purpose is not to describe the servicing of any particular receiver but to instruct the student in the rapid location of faults through a knowledge of "cause and effect."

Variations in Circuit Design.

Now let us see the various means which may be applied to bring about the same end. Some of the variations to follow have little to recommend them other than their originality, while others enable the manufacturer to produce a cheaper though better receiver. Starting at the antenna and skipping the volume control, the first item is the antenna input circuit.

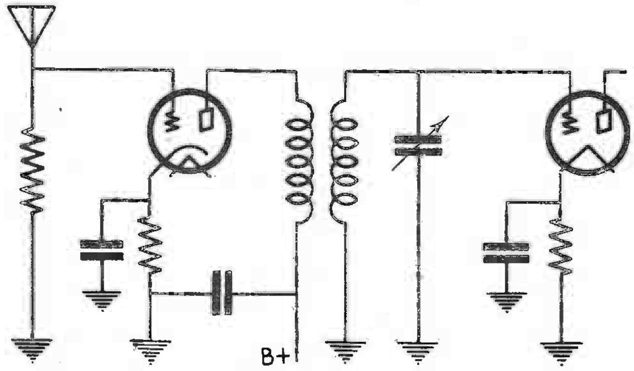


FIG. 33

Some receivers—now more or less obsolete—achieved single control without the necessity of careful design by the simple expedient of using an untuned vacuum tube as a coupling device. This saved the labor of designing an input circuit in which the antenna characteristics did not affect the tuning of the first circuit, but otherwise was rather useless since the gain through the coupling tube was negligible. Without this tube, in the absence of accurate inductances and condensers, it was necessary to employ an additional control in the antenna circuit or a device which changed its value with the tuning of the circuit.

In Figs. 33 and 33A there are shown an untuned input circuit and the input circuit of one of the earlier Bosch single control sets in which a variometer (variable inductance) was coupled to the condenser shaft and counteracted the effects of the antenna over the entire band. Employing the first type in the neighborhood of a strong local transmitter allows cross-talk to take place, cross-talk being the condition in which the local signal is superimposed upon others quite removed from it in frequency as differentiated from ordinary broadness of tuning where the interference takes place only on desired stations having a frequency close to that of the nearby transmitter. A wave trap might cure this condition if it were not too aggravated. Misadjustment of the variable inductance on its shaft in the second type would result in broadness of tuning accompanied by a loss in signal strength.

In some types of receivers the antenna is connected to the high potential (farthest from ground) end of the first tuning inductance and is coupled

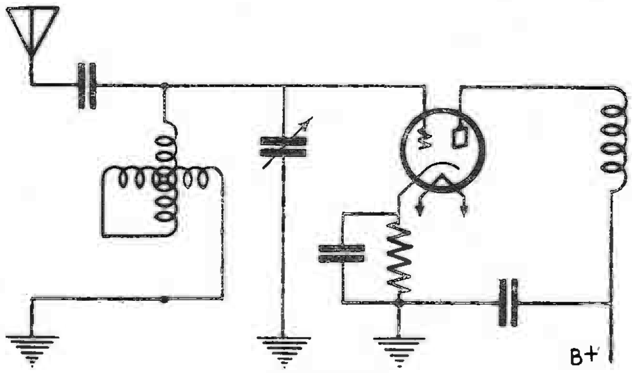


FIG. 33-A

thereto by means of a small variable condenser. This means that the receivers are ganged on a standard antenna at the factory with the coupling condenser set at its mid-point. After installation, it is necessary to make an adjustment of the coupling condenser which will remain in a fairly efficient state of operation until the constants of the antenna are changed to a marked degree.

In the majority of modern receivers, the tuning arrangement between the antenna and the grid of the first radio frequency amplifier tube has been made independent of the antenna characteristics by virtue of long research in the laboratory.

In certain of the receivers licensed under the patents of the Hazeltine Corporation, the antenna coupling transformer (two windings coupled magnetically are always referred to as a transformer) has a primary or antenna coil consisting of many turns of fine wire in a slotted form placed inside the tuning coil or secondary. This antenna coil resonates at some frequency just outside the broadcast band—at about 500 kc. for example—the capacitance tuning the coil being the inherent capacitance of the antenna. In changing from an antenna of fairly usual characteristics to a very short one, resonance is maintained by shunting a small condenser across the antenna and ground terminals as shown in Fig. 34. This condenser makes up the deficiency in capacitance. Trouble in such systems may be due to an open or a short-circuited primary winding—or in the "short antenna" position, to a shorted or open compensating condenser.

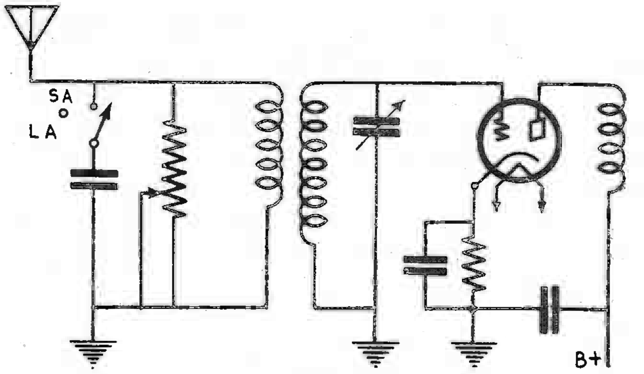


FIG. 34

Band-Selectors.

Band-Selectors, Band-Pass Circuits or Coupled Circuit systems, such as we have employed in the preliminary portion of our receiver, are used not only in an attempt to attain the square response characteristic shown in the dotted line in Fig. 31, but because of the fact that, even though the circuits are less "sharply tuned" as far as cutting off of the desired side-bands is concerned, designers are often able to obtain better selectivity so far as the sloping off of the "petticoats" of the curve is concerned. This is shown in the figure.

Band-Selectors may be coupled in several ways as shown in Fig. 35. In the first two, where the coupling is obtained by an inductance common to the two circuits and by magnetic coupling, the distance separating the two peaks becomes greater as the frequency becomes higher. Where the coupling is capacitative the separation is greater at the low frequency end of the tuning range.

It is also possible in the manner shown to achieve a combination of capacitative and inductive coupling so as to render the separation between the peaks constant throughout the range. The choice is in the hands of the individual designer as an efficient arrangement can be made in either fashion. Where the coupling is inductive, the extra resistance providing the grid return for the first tube is unnecessary as the circuit is not broken.

Interstage Coupling Devices.

In receivers in which an attempt is made to actually achieve the ideal square response curve, use is made of band selectors as interstage couplings replacing the transformer coupled system of Fig. 30. The simplest way of doing this is to tune both primary and secondary circuits of a transformer so arranged, so that the inductive coupling between the windings is of the correct value.

This method is shown in Fig. 35 where it may be readily seen that the first condenser is at high potential. This is not theoretically wrong, but care must be taken in working with receivers of this type if accidental short circuits are to be avoided. The other arrangements in Fig. 35 are methods of coupling by feeding the plate supply of the tube through

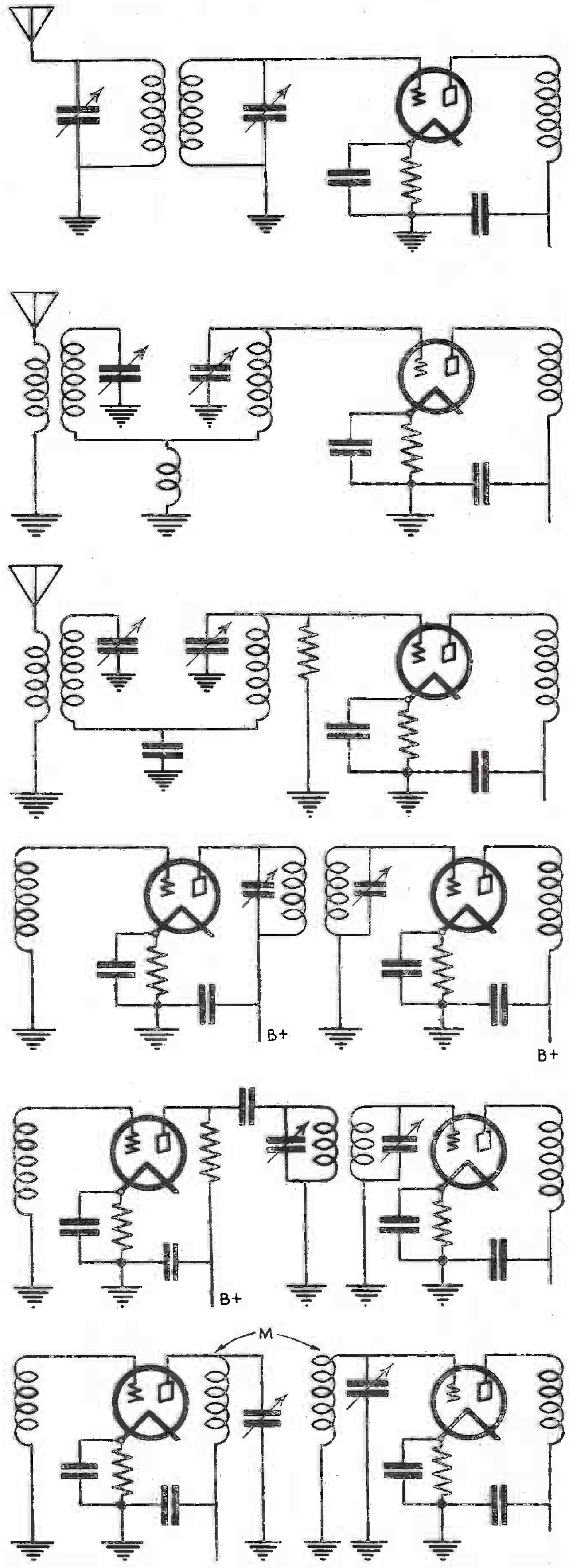


FIG. 35

a choke or resistance so as to keep the D.C. out of the coupling circuits. This may also be done by the use of a large fixed condenser in series with the plate tuning coil and condenser—so large as to have no effect on the constants of the circuit. The numerous circuits shown in the figure have been used in various commercial receivers.

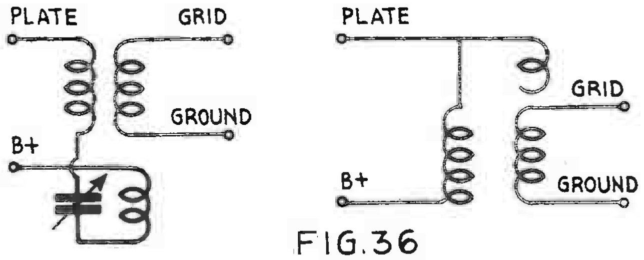


FIG. 36

In order to make the sensitivity of a receiver at the low frequency end of the range equal to that at the high frequency end, it is at times necessary to employ special circuit arrangements. One method used in many receivers of today is that of resonating a portion of the primary to some frequency just outside the low frequency end of the broadcast band.

The increased response, due to the approach of the resonant condition as the low frequency end of the range is reached, is then used to counteract any relative inefficiency existing in the coupling system. Another method utilizes a single turn of wire wound close to the secondary to achieve a capacitative coupling which reduces the amplification at the high frequency end of the range, thus equalizing the over-all gain. These two systems are shown in schematic in Fig. 36.

Introduction of the additional windings and the tuning condenser adds to the possibility of failure and in receivers where these arrangements are employed careful note should be taken that all is well in each coupling system. In the first mentioned where the double primary is employed, it should be noted that the one primary is wound in the reverse direction from the other. In replacing interstage coupling transformers, care should be taken that the leads are properly connected.

A single tuned winding may be employed in the so-called "tuned impedance" systems—the tuned

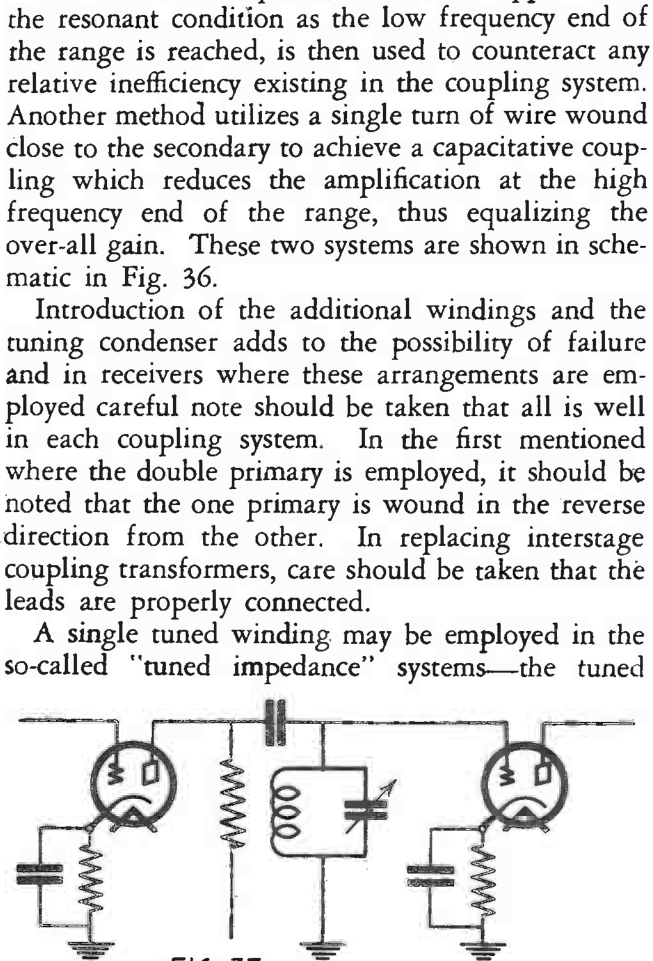


FIG. 37

circuit being either in the grid or plate circuit as shown in Fig. 37. The coupling condensers are very small and are, in some cases, subject to failure. Failure of the condenser results in a simple short circuit to ground of the plate voltage of the preceding tube in the system shown in Fig. 37.

In Fig. 37A, a more serious condition exists, as a short circuit of the coupling condenser will result in the plate voltage of the preceding tube being directly on the grid of the next. This high positive grid bias will result in the destruction of the tube due to the enormous plate current which will flow. Subsidiary apparatus may also suffer if such failure takes place.

Receivers employing the screen-grid tube depend for freedom from oscillation upon the inherent characteristics of the tube and a complete isolation of the various circuits by filtering and by shielding.

With the three electrode tube, the grid to plate capacitance of the tube was so high that a portion of the amplified voltage was fed back to the grid circuit through the tube itself resulting in oscillation.

Many "losser" methods were employed for the remedy, such as the insertion of a resistance in series with each grid. These resistors might give trouble due to a short circuit causing oscillation, or an open circuit resulting in a dead receiver, with no bias applied to the grid of the tube in question.

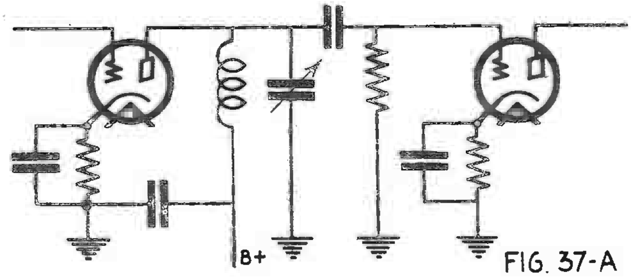


FIG. 37-A

The most satisfactory methods were those in which a capacitance, or a network of inductance and capacitance, was employed to balance out this feedback voltage. This is not a technical work and we will not enter here into a description of "neutralization". It suffices to say that the adjustment of these circuits is quite delicate and any disturbance of the neutralizing condensers requires a complete re-neutralization of the set. The manner in which this is done is described in another portion of this manual under the use of service apparatus. Fig. 38 shows a representative group of such arrangements in which the short circuits which might cause trouble are readily apparent.

Some receivers—notably the Sparton line, employ a four-circuit band-selector in which a fair approximation of the ideal square response characteristic is obtained. This is followed by a "broadband" R.F. amplifier employing untuned transformers. These are highly developed air core transformers giving amplification over the entire broadcast band. In these receivers, it is interesting to note that the functions of selectivity and of amplification are isolated one from the other. Connected to an open antenna without the tuning unit, the amplifier would pick up and amplify a conglomeration of everything that happened to be on the air at the time.

These receivers are of more interest than importance, but a mention of untuned amplifiers is essential as many modern receivers employ a single untuned stage for one reason or another. The reason may be one of desiring slight additional gain without the necessity of an extra condenser or it may be, as will be seen shortly, that the succeeding tube has characteristics which do not fit in well with the operation of tuned circuits.

Detectors are probably the least understood of all the circuit elements which the service man may be called upon to check, and while we are mostly interested in circuit arrangements in this particular chapter, the one covering "Vacuum Tubes" will deal at length with the problem.

Detector Circuits.

There are as many types of detectors as one can shake the proverbial stick at. For the most part, they are divided into two classifications—"grid circuit" and "plate circuit," depending upon whether the audio frequency component first makes its appearance in the grid or the plate circuit of the detector tube. Plate circuit detection was shown in our receiver and the curve in the figure showed that the tube received a large negative bias so as to operate on a portion of its characteristic favorable to the detector action.

Grid circuit detectors differ from the others in that they are not biased negatively, employ the familiar grid condenser and leak, draw a rather high plate current for the plate voltage applied, and have a low plate impedance in comparison. While the majority of grid leak detectors are found to have a grid condenser of .0005- or .00025-mf. and a leak of from 1 to 5 megohms, the quality of reproduction may be distinctly improved at a slight loss in sensitivity by replacing these with .0001-mf. condensers and leaks not larger than 250,000 ohms. If the sensitivity is not cut down too much, replacement of the old leak by one of 100,000 ohms is still better. Except that one may expect to find a fairly high plate current flowing, the grid circuit detector shown in Fig. 39A

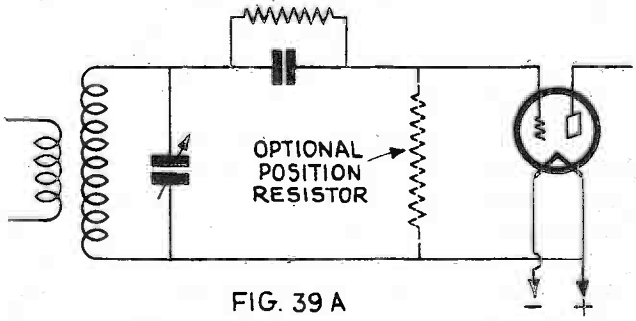


FIG. 39 A

does not differ greatly from the plate circuit type as far as service requirements are concerned.

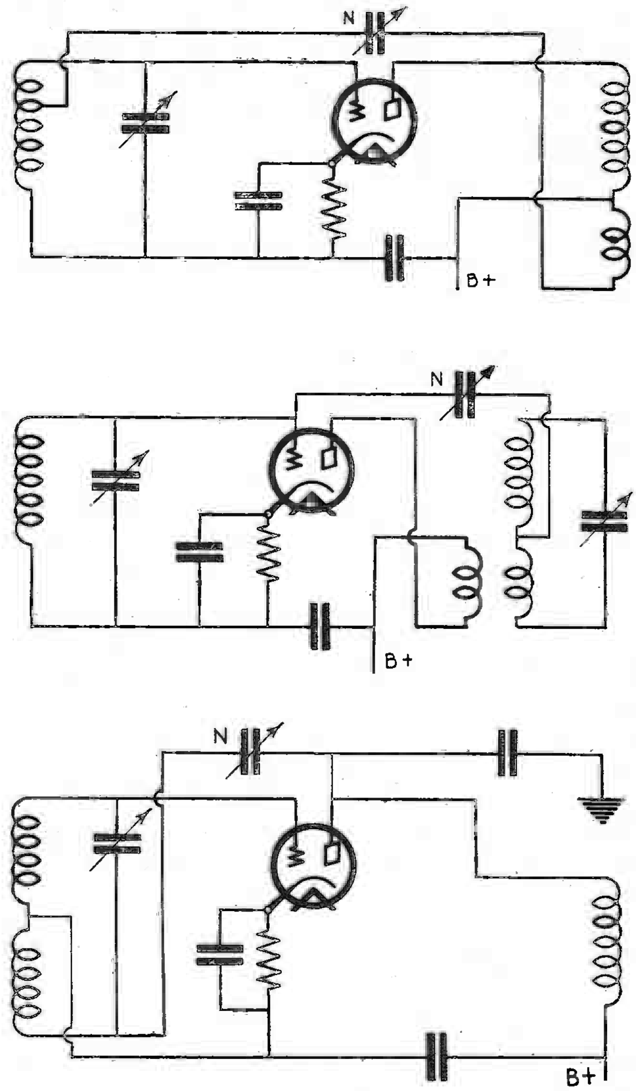


FIG. 38

There is one important fact in connection with the two types of detectors which will be put to use as a service aid in another section of this publication. The plate circuit detector normally operates with a rather low plate current which increases with the signal intensity, whereas the grid circuit detector operates with a relatively high plate current which decreases in value under the effects of the signal.

The choice of detectors rests with the individual designer and equally good quality of output can be obtained with either, provided the limitations of each are recognized.

The original vacuum tube detector was the Fleming valve—a two-element valve consisting of a hot filament and a plate not unlike those of the rectifier tubes in use in many receivers today. Its ability as a detector of radio signals was based upon the fact that it is conductive in one direction only. That is to say, that current will flow only at such times as the plate is at a positive potential with respect to

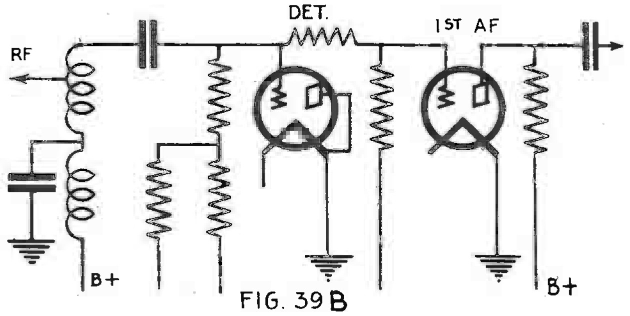


FIG. 39B

the filament or cathode.

A device of this type is not as efficient a detector as a three-element tube, but certain designers have found that by employing a three-element tube with the grid and plate elements tied together so as to operate as a two-element detector, a certain freedom from distortion in the detector stage can be obtained.

A circuit of this nature such as employed commercially in the Philco Transitone receiver is shown schematically in Fig. 39B. It should be noted here that little can be learned of what is actually going on in the circuit through the use of the usual testing equipment, and that lack of sensitivity in the receiver due to a detector tube which is under par had best be checked by replacing the tube in question by one having known characteristics. Note that no active plate voltage is applied to any of the tubes employed in various receivers as "diode" detectors.

Volume Control.

It should be noted that but few of the receivers on the market today have volume controls following the detector. This is because of the fact that the major portion of the distortion normally encountered in radio receivers is due to overload of the detector.

Volume control is achieved either by the use of a resistance across the antenna input circuit, by varying the grid bias or screen grid potential, or by a combination of the two.

In the latter case, the two controls are so arranged that they are driven by a single control shaft. In one particular instance—as shown in Fig. 40, a

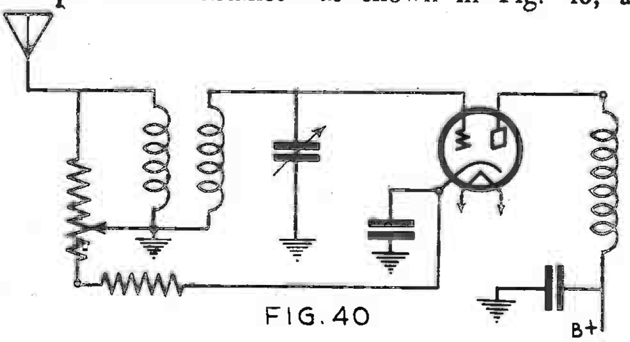


FIG. 40

single resistance is employed to operate in such a fashion that rotating it toward the minimum setting decreases the resistance across the input circuit at the same time that the bias is being increased.

This is done by employing a potentiometer having its center arm to ground, one end connected to the high potential end of the antenna input coil, and the other to the cathodes of the R.F. tubes. A single fixed resistor in series with the cathode end of the potentiometer assures us that a certain minimum bias is applied to the grids of the R.F. tubes at the maximum volume setting.

We have already set forth, as our reason for employing an additional control, the fact that, with the volume control in the antenna or across any one of the tuned circuits, sufficient stray coupling would exist to make a zero setting impossible. Now one may ask why it is not sufficient to increase the bias or decrease the screen-grid potential over such a range that the signal would be entirely wiped out if desired. This would also involve certain difficulties, for under these conditions the tubes are operating on portions of their characteristic curves conducive to the effects of cross-modulation. If, however, we employ a mixture of the two, the decreased input voltage due to the smaller resistance across the input circuit removes the undesired signal likely to cause cross-talk at the same time that the volume is being decreased by the increase in biasing potenital or the decrease in the screen-grid voltage. The method employed in varying the screen-grid potential is shown in Fig. 41.

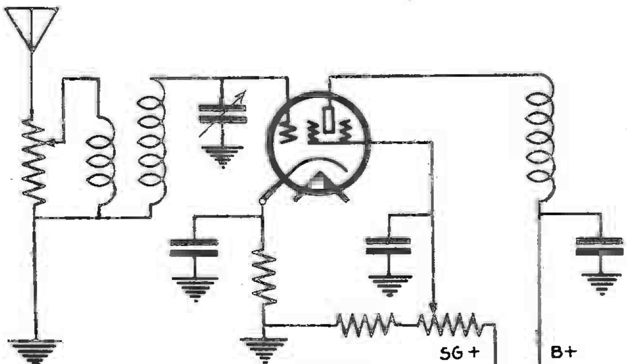


FIG. 41

Automatic Volume Controls.

Sales bulletins on receivers employing automatic volume controls give two reasons for their use—one being the reduction of "fading" and the other the ability to tune through locals without a terrific "blatt" from the speaker as the dial is moved across the frequency setting of some near-by transmitter.

By setting the manually operated control at some one position, the dial may be swung across its full range without the volume of any single station being greater than that of the others. The majority of the commercial receivers employing this feature do so in a manner whereby the automatic control is effected by a variation in the bias on the R.F. tubes, depending for its degree on the amplitude of the received carrier.

Quite naturally, if the volume control operates so

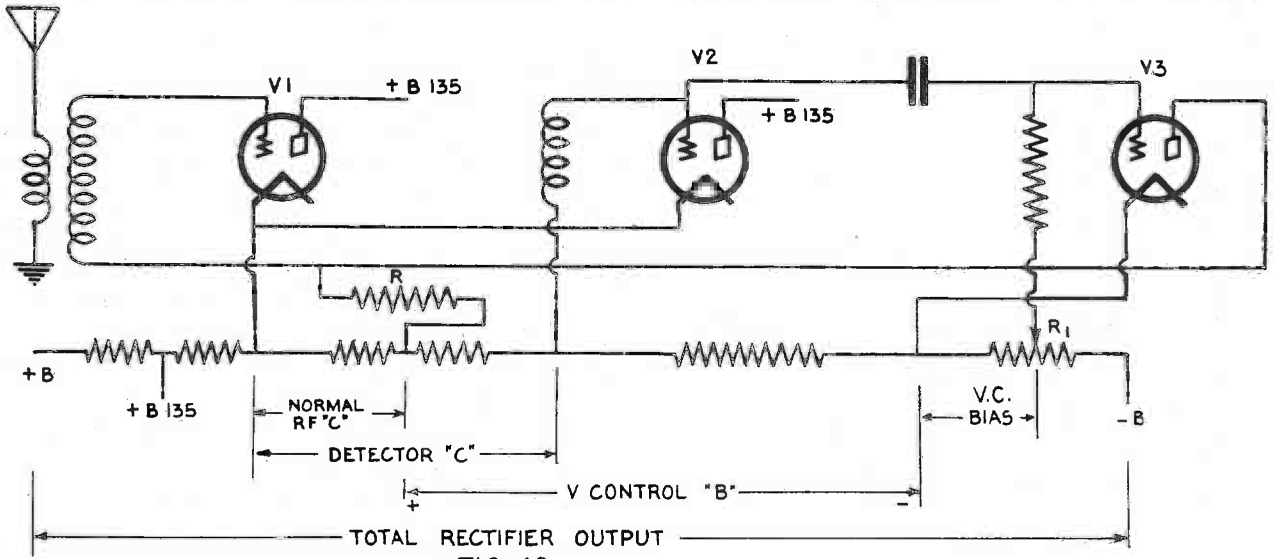


FIG. 42

as to limit the gain through the amplifier, it is essential that it should not work fast enough to wipe out the variations in carrier amplitude due to modulation. This is determined by choosing the value of coupling condenser feeding the controlling tube in such a manner that the system will not operate rapidly enough to affect the quality of reproduction. For this reason, service men working on such receivers should not replace this condenser with one of another value should a replacement become necessary.

Since the majority of automatic volume control tubes operate on a similar principle, it will not be necessary to describe a great many systems—representative ones of each type will suffice to demonstrate the principles of their operation.

Fig. 42 shows the type of control employed in some of the Radiola models. The R.F. amplifier tubes are represented by a single tube V_1 biased to a certain minimum value by tapping off at a point on the voltage divider about three volts negative, with respect to ground, through a resistance "R" which normally has no current flowing through it and, in consequence, does not affect the operation of the receiver. V_3 is the volume control tube which takes its operating signal from the grid of the detector tube.

This tube is in reality a form of vacuum tube voltmeter and is so biased, by means of the manual control R_1, as to permit a certain value of plate current to flow for a given amount of signal on its grid; note that "R" is also the plate circuit resistance of the volume control tube. If the control tube is biased so that no plate current flows, the drop across "R" is zero but, when under the influence of a signal the control tube draws plate current, there is a voltage drop across "R" in such a sense as to increase the negative R.F. bias. The biasing potential applied to the R.F. grids is now the normal bias plus an additional negative potential due to the drop across "R" and the volume is reduced to a degree determined by the manual setting of the control tube bias.

It is still necessary to employ a manual volume control in the antenna circuit as, otherwise, tuning across the range between stations would leave the receiver in its maximum condition of sensitivity and the noise level would be high. With the constants of the circuit in correct proportion, all signals will give the same output across the speaker—an output which is controllable by adjustment of the bias on the grid of the control tube.

Certain of the Stromberg-Carlson receivers employ an automatic volume control which is theoretically similar, but is slightly more refined in the sense that the first R.F. tube receives a different control voltage than does the second—the third is not controlled. In these receivers, the input for the control tube is taken from the plate circuit of the third R.F. stage through a .00025-mf. condenser and a 2-megohm leak. The plate circuit of the control tube is connected to ground through a pair of 100,000-ohm resistors in series. The drop across one of the resistances furnishes the additive bias for the second R.F. tube, and the drop across the other, the bias for the first R.F. tube. The skeleton arrangement of the circuit as employed in the Stromberg-Carlson 846 receiver is shown in Fig. 43. An almost identical arrangement is employed in the Kellogg 523 receiver.

The Two Element or "Diode" Detector as an Automatic Volume Control.

Certain manufacturers—Philco, for example—employ the diode detector as an automatic volume control tube. The circuit arrangement of such a control device is shown in Fig. 44. Note that the detector input is through a special type of untuned transformer as the low input resistance of the diode does not lend itself to the use of tuned circuits. The diode detector gives a relatively small output requiring an additional stage of A.F. amplification but has the advantage of not requiring an added tube for the purpose of automatically controlling volume.

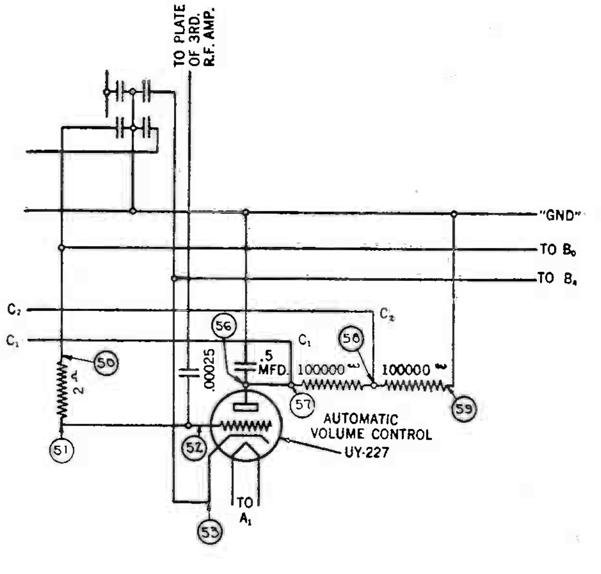


FIG. 43

The grid and plate of the tube are tied together and act as the plate of the diode. Connected between this plate and the cathode are two 100,000-ohm resistors. The midpoint of these series resistors connects through a 500,000-ohm isolating resistance to the grid of the third R.F. tube. The grids of the first and second R.F. tubes take their bias through the 250,000-ohm resistance which couples the detector to the first A.F. tube. Appropriate isolating resistances are employed as shown to prevent coupling between the R.F. circuits.

In this type of receiver, the automatic effect is not under manual control, the circuits being so proportioned that the output of the first amplifier tube (called the "detector amplifier") is a constant value regardless of the strength of the incoming signal. In receivers of this type where the signal at the detector output is limited at all times to a fixed value, the sensitivity of the receiver is at all times varying in accordance with the received signal.

Distortion Limiting Devices.

The same end may be accomplished where a three-element detector is used by a circuit arrangement such as appears in Fig. 45 where the grid returns of the R.F. stages and the detector are connected to ground through a series of 60,000-ohm resistances. The criterion of distortion is the flow of grid current in the detector circuit.

The bias of the R.F. and detector circuits is taken in the usual manner by the use of resistances between the cathodes and ground. Additional bias is provided due to the drop through the 60,000-ohm resistance in the detector grid circuit which occurs when overload of the detector causes grid current to flow. This system is not a true automatic volume control as it has no effect in leveling all signals to a single output strength—it merely acts as a volume limiting device preventing overload on strong signals. This arrangement is employed in the Amrad 84 receiver and in the Crosley 77 and 84 models.

Although there are other methods of automatic volume control, they are not common in commercial receivers and when encountered can readily be understood by reference to the types described here. As we noted before, the characteristics of volume control tubes are not readily checked by service instruments, and the best method of checking them is by a continuity test of the circuits and by the replacement of the control tube by a tube known to have good characteristics in other circuits.

Phonograph Pick-ups.

Most receivers sold today are equipped with input connections for phonograph pick-ups. There are many ways in which a device of this character can be connected into the circuit, the major consideration being whether the pick-up must be connected into the detector circuit or into the input to the first A.F. tube.

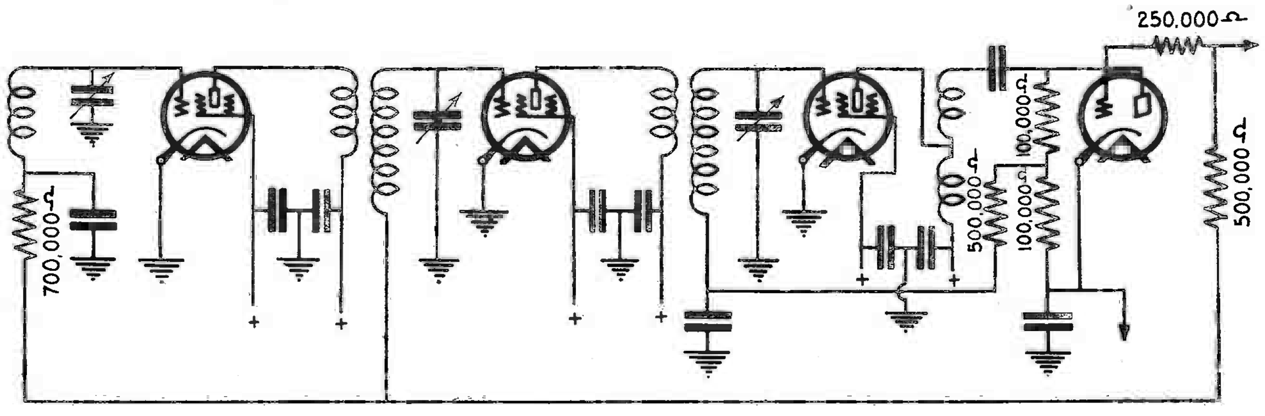


FIG. 44

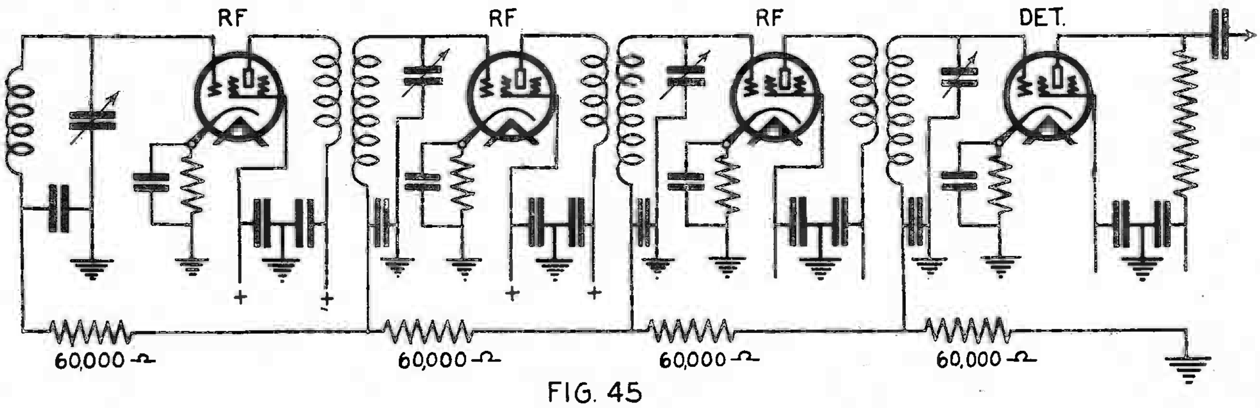


FIG. 45

In those receivers which employ a single stage of A.F. amplification, the gain between the A.F. input and the speaker is insufficient for the purpose, and connection must be made in such a manner that the detector is used as an A.F. amplifier when playing records. This demands also that the detector be biased as an amplifier when so used. There are so many ways in which this may be accomplished that the writer will take only three examples to establish the point.

In the Victor model 7-26, the coupling transformer between the detector and the first A.F. tube has a tapped primary, so that one section of the winding matching the impedance of the pick-up device can be tapped off by means of a change-over switch. When making the change-over, the switch automatically breaks the plate voltage connection to the detector tube so that interference from broadcast programs can not be superposed on the recorded music. Fig. 46 illustrates this point.

In this receiver, the two A.F. stages give adequate gain, but in a receiver such as the Sparton model 931 where a single A.F. stage is employed, it is necessary to employ the detector as an A.F. amplifier when reproducing recorded music.

When the pick-up is plugged into its jack, the jack sleeve shorts out the detector biasing resistance with a 1000-ohm unit as shown in Fig. 47. At the same time, the pick-up is connected in series with the input of the detector. When a method of this kind is employed, care should be taken that broadcast interference does not spoil the reproduction.

In the Stromberg-Carlson receivers, the pick-up is connected as shown in Fig. 48—without changing the detector bias. The level of the input to the detector is so low, that the distortion incurred by this use of the detector tube as an A.F. amplifier with

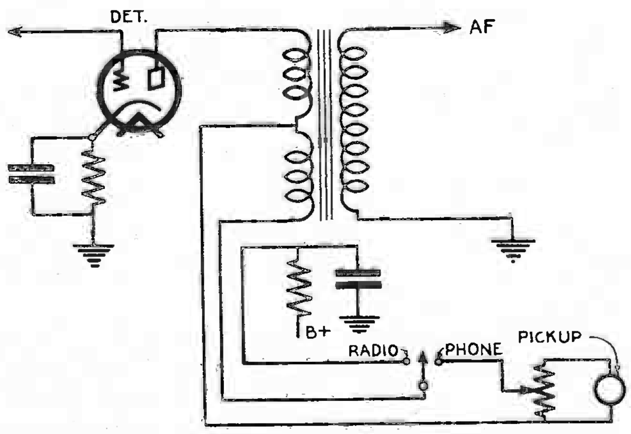


FIG. 46

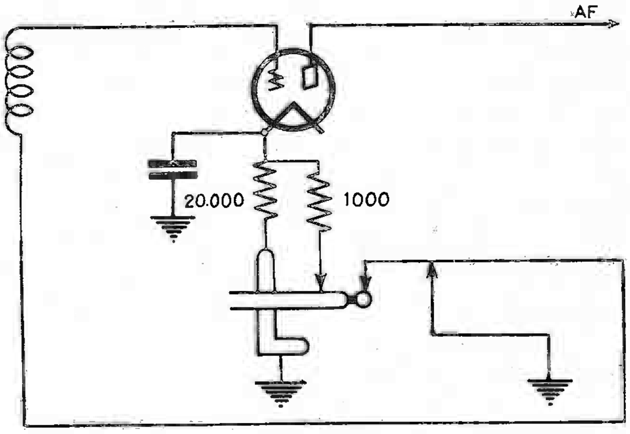


FIG. 47

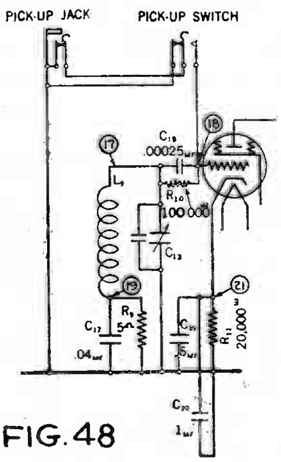


FIG. 48

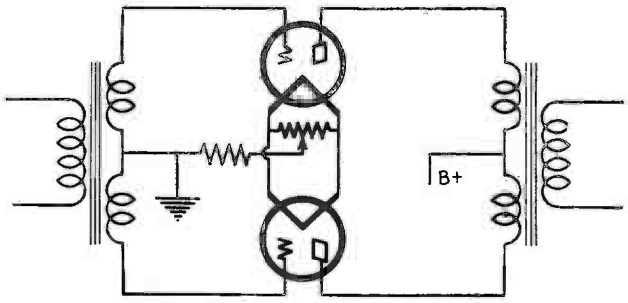


FIG. 49

improper bias results in negligible distortion. Connecting the pick-up from grid to ground in this fashion effectively short-circuits the broadcast reception while the pick-up is in use, so that no interference from this source occurs.

From the figure, it will be seen that although "bias" detection is used, a grid leak and condenser are in the circuit. These have no effect on the operation of the circuit either for radio or phonograph reproduction, the reason being the prevention of short circuit of the phonograph pick-up by the secondary of the R.F. transformer.

The pick-up may also be connected directly across the secondary winding of the first A.F. transformer in sets having two A.F. stages. The impedance is so high in the transformer secondary circuit that it has little or no short-circuiting effect on the pick-up. In all of the circuits described, a volume control separate from the receiver is necessary. In those sets which have been described which use manual volume control following the detector, a method of pick-up connection might be employed which permitted the use of the regular volume control during record reproduction.

Push-pull Amplifiers.

There are many advantages to be gained through the use of vacuum tubes in the push-pull connection. First, the fact that the circuit cancels out harmonic distortion enables one to obtain an output far greater than twice that obtainable with the single tube. Secondly, the ripple voltages due to poor filtering of the supply are also canceled out so that less filtration is necessary. Thirdly, the fact that the direct currents in the output transformer cancel out enables the use of a cheaper output transformer than is possible with the single tube.

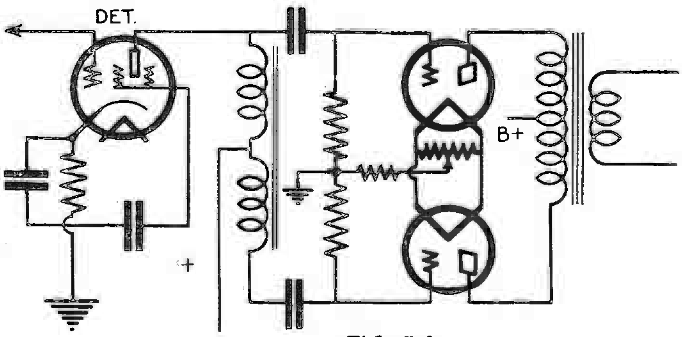


FIG. 50

Other advantages, such as the fact that the biasing resistance does not require a by-pass condenser across it, are also useful in cheapening the receiver without loss of quality. All in all, it may be said that a push-pull output stage more than doubles the output of a single tube without adding more than the cost of the additional tube to the price of the receiver.

Troubles in push-pull circuits caused by an open in one side of the input or output transformer, result in loss of grid or plate voltage in the tube involved. These faults are readily checked with the normal type of servicing equipment. A typical push-pull circuit is shown in Fig. 49.

The Single A.F. Stage.

Many types of detectors are operated with so high an input from the R.F. amplifier that an intermediate A.F. amplifier preceding the output stage is not necessary. There is no need for special mention of the circuits as they do not involve the use of any unusual connections or apparatus.

It has already been noted that in such receivers a phonograph pick-up must be connected into the detector circuit in order to achieve adequate gain for operation of the loud speaker at a reasonable degree of volume.

Some of the newer receivers, employing screen-grid detectors with push-pull amplifiers, employ slightly involved circuits such as that shown in Fig. 50 and used in the Victor model R-15. In this case, the split choke acts as an autotransformer of 1 to 1 ratio and feeds the plate voltage to the screen-grid tube as well as providing the signal for the grid of one of the output tubes.

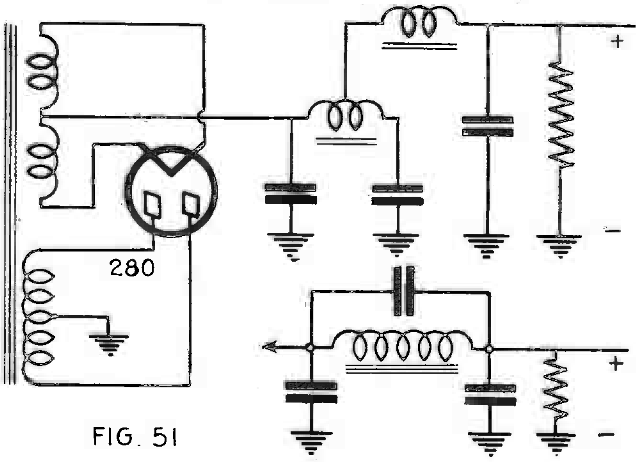


FIG. 51

The coupling condensers are .025-mf. units and the grid leaks providing the grid return path are 430,000 ohms each.

Breakdown of the coupling condensers will put the full plate voltage on the grid of one of the output tubes. The high plate current resulting from this positive grid bias will result in destruction of the tube before the service man has an opportunity to correct the defect. Open circuit in either of the grid leaks will result in loss of bias and high current through the tube involved.

Tone Controls.

The tone controls employed in modern receivers are employed to limit the higher frequencies so as to produce a more "mellow" effect. They may be of the type shown in our Fig. 30, or may be made up of a series of condensers with a switching arrangement to vary the capacitance introduced in shunt with the A.F. channel.

In neighborhoods where the "man-made" interference is exceptionally great, a control of this nature helps to cut down the interference which consists mainly of high frequency impulses.

In extreme cases, the service man called in to remedy such noise in a receiver not equipped with "tone control" can effect a cure by connecting a condenser of from .00025- to .01-mf. across one of the A.F. transformers.

Filter Variations.

Filter systems for radio power supplies may be of the tuned or "brute force" type. In the tuned type, an example of which is shown in Fig. 51, various savings in the total capacitance of the condensers required in the system may be effected. They require extremely careful design, however, and it is essential that, in making replacements, the parts used be identical with the original. Otherwise, hum may result regardless of the fact that a larger condenser than was originally employed may have been used in replacement.

The theory of the type shown is that the small portion of the first choke and the condenser which connects it to ground are resonated to the ripple frequency (120 cycles for a full wave rectifier with 60 cycle supply), and if the resistance of the choke is low compared with its inductance, they offer as a "series resonant circuit" a virtual short circuit to ground for all currents of that frequency.

The second type of tuned filter, where the condenser is connected in parallel with the choke, operates on the opposite principle—that the parallel resonant circuit formed offers a high impedance to the resonant frequency.

Brute force filters are simply low-pass filters so designed that the cut-off point above which frequency they will transmit nothing is below the ripple frequency. This means that a larger filter is necessary with half wave than with full wave rectifier circuits.

Despite the savings possible with tuned filters, many manufacturers do not use them, for the high capacitance with small bulk available in the shape of electrolytic condensers offers as economical a means of filtration.

The filter circuits we have shown so far show the chokes in the positive side of the filter system with the entire negative portion of the circuit at ground potential.

Certain receivers employ variations in which the filter chokes are in the negative portion of the circuit. The method employed in the Victor R-15 is shown in Fig. 52. The second inductance which connects to ground from the tap on the first inductance is the field winding of the dynamic speaker.

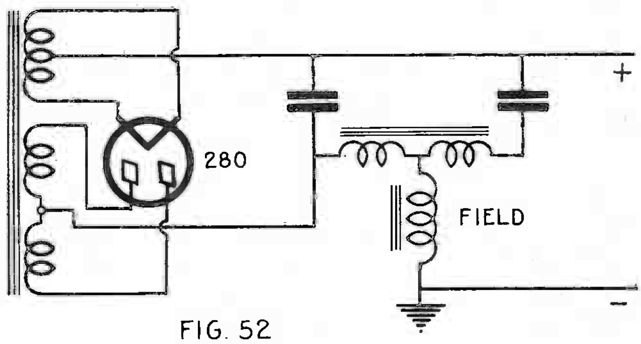


FIG. 52

Do not assume that the chokes in a receiver are at maximum potenial and that grounds at that point will be indicated by a loss of plate voltage in all cases. A ground in the filter reactor will result in a short-circuited field coil in the speaker and a high plate voltage at all points in the receiver.

This is, of course, not the only case in which the field winding of the dynamic speaker forms a portion of the filter circuit. In nearly all cases, the field is energized by passing the plate current through it. There are countless methods by which this may be done and a very few of them are shown in Fig. 53. In the first sketch, the field winding is the only inductance in the filter system, the capacitance being obtained from high-capacity electrolytic units.

In the second sketch, the field winding has been designed with the proper D.C. resistance to act as the biasing resistor for the output tubes. An advantage of this system is the fact that the speaker can be replaced with a resistance of the correct value if it is desired to operate the receiver with a magnetic speaker or any other external speaker.

In the third method shown, the speaker field provides the voltage drop for the negative bias of the output tubes. The drop is slightly high for this

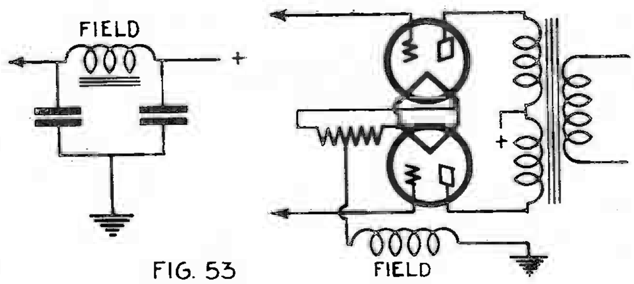


FIG. 53

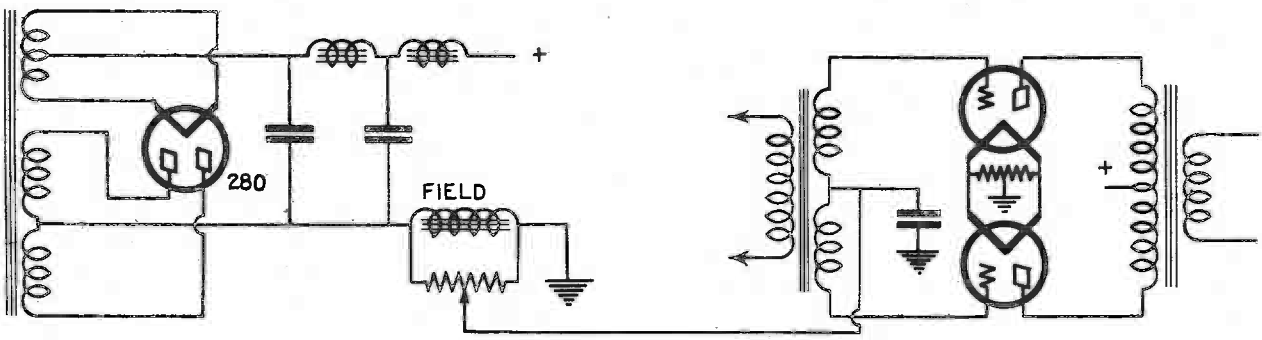


FIG. 53 A

purpose in the Atwater Kent 55, from which the circuit is drawn, and a voltage divider across the field winding taps off the proper voltage. This divider carries but a slight portion of the current and no current whatever flows in the biasing circuit.

The speakers employed in these connections are specially designed for the purpose and, where replacement of the loud speaker is found necessary, care should be taken that one having the proper field winding characteristics is chosen if an identical one is not available.

Voltage Distribution in Power Supply Circuits.

In the circuit shown in Fig. 30, the voltages for the plate circuits of the various tubes are obtained by a combination of the voltage divider and voltage drop methods. Either of these may be employed in a receiver and a combination of the two is not at all unusual.

In any event, the "bleeder" resistance across the output of the rectifier is essential to the safe operation of the power supply, especially in the case of heater type tubes, where there is a short interval following the throwing of the switch during which no plate current is drawn by the tubes. If there were not some sort of load across the power supply output, the voltage across the power supply condenser would rise to high values during the initial surge.

The load is also necessary if we are to operate the power supply in a manner so as to allow for considerable variation in plate current without unprecedented departure from the desired voltages. This wasted current establishes a condition where variations in the plate current, drawn by one or more of the tubes, represent so small a percentage of the total current drawn from the rectifier tube that there is but slight change of the output voltage. The methods of design will be taken up later in discussing the characteristics of the rectifier tubes.

The voltage across the output of the rectifier and filter must be at least as high as the total plate and bias voltages required by the output tube—300 volts in the case of the '45. For the tubes employing lower plate voltages, the drop may be secured either by using the "bleeder" resistance as a potentiometer or by inserting series resistances between the plate circuits of the various tubes and the positive side of the power supply. Examples of each system are shown in Fig. 54.

Biasing potentials may also be obtained from the voltage divider rather than by the methods shown in the original sketch. This is done by making "ground" positive by an amount equal to the highest biasing potential required. In Fig. 55, it will be seen that the various cathodes and filaments are brought directly to ground and that the grid returns are brought to a point negative with respect to ground by the required amount.

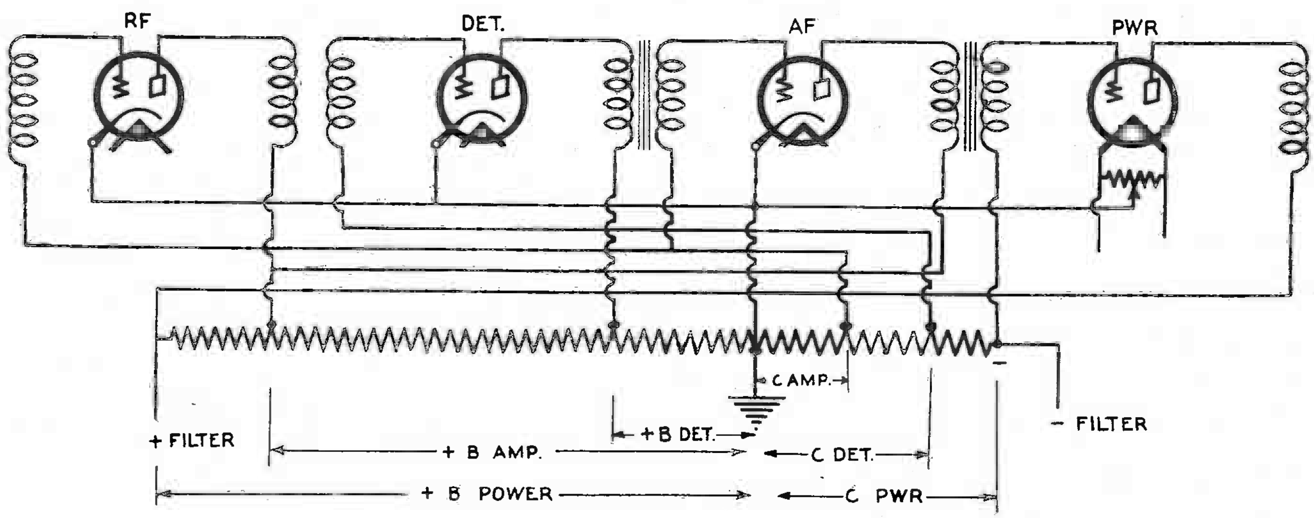
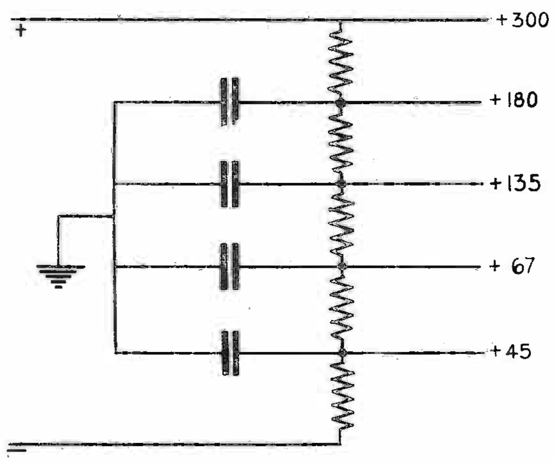


FIG. 55



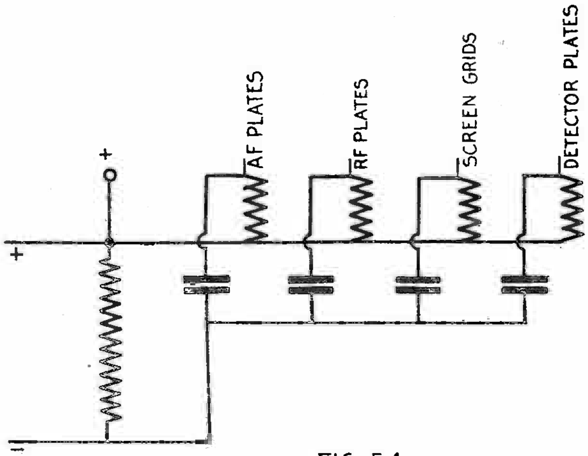


FIG. 54

This may aid in the explanation of the automatic volume control sketches previously shown if any obscurity concerning them still exists. As was noted before in respect to the plate voltages, a combination of the two methods may be effected if it seems necessary to do so.

In Fig. 56, this also has been done. Note that been obtained by connecting the plate lead of the detector circuit to the positive end of the biasing resistance serving the output tubes. This gives a plate voltage equivalent to the biasing voltage of the output tube. A studious tracing of circuits having an, at first, unfamiliar appearance will clear up many difficulties if the basic principles are borne in mind.

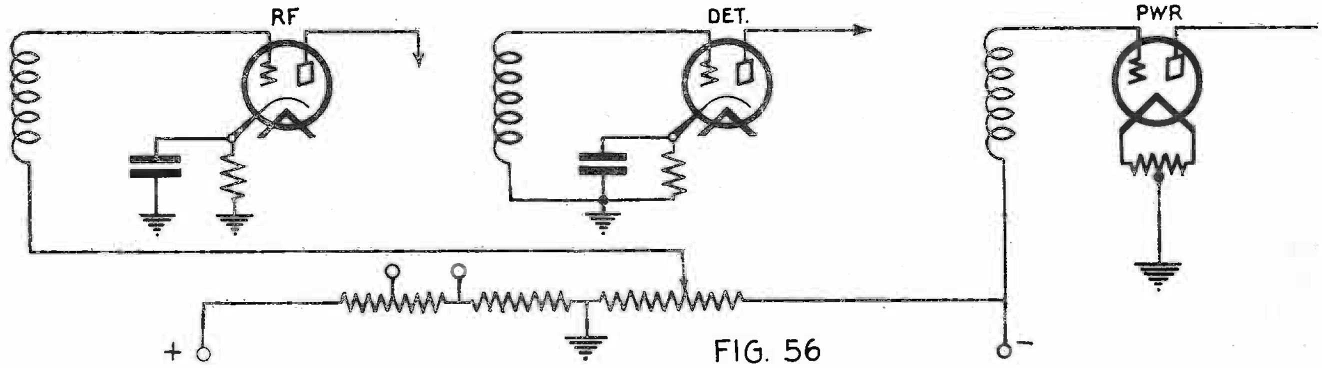


FIG. 56

the minimum bias for the R.F. tubes has been obtained by the use of individual resistances in each cathode circuit, whereas the additional bias necessary for volume control has been obtained by returning the grids to some point negative with respect to ground.

In some receivers, the detector plate voltage has

The circuit diagrams given in this manual can never be more than a time-saving aid and are, even as such, worthless, if the service man fails to use everyday "horse sense" in attacking his problems. It is this "horse sense" that keeps customers by making up the difference between a mediocre man and an expert.

DIRECT CURRENT RECEIVERS

Receivers for Direct Current Operation.

Receivers for D.C. operation present a problem because of the initial low voltage available for the power tubes. If, with a maximum plate supply of 90 to 100 volts, any power output is to be attained some system of parallel operation of the output tubes must be employed.

In Fig. 57, the filament circuits of the Stromberg-Carlson 638 receiver are shown isolated from the balance of the receiver. Five 201A tubes are employed in the preliminary stages with their filaments connected in series. If one tube should burn out, the balance would not light and no tests could be made until the defective tube had been located.

The four '71A tubes in the output are connected in parallel both as to filaments and as to grids and plates. Do not remove one of these output tubes from the socket without first turning off the set, as the remaining three filaments would be seriously overloaded.

Plate voltages for all stages in this set are taken from the maximum positive point as shown in Fig. 58. Grid bias is obtained by bringing each grid return of each tube to a point on the filament system negative by the required amount with respect to its own filament. For example, the grid return of the first stage is to the negative filament terminal of the second tube and thus receives a 5-volt negative bias. Grid return of the four '71A tubes is to the negative side of the 12-ohm series resistance —thus giving their grids a negative potential of 12 volts.

The power output available with the four tubes in parallel is approximately that obtained with a single '71A with the full plate voltage, 180 volts, applied.

Biasing of D.C. receivers is simpler in those sets employing heater type tubes, as the bias may be obtained by a resistance between the cathode and ground as in the case of A.C. receivers.

The circuit arrangement of such a receiver is quite simple, as shown in Fig. 59, where a system employing a series of two '24 tubes as radio frequency amplifiers, a '27 detector and two '45's in push-pull is used. The current requirements of such a filament supply system are large—there being a dissipation in the series resistor of about 175 watts.

Biases for all except the output tubes are taken through the use of resistors in series with the cathodes. The secondary of the transformer feeding the power stage is split, so that the fact that one '45 filament is more negative by 2.5 volts than the other can be compensated for by obtaining the bias for that tube at a point differing from the other by 2.5 volts. The plate circuits are connected in normal push-pull fashion.

The D.C. receiver is difficult to service without the schematic circuit available because of the many systems which can be employed in obtaining the fila-

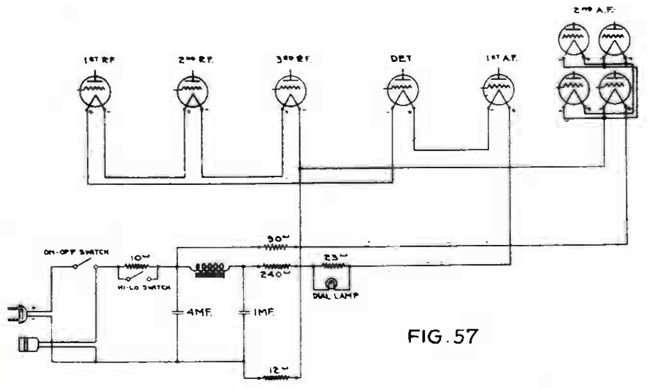


FIG. 57

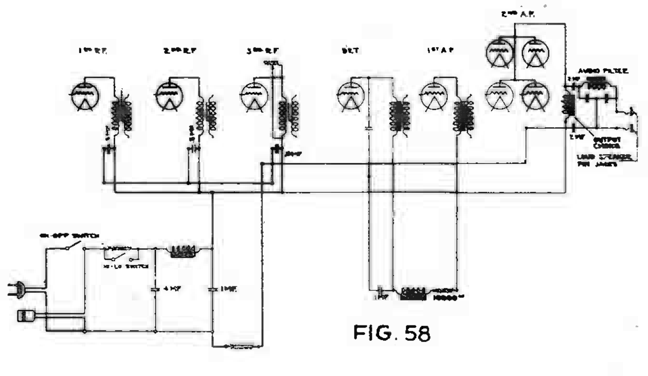


FIG. 58

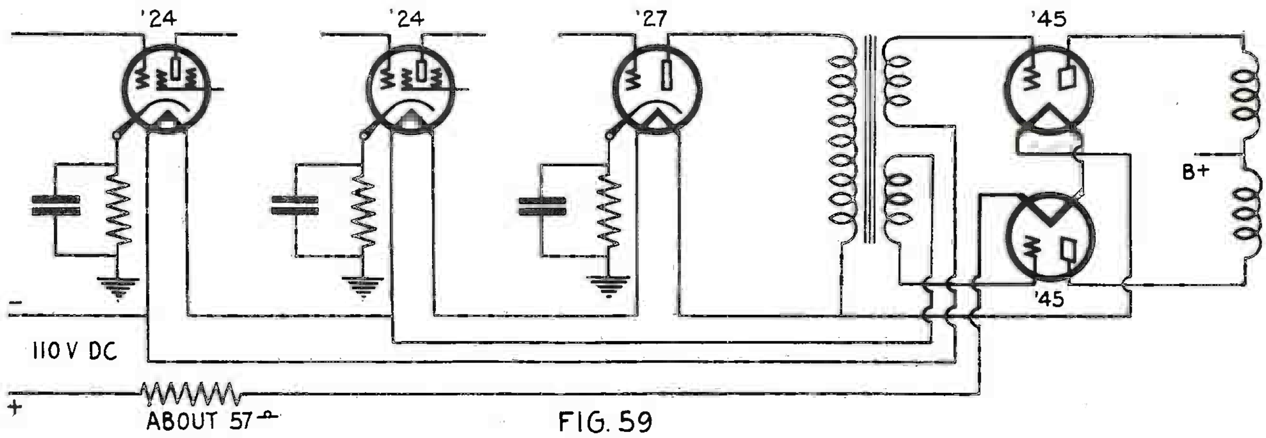


FIG. 59

ment and grid voltages. A hint on what may be expected is contained in the fact that receivers employing separate biasing batteries for use with the power tubes usually have those tubes placed at the most negative end of the circuit, so that the filament and plate of each tube will have the maximum possible potential difference.

Where the power stage biases are obtained by a method similar to that shown in Fig. 59, the power tube filaments are positive so that the negative biases may be obtained from the voltage drop across the other filaments. The first method is employed so as to obtain the highest possible plate voltage from the line at a sacrifice of the "all electric" feature.

While working on this section, the writer was informed of the introduction of three new tubes for use in automotive and direct current receivers. These are heater type tubes having filaments operating at 6.3 volts and .3-ampere. In automotive receivers, these tubes take their filament supply directly from the storage battery of the car. In D.C. receivers, the fact that the heaters are isolated from the actual circuits of the receiver makes filtering of the heater supply entirely unnecessary.

The reduced current at which the tubes operate effects another economy in that the receiver will draw about 35 watts from the line as compared with 175 to 200 watts required by most modern D.C. receivers employing '27's or '24's and '45's.

The tubes are designated as the '36, '37, and '38 types and are, respectively, a screen-grid tube for radio frequency amplification and detection, a three-element general purpose tube, and a Pentode output tube comparable with the '47 mentioned in the vacuum tube section of this book except for the fact that a heater type cathode is employed. Because of the economy possible, both in construction and in operation, it is probable that a great many receivers issued this season will employ the tubes.

In anticipation of this fact, the circuit in Fig. 60 shows the filament circuit arrangement which will be employed with these tubes. For reasons stated in the discussion of Pentode tubes in another section of this book, it is not desirable to obtain the bias of a Pentode circuit by means of a resistance from cathode to ground except where push-pull circuits are employed. Fortunately, we are able, in a circuit of the nature shown, to connect the cathode of the output tube directly to a point positive by the required amount with respect to ground. To be sure, the voltage thus obtained is not filtered—but neither does the possible noise voltage, developed across the two filaments from which the bias is obtained, amount to enough to become troublesome. As was the case before, one can never tell how the filament circuits of a D.C. receiver are connected without first seeing the schematic or tracing the circuit itself; in consequence, do not remove a tube from any D.C. receiver without first disconnecting it from the power source—otherwise a few ruined tubes may be chalked up to your debit.

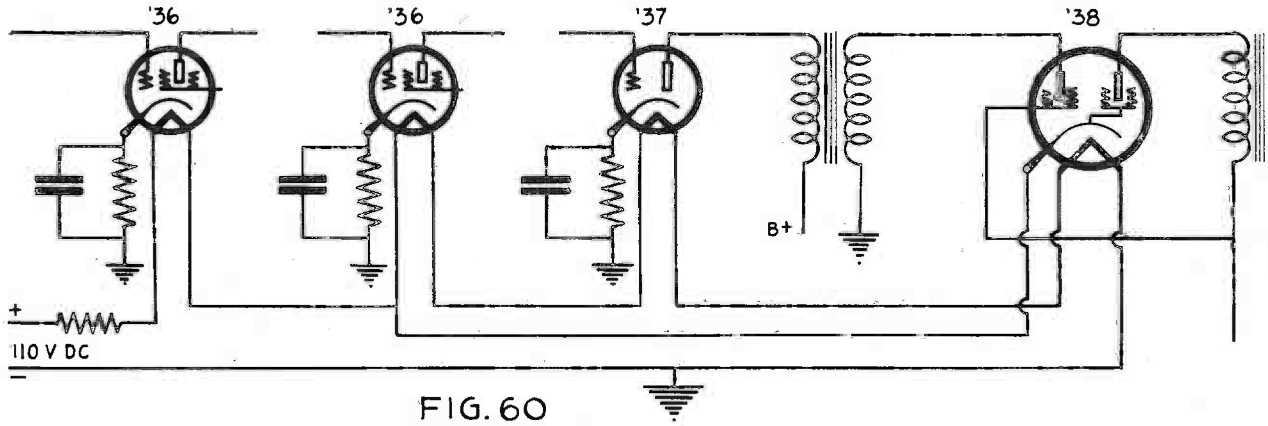


FIG. 60

SUPERHETERODYNE SERVICE NOTES

No analysis of the "Super" is complete without a brief historical note concerning the origin of the idea. At the time of the entry of the United States into the war, there were many European amplifiers constructed to amplify at radio frequencies coincident to the long waves which theretofore had been employed in all commercial work.

One of the first jobs handed the Signal Corps laboratory, maintained by our army in Paris, was that of developing a receiver to operate with extreme sensitivity in the short-wave band employed by the enemy in their army communications. This was prior to the development of neutralizing circuits, and the development of an extremely sensitive receiver in those bands would have been a long and tedious process.

Armstrong, who was among the engineers working in the Paris laboratory, hit upon the idea of modulating the incoming signal with a locally generated one and amplifying the resultant frequency which fell within the range of the existent and efficient radio frequency amplifiers then available.

From this idea grew the superheterodyne receiver of today—albeit by a long and devious pathway. It is only with the growing knowledge of radio engineering principles, that the present "super" has been made possible.

Let us, for example, assume two frequencies—an incoming signal of 1000 kc. and a local signal of 1175 kc. We may obtain beat-notes of either the sum of or the difference between the two frequencies. The difference frequency in this case is 175 kc. This frequency is a favorable one for amplification as its relatively low frequency enables the radio frequency amplifiers (known as "intermediate frequency" amplifiers) to operate at a relatively high gain per stage as compared with that obtainable at broadcast frequencies.

Not only is the amplication more favorable at the intermediate frequency, but the selectivity is also much greater. At 1000 kc., an interfering station 10 kc. away on 1010 kc. is separated from the desired signal by but 1% of its frequency. At 175 kc.—after being "beat" with a local oscillation of 175 kc.—the interfering station is at 165 kc. and the desired one is at 175 kc. The difference is still 10 kc. but now the interfering signal is removed from the desired one by approximately 6%.

Inasmuch as the selectivity is measured by the response a given percentage away from the frequency to which the circuit is tuned, the reader will have little difficulty in grasping the advantage which a properly designed "super" may well have over a receiver employing straight tuned radio frequency amplification.

Because of the high degree of selectivity available, it is essential that "band-selector" circuits be employed in the intermediate frequency stages if the "side-band" cutting common to excessively selective circuits is to be avoided. In this connection it might be noted that with the superheterodyne, it is possible to come quite close to a realization of the ideal "square" response characteristic evidenced in Fig. 31.

While discussing the selectivity of the "super", it might be well to note that it is essential that a certain degree of selectivity be obtained ahead of the first detector—that is, the selectivity cannot be localized in the intermediate frequency amplifiers so favorably disposed toward it.

For an example, it is readily seen that the oscillator set at 1175 kc. to produce an intermediate signal of 175 kc. from a signal of 1000 kc. will produce a similar 175 kc. signal from a station on 1350 kc. If we are not to have two signals interfering in the intermediate frequency circuits, it is essential that no portion of the 1350 kc. signal reach the grid of the mixer tube in which the 175 kc. signal is produced (this tube is known variously as the mixer, modulator or first detector).

In the case of the 1350 kc. signal being from a strong local station, it is difficult to prevent this and the average "super" has at least one stage of radio frequency amplification operating at the signal frequency located ahead of the mixer tube—not for the purpose of obtaining amplification so

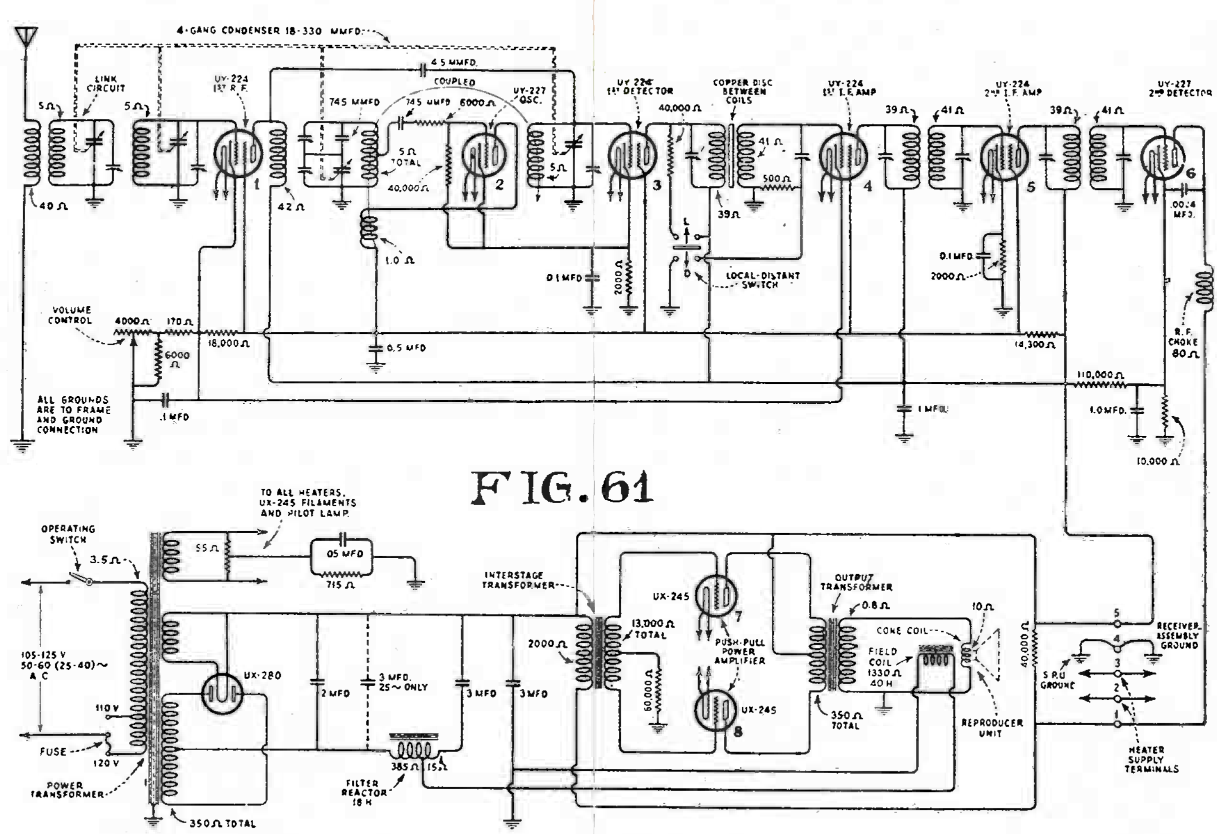


FIG. 61

much as for the additional selectivity obtainable.

The average detector tube has, in its plate circuit, strong radio frequency components of the harmonics of the intermediate frequency. Harmonics are caused by non-linear operation of the tube and result in spurious oscillations or currents having a frequency which is some multiple of the original.

Care must be taken in shielding the detector output of "supers" for this reason as, otherwise, stray harmonic voltages may find their way back to the input to cause trouble. Early superheterodynes were full of spurious signals of this character and it was this characteristic which prevented their becoming popular as commercial receivers.

In Fig. 61, there is a simplified diagram of the Radiola 80 receiver which is a characteristic example of the modern superheterodyne receiver. Here a "band-selector," in which the coupling is obtained by winding the coils adjacently on the same form, is employed in the antenna coupling.

The first tube is the radio frequency amplifier which operates at the frequency of the incoming signal. Coupled to this tube by means of a radio frequency choke and a small coupling condenser, is the first detector tube which is the third tube in from the antenna.

The second tube is a '27 which acts as the local oscillator. In order to make this oscillator track so that it will always have a frequency exactly 175 kc. higher than the frequency to which the other tuned circuits are adjusted, a special network of four condensers is employed in tuning the oscillator inductance. Note that the coupling between the first detector and the oscillator is secured by winding the oscillator and detector tuning inductances on the same form or on forms quite close to each other.

From the plate circuit of the first detector onward, the circuits are tuned to 175 kc., and a local-distance switch for cutting down the sensitivity of the receiver when receiving strong locals is provided in the coupling circuit between the first detector and the first intermediate or 175 kc. amplifier.

This arrangement is made up of two resistances of 40,000 and 500 ohms which are introduced into the tuned circuits of the 175 kc. band-selector when the switch is in the least sensitive position. Volume control is secured by varying the grid bias of the radio frequency amplifier simultaneously with that of the first intermediate frequency amplifier.

The grid biases for the other tubes are taken independently, that of the power output tubes being obtained by means of the voltage drop between the center of the filament winding and ground across a 715-ohm resistance.

It is interesting to note that the plate current of the oscillator tube flows through the biasing resistance in the cathode circuit of the first detector. This is arranged so that the bias received by the first detector tube will have a more constant character, since changes in the detector plate current due to the signal will have but slight effect on the total current flowing through the biasing resistance.

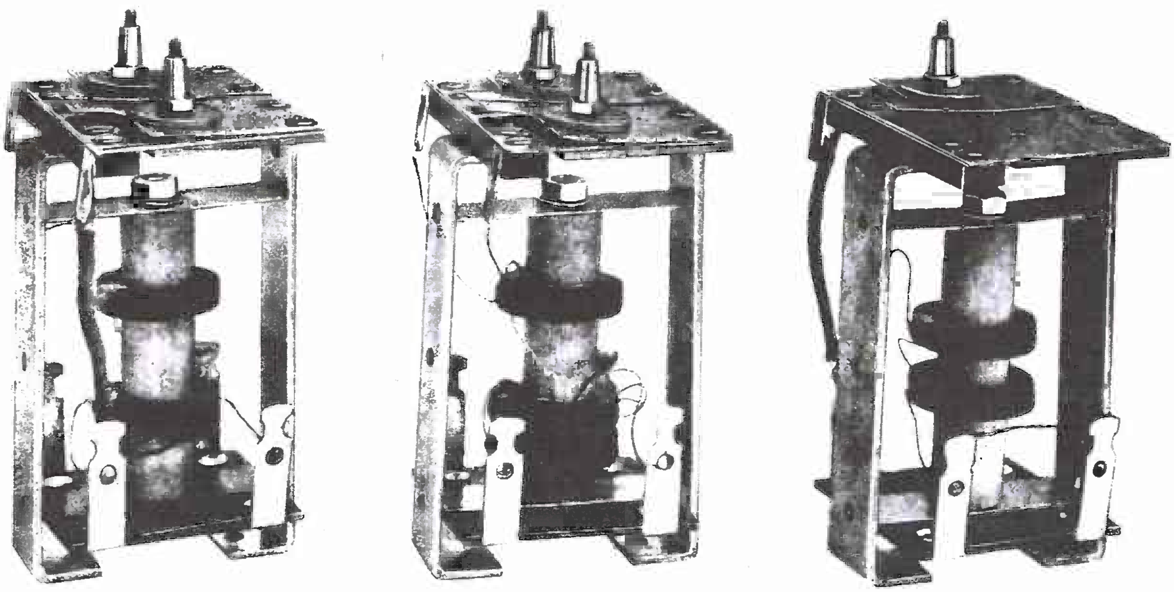
It is essential that the oscillator track exactly 175 kc. higher than the other tuned circuits across the band. To this end, two small trimmer condensers form a portion of the oscillator tuning network.

This network is so devised that the tracking along the mid-tuning range will be fairly good, but a certain amount of adjustment may be necessary at the high and low frequency limits of the range. The trimmer across the oscillator tuning condenser is used in adjusting for maximum sensitivity at the high frequency end of the band, while that across the fixed condenser is used in aligning the circuits at the low frequencies. A discussion of the alignment of the intermediate frequency amplifier will be found in the section of this manual devoted to the use of service apparatus.

Certain receivers employ oscillators which maintain their 175 kc. separation by the use of tuning condensers with specially cut rotors. These receivers do not require tracking in the same manner as those employing the condenser networks as shown—a simple adjustment of the trimmer condenser being all that is necessary in most cases.

Outside of the use of the oscillator and the fact that the latter R.F. stages are pretuned to 175 kc., the superheterodyne needs little explanation—service is carried out along lines parallel with tuned radio frequency receivers.

The sole differences in service procedure lie in the possible necessity for checking the oscillator alignment as mentioned or the alignment of the intermediate frequency transformers. The major faults manifest themselves in a manner identical with those found in other receivers—oscillation may be found difficult to trace to its source, however, and certain manifestations are described in the section on servicing.



View of Three I. F. Transformers with the Shields Removed.
Stromberg-Carlson Telephone Manufacturing Company

REMOTE CONTROL DEVICES

During the past season, many remote control devices have made their appearance. So far as can be ascertained, these have enjoyed but a limited popularity—but however limited their distribution, there is no certainty that any service technician will be exempt from servicing them, and it is essential that they be a familiar subject so that time and trouble may be avoided.

The Sleeper Kinematic Control.

The Kinematic control system demands the use of two separate controlling systems—one to operate the station selector mechanism and the other to switch the set on and off and to control volume.

The apparatus involved consists of two motors at the receiver and two control devices in a small box at the control point. In A.C. neighborhoods, the control mechanism operates from 25 volts A.C., and in D.C. districts, an 18 volt supply is tapped from the line. In D.C. districts, the control switch operates to switch a motor generator on and off if an A.C. receiver is used.

Each driving member consists of a field winding with six pole pieces and a rotating steel armature as shown in Fig. 62. At the control box, a rotary switch is employed which operates as shown. With the switch at 1, the armature lines up across 1-1 of the poles. At 2, the alignment is across 2-2, while at 3, the alignment of the armature is across 3-3. It may be seen that the constant rotation of the switching member at the control point will result in a continuous rotation of the armature which is geared to the condenser shaft of the receiver or to the volume control and switch, as the case may be.

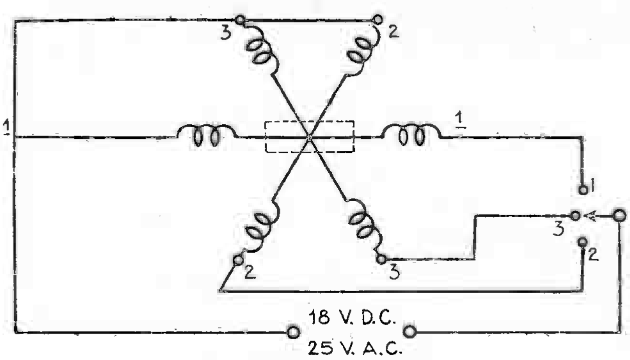


FIG. 62

Westinghouse Remote Control.

In the Westinghouse remote control device, the same driving motor for both the volume and station selector motion is used. Normally, when the receiver is at rest, a spring holds the motor gears engaged with the volume control. Pressing buttons marked *Volume Control Plus* or *Volume Control Minus* will result in the motion of the driving member in the desired sense.

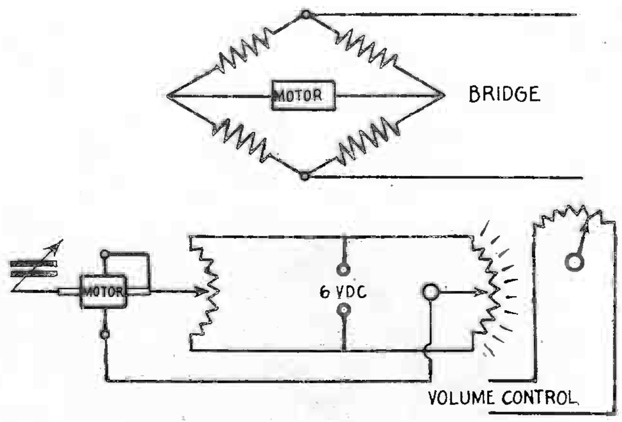


FIG. 63

Pressing one of the selector buttons will allow the motor to speed up so that the armature rises and the gears engage so as to rotate the tuning drive. A fine adjustment of the springs is necessary so that the armature does not rise when the volume control buttons are pushed, but rises completely when the station selector buttons are touched. This adjustment is easily carried out.

The control box contains on and off switches, the two volume control buttons, and six channel selectors which are adjusted by the service man for the desired channels. A twelve-wire cable connects the two units.

This type of control is typical of many which employ contactors for shutting off the motor when the receiver is tuned to the desired channel. Adjustment of the tuning controls is quite simple. The station desired for number six contactor is tuned in manually. The cam for that contactor is then released from the shaft and rotated to the correct position. It is then tightened to the shaft again.

This same arrangement is used in both the ordinary models and in the Columaire. In the latter case, the gears are held engaged in the volume control position by gravity instead of by a spring. In testing the receiver, the manual control should not be operated unless the chassis is on end (vertical) as it is operated in the cabinet—otherwise, the gears may be damaged.

The Westinghouse arrangement is typical of the contactor-operated remote control units as a whole. The wiring arrangement is shown in the text dealing with Westinghouse receivers.

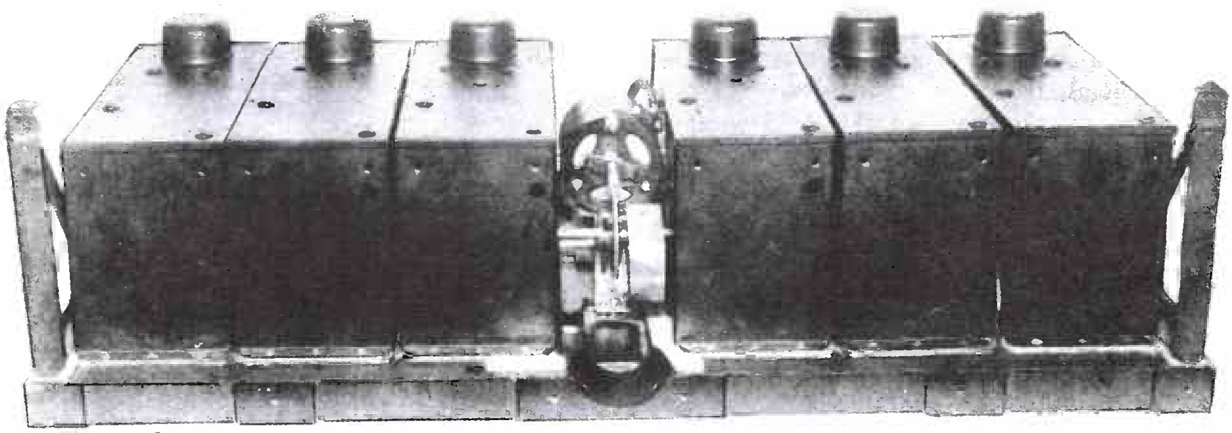
Other Remote Control Systems.

As is the case with every radio innovation, there are a thousand and one ways of doing the job. In Fig. 63 is shown a method which has given much promise but which has had no commercial realization so far. For those experimenters desiring to work up their own systems rather than to purchase units, this offers the best and simplest idea. The motor is in the indicator arm of a simple Wheatstone bridge such as is employed in laboratory testing. The motor moves automatically in either direction in an attempt to re-establish a balance of the bridge. The motor drives the moving arm of a potentiometer as well as the tuning elements of the receiver.

A very sensitive reversible motor is necessary to this device—a motor which will continue to run under load with a very small input—so that motion continues until an exact balance of the bridge elements is attained. In the balanced condition, the arm of the potentiometer on the motor shaft is in the same position as the arm of the potentiometer in the control box.

Volume control is achieved by placing the biasing resistance in the control box and connecting the R.F. cathodes and ground through this remote resistance. The motor should be geared to the condenser shaft through a reduction of about 60 to 1. Such gears are readily obtainable in nearly every location in the United States.

If your hardware dealer does not stock them, it is a certainty that he has a catalog of the Boston Gear Works from which you can make a choice. The disadvantage of this device in operating from a separate battery may be avoided by the use of a Tungar charger, either as a trickle charger on the battery or to drive the motor directly.



Stromberg-Carlson Special Remote Control Receiver

VACUUM TUBES AND THEIR OPERATION

Strange to say, it was Thomas Alva Edison who first noted the effect which later led to the development of the present day Vacuum Tube which made Radio a possibility.

In 1883, while working out problems concerning incandescent filaments, he sealed a metallic plate into the glass envelope with the filament and discovered that when the plate was electrically positive with respect to the filament a current flowed in the plate circuit but that when the plate was negative the current ceased to flow. Fig. 64.

Fleming, continuing the investigation of the "Edison effect," discovered that the path between the filament and plate exhibited effects of unilateral conductivity—that is to say, current would flow from the filament to the plate but not in the opposite direction.

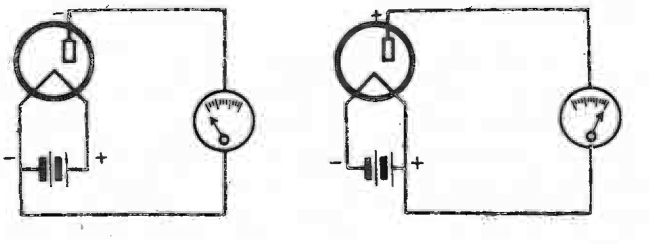


FIG. 64

For some time, the Fleming Valve was employed as a detector of wireless signals and the writer used quite effectively one which was made from an old style double filament automobile lamp—using one filament as the plate. The incoming signal was impressed upon the plate of the valve and, at any instant when the signal was positive in value, current flowed—while on the other portion of the wave, when the current was negative, no current flowed.

The curve shown in Fig. 65 indicates graphically the manner in which rectification of the signal occurs. The continuous line P is the graph of plate current against applied voltage. Note that this approximates a straight line up to a certain input voltage where "saturation" occurs. That is to say, the output current steadily increases with increased signal voltage up to a certain point where the curve flattens out. Increase of the signal beyond this point does not result in any increase in current.

The Fleming Valve had a decided superiority over the previous types of detectors, which rested in its reliability rather than its increased sensitivity.

It was no longer necessary to search for a sensitive point on the crystal nor to employ mechanical means for re-sensitizing as was required with certain other types of detectors.

It remained for De Forest to insert the third element into the envelope in order to improve the sensitivity of the valve and to start the long period of scientific development which followed.

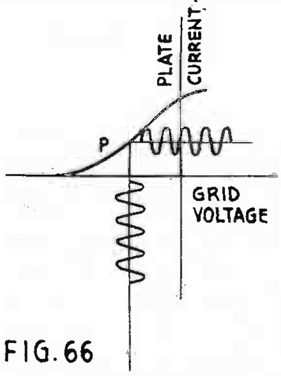


FIG. 66

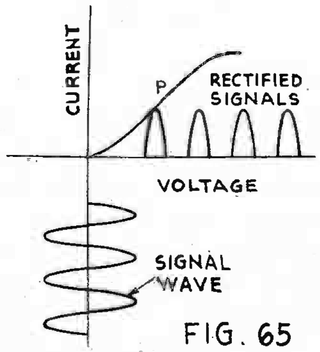


FIG. 65

Dr. Lee De Forest discovered that if the positive voltage were applied directly to the plate from an external source rather than from the signal, and if a third element—the grid—were inserted between the filament and the plate, there would be much larger changes in the current in the plate circuit for a given signal voltage. What is more, he discovered that by coupling together two or more of these three-element tubes, the signal voltage could be amplified to a tremendous extent.

The manner in which the amplification of the signal takes place is shown graphically in Fig. 66 where the characteristic curve of the tube—that is, the graph of the changes in plate current incident to a change in grid voltage—is given.

In order to operate the tube over a range where the output variations will be identical in form with the input, it is necessary to apply a fixed grid voltage "e" about which the signal will produce a variation.

Operation of the three-element tube as a detector or rectifier may be obtained in two ways. The tube may receive a bias or initial grid voltage so large as to reduce its place current almost to zero as shown in Fig. 67, so that only the positive halves of the signal waves produce a change in plate current; or it may be adjusted so as to have the signal effect the plate current changes in the region of the upper bend in the curve where saturation takes place. The first method is known as "bias" or plate circuit detection, and the second as "grid-leak' 'or grid circuit detection.

The second method is shown in Fig. 68. In this second method, a resistance from grid to ground

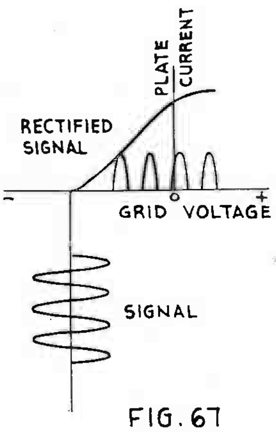


FIG. 67

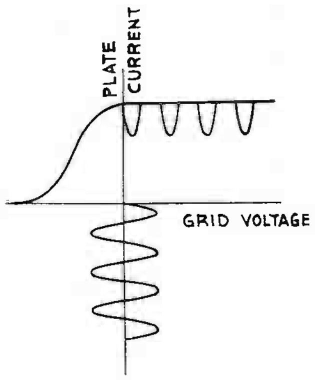


FIG. 68

is employed in order to prevent paralyzing of the tube, due to the fact that when the tube is so operated the grid will assume and retain an electric charge. The resistance permits this charge to leak off in time for the next cycle of the signal. Were it not for this, the charge on the grid would build up until the tube became inoperative.

The vacuum tube may be used as a generator of alternating current by virtue of its ability to amplify. In this connection, a portion of the voltage in the plate circuit is fed back to the grid in such a manner and in such magnitude as to sustain the tube in oscillation. This is due to the fact that a small portion of the output finds its way back to the input circuit by means of a capacitative or inductive coupling between the two.

There are many circuit arrangements which, properly proportioned, will permit of sustained oscillation. The small portion of the output fed back to the grid circuit is re-amplified—fed back to the grid again and reamplified so that the oscillation is continuous. The frequency of the oscillation thus produced is determined by tuning the grid or plate circuit to the required frequency.

The Factors Affecting Operation.

Certain definitions with respect to the vacuum tube are in order before a description of the operation of the device may be continued. The most important factors follow.

Cathode.

The cathode is the portion of the tube which emits electrons along the path of which the current from cathode to plate may flow. In general practice, the term "cathode" is applied to those emitters which are heated indirectly as in the case of the '27 tube.

Filament.

The filament is the cathode also, but in general is an emitter which is directly heated by the flow of current through it. The filament or cathode is constructed of some material which is capable of emitting a strong electronic stream.

Plate.

Plate and "anode" are interchangeable terms. This element is maintained at a potential, positive with respect to the cathode, so as to establish a current flow between the two elements.

Grid.

An electrode placed between the cathode and plate, and so constructed as to permit the flow of electrons through it.

Control Grid.

The control grid is an electrode placed between the cathode and plate through which the electrons may flow on their journey between the two. It is to this electrode that the incoming signal is applied. The name implies the effect of the electrode in varying the plate current in accordance with the voltage applied to it.

Screen-Grid.

A fourth electrode is included in some tubes to screen the electrodes one from the other in order to reduce the capacity existing between them.

Grid Voltage.

The voltage difference existing between the grid and the cathode.

Grid Bias.

The direct current portion of the grid voltage placed intentionally on the grid so as to operate the tube at some specified point on its characteristic curve.

Amplification Factor.

The effectiveness of the tube in effecting a change in the voltage in the plate circuit. It is the ratio between a change in grid voltage and the corresponding change in plate voltage with the plate current held constant. It is represented by the symbol μ (Mu).

A.C. Tube.

Any tube particularly designed for service with raw or unrectified alternating current on its filament is in this classification. A.C. tubes may be of the indirectly heated cathode type, such as the '27, or they may be made with particularly sturdy filaments as in the case of the '26. In this latter case, freedom from hum is gained by a high thermal inertia—that is to say, the filament is so bulky that it does not cool and heat again in step with the A.C. cycle as would be the case with a lighter and less sturdy filament.

Grid Emission.

This is an effect which takes place in some tubes when the filament is run at too high a temperature and the grid becomes hot enough to emit electrons.

Secondary Emission.

The kink so pronounced in the characteristic curves of screen-grid tubes is caused by secondary emission—or the emission of electrons from the plate under heavy bombardment from the filament, which are attracted to the screen-grid when the screen-grid potential is not sufficiently negative with respect to the plate.

Screen-Grid Tubes.

Screen-grid tubes are those in which an electrode has been added for the purpose of screening the plate from the grid in such a manner as to reduce the effective capacity between the grid and plate. This is done so that the tube may be used as a high gain amplifier without danger of its becoming an oscillator due to the feeding back of energy from the plate circuit to the grid through the inter-electrode capacity of the tube.

Dynatron Oscillator.

Reference to the curves of the screen-grid tubes will show that there is a portion of the characteristic curve which slopes steeply downward from left to right. In this range of operation, the tube exhibits a "negative resistance" characteristic—which is to say that the addition of greater voltage results in the flow of less, rather than more, current in the plate circuit of the tube. Tubes operated in this range will act as oscillators by the simple procedure of placing a tuned circuit in series with the plate.

Maximum Undistorted Power Output.

This is the highest power output obtainable with a tube at the voltages specified without the harmonic distortion exceeding 5% of the total output. Research workers have found that this condition obtains when the tube works into a load of twice its own plate impedance. Maximum undistorted power output should not be confused with maximum power output or with maximum efficiency.

Maximum power output is obtained when the load impedance is equal to the tube impedance, and maximum efficiency is obtained when the impedance of the load is many times that of the tube. In using the tube for operating commercial devices, one of the latter would be desirable, but in Radio, we are interested in the entertainment possibility which can only be realized to its fullest extent when the distortion is negligible. In Radio, then, we are interested in the maximum undistorted power output which is obtained when the impedance of the load is double that of the tube.

The new "Pentode" type of tube requires a load in the plate circuit approximately equal to one-fourth the plate resistance of the tube. The output of the pentode cannot be fully realized, due to the high second harmonic component present in this type tube. In order to minimize the second harmonic output, it then becomes necessary to reduce the operating load to such a value that the second harmonic output is less than 5% of the fundamental.

Plate Impedance.

The ratio of a change in plate voltage to the corresponding change in plate current with the grid voltage held constant. The A.C. impedance between the filament and the plate. This should not be confused with the D.C. resistance.

Mutual Conductance.

The mutual conductance of the tube is the figure of merit for tubes of a given type. It is the ratio between a change in grid voltage and the corresponding change in plate current. It is expressed in micromhos and is designated by the symbol Gm. In some texts, the mutual conductance is expressed in terms of milliamperes per volt and a tube exhibiting a change of 1.5 milliamperes has a mutual conductance (Gm) of 1500 micromhos.

Inter-electrode Capacitance.

The capacitance existing between the various elements by virtue of their proximity. These factors have no effect upon the plotting of the curves of the tubes with direct currents only applied, but are a large factor in the operation of the tube at high audio frequencies or at radio frequencies.

Plate Voltage.

The voltage difference effective between the plate and the cathode or filament.

Plate Current.

The direct current flowing between the plate and the cathode through the evacuated space within the tube.

Gassy Tubes.

The presence of gas in a vacuum tube will seriously affect its operation as at some voltage the gas becomes ionized and is conductive. When ionization occurs, the current through the tube is not flowing between filament and plate through the electron stream only, but also through the gas due to its conductivity when ionized.

Space Charge Grid.

An additional grid placed in the vacuum tube close to the filament, in most cases, for the purpose of dispelling the space charge existing in the region of the filament or cathode, which permits the formation of a cloud of electrons in this region impeding the flow of the electron stream from cathode to plate. This extra grid is found in the new Pentode output tubes and permits of increased sensitivity and efficiency.

Diode—Triode—Tetrode—Pentode.

The terminology applied to various forms of vacuum tubes accordingly as they have two, three, four or five operative electrodes. Some French tubes for special purposes have two control grids and are known as double grid or "bigrille" tubes.

As we have noted before, a profound study of vacuum tube theory is not essential to efficient radio servicing. It is, however, necessary that the service man have a good idea of the factors affecting the operation of the tubes so that various difficulties will make themselves at once obvious. It is a distinct advantage to the service man if he memorizes the electrical constants of the various tubes as tabulated on the tube chart shown in this manual. Set manufacturers generally design their sets so that the tubes are used at the recommended voltages.

Voltage Amplification.

Tubes which are employed as voltage amplifiers are concerned more with the "gain" or amplification which can be obtained within the individual stage than with the power available at the output. With three-element tubes, the amplification may readily be calculated through a knowledge of the amplification factor of the tube and of the load into which it will work. A simple relation exists here in which

$$\text{Amplification} = \frac{Zo}{Rp+Zo}$$

where μ is the amplification factor of the tube as obtained from the manufacturer's data, and Rp and Zo are, respectively, the plate impedance of the tube and the load impedance at the frequency for which we desire to obtain the amplification. It should be remembered that, in case of audio frequency transformers the primary inductance must be high so that the impedance at a low frequency is sufficient to permit a fair degree of amplification — naturally, the impedance of the transformer will be high enough at the higher frequencies transmitted.

Transformer Coupled Audio Frequency Amplifiers.

Audio transformers to operate between vacuum tubes have a ratio of transformation—that is, a "step-up ratio"—of from 2:1 to 8:1. The amplification to be obtained from a stage would normally be thought to be the amplification factor of the tube times the step-up ratio of the transformer. At the medium frequencies to be amplified, this is true, but at the low frequencies we are limited by the primary inductance of the transformer. From the equation above, it will be seen that, if the primary impedance is equal to Rp, but half the amplification of the tube will be realized.

Bias detectors operate at extremely high plate impedances and, in consequence, transformers working out of the detector stage must have extremely large primary windings. At the medium frequencies, the impedance of even a small winding is sufficiently high to permit of the full amplification being realized. Now at the high frequencies, the gain is affected by the capacitance of the windings themselves and of the wiring. Resonance occurs between the leakage inductance of the windings and this capacitance, and results in an amplification peak followed by a rapid cut-off in response as is shown

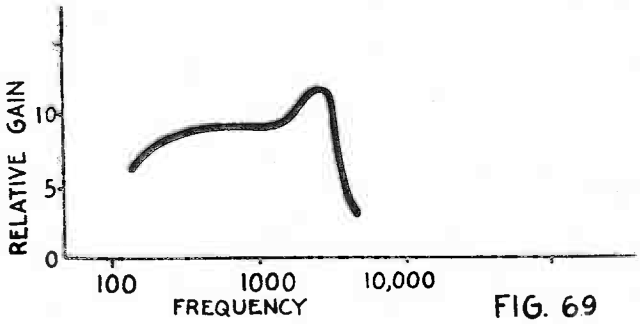


FIG. 69

in Fig. 69. This curve is that of a commercial transformer taken by the writer from a receiver of a season ago. The high peak is there for the purpose of compensating for lack in high frequency response due to the sharpness of tuning in the radio frequency circuits. Referring back to the previous section in which we discussed resonance, it may be readily seen how this occurs.

Parallel Feed Circuits.

It is possible to improve the low frequency response of a transformer by resonance at some low frequency—you will remember that we made note of the fact that with series resonance we often obtained large voltages across the individual elements. Let us suppose that the plate voltage for the amplifier or detector tube is fed through a high resistance or an impedance as shown in Fig. 70, and that the transformer is coupled to the tube through a condenser. We then have a series resonant circuit across the output of the tube composed of the coupling condenser and the primary inductance of the transformer. By carefully choosing the value of the condenser, we can obtain a resonant effect which will increase the voltage across the primary at some particular frequency—50 cycles, for example—and the result will be a response curve of the type shown in Fig. 71. It is possible in this manner to achieve good response at the lower frequencies without having a very large primary.

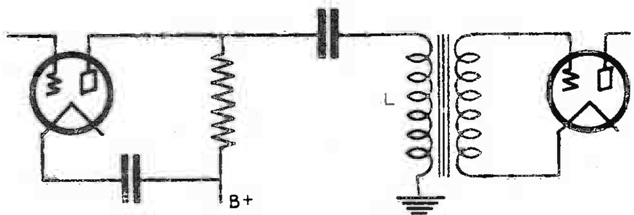


FIG. 70

The ratio of a transformer is limited by the bulk of the winding necessary to obtain satisfactory low frequency response, since a large winding would mean a large capacitance and a cut-off of the amplification at the higher frequencies.

Resistance Coupled Amplifiers.

Resistance coupled amplifiers and the direct-coupled type do not fall heir to many of these complications and they will be found in many commercial receivers. The resistance coupled amplifier has a mid-frequency response determined by the load across the plate circuit of the tube which is equivalent to the parallel value of the grid and plate resistances. The high frequency response is determined by the point at which the reactance of the condenser becomes low enough to effectively short-circuit the resistances. For this reason, the resistances must be sufficiently low to prevent this reactance from becoming low enough to affect them at the highest frequency desired. This is shown diagrammatically in Fig. 72. Note that the load is composed of R_1, R_2 and Xc in parallel.

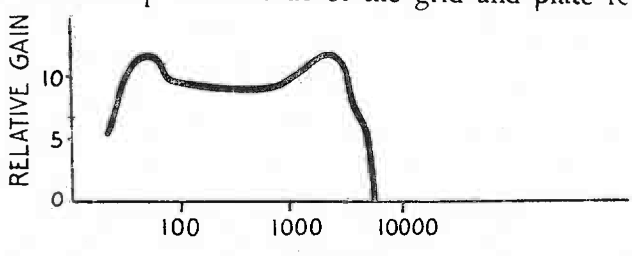


FIG. 71

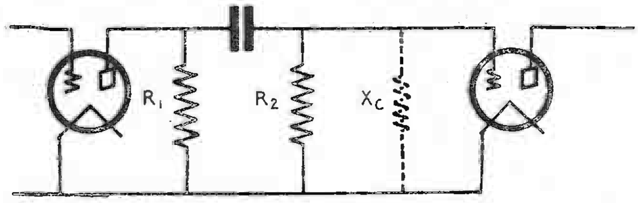


FIG. 72

Low frequency response in resistance coupled amplifiers is determined by the relative values of the coupling condenser and the grid leak. In Fig. 73, it is obvious that signal voltage is across the condenser and leak in series. The two should be chosen in such a manner that the reactance of the condenser is never high enough to become appreciable in value as compared to R_2. This means that the higher the resistance of the grid leak, the lower may be the value of the condenser.

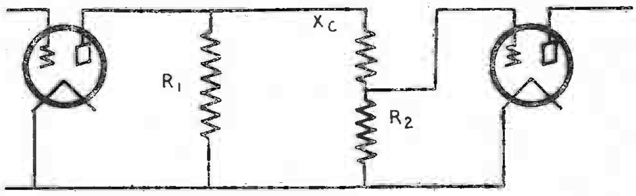


FIG. 73

Direct Coupled Amplifiers.

Direct coupled amplifiers such as the Loftin-White are found to a great extent in commercial midget receivers, and in small sound systems. Characteristic of the circuit is the fact that the plate of one tube is connected directly to the grid of the succeeding tube. The tube elements are maintained at their correct relative operating voltages by virtue of the voltage drop through the various resistances in the circuit. A commercial application is shown in Fig. 74.

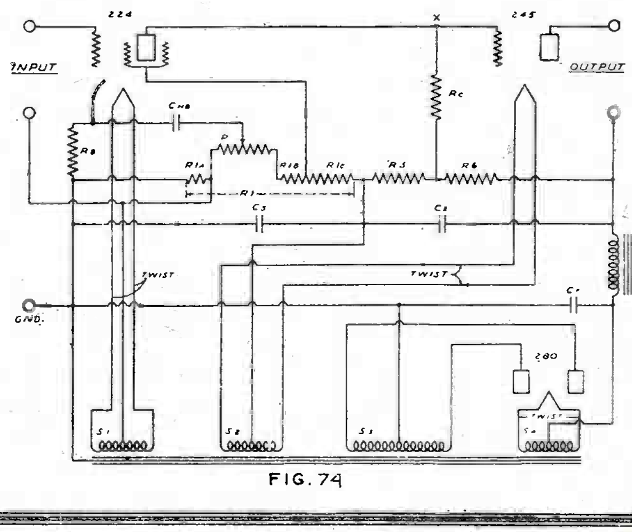


FIG. 74

OPERATING DATA ON COMMERCIAL VACUUM TUBES

THE previous section dealt briefly with the theoretical knowledge necessary to the service man who wishes to know more than the ordinary regarding the vacuum tubes which are his stock in trade. This second section on vacuum tubes will deal with the actual characteristics of the tubes now in use.

Although there are many special-purpose tubes to be found on the American market which are not listed they are rarely, if ever, found in commercial receivers—in fact, certain of the tubes to be noted in these columns are now obsolete but are included due to the fact that they are still to be found in some of the older receivers.

Where the designation is that of some particular manufacturer, no specific advertisement is intended—credit is merely given that particular manufacturer for the courtesy shown in allowing data to be drawn from certain sources which may not be available to the man in the field save through these columns.

'99 and 'X-'99.

These two tubes are employed as general purpose tubes for radio and audio frequency amplification in receivers designed for use with dry batteries, the sole difference between them being in the type of base employed.

The tubes employ the "thoriated" filament and are particularly sensitive to filament overload. This fact makes the use of a filament voltmeter desirable so that the operator may at all times be sure that the filaments are not receiving more than their rated voltage. The extreme delicacy of the filament is compensated in a measure by the fact that the tubes respond readily to reactivation. Where the single tube is used with a bank of dry cells having a terminal voltage of 4.5 volts, a 60-ohm rheostat is necessary. The correct rheostat for use with three tubes in parallel under the same conditions is 20 ohms.

As a Detector

When the tube is used as a grid circuit detector, the plate voltage should be about 45 volts with a grid condenser of .00025-mf. and a leak of about 3 to 5 megohms. The grid leak should be connected between the grid and the positive side of the filament.

As an Amplifier

When these tubes are used as amplifiers, a grid bias should be used whenever the plate voltage is over 45 volts. The following values of grid bias for various plate voltages are recommended:

Plate Voltage	Grid Bias
67.5	—3.0 volts
90.0	—4.5 volts

Rating

Filament Voltage	3.0-3.3 volts
Filament Current	0.060-0.063-ampere
Plate Voltage (maximum)	90 volts

Average Characteristics

Plate Voltage	90 volts
Grid Bias Voltage	–4.5 volts
Amplification Factor	6.6
Mutual Conductance	15500 micromhos
Plate Resistance	425 ohms
Plate Current	2.5 milliamperes
Undistorted Power Output	7 milliwatts
Grid-Plate Capacitance	3.3 mmf.

Average Characteristic Curves

Filament and Emission Characteristics—Fig. 75 shows the change of filament current with various filament voltages.

Grid Characteristics—Fig. 76 shows the relation between grid current and grid voltage.

Plate Characteristics—Fig. 77 shows a family of plate voltage—plate current curves at various grid bias voltages.

Mutual Characteristics—Fig. 79 shows a family of grid voltage—plate current curves for various plate voltages.

Dynamic Characteristics—Fig. 78 shows the effect of grid voltage upon the amplification factor, mutual conductance and plate resistance.

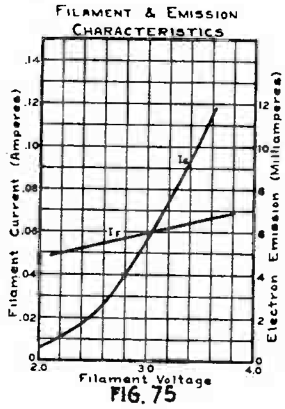


FIG. 75

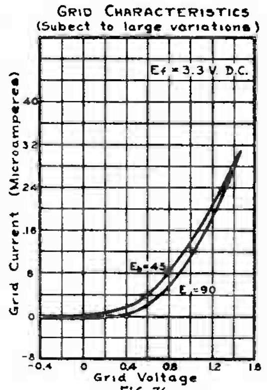


FIG. 76

'X-'20.

The '20 tube is used as a power output tube in circuits employing the '99 in the preliminary stages. Its filament voltage is the same but the current drawn is twice that drawn in the case of the '99. With a plate voltage of 135 volts and a bias of --22.5 volts, the maximum power output obtainable is quite satisfactory for home use in locations where commercial current is not available. Two of these tubes may be used in push-pull with exceedingly gratifying results.

It is not necessary to use an output transformer with this tube and a cushion or spring mounting need not be provided when it feeds directly into a loud speaker.

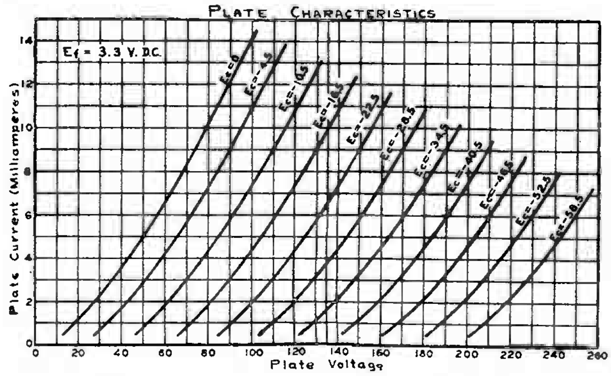


FIG. 77

RATING

Filament Voltage ....3.0-3.3 volts
Filament Current 0.125-0.132-ampere
Plate Voltage (maximum)......135 volts

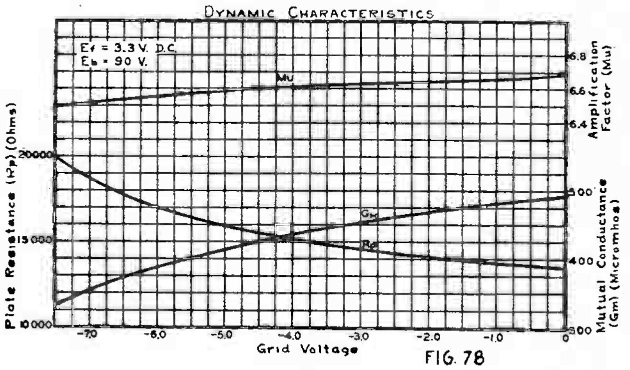


FIG. 78

AVERAGE CHARACTERISTICS

Plate Voltage	90	135 volts
Grid Bias Voltage	16.5	–22.5 volts
Amplification Factor	3.3	3.3
Mutual Conductance	415	525 micromhos
Plate Resistance	8000	6300 ohms
Plate Current	3	6.5 ohms
Undistorted Power Output	45	110 milliwatts

AVERAGE CHARACTERISTIC CURVES

Filament Characteristics—Fig. 80 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 82 shows the relation between the plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 81 shows a family of grid voltage—plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 83 shows the effect of grid voltage upon the amplification factor, mutual conductance and plate resistance.

Output Characteristics—Fig. 84 shows the undistorted power output obtainable at various load resistances.

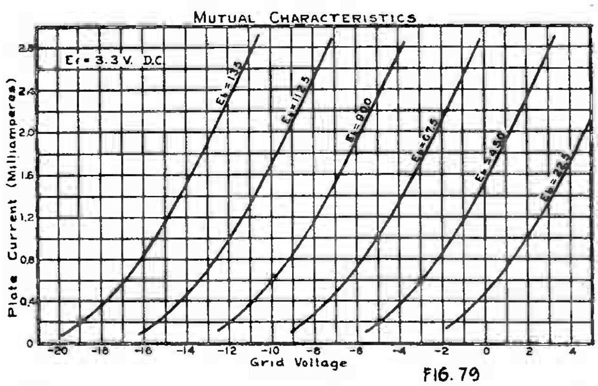


FIG. 79

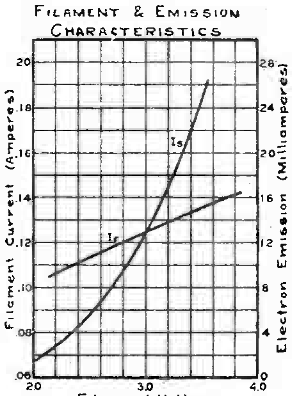


FIG. 80

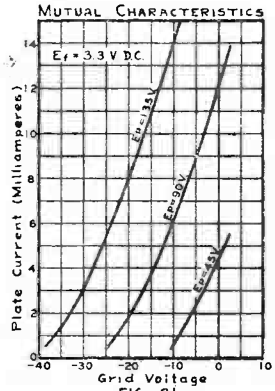


FIG. 81

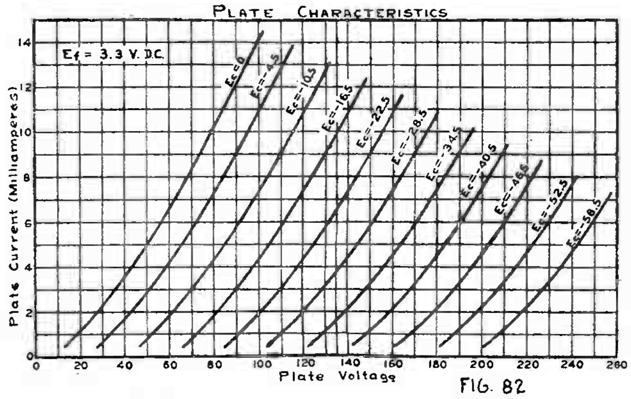


FIG. 82

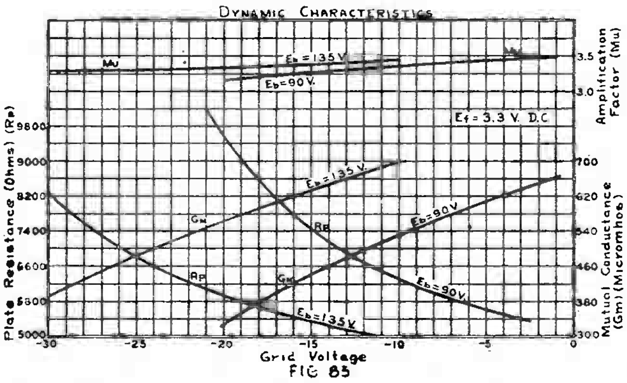


FIG 83

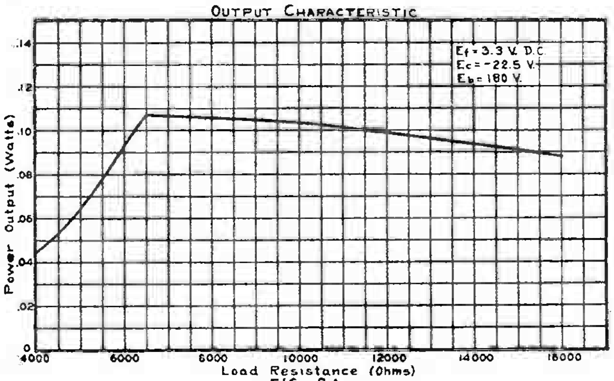


FIG 84

'01A.

This is the "grand old man" of Radio. It first appeared on the market when a single tube drew a full ampere of current at five volts and a three tube receiver wrought havoc with a storage battery in a single night of operation. The '01A is still used in many receivers of quite recent vintage—particularly those designed for use on direct current supply lines. This tube will be found used in all circuits. It suffers in some measure from the weakness noted in the case of the '99 but responds fully as well to reactivation.

As a Detector

When the '01A is used as a detector with grid leak and condenser, the plate voltage should preferably be not more than 45 volts. The grid condenser should have about 0.00025-mf. capacity and the grid leak should have a resistance of 2 to 9 megohms, the latter giving greater sensitivity on very weak signals but with somewhat inferior fidelity.

As an Amplifier

The '01A, when used as an amplifier, should have the following recommended grid biases applied whenever the plate voltage is over 45 volts:

Plate Voltage	*Negative Grid Bias*
67.5	3.0
90.0	4.5
135.0	9.0

In radio frequency circuits, there is little advantage in using more than 90 volts on the plate and when used for loud-speaker operation, the plate voltage should be 135 volts with suitable bias.

Rating

Filament Voltage	5.0 volts
Filament Current	.25-ampere
Plate Voltage (maximum)	135 volts

Average Characteristics

Plate Voltage	90	135 volts
Grid Bias Voltage	—4.5	—9.0 volts
Amplification Factor	8.0	8.0
Mutual Conductance	725	800 micromhos
Plate Resistance	11000	10000 ohms
Plate Current	2.5	3.0 milliamperes
Undistorted Power Output	15	55 milliwatts
Grid-Plate Capacitance	8.1 mmf.	
Grid-Filament Capacitance	3.1 mmf.	
Plate-Filament Capacitance	2.2 mmf.	

Average Characteristic Curves

Filament and Emission Characteristics—Fig. 85 shows the change of filament current and electron emission with various filament voltages.

Grid Characteristics—Fig. 86 shows the relation between grid current and voltage.

Plate Characteristics—Fig. 87 shows a family of plate voltage—plate current curves at various grid bias voltages.

Mutual Characteristics—Fig. 89 shows a family of grid voltage—plate current curves for various plate voltages.

Dynamic Characteristics—Fig. 88 shows the effect of grid voltage upon the amplification factor, mutual conductance and plate resistance.

'12 or '12A.

The '12 and '12A differ only as to the type of filament employed. Certain other minor differences may be forgotten. The '12 draws .5-amp. at 5 volts and the '12A, .25-amp. at 5 volts. The tube is ideally suited to use as a general purpose tube replacing the '01A and in certain cases a distinct improvement in results may be so gained. Operating conditions in amplifier circuits are indicated in the Tube Data Chart.

The tube has been used in some circuits with alternating current on its filament in the last audio frequency stage. This is an economy not practiced today and is only possible because of the use of push-pull circuits in which the hum voltages present in the output stage cancel out. The high thermal inertia of the filament as compared with earlier tubes helps to make this type of operation possible.

As a Detector

When grid bias detection is used, plate voltages up to 180 volts may be applied. The grid bias should be such that the plate current is about .1-milliampere when no signal is being received.

The requirements for grid leak-condenser detection with the '12A are that the plate voltage should be not more than 45 volts, the grid condenser should be about .00025-mf. capacity and the grid leak should have a resistance of 2 to 9 megohms. For maximum sensitivity, it is best to use the higher values of grid leak and for more stable operation, the lower values should be used.

As an Amplifier

The '12A may be used as an R.F. or A.F. amplifier and should always be operated with the proper value of grid bias to secure maximum undistorted amplification. When used in the last audio stage, the power output can be calculated from the curve shown in Fig. 94.

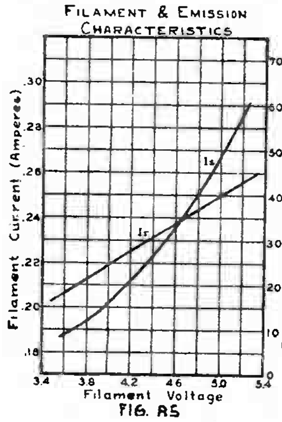


FIG. 85

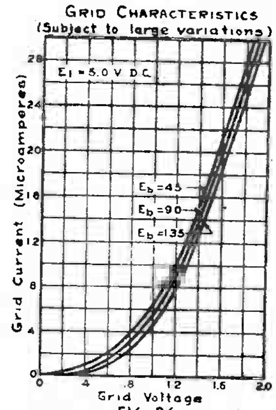


FIG. 86

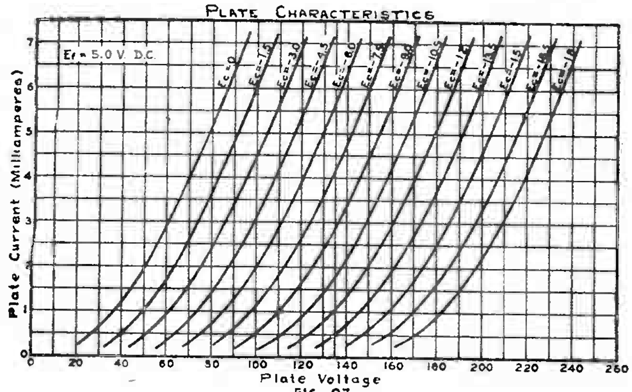


FIG. 87

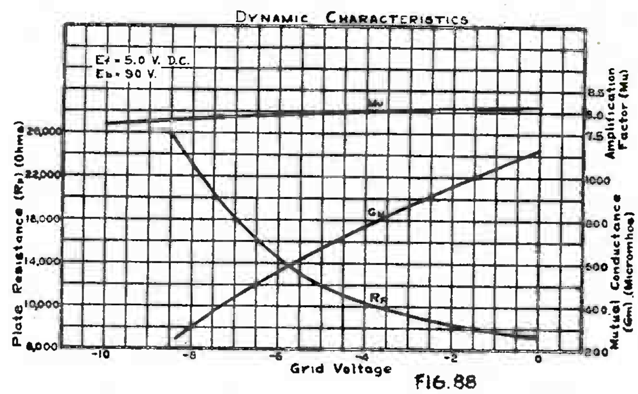


FIG. 88

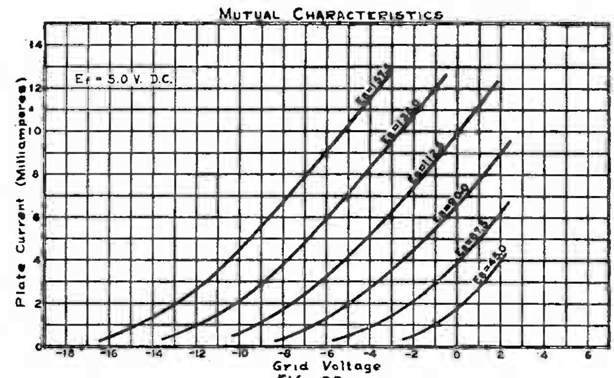


FIG. 89

Average Characteristics

Plate Voltage	90	135	180 volts
Grid Bias Voltage	–4.5	–9	–13.5 volts
Amplification Factor	8.5	8.5	8.5
Mutual Conductance	1500	1600	1700 micromhos
Plate Resistance	5600	5300	5000 ohms
Plate Current	5.2	6.2	7.6 milliamperes
Undistorted Power Output	30	115	260 milliwatts
Grid-Plate Capacitance	8.1 mmf.		

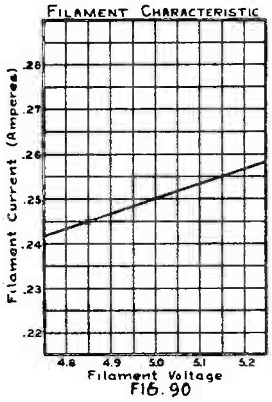


FIG. 90

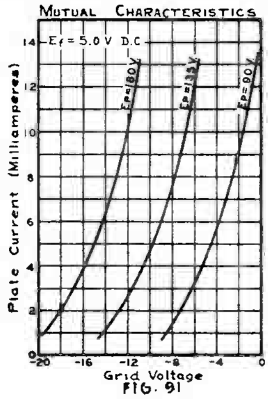


FIG. 91

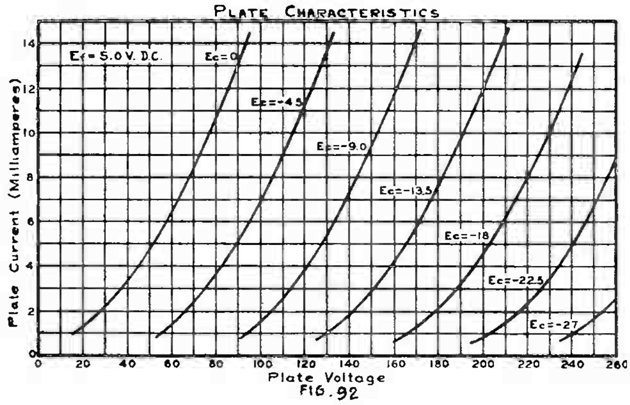


FIG. 92

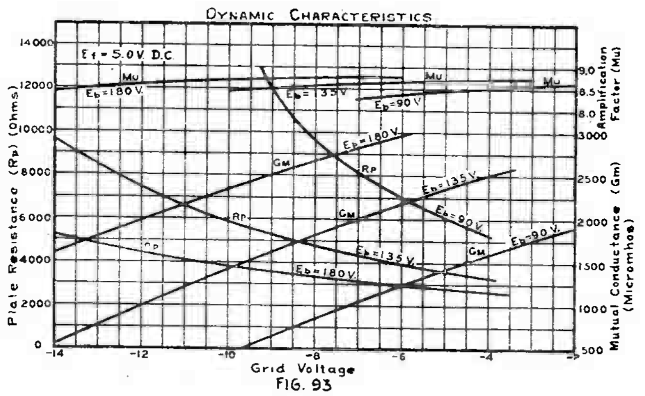


FIG. 93

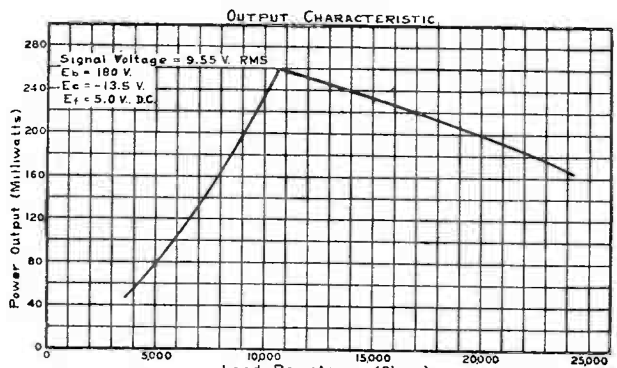


FIG. 94

AVERAGE CHARACTERISTIC CURVES

Filament Characteristics—Fig. 90 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 92 shows the relation between plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 91 shows a family of grid voltage—plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 93 shows the effect of grid voltage upon the amplification factor, mutual conductance and plate resistance.

Output Characteristics—Fig. 94 shows the undistorted power output obtainable at various load resistances.

'71 and '71A.

Here again are two tubes which differ only with regard to their filament characteristics. The difference is the same as in the case of the '12. Since certain of the early A.C. receivers employed these tubes in the output stage in a single or push-pull connection, care should be taken in cases where the "A" type is used in replacement in receivers originally designed for use with the '71 as the decreased current consumption may result in too high a filament voltage where the power transformer has been economically designed. In case this condition is found the 5-volt secondary of the transformer may be loaded up by short-circuiting it with a 10-ohm resistance where two tubes were used, or a 20-ohm resistance where a single '71 was originally employed.

Grid bias is preferably obtained by the use of a resistance between the center point of the filament winding and ground. The resistance required to give the correct bias at the ordinary plate voltages found is as follows:

Plate Volts	Single Tube	Two tubes in parallel or Push-Pull	Total Plate Volts required
90	1580 ohms	790 ohms	106.5
135	1685 ohms	840 ohms	162
180	2150 ohms	1075 ohms	220.5

As in all cases where the grid bias is obtained by making the cathode or filament positive with respect to the grid in the manner described above, the plate voltage must be correspondingly greater as shown in the table. The filament of the tube is subject to failure when the plate voltage of 180 is applied and the voltage should be held down to 135 except in cases where the additional power output is necessary. The '71A is the smallest of the tubes in which the plate current is far beyond the limits of the carrying capacity of loud-speaker windings and some form of output device which prevents the flow of direct current through the speaker windings is required. These arrangements may be obtained either through the use of a choke and condenser or by means of an output transformer of such a turns ratio as to match the impedance of the output load to that of the tube.

Rating

Filament Voltage	5.0 volts
Filament Current	0.25-ampere
Plate Voltage (maximum)	180 volts

Average Characteristics

Plate Voltage	90	135	180 volts
Grid Bias Voltage	–16.5	–27	–40.5 volts
Amplification Factor	3	3	3
Mutual Conductance	1330	1520	1620 micromhos
Plate Resistance	2250	1960	1850 ohms
Plate Current	12	17.5	20 milliamperes
Undistorted Power Output	125	370	700 milliwatts

Average Characteristic Curves

Filament Characteristics—Fig. 95 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 97 shows the relation between plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 96 shows a family of grid voltage—plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 98 shows the effect of grid voltage upon the amplification factor, mutual conductance and plate resistance.

Output Characteristics—Fig. 99 shows the undistorted power output obtainable at various load resistances.

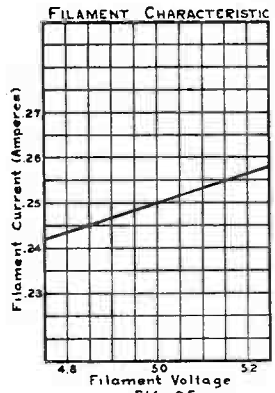


FIG. 95

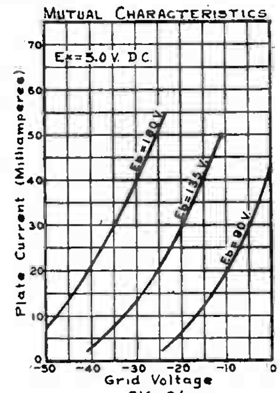


FIG. 96

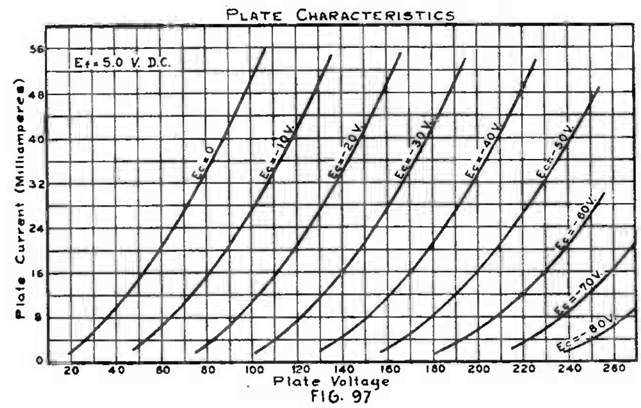


FIG. 97

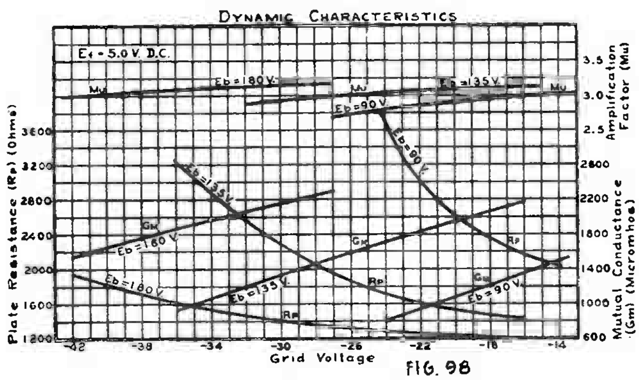


FIG. 98

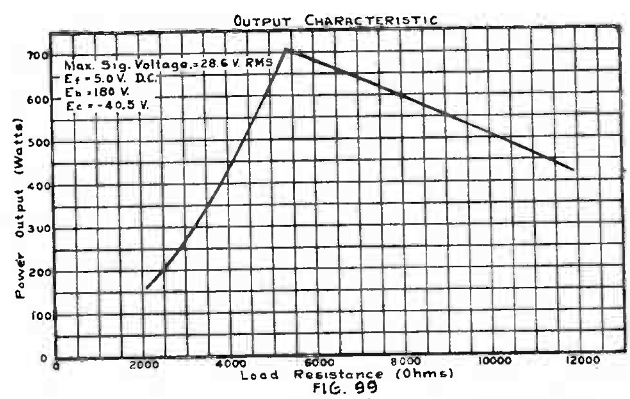


FIG. 99

'X-'22.

The '22 was the first of the tubes to employ the screen-grid or shielded-grid principle, in which the plate of the tube was electrostatically shielded from the control grid by means of a screen which was given such a potential, with respect to the plate, as to permit the shielding effect without any detrimental action insofar as the operating characteristics of the tube were concerned. This tube made possible the construction of high gain stages of radio frequency amplification without the necessity for neutralization, but at the same time the high gain obtainable made it essential that the circuits and, in most cases, the tubes themselves be shielded from interaction between the stages.

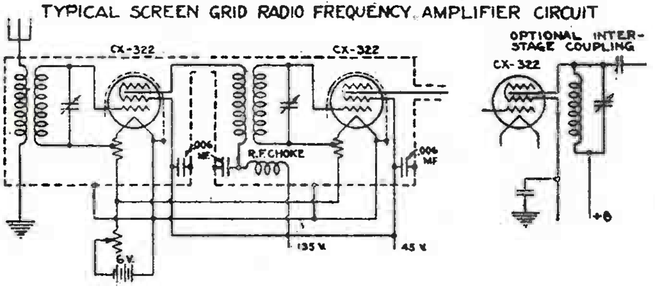
Use as Detector

The tube may be used as a detector with grid leak and grid condenser or with grid bias. Resistance coupling is recommended as giving the most satisfactory frequency characteristics because of the high internal resistance of the tube. See Fig. 100 for recommended circuit.

Use as a Radio Frequency Amplifier

This tube has been especially designed for use as an R.F. amplifier. When so used, the most important advantage gained is elimination of all feed-back through coupling between grid and plate, due to capacity between these elements. It is also possible to obtain higher voltage amplification per stage, 25 to 50 in the broadcast range as compared with the

TYPICAL SCREEN GRID RADIO FREQUENCY AMPLIFIER CIRCUIT



TYPICAL SCREEN GRID AUDIO FREQUENCY AMPLIFIER CIRCUIT

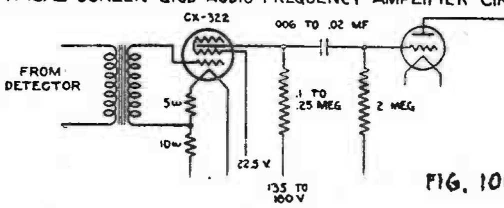


FIG. 100

usual range of 5 to 12 per stage with three-element tubes.

In the operating range the plate current does not vary appreciably with changes in plate voltage, this being due also to the screening effect of the second grid. As a result, the amplitude of the plate current change caused by a signal voltage impressed on the grid is scarcely affected by an increase in load resistance. Thus, it is of advantage to use a very high resistance or impedance in the plate circuit, in order to obtain high voltage amplification.

The voltage amplification depends only upon two factors:

A—The mutual conductance of the tube, which determines the amplitude of the plate current change, resulting from a signal voltage impressed on the control grid, and—

B—The load impedance. The voltage across the output load is directly proportional to the local impedance, since the amplitude of the signal current, with moderate loads, remains unchanged with an increase in impedance. This is unlike the condition with three-element tubes, where an increase in load resistance results in a decrease in the amplitude of the signal current.

At low radio frequencies, 50 to 100 kilocycles, it is possible to build up a very high load impedance by using a tuned plate circuit, and a voltage amplification of 200 per stage is obtainable. At broadcast frequencies it is not possible to obtain a sufficiently high load impedance to realize maximum voltage amplification, and the values quoted above represent average results (25 to 50 per stage).

Since the voltage amplification depends only upon the load impedance and mutual conductance, it may be quickly computed when these values are known. The voltage amplification obtained with a load impedance of 100,000 ohms, using a tube having a value of mutual conductance of 350 micromhos (.00035-mho).

Av.=100,000 x .00035=35 per stage.

With 250,000 ohms. Av.=250,000 x .00035=87 per stage.

It is possible to obtain the desired high load impedance by use of a tuned circuit connected in series with the plate, but it may be preferable to use a transformer connection with a ratio of 1:1 or slightly lower so that low frequency disturbances do not reach the grid of the succeeding tube and to facilitate the use of ganged condensers for uni-control. Both connections are shown in the circuit diagrams.

Although the internal shielding prevents feedback through the tube inter-electrode capacities, this is only one source of coupling between stages, and it is necessary to shield the input circuit from the output circuit. The amount of shielding necessary will depend upon the voltage amplification per stage and the circuit design. A metallic shield enclosing each tuned stage is usually sufficient, as indicated in the circuit diagram. It may be necessary, if the voltage amplification is high, to place a metal cap over the tube, extending to the base, and connected to ground. Clearance for the grid connection must be provided at the top.

Use as an Audio Freqency Amplifier

The tube may be used as an audio frequency amplifier with resistance coupling, the connections being the same as when the tube is used for radio frequency amplification, except that the screen-grid voltage should be lowered to compensate for the voltage drop in the load, unless a high plate voltage is available. With this connection, a voltage amplification of 35 per stage may be readily obtained with perfectly flat frequency characteristics down to 50 cycles and below (the lower limit is fixed only by the size of the blocking condenser); and extending on the high frequency and well above 10,000 cycles.

Operating Conditions

Filament Volts	3.3
Filament Amperes	.132
Control Grid Volts (Average)	–1.5
Screen-Grid Volts (Average)	45
Plate Volts	90 to 135

Average Tube Characteristics

Plate Voltage	135	135
Grid Voltage	–1.5	–1.5
Screen-Grid Voltage	45	67.5
Amplification Factor	300	290
Plate Resistance (ohms)	850,000	600,000
Mutual Conductance (Micromhos)	350	480
Plate Current (Ma.)	1.5	3.3

Inter-electrode Capacity

Plate to control grid (max) .025-mmf.

Rheostat Recommendations

For use with 4.5-volt dry cells use a 20 to 30-ohm rheostat.

For use with 5-volt tubes; connect a fixed resistance of 15 ohms in series with the filament of the tube. It may then be connected in parallel with other 5-volt tubes; operating from a common rheostat. If placed in the negative lead a tap at 10 ohms will provide –1.3 volts bias for the control grid.

Modern Dry-Cell Tubes.

Within the past year, the announcement of new type dry-cell tubes for economical operation in localities not served with commercial electric service has done much to revive the battery-operated receiver. Many of the commercial manufacturers have developed receivers for this market and their schematics are included in this manual.

'30.

General Purpose Tube

The '30 is a new general purpose tube designed to operate in battery receivers where economy of filament consumption is important. It may be used as a detector or ampliner and has an appearance similar to the '99, but has electrical characteristics which are considerably better. By using the '30 with the '31 (power tube) and '32 (screen-grid tube) it is possible to construct a modern radio receiver having screen-grid R.F. amplification and a power output stage.

Circuit Recommendations

As an R.F. Amplifier

The '30 may be used in circuits of conventional design, as a radio frequency amplifier in which case the grid and plate circuit return should be completed through correct batteries to the negative filament terminal of the tube. It is also possible to reduce the plate voltage to 67.5 volts and the grid bias to –3.0 volts and still secure proper amplification.

It is not recommended that a rheostat be used as a volume control unless provision is made that the highest voltage applied to the filament is never above 2.2 volts.

As a Detector

When used as a detector with grid leak and condenser, the plate voltage should not be higher than 45 and the grid return should be connected to the positive side of the filament. The grid condenser should have a capacitance of .00025-mf. and the grid leak a resistance of from ¼ to 5 megohms. The higher the value of grid leak, the greater will be the sensitivity on very weak signals, but the fidelity will be somewhat inferior to that obtained with the lower value.

The grid bias method of detection is recommended where better quality and selectivity are desired at the expense of sensitivity. The following table gives the approximate grid voltages to be used for a number of different plate voltages. Plate voltages above 90 volts should only be used when operating as a bias detector at the grid bias recommended below. The values of Ep are actual plate-filament voltages. The "B" battery voltage is higher by the drop in the plate resistance if resistance coupling is used.

Ep	Eg
90	–10.5
135	–15.0
165	–18.0

As an A.F. Amplifier

As in R.F. amplification, the grid return should be connected to the negative filament terminal, when the '30 is used as an A.F. amplifier. With resistance coupling, the grid resistance should not be greater than 2 megohms.

Operating Conditions

Filament Voltage	2.0 volts
Filament Current	0.06-ampere
Plate Voltage (maximum)	90 volts
Grid Bias Voltage	–4.5 volts

Average Characteristics

Amplification Factor	9.3
Mutual Conductance	700 micromhos
Plate Resistance	13000 ohms
Plate Current	1.8 milliamperes
Maximum Undistorted Power Output	16 milliwatts
Grid-Plate Capacitance	6.0 mmf.
Grid-Filament Capacitance	3.5 mmf.
Plate-Filament Capacitance	2.0 mmf.

Average Characteristic Curves

Filament Characteristics—Fig. 101 shows the change of filament current with various filament voltages.

Grid Characteristics—Fig. 102 shows the relation between grid current and voltage.

Plate Characteristics—Fig. 103 shows a family of plate voltage—plate current curves at various grid bias voltages.

Mutual Characteristics—Fig. 105 shows a family of grid voltage—plate current curves for various plate voltages.

Dynamic Characteristics—Fig. 104 shows the effect of plate current upon the amplification factor, mutual conductance and plate resistance.

Detector Characteristics—Fig. 106 shows the relation between the radio frequency input and the audio frequency output, for several percentages of modulation.

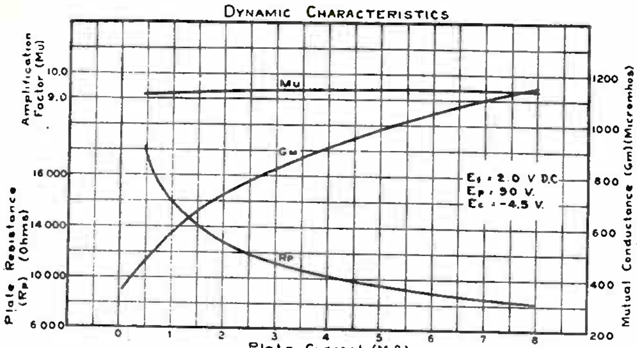


FIG. 104

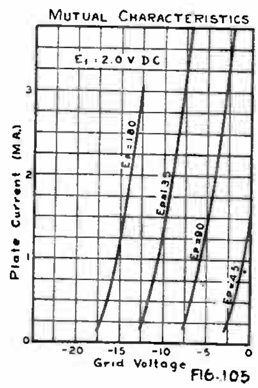


FIG. 105

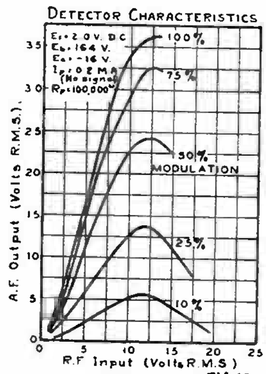


FIG. 106

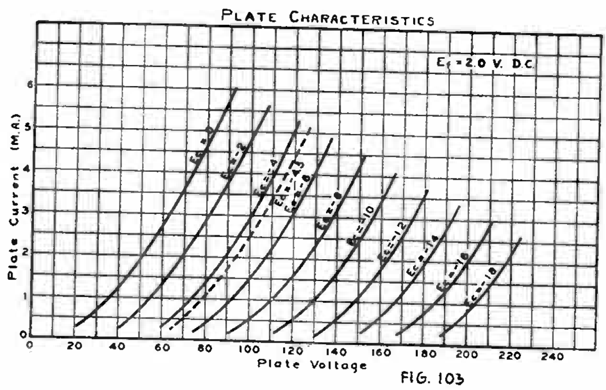


FIG. 103

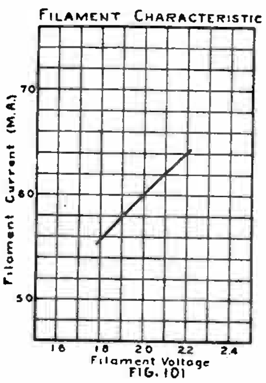


FIG. 101

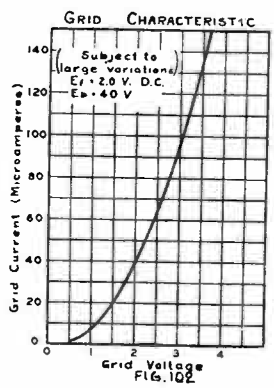


FIG. 102

'31.

Power Amplifier

The '31 is a new power amplifier tube designed to give good output volume from battery operated receivers where economy of filament consumption is important. It is the power output member of the "Two Volt Line" which has been developed for economical battery operation. The other tubes in this line are the '30 (general purpose tube) and the '32 (screen-grid tube). By employing these three types of tubes, it is possible to construct a modern radio receiver employing screen-grid tubes for R.F. amplification, general purpose tubes for detection and first audio amplification, and this special tube for power output purposes.

The power output of '31 is 150 milliwatts, which is probably sufficient for loud-speaker operation in portable sets, but where additional loud-speaker volume is required two of these tubes may be used in push-pull to give sufficient volume for ordinary home reception when an efficient loud-speaker is used.

Filament

The '31 has a coated type filament which operates at a normal voltage of 2 volts and a current of 130 milliamperes.

Average Characteristics

Amplification Factor	9.3
Mutual Conductance	700 micromhos
Plate Resistance	13000 ohms
Plate Current	1.8 milliamperes
Maximum Undistorted Power Output.	16 milliwatts
Grid-Plate Capacitance	6.0 mmf.
Grid-Filament Capacitance	3.5 mmf.
Plate-Filament Capacitance	2.0 mmf.

Average Characteristic Curves

Filament Characteristics—Fig. 107 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 109 shows the relation between plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 108 shows a family of grid voltage—plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 110 shows the effect of plate current upon the amplification factor, mutual conductance and plate resistance.

Output Characteristics—Fig. 111 shows the undistorted power output obtainable at various load resistances.

'32.

Screen-Grid Tube

The '32 is a new screen-grid tube designed for use as a radio frequency amplifier or detector in battery operated receivers where economy of filament consumption is important. This tube, used with the others of the new "Two Volt Filament" type, makes possible the construction of a most modern type of receiver operating with much greater economy than has heretofore been possible when using batteries.

The amplification factor of the '32 is 580 and the control grid to plate capacity is 0.020-mmf. This high amplification factor and low control grid to plate capacitance makes possible a high voltage amplification per stage.

Filament

The '32 has a coated filament which operates at a normal voltage of 2.0 volts and a current of 60 milliamperes. The filament should be operated in accordance with the data specified.

Plate Characteristics—Fig. 103 shows a family of plate voltage—plate current curves at various grid bias voltages.

Mutual Characteristics—Fig. 105 shows a family of grid voltage—plate current curves for various plate voltages.

Dynamic Characteristics—Fig. 104 shows the effect of plate current upon the amplification factor, mutual conductance and plate resistance.

Detector Characteristics—Fig. 106 shows the relation between the radio frequency input and the audio frequency output, for several percentages of modulation.

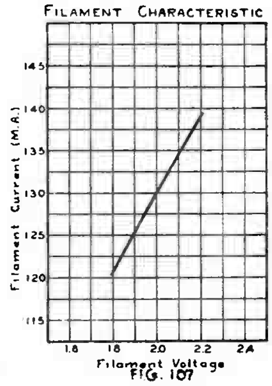


FIG. 107

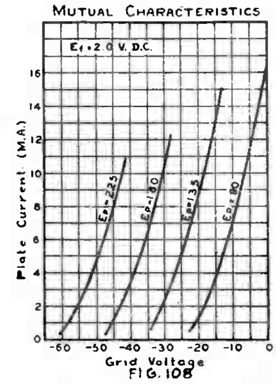


FIG. 108

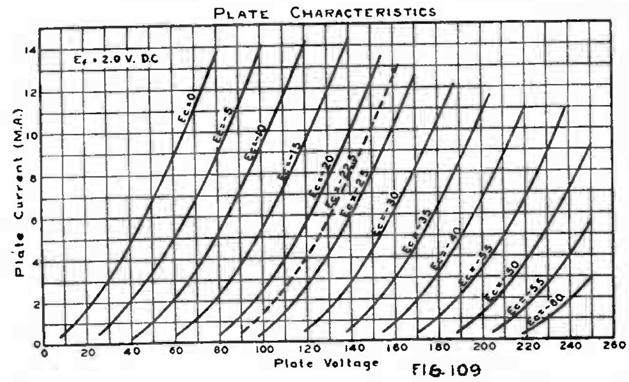


FIG. 109

'31.

Power Amplifier

The '31 is a new power amplifier tube designed to give good output volume from battery operated receivers where economy of filament consumption is important. It is the power output member of the "Two Volt Line" which has been developed for economical battery operation. The other tubes in this line are the '30 (general purpose tube) and the '32 (screen-grid tube). By employing these three types of tubes, it is possible to construct a modern radio receiver employing screen-grid tubes for R.F. amplification, general purpose tubes for detection and first audio amplification, and this special tube for power output purposes.

The power output of '31 is 150 milliwatts, which is probably sufficient for loud-speaker operation in portable sets, but where additional loud-speaker volume is required two of these tubes may be used in push-pull to give sufficient volume for ordinary home reception when an efficient loud-speaker is used.

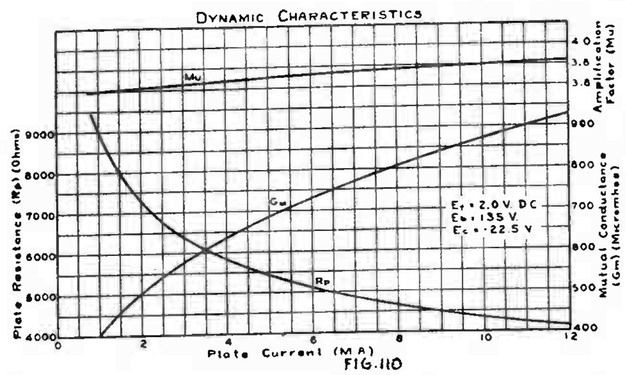


FIG. 110

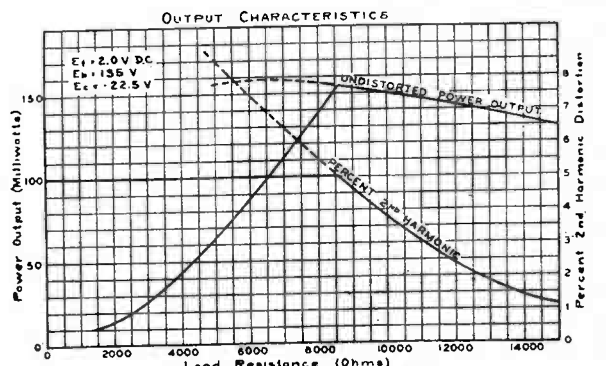


FIG. 111

Filament

The '31 has a coated type filament which operates at a normal voltage of 2 volts and a current of 130 milliamperes.

Average Characteristics

Amplification Factor	9.3
Mutual Conductance	700 micromhos
Plate Resistance	13000 ohms
Plate Current	1.8 milliamperes
Maximum Undistorted Power Output	16 milliwatts
Grid-Plate Capacitance	6.0 mmf.
Grid-Filament Capacitance	3.5 mmf.
Plate-Filament Capacitance	2.0 mmf.

Average Characteristic Curves

Filament Characteristics—Fig. 107 shows the change of filament current with various filament voltages.

Plate Characteristics—Fig. 109 shows the relation between plate current and plate voltage at various bias voltages.

Mutual Characteristics—Fig. 108 shows a family of grid voltage—plate current curves at various plate voltages.

Dynamic Characteristics—Fig. 110 shows the effect of plate current upon the amplification factor, mutual conductance and plate resistance.

Output Characteristics—Fig. 111 shows the undistorted power output obtainable at various load resistances.

'32.

Screen-Grid Tube

The '32 is a new screen-grid tube designed for use as a radio frequency amplifier or detector in battery operated receivers where economy of filament consumption is important. This tube, used with the others of the new "Two Volt Filament" type, makes possible the construction of a most modern type of receiver operating with much greater economy than has heretofore been possible when using batteries.

The amplification factor of the '32 is 580 and the control grid to plate capacity is 0.020-mmf. This high amplification factor and low control grid to plate capacitance makes possible a high voltage amplification per stage.

Filament

The '32 has a coated filament which operates at a normal voltage of 2.0 volts and a current of 60 milliamperes. The filament should be operated in accordance with the data specified.

As an R.F. Amplifier

Stable operation of this screen-grid tube in circuits designed to give maximum gain per stage, requires separation of the input and output circuit elements. Internal shielding of the screen makes neutralization of the plate to grid capacity unnecessary. However, the high amplifying ability of this tube makes it essential to prevent external coupling between circuit elements if the full capabilities of the tube are to be obtained. In general, with multistage amplifier circuits, it is necessary to use complete stage shielding including all the components of each stage. It is particularly necessary to shield the control-grid circuit from the plate circuit.

The use of filters in all leads entering the stage shields may be necessary in high gain amplifiers to reduce coupling in external parts of the circuits. In the construction of filters for the screen circuit, a by-pass condenser should be provided to keep the impedance from screen to ground as low as possible.

In general, properly designed radio frequency transformers are preferable to impedances for interstage coupling. If, however, impedance coupling is used, the grid resistance should not exceed 2.0 megohms.

As a Detector

The '32 may be used as a detector providing the audio amplification is comparatively low in order to prevent microphonic disturbances. The audio gain permissible depends on the type of cabinet, speaker design, and power output capabilities of the power output tubes. In any circuit a cushion type socket is recommended. The following operating conditions are suggested:

Plate Load Resistor	100000	100000
Screen-Grid Voltage	67.5	45
Control Grid Bias Voltage	–6	–4.0

The Plate Battery Supply Voltage may be either 135 or 157.5 volts.

In addition to its recommended application as a screen-grid-radio-frequency amplifier, this new tube may be employed in experimental circuits wherever a double grid, four-electrode tube is desired.

In circuits designed for the '22, the '32 may be substituted providing the filament and grid circuit voltages are altered to conform to the requirements of this new tube. A typical circuit diagram using the '32 as an R.F. amplifier is shown in Fig. 119.

Operating Conditions

Filament Voltage	2.0 volts
Filament Current	0.06-ampere
Plate Voltage	135 volts
Control Grid Voltage	–3 volts
Screen-Grid Voltage	67.5 volts

Average Characteristics

Amplification Factor	580
Mutual Conductance	505 micromhos
Plate Resistance	1150000 ohms
Plate Current	1.4 milliamperes
Grid-Plate Capacitance	0.020-mmf.
Input Capacitance	6.0 mmf.
Output Capacitance	11.0 mmf.

Average Characteristic Curves

Filament Characteristics—Fig. 112 shows the change of filament current with various filament voltages.

Inter-Electrode Characteristics—Figs. 113, 114 and 115 show the relations existing between the plate, control grid and screen-grid by means of the following curves:

Plate Voltage—Plate Current	Fig. 114
Plate Voltage—Screen Grid Current	Fig. 114
Control Grid Voltage—Plate Current	Fig. 113
Control Grid Voltage—Screen-Grid Current	Fig. 113
Screen-Grid Voltage—Plate Current	Fig. 115
Screen-Grid Voltage—Screen-Grid Current	Fig. 115

Dynamic Characteristics—Figs. 117 and 118 show the effect of control grid and screen-grid voltage (respectively) upon the amplification factor, mutual conductance and plate resistance of the '32.

Detection Characteristics—Fig. 116 shows the relation between the radio frequency input and the audio frequency output, for several percentages of modulation.

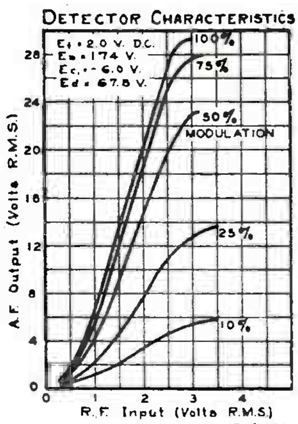


FIG. 116

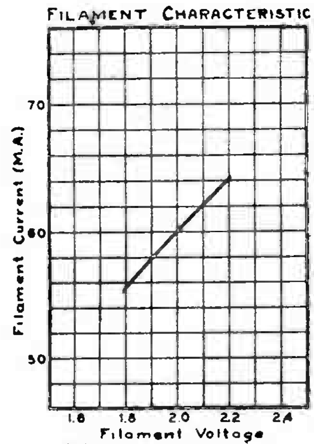


FIG. 112

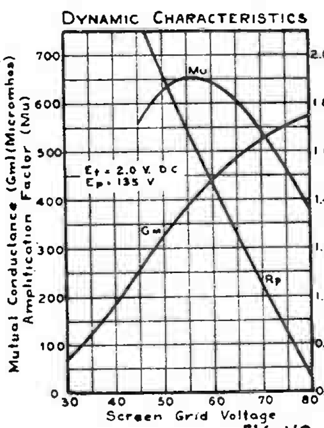


FIG. 118

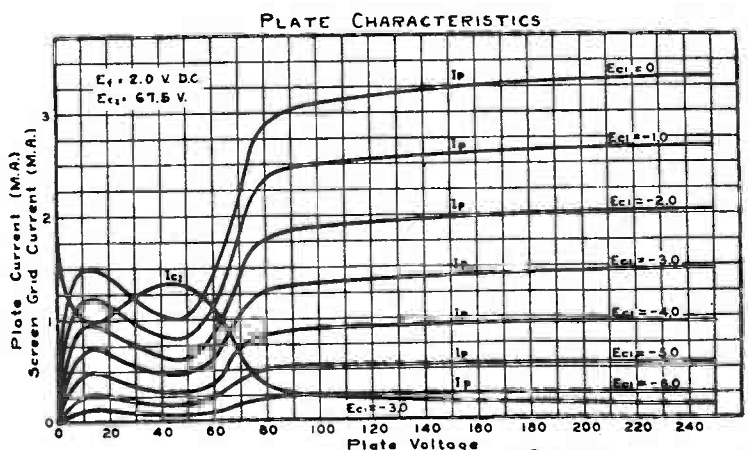


FIG. 114

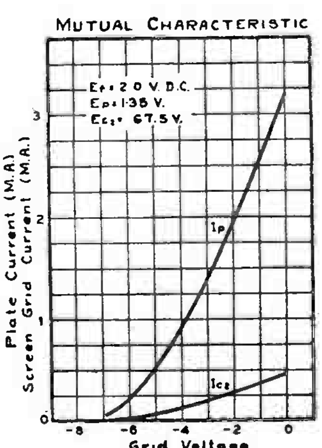


FIG. 113

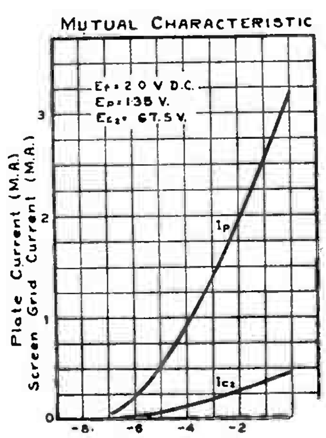


FIG. 115

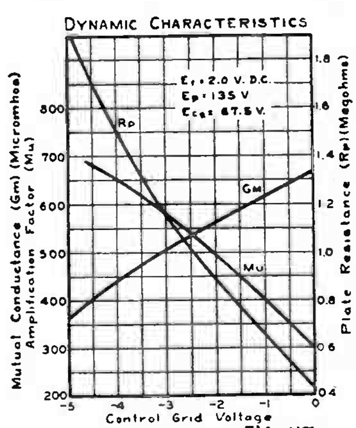
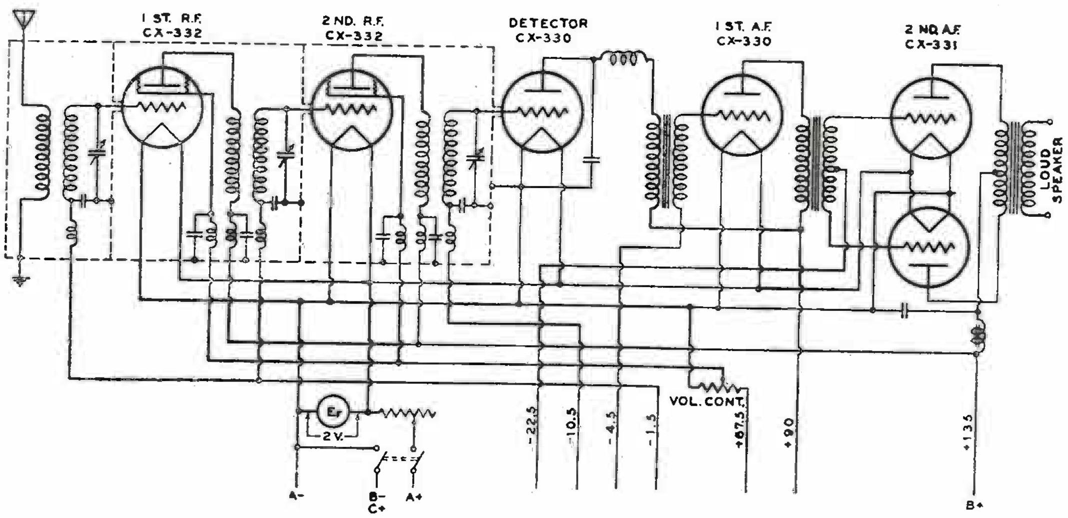


FIG. 117



Typical Circuit Using CX-330, CX-331, and CX-332 Two Volt Filament Tubes
FIG. 119

Alternating Current Tubes.

The tubes mentioned up to this point are suitable for use with batteries, as in no case do the power demands exceed the limits of the standard types of storage "A" batteries or the usual "B" batteries. With the exception of the special purpose tubes mentioned in the latter portion of this section, the tubes to follow place such demands upon the power supply equipment as to render the use of batteries uneconomical except in special services where peculiar situations demand their use.

'X-'26.

The '26 tube was originally designed for use in conjunction with the '27 in circuits where the latter was employed as the detector and special output tubes in the output stage. Recent developments have made the '26 obsolete—foremost among them being the cheapening of the '27 which was originally too high in price to be economical for use throughout a multi-tube receiver.

The '26 has an exceptionally sturdy filament which has a high degree of thermal inertia—which means, as has been explained before, that the cooling is so slow as not to follow the variations in applied voltage due to the alternating current cycle. Except for the fact that the filament draws a high current at a relatively low voltage, the tube does not differ materially from the ordinary three-element tube. Because of the extreme sensitivity of detector circuits to the effects of hum, the tube was never employed in detector circuits.

When used as an amplifier, the grid return is, in most cases, made to ground and the grid bias obtained by making the filament positive with respect to the grid by inserting a resistance of the required value between the center tap of the filament winding and ground. This gives the grid a bias equal to the voltage drop through the biasing resistance due to the total plate current flowing through it. It is essential that the center tap of the transformer, or of its shunting resistance, be accurate if no hum is to result. In most of the original A.C. receivers, this center tap was adjustable.

OPERATING CONDITIONS

Filament Volts	1.5		
Filament Amperes	1.05		
Plate Volts	90	135	180
Grid Voltage	6.0	-9.0	-13.5

AVERAGE TUBE CHARACTERISTICS

Plate Voltage	90	135	180
Grid Voltage	-6.0	-9.0	-13.5
C Bias Resistor	1700	1500	1800 ohms
Amplification Factor	8.2	8.2	8.2
Plate Resistance	8600	7200	7000 ohms
Mutual Conductance	955	1135	1170 micromhos
Plate Current	3.8	6.3	7.4 milliamperes
Undistorted Output	30	80	180 milliwatts

The higher plate voltages are recommended only where the signal input to a particular stage might be large enough to cause overloading or a flow of gold current.

USE AS AN AMPLIFIER

Operation as an amplifier for either A.F. or R.F. is essentially the same as for the '01A. The electrical characteristics are substantially the same and ordinarily do not require any changes in the characteristics of the A.F. and R.F. transformers as previously employed with the '01A. Grid and plate return leads should be connected to the movable arm of a low resistance potentiometer connected across the filament, and in operation this arm should be adjusted for minimum hum.

The '26 cannot be used satisfactorily as a bias detector when operated from alternating currents as the hum present under such conditions is objectionable.

Curves and Diagrams

The variation of filament current with filament voltage is shown in Fig. 120.

The relation between plate current and plate voltage at several values of bias is shown in Fig. 121 From this curve it is possible to determine approximately the plate current under given conditions of grid and plate voltage.

Fig. 122 shows the variation of plate current with grid voltage for various values of plate voltage.

The effect of plate voltage upon amplification factor, plate resistance and mutual conductance at various grid bias voltages is shown in Fig. 123.

'Y-'27.

The '27 was originally intended for use as a detector in conjunction with the '26 and one of the power output tubes described here. As production of the tube increased, the list price of the tube fell and it became possible to use the tube throughout receivers. A considerable gain in sensitivity and in lack of hum resulted, as the '27 is of the indirect heater type in which the alternating current used in heating the cathode does not flow directly in the cathode circuit, but is insulated therefrom by a small ceramic sleeve which readily transmits the heat to the cathode proper.

The original indirect heater tubes required some thirty or forty seconds to reach their operating temperature and some annoyance was experienced because of the delay. Judicious cutting down of the material insulating the heater from the cathode and improvement of its thermal characteristics has resulted in considerable improvement in this time lag, and the present tubes heat up to their operating temperature in from five to six seconds.

Although the heater is rated at 2.5 volts at 1.75 amperes, it may be operated at considerably lower voltages as the maximum electron emission obtains at a filament voltage of about 1.9. Although perfect operation is achieved with this low voltage, the heating time is considerably increased. It will be noted in many receivers that the '27 is operated at some voltage between 1.9 and 2.5.

It is essential that the tube should not be operated at a voltage higher than 2.6 as the intense heat generated will, after a short period of operation, be

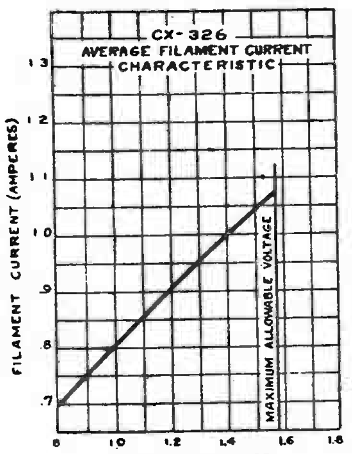


FIG. 120

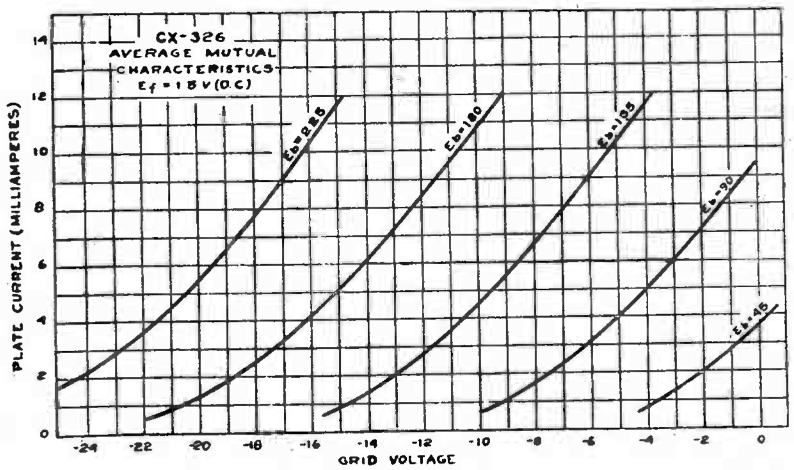


FIG. 122

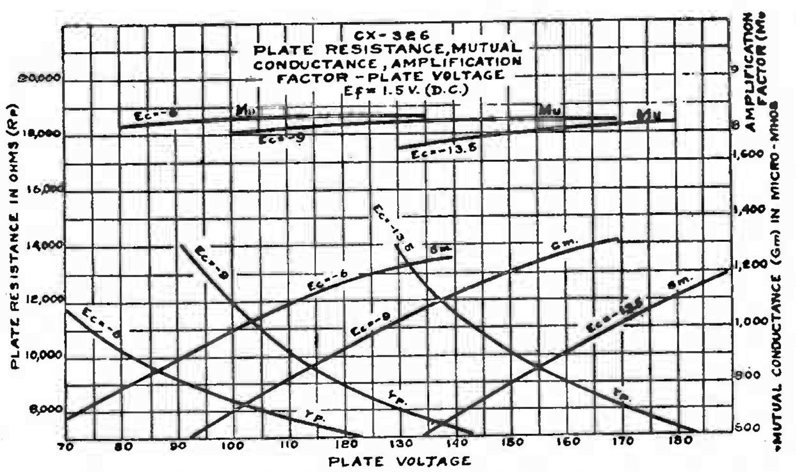


FIG. 123

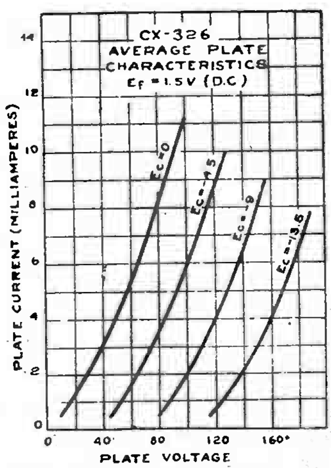


FIG. 121

sufficient to make the grid emit electrons—this is termed *grid emission* and is ruinous to reception. If you should, in the course of your travels, find a receiver which works well when first switched on but gradually loses volume, it is highly probable that the heater voltage is too high and that grid emission is taking place.

Before leaving the subject of the '27 cathode it should be noted that some of these tubes are found with thermostatic open circuits. That is to say, that while the tube is operating at a low temperature as when first switched on, there will be no trouble indicated, but as the temperature within the tube increases, expansion of the elements will cause an open circuit which will cut out the signal entirely until the tube cools off to a low enough temperature for contraction of the elements to complete the circuit again. This intermittent operation is easily recognized when met and a knowledge of the fact that such a condition may possibly exist is all that is needed to cure the fault.

Operation of the '27 as an audio frequency or radio frequency amplifier is described in the Data Chart. It may also be operated as a grid circuit detector with a plate voltage of 45 and a grid condenser and leak of .00025-mf. and 2 megohms, respectively. Operation as a "bias" detector requires the use of a biasing resistor of from 20,000 to 100,000 ohms in series with the cathode circuit. The higher the value of this resistance, the greater will be the allowable signal on the grid before distortion occurs. The tube may be operated as a power grid detector with 180 volts on the plate, and a grid condenser and leak of .0001-mf. and 100,000 ohms, respectively. This last type of operation gives the greatest freedom from distortion of all types of detectors.

Grid bias is obtained by inserting a by-passed resistance in series with the cathodes so that the plate current flowing through the resistance will create a voltage drop sufficient to place the cathode at the required potential positive with respect to ground. In such case, the grid return is brought directly to ground.

Although it is not recommended, the '27 may be used as a power output tube in cases where no large degree of volume is demanded. In this mode of operation the plate voltage is 180 and the grid bias —13.5 volts.

The '27 may not be operated as a radio frequency amplifier unless measures are taken either to prevent oscillation by the so-called "losser" methods or by some system of balancing out the inter-electrode capacity of the tube.

Although the center tap of the heater winding of the power transformer is normally grounded, there are cases where the heaters are on the same winding as the '45 output tubes and are at the same potential as the '45 filaments—about 50 volts positive with respect to ground. This should be taken into account when making measurements on the '27 circuits. In cases of obstinate hum, a cure may at times be effected by deliberately making the heaters positive with respect to the cathodes by returning their center tap to some point on the voltage divider rather than directly to ground.

Operating Conditions

Plate Volts	Detection Grid Leak (Megs)	Detection Grid Bias (Volts)	Amplification Grid Bias (Volts)
45	2	-5.0	
90		-10.0	-.60
135		-15.0	-9.0
180		-20.0	-13.5

Curves and Diagrams

Fig. 124 shows the variation of filament current with filament voltage.

Fig. 125 shows the variation of plate current with plate voltage for various values of bias voltage.

Fig. 126 shows the variation of plate current with grid voltage for various values of plate voltage.

Fig. 127 shows the variation of amplification factor, plate resistance and mutual conductance with grid voltage for various values of plate voltage.

Fig. 128 shows the detector action as a grid leak detector with plate voltage of 45 volts, 2-meg grid leak and for 22% modulations.

Fig. 129 shows the detector action of the '27 operating as a bias detector under various voltage conditions, with a plate load of 200,000 ohms and 22% modulation. The star marked on each curve indicates the point at which grid current begins to flow.

'Y-'24.

The '24 is a screen-grid tube with the same heater-cathode structure as the '27. The other elements are so proportioned as to have a definite gain over the structure of the '22 in so far as possible amplification is concerned. The control grid is brought out through the cap and the screen-grid is connected to the terminal provided for the grid in the case of the '27.

Operating Conditions

Heater voltage	2.5	2.5 volts
Heater current	1.75	1.75 amperes
Plate voltage	180	180 volts maximum
Control grid voltage	-1.5	-3.0 volts maximum
Screen-grid voltage	75	90 volts maximum

Average Tube Characteristics

Tube characteristics at above operating conditions

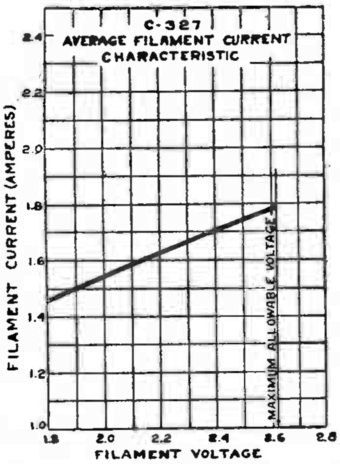


FIG. 124

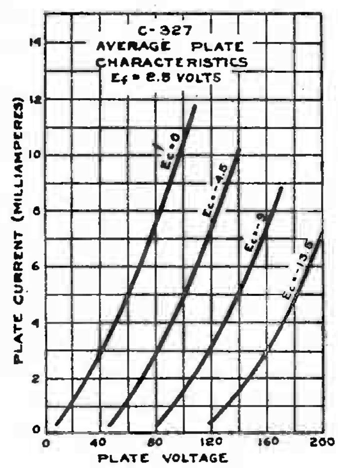


FIG. 125

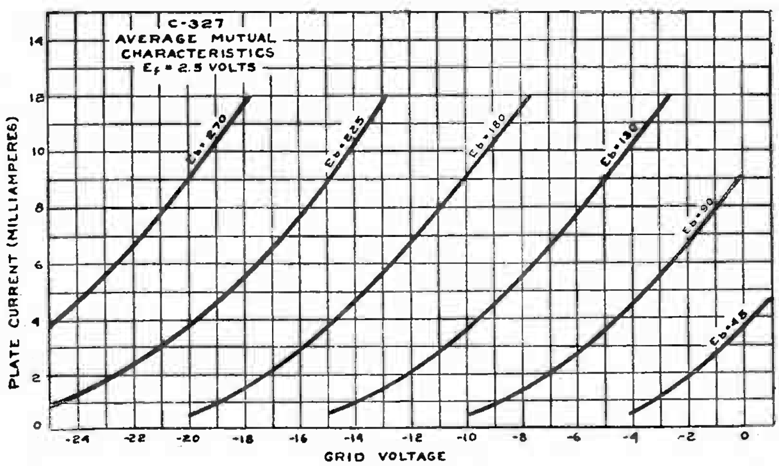


FIG. 126

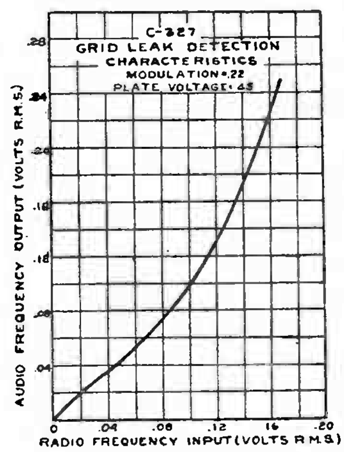


FIG. 128

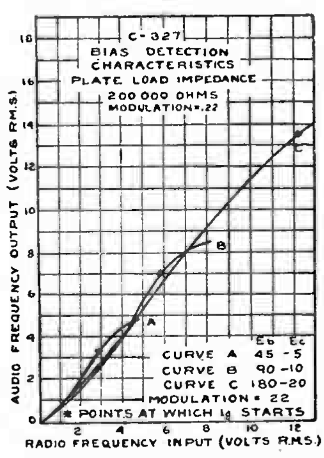


FIG. 129

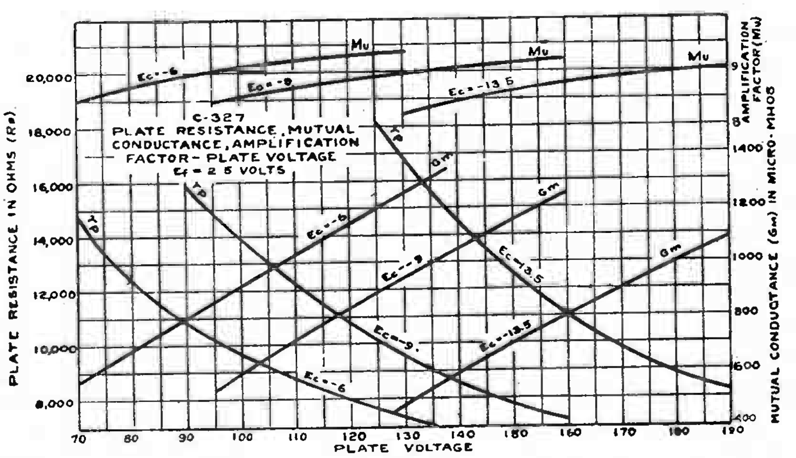


FIG. 127

Amplification factor	420	400
Plate resistance	400,000	400,000 ohms
Mutual conductance	1,050	1,000 micromhos
Plate current	4.0	4.0 milliamperes

Use as a Radio Frequency Amplifier

In order to obtain stable operation in circuits designed to give normal gain per stage, it is necessary to use shielding to separate the input and output circuits. The internal shielding of the tube makes neutralization unnecessary, providing extraneous external couplings are eliminated by means of shielding. Suitable ventilation must be provided through the shielding to prevent excessive tube temperatures. Radio frequency filters should be used in circuits employing more than two stages and also in circuits which are designed to give the maximum amplification per stage. The high plate circuit impedance necessary for obtaining the normal amplification may be obtained either with closely coupled R.F. transformers or by means of the tuned plate impedance method. At broadcast frequencies, a voltage amplification from 50 to 100 per stage can be obtained. To prevent regeneration or oscillation in a two-stage radio frequency amplifier, the amplification should not exceed 100 per stage at the highest broadcast frequencies.

The volume of the R.F. amplifier may be controlled by a potentiometer control on the screen-grid voltage so that the screen-grid voltage may be varied between zero and plus 75 volts. Control grid voltage adjustment may also be used as volume control providing the control grid bias is always greater than 1.5 volts negative. The negative grid bias maintains high input resistance, resulting in good gain and selectivity of the preceding circuit.

Use as a Detector

The '24 is an excellent bias detector either with small signal or high signal input. The screen-grid voltage and control grid bias should be so chosen that the control grid does not swing to a point where grid current is drawn. For small R.F. signals when a first audio stage is used, it is best to operate the screen-grid at 35 or 45 volts and the control grid at minus 3.5 or 4.5 volts, respectively. The output under this condition into a 200,000-ohm load choke fed with one volt R.M.S. radio frequency input modulated 22%, is 5.5 volts R.M.S. audio output. With 75 volts on the screen-grid and a control grid bias voltage of 7.5 volts, the audio output at the point where grid current starts is 49.5 R.M.S. audio voltage output with an input of 4.28 volts R.M.S. with 22% modulation. This is more than sufficient to operate a '45 to full output by means of direct coupling; or two '45 tubes in push-pull by means of a low gain audio stage.

Curves and Data

Fig. 130 shows the filament current and emission variation with filament voltage.

Fig. 131 shows the average plate current over a range of screen-grid voltages at various control grid voltages. A curve also of the screen-grid current is plotted for the control grid voltage of negative 1.5 volts.

Fig. 132 shows the variation of amplification factor, plate resistance, and mutual conductance for various control grid voltages at screen-grid voltages of 75 volts and plate voltage of 180 volts.

Fig. 133 shows the variation of amplification factor, plate resistance, and mutual conductance with various screen-grid voltages at a control voltage of minus 1.5 volts and plate voltage of 180 volts.

Fig. 134 shows the variation of plate current with plate voltage for various control grid voltages at screen-grid voltage of plus 75 volts.

Fig. 135 is similar to Fig. 134 except it has been plotted with a screen-grid voltage of plus 45 volts.

Fig. 136 shows the detector action in audio frequency volts output against radio frequency input, both measured in R.M.S. volts. The point where grid current starts to flow is noted on each curve. Curve A was taken at a plate voltage of 180 volts, a screen voltage of plus 45 volts and a control grid voltage of minus 4.5 volts. The plate voltage was fed through a high impedance choke and the resistance load so chosen to give a total plate circuit impedance of 200,000 ohms with a power factor of .96. The D.C. resistance of the choke was 3,000 ohms. Curve B was taken with the same circuit at a screen-grid voltage of plus 75 volts and control grid voltage of minus 7.5 volts.

While the high impedance tube is inherently possible of greater selectivity than the three-element tube, there are certain characteristics peculiar to the tube which make the apparent selectivity less. These are the effects of *cross-modulation* or "cross-talk" and of *beat interference*.

Because of its high amplification, the screen-grid tube is subject to the effects of cross-modulation as it requires but a slightly higher applied voltage on the grid of the tube to cause it to operate in the region favorable to detection. It will be noted from the preceding data, that the bias required for detection is but 4.5 volts. The voltage developed across the grid circuit of the first tube by a strong local signal is often sufficient to operate the tube as a detector even though the circuits are tuned to some frequency greatly removed from the interfering signal. Variations in the intensity of the interfering signal serve to modulate the desired signal accordingly, and the signal to which we are tuned is doubly modulated—once by its own modulation, and once by that of the interfering signal. Once this *cross-modulation* takes place, no amount of selectivity in the succeeding cir-

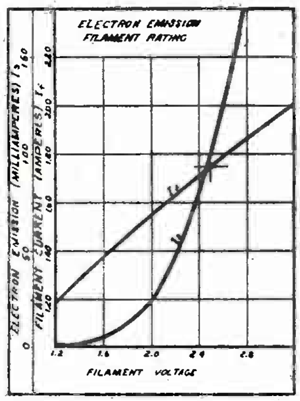


FIG. 130

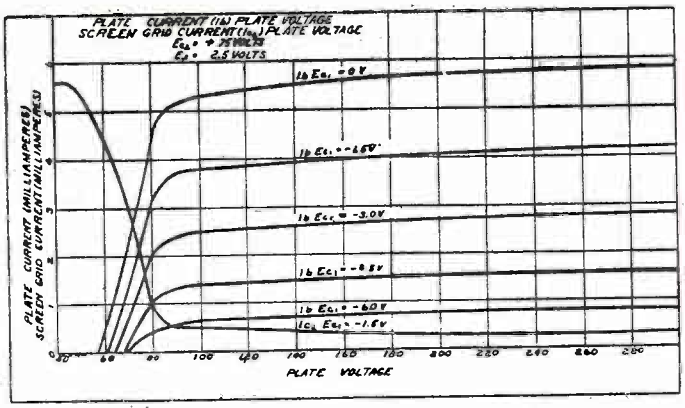


FIG. 134

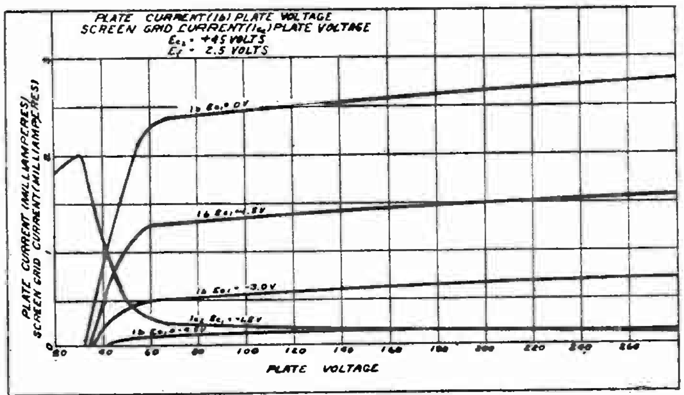


FIG. 135

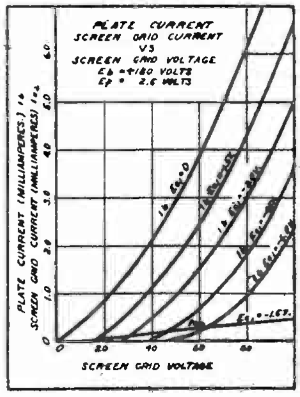


FIG. 131

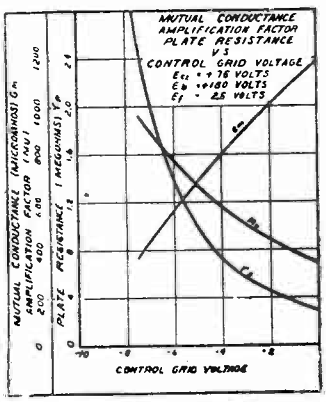


FIG. 132

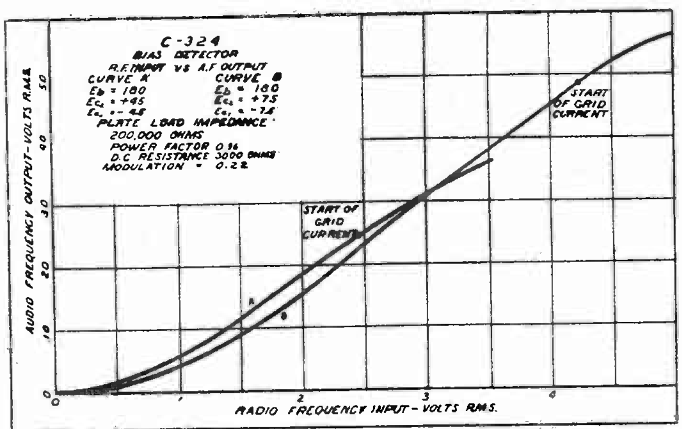


FIG. 136

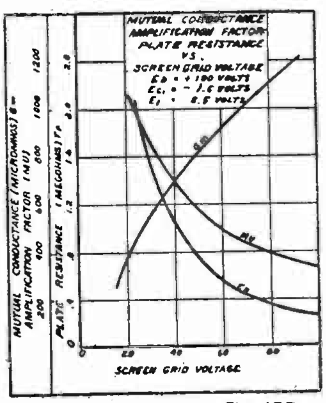


FIG. 133

cuits will serve to rid us of it as it is actually impressed upon the desired signal. To avoid this, it is now standard practice to employ "band-selector" or coupled circuit systems between the antenna and the first tube; these are an absolute necessity to successful operation of the screen-grid tube.

If two such local signals are impressed upon the grid of the first tube they will create *beats*, or secondary signals, having frequencies equal to the sum and difference of the two original signals. Thus, two signals at 550 and 900 kc. will produce beats at 350 and 1450 kc., the latter of which will appear in the receiver as a signal modulated by the modulations of both the original signals intermingled. It may readily be seen that every precaution must be taken to prevent the appearance of strong locals across the input circuit of the first tube, and the use of at least two tuned circuits between the antenna and the first grid are necessary. The effects noted obtain only when the local signals are of sufficient intensity to operate the tube on a portion of its characteristic curve favorable to detection. The effects are not noticeable to a great degree with tubes other than the '22 or '24.

POWER OUTPUT TUBES

It has been fairly obvious throughout the previous discussion that the vacuum tube is a voltage operated device. Little or no power is consumed in the grid circuit of a vacuum tube and the sole purpose of the R.F. and A.F. amplifiers is to obtain the largest possible voltage output.

The loud speaker, however, is a power-consuming device and the purpose of the output tube, or last tube in the chain, is to provide the greatest power possible for the operation of the speaker. It is, of course, essential that the power supplied be free from distortion in as great a degree as possible and, as we noted in the definitions, the maximum undistorted power output is obtained when the load impedance is twice the output impedance of the tube except in the case of pentodes. The impedance of the tube is practically invariable over the range of frequencies employed but the impedance of the speaker is a variable factor and it is usual to take the speaker impedance at 200 cycles as the criterion in design. This may vary from about 5000 ohms in the case of the magnetic speaker to 15 ohms in the case of the dynamic type.

It is necessary that a transformer be used to match the impedance of the tube to that of the speaker, and the formula for obtaining a condition where the load of a power tube will be twice its own impedance is as follows:

$$T = \sqrt{\frac{2R_P}{R_S}}$$

Where T is the turns ratio of the transformer, Rp the tube impedance, and R1 the impedance of the loud-speaker winding at 200 cycles.

As an example let us assume that we desire to match the impedance of a '71A tube to a speaker having an impedance of 15 ohms. The impedance of the tube is 1850 ohms. Then by the formula

$$T = \sqrt{\frac{3{,}700}{15}}$$

=approximately 15.7

Where two tubes are in push-pull, the total tube impedance is double that of a single tube and the turns ratio of the transformer would be about 22.2.

The characteristics of output tubes involve relatively low plate impedance—high plate voltage and plate current and a high mutual conductance. It should be remembered that the signal voltage as measured by instruments in the grid circuit of the output tube is in R.M.S. readings, while the peak voltage is what swamps out the grid bias and permits distortion to occur by operating the tube on a curved portion of its characteristic curve. This means that we should never apply a voltage to the grid of a tube whose peak value exceeds the value of the bias.

The figures given in the Data Chart for the undistorted power output are those of the maximum obtainable with the tube without operating the tube on a curved portion of the characteristic.

It is often desirable to know what power output is obtained from a tube when the signal is not of the maximum allowable intensity. This figure may be obtained from the formula

$$P = \frac{P = 2(uEg)^2 x1000}{9Rp}$$

where P is the power output in milliwatts, u the amplification factor of the tube, Eg the value of the signal in R.M.S. volts, and Rp the plate impedance of the tube. Suppose that we wish to find the power output of a '71A with an input signal of 20 volts (R.M.S.) From the equation

$$P = \frac{P = 2x(60)^2\ 1000}{16630}$$

$$P = \frac{7200{,}000}{16630}$$

or P=432 milliwatts

There are certain advantages incident to the operation of tubes in push-pull which are not generally understood. In the first place the D.C. forces in the output transformer cancel out and permit of considerable economy of design and improved quality.

Secondly, no signal voltages are flowing in either the plate voltage circuit or in the grid biasing circuit. For this reason there is no necessity for by-passing in either circuit.

We might leave the discussion of the push-pull circuit here, while its advantages are fresh in our minds, to note that the biasing of power tubes should be such that normally no change in the plate current takes place under the influence of an applied signal. A fluctuation in plate current when a signal is present indicates overloading of the tube.

By-passing of the biasing resistances in all amplifier tubes should be sufficient to effectively short-circuit the bias resistance so far as all low frequencies are concerned. In the case of the '71A, it is possible that the response is desired perfect as low as 50 cycles. With a biasing resistance of 2150 ohms, this means that a condenser of at least 15 microfarads would be necessary to effectively short-circuit the biasing resistance. This is on the basis of a condenser reactance of 212 ohms at 50 cycles. Otherwise, a signal exactly out of step with the input would appear across the biasing resistance in opposition to the input signal which would "buck out" the incoming low frequency signals.

'X-'10.

The '10 is a power output tube of relatively high impedance for use in A.C. receivers and low power transmitters. Its characteristics are fully described in the Data Chart. Subsequently released tubes, because of their improved power efficiency, have rendered the 10 somewhat obsolete.

Rating

Filament Volts	7.5
Filament Amperes	1.25
Type	Thoriated Tungsten

Average Characteristics

Plate Voltage	425 volts
Plate Current	.018-ampere
Amplification Factor	8
Plate Resistance	5000 ohms
Mutual Conductance	1600 micromhos
Control Grid Voltage	35 volts
Load Impedance in ohms	10000
Output (5% second harmonic)	1.6 watts

'X-'45.

The '45 tube is the power output tube found in most of the modern receivers. Inasmuch as its undistorted power output of 4.5 watts, when two tubes are connected in push-pull, is sufficient to fill a good-sized auditorium, there is little reason why a larger tube should be desired in the average radio receiver. The characteristics of the '45 are such as to make it useless in positions other than in the output, although in certain power amplifiers requiring a large signal at the output, the '45 has been used as an intermediate A.F, stage. The filament is to be operated at not more than 5% above or below its normal rating. Operation of the tube without grid bias will result in the destruction of the filament due to the heavy current drawn. The biasing resistance with 250 volts on the plate is 1470 ohms, and with 180 volts is 1380 ohms. Total plate voltage required in the first case is 300 volts, and in the second, 214.5 volts. When connected with the bias obtained by the drop due to the plate current flowing through a resistance, the arrangement will effectively compensate for minor changes in line voltage. Note that in push-pull circuits, just half the normal biasing resistance is required.

Operating Conditions

Filament Volts	2.5	
Filament Amperes	1.5	
Plate Volts	180	250
Grid Voltage (A.C.Fila.)	34.5	-50

Average Tube Characteristics

Plate Voltage	180	250
Grid Voltage (A.C. Fila.)	-34.5	-50
C Bias Resistor	1380	1470 ohms
Amplification Factor	3.5	3.5
Plate Resistance	1900	1750 ohms
Mutual Conductance	1850	2000 micromhos
Plate Current	27	34 milliamperes
Undistorted Output	780	1600 milliwatts

The curve of Fig. 137 shows the average filament current of type '45.

Fig. 138 gives the average plate current over a range of plate voltages at zero grid bias.

Fig. 139 shows the amplification factor (Mu), plate resistance (rp), and mutual conductance (Gm), plotted in relation to grid voltage at plate voltage of 180 volts.

Fig. 140 shows the amplification factor (Mu), plate resistance (rp), and mutual conductance (Gm), plotted in relation to grid voltage at plate voltage of 250 volts.

Many times it is convenient to know the tube characteristics when the plate current only is known at an approximate value of plate voltage. For this reason we have included Fig. 141 which shows the various characteristics plotted against plate current. At the normal operating current, there is little difference between the various values, but at the lower plate currents the variations are somewhat greater.

Fig. 142 shows the family of plate current—plate voltage curves which are useful in calculating power output and determining the proper "C" battery voltages for definite plate currents. If A.C. filament operation is used, add 1.5 volts to the grid bias values given on the curves.

'X-'50.

The '50 tube is employed either singly or in push-pull in many of the receivers now in use. The remarks passed regarding the '45 apply in full to the '50. It is essential that the resistance in the grid circuit of the tube be kept low to avoid decrease in bias due to the flow of grid current as the tube is not

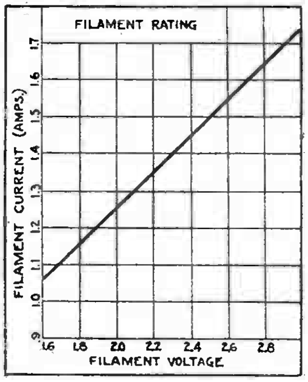


FIG. 137

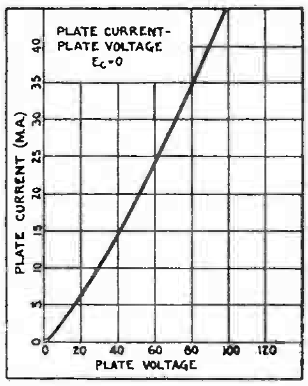


FIG. 138

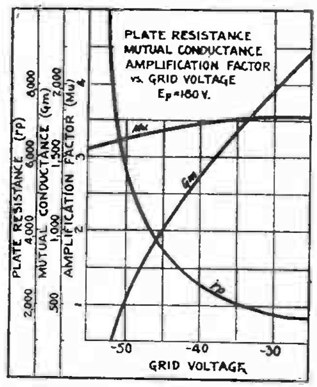


FIG. 139

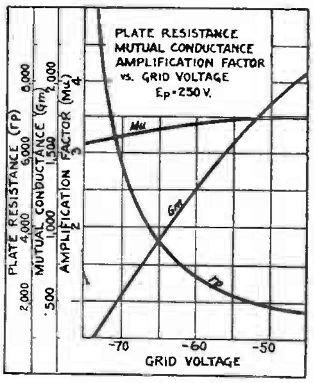


FIG. 140

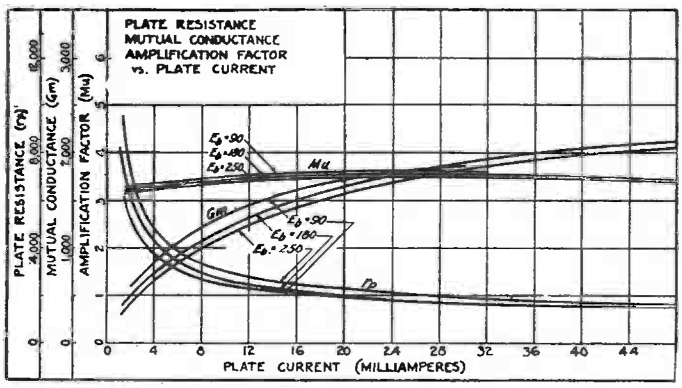


FIG. 141

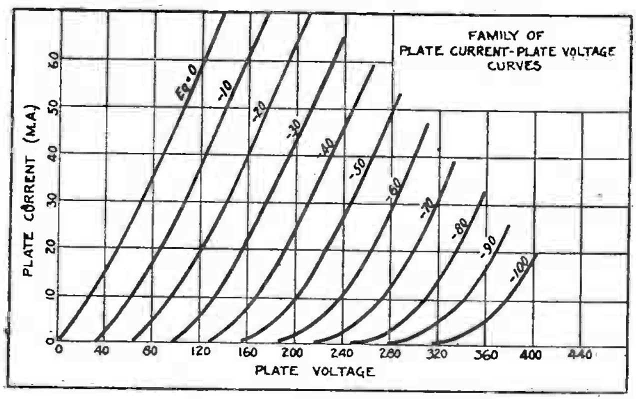


FIG. 142

FIG. 143

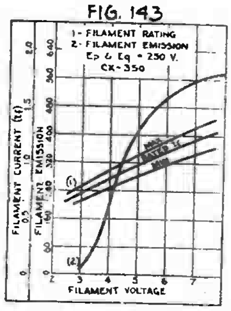
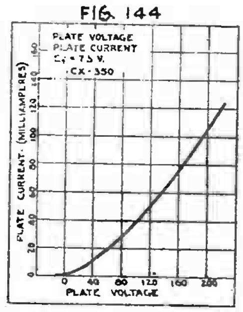


FIG. 144



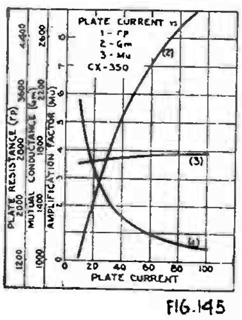


FIG. 145

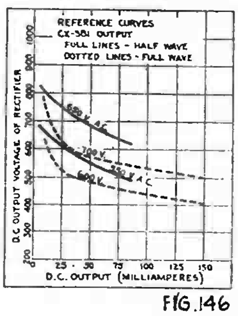


FIG. 146

entirely free from gas. This makes the use of the tube as a resistance coupled amplifier impossible unless it succeeds a tube of low plate impedance such as the '45. In this case a grid resistance of sufficiently low value may be employed without seriously affecting the gain of the preceding tube.

The life of the '50 is seriously limited by operation at its maximum plate voltage and this is not usually done except where large output is the paramount consideration. Biasing resistances and total voltages required for operation at various plate voltages follow:

Plate Voltage	Bias Resistance	Total Voltage
250	1600	295
350	1400	413
400	1300	470
450	1550	534

Resistance values are halved where two tubes are operated in parallel or in push-pull at the voltages specified.

Operating Conditions

Filament Volts	7.5
Filament Amperes	1.25
Plate Volts (Max.)	450.
Plate Current (Max.)	55 ma.
Grid Volts	See Table

Average Tube Characteristic

Plate Volts	Grid Bias	Mu	Plate Resis.	Mut. Cond.	Plate Ma.	Bias Res-istor Ohms	Undis. Power O'put Mw.
250	-45	3.8	2100	1800	28	1600	1000
350	-63	3.8	1900	2000	45	1400	2400
400	-70	3.8	1800	2100	55	1300	3400
450	-84	3.8	1800	2100	55	1550	4600

Use

Maximum life is obtained from the '50 when the tube is used at conservative plate voltages. Voltages between 250 and 400 volts are recommended, and the voltage must not exceed a maximum value of 450 volts. When the tube is used in place of the '10 (as noted below circuit changes should be made before the tube is substituted for this type) the plate voltage need not exceed 300 volts if the power output obtainable from the '10 operated at 425 volts has proved adequate. Thus for equivalent power output a considerably lower plate voltage may be used with the '50, the total required for the tube and grid biasing voltage being 300+54, or 354 volts as compared with 425+35 or 460 volts for the '10.

The higher current required by the '50 can be conveniently supplied by an '81 rectifier (or by two such tubes with full wave connection). The average plate current required ranges from 28 ma. at 250 volts to 55 ma. at 400 volts. Since the '81 is rated at 85 ma. output (see Fig. 146) sufficient margin is available so that the same rectifier used for the '50 may also supply the plate current required by the remaining tubes in the receiver.

The grid bias must be applied at all times while the tube is in operation. If the grid circuit is opened the plate current will increase to a high value, overloading both the power tube and particularly the rectifier tube—if the current is supplied from such source—and is very apt to cause burn-out of the filament in the latter. It is very desirable to protect both by a fuse, or similar device, operating at about .1-ampere, and which should be placed in the rectifier circuit between the rectifier and the filter. It is possible to use the .1-ampere 6-volt dial lamp, type T3, which, although not designed for high voltage, will usually break the circuit.

The coated filament is not affected by traces of gas, and a slight blue glow will not impair or affect the performance of the tube provided the resistance in the grid circuit is kept low, preferably not over 10,-000 ohms, to avoid a decrease in bias which may otherwise result from the flow of gas current to the grid. The tube is not intended for use in resistance coupled amplifiers.

It is desirable that the bias required by the tube be supplied from the drop across a resistor in series with the -B return. It will be found that this connection compensates almost completely for changes in plate voltage which may occur as a result of line voltage variations, as an increase in plate voltage causes a small increase in plate current which in turn raises the applied "C" bias sufficiently to compensate for the new value of plate voltage, thus maintaining the proper operating condition at all times. If a decrease in voltage occurs, the reverse action takes place. This desirable operating condition is sacrificed if a fixed "C" bias derived from a battery or other source is provided, as in such cases a decrease in plate voltage will cause a large decrease in plate current which will greatly reduce the power output obtainable from the tube, while an increase in plate voltage will overload the tube.

A low resistance output choke with a condenser, or a transformer capable of handling the heavy plate current of the '50 without saturation of the core, or overheating of the windings must be provided for this tube to prevent excessive voltage drop in the plate circuit and to protect the loud-speaker windings.

Curves and Data

The curves, Fig. 143, show the average filament current and the filament emission of type '50.

Fig. 144 gives the average plate current over a range of plate voltages, with no applied grid bias. In taking this data, the grid return was connected to the midpoint of the filament, and for this reason the plate current does not reach zero until a negative plate voltage is applied.

Fig. 145 shows the amplification factor (Mu), plate resistance (rp), and mutual conductance (Gm), plotted as a function of plate current. This method of showing tube characteristics is convenient, since a single measurement, that of plate current, suffices to determine the operating point.

Fig. 146, furnished for convenient reference, shows the voltage and current output of the '81 at various loads: The full lines show the output of a single '81 with the usual filter arrangement, while the dotted lines show the output obtained from two '81 tubes in a full-wave rectifier, using a filter in which the first filter condenser is omitted. The IR drop in the filter must be taken into consideration before this data is complete. As soon as the resistance of the filter chokes is measured the output voltage obtainable can be computed.

'40.

This tube is a high impedance tube with a high amplification factor for use in resistance coupled amplifier circuits where a filament supply of 5 volts is available. It may also be used as an R.F. amplifier in circuits specially designed for it. The tube is also a good detector under like conditions. The tube is now almost obsolete and, to the writer's knowledge, was employed in but one commercial receiver.

SPECIAL PURPOSE TUBES

'00 and '00A.

These tubes were originally intended for use as detectors in radio receivers. The first was a gassy, or poorly evacuated, type and the second was purposely filled with gas. Both are now obsolete and they will probably not be found once in ten thousand service calls. The tubes were extremely sensitive detectors but were not in the "high quality" class now so necessary. Critical voltage adjustment was their most notable requirement and you may remember the 22.5 volt "B" batteries with taps at 16 volts and on up for adjustment of the detector plate voltage. In no receiver that the writer can remember from the earliest days onward, were the full advantages of either of these tubes employed save in the case of the Garod "coffin" neutrodyne. This set was quite ordinary in performance with an '01A as detector, but with an '00 type it stepped out into the far reaches of the country when the critical adjustment was achieved. If ever you come upon one of these monster old receivers and want a real demonstration of what the "old-timers" were capable of, dig up a '00 detector, put 16 volts of "B" on it and twiddle the detector rheostat while your two helpers adjust the tuning controls. Then thank the particular "Djin" who watches over radio men for John V. L. Hogan and single-control.

'X-'74.

Output Voltage Regulator

The '74 is a special "glow" type voltage regulator designed for service in "B" supply units where great flexibility in output is required or where the A.C. line voltage varies over rather wide limits. This tube accomplishes voltage regulation from its characteristic that on any current flow from 10 to 50 milliamperes the tube develops a constant voltage averaging 90 volts. It consists of two elements, (an anode and a cathode) in a gas-filled space and shows a pronounced glow when in operation.

Circuit Requirements

This tube cannot be used without a series resistance to limit the maximum current to 50 milliamperes. The application of the tube to a typical "B" supply unit is shown in Fig. 147. If the tube connections are reversed a bright glow will occur at the small terminal, and the connections should be corrected. Proper results will not be obtained unless connections are made as indicated in the diagram. The terminals which would normally be "+F" and "plate" are connected together in the base of the tube and this short-circuited connection may be used as a line switch in the transformer primary. With this connection, the eliminator cannot be turned on until the '74 tube is inserted in the socket nor can the tubes be interchanged in such a way as to damage either the equipment or tubes themselves. If a rectifier or power tube is inserted in the socket intended for the '74, the transformer primary will remain open and no power will flow to the equipment.

Two '74 tubes may be placed in series to obtain 180 volts, a center tap between the two tubes then providing 90 volts.

Rating

Rated Voltage	90 volts D.C.
Starting Voltage	125 volts D.C.
D.C. Current	10-50 milliamperes

'76 and '86

The '76 and '86 are Iron filament tubes with the filament in a hydrogen atmosphere. They develop considerable heat in operation and are placed in a metal chimney for the purpose of creating a cooling draft and for protection of the operator from flying glass in the event of breakage. *Do not work in the vicinity of these tubes* unless the protective screening is in place, as a slight jar may fracture the glass and allow the hydrogen to ignite. A terrific detonation will result. This warning should therefore be taken into full account in working with equipment in which these tubes are placed. Their purpose is that of voltage regulation in the primary circuit of power transformers. They incur a voltage drop of about 50 volts and the power equipment used with them is designed accordingly. Apparatus designed for use at 60 cycles with the '76 can be employed on 40 cycle lines by the substitution of the '86. The circuit arrangement of a power supply circuit employing these tubes and the '74 appears in Fig. 147.

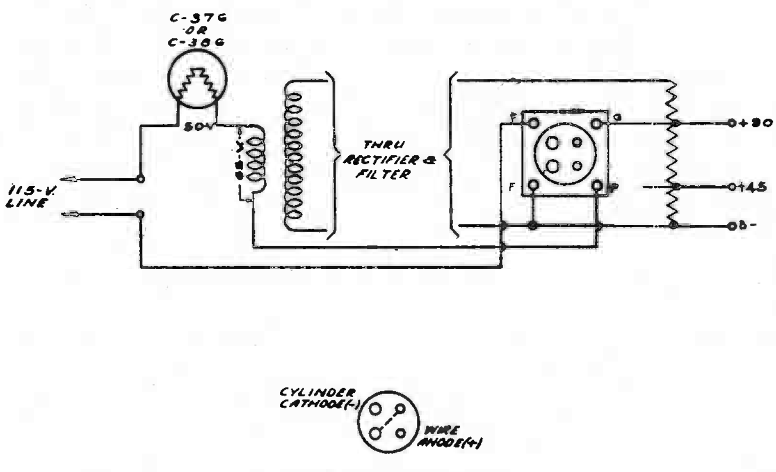


FIG. 147

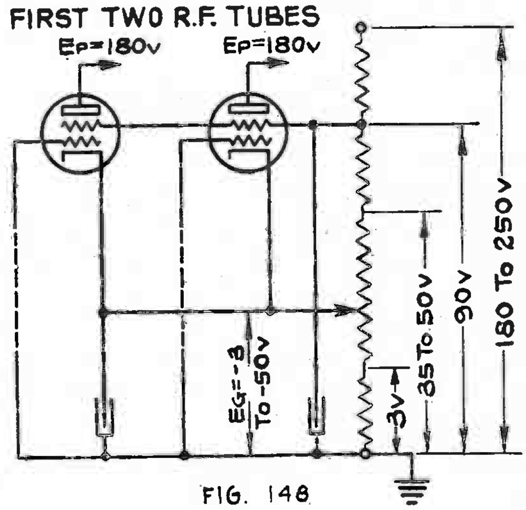


FIG. 148

'77

The '77 tube is a protective device placed in the negative "B" battery lead of receivers using '99 tubes. They are found in early Radiola 25 and 28 receivers. The filament characteristics of these tubes are such that should the "B" voltage be applied to the "A" circuit unintentionally, the voltage drop through the tube will be great enough to protect the tube filaments from destruction.

The Variable-Mu Tetrode

The Variable-Mu tube is similar in most respects to the screen-grid tube but is so designed that overloading of the grid does not cause cross-modulation in the manner peculiar to screen-grid type and, thus, the necessity for the use of band-selectors in the preliminary tuning is avoided. Volume control is achieved smoothly by variation of the grid bias over the range from the minimum specified to 40 or 50 volts negative for minimum volume. Note Fig. 148. While the tube is similar to the '24 in many respects, it is not interchangeable therewith. It may be used as the first detector in superheterodyne circuits but not as a high level detector as in normal usage.

Two types, '35 and '51, are now in commercial use having differing characteristics which will be described.

'51

TENTATIVE RATING AND CHARACTERISTICS

Heater Voltage .... 2.5 volts
Heater Current .... 1.75 amperes
Plate Voltage .... 250 volts
Screen Grid Voltage (Maximum) .... 90 volts
Control Grid Voltage .... -3 volts
Plate Current .... 6 milliamperes
Screen Grid Current—Not more than 1/3 of Plate Current
Plate Resistance .... 400,000 ohms
Amplification Factor 420
Mutual Conductance (Ecg=-3 Volts) .... 1050 micromhos
Effective Grid-Plate Capacitance (Max.) .... 0.010-mmf.
Input Capacitance .... 5 mmf.
Output Capacitance .... 10 mmf.

'35

TENTATIVE RATING AND CHARACTERISTICS

Heater Voltage .... 2.5 volts
Heater Current .... 1.75 amperes
Plate Voltage .... 250 volts
Screen Grid Voltage (Maximum) .... 90 volts
Control Grid Voltage .... -3 volts
Plate Current .... 7 milliamperes
Screen Grid Current—Not more than 1/3 of Plate Current
Plate Resistance .... 300,000 ohms
Amplification Factor 300
Mutual Conductance (Ecg= -3 volts) .... 1000 micromhos
Effective Grid—Plate Capacitance (Max.) .... 0.010-mmf.
Input Capacitance .... 5 mmf.
Output Capacitance .... 10 mmf.

NEW TUBES FOR AUTOMOTIVE AND D.C. RECEIVERS

The three tubes to follow are specially designed for operation directly from the 6-volt battery of the motor car or from D.C. lines with the heaters in series. There are three tubes in the group: a general purpose tube, the '37; a screen-grid tube, the '36; and a Pentode output tube, the '38. Their characteristics are as given below. Employment of the indirectly heated cathode tends to avoid a large part of the noise found in auto and D.C. sets.

'36

CHARACTERISTICS

Heater Voltage			6.3 volts D.C.
Heater Current			0.3-ampere
Plate Voltage	90	135	135 volts
Screen Voltage	55	67.5	75 volts
Grid Voltage	-1.5	-1.5	-1.5 volts
Plate Current	1.8	3	3.5 milliamperes
Screen Current—Not over 1/3 of plate current			
Plate Resistance	200,000	300,000	250,000 ohms
Amplification Factor	170	315	275
Mutual Conductance	850	1,050	1,100 micromhos

'37

CHARACTERISTICS

Heater Voltage		6.3 volts D.C.
Heater Current		0.3-ampere
Plate Voltage	90	135 volts
Grid Voltage	-6	-9 volts
Plate Current	2.7	4.5 milliamperes
Plate Resistance	11,500	10,000 ohms
Amplification Factor	9	9
Mutual Conductance	780	900 micromhos
Load Resistance	14,000	12,500 ohms
Undistorted Power Output	30	75 milliwatts

'38

CHARACTERISTICS

Heater Voltage	6.3 volts
Heater Current	0.3-ampere
Plate Voltage, Recommended	135 volts
Screen Voltage, Recommended	135 volts
Grid Voltage	-13.5 volts
Plate Current	8 milliamperes
Screen Current	2.5 milliamperes
Plate Resistance	110,000 ohms
Amplification Factor	100
Mutual Conductance	900 micromhos
Load Resistance	15,000 ohms
Undistorted Power Output	375 milliwatts

THE PENTODE OUTPUT TUBE

The space charge in a vacuum tube causes a cloud of electrons to collect in the neighborhood of the cathode. This means that in order to draw electrons through this cloud, an extremely large proportion of the total plate voltage is used up. Scientists have discovered that by the inclusion of an extra grid in the neighborhood of the cathode, this cloud may be dispelled with a resultant increase in the sensitivity and efficiency of the tube. The pentode for a given output power requires but one third the input signal and makes possible the operation of the power stage directly out of the detector by resistance coupling. The distortion usually encountered in the intermediate A.F. stage is thus removed. Contrary to the case of the triode, the optimum output load for maximum undistorted power is not twice the plate impedance of the tube. This figure is specified definitely by the manufacturer in each case.

'47

This tube is a power output pentode of the type described above. The connections to the tube, which employs the UX base, are with the filament at the heater terminals (referring to the '27), the plate and grid to their usual terminals, and the screen-grid to the cathode terminal.

Because of the high gain of the tube it is not desirable to use the familiar type of biasing where the bias is provided by the drop through a resistor in series with the filament center tap. Because of the high amplification factor the out-of-phase voltage fed back to the input across this resistance would be abnormally high and any condenser suitable for bypassing of the resistance would be too large for economy. If return of the grid is made to some point in the voltage supply negative by the required amount with respect to the filament, no undesirable effects will be encountered.

CHARACTERISTICS

Filament Voltage	2.5 volts
Filament Current	1.5 amperes
Plate Voltage, Recommended	250 volts
Screen Voltage, Recommended & Maximum	250 volts
Grid Voltage	-16.5 volts
Plate Current	32 milliamperes
Screen Current	7.5 milliamperes
Plate Resistance	38,000 ohms
Mutual Conductance	2,500 micromhos
Load Resistance, Approximate	7,000 ohms
Power Output	2.5 watts

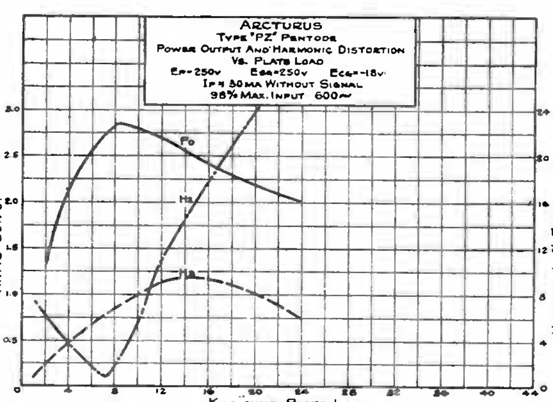


FIG. 149

HARMONIC DISTORTION

The output of the pentode tube when examined for harmonic content at various loads in the plate circuit reveals the magnitudes shown in Fig. 149 where H represents the harmonic percentage of the fundamental. The second harmonic H2 rapidly diminishes as the load impedance is increased, reaching zero or a very small value at 7,500 ohms; then increasing at practically the same rate. Quite a different state of affairs is represented by the third harmonic H3 which continually increases until a maximum is reached at approximately two times the load impedance.

Power Output

While the usual graphical method of determining the undistorted power output of triodes by use of a family of plate current—plate voltage curves in conjunction with balanced load impedance lines are applicable to pentodes, the data here presented are those obtained from direct measurement of pentode output containing less than 5% harmonic distortion. The method of measurement is based fundamentally upon the harmonic analysis of the pentode output.

(See Standard methods of testing vacuum tubes, Chapter VI, paragraph D, IRE Committee on Standardization, 1930.)

The graphs of Fig. No. 150 illustrate the undistorted power output of the pentode when operated at various plate voltages. This graph also shows the optimum load impedance for minimum second harmonic and the degree of third harmonic present at various plate voltages. Curve No. 151 illustrates the change of power output of the pentode as the input is varied. It should be noted that the harmonic distortion does not increase in proportion to the input but as maximum input is approached the harmonic content increases at a lower rate.

Fig. 152 shows characteristic variation with changes in plate voltage.

Power Sensitivity

The power sensitivity of an output tube has been defined by Stuart Ballantine as the ratio:

Power Sensitivity $S = \sqrt{Po}/Eg1$

where S is the Power Sensitivity

Po the power delivered to the load

and Eg1 the R.M.S. value of the A.C. sinusoidal grid voltage.

This factor possesses several advantages not found in previous definitions and is employed in this report.

Accepting the value of the grid bias as a measure of the peak signal voltage required to deliver maximum useful power output, the following table is arranged to illustrate the power sensitivity of the pentode in comparison with various triodes.

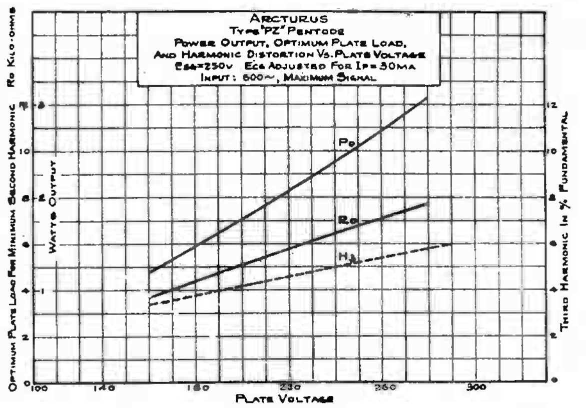


FIG. 150

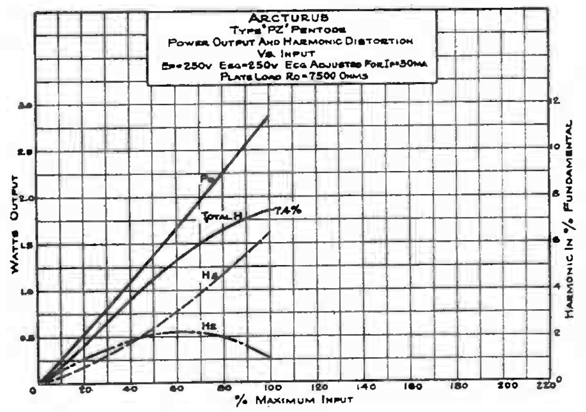


FIG. 151

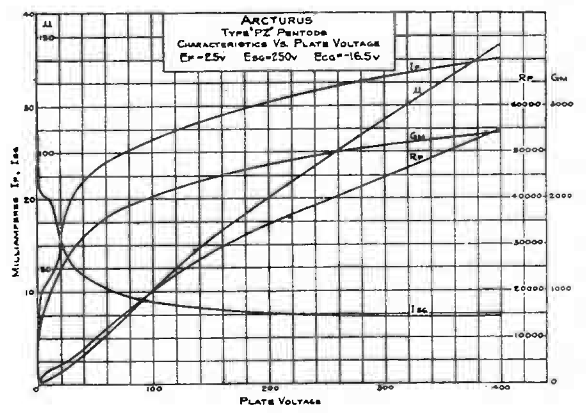


FIG. 152

Power Sensitivity of Output Tubes

Type Tube	Ep	Eg1	Po	S
'12-A	157.5	10.5	.195	.0594
'71-A	180	20.5	.700	.0292
'45	250	50	1.60	.0358
PZ, '47	250	18	2.85	.1326
'50	450	84	4.05	.0239

'33 Power Pentode

The low power output of the '20 and '30 type power tubes, plus their low amplification constant,

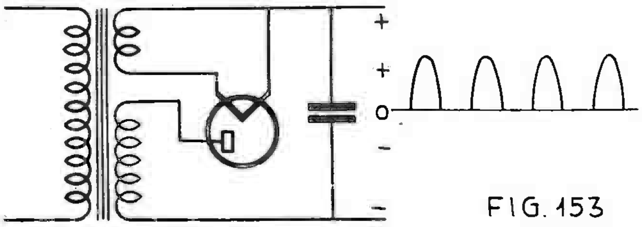


FIG. 153

was a serious drawback to those interested in battery type tubes.

The new power pentode, known as the '33, when introduced, offered a satisfactory tube for the portable set or for sets used in isolated places such as farms not equipped with electrical supply.

This tube has considerably greater power output and sensitivity than three-electrode power tubes of the '31 type. In fact, when used in push-pull they will deliver a power output of over 1.3 watts.

Tentative Rating and Characteristics

Filament Voltage	2.0 volts
Filament Current	0.260-ampere
Plate Voltage	135 volts
Screen Voltage	135 volts
Control Grid Voltage	13.5 volts
Plate Current	14 milliamperes
Screen Current	3 milliamperes
Plate Resistance	45,000 ohms
Mutual Conductance	1,400 micromhos
Amplification Factor	63
Load Impedance	7,500 ohms
Undistorted Power Output	650 milliwatts

The '33 utilizes 5 electrodes concentrically arranged in the following order; cathode (filament type), control-grid, screen-grid, cathode grid and plate. The cathode grid is connected to one end of the cathode and serves to practically eliminate secondary emission effects. The screen-grid acts as an electrostatic shield between the control grid and plate elements.

The cathode is an oxide-coated ribbon type filament and it is extremely important that it should not be operated above its normal rated voltage.

Fixed grid bias or preferably self-bias may be used with the '33, and its grid circuit should not include more than 500,000 ohms of external resistance.

In order to minimize second harmonic distortion, the '33 should work into a load having substantially constant impedance approximately equal to the rated load impedance of the tube.

RECTIFIER TUBES AND CIRCUITS

Rectifiers are classified as half wave, full wave, and voltage-doubling for the elementary consideration we will give. In the half wave type, rectification such as to cut off one half of the A.C. cycle is provided. In this case, the ripple has a 60 cycle tone, and the gaps as shown in Fig. 153 require considerable filtration for smoothing the resultant pulsating D.C. into a form suitable for use as the supply voltage for vacuum tubes. By connecting two tubes, or a single specially designed tube, in the manner shown in Fig. 154, both halves of the A.C. wave are brought into play, and the resulting tone is 120 cycles. This type of pulsating D.C. is much easier to filter as may be imagined from the sketch.

'80 and '81 Rectifiers

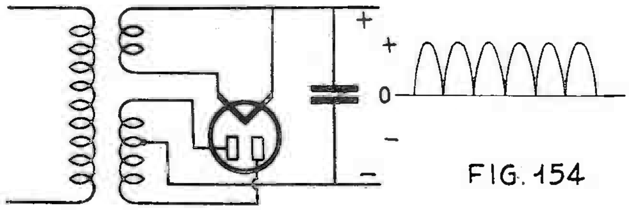


FIG. 154

These two tubes are very popular, especially the '80 type which is used in practically every modern radio set today.

'80

Full Wave Rectifier

The '80 is a full-wave rectifying tube intended for use in power supply devices that operate from an alternating current supply.

Filament

The filament of this tube is of the oxide coated type and is designed to operate at 5 volts. The filament current is supplied from one of the windings of a power transformer, the leads to which should be of high current carrying capacity.

Plate

There are two plates in the '80, both designed to operate at voltages *no higher than* 550 volts A.C. each, which value is permissible only with filter circuits having an input choke of at least 20 henries. Under these conditions it is possible to obtain a D.C. load current of 135 milliamperes. Where ordinary type filters are used lower ratings are indicated below and should all be carefully observed, otherwise the life and performance of the tube may be seriously affected.

Circuit Recommendations

The most generally used full-wave rectifier circuit employing the '80 is shown in Fig. 156A. The filter used may be either of the condenser or choke in-

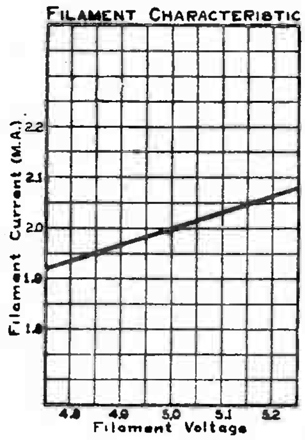
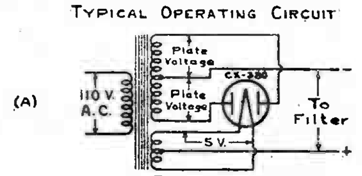
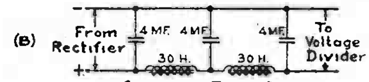


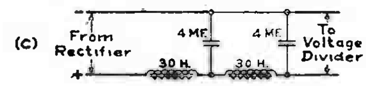
FIG. 155



Rectifier Circuit
FIG. 156-A



Condenser Filter Circuit
FIG. 156-B



Choke Filter Circuit

FIG. 156-C

put types. With condenser input (as shown in Fig. 156B) care must be taken that this input condenser should have a rating sufficiently high to withstand the instantaneous peak value of the A.C. input voltage.

In the case of the choke input method (Fig. 156C) where the input condenser of Fig. 156B is omitted, there will be a somewhat lower available D.C. output voltage for a given A.C. plate voltage than with the condenser input method. However, improved regulation with lower peak current will be obtained. When using 550 volts per plate, this type of filter is necessary as mentioned before and an input choke of at least 20 henries must be used. If desired, a condenser of not more than 0.1-mf. may be used across the input.

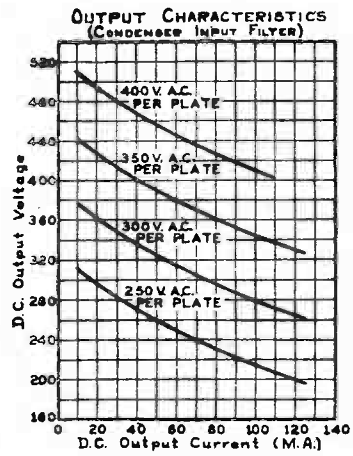


FIG. 157

Operating Conditions

Filament Voltage . . . . . . 5.0 volts

Filament Current . . . . . . 2.0 amperes

A.C. Voltage per Plate with

135 ma. D.C. Output Current (max.) 550 volts (R.M.S.) —permissible only with filter circuits having an input choke of at least 20 henries. If desired, a condenser of not more than 0.1-mf. may be used across the input of the filter.

125 ma. D.C. Output Current (max.) 350 volts (R.M.S.)

110 ma. D.C. Output Current (max.) 400 volts (R.M.S.)

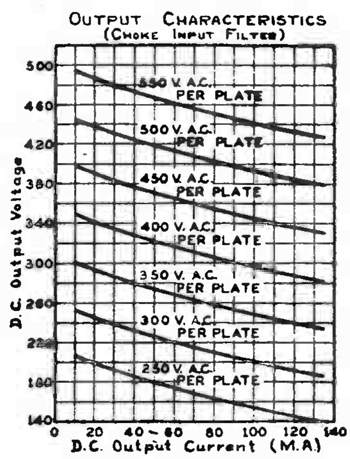


FIG. 158

Average Characteristic Curves

Filament Characteristics—Fig. 155 shows the change of filament current with various filament voltages.

Output Characteristics—Fig. 157 shows the relation of load current to the rectified voltage at various plate voltages when using a condenser input filter.

Fig. 158 shows the relation of load current to the rectified voltage when using a choke input filter.

Because of their internal resistance, i.e., the resistance of the path between the filament and the plate, the voltage output varies with the load drawn. For this reason a number of factors enter into the design of a power supply to provide a given output voltage. To begin with, we are at a loss to perform

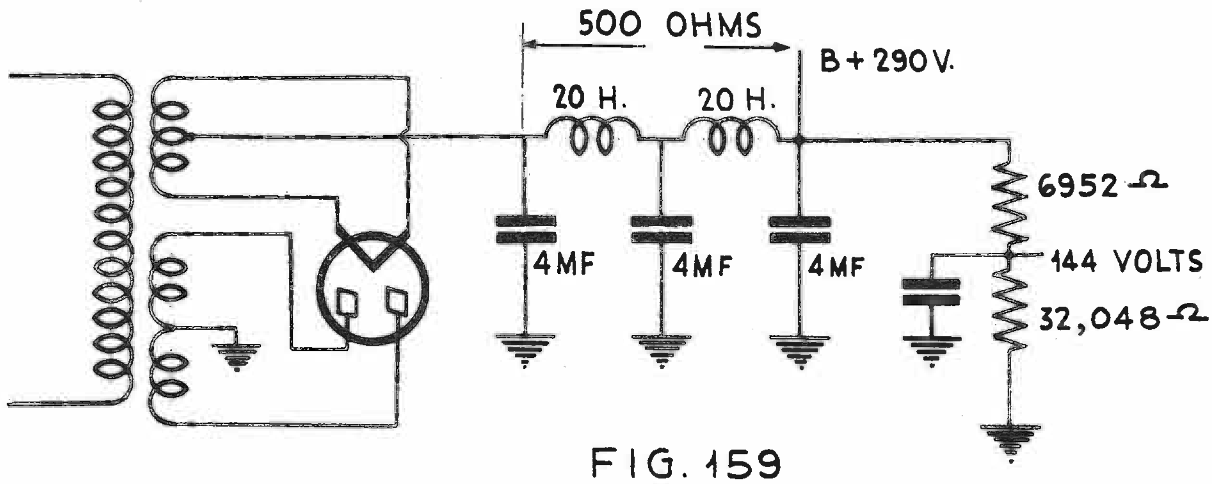


FIG. 159

any calculations until we are certain of the power transformer we intend to use—its voltage output and its regulation—that is, its ability to maintain a constant output voltage across its secondary terminals regardless of the load drawn. Note that a filter may be of either the inductance input or condenser input type. The voltage obtained across the filter output is not so great with the inductance input filter, but the load on the tube is much less, the regulation is better, and the initial surge as the power is switched on is much slighter.

It is this initial surge, by the way, which sends the filter condensers "galley-west" and it ruined more than one manufacturer in the early days of A.C. operation. By all means, if you are building any equipment of your own use the inductance input. It is much easier to explain the process of power supply design by taking an actual example than by "beating around the bush," so we will assume that we require power for a receiver employing 4 '27 tubes and a '45 as an output tube.

First, we know that the voltage requirements for the power stage are 250 volts plate and 50 volts grid —total, 300 volts. This sets the maximum voltage for our power supply system at 300 volts. Tabulating the rest of the receiver as follows:

Number	Tube	Plate volts	Grid volts	Total volts	Total Plate Cur.
2 R.F.	'27	135	9	144	9 ma.
1 Det.	'27	135	variable	144	.1-ma.
1 A.F.	'27	135	9	144	4.5 ma.
1 A.F.	'45	250	50	300	34 ma.

The total plate current for all tubes is seen to be 47.6 ma.

We must take into account now the voltage drop through the filter chokes which will have a resistance of at least 500 ohms. Inspection of the regulation curves for the '80 tube will show a voltage output of about 315 volts D.C. at 300 volts A.C. per plate each side of center tap, when the current drawn is 60 ma. at 60 ma., the voltage drop through the chokes is 30 volts (500 ohms x .06-amp). This leaves us a bit less than 300 volts total and we must try again. A load of 55 ma. would give a terminal voltage of 320 and the drop through the chokes would be 27.5 volts. This would leave us just a bit short of our total 300 volts again. The discrepancy does not amount to a great deal and we can continue on this basis—a terminal voltage at the filter output of 293.5 volts, or 290 volts to make things even. We must, however, arrange for a loss of some 7.4 ma. in order to bring our total drain up to 55 ma. This is done by inserting a resistance across the output of such a value as to provide a drain of 7.4 ma. at 290 volts. From Ohms Law (R=E/I or 290/.0074=39189 ohms) we obtain a value for this resistance of about 39,000 ohms.

The next process is to discover where we must place the tap on this resistance in order to obtain 144 volts for our detector and amplifier stages. We desire to drop the output voltage from 290 to 144, or 146 volts—the current for the four tubes receiving this voltage is 13.6 ma. and there are already 7.4 ma. flowing through the output resistance. With this total of 21 ma., the resistance required to give a drop of 146 volts is 6,952 ohms. This means that our output resistance will have a tap at this point to provide the plate voltage for the tubes other than the power tube. This is shown in Fig. 159. If more than a single tap were required we would proceed in the same fashion.

'81

The type '81 is a half-wave rectifier tube with a rating of 700 volts A.C. input and 85 ma. D.C. output permitting D.C. voltages on the order of 600 volts to be obtained from a single wave rectifier, and of 700 volts with a full wave connection. When higher voltages are required it is posible to use a single or full wave voltage doubling arrangement by which voltages of 1000 to 1500 volts may be obtained (using low transformer voltages), two to four '81 tubes being required.

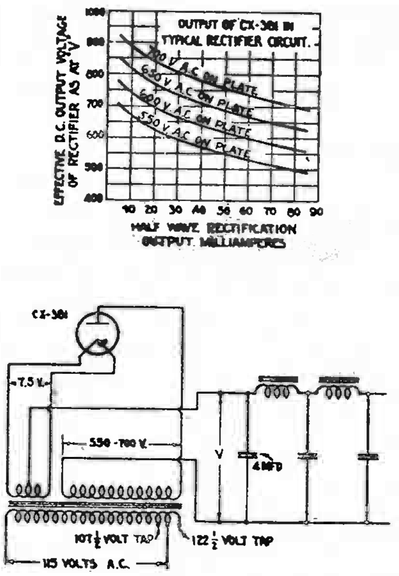


FIG. 160

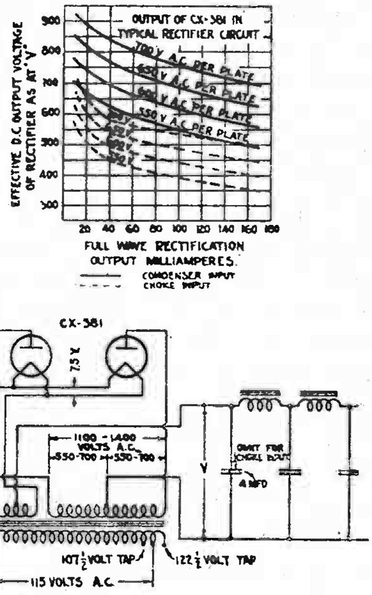


FIG. 161

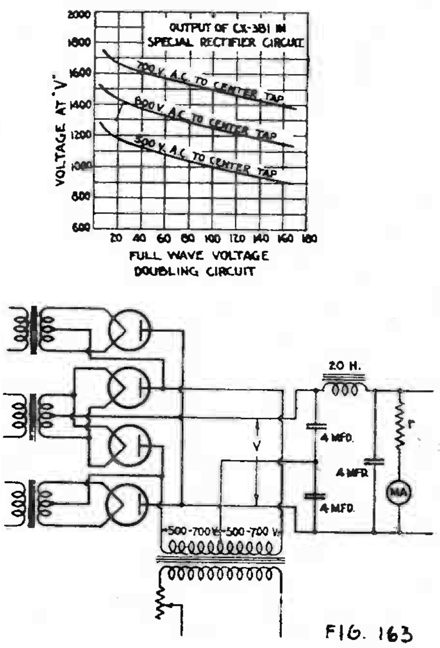


FIG. 163

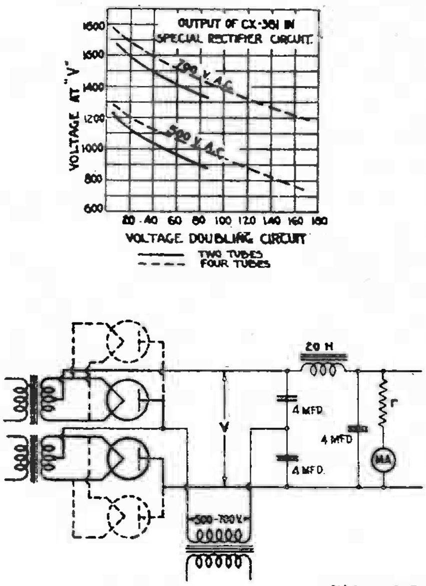


FIG. 162

Normal Service

Typical connections and output voltage secured from the '81 in a half wave rectifier circuit are shown in Fig. 160, while Fig. 161 shows similar data for two 81 tubes used in a full wave circuit. When an output voltage under 500 volts is required the first filter condenser should be omitted. The effect of this connection is to greatly reduce the peak current supplied by the '81 tubes, which will run cooler and give much better life service under such conditions. The regulation is also much improved, as may be seen by comparing the output voltage curves.

This latter system of filtering was tried at station 2AQO, in place of a single section filter, with improved results when supplying a Hartley oscillator and especially for phone modulation. The filtering action was better than necessary for crystal controlled operation, some A.C. modulation being found preferable. The input choke in these tests was a 7-henry inductor, the self-inductance being measured with full load current of 85 ma. flowing.

Higher Voltages

A familiar type of voltage doubling connection was tested (Fig. 162). The voltage regulation was rather poor, as indicated, but for low currents the small amount of apparatus required makes it convenient. The regulation can be improved by using two '81 tubes in parallel on each side as indicated by the dotted lines. The voltage increases rather rapidly below a load of 20 ma., and to prevent it from rising a fixed load (r) is indicated in the diagram. This may be a 100,000-ohm resistor capable of carrying 20 ma. A milliammeter in series with this resistor is indicated (M.A.), and will give an indication of the output voltage. The scale reading with the resistor specified becomes 100 volts per milliampere; thus a full scale reading of 200 milliamperes indicates an output voltage of 2000 volts.

Much improved results were obtained with the full wave voltage doubling circuit shown in Fig. 163. The adjacent curves show the very high output voltage obtainable with this circuit, and the excellent regulation secured. The high voltage transformer may be a 1400-volt winding center tapped, or two similar 700-volt transformers connected in series. Regulation curves are shown for transformer voltages of 1000 and 1400 volts. The current output should not exceed 170 ma. Three separate filament transformers insulated for the full output voltage are required.

When tested at Station 2ABQ this latter arrangement, with a 10-henry choke, gave slightly better results than the equipment formerly used, a 3000-volt transformer center tapped two 1500-volt rectifiers and a 50-henry choke. The transformer used was a 1200-volt unit, center tapped. The '81 tubes, supplying 100 ma. ran quite cool, the output being well below rated maximum.

The filter condensers, C1, must be capable of withstanding one-half the load voltage as the normal working voltage. A condenser larger than 4 mf. should not be used unless it is possible to close the filament circuit of the rectifier tubes before the high voltage is applied. The initial charging surge may overheat the tubes and cause an arc if the filament is allowed to come up to temperature with the high voltage turned on.

Filament

The filament used in type '81 is of the rugged coated type. With this filament the difficulties in handling the shipping are overcome, as severe mechanical shocks cannot break the filament. The filament should be operated at, or slightly below, the rated voltage of 7.5 volts, and the voltage across the filament should never exceed 7.9 (rated voltage+ 5%).

The main precaution to be observed in operating the '81 tubes is that of avoiding an overload with respect to plate current. The shorting of the rectifier output, such as may occasionally occur due to the failure of some part of the apparatus (as by the breakdown of a filter condenser) will overload the filament and result in filament failure, unless the current is turned off promptly. An indicating lamp may be placed in the circuit in series with each plate lead adjacent to the plate; if a .15-ampere 6-volt dial lamp is used in this position it will glow at normal brilliancy when the full rated current of 85 ma. is flowing through each tube (170 ma. from a full wave rectifier). Excessive brilliancy of this lamp will immediately indicate an overload on the tube, which can be corrected before damage results.

'66 Half-Wave Rectifier

This new tube was introduced for use in conjunction with the newer high power audio systems such as employed in public address systems, talking picture reproducing equipment, and radio transmitters.

The voltage and current limitations of the '81 type tube are such as to make it unsatisfactory or impractical for use especially where the voltage exceeds 1000 volts with current drains of more than 150 milliamperes.

The Cunningham '66 is a half-wave, hot-cathode, mercury vapor rectifier tube for use in suitable rectifying devices designed to supply D.C. power from A.C. supply lines. This tube is particularly suited for use in the "B" supply of amateur power transmitting equipment where it has been necessary heretofore to use a combination of '81's for such purposes. Full wave rectification is accomplished by using two of these tubes.

Filament

The filament of this tube is of the ribbon coated type and should be operated from a filament transformer capable of delivering 5 amperes at 2.5 volts to the filament terminals.

Plate

There is one plate in the '66 and it is in the form of a circular pan mounted above the filament with a cap provided at the top of the bulb for external connection. It is rated at what is known as a peak inverse voltage of 5000 volts (max.). By peak inverse voltage is meant the maximum instantaneous voltage that exists across the plate to filament during that half of the cycle in which the plate is negative with respect to the filament.

Installation and Operation

The 66 is designed for use with the standard X socket and a plate clip. It must be mounted so that it is in a vertical position with the filament end down. Fig. 164 shows details of base and cap connections. This tube is designed to operate without forced ventilation at an air temperature of from 32° to 122° Fahrenheit. Where higher temperatures are encountered, forced ventilation should be provided. As the bulb becomes rather hot in operation, precautions should be taken to prevent any inflammable material or metallic body from making contact.

Upon initial installation, the filament of the '66

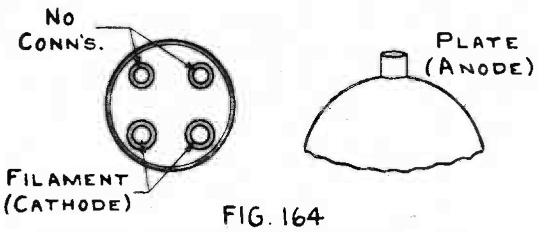


FIG. 164

SINGLE PHASE FULL WAVE RECT. CKT.

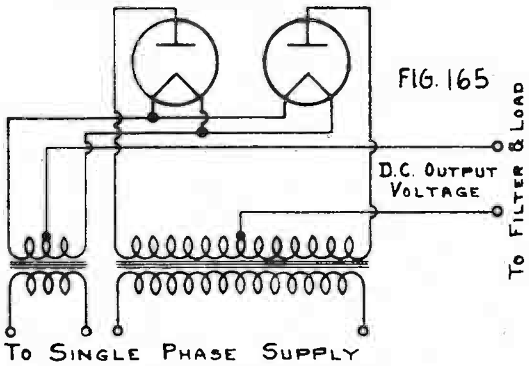


FIG. 165

THREE PHASE HALF WAVE DOUBLE "Y" (INTERCONNECTED) RECTIFIER CKT.

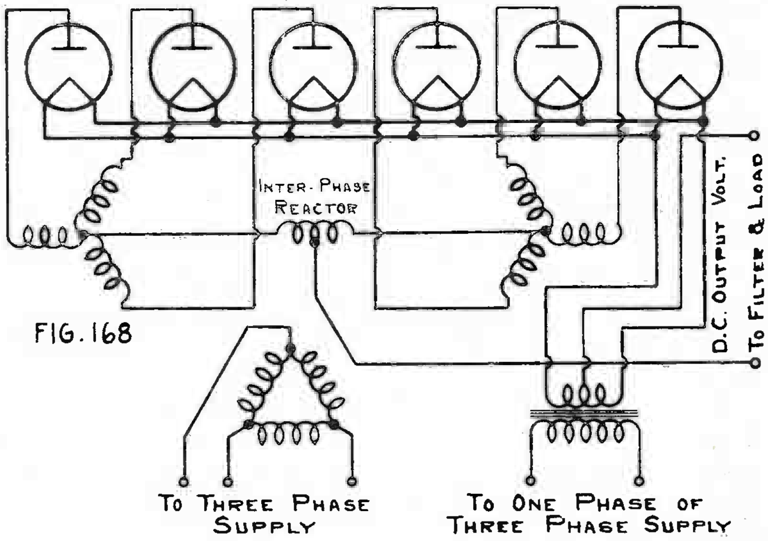


FIG. 168

THREE PHASE HALF WAVE RECT. CKT.

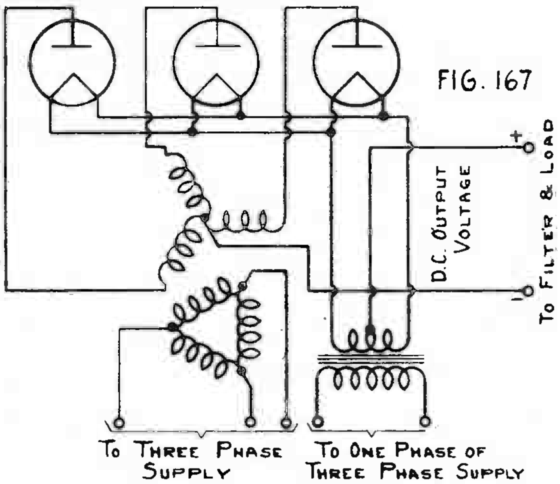


FIG. 167

SINGLE PHASE FULL WAVE RECT. CKT.

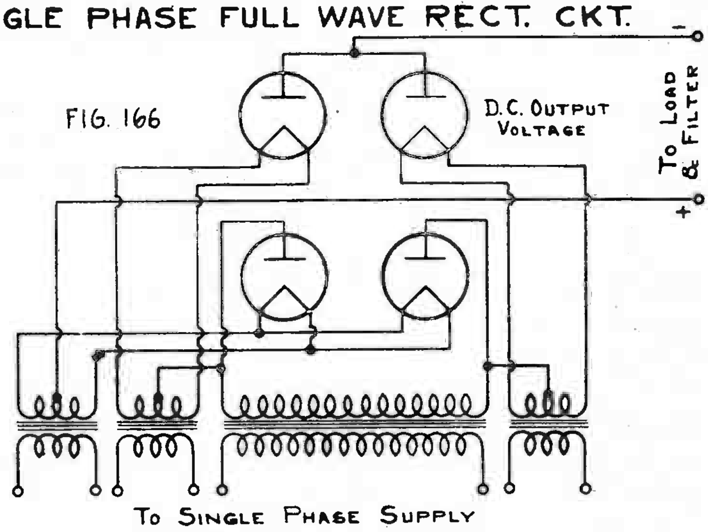


FIG. 166

THREE PHASE FULL WAVE RECTIFIER CIRCUIT

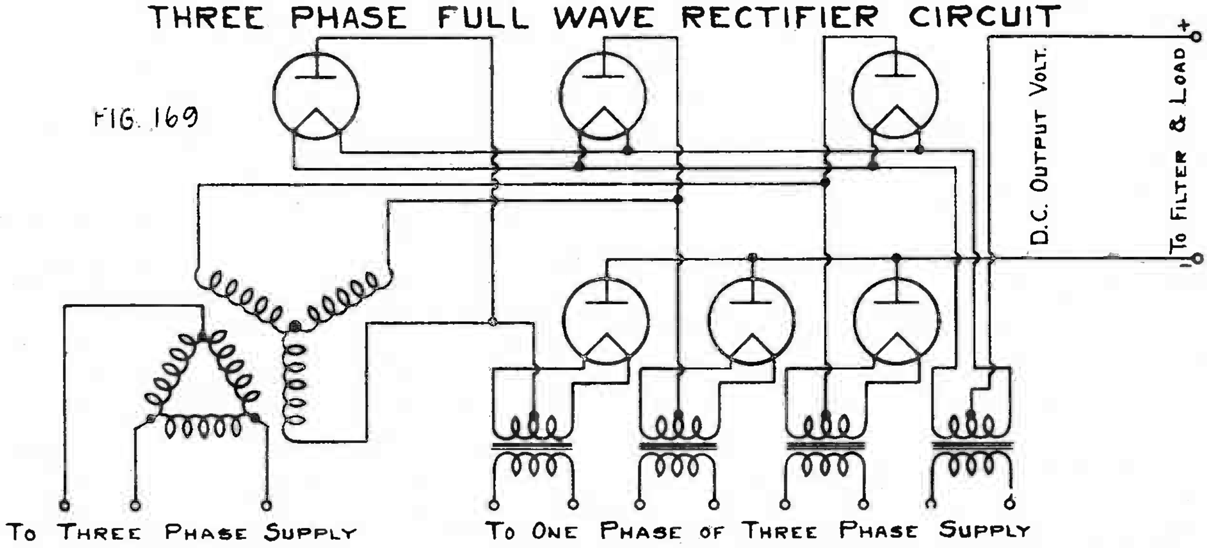


FIG. 169

should be lighted at rated voltage for approximately 15 minutes without any applied plate voltage, in order to properly distribute the mercury.

The filament should always be operated at rated voltage. Less than this voltage may cause a high tube voltage drop, eventually leading to loss of emission. Greater than rated voltage will shorten the life of the tube.

On account of the high filament current drain, it is extremely important that the socket makes good filament contact and is capable of passing 5 amperes continuously, otherwise high contact resistance will be encountered. The filament voltage should be measured at the terminals of the socket and should be controlled by means of a rheostat placed in the primary circuit of the transformer.

If an inverse peak voltage of more than 2100 volts is used, the plate supply of the circuit should be provided with a time delay relay having a period of at least 30 seconds so that the filament will be allowed to come up to temperature before plate voltage is applied.

In operation, the performance of the '66 is limited by the peak inverse voltage applied to it and by the peak plate current passed through it. The maximum peak inverse voltage should never exceed 5000 volts. This is the safe flash back limit for the '66 operating within its normal temperature range. The maximum peak plate current should never exceed 0.6-ampere.

TABLE I.

Type of Circuit	Number '66's required	Input Voltage R.M.S. volts	Output Voltage D.C. volts	Output Current D.C. amperes
Single Phase Full Wave (Fig. 165)	2	1750 per tube	1570	0.4
Single Phase Full Wave	2	1750 per tube	1980*	0.22*
Single Phase Full Wave (Fig. 166)	4	3500 total	31510	0.4
Single Phase Full Wave	4	3500 total	3960*	0.22*
Three Phase Half Wave (Fig. 167)	3	2050 per leg	2400	0.5
Three Phase Half Wave Double Y (Fig. 168)	6	2050 per leg	2400	1.2
Three Phase Full Wave (Fig. 169)	6	2050 per leg	4800	0.6

*Condenser input to filter

The use of a choke input filter is to be preferred to condenser input whenever possible because the peak current demand during rectification is considerably less with the former method.

The terminal connections are shown in Fig. 164.

Circuit Recommendations

Several circuits particularly suited for use with the '66 are schematically given in the diagram of Figs. 165 to 169. Their circuits together with their safe maximum input and output operating conditions are shown in Table I.

The values given in Table I are based on the use of a suitable choke preceding any condenser in the filter circuit, except as indicated for the single phase connections. If the choke is not used, the tabulated D.C. output current values cannot be obtained without exceeding the peak current rating of the tube. In the case of the double Y circuit (Fig. 168) the interphase reactor itself acts as a choke.

Each tabulated value of D.C. voltage is the effective D.C. output voltage from the tube and any drop in the filter, therefore, must be subtracted from the value given, in order to obtain the available output. Owing to the low tube voltage drop of approximately 15 volts, the only reduction in rectified voltage when the load is increased, is due to drop in the transformer and filter windings.

In the case of the three phase full wave (Fig. 169) and single phase full wave (Fig. 166) circuits, two '66's are used in series. This arrangement is made possible by the low and constant voltage drop within this tube. These two circuits are desirable where higher D.C. voltages are required. In the three phase full wave circuit, six phase wave form is obtained.

The '66 has a characteristic blue glow when it is operating. In service the bulb will eventually darken but this change has no effect on the performance of it.

Operating Conditions

Filament Voltage	2.5 volts
Filament Current	5.0 amperes
Maximum Peak Inverse Voltage	5000 volts
Maximum Peak Plate Current	0.6 amperes
Approximate Tube Voltage Drop	15 volts

Dimensions

Length	6-5/8"
Diameter	2-7/16"
Base	Large CX

Raytheon BH Tube

This rectifier was the old time favorite and still finds considerable use today. At one time, there were more than one hundred manufacturers of "B" supply units, for which the BH tube was standard.

To most service men, this tube is an old acquaintance but as most of the circuits of the eliminators incorporated this tube, we are including it for reference as there is no telling when or where you will meet up with the BH.

The best way to test this tube is to make an adapter or buy one of the Alden Adapters made for this purpose. Fig. 170 shows how to make the connections in the adapter. Be careful that there are no short circuits in the power unit which would place a dead short through the milliammeter and burn it out. It would be best to use a meter with a 150-ma. range. Place the tube in the adapter and the adapter in the Ratheon tube socket. The milliammeter will indicate the total current being delivered by the tube.

The tube is of rugged construction comprising a glass bulb containing helium gas and internal elements consisting of a hollow cap or cathode and two rods or anodes protruding into the hollow cap and insulated by the short path method of insulation.

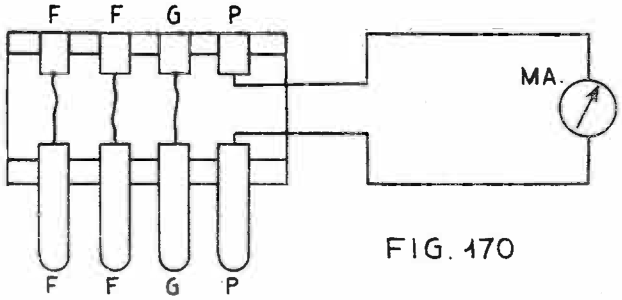


FIG. 170

The ionization of the gas, which is the basis of the rectifying action of the BH tube, takes place inside of the cap and is therefore concealed from view. The only sign of the operation of the tube is in the heating of the glass bulb.

RATING

The BH has an output rating of 125 milliamperes with a maximum allowable input voltage of 350 volts R.M.S. per anode. Typical output regulation curves are shown in Figs. 171 and 172. The solid curves in Fig. 171, show the values of D.C. voltage and current delivered to the filter with the circuits shown in Fig. 174, with choke coils L_1 and L_2 each having inductance values of 15 henries. The broken line curves show the corresponding values when the condenser C_1 is increased to 4 mf. The curves in Fig. 172, show the corresponding values when the condenser C_1 is omitted. To obtain the value of D.C. voltage delivered by the power unit to the receiver set the D.C. voltage drop in the choke coils must be subtracted from the values shown on the curves. The output voltages will also be affected by the characteristics of the particular transformer used.

Fig. 173 shows the socket terminal connections for the BH tube while Fig. 174 shows the more or less standardized circuit of power supply units which use this tube.

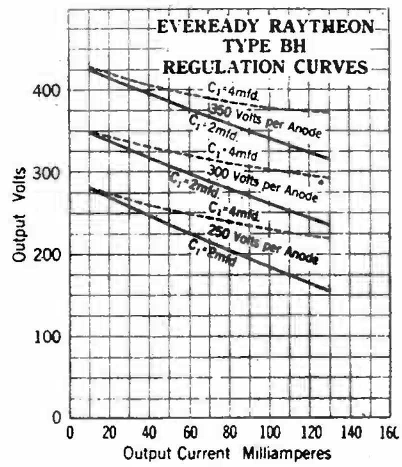


FIG. 171

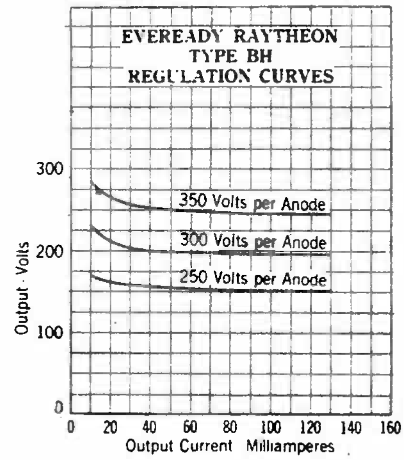


FIG. 172

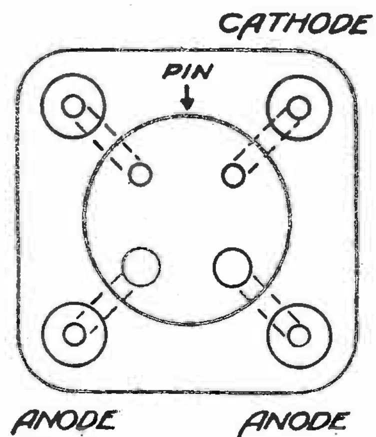


FIG. 173

Raytheon Type BA 350 Milliampere Rectifier

The BA tube was used extensively several years ago in the radio receivers that had their filaments connected in series. Early model radio sets of the battery type using '01A tubes with the filaments connected in parallel could be converted into electric sets by changing the filament circuits over to a series arrangement as indicated in the revised circuit of the A.K. 30 shown in Fig. 175.

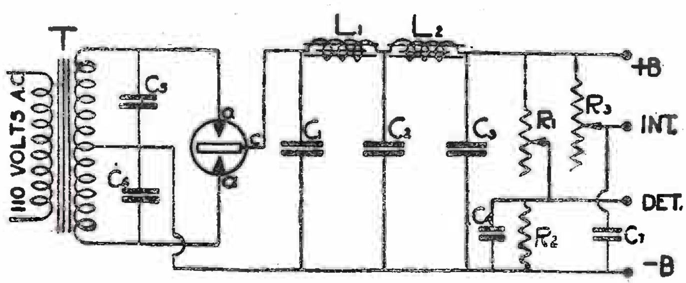


FIG. 174

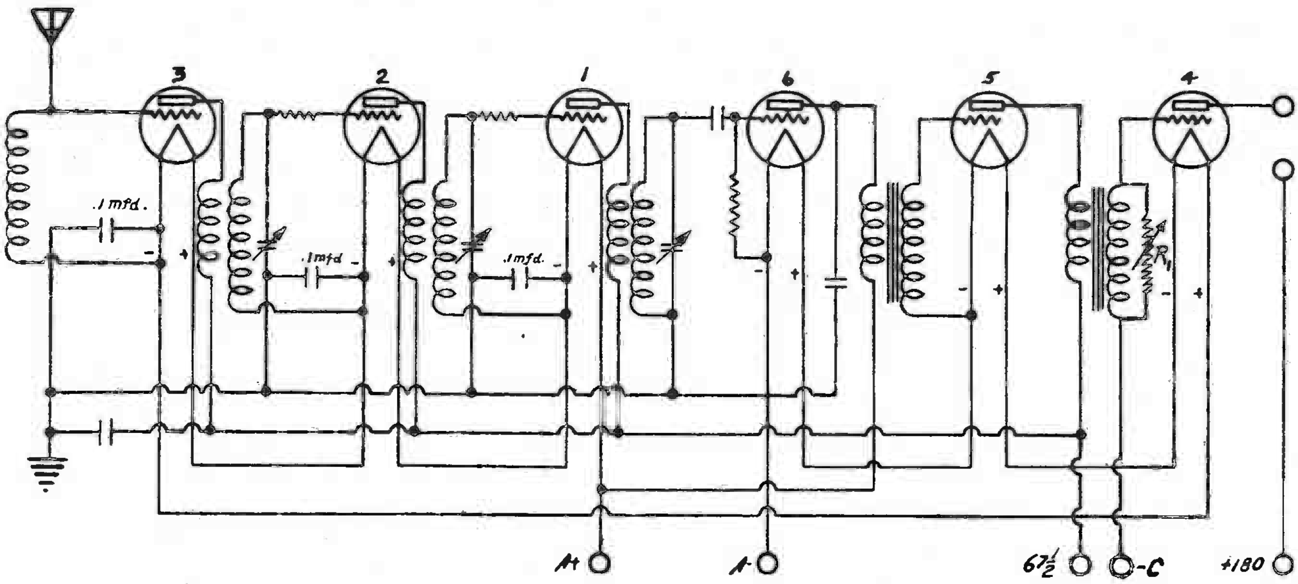


FIG. 175

Description

The tube makes use of the ionized helium method of rectification.

Rating

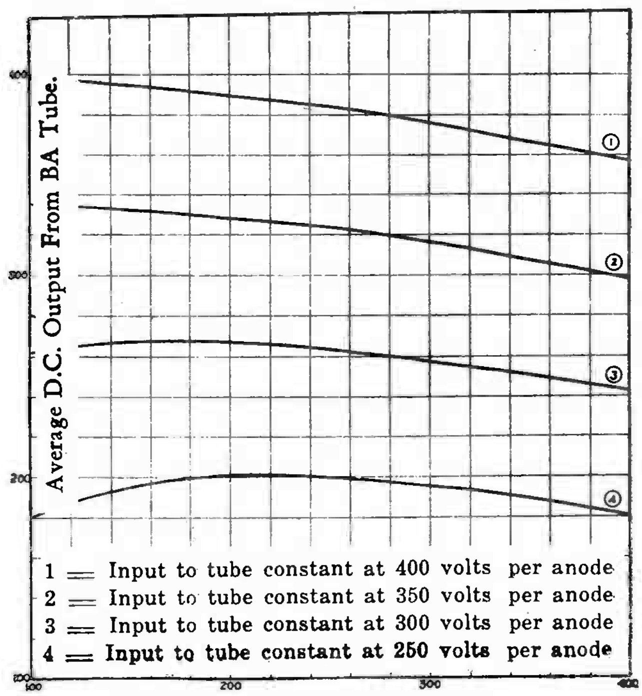
Maximum A.C. Input Voltage (per anode) 350 R.M.S. volts.

Maximum Rectified Output (both anodes) 350 milliamperes.

Maximum Output Voltage, 250 volts.

Fig. 177 shows the voltage regulation curves of the BA. The voltage drop through the tube with an increase in the load is not as great in the new models of this tube as it was in the old. Thus the new tubes have much better output regulation. The BA tube is not recommended for loads of less than 200 ma., its range of efficiency lying between 200 and 350 ma. The conventional circuit of an ABC power unit is indicated in Fig. 178.

Voltage Regulation Curves of Raytheon 350 M.A. Full Wave Rectifying Tube.



Load Current in Milliamperes.

FIG. 177

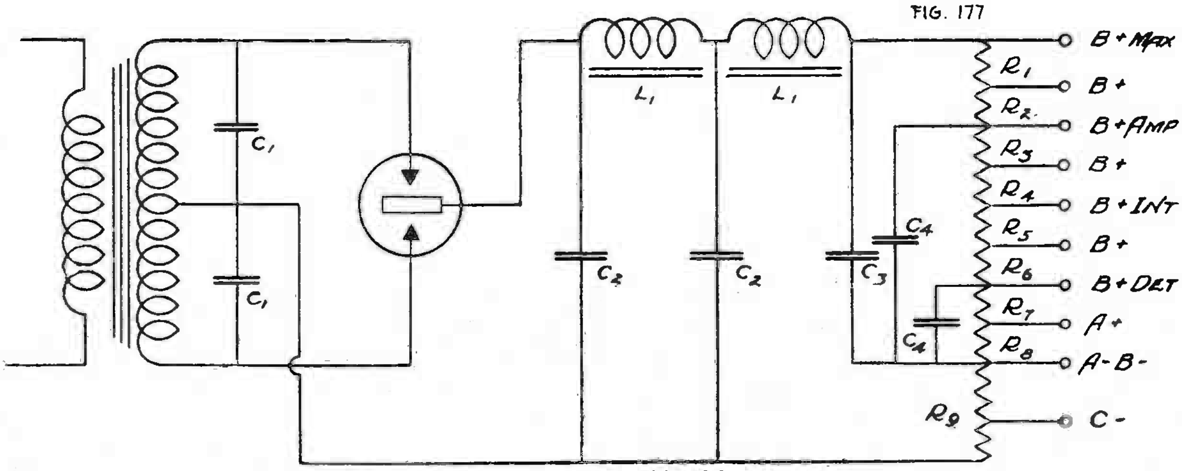


FIG. 178

RADIO TUBE CHART

LATEST TECHNICAL INFORMATION ON STANDARD RADIO TUBES SUCH AS
EVEREADY RAYTHEON 4-PILLAR TUBES

DETECTOR AND AMPLIFIER TUBES

TYPE	USE	BASE	MAX. OVERALL DIMENSIONS HGT.	DIAM.	FILAMENT SUPPLY	FILAMENT VOLTAGE	FILAMENT CURRENT (AMPERES)	SCREEN GRID VOLTAGE	WHEN USED AS	PLATE SUPPLY VOLTAGE	GRID BIAS VOLTAGE	PLATE CURRENT MILLIAMP.	AMPLIFICATION FACTOR	PLATE RESISTANCE (OHMS)	MUTUAL CONDUCT. MICROMHOS	MAXIMUM UNDISTORTED OUTPUT MILLIWATTS	OPTIMUM LOAD RESIS. (OHMS)
ERV-199	DETECTOR	UV	3 1/2"	1 1/16"	DRYCELL 4 1/2 V.	3.3	0.063		DETECTOR	45	+A	1.5	6.6	17000	370		
ERX-199	AMPLIFIER	UX	4 1/8"	1 3/16"	STORAGE 4 V.				AMPLIFIER	90	4.5	2.5	6.6	15500	425	7	15500
ER-120	POWER AMPLIFIER	UX	4 1/8"	1 3/16"	DRYCELL 4 1/2 V. STORAGE 4 V.	3.3	0.132			90	16.5	3	3.3	8000	415	45	9600
										135	22.5	6.5	3.3	6300	525	110	6500
ER-200A	DETECTOR	UX	4 11/16"	1 13/16"	STORAGE 6 V.	5	0.25			45	−A	1.5	20	30000	670		
ER-201A	DETECTOR AMPLIFIER	UX	4 11/16"	1 13/16"	STORAGE 6 V.	5	0.25		DETECTOR	45	+A	1.8	8	12000	670		
									AMPLIFIER	90	4.5	2.5	8	11000	725	15	11000
										135	9	3	8	10000	800	55	20000
ER-240	DETECTOR	UX	4 11/16"	1 13/16"	STORAGE 6 V.	5	0.25		DETECTOR WITH 1/4 MEGOHM COUP. RESISTOR	180	+A	0.5	30	90000	330		
	AMPLIFIER								RADIO FREQUENCY AMPLIFIER	135	1.5	0.6	30	65000	450		
									AUDIO AMP. WITH 1/4 MEGOHM COUP. RESIS.	180	3	0.2	30	150000	200		
ER-222	AMPLIFIER	UX	5 1/4"	1 13/16"	DRYCELL 4 1/2 V. STORAGE 4-6 V.	3.3	0.132	67.5	RADIO FREQUENCY AMPLIFIER	135	1.5	3.3	290	600000	480		
								22.5	AUDIO AMPLIFIER WITH 1/4 MEGOHM COUP. RESISTOR	180	1.5	0.3	350	2000000	175		
ER-112A	DETECTOR	UX	4 11/16"	1 13/16"	STORAGE 6 V.	5	0.25		DETECTOR	45	+A	4	8	6100	1300		
	AMPLIFIER								AMPLIFIER OR POWER AMPLIFIER	90	D.C. 4.5 / A.C.	5.2	8.5	5600	1500	30	5600
	POWER AMPLIFIER				STORAGE 6 V. OR A.C.					135	9 / 11.5	6.2	8.5	5300	1600	115	8700
										180	13.5 / 16	7.6	8.5	5000	1700	260	10800
ER-171A	POWER AMPLIFIER	UX	4 11/16"	1 13/16"	STORAGE 6 V. OR A.C.	5	0.25			90	−16.5 / −19	12	3	2250	1330	125	3200
										135	−27 / −29.5	17.5	3	1960	1520	370	3500
										180	−40.5 / −43	20	3	1850	1620	700	5350
ER-226	AMPLIFIER	UX	4 11/16"	1 13/16"	A.C.	1.5	1.05			90	6	3.8	8.2	8600	955	30	9800
										135	9	6.3	8.2	7200	1135	80	8800
										180	13.5	7.4	8.2	7000	1170	180	10500
ER-227	DETECTOR AMPLIFIER	UY	4 11/16"	1 13/16"	A.C.	2.5	1.75		DETECTOR GRID LEAK	45	0	3.5	10	9000	1100		
									DETECTOR BIAS	180	25	CHARACTERISTICS DEPEND UPON SIGNAL AMPLITUDE & CIRCUIT					
									AMPLIFIER	135	9	4.5	9	9000	1000	80	13000
										180	13.5	5	9	9000	1000	165	18700
ER-224	DETECTOR AMPLIFIER	UY	5 1/4"	1 13/16"	A.C.	2.5	1.75	45	WITH 1/4 MEGOHM COUP. RESIS. DETECTOR	180	4	CHARACTERISTICS DEPEND UPON SIGNAL AMPLITUDE & CIRCUIT					
								45	WITH 1/4 MEGOHM COUP. RESIS. AMPLIFIER	180	3	0.3	300	600000	500		
								90	R.F. AMPLIFIER	180	3	4	400	400000	1000		
								90		250	3	4	615	600000	1025		
ER-235	AMPLIFIER	UY	5 1/4"	1 13/16"	A.C.	2.5	1.75	90		180	3	6.3	255	250000	1020		
								90		250	3	6.5	370	350000	1050		
ER-551	AMPLIFIER	UY	5 1/4"	1 13/16"	A.C.	2.5	1.75	90		180	3	5.8	280	275000	1020		
								90		250	3	6.0	430	410000	1050		
ER-245	POWER AMPLIFIER	UX	5 5/8"	2 3/16"	A.C.	2.5	1.50			180	34.5	27	3.5	1900	1850	780	3500
										250	50	34	3.5	1750	2000	1600	3900
ER-247	POWER AMPLIFIER	UY	5 5/8"	2 3/16"	A.C.	2.5	1.50	250		250	16.5	32	95	38000	2500	2500	7000
ER-210	POWER AMPLIFIER	UX	5 5/8"	2 3/16"	A.C.	7.5	1.25			250	22	10	8	6000	1330	400	13000
										350	31	16	8	5150	1550	900	11000
										425	39	18	8	5000	1600	1600	10000
ER-250	POWER AMPLIFIER	UX	6 1/4"	2 11/16"	A.C.	7.5	1.25			250	45	28	3.8	2100	1800	1000	4300
										350	63	45	3.8	1900	2000	2400	4100
										450	84	55	3.8	1800	2100	4600	4350
ER-230	DETECTOR AMPLIFIER	UX	4 1/4"	1 9/16"	AIRCELL 2 V. STORAGE 2 V.	2	0.060		DETECTOR GRID LEAK	45	+A	1.5	9.3	14000	660		
									DETECTOR BIAS	135	7.5	CHARACTERISTICS DEPEND UPON SIGNAL AMPLITUDE & CIRCUIT					
									AMPLIFIER	90	4.5	1.8	9.3	13000	700	16	15000
										135	9	2.2	9.3	12000	775	55	20000
ER-231	POWER AMPLIFIER	UX	4 1/4"	1 9/16"	AIRCELL 2 V. STORAGE 2 V.	2	0.130			135	22.5	6.8	3.8	4950	760	150	9000
ER-232	DETECTOR AMPLIFIER	UX	5 1/4"	1 13/16"	AIRCELL 2 V. STORAGE 2 V.	2	0.060	40	DETECTOR WITH 1/4 MEGOHM COUP. RESIS.	135	3	CHARACTERISTICS DEPEND UPON SIGNAL AMPLITUDE & CIRCUIT					
								67.5	AMPLIFIER	135	3	1.4	580	1150000	505		
ER-233	POWER AMPLIFIER	UY	4 11/16"	1 13/16"	AIRCELL 2 V. STORAGE 2 V.	2	0.260	100		100	8	10.5	60	50000	1200	300	7000
								135		135	13.5	14	63	45000	1400	650	7500
ER-236	DETECTOR AMPLIFIER	UY	4 11/16"	1 9/16"	STORAGE 6 V. 110 V. D.C. LINE	6.3	0.30	55	AMPLIFIER	90	1.5	1.8	170	200000	850		
								75		135	1.5	3.5	275	250000	1100		
ER-237	DETECTOR AMPLIFIER	UY	4 1/4"	1 9/16"	STORAGE 6 V. 110 V. D.C. LINE	6.3	0.30		AMPLIFIER	90	6	2.7	9	11500	780	30	14000
										135	9	4.5	9	10000	900	75	12500
ER-238	POWER AMPLIFIER	UY	4 11/16"	1 9/16"	STORAGE 6 V. 110 V. D.C. LINE	6.3	0.30	100		100	9	6.5	110	150000	750	170	17000
								135		135	13.5	8.0	100	110000	900	375	15000

RECTIFIER TUBES

TYPE	USE	BASE	HGT.	DIAM.	FILAMENT SUPPLY	FILAMENT VOLTAGE	FILAMENT CURRENT	MAXIMUM A.C. VOLTS PER ANODE	MAX. DC OUTPUT CURRENT (AMPERES)	MINIMUM CHOKE BEFORE FILTER CONDENSER	MAXIMUM D.C. VOLTS DELIVERED TO FILTER (NOMINAL)
BH	FULL WAVE RECTIFIER	UX	4 5/8"	1 13/16"		GAS TYPE NO FILAMENT		350	0.125		300
BA	FULL WAVE RECTIFIER	UX	5 5/8"	2 7/16"		GAS TYPE NO FILAMENT		350	0.350		300
ER-280	FULL WAVE RECTIFIER	UX	5 5/8"	2 3/16"	A.C.	5.0	2.0	350	0.125		300
								400	0.110		370
								550	0.135	20 HENRIES	425
ER-281	HALF WAVE RECTIFIER	UX	6 1/4"	2 7/16"	A.C.	7.5	1.25	700	0.085		700

6-15-31

Arcturus 15-Volt Tubes

Type	22	26-28	30	32	40	48
Plate Voltage (max.)	135	90	180	135	180	90
Plate Current (ma.)	2.0	7.5	22	1.5	21	4.5
Plate Resistance (thousands of ohms)	475	9	3.5	32	2	9.2
Grid Bias (volts)	1.5	1.5	27	3	40.5	4.5
Amplification Factor (mu)	300	10.5	3.8	30	3	11
Mutual Conductance (Gm) or Transconductance (micromhos)	630	1165	1085	940	1500	1185

The filament consumption is 350 ma., except for the 40 type, which takes 400 ma.

The 26 is a detector, the 28 an amplifier. The 22 is a screen-grid tube, using 45 volts on the screen-grid, with 135 on the plate.

The Arcturus 15-volt tubes have but four terminals in the base; the cathode being connected to one side of the filament.

The Sonora RA-1 and SO-1 are equivalent, respectively, to the Arcturus 48 and 40.

Kellogg 2½-Volt A.C. Tubes

Type	K-24	K-27
Plate Voltage	180	90
Plate Current (minimum)	2.0	——
Plate Resistance (ohms)	400,000 to 1,000,000	——
Grid Bias (volts)	1.5	4.5
Amplification Factor	——	8 to 10
Mutual Conductance	800 to 1600	800 to 1200

These tubes draw 1.75 amperes at 2.5 volts across their filaments. The K-24 takes 75 volts on its screen grid.

SERVICING THE AUTOMOTIVE RECEIVER

THE public acceptance of the auto radio opens a new source of revenue for the service man. It is important that the service man understands the peculiar conditions which exist in the installation and servicing of these sets. For this reason the Editors have selected the most interesting and informative data compiled by the various manufacturers of this equipment during years of test and research.

THE ANTENNA

Differences in Antennas.

In considering the antenna system, it is safe to say that there are as many different types of antennas as there are different types of cars. No two types are the same either in physical dimensions or in electrical characteristics. The antenna which will perform most efficiently in one type of car will give very indifferent results in another. To understand the difficulties which must be overcome in each individual installation, it is necessary to understand certain fundamental laws which govern receiving antennas.

The Function of the Antenna.

When a distant broadcasting station is in operation, the electromagnetic lines of force radiated from the station's antenna impinge upon the car antenna and induce in it radio-frequency oscillations which pass through the receiver and are reproduced by the speaker in the form of voice or music. It will be seen therefore that the antenna is a collector of electrical energy. Each passing wave radiated by the broadcasting station striking the antenna creates a difference of potential between the antenna and the ground which is equal to the length of the antenna multiplied by the intensity of the passing wave.

The Most Efficient Antenna.

Up to certain limits a large antenna will deliver greater signal strength than a small one. The current flow in a receiving antenna is directly proportional to its length and to its effective height and inversely proportional to the resistance of the antenna. In simple language, this means that best reception is secured when the largest possible antenna is installed in the car top, when it is farthest separated from the ground, and when the antenna and lead-in wires are securely soldered and offer the least possible resistance to the flow of antenna current.

The Effective Height of the Antenna.

It must be understood that the effective height of the antenna does not necessarily mean the distance between the flat-top portion of the antenna and the earth. In the automobile, no earth connection is possible. In the automobile installation, the chassis of the car is used as a counterpoise which in a sense performs the same function, although not as efficiently. The effective height of the antenna, therefore, is the distance between the antenna and any metallic portion of the car.

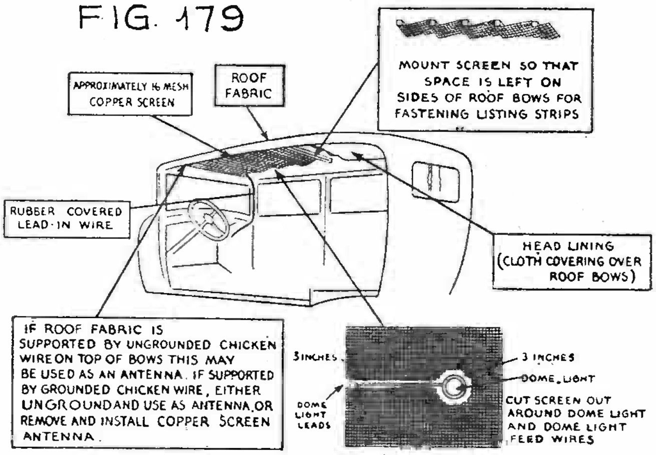
Physical Dimensions of the Antenna and the Ground Connection.

It will be seen that the physical dimensions of the car antenna must necessarily be limited, depending in each case on the type of the car and the construction of the body. It cannot be concluded that the most efficient antenna is to be secured by filling up the car roof with antenna screening. The trend of modern car design is toward all-metal body construction and as the over-all dimensions of the antenna are increased, the effective height is reduced. If the antenna approaches too close to the metallic body of the car, or to the dome light or associate wires located in the car roof, the efficiency of the antenna decreases in proportion to the separating distance. It will be seen, therefore, that some limit must be made in the antenna dimensions.

The Dome Light and Associate Feed Wires.

Experiments conducted over a period of four years have established the fact that the antenna should be separated from the metallic body of the car by at least three inches. It is well to note at this point that wood bodies do not offer this objectionable feature. The antenna screening must be cut out around the dome light and properly spaced from the mounting plate to prevent high frequency leakage. Precaution must be taken to see that the feed wires running to the dome light do not touch the antenna screening. These wires are usually insulated but they should never be allowed to rest upon the antenna. They should be fastened to the extreme upper portion of the bows to reduce the possibility or antenna leakage. See Fig. 179.

FIG. 179



Cars Equipped at the Factory with Antennas.

A number of car manufacturers are equipping certain models of their cars with antennas. Most of these cars will be marked with a sticker placed on the windshield indicating that the car is equipped with an antenna for operation with *Transitone* radio Where this is not indicated by means of a windshield sticker, an investigation will show the lead-in from the antenna running down the right front body post and tucked under the cowl.

The Lead-in and Antenna Leakage.

The antenna lead-in offers another problem which must not be considered lightly. This wire, which extends from the flat-top portion of the antenna to the receiver behind the dash, must by force of circumstances run parallel with and close to the metal side post of the car. This close relation offers a path of leakage between the antenna and chassis which is objectionable and should be reduced to a minimum. By virtue of the capacity existing between the two, it also tends to destroy the electrical balance of the receiver. This in effect reduces the over-all efficiency and results in weaker signals.

Antenna Requirements for Limousine and Town Car.

The antenna and lead-in requirements of the limousine and town car differ slightly from the above. The limousine is divided into two sections, the forward compartment for the chauffeur and the rear compartment or tonneau for the owners and their guests. These compartments are separated from each other by a heavy glass window for the privacy of the passengers. As the dividing framework extends to the roof, it becomes necessary to install two separate antennas, one in front and one in the rear section, which must be connected together by wires extending through holes drilled in the dividing partition. Three wires are usually sufficient to bond the two sections of the antenna together. As the separating framework is usually constructed of metal, care must be taken that the two sections of the antenna do not approach closer than three inches to the structure.

Lead-in Requirements for the Town Car.

In some cases where time for installation is at a premium, and where the rear portion of the limousine is large enough to accommodate an efficient antenna, the forward section of the car may be disregarded. In this particular case, as in the case of the town car where the forward section is not roofed over, it becomes necessary to deviate from the standard system of running the lead-in wire. In these cases the lead-in is brought down at the front corner post of the rear section. Here the same precaution must be observed as in the sedan and coupé to see that the lead-in wire is run in non-metallic insulating housing. The lead-in should extend to the floor, where it is carried forward to the instrument board in a chiseled groove out in the floorboard.

Care must be taken that this lead-in is not run underneath the metal sill of the front door, as the sill is usually grounded. Such a procedure may materially overload the antenna system and destroy the electrical balance of the receiver. It is sometimes more convenient to carry the lead-in underneath the body of the car. In this case it is necessary to use non-metallic insulating housing as a protection against moisture and abrasion to which the under side of the car is subjected. This housing should extend above the floorboard at the front end and be rigidly supported.

The Metal Roof and Its Effect on Radio Reception.

It has been previously mentioned that the trend of modern car construction is toward an all-metal body. This refinement in body design is also carried to the car roof by many manufacturers. In a great many cases the fabric of the roof is supported by an iron wire mesh which is laid on top of the wooden bows. In some cases the bows themselves are of metal. This metallic screen extends to the sides of the car and is usually grounded to the body.

This particular feature, while advantageous to the body-builder, offers a serious obstacle to the operation of a radio receiver in a motor car. In effect the iron wire mesh which supports the fabric roof, so sufficiently shields the antenna installed in the car that it prevents the operation of the receiver. The passing electromagnetic waves radiated by a broadcasting station strike the grounded screen supporting

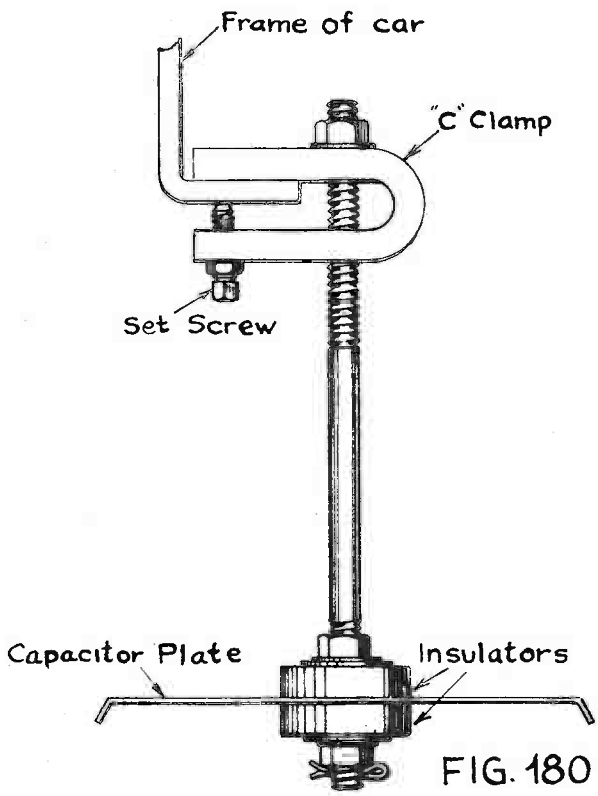


FIG. 180

the fabric top and pass directly to the ground. The iron mesh effectively shields the antenna and prevents the flow of antenna current. Obviously the practical solution to the problem is to remove the iron wire mesh before installing the car antenna or install capacitor plates under the running board. Fig. 180 shows how plates are mounted under car.

Supporting the Top-Fabric.

The purpose of the iron wire mesh must not be overlooked. It is placed over the bows of the roof to support the fabric top. Removing the mesh, while aiding the reception of radio broadcasting, defeats the purpose for which it was intended. In order to prevent the top from sagging, a practical substitute must be provided. This is accomplished by stretching upholsterers' webbing over the tops of the bows.

The exact number of webbing strips and their location in respect to one another are of considerable importance if the fabric is to be effectively supported. It has been found that eight or nine strips are necessary on cars having a bowed roof. On this type of roof, the webbing must not be separated by more than half an inch. If this requirement is neglected the roof will sag in unsupported portions. On flat roofs the webbing may safely be separated by two inches.

Installing the Closed Car Antenna.

The installation of the closed car antenna may be briefly summarized as follows:

It will be necessary to unfasten the front and sides of the head-lining, the back end remaining untouched, then carefully remove the tacks from the listing strips, which are the muslin strips used to support the head-lining at the bows.

Cut the iron mesh as closely as possible to the sides, front, and back of the car. Particular care must be observed that no sharp protruding wires are exposed which may cut into the top-fabric or head-lining.

Remove the iron mesh as well as the staples which are used to fasten it to the top of the bows. It will be found convenient to remove the mesh in small sections.

Stretch the upholsterers' webbing from the back to the front of the car on top of the bows. The number of strips to be used depends on the type of car, as outlined before.

The Screen Antenna.

Tack the copper antenna screen securely into position, making sure that it is separated from the dome light and the metal body of the car by at least three inches. See that lighting wires in the roof are separated from the antenna screen as far as possible.

Securely solder the lead-in wire to the proper corner of the antenna screen.

Testing the Antenna for Possible Grounds.

Test the antenna for possible ground by means of a voltmeter and battery. This test should be made from the antenna lead-in to any metallic portion of the chassis, preferably the gear shift lever.

Carefully replace the car head-lining, working from the middle of each listing strip, progressing toward the front of the car. After the listing strips are in position the sides and front of the head-lining should be replaced.

Run the lead-in as previously outlined.

Retest the antenna for possible ground.

The above installation data refers exclusively to closed cars of metal body construction having wood bows. Cars having metal bows do not come under the above classification. The antenna system used in this type of car will be discussed later.

Antennas for Roadsters and Touring Cars.

In cars of the open type, i.e., touring cars, roadsters, etc., the method of installing the antenna differs considerably from that of the closed type car. This is due to the fact that the tops of these cars are designed to fold back. It will be seen, therefore, that the employment of a copper screen is out of the question. It will also be seen that the antenna lead-in cannot be taken off the front portion of the antenna.

The most satisfactory antenna for this type of car consists of from 65 to 100 feet of No. 18 gauge rubber-covered stranded wire, laced in grid formation in drill cloth and sandwiched between the top of the car and a head-lining of the same material. If the car is not already equipped with a head-lining, the extra material may be procured from the local dealer in automobile fabrics. The stranded wire should be woven back and forth through holes punched in the drill cloth and be so located that the parallel sections of the wire do not approach closer than three inches to each other. The total length of the antenna wire depends upon the dimensions of the top. The touring car will naturally require more wire than the roadster.

The Lead-In of the Roadster and Touring Car.

The antenna lead-in in this type of installation must be taken from the back end of the car. It may be carried to the dash in a groove cut in the floorboards, or it may be run underneath the body of the car. (Refer to lead-in description of Sedan.) The antenna lead-in should always be run on the set side of the dash. If the lead is carried through the motor compartment it may be difficult to eliminate the ignition disturbances.

Installing the Open Car Antenna.

The installation of the open car antenna may be briefly summarized as follows:

Remove the top covering of the car, leaving underside flaps in place.

Cut a piece of drill cloth approximately 3 inches smaller than the width of the top and equal in length to the top.

Procure from the local dealer sufficient top material to construct a false top or head-lining. This material should match the top-fabric and be cut to the same length and width.

Secure this top material in its proper place over the cross-ribs and over the side flaps left exposed by removing the top-covering.

Fasten the drill cloth in which the antenna wire has been woven. This should be tacked to the bows at the front and rear of the car only.

Solder the antenna lead at the back end of the car.

Replace the top-covering.

Run the antenna lead as mentioned above.

Test the antenna for possible ground.

NOTE: *It should be seen* that the antenna wire is not allowed to approach closer than three inches to the top of the windshield. This frame is constructed of metal and if the antenna is not properly located, high frequency leakage will take place. In the event the bows are of metal construction, it must be seen that the antenna wire does not rest upon the bows. The same three-inch separation must be observed here if efficient operation is to be secured.

The Antenna for Cars Having Metal Bows.

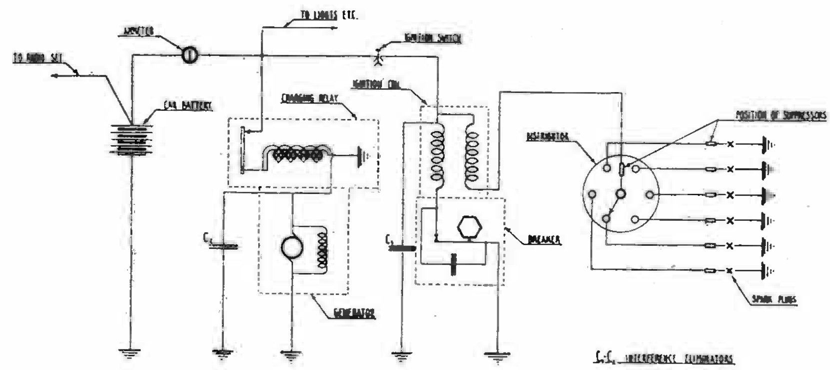
As has been previously mentioned, the trend of modern car design runs toward all-metal body construction. In some cases, as in the Dodge Victory Six, the bows are made of this material. Considering the high frequency leakage and the shielding effect that exists when the antenna is located too closely to the metallic body, it will at once be seen that the copper screen will not constitute an efficient antenna in bodies of this particular construction. Here, as in the open car, the only logical solution to the problem is to resort to the insulated stranded wire antenna properly separated from the metal bows. A number of staples or screw-eyes should be securely fastened around the top frame of the car and separated from the metal bows by not less than three inches. As the top frame is relatively close to the metal body, the stranded antenna wire must not be laced directly through the staples or screw-eyes. A section of heavy twine must be tacked to the top frame, and carried through the screw-eyes or staples in loop fashion. These loops must be long enough to afford the proper separation from the metal structure, after which the antenna wire should be laced grid fashion through the twine loops. No special requirements for the antenna lead-in are necessary.

THEORY OF INTERFERENCE ELIMINATION

In order to fully understand the application of the elimination system it is necessary to consider in a general way the cause of the electrical disturbances.

The Cause of Electrical Disturbances.

In considering the ignition system of the car with its ignition coil to supply high voltage to a series of spark plugs, one important fact cannot be overlooked. The system is, in every sense of the word, an exact duplication of a radio spark transmitter.



ELECTRICAL SYSTEM OF A CAR FIG. 181-A

The ignition system, therefore, is a radio transmitting station located directly under the antenna of the automobile receiver. Fig. 181A indicates electrical circuits of the average motor car.

Function of the Interference Suppressor.

When the ignition system is in operation, the high tension current sets up a series of electromagnetic and electrostatic fields about the high-tension wires which are propagated through space at the speed of light. These fields or impulses, due to the arrangement and physical dimensions of the ignition system, assume a more or less definitely tuned characteristic which is most pronounced over the lower dial settings. It is obvious that if this disturbance is to be avoided, the radiating characteristic of the energy must be reduced or destroyed. The reduction of the undesirable radiated energy is brought about by the introduction in the radiating circuits of units which have been designated as *ignition interference suppressors.* (Fig. 181B.) These are mounted in series with the high-tension leads directly at the plugs and distributor-head and effectively reduce the disturbance without in any way affecting the performance of the engine. Fig. 181C shows position of various resistors and condensers used in suppression systems.

The Magnetic Field.

To understand the function of the unit designated as an interference eliminator, it is necessary to consider the location of the source of the disturbance and its position in respect to the receiver and associate equipment. It will be noted that the high-tension wires of the ignition system are surrounded by the engine, hood, radiator, cowl and engine partition. This metal structure constitutes a shield which surrounds and confines a powerful magnetic field. The receiver, which is located on the instrument board and separated by the cowl and engine partition, is therefore shielded. The actual shielding, however, is more apparent than real. In many of the late model cars the ignition coil is mounted on the instrument board side of the engine partition or on the instrument panel. It will be seen, therefore, that in these particular cases the shielding effect of the engine partition will have little effect on the receiver. In this case the magnetic field is not confined to the engine compartment.

Possible Sources of Disturbances.

The wiring system of the car and the mechanical arrangement whereby the various units of the power plant are operated from the instrument board are also important factors which reduce the shielding effect of the engine compartment. The numerous heat rods, choke rods, thermostat lines, and oil pipes which are carried through the engine partition as well as the necessary wires incorporated in the lighting and ignition systems offer conducting paths which in some cases may cause considerable interference.

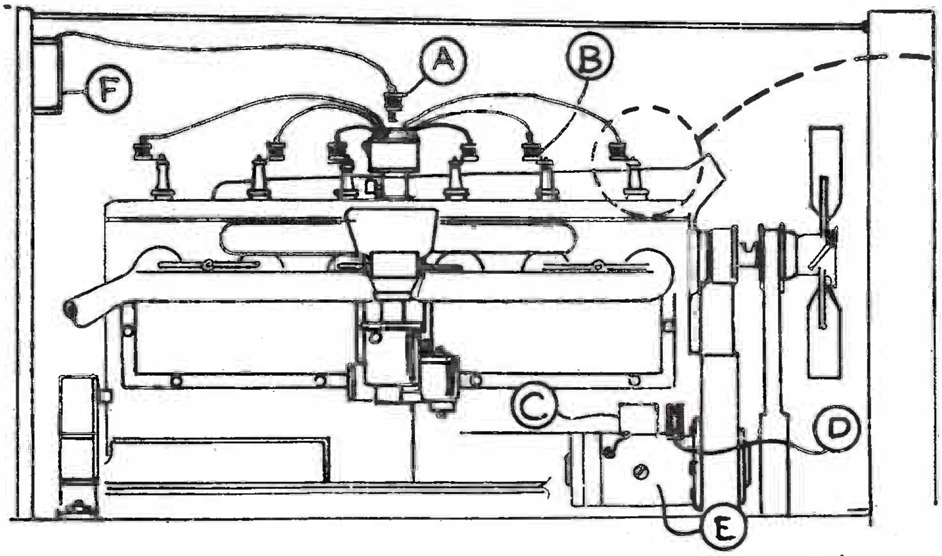
Grounding the Choke Rods, etc.

It is possible in the case of the metal conductors (oil pipes, choke rods, etc.), to eliminate them as a possible source of disturbance by grounding them to the frame of the car at the motor side of the partition. These leads must be as short and direct as possible, otherwise they may defeat the purpose for which they are intended.

Locating the Source of Disturbance.

The method employed in determining the conductor which is responsible for the disturbance is a relatively simple one. The various pipes and rods extending through the engine partition should be temporarily grounded to the metallic structure by means of a screw-driver or other convenient tool. This grounding should be done while the motor is running and the set is in operation, with the hood closed and with the hood clamps fastened.

Interference Eliminators.



A- SUPPRESSING RESISTOR AT DISTRIBUTOR
B- SUPPRESSING RES' AT PLUGS
C- GENERATOR CUT-OUT
(D)- CONDENSER
(E)- CAR GENERATOR
(F)- HIGH TENSION COIL
(H)- SPARK PLUG.

FIG. 181-C (SIDE)

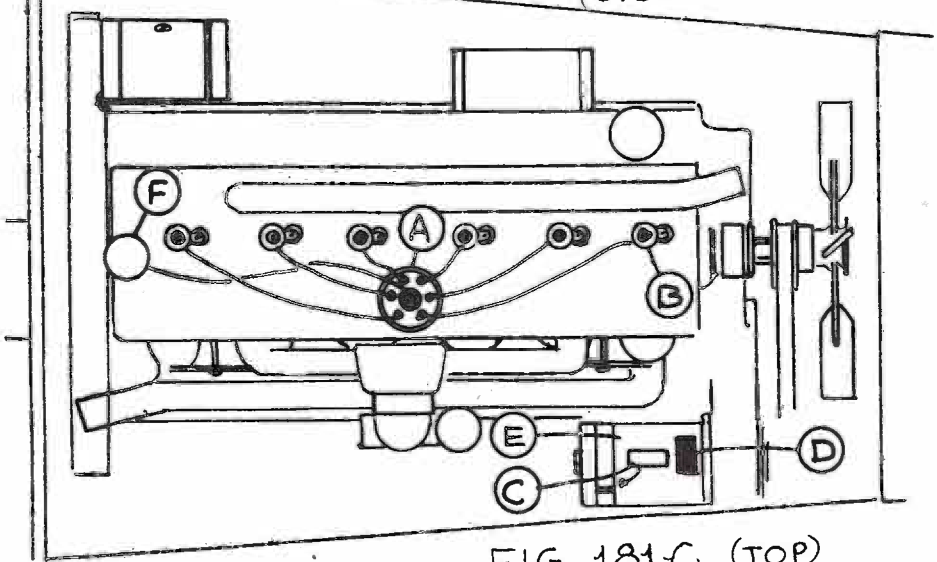
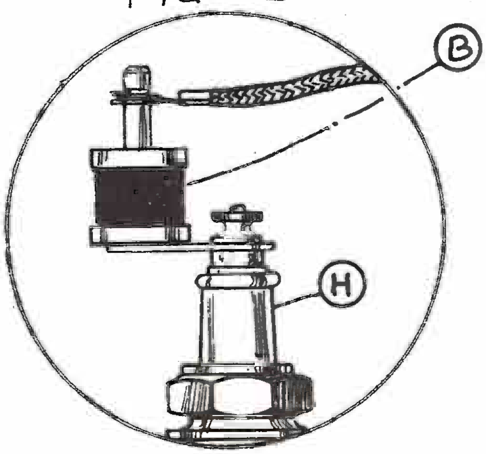


FIG. 181-C (TOP)

FIG. 181-B



This method of bonding or grounding the various conducting paths which allow the transfer of energy from the engine compartment to the receiver cannot be applied to the various wires which pass through the engine partition. Such an attempt to prevent the passage of undesirable impulses would result only in short-circuiting and grounding the wiring system of the car. For this particular purpose interference eliminators are introduced into the circuit.

Electromagnetic Induction.

At this time it becomes necessary to describe the theory involved whereby the magnetic field surrounding the high tension wires of the distributor and ignition systems is carried to the receiver by means of the various pipes and wires running through the engine partition. In engineering parlance this transfer of energy is described as Electro-magnetic Induction. It may be defined as the process by which electrical energy is transferred from one circuit to another by means of electromagnetic lines of force of varying density or changing strength. To the layman, it is only necessary to state that when the current in one conductor is changing at a unit rate per second, it induces similar currents in wires or conductors which are in close relation to its magnetic field.

The Isolation of High-Tension Wires.

It will be seen from the above that the most convenient and effective method of preventing the transfer of energy from the motor compartment to the receiver is to separate all the low-tension wires of the car as far as possible from the high-tension wires of the ignition system. Many car manufacturers utilize the high-tension manifold as a convenient place in which to run the horn wire and the low-voltage lead extending from the primary winding of the ignition coil to the distributor. The close proximity of these leads will cause the condition described in the preceding paragraph. The lines of force surrounding the high-tension plug wire will induce a corresponding intermittent pulsation in the low-tension wire of the coil which will in turn induce similar pulsations into the receiver by means of the wire which extends from the coils to the ignition lock. The horn wire extending to the button on the steering column may contribute to the disturbance, although not to as great a degree, as this wire is usually located at a considerable distance from the receiver.

The High-Tension Manifold.

The obvious remedy in cases of this kind is to remove the horn and low-tension ignition leads from the high-tension manifold.

Suggested Remedy.

If necessary, these wires must be lengthened and relocated at a position which will remove them from the limit of the magnetic field.

The Low-Tension Distributor Wires.

Another serious source of disturbance is caused by the fluctuating magnetic field which surrounds the wires associated with the low-tension side of the distribution system. These wires which run from the ignition switch to the coil and to the breaker-points in the distributor-head, carry a low-tension current of an intermittent character. As the breaker-points open and close, the magnetic field surrounding these wires builds up to maximum and then suddenly collapses, at which time the collapsing field induces a back or counter-electromotive force which may build up to infinity. This intermittent characteristic of the current flowing through the wires, together with the fluctuating field surrounding the same, may cause considerable disturbance in the reproduction of the broadcast program.

Function of the Interference Eliminator and Method of Application.

It will be seen, therefore, that in order to secure reception which is free from interference, it will be necessary to filter or smooth out the fluctuations or pulsations of the current flowing in these wires. This is accomplished by means of the interference eliminators which may be mounted in a convenient position on the engine partition or instrument board of the car. These must be connected by short leads. One terminal of the eliminator should be connected to the wire causing the disturbance and the other terminal to the metallic structure of the car.

Locating the Offending Wires.

This is accomplished by using an interference filter unit as an exploring unit. Flexible leads about five or six inches in length are attached to the terminals of the unit. It may be desirable to fasten clips to the ends of the leads to afford a convenient temporary connection. To detect the offending wire it is only necessary to progressively connect one lead of the exploring unit to every accessible wiring terminal that can be located underneath the cowl or at the engine partition. The other terminal of the unit is connected to the metallic structure of the car. When the interfering lead is located, the spark disturbance will disappear entirely or be considerably reduced. This experiment must be conducted while the receiver is in operation and tuned to a relatively short wave-length, and the car motor is running, with the hood down.

Location of Interference Filter Units.

For the information of the operator or the radio man who is called upon to test the receiver at the completion of the installation, it may be well to designate the places where interference filter units are most frequently required. It must be understood, however, that the use of these units is the exception rather than the rule. In the average installation the standard elimination system successfully overcomes the disturbances of the generator and ignition systems of the car.

The Ammeter.

The most usual location for the interference filter unit is at the ammeter. The interference filter unit should be connected to the terminal which affords the greatest reduction of the disturbance and mounted on the back of the instrument board.

The Cigar Lighter.

The cigar lighter is another point at which an interference filter unit is frequently needed. This is due to the fact that in some cars the connection leading to the dome light is taken off the terminal of the cigar lighter. The filter unit is to prevent the passage of energy to the antenna screen which may be induced in the lighter circuit by a stray magnetic field underneath the cowl. In testing the receiver, care should be taken that the dome light is turned on and off. In some cases where no spark disturbance is present, completing the circuit to the dome light by turning on the switch will cause the spark to appear.

The Ignition Switch.

The ignition switch is another location where an interference filter unit is sometimes necessary. This is used to smooth out the fluctuations of current due to the interruption of the circuit by the breaker-points.

NOTE: *Considerable caution* should be exercised in attaching filter units to any part of the low-tension side of the ignition system. The introduction of a unit at the wrong point in the system may slow up the motor.

Horns, Fans, and Windshield Wipers.

There are other electrical disturbances originating from entirely different sources which may be desirable to eliminate. These may be caused by motor-driven horns, windshield wipers, electric fans, etc. The elimination principle in these cases is similar in every respect to the above. The interference filter unit is mounted close to the disturbing accessory and connected between it and the ground. In these cases, however, the terminal leading to the accessory must be connected to the wire leading to the battery or ammeter.

NOTE: *It must be understood* that all of the above mentioned interference elimination requirements are never needed for any one motor car. The mechanical and electrical design of the car will determine the number of units which must be used.

The Ignition Coil on the Instrument Board.

Mention has been made of the ignition coil which in some cases is mounted on the instrument board side of the engine partition or on the instrument panel. This particular mounting arrangement calls for a slight deviation from the accepted method of interference elimination. It will be seen that in cases of this kind the magnetic field is not confined entirely to the engine compartment. A considerable field surrounds the exposed high-tension lead which runs in the immediate vicinity of the receiver and the various connecting wires. In order to overcome the disturbing effect of this magnetic field, certain additional requirements are necessary.

In many of the cars in this class, foremost of which are the Packard, Franklin, Oldsmobile, Marquette, De Soto, Viking, Dodge, and Chrysler, it will be necessary to enclose the high-tension lead which extends from the center tap of the ignition coil to the distributor-head in a copper braid. This effectively confines the magnetic field and prevents any transfer of energy to the receiver or associate wires. The braid must extend from the ignition coil to the motor side of the engine partition and be grounded to the car structure at both ends. In some cases, where the ignition switch and coil are not made up in an integral unit, the coil may be re-located on the motor side of the engine partition.

Wooden Engine Partitions.

It must be observed that in some of the cars the engine partition is constructed of wood. In these particular cases the partition must be covered with galvanized sheet-iron and be grounded to the chassis in several places. This may most conveniently be done on the instrument board side of the engine partition. The Nash and Auburn afford the most common examples of this body construction.

The Distributor and Breaker-Points.

It is not unusual, especially in the case of cars which have been on the road for a considerable length of time, to find that the interference elimination methods thus far outlined do not reduce the disturbance below an objectionable level. The noise usually manifests itself in intermittent surges or crackling sounds resembling static which bear no relation to the uniform discharge of the spark plugs.

This disturbance is usually caused by a dirty condition of the distributor. Examination will show that in many cases the breaker-points are dirty and pitted, that the distributing arm and stationary electrodes are oxidized, and that the entire assembly is covered with a film of oil. This unhealthy condition offers a path of leakage for the high-tension currents and prevents the immediate quenching of the low-tension spark which takes place when the breaker-points are opened. It is necessary therefore that the distributor be wiped clean of oil and the electrical members which comprise the unit be placed in a perfect condition.

In some particularly stubborn cases where the intermittent character of the disturbance indicates that the trouble is caused by the distributor, a generator interference filter unit connected across the breaker-points may overcome the disturbance. At other times the introduction of the unit at this point may intensify the volume. It has been found in cases of this kind that an additional unit located at the ammeter may reduce the disturbance to zero.

This last illustrates one of the peculiarities of interference elimination. No set rule may be designated which will eliminate the disturbing interference in every case. The system whereby the disturbance may be overcome in one case may serve to intensify the condition when applied to another. It is only necessary, however, to know that the aforementioned elimination methods, when intelligently applied, will successfully overcome the ignition disturbances in any type of car.

GENERAL TESTS FOR AUTO RECEIVERS

Power Supply ("A" and "B" Batteries and Connections).

(A). Check connections at the storage battery. Make sure that there is no looseness or corrosion present at the terminals. Note that the polarity of the filament leads is correct.

(B). Check voltage of the storage battery with the set turned on, motor not running, and the car lights off. The correct reading should be 6 volts. A reading of less than 5.6 volts indicates a discharged battery or faulty connection.

(C). Check voltage of the "B" batteries. Each 45 volt unit that shows a terminal voltage of less than 35 volts should be discarded.

Input System (Antenna in Car Roof).

(A). Test for shorts between antenna and the metal body of the car.

(B). Test for open in the lead from the antenna in roof of car to set.

Input System (Capacitor Plate Method).

(A). Check connection of the shielded lead to capacitor plate.

(B). Check capacitor plate for grounds against car frame. Make sure that the shielding of the input cable does not touch the capacitor plate. Clean off any mud or dirt which may collect on the capacitor plate insulators.

(C). Check condition of tubes by using an analyzer to make the "tube test" or substitute tubes known to be good. Use standard tube checker if handy.

Chassis.

Check R.F., Det. and A.F. tubes with set analyzer. Proceed in the manner of checking the various circuits as explained in the section devoted to servicing radio receivers.

WEAK RECEPTION

Low "B" Battery Voltage.

As the "B" batteries drop in voltage a slight falling off in the sensitivity of the receiver will be noticed. Batteries as low as 35 volts must be replaced or noisy reception and poor tone will result.

Occasionally, due to some defect or misuse, one battery may drop excessively in voltage. While the total "B" supply may be between the correct limits, the extremely poor condition of the one battery may cause poor reception. In such an extreme case it is necessary to measure the voltage of each individual battery to locate this defect, and, of course, replace the defective battery.

Low "A" Battery Voltage.

This source of trouble is uncommon due to the fact that it seriously affects the operation of the car and is, therefore, immediately noticed and corrected. However, there may be difficulty due to a poor connection at the battery causing low voltage at the receiver. Make sure that all "A" connections are clean and tight.

Capacitor Plate or Antenna Disconnected.

The shielded lead from the receiver may be broken or disconnected at either end. Weak reception will result if the capacitor plate is grounded at any point. Make sure that the shielding of the "lead-in" cable is not touching the plate, and that the insulators are not broken.

Condenser Misalignment.

Poor condenser alignment may be caused by lengthwise movement of the rotor assembly or one of the stator plates. The setting of the alignment condensers may also have been altered. Make sure that the rotor plates are accurately spaced between the stator plates and that they have not become bent or damaged. The alignment condensers may generally be checked or adjusted without disturbing the set. The receiver should be tuned preferably to a station coming in from 20 to 50 on the dial. Do not, however, attempt to make this adjustment until every other possible source of trouble has been carefully checked.

Speaker Adjustment.

Very weak reception will result if the speaker is enough out of adjustment to allow the armature to rest against the pole pieces. A broken joint in the

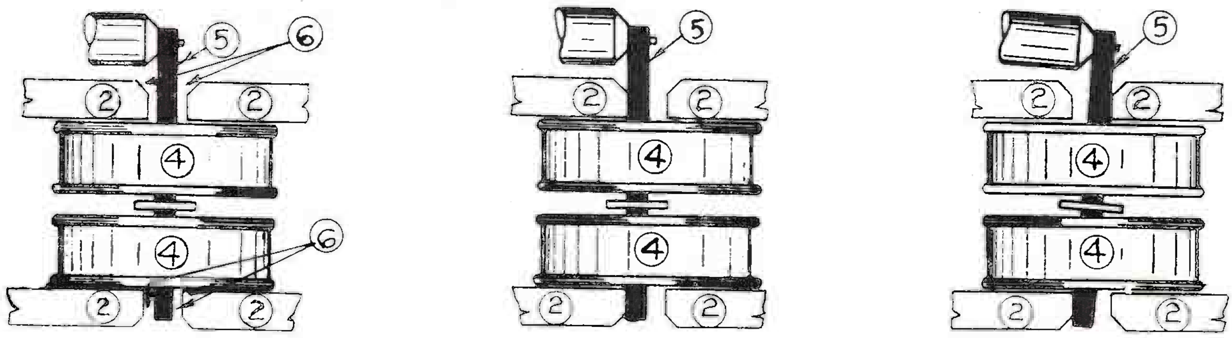


FIG.182

linkage between the armature and the actuating pin will produce the same effect. Fig. 182 shows correct armature position for no signal condition.

Chassis Defects.

Poor reception may be caused by certain defects in the chassis which can best be located by checking socket voltages with the set analyzer as outlined under "General Test."

NO RECEPTION

No. "A" Voltage.

This condition is obviously indicated by the fact that the tubes and dial light do not light. Battery switch defective. Battery cable open.

Open "B" Connection.

Measure "B" voltages and inspect the "B" connection as outlined under "General Test."

Defective Tubes.

Inspect the tubes for burn-outs or poor contact in the socket. Test the tubes as previously explained under the heading "General Test."

Speaker.

Check the loud speaker on another set or touch its terminals across a radio "C" battery. A click indicates that the speaker is not "open."

Defect in Chassis.

See "General Test" for method of completely checking chassis circuits.

POOR TONE QUALITY

Low or Open "B" Battery.

When "B" batteries are allowed to drop below 35 volts per unit before being replaced there is likelihood of poor tone resulting, accompanied sometimes by a slight whistle. Check voltages as outlined under "General Test."

Defective Tubes.

A defective tube, particularly in the detector or audio stage, will cause very poor tone. This condition can be checked by means of the set analyzer or by substituting tubes known to be good.

Speaker Out of Adjustment.

Rattles in the speaker are caused by loose parts or by the armature striking the pole pieces. Refer to the section on the "Loud Speaker."

Defect in Chassis.

There are certain defects in the chassis which may cause poor tone. Open "C" bias resistors will cause weak and distorted reception. Use the set analyzer to check all socket voltages as outlined under "General Test."

NOISE OR INTERFERENCE

Defective Tube or Socket.

Poor welds or loose elements in the tubes themselves may cause intermittent noise due to the vibration of the car. Poor contact in the sockets will also produce the same result. To locate this trouble, remove the tube shield and jar the tubes vigorously while the set is operating. The defective socket or tube will immediately become apparent through the noise produced.

Loose Connection in Radio Installation.

A loose connection or partial "Ground" in the radio installation will cause irregular interference and noise. The trouble can best be located by inspecting all wiring and connections, particularly at the capacitor plate and batteries.

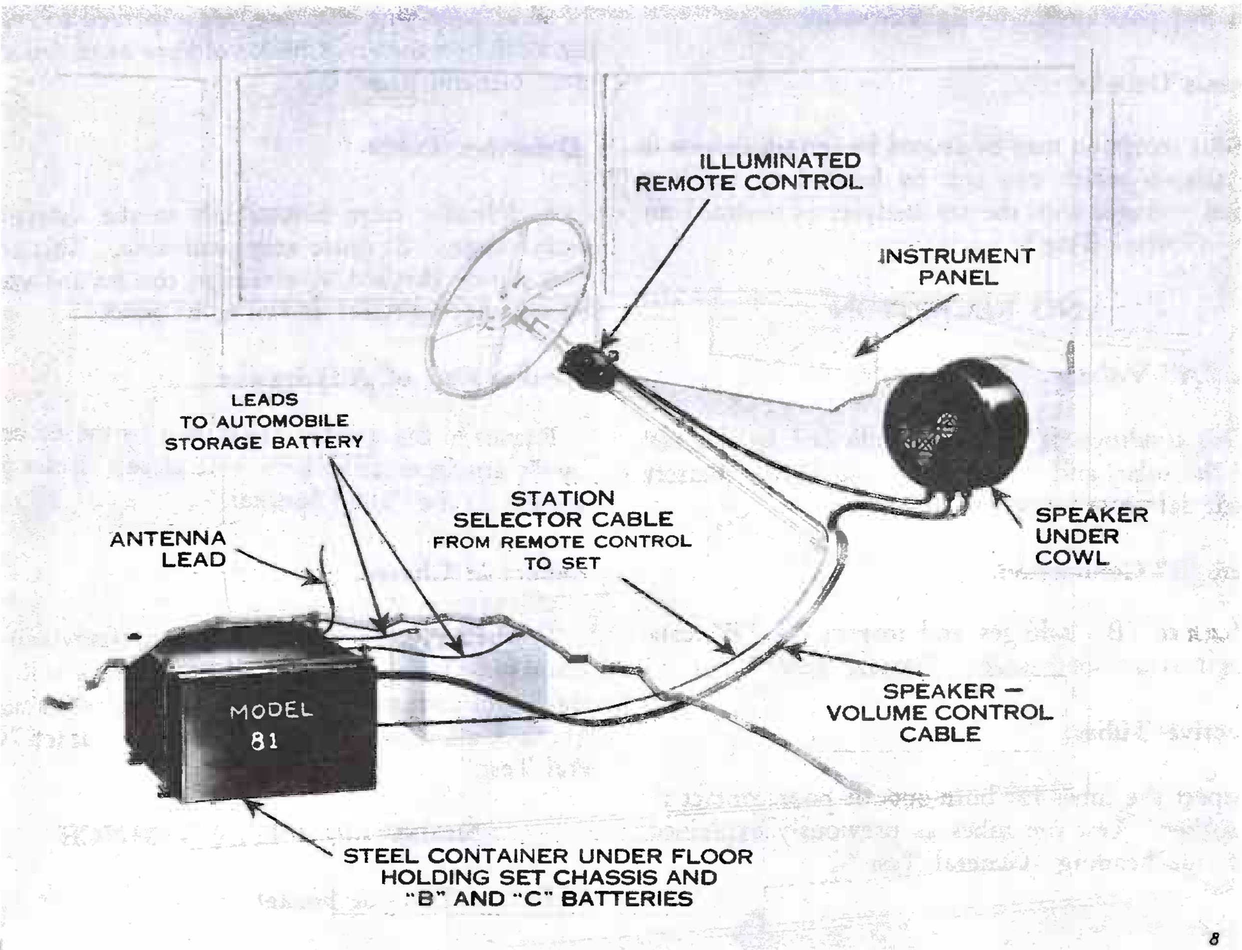
Ignition Interference.

This type of interference is a regular succession of popping noises, especially evident when the motor is idling. The resistance in the spark coil and spark plug leads, as already mentioned, will eliminate this interference except in special cases. As a remedy a 1.0 microfarad condenser may be connected from one of the ignition switch terminals to "ground" or from one of the low tension terminals of the ignition coil to "ground." The proper terminal is best determined by actual trial.

Generator Interference.

A one microfarad condenser connected from the generator terminal to "ground" will eliminate ordinary generator interference. A dirty commutator or worn brushes may cause an excessive amount of interference which can only be eliminated by repairing the generator.

Acknowledgement and thanks are hereby expressed to the following for their kind permission to publish in whole or in part material from their files:
Automobile Radio Corp., N. Y.
Transitone Corp. (Philco)
United American Bosch Corp.



The new Atwater Kent automobile receiver can be easily installed in any automobile. It has a specially developed tuned radio frequency circuit employing seven tubes, with push-pull amplification, one bank of three condensers, automatic volume control, illuminated remote control, and a large-size improved electro-dynamic speaker.

SOUND PICTURES AND THE SERVICEMAN

TRAINED men capable of servicing "Talkie" equipment are finding this field a profitable one. The larger manufacturers of this type of equipment maintain large service organization for the theater owners and, of course, prefer to have their units serviced by their own men. Many small houses use less costly equipment and, of course, furnish their own service. This is the best point of attack for the independent service man. In many small cities, one man services all the theaters. Some theater owners "chip in" and employ a man to service two or more theaters, thus reducing their individual service expense.

The following paragraphs offer a brief explanation of the principles involved in the recording and reproduction of sound and a general discussion covering the troubles encountered in servicing the equipment. No attempt has been made to make this section anything more than an outline, because space will not permit the inclusion of everything that could be said on the subject.

Sound.

Sound may be considered as a series of vibrations of the air of such frequency or pitch, that it creates the sensation of hearing to the human ear. When the air is set in motion by any means whatsoever sound is produced, provided that the frequency of the vibrations are audible. An interesting chart is shown in Fig. 183 indicating the frequency range of various sounds and noises and their relation to the musical notes of the piano for comparison.

Sound Recording On Film by the Variable Density Method.

There are two methods in common use in recording the sound on the film. The method called "variable density" recording has the entire sound track exposed, and the amount of light passed through it is varied by regulating the amount of exposure. The voice or sound causes a variation of the electric current flowing in the microphone circuit. These variations are magnified by the amplifier and operate a shutter or "light valve" in the recorder to permit more or less light to fall on the sound track.

For each electrical impulse the shutter will open in proportion to the strength of the impulse and then close. This results in a series of lines entirely

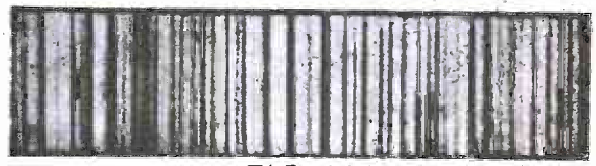


FIG. 184 A

across the sound track, the darkness of the lines corresponding to the volume of the recorded sound and the number of lines per inch corresponding to the pitch. This system is used by the Western Electric Co. and its licensees. Fig. 184A is an example of this method of recording.

Sound Recording on Film by the Variable Area Method.

In this method of recording, the electrical vibrations from the amplifier are changed into correspond-

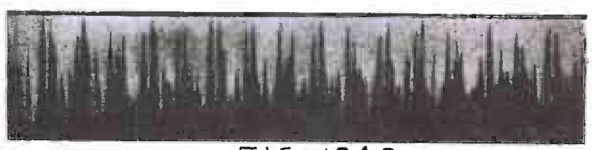


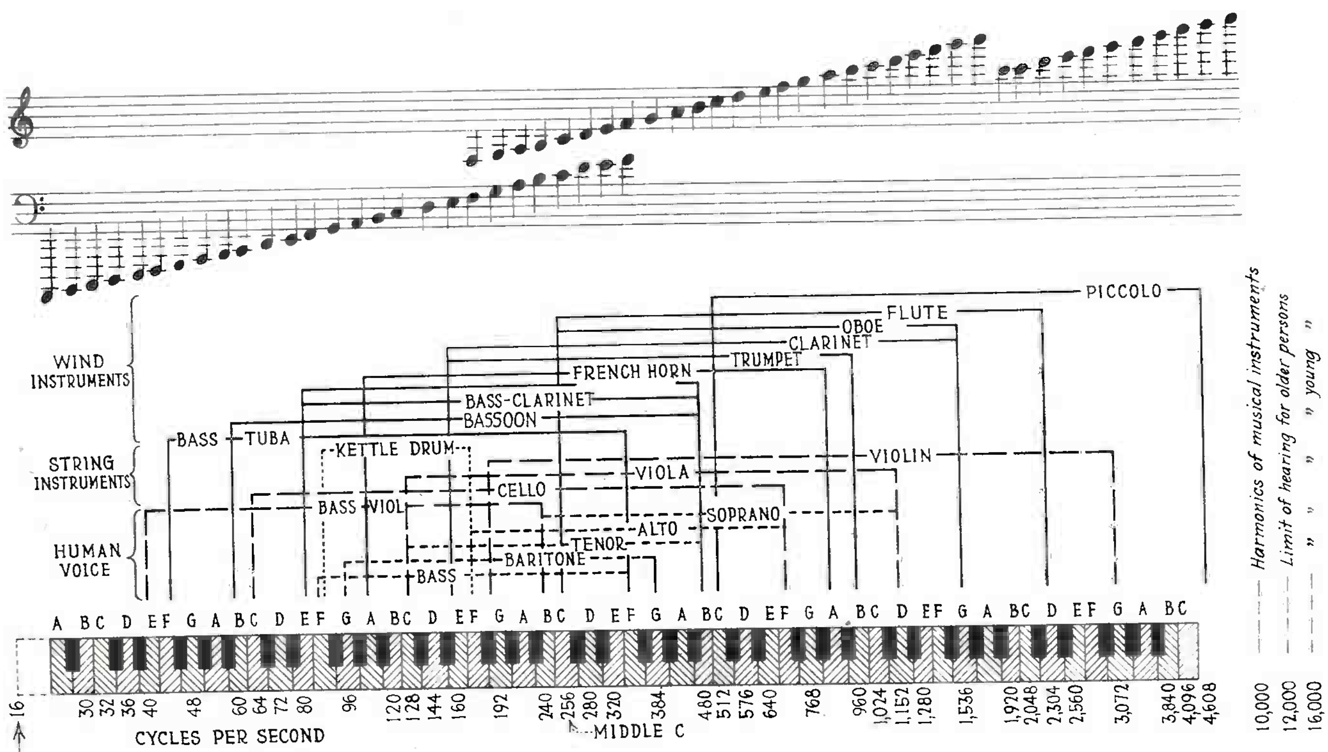
FIG. 184 B

ing variations in the movement of a narrow beam of light focused on the sound track of the unexposed film as the film moves past the recording optical system.

This sound track appears as a series of dips and peaks, the height of the peaks corresponding to the loudness of the sound recorded and the number of peaks per inch corresponding to the pitch. The peaks will be of the same darkness (that of completely exposed film) and will pass the minimum

Electronics' Chart of

Sound Frequency Characteristics



Point at which sense of feeling begins, before sense of hearing

WIRE TRANSMISSION CIRCUITS

Television wire circuit (20 to 18,000 cycles per second)
Highest-class wire line for broadcasting (50 to 8,000)
Ordinary wire circuit for broadcasting (50 to 5,000)
Ordinary telephone talking circuit (250 to 2,750)
Trans-oceanic telephonic cable (300 to 2,500)
Standard telephone instrument (300 to 1,800)
Early telephone lines (500 to 1,800)

Door squeak

RADIO BROADCASTING AND RECEPTION

Modern broadcasting transmitter (30 to 7,500)
Broadcasting station transmitting chain program (90 to 5,000)
High-quality radio set (50 to 5,500)
Obsolete or poor radio set (256 to 2,200)

Chirp of insects

SOUND REPRODUCERS

Public-address system (60 to 5,500)
Dynamic loud-speaker (40 to 5,500)
Exponential loud-speaker (70 to 5,500)
Electro-magnetic pickup (60 to 5,500)

SOUND RECORDINGS FOR RADIO AND FILMS

Highest type electrical trancriptions for radio ("Hill & dale" cut) 30 to 10,000)
Sound-picture film sound track recording (0 to 8,500)
Sound-picture disc record 33⅓ r.p.m., lateral cut (60 to 6,000)

HOME PHONOGRAPHS

Modern electric recorded home phonograph (60 to 5,000)
Recent acoustic phonograph (90 to 4,500)
Old fashioned phonograph (256 to 3,000)
Office dictating machines (350 to 2,000)

MISCELLANEOUS

Niagara Falls 40 to 50

Thunder 20 to 40

Distant gunfire

60-cycle A.C.

Average man's speaking voice Av. 128

Average woman's speaking voice Av. 256

amount of light. It will be noted that the amount of light passing through the sound track will depend upon the area of the unexposed portion. Fig. 184B.

"AEO" Light Recording.

Another system of recording is used by Fox Movietone. In this system, the electrical pulsations from the amplifier are used to vary the brilliancy of a lamp instead of opening and closing a "light valve." The lamp used for this purpose is called an "AEO" light.

General Requirements for Good Reproduction from Film Recordings.

We have seen that the aim, in all types of recording on film, is to create a photographic record in the form of a narrow sound track which would vary the amount of light through it (from a steady source of illumination) in proportion to the sound pressures on the diaphragm of the microphone.

Sound reproduction from film recordings requires that the variations of the amount of light transmitted through the photographic record be accurately translated into sound. To accomplish this, a thin beam of intense light, the width of which is equal to the width of the sound track, is focused on the sound track. The varying light which passes through the sound track affects a sensitive photo-electric cell so as to cause a varying electric current to pass through it. In the RCA Photophone system, this varying current is passed through a transformer primary. The voltage generated in the secondary of the transformer is amplified in the vacuum tube amplifier, the output of which is used to operate loud-speakers.

The Western Electric Co. feeds the output of the photo-electric cell into an amplifier unit mounted in the same compartment with the cell; the output of this so-called "head amplifier" being fed to the voltage amplifiers, power amplifiers, and then to the speakers.

The source of the light (exciter lamp) which shines through the film must be steady, that is, there must be no fluctuations in the amount of light. The beam of light must be nearly as thin as the beam used in recording, and exactly as wide as the sound track. The beam should not be more than 0.001 of an inch thick and should be exactly 0.084 of an inch wide.

The speed of the film passing the light beam must be the same as the film speed of recording and must be absolutely constant. Variations in speed would cause variations of pitch which would be recognized as "wows." This speed is 90 ft. per minute.

Reproduction from Variable Density and Variable Area Recordings.

Although the sound tracks of the variable area and variable density recordings do not look alike, the variations of the light transmitted through them are the same. Reproducing equipment which is suitable for reproducing from one type of recording is equally capable of reproducing from the other. All producers of standard sound recordings on film use the same width of sound track, and use a light beam of approximately the same thickness.

Exciter Lamps.

These lamps should not be operated at a higher current than that for which they are rated. As the lamp becomes old a dark coating inside the lamp materially decreases its efficiency. For this reason exciter lamps should not be used until burned out, but should be replaced when the coating reduces the efficiency of the lamp to a point where satisfactory results cannot be obtained when the lamp is drawing its rated current. The exciter lamp is illustrated in Fig. 185.

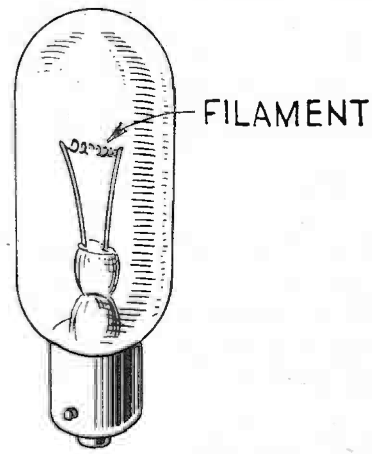


FIG. 185

Photo-Electric Cells.

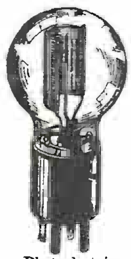
A photo-electric cell is a device which varies in electrical resistance in proportion to the amount of light falling upon it. Therefore, a varying amount of light falling on its internal elements will cause a varying current in the external circuit. A standard photo-electric cell is shown in Fig. 186.

VACUUM TUBES

In many of the sound systems, standard tubes such as '24, '27, '50, '80, and '81 tubes are used. These tubes are covered in the section of this manual devoted to "Vacuum Tubes and Their Operation."

AMPLIFIERS

In general, the amplifiers used in "talkie" systems are divided into two classifications. The output stage is termed the "power amplifier" as it furnishes the power to operate the speakers. The preceding stages are termed the "voltage amplifiers." Some models combine these two sections into one unit being entirely self-contained and A.C. operated.



Photoelectric Caesium Type cell.

TROUBLES IN SOUND SYSTEMS

Even with the best of care, troubles can develop which require immediate attention and correction. It is important that the operator or service man be ready to meet them with a definite idea as to what is to be done.

The troubles which may be experienced with sound reproducing equipments depend upon the type of equipment used. These are discussed in this section and more detailed discussion of troubles for a particular type equipment can be found in the instruction book which is sent along with the apparatus.

Probably the most common of the troubles experienced are those which are due to "slip-ups" in operation. It is important to check over the operating procedure before looking elsewhere.

If the trouble is not due to a "slip-up" in operation, then the portion of the equipment causing the trouble should be isolated by systematic tests. The instruction books sent out with equipment should be studied and the service man should familiarize himself with the individual peculiarities of the equipment.

When the fault has been discovered, it is usually a fairly simple matter to remedy the condition. The more probable causes of trouble in the various portions of the equipment are discussed in the manufacturers' service books.

Checking for Errors in Operation.

If no sound is obtained when starting, or when "changing-over" from one projector to the other, check for any of the following errors:

(a) Switches or other controls set incorrectly anywhere in the equipment or in its power supply circuits. (While checking the controls of the amplifier, inspect the tubes of the voltage and power amplifiers to see that they are all lighted.)

(b) Fader switch set for the wrong projector, or fader set in the "Off" position or for the wrong projector.

(c) Loud speakers not plugged in at the stage. (If "no sound" is due to the stage speakers being disconnected, sound can still be heard at the monitor speaker.)

If in checking over the routine operation no error is noted, the trouble is probably due to some defective part, and the next thing to be done is to isolate that defective part.

Systematic Tests for Locating a Defective Part.

Usually the most effective method of locating a defective part is by determining to what extent the equipment is still operative. If no sound is obtained from the photo-cell circuit of one projector, the other projector should be "faded in" and tested. If sound can be obtained from one projector and not from the other, the indication is that the defect may be in the fader circuit or in the sound head from which no sound can be obtained.

If it is found that sound cannot be obtained from either projector, the indication is that the trouble is in the amplifier equipment. If a non-synchronous phonograph attachment is available, the amplifier can be checked by plugging the non-synchronous phonograph input plug into the jack provided, and listening for sound while tapping the pick-up needle of the phonograph. If sound can be obtained from the non-synchronous phonograph and not from the projectors, the indication is that the amplifiers are O.K. and the defect is in the fader photo-cell units.

If no sound can be obtained from either of the projectors or from the non-synchronous phonograph, the indication is that the trouble is in the amplifier rack equipment or in its power supply circuit

No Sound From the Stage Speaker.

In case no sound is obtained at the stage and the sound is O.K. at the monitor speaker, the trouble must be somewhere in the line leading from the amplifier rack to the stage speakers.

Low Volume.

Low volume when using sound-on-film may be due to any of the following:—incorrect exciter lamp current, dirty or old exciter lamp, exciter lamp out of focus, sound gate aperture partly clogged, a defective photo-cell, or defective tubes.

Unequal Volume from Projectors.

If unequal volume is obtained from the two projectors when using sound film, the projector giving the lowest volume should be checked for trouble. If no cause is found for low volume the output of the projectors should be balanced by following the directions in the manufacturers' service sheets furnished with the equipment.

Poor Quality.

Poor quality of sound from sound film may be due to any of the following causes:—poor sound film, dirty sound gate, dirty film, dirty constant speed sprocket, a defective photo-cell, an out-of-focus optical system, or defective tubes.

Poor quality of sound is often blamed on the equipment when the fault is in the film itself. On the other hand, dirt on the film or on the sound gate will ruin the quality of sound from a good recording.

A defective photo-cell can spoil the quality of the reproduced sound.

A photo-cell can be spoiled by misuse. It is important that the photo-cell should not be exposed to strong light at any time, whether the polarizing voltage is applied or not. They should be handled gently and not jarred. When no film is in the projector, the circle of light from the exciter lamp can be seen on the photo-cell. This circle should be located at the exact center of the plate of the photo-cell. Dirty prongs on the photo-cell may also cause trouble. These can be readily cleaned with fine sandpaper.

Exciter Lamps.

It is very important that the adjustment of the exciter lamps be checked by the projectionist before beginning the show at least once a day, as a loss of volume will be the result of any defect in their adjustment.

Exciter lamps should not be used after they have become excessively dark, but should be replaced.

All finger marks should be wiped off the lamp immediately. If the lamp becomes hot while greasy finger marks are upon it, the marks will be hard to remove later. The condensing lens on the optical system should be kept clean at all times.

The socket in which the exciter lamp is mounted should not be allowed to become loose. If the exciter lamp is loose it will be difficult, if not impossible, to keep the exciter lamp focused during the operation of the machine.

Amplifier Tubes Fail to Light.

If some of the voltage or power tubes fail to light while others in the same unit do light, the indication is that the unlighted tubes are burned out, and should be replaced; but if none of the tubes of a unit light when the amplifier is turned on, the indication is that the fuse is burned out or that there is something at fault in the power supply feeding the amplifier unit. As soon as it is noticed that none of the tubes light, the equipment should be turned off and all fuses and circuits checked.

Noise and "Motorboating."

Noise and "motorboating" when using sound film may be due to any of the following reasons:

Poor ground connections on the projectors. Clean and tighten.

Optical systems out of adjustment in such a way that the light ray passes through the sprocket holes of the film, or through the frame lines of the picture.

Guide rollers out of adjustment. The guide rollers in the sound gate should rotate freely. There should not be side play in the outside roller, but it should not bind on the gate shoe. If the guide roller is loose or out of position, the film will weave in and out through the gate, thereby causing "flutter" or "film noise," and the reproduction will be poor.

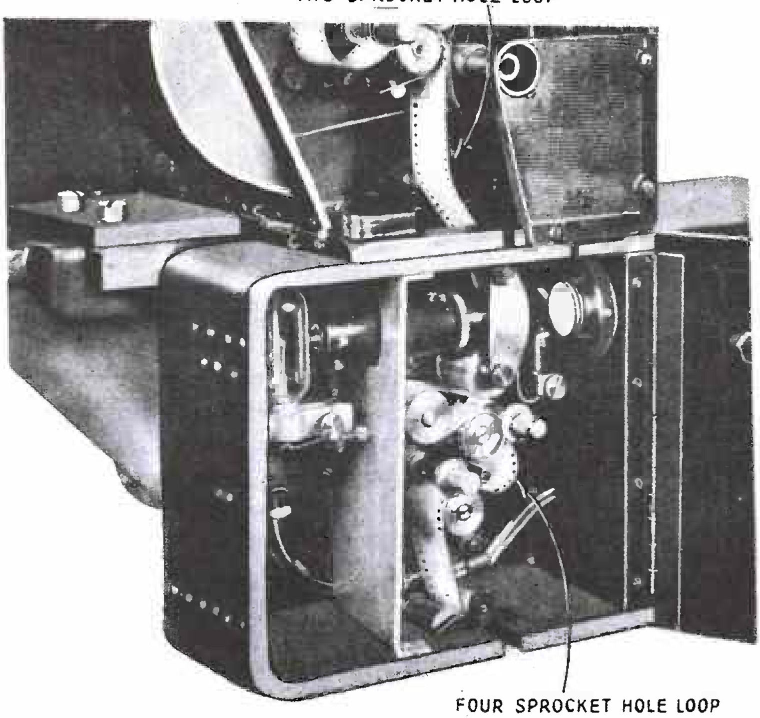
"Putting" noise in amplifier. In cases where the amplifier "motorboats" it is necessary to check over the tubes, and if batteries are used test them, because as the batteries age, they generally offer a common path of high impedance to the various tube circuits.

Reverberation and Its Elimination.

Reverberation can be stated as the persistence of sound in an enclosed space. When a sound wave is created in an enclosed room and strikes one of the walls, part of the sound is reflected, part transmitted, and part absorbed. It will be noted that an echo is simply a sound wave which is reflected back to the ear after the original impulse has died out. If two sounds strike the ear with a shorter period of time than one-tenth of a second, the ear cannot recognize them as separate sounds. As sound travels 1100 feet per second, we cannot receive an echo from an object that is closer than about 55 feet.

If a hall or auditorium uses hard materials for the floors, walls and ceilings, and the distance which the sound travels is less than 55 feet, the repeated reflections from the various surfaces bound back on the original sound and interfere with it to such an extent that a condition called reverberation is brought about resulting in "garbled" speech and music. The cure for this condition is to cover the floors, walls, and perhaps the ceiling, with some material capable of absorbing the excess sound that is represented by reflection.

One way to do this is to break the reflecting surfaces up into small sections so that the sound reflections by colliding with each other, will waste their energy and quickly die out. This is done in modern theater design. In old buildings, the established practice is to line the walls with sound absorbing material, using as much material as is necessary to reduce the period of reverberation to a satisfactory value.



Film side of PS-16 sound head RCA Photophone, Inc.

the tubes light, the equipment should be turned off and all fuses and circuits checked.

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Reverberation Time.

Professor Wallace C. Sabine found that a definite relation exists between the time of reverberation in seconds (t), the volume of the room in cubic feet (V), and the absorbing effect of the various materials present per square foot (A).

$$t = \frac{0.05V}{A}$$

Sound-Absorbing Coefficients for Pitch 512

Material	Coefficient per sq. ft.
Open Window	1.00
Acoustex 1 in. thick	0.37
Balsam Wool, bare, 1 in. thick, 0.26 lb. per sq. ft.	0.44
Brick wall	0.032
Brick wall, painted	0.017
Carpet, unlined	0.15
Carpet, lined	0.20
Carpet, with ½ in. Ozite hairfelt	0.25
Celotex, unperforated, 7/16 in. thick	0.20
Acousti-Celotex, type BB, painted or unpainted	0.70
Cork tile	0.03
Curtains in heavy folds	0.40-0
Flaxlinum Acoustic Tile, ½ in. thick, with wooden casing and metal screen	0.42
Glass (single thickness)	0.027
Hairfelt, bare, 1 in. thick, 0.75 lb. per sq. ft.	0.58
Oil painting, per sq. ft.	0.28
Linoleum	0.03
Marble	0.01
Plaster on wood lath	0.034
Plaster on metal lath	0.033
Plaster on tile	0.025
Sabinite Acoustical Plaster	0.21
Stage opening, depending on stage furnishings	0.25-0.40
Ventilators	0.75
Wood, plain	0.06
Wood, varnished	0.03
Adult person	4.7
Plain wood seats	0.15
Church pews, per seat	0.2
Seat cushions, per seat	1.00-2.00
Opera chairs.	
(a) plywood seat and back, no upholstery	0.24
(b) padded seat and back, covered with pantasote (imitation leather)	1.6
(c) various paddings, covered with velour or mohair	2.3-3.5
Piano	.6
Table	.2

Trade Name	Fire	Thickness	Coeff. per sq. ft.
Acousta-Zenitherm	Inflammable	1¼″	.33
Acoustex	Fireproof	1″	.54
Acousti-Celotex B	Inflammable	¾″	.43
Acousti-Celotex BB	Inflammable	1¼″	.63
Acousti-Celotex C	Inflammable	⅜″	.28
Acoustile	Inflammable	¾″	.37
Acoustolic	Inflammable	½″	.37
Akoustolith	Fireproof	½″	.29
Akoustolith Sound Abs. Stone	Fireproof	1″	.32
Ambler Plaster	Fireproof	¼″	.08
Asbestos Akoustikos Felt	Flameproof	½″	.31
		¾″	.45
		1″	.59
		1½″	.73
		2″	.79
		3″	.79
Balsam Wool	Flameproof	1″	.56
		½″	.41
Blast Hair Blanket	Inflammable	2″	.76
Celotex Building Board	Inflammable	7/16″	.22
Corkoustic	Inflammable	1″	.30
		1½″	.32
		2″	.35
Flaxlinum	Inflammable	½″	.34
		1″	.61
Gimco Acoustic Flexfelt	Fireproof	1″	.56
		1½″	.61
Insulite Building Board	Inflammable	½″	.30
Macoustic Plaster	Fireproof	½″	.08
Masonite Building Board	Inflammable	7/16″	.28
Nashkote A Perforated	Flameproof	½″	.43
		¾″	.53
		1″	.67
Nashkote AX	Flameproof	½″	.34
		¾″	.38
		1″	.43
Nashkote A-1-S, A-C-S	Flameproof	½″	.31
		¾″	.38
		1″	.46
Nashkote B-045	Flameproof	½″	.39
		¾″	.49
		1″	.64
Nashkote F	Flameproof	½″	.35
		¾″	.49
		1″	.65
		1½″	.72
		2″	.76
		3″	.77
Nashkote O-M-C	Flameproof	½″	.34
		¾″	.47
		1″	.67
Nashtile	Inflammable	¾″	.38
Nephi	Fireproof	¾″	.16
No-Echo Acoustical Tiles	Fireproof	⅞″	.35
Ozite Carpet Cushion	Inflammable	¼″	.13
		⅜″	.17
		½″	.20
		¾″	.28
Penn Acoustic Felt	Inflammable	½″	.31
Sabinite Plaster	Fireproof	½″	.29
Sanacoustic Tile	Fireproof	1¼″	.71
Spray-Acoustic	Flameproof	½″	.45
		¾″	.61
		1″	.70
U. S. G. Acoustical Tile	Fireproof	½″	.47
		¾″	.56
		1″	.61
Westfelt	Flameproof	¼″	.19
		½″	.32

Acceptable Limits of Reverberation.

The figures given in the table are not to be regarded as absolute. Many rooms have values which exceed these mentioned in either direction by tenths of a second but are still satisfactory acoustically.

VOLUME OF ROOM IN CU. FT.	ACCEPTABLE REVERBERATION TIME IN SECONDS	
	Half audience	Full audience
10,000	0.9-1.2	0.6-0.8
25,000	1.0-1.3	0.8-1.1
50,000	1.2-1.5	0.9-1.3
100,000	1.5-1.8	1.2-1.5
200,000	1.8-2.0	1.4-1.7
400,000	2.1-2.3	1.7-2.0
600,000	2.3-2.6	1.8-2.2
800,000	2.5-2.8	1.9-2.3
1,000,000	2.6-2.9	2.1-2.5

Sabine's formula can be rearranged so that it states that the absorption units required to reduce reverberation to a certain period are equal to 0.05 times the cubic feet volume of the room divided by the reverberation period; thus simplifying the mathematics necessary for the proper selection of absorbing materials.

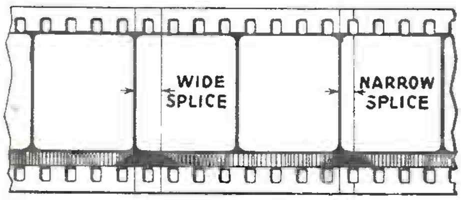


FIG. 187A

Phasing Speakers.

In installations using more than one speaker it is necessary that the movements of the voice-coils be in phase. This is accomplished by connecting a small 4.5-volt flashlight battery with a circuit-closing arrangement to the speaker voice-coil lines. One man should stand in front of the speakers and closely observe the motion of the cone on the speaker. Close the battery circuit and note the direction of motion of the cone. The cone will move either in or out from the starting position. Check all of the speakers, one at a time, noting the direction of movement of each.

If one of the speakers' voice coils moves in while another moves out, it is necessary to reverse the voice

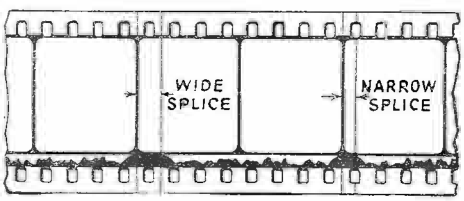
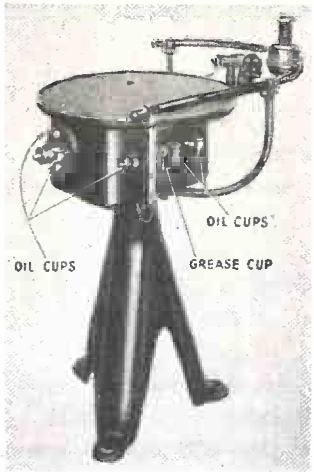


FIG. 187-B



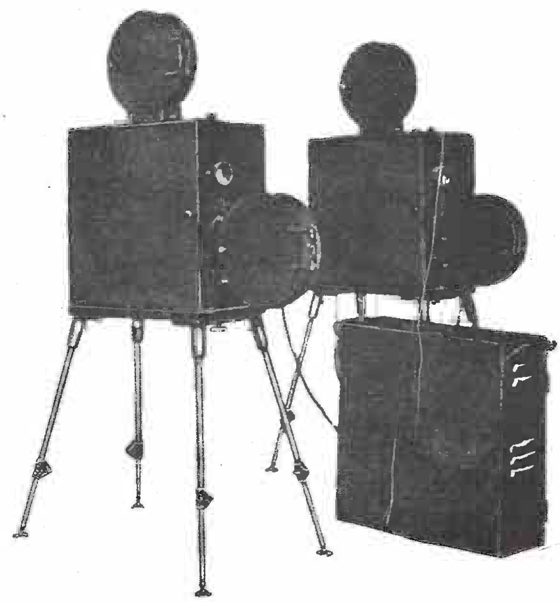
Type PT-7 synchronous turntable (Used in PG-10 equipments)

RCA Photophone, Inc.

coil connections of one of the speakers. All of the voice cones should move in or out in unison as the battery circuit is closed and opened.

Patching.

When a break occurs in a sound film it should be patched in the usual manner, but the sound track requires special treatment. The sound track should be painted as shown in Figs. 187A and B. Paint a half-moon over the sound track if the recording is variable area, and a blunt apex if the recording is variable density. Use Zapon concentrated Black Lacquer No. 2002-2.



The projectors and amplifier used with the PG-5 portable equipment

RCA Photophone, Inc.

ERECTING AERIAL AND INSTALLING SET

Although complex antenna systems have been used in transmission to good effect, it will be noted by those of you who reside in maritime ports that the big liners now employ a simple single wire antenna of heavy wire. Cages and fancy "gadgets" may present a pleasing appearance but add little to the collecting properties of the system.

The "doo-dads" and "gadgets" in various forms offered as "staticless" by certain advertisers have little merit save in locations where it is impossible to install a flat-top antenna of sizable proportions. Here these devices are sometimes able to give good accounts of themselves.

In installing the antenna it should be kept high and wide from all obstructions—particularly from structural steel formations. The "L" antenna shown in Fig. 188 is the usual type and although its directional properties are not pronounced, it is slightly more sensitive in the direction of the tap off. It is therefore, wasteful to tap off an "L" type antenna in the direction from which little of entertainment value can be expected.

How Long?

Many times the question is propounded—how long an antenna should be used? With the modern and highly sensitive receivers of today, the answer is to the effect that the antenna should be just as short as is compatible with the reception of distant signals. In rural districts where there are no locals to produce interference, a long antenna may be used to increase the sensitivity during daylight hours—for in many such localities, the nearest broadcaster may be a hundred or more miles away and a high degree of sensitivity is required if satisfactory daylight service is to be obtained.

The flat-top portion of the antenna may vary from twenty to a hundred feet in length, therefore, as a longer antenna might possibly result in upsetting the ganging of the tuned circuits.

The lead-in should run as directly to the receiver as possible. This lead wire should be kept clear of the building by at least six or eight inches. Unless the customer seriously objects, the receiver should be placed in such a manner as to make both the lead-in from the antenna and the ground lead as short as possible.

For the antenna itself, any good grade of antenna wire may be used although due care should be given to its tensile strength. Stranded phosphor-bronze wire has the best all-round characteristics and the enameled wire now on the market aids materially in reception as the enameled covering prevents oxidation of the wire and consequent increase in its radio frequency resistance.

In certain locations, the interference picked up by the down-lead running close to the building is great due to the presence of elevators and what-not in the building. In these locations a shielded wire may be used to advantage. This wire resembles BX cable on a diminutive scale and the sheathing should be grounded at the lightning arrester.

Contrary to belief in some circles, the lightning arrester is a decidedly important piece of apparatus. Not only is it necessary to use an arrester of high quality for the protection it affords, but for the assurance that the arrester will not short-circuit and cause a total loss of signals which condition is difficult to diagnose.

The arrester does not protect one materially from a direct stroke of lightning—neither does the antenna provide a hazard in this respect. The arrester does protect the set from the ravages of heavy static discharges such as may readily burn out the input coils of the receiver.

In some locations this occurs to every receiver at least once in its life-time. Arresters approved by the Underwriters are satisfactory for use and care should be taken that an approved model is employed.

In the country, it is possible to keep the arrester out of doors as shown in the figure, but in the city the best form of installation is the mere placement of the device across the antenna and ground leads at a point as near their entry to the house as possible. By all means, do not skimp on the lightning arrester as you may be held responsible for any damage to the receiver resulting from such neglect.

In cities, the ground may be a water pipe (preferably "cold") or a radiator—but by no means should a gas pipe be taken as the ground.

There are many forms of ground clamps for making this connection and much time may be saved in the installation of a receiver by using a clamp which is readily attached. In country districts, it is sometimes impossible to ground the receiver to a pipe and in these cases some sort of manufactured ground is necessary.

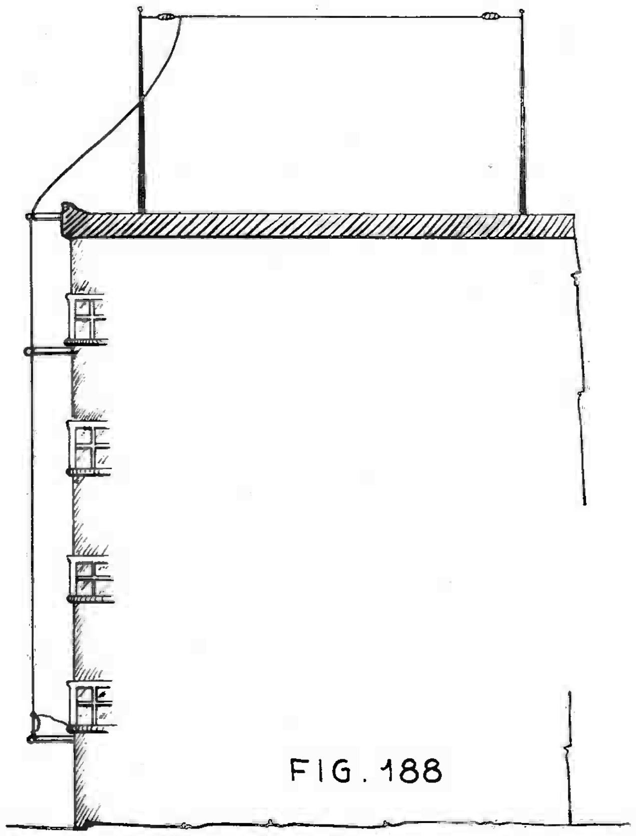


FIG. 188

The best manner of grounding the receiver in such locations is by digging a number of shallow trenches fan-wise under the antenna and burying wires in them. These wires may be as long or a bit longer than the antenna itself. An alternative method is to bury a bucket to which a connecting wire has been soldered, several feet in the moist earth. If the earth is naturally dry, some means should be provided for periodically moistening the surrounding earth.

A Good Ground Is Essential on Modern Receivers If Oscillation Is To Be Avoided.

The antenna lead-in and the lead-in from an external ground of the type just described may be by means of the familiar window strips. It is preferable that the connecting wires be soldered firmly to these strips and the joints taped. The interior wiring should be done with silk covered wire which matches the wood work as closely as possible. There is no excuse for a sloppy interior job and the customer has every right to kick if a job of this nature is turned out. In wiring the interior, care should be taken that the lead wire does not traverse the back of the receiver cabinet as undesirable coupling may result.

Bring the antenna and ground lead wires up to the receiver on the back side near the "A" and "G" terminal posts. This is usually on the left as we face the front of the receiver.

In installing a new receiver, make sure that all packing strips, etc., have been removed and that the receiver and speaker are bolted down securely in the cabinet. If cushions are provided to be placed under the receiver or speaker to avoid acoustic feed-back and howl, make sure that these are in place so that future trouble may be avoided.

Extraneous Noise.

In many cases it is found that noise cannot be eliminated by servicing the receiver. Noise may enter the home from outside via the electric light lines or through the antenna. In such cases, the only way in which you can check the source is to turn off—one after the other—all electrical apparatus in the near vicinity. First make sure that the noise is not due to a loose antenna connection or to some fault in the receiver which you have slipped over without recognizing it.

Where it is impossible to get at the source of the interference, a shielded antenna down-lead may be employed and an interference filter of one of the commercial types may be inserted in the power supply circuit. These may be obtained from most radio jobbing houses and are not economical to construct at home.

When the interference source can be located, it is possible that—in the case of motors, etc.—the trouble can be remedied by merely cleaning the brushes.

X-ray machines and other electro-medical apparatus rarely yield to any form of treatment.

If the trouble cannot be remedied through the servicing of the appliance in question, a filter system of large current-carrying capacity can be inserted between the interfering equipment and the supply line. Such apparatus is readily obtainable from many manufacturers who specialize in this class of equipment.

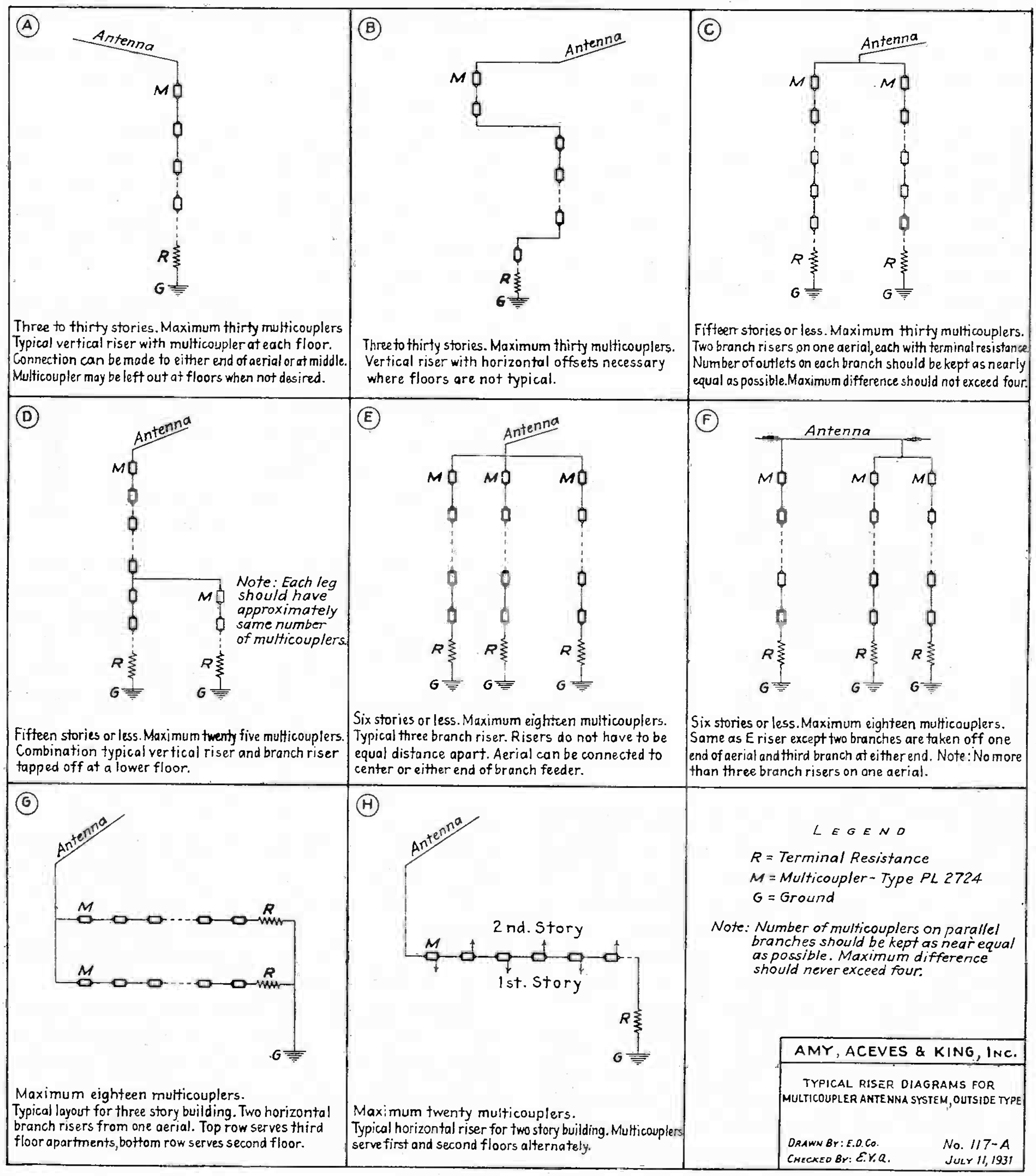
Where the interference is picked up in the antenna it may often be remedied by shielding the antenna down-lead. This is done by using lead-covered cable for the lead-in and grounding the lead casing at one or both ends. While this does not seem a particularly efficient form of coupling, it is in reality quite effective in achieving the desired end. When using a shielded lead-in of this type it is often necessary to increase the effective length of the antenna. This is due to the fact that the shielded lead-in is no longer an efficient collector of energy.

Some of the classes of equipment likely to cause interference are as follows:

Vacuum cleaners
Dial telephones
Electric sewing machines
Door bells
Motors of all kinds
Sign flashers
Traffic signals
Electric refrigerators
Oil burners
Electric fans
Electrically operated cash registers
Dental equipment
All types of electro-medical equipment

Defective power equipment—transformers, street lighting sockets, etc.—may cause bad interference to radio programs. In most instances, when such disturbances are suspected the power company in your community will be glad to aid in their solution.

TYPICAL RISER DIAGRAMS
for
MULTICOUPLER ANTENNA SYSTEM



(A) Three to thirty stories. Maximum thirty multicouplers. Typical vertical riser with multicoupler at each floor. Connection can be made to either end of aerial or at middle. Multicoupler may be left out at floors when not desired.

(B) Three to thirty stories. Maximum thirty multicouplers. Vertical riser with horizontal offsets necessary where floors are not typical.

(C) Fifteen stories or less. Maximum thirty multicouplers. Two branch risers on one aerial, each with terminal resistance. Number of outlets on each branch should be kept as nearly equal as possible. Maximum difference should not exceed four.

(D) Fifteen stories or less. Maximum twenty five multicouplers. Combination typical vertical riser and branch riser tapped off at a lower floor.

(E) Six stories or less. Maximum eighteen multicouplers. Typical three branch riser. Risers do not have to be equal distance apart. Aerial can be connected to center or either end of branch feeder.

(F) Six stories or less. Maximum eighteen multicouplers. Same as E riser except two branches are taken off one end of aerial and third branch at either end. Note: No more than three branch risers on one aerial.

(G) Maximum eighteen multicouplers. Typical layout for three story building. Two horizontal branch risers from one aerial. Top row serves third floor apartments, bottom row serves second floor.

(H) Maximum twenty multicouplers. Typical horizontal riser for two story building. Multicouplers serve first and second floors alternately.

ELECTROLYTIC CONDENSERS

A great majority of present day receivers employ the electrolytic type of filter condenser. These are obtainable with a dry electrolyte or with liquid. It is not the present writer's task to glorify the one at the expense of the other and we will leave all discussion of the relative merits to salesmen and the like.

While the majority of set analyzers provide for the measurement of condenser capacitance by means of the A.C. meters with which they are furnished, these tests hold good only for paper condensers. Bridge methods or other methods where A.C. is involved are also unsuited to measurements of the capacitance

of electrolytic condensers.

The only methods by which these measurements can be made involve the use of direct current and a rapid make and break switch—such as a rotating commutator. The writer doubts the advisability of such equipment for the service laboratory as the different units on the market are readily distinguishable as to capacitance and the sole tests of actual interest to the service technician are those of operation.

The dielectric in an electrolytic condenser consists of a thin film on the surface of the plates and, under certain conditions, this film will break down—conditions not always due to excessive voltage. The leakage current through an electrolytic condenser should not exceed 5 milliamperes per section of 8 microfarads—this permits of a leakage of 20 ma. for a 32 mf. section—at a terminal voltage of 350, the correct polarity being, of course, observed. Fig. 189 shows test circuit.

In measuring the leakage through a condenser, do not place the milliammeter directly in the circuit but allow it to be shunted by a relatively low resistance during the first period of operation gradually increasing the resistance across the meter until it is entirely removed from the circuit.

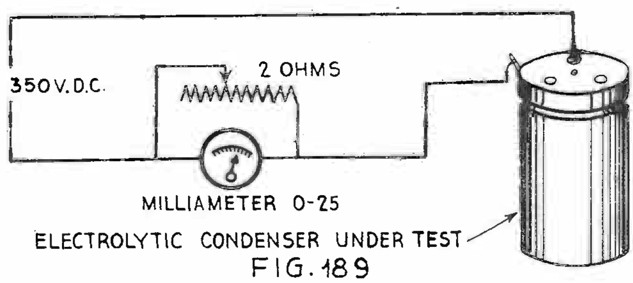


FIG. 189

After a long period of inoperation, an electrolytic unit will be found to have a greatly increased leakage. To "form" the plates, the condenser should be left across a voltage almost equal to its maximum safe value for a period of from ten to fifteen minutes. At the end of this time the leakage will be reduced to its allowable value.

Electrolyte escaping from the vent due to breakdown should be wiped away as its presence across the terminals will greatly increase the leakage.

Electrolytic condensers begin to jell at about 29° F. and freeze solid at 18° F., but they will return to normal operation after a brief period at normal room temperature. This precludes the possibility of using electrolytic condensers in portable apparatus to be operated at low temperature in the open.

Re-forming of the condensers may be carried out in the receiver by removing all tubes but the rectifier and allowing the receiver to run idle in this condition for a short period of time—any excess hum due to de-forming of the condenser plates will be found to have disappeared after about 15 minutes of such operation.

A MODULATED TEST OSCILLATOR

The oscillator shown in Fig. 190 employs a separate oscillating tube for modulation. The frequency of modulation may be altered by adjusting the value of the capacitance across the iron cored coil.

It is possible to shift from the broadcast range to the range between 115 and 200 kc. for lining up intermediate amplifiers in superheterodyne receivers by a single switching arrangement.

In calibrating the oscillator in the broadcast band, it is only necessary to tune in a number of broadcasters of known frequency; beating the output of the oscillator against the broadcast carrier gives an accurate knowledge of the frequency to which the oscillator is tuned. The oscillator is in tune with the incoming signal when the output of the radio set, which is used for the calibration, delivers a low-pitched growl along with the music. If the signal of the oscillator is high in pitch, then the oscillator is not in absolute resonance with the incoming signal.

In calibrating the low frequency range, a more difficult procedure is required. All oscillators are generators of harmonics of higher frequency than the basic carrier. Ours is no exception to this rule. The harmonics of various frequencies in this range are as follows:

Harmonic	200 kc.	175 kc.	150 kc.	120 kc.
2nd	400	350	300	240
3rd	600	525	450	360
4th	800	700	600	480
5th	1000	875	750	600
6th				720

Note that many of these values lie in the broadcast band.

The procedure in calibration is to hook up the oscillator operating in the low frequency range to the receiver through the dummy antenna described. With the oscillator condenser almost closed, it should be oscillating in the neighborhood of 120 kc. The sixth harmonic of 120 kc. is at 720 kc. and if we tone our receiver to this point and move the oscillator condenser slowly, we should find a weak signal when the oscillator passes through the 120 kc. mark. Mark the oscillator dial setting at this point and tune the receiver to 750 kc. which is the 5th harmonic of 150 kc. Repeat the first procedure and mark the oscillator setting as 150 kc. Check this reading by adjusting the receiver to 600 kc. where the 4th harmonic of 150 kc. should appear. If this is not in evidence, it is possible that your oscillator is not tuned to 150 kc. but to some other frequency of which 750 kc. is also a harmonic. If you get signals at 600,800, and 1000 kc., your oscillator is tuned to 200 kc. and you are getting the 3rd, 4th, and 5th harmonics, respectively. If you find a signal at 600 and 720 kc., you are tuned to 120 kc. and are picking up the 5th and 6th harmonics thereof. It is easy to identify the frequency to which you are tuned by calculating the intervals between the harmonics received. An extremely accurate calibration curve can be plotted in this manner if reasonable care is taken.

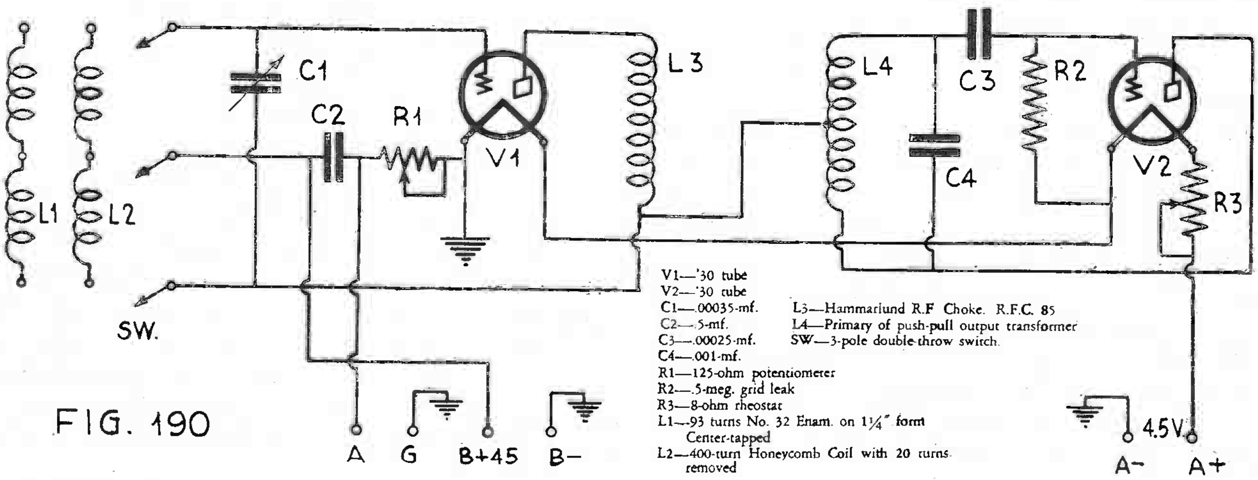


FIG. 190

V1—'30 tube
V2—'30 tube
C1—.00035-mf.
C2—.5-mf.
C3—.00025-mf.
C4—.001-mf.
R1—125-ohm potentiometer
R2—.5-meg. grid leak
R3—8-ohm rheostat
L1—93 turns No. 32 Enam. on 1¼" form Center-tapped
L2—400-turn Honeycomb Coil with 20 turns removed
L3—Hammarlund R.F Choke. R.F.C. 85
L4—Primary of push-pull output transformer
SW—3-pole double-throw switch.

POTENTIOMETERS

Many experimenters find some difficulty in applying potentiometer arrangements in radio circuits. Much has been written on the more complex theories of radio, but in most cases the practical application of potentiometers has been obscured in a mass of other explanations, it being assumed that potentiometers are so simple as to require no explanation.

The difficulty is that the mere buying of a unit labeled "potentiometer, so and so many ohms," is not all that is necessary. There is no mystery about a potentiometer as sold; it is only an electrical resistance with a tapping, or, if it is variable, it has a rotatable contact just the same as a filament rheostat, the only difference being the provision of an additional terminal to enable the resistance to be connected as a shunt across the circuit instead of two terminals for enabling the contact and part of the resistance to be connected in series in the circuit. Fig.

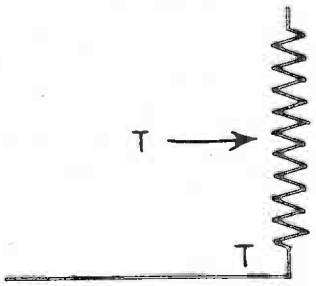


FIG. 191

191 illustrates a filament resistance and Fig. 192 illustrates a potentiometer, the terminals being marked T in each case.

Many service men fail to consider the effect of the resistance in the external circuit altogether, and as a consequence obtain results seemingly incongruous with theory. The division of potential calls for a particular electrical circuit and the potentiometer as sold is only a convenient unit for use in such a circuit; the circuit is of paramount importance.

All radio men know that potential is always dropped across an electrical resistance when current flows and the drop in voltage is dependent upon the resistance in accordance with Ohm's Law: $E = IR$; when E is the voltage, R the resistance, and I the current flowing.

If an electrical circuit is arranged as illustrated in Fig. 193, in which a resistance R is connected across the supply voltage, and if such resistance is divided

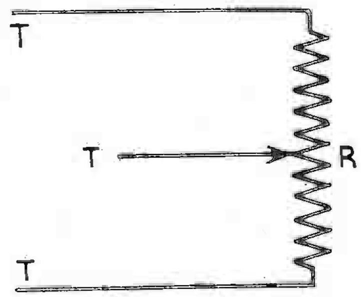


FIG. 192

into ten equal parts, so that the electrical resistance in ohms between the first contact and contact 1, is equal to the number of ohms between the contacts 1 and 2 and so on, then any proportion in tenths of the voltage between the positive and negative leads can be obtained by placing the arm B on a suitable con-

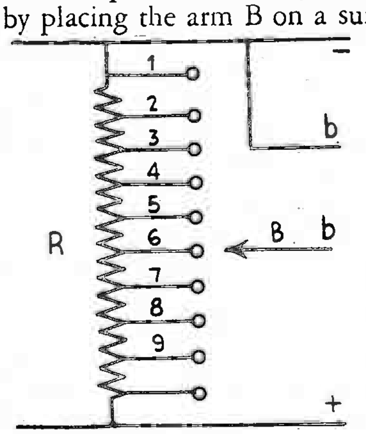


FIG. 193

tact provided no appreciable current flows through B. For example, if the potential difference between positive and negative is 10 volts, then the potential at stud 1 will be one volt, at stud 2 will be two volts, and so on if no current flows in the external circuit through B, that is to say, only a state of electrostatic tension occurs at b—b. This condition of affairs exists when variable grid bias is provided for by means of a potentiometer, and in such a case the potential values will be substantially the obvious division of the potential, as all that is required is an electrostatic condition. The circuit of Fig. 194 shows a common application of this. In this arrangement the value of R has no bearing on the potential and a value can be selected to economize in current flow. The same condition exists when a potentiometer is used in leaky grid detectors.

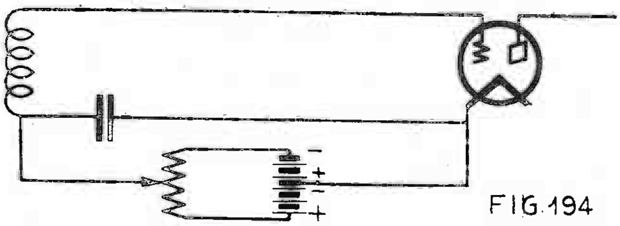


FIG.194

When a current flows in the external circuit then the conditions are altered and the values of the potential at the contacts 1, 2, etc., are quite different. Fig. 195 illustrates diagrammatically the new conditions in the circuit; here r represents the electrical resistance in the external circuit, and owing to the flow of current through r, the potential at the stud 5 will

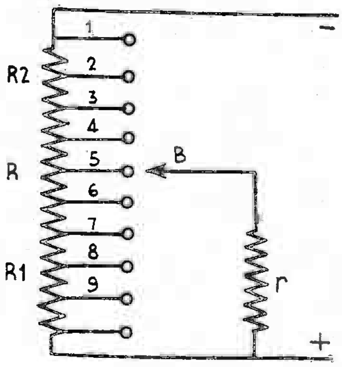


FIG.195

not be half the potential difference across the positive and negative mains. It will be seen that r and the portion R_1 of the resistance R are in parallel, and the equivalent resistance will be

$$\frac{R_1 \times r}{R_1 + r}$$

Incidentally, the value of the resistance across the positive and negative has changed from R to

$$R_2 + \frac{R_1 \times r}{R_1 + r}$$

but that is by the way. Fig. 196 exhibits a family of curves showing how the value of the potential across r varies when the value of r changes. In these graphs, the potential difference across positive and negative has been taken as E=100 volts, and the resistance of R is 1000 ohms. Consider the tapping at R_2=500 ohms, when r is infinitely great then the voltage Er is 50; when r is 1000 ohms the voltage Er is 40; when r is 300 ohms the voltage Er is about 27; when r is 100 ohms, the voltage Er is about 13, and when r is only 50 ohms, then the voltage Er falls to about 8. From the above it will be clear that if a drop of 50 volts is required across r for some reason, it will be useless to use the tapping R_2=500 ohms regardless of the value of r.

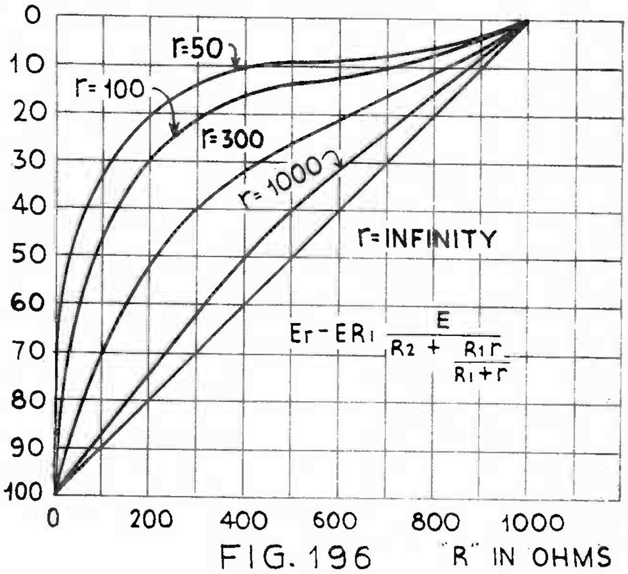


FIG. 196

This is of great importance today especially when we use a portion of the voltage divider to furnish the biasing potentials for the new variable-mu tubes as indicated in Fig. 197.

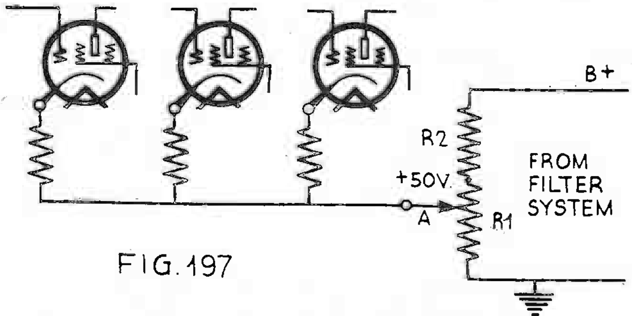


FIG.197

The points to be considered in calculating the value of the resistance R1 are as follows:

What voltage drop is necessary? How much current will flow through the resistor? What should the watts rating of the resistor be?

When the contact A is turned to B—the current through the resistor is the bleed current consumed by R_1 and R_2. The bias on the tubes being furnished by the resistors in the cathode leads. If the contact A is moved up to the point +50 then the currents from the plate and screen circuits of the tubes have to flow through the resistor R1 as well as the current consumed by R_1 and R_2. To be sure, the current which flows in resistor R1 will always be the bleed current consumed by the resistors but as the arm A moves up it increases the value of the negative bias on the grids of the tube which in turn causes an increase in the voltages applied to the plates of the tubes due to the decrease in plate current caused by the additional grid bias. Thus the current through the resistor R1 should be so large that the addition of the currents flowing through the arm A will be but

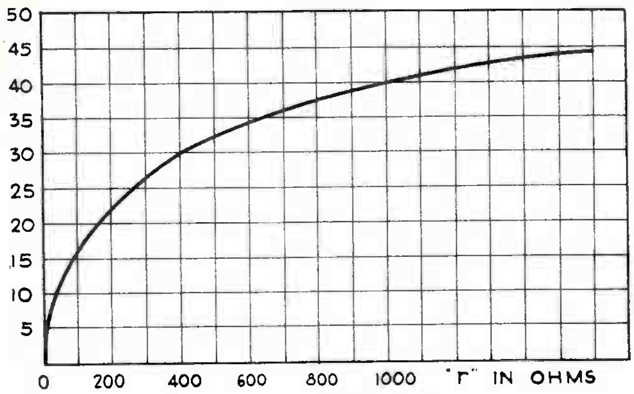
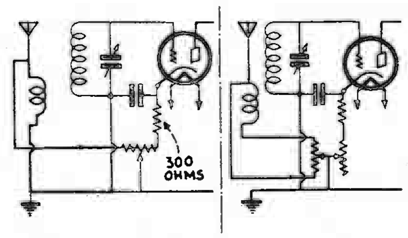
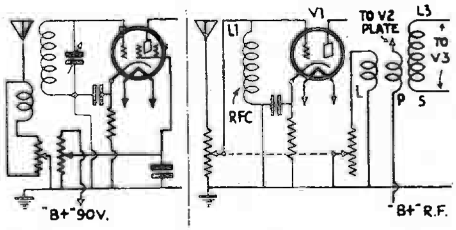


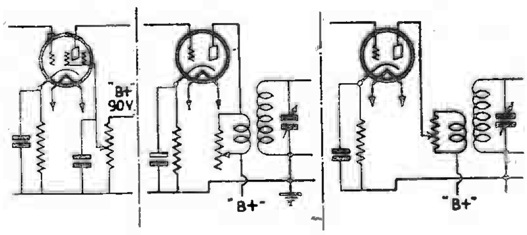
FIG. 198

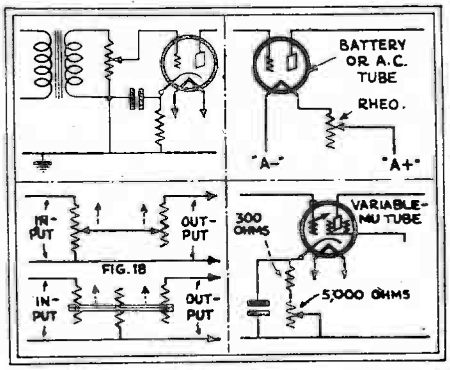
a small portion of the total current in R1 so that the volume control will operate smoothly without jumps or drops in the volume level as the arm is turned.

Many failures are due to no other cause than lack of proper appreciation of the conditions and values in the external circuit. Fig. 198 shows how the voltage across r varies with the value of r assuming R=1000 ohms and E is 100 volts, the tapping located so that $R_1 = R_2 = 500$ ohms.

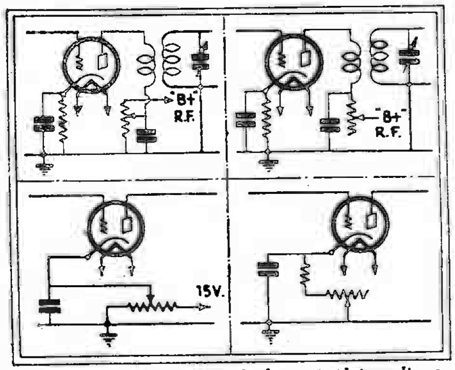




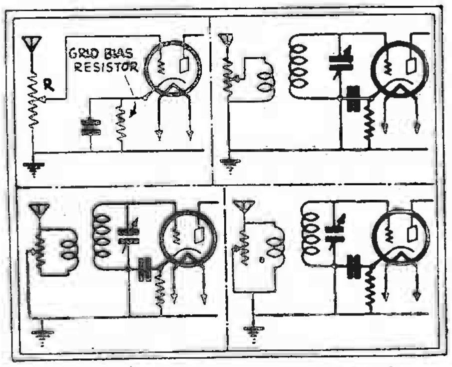




Above, old methods of volume control; below, two of the latest systems.



Above, potentiometer and rheostat plate-voltage control. Below, potentiometer and rheostat control of cathode bias. The fixed resistance sets a minimum negative bias.



Four types of antenna volume control.

R.M.A. COLOR CODE

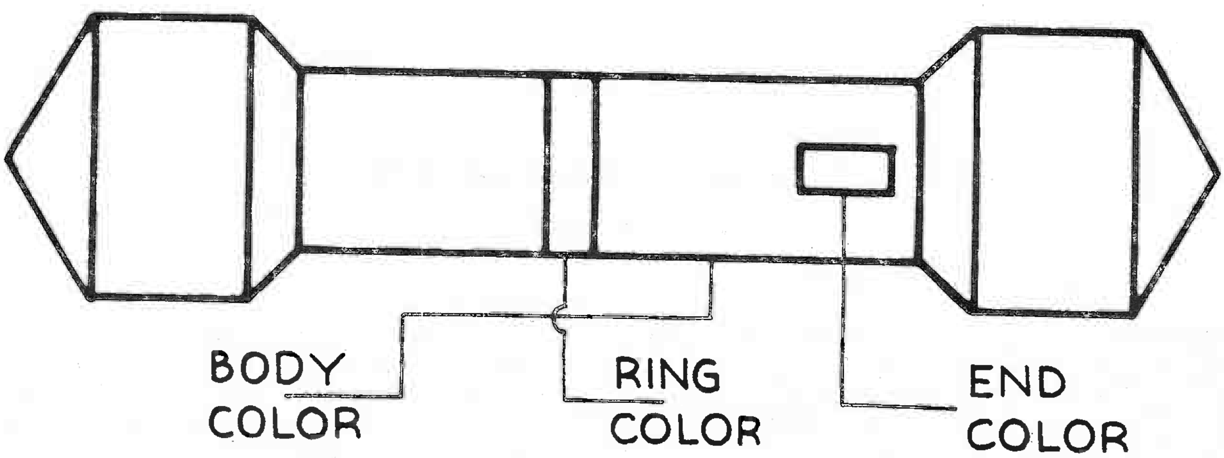


FIG. 199

Body Color indicates first significant figure.
End Color indicates second significant figure.
Band Color indicates third significant figure.

Body Color		*End Color*	
1	brown	0	black
2	red	1	brown
3	orange	2	red
4	yellow	3	orange
5	green	4	yellow
6	blue	5	green
7	violet	6	blue
8	gray	7	violet
9	white	8	gray
0	black	9	white

Band Color	
.0	black
0.	brown
00.	red
000.	orange
0000.	yellow
00000.	green
000000.	blue

For example, a Resistor has a blue body, a yellow end color and a red band color. What is the resistance in ohms? Answer, 6400 ohms. Fig. 199 shows position of identifying colors and bands. (*Courtesy International Resistance Co.*)

BALLAST RESISTOR CALCULATION

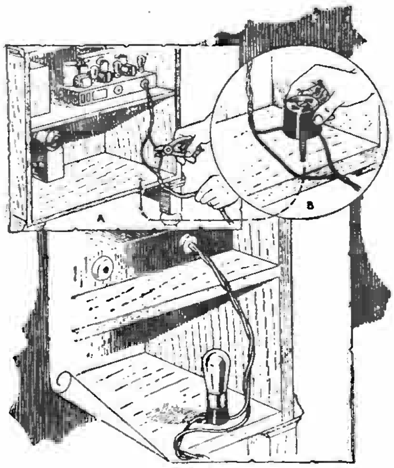
HOW TO DETERMINE THE PROPER AMPERITE

The service man is often called upon to install a voltage regulating device but is at a loss as to the proper type to use. The following tables cover practically every combination of current drains which can exist and it surely is a time saver.

Tubes of the '24, '26, '27, and '35 class, consume approximately 5 watts of the power line load.

Output tubes such as the '45 and '47 consume approximately 30 watts—6 times that of the tubes mentioned above.

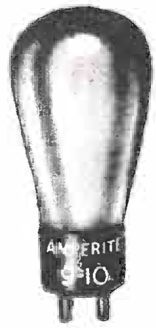
Thus, the output tube practically determines the wattage of the set and the proper Amperite for any 110-120 volt A.C. set can be approximated from the following chart:

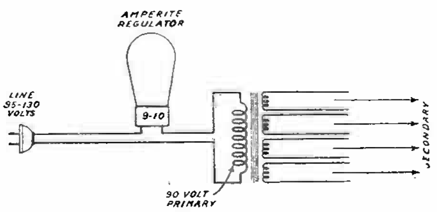


Output tubes in set	Total No. in set	Use Amperite
2-'45's (or Pent)	7 to 10	9-A-5
1-'45 "	5 to 8	7-A-5
1-'45 "	3 and 4	5-A-5
1 or 2-'12A ('71A)	6 to 9	7-A-5
1 210	6 to 8	9-A-5
2 250	7 to 10	9-A-5 (use 2)

When operating, the Amperite will get warm. It should not operate above a very dull red glow. If the Amperite burns higher than a dull red glow—use the next larger size, e.g., if 7-A-5 is too bright, use 8-A-5, etc.

Some sets are wound with a special 90-volt primary and require an Amperite of -10 or -20 series as e.g.





Victor R-32, R-52, RE-45	10-V-10
Victor R-35, R-39, R-57	9-V-10
General Electric 31, 51, 71	9-V-10
Radiola 80, 82, 86	9-V-10
Westinghouse WR-5, WR-6, WR-7	9-V-10
Peerless models 21 to 25	11-20
Kylectron K-71, K-72	11-20
Hi-Q 30	11-20
Brunswick 14, 21, 31	9-20
Silver Marshall, 20, 20-B, 60, 75, 95	10-25
Special mounting adapter used on	9-V-10
Special mounting adapter used on	10-V-10

REPLACEMENT CONDENSER NOTES

The service man is at a loss as to the proper value of a fixed condenser which, when burnt out, has to be replaced in order that the set will be operative.

Of course, if the circuits of the receiver are available and the value of the condenser is marked on the diagram, it is a simple matter to obtain a condenser of the same value and mechanical size and substitute it for the defective unit. Sadly enough, this information is never at hand when it is desired.

Modern radio receivers are so designed today that each tube must work at the greatest possible efficiency, thus any change in the electrical values may seriously affect the operation of the receiver.

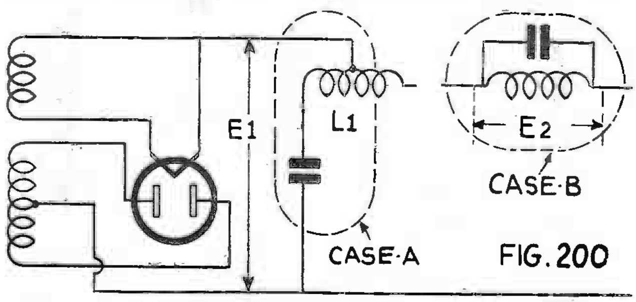


FIG. 200

Some manufacturers use filter systems as shown in Fig. 200, and, due to the resonant condition which exists in circuits of this type, condensers are known to puncture, placing a short on the rectifier in case A and shorting the filter choke in case B with a large increase in the hum output.

If the value of the condenser is not known, it is a difficult job to guess as to its capacity. If the inductance of the choke is known, and that means with the normal current consumed by the set flowing through the choke, the value of the condenser can be found. This applies to case B, as the current flowing through L1 in case A is not a direct current but a pulsating one and large currents appear only at the resonant frequency. The resonant frequency for full-wave operation would be at 120 cycles and for half-wave, 60 cycles.

For those interested in the solution of problems of this kind, the procedure noted in the following can be used. The first thing that should be known is the LC constant which is derived from the equation below.

$$LC = \frac{1}{4\pi^2 f^2}$$

$$LC = \frac{25300}{f^2}$$

$$LC = \frac{25300}{60\,(\text{Cycles})^2} = 7.02+$$

$$LC = \frac{25300}{120\,(\text{Cycles})^2} = 1.7+$$

Thus we find that the LC constant for 60 and 120 cycles is respectively 7.02 and 1.7. That is, the product of the capacity and the inductance will determine the resonant frequency. If the capacity is known, the inductance can be determined by simple division; for example, the capacity is .2 mf., what inductance is necessary for resonance at L1 for 60 cycles? for 120 cycles?

$$L = \frac{7.02}{.2\text{-MF.}} = 35.1\ \text{h. Approx.}$$

$$L = \frac{1.7}{.2\text{-MF.}} = 8.5\ \text{h. Approx.}$$

$$X_C = \frac{1{,}000{,}000}{6.28 \times 120 \times .2} = 6635\ \Omega$$

$$X_L = 6.28 \times 120 \times 8.5 = 6405\ \Omega$$

The best way from the service angle to find the proper value of capacity is by actual test, the value of capacity which permits of the least amount of hum in the speaker being the value to be used as the replacement unit.

UNCASED REPLACEMENT CONDENSER

The replacement capacity should be rated at a much greater voltage than the apparent voltage in the circuit. This will be noticed when the fact that voltages which appear across the condenser can be greater than the applied voltage as shown below. Fig. 201 shows the circuit in case A reduced to its simple form.

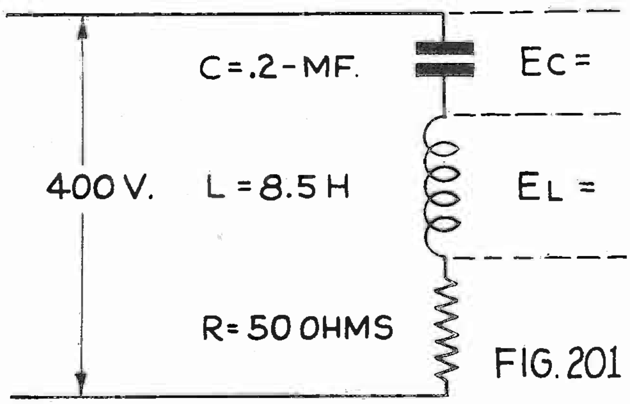


FIG. 201

Therefore, care must be exercised not only in selecting the condenser of the right capacity but, as shown in the above example, the voltage rating of the substituted condenser must be such that it can be used without danger of break down. A 1500-volt working voltage type condenser should be used in this case.

$$Z = \sqrt{50^2 + (X_L - X_C)^2} = 236\ \Omega$$

$$i = \frac{E}{Z} = \frac{400}{254} = 1.7 \text{ Amps.}$$

$$E_C = i \times X_C = 1125 \text{ V.+}$$

$$E_L = i \times X_L = 1090 \text{ V.+}$$

When filter condensers are used in so-called brute-force filters, the danger of resonant conditions is more or less minimized due to the fact that resonance generally appears below 60 cycles and the individual units have a comparatively high impedance at 60 to 120 cycles. The voltage rating of the capacity should be such as to be greater than the peak value of the voltage output of the transformer which is 1.4 times the value indicated on the transformer data plate.

The selection of capacity values for use in audio frequency amplifiers can be simplified a great deal by making the reactance of the condenser about one-tenth the reactance of the choke or resistor which is in the circuit and which the condenser is supposed to

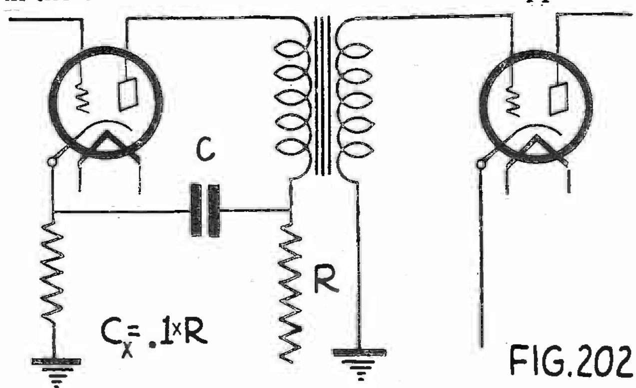


FIG. 202

by-pass. The reactance of the condenser employed should be of the required value at the lowest audio frequency which the amplifier will pass. Fig. 202 is an example of this type circuit.

The average value of condenser used in circuits of this type is one mf. or larger.

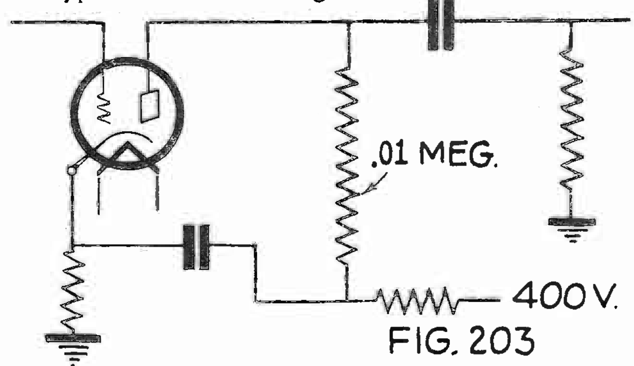
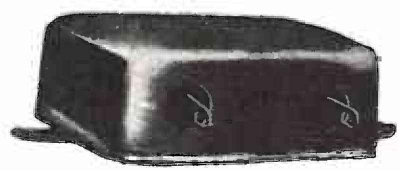


FIG. 203

Radio frequency circuits, due to the fact that the reactance of a condenser is extremely low at the higher frequencies, will not have as great a value as at audio frequencies. This results in a cost and space saving condition but does not mean that the value of the voltage appearing across the condenser can be ignored. The majority of receiver manufac-



SHIELDED BY-PASS CONDENSER

A. M. FLECHTHEIM & CO., INC.

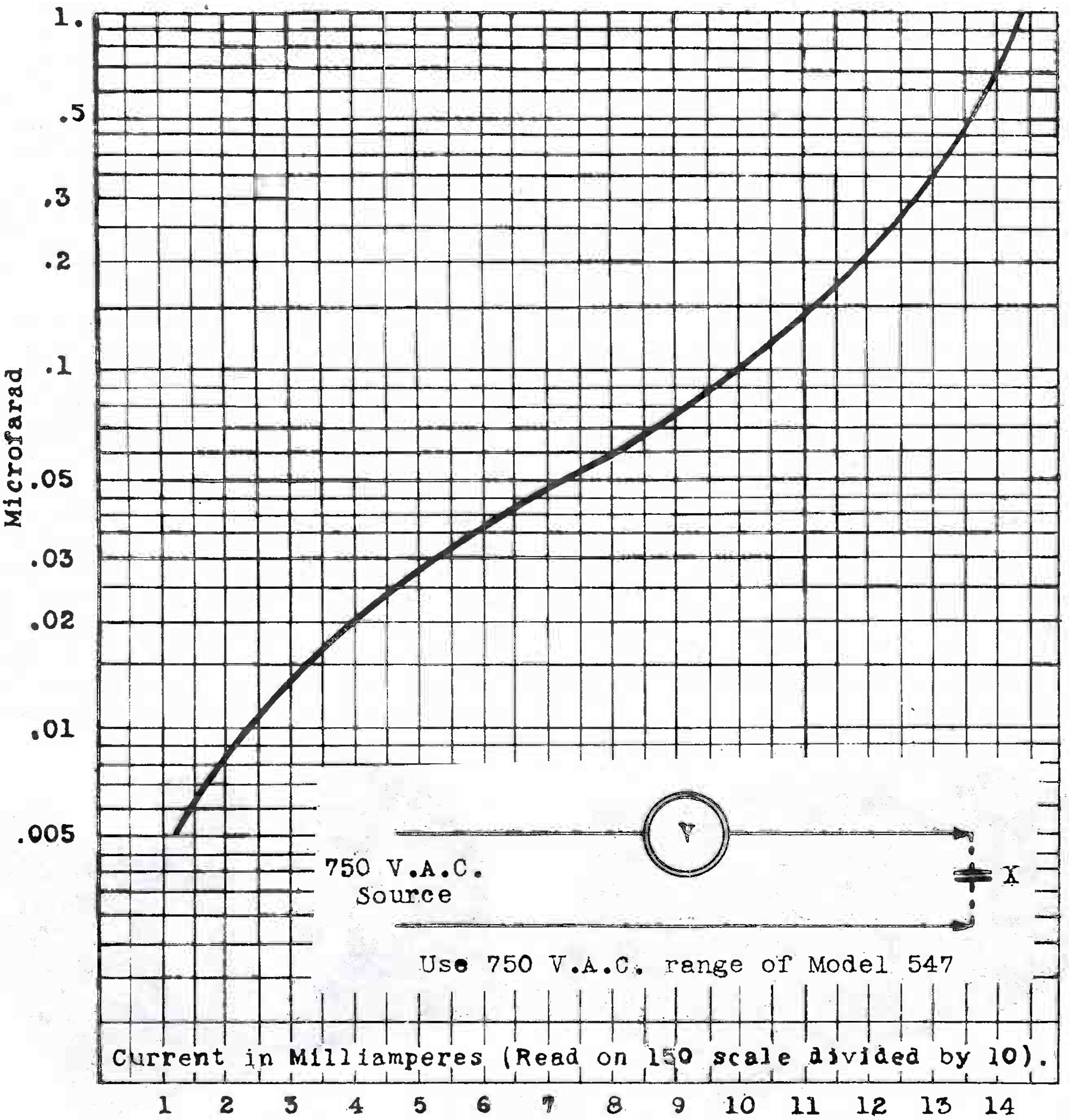
turers use .1-mf. condensers as by-pass units and, in most cases, this value is satisfactory for radio frequency replacement work.

In cases where the condenser is used as part of an isolator circuit a ratio of ten to one as stated above should be used.

Many condensers are used in circuits as shown in C_1, Fig. 203; in this case, until the tube warms up, the total voltage will be applied across the condenser and after the tube heats to the normal operating condition, we find that the voltage has dropped across the condenser due to the voltage drop across the resistor. The condenser should be rated at the voltage which will appear across the condenser while the tube is heating. In this circuit the voltage rating of the condenser should be at least 400 volts.

In the final analysis, the substitution of a condenser should be made with the idea of using one of the specified value if such information is obtainable. When in doubt, try several and replace with the value which gives the best results and be sure that the condenser is rated above the voltage requirements of the circuit.

To Measure Small Capacities With Weston Model 547 Set Tester

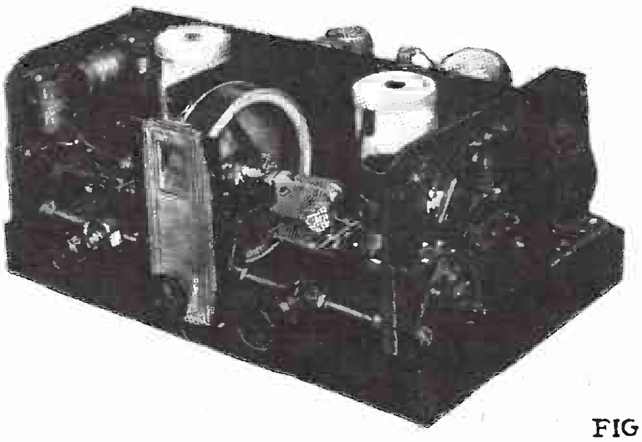


SHORT-WAVE RECEIVERS AND CONVERTERS

IN the belief that a continued and increasing interest in the short waves and their entertainment value prevails throughout the industry, the editors have included in this Manual a large number of short-wave and all-wave receivers and the schematic circuits of many of the converters available on the market. The technician will note that a great many different forms of design are presented. Within the past year, marked advances have been made in the way of the complete elimination of plug-in coils. This has presented a serious problem and the manufacturers who have succeeded in this work are to be congratulated on their technical aptitude as well as upon their commercial acumen.

Perhaps a few notes on short-wave reception—on what may and what may not be expected—would be in order. It is true that, with very simple equipment, it is possible to receive foreign transmitters at great distances. It is also true—alas and alack—that the short waves suffer greatly from astronomical and meteorological conditions from which the broadcast band is quite free.

The radio wave as emitted from the transmitter consists in the main of two components—the ground wave and the sky wave. The ground wave in the broadcast bands is apparent at a considerable distance from the transmitter—but the sky wave continues onward for a much farther distance. As the waves become shorter, the distance at which the ground wave is apparent decreases, and even at short distances from the transmitter, the sky wave is predominant. But the real difficulty now enters into the picture. High above the earth is an ionized layer or barrier from which these waves are reflected—the angle of reflection being dependent upon the frequency of the wave. This results in a phenomenon known as "skip-distance"—the wave receivable close to the transmitter may not be found to be receivable again until a point many miles from the transmitter is reached. The height of this layer above the earth is at all times changing—its height and density being dependent upon the time of day or night, upon the season of the year, and upon certain astronomical and meteorological conditions as yet



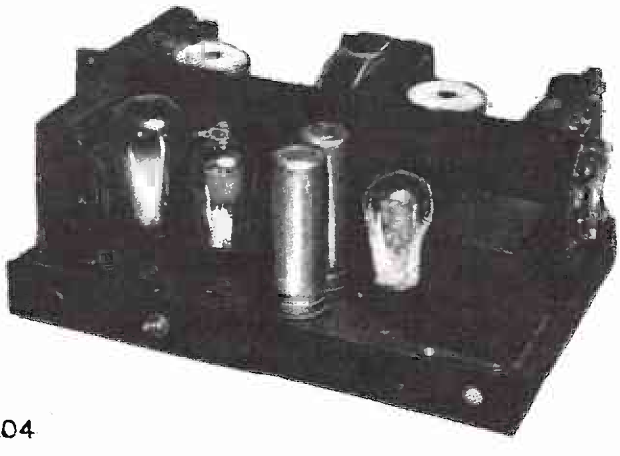


FIG 204

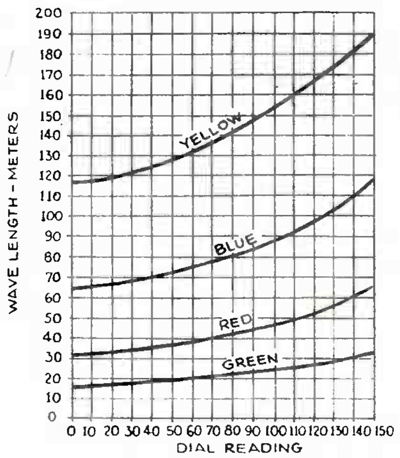


FIG. 205

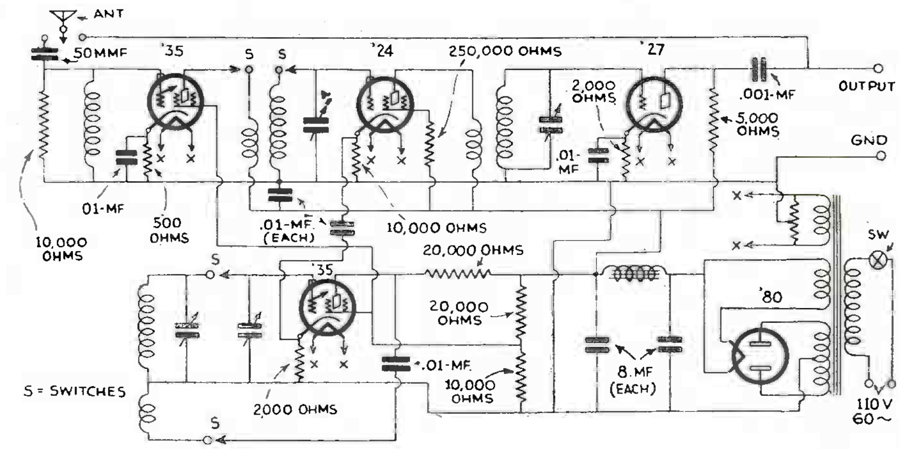


FIG. 206

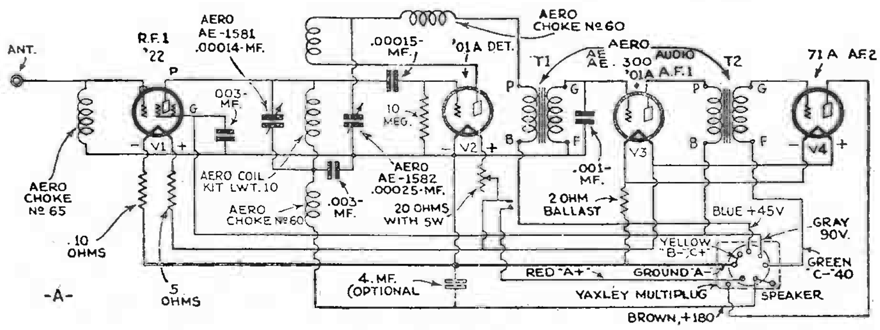


FIG. 207 A

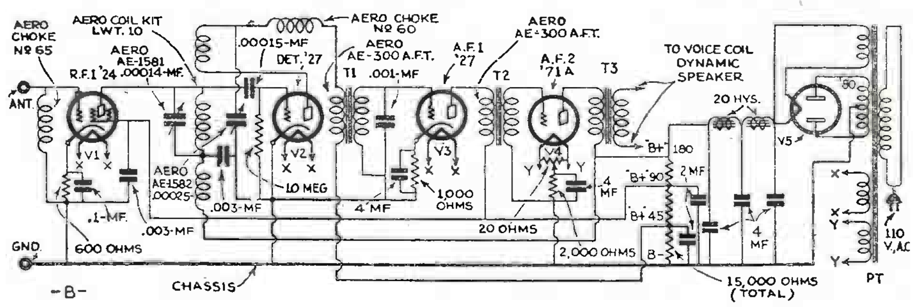


FIG. 207 B

not pronounceable in elementary terms. This results in a condition which is not entirely unsatisfactory where point to point communication is concerned, but which is a decided detriment to short-wave broadcasting. In point to point services, it is possible to use directional antennas which will pre-determine the angle at which the wave strikes the *Heaviside* layer and will, in a measure, control the effects of skip-distance. Even then, however, the frequency most favorable to laying down a strong signal in Buenos Aires tonight at eight o'clock will not be the frequency most favorable to the same tomorrow morning, and the engineers engaged in this development of trans-oceanic telephone services are at a loss to explain some of the phenomena encountered.

Thus, it may be seen that the reception of short-wave programs is not all a "bed of roses" and that one cannot expect to get foreign stations at all hours of the day and night. It is not our place here to give accurate data on these effects but merely to elucidate some of the problems encountered so that the service technician will be on his guard at all times and will not expect too much either for himself or for his customers. Many magazines—SHORT WAVE CRAFT for an example—carry much data on the reception of the short waves and on how and at what time they are best received. Another point of importance is that, in order to achieve success in short-wave reception, extreme patience is necessary—for with a one-tube regenerative short-wave receiver and a large supply of "stick-to-it-iveness" the "fan" can line up an incredible list of "stations

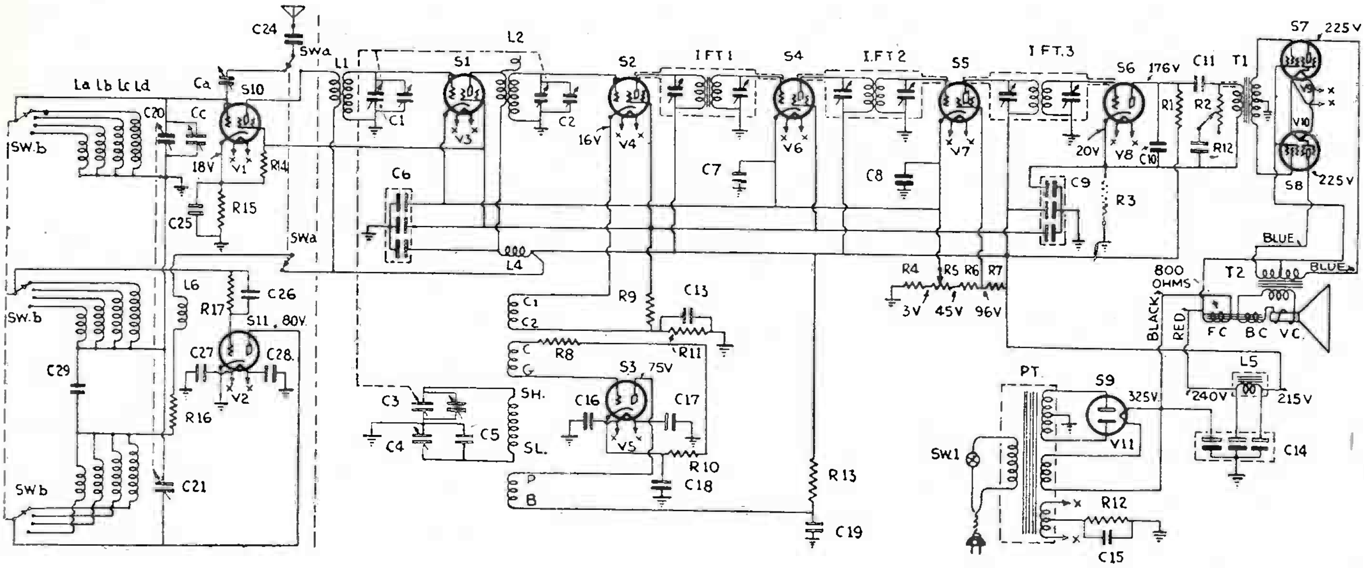


FIG. 208 SM 726 SW.

received."

The new short-wave receivers brought out for the present season are examples of the tendency to do away with plug-in coils. The picture of the latest National receiver shows the use of switches for changing from one band to another. The changes are made by the simple manipulation of the control knob mounted on the right, facing the set. The tuning chart in Fig. 205 shows how the various ranges are covered with the minimum of over-lapping.

The ease of tuning, wave-band coverage, simplicity of design, and A.C. operation make the latest developments in short-wave receivers appealing to the ordinary user of radio receivers and open a new avenue of profitable sales to the wide-awake service man.

The complete electrical circuit of the receiver with the values of the components is shown in Fig. 206.

One of the most popular receivers was the old Aero Short-Wave job, the circuit of which is shown in Fig. 207A. As so many letters have been received for information on an A.C. version of this receiver, the circuit is shown in Fig. 207B.

The present season has witnessed the introduction by practically all of the receiver manufacturers, of broadcast "super-het" models which can be readily converted into short-wave receivers by the addition of so-called converters, an example of which is shown in Fig. 208. Here the short waves are beat against the local oscillator V2 and the resultant output of the detector tube V1 is fed to the conventional input circuit of the super.

The characteristics of simplicity of control, lack of plug-in coils, and satisfactory sensitivity play an important part in the public acceptance of these receivers.

PUBLIC ADDRESS AND CENTRALIZED RADIO SYSTEMS

ALTHOUGH the amplifiers employed in Public Address and Centralized Radio Systems are not altogether different from those employed in commercial radio receivers, there are some interesting points regarding their operation which are worthy of mention. In the first place, it is probable that in all instances these amplifiers will be designed for use with microphone, radio or phonograph pick-up. These three services require widely different gain characteristics since the output of the microphone is far below that possibly obtainable from the output of the average detector tube, and still further below that obtained from a phonograph pick-up of standard design. It is necessary then that this fact be taken into account in the design of a system for such mutiple service if the minimum labor is to be involved in the change-over from one form of reproduction to the other. In the typical systems shown in Figs. 211 to 216, it will be seen that individual volume controls are employed in the input circuit of the amplifier so that the average levels may be adjusted in such a manner that, in the changing-over process, no great difference in the relative output volume will be observed.

Impedance Matching.

In all systems of this character, the impedance of various components should be matched by the use of appropriate transformers. While—as we have seen before—the maximum undistorted power output of a vacuum tube is achieved when the load impedance is twice that of the tube itself, the maximum quality and efficiency is achieved in other circuits when impedances are identically matched. In doing this, it is necessary to employ a transformer which will make the load "look" like the desired impedance insofar as all electrical characteristics are to be considered. This effect is achieved by employing transformers having turns ratios which are the square roots of the impedance ratios. Let us suppose that we wish to match the impedance of a 500-ohm pick-up to the input of a tube (which may be considered as having an impedance of 250,000 ohms). The impedance ratio is 500:1 and the required turns ratio would be approximately 22.5:1. Since the tube is purely a voltage-operated device and consumes very little power, this gives us a gain of 22.5 in the transformer alone. It is usual to construct amplifiers in such a manner that their input and output

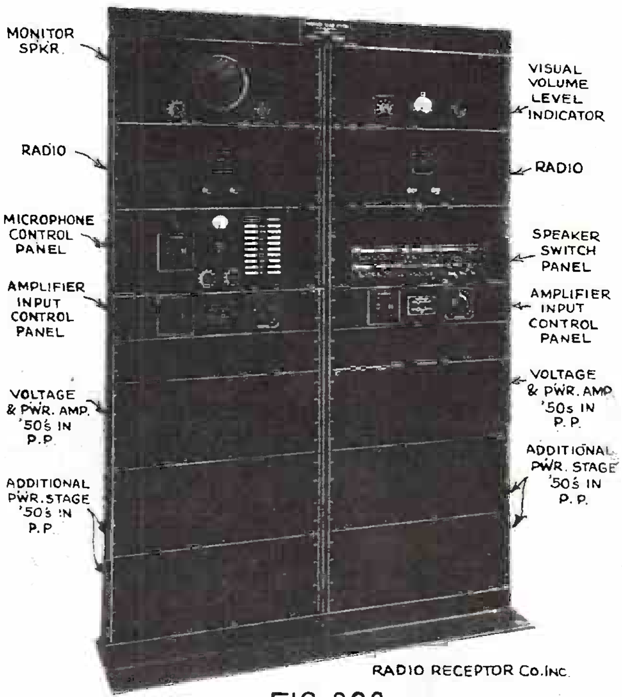


FIG. 209

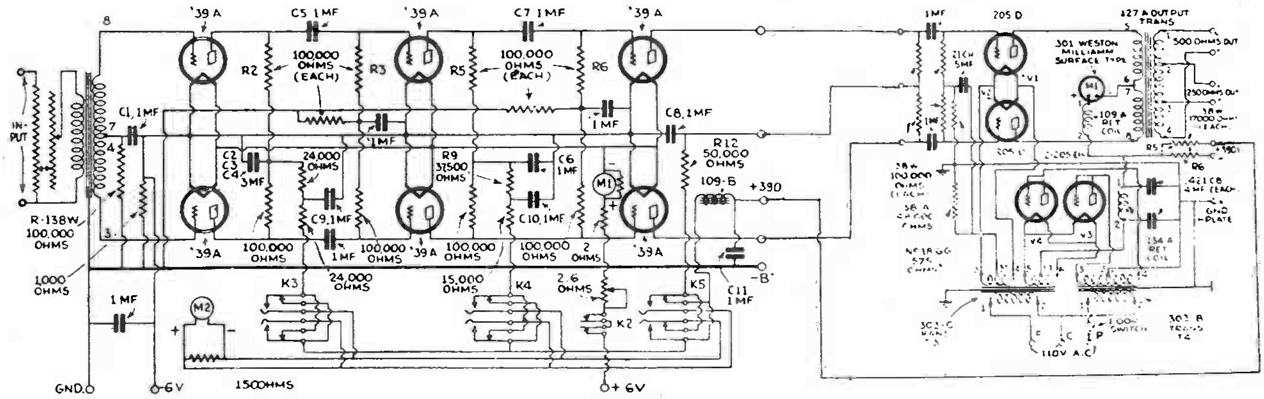
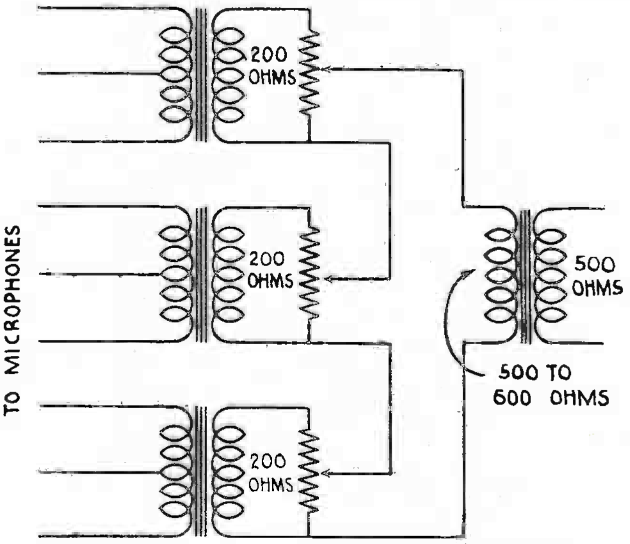


FIG. 210

impedances are equal. This impedance value may be either 200 or 500 ohms—the latter being the more usual. In working into the 500-ohm amplifier input from the detector tube of the radio receiver, it is necessary to employ a step-down transformer to match the relatively high impedance of the detector tube to the 500-ohm circuit.

All the various components employed are available on the open market and the characteristics and specifications are given in the circuit diagram. Note that the output transformer has two windings, one of which feeds a 500-ohm transmission line terminated in an audio-transformer designed to match the impedance of the line to any number of dynamic moving coils. Remember that the current is high in low impedance circuits such as dynamic moving coils and the voltage drop in the interconnecting wires must be guarded against. Do not use long lengths of wire in connecting up multiple-speaker arrangements of this type and be sure to use nothing smaller than No. 12 wire in the connections. The correct tap to employ on the auto-transformer depends upon the number of speakers used and whether they are connected in series, parallel, or series-parallel. The resultant impedance may be calculated in the same manner as in the case of series or parallel resistances.



MIKE MIXER SERIES TYPE

FIG. 211

In centralized radio systems, a great number of small magnetic or dynamic speakers are employed in a similar series-parallel arrangement. It is best to utilize the high-impedance transformer winding when the small dynamics are employed in this arrangement. The impedance of such a winding is in the neighborhood of 2500 ohms and they should be so connected as to approximately match the 500-ohm output winding of the amplifier itself. The output transformer also has as a monitor a small 15-ohm winding designed to feed the moving coil of a monitoring speaker.

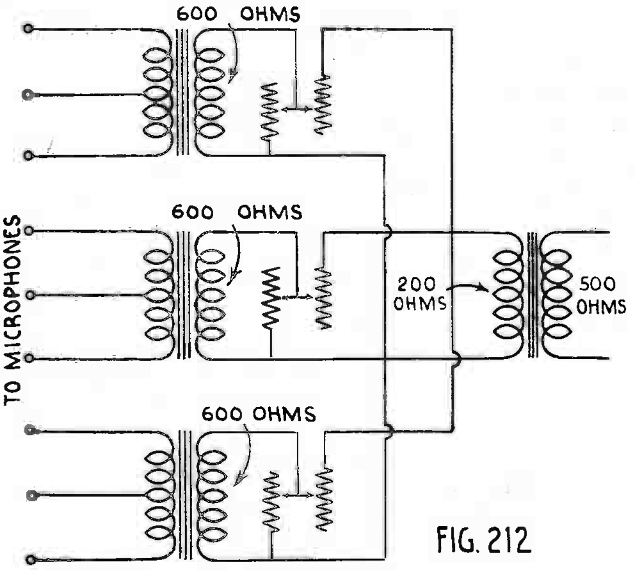


FIG. 212

MIKE MIXER
PARALLEL CONSTANT OUTPUT TYPE

Power Output Requirements.

In calculating the power output requirements of systems, there is no set rule to follow. We may, however, assume that the larger dynamic speakers and dynamic horn units require an output of about two watts while the small speakers used in hotel systems do not require more than ¼ watt for good results. We are able to calculate from this data the requirements for operation of most systems. The tubes necessary for the output stage in any system may be chosen from the tube data available in this book. Remember that tubes in parallel give double the output of a single tube while tubes in push-pull may be relied upon to give about 2.4 times the output of the single tube. The range available is all the way from the output obtainable from a single '71 up to the output of 60 watts available from two '45's in push-pull. Tubes of a special character capable of an output in excess of one kilowatt are obtainable in special cases and there is no reason why large power requirements should baffle the accomplished service technician.

In Fig. 209, a commercial type or a centralized system mounted in rack form is shown. The various panels and their use are indicated in the figure. The system offers a complete microphone control unit, voltage amplifier, and a 50-watt push-pull output stage for use with as many groups of speakers as desired. The change from "mike" to broadcast reproduction is accomplished by throwing the switches on the control panel. The circuits of the units which are incorporated in this unit are to be found

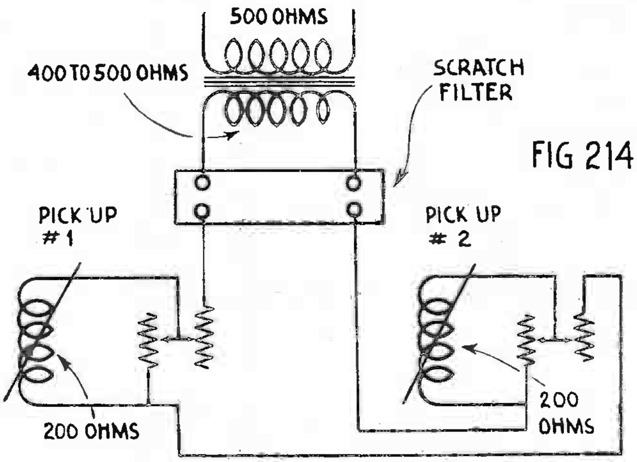


FIG 214

PHONOGRAPH PICK UP CONNECTIONS
DOUBLE TURNTABLE TYPE

in detail in the section of the Manual devoted to sound-system circuit diagrams.

A typical circuit diagram of a W.E. Co. 41A speech amplifier unit is shown in Fig. 210 and is an example of excellent design. The service man can build a real recording or public-address amplifier by following the information given in the drawing.

The necessity of proper impedance matching as stated above is an important consideration and it will be noted that the circuits shown in Figs. 211 to 216 are designed with this consideration in mind.

Mixers.

The simple series type of mixer is shown in Fig. 211. While it has the advantage of simplicity, it has the disadvantage of not being constant in its impedance of the operating range. The circuit of

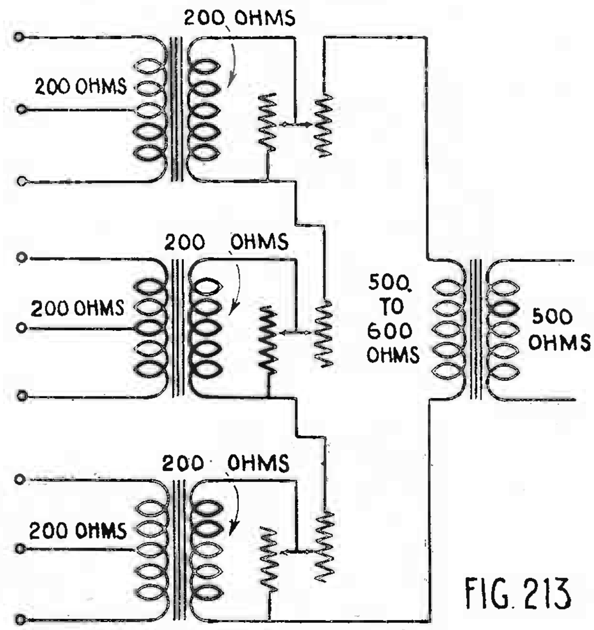


FIG. 213

MIKE MIXER
CONSTANT OUTPUT TYPE

Fig. 212 is better as the type of control is practically constant-impedance and is superior to the method shown in Fig. 211. The most generally used type of control found in the better type of installation is indicated in Fig. 213. This system gives practically constant impedance with the various settings of the controls and is an important part of a first-class installation.

The use of phonograph records and electrical pick-ups for entertainment purposes in place of radio programs has become commonplace and the average system must include at least one electric turntable for record reproduction. The circuit shown in Fig. 214 indicates individual control of output of the two pick-ups so that the output of one can be faded into the output of the other so that the musical program can be continued without interruption.

The average radio detector-plate circuit has a very high impedance which must be matched to the 500-ohm line by means of a step-down transformer. See Fig. 215. The primary of the matching transformer for use with a '27 type tube used as a detector should have an inductance of about 250 henries to

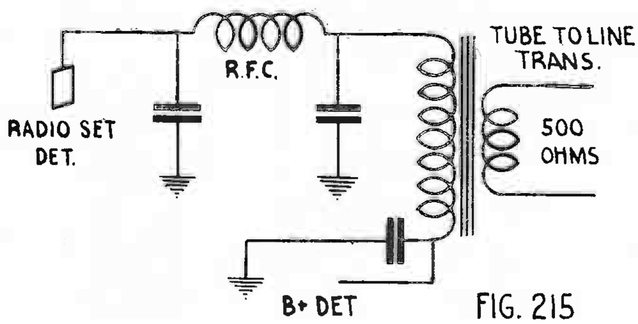
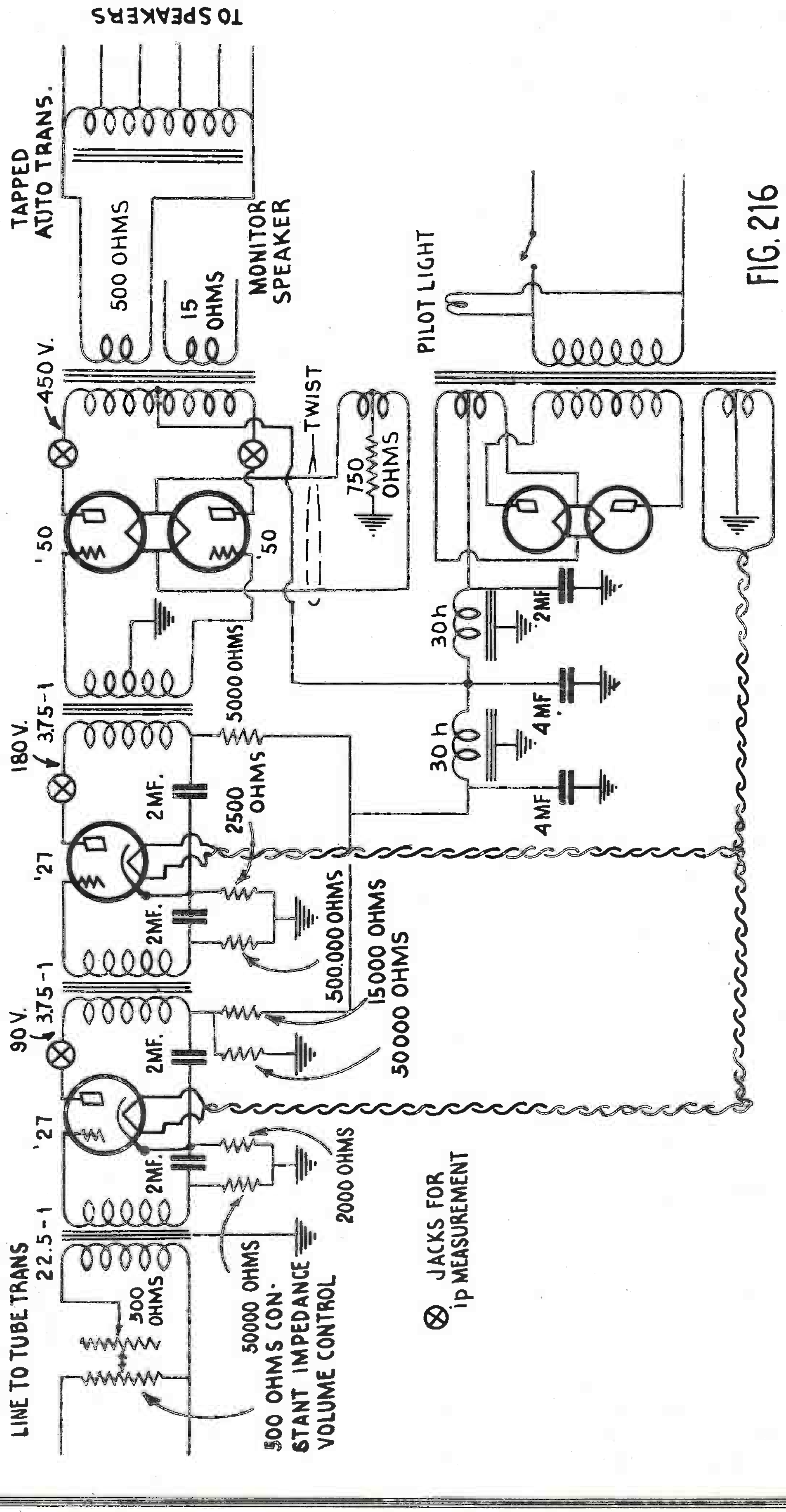


FIG. 215



VOLTAGE AND POWER AMPLIFIER COMBINED WITH POWER PACK

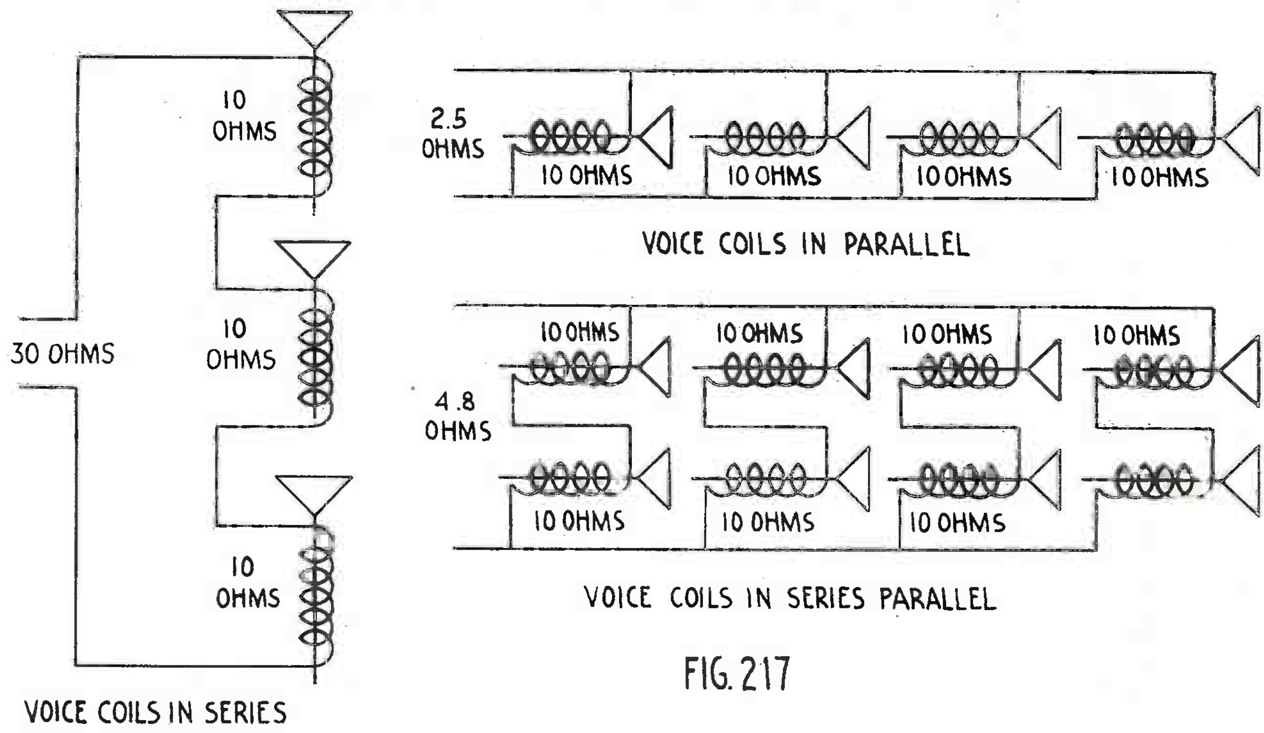


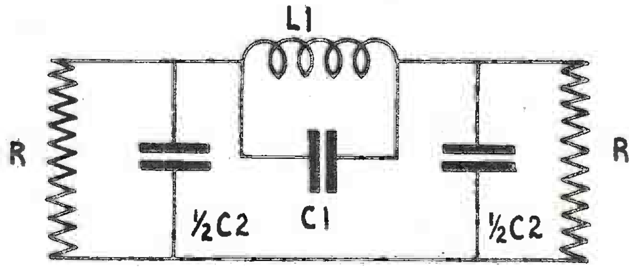
FIG. 217

afford ample bass frequency response. It is important that the direct current flowing in the plate circuit of the detector tube does not cause a drop in the inductance of the transformer primary. It is fortunate that the tubes used as detectors with the present systems of detection seldom require more than 1 to 1.5 ma., thus reducing the possibility of a serious drop in the inductance of the primary of the detector output matching transformer.

In Fig. 216, a more or less standardized circuit of a combined voltage and power amplifier circuit complete with its power supply is shown. It will be noticed that the input circuit and the output circuit both terminate with impedances of 500 ohms. The special output transformer, called an auto-transformer, is used for the purpose of matching the 500-ohm line to the speakers. The use of a device of this type is absolutely necessary if quality reproduction is to be obtained.

Jacks are included in the plate circuits of the various tubes so that an accurate check can be made on the plate current flowing. In the '50 stage, it is convenient to have some method whereby the two tubes can be matched as closely as possible. Tubes should be selected for their equality in plate-current drain under actual operating conditions.

In public address systems, the speakers are generally operated in banks of 25 or more and, to enable the designer to establish a low impedance line between the output transformer and the speakers, the voice-coils are connected in series or parallel, as the case may be. Fig. 217 shows the connections of speakers in series, in parallel, and in series-parallel with the effective of the resultant load when each voice-coil has an impedance of 10 ohms.



$L_K = \frac{R}{\pi f_2}$ $\qquad L_1 = m L_K$

$C_K = \frac{1}{\pi f_2 R}$ $\qquad C_1 = \frac{1-m^2}{4m} \times C_K$

$m = .6$ $\qquad C_2 = m C_K$

L = in henrys. C_2 = in microfarads.

f_2 = CUT OFF FREQUENCY.

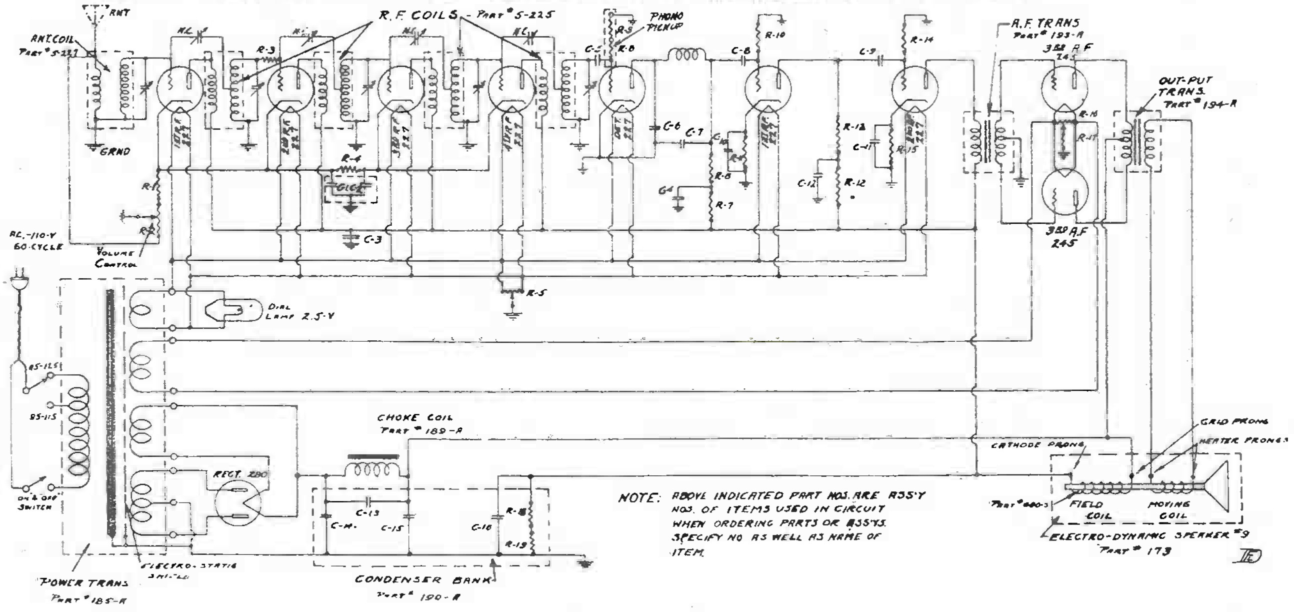
FIG. 218

Many times the service man is called upon to install a scratch-filter which is used to reduce the surface noise present in all phonograph records. Fig. 218 gives all the information for the computation of the necessary values of inductance and capacity for such devices. The cut-off frequency should generally be computed for frequencies of 3000 cycles or higher.

ALL-AMERICAN MOHAWK CORP.

VALUE AND PART NUMBER OF CIRCUIT ELEMENTS

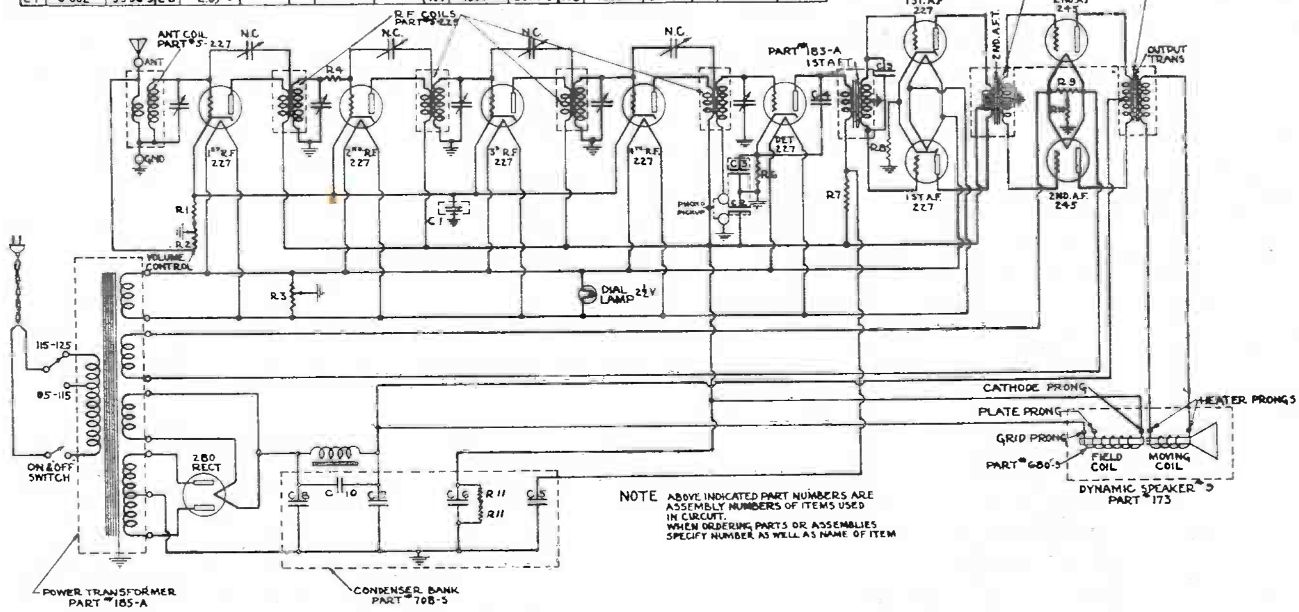
UNIT	CAP IN MFD	PART No	UNIT	CAP IN MFD	PART No	UNIT	CAP MFD	PART No	UNIT	RES IN OHMS	PART No	UNIT	RES IN OHMS	PART No	UNIT	RES IN OHMS	PART No	UNIT	RES IN OHMS	PART No
C-1	0.1 ONE	5593-5	C-7	0.001	5124-5	C-13	0.1 COND BANK	190-A	R-1	380	5520-5	R-7	70,000	5295-5	R-13	25,000	5172-5	R-19	6,000	5407-5
C-2	0.1 UNIT	5593-5	C-8	0.01	5803-5	C-14	2.0		R-2	10000	731-5	R-8	2 Megohms	5001-5	R-14	0.5 Megohm	5221-5			
C-3	0.5 ONE	5592-5	C-9	0.01	5803-5	C-15	2.0		R-3	1,500	6004-5	R-9	0.5 -	5221-5	R-15	2,400	5274-5			
C-4	0.5 UNIT	5592-5	C-10	0.5		C-16	2.0		R-4	100	5594-5	R-10	0.5 -	5221-5	R-16	20	5277-5			
C-5	0.00025	5125-5	C-11	0.5					R-5	20	5277-5	R-11	2,400	5274-5	R-17	1,000	5559-5			
C-6	0.001	5124-5	C-12	1.0 COND BANK					R-6	70,000	5295-5	R-12	70,000	5295-5	R-18	6,000	5407-5			



CIRCUIT DIAGRAM NO. 90 CHASSIS 60 CYCLE

VALUE AND PART No OF CIRCUIT ELEMENTS

UNIT	CAP IN MFD	PART No	UNIT	CAP IN MFD	PART No	UNIT	CAP IN MFD	PART No	UNIT	RES IN OHMS	PART No	UNIT	RES IN OHMS	PART No	UNIT	RES IN OHMS	PART No
C1	0.1	5593-5	C5	1.0 COND BANK		C9	0.00025	5125-5	R1	380	5520-5	R5	100	5594-5	R9	20	5277-5
C2	0.5 ONE	5592-5	C6	1.0	708-5	C10	0.5	5612-5	R2	10000	731-5	R6	10000	5170-5	R10	1000	5559-5
C3	0.5 UNIT	5592-5	C7	1.0					R3	20	5277-5	R7	70000	5295-5	R11	6000	5568-5
C4	0.002	5596-5	C8	2.0					R4	1500	6004-5	R8	1000	6005-5			

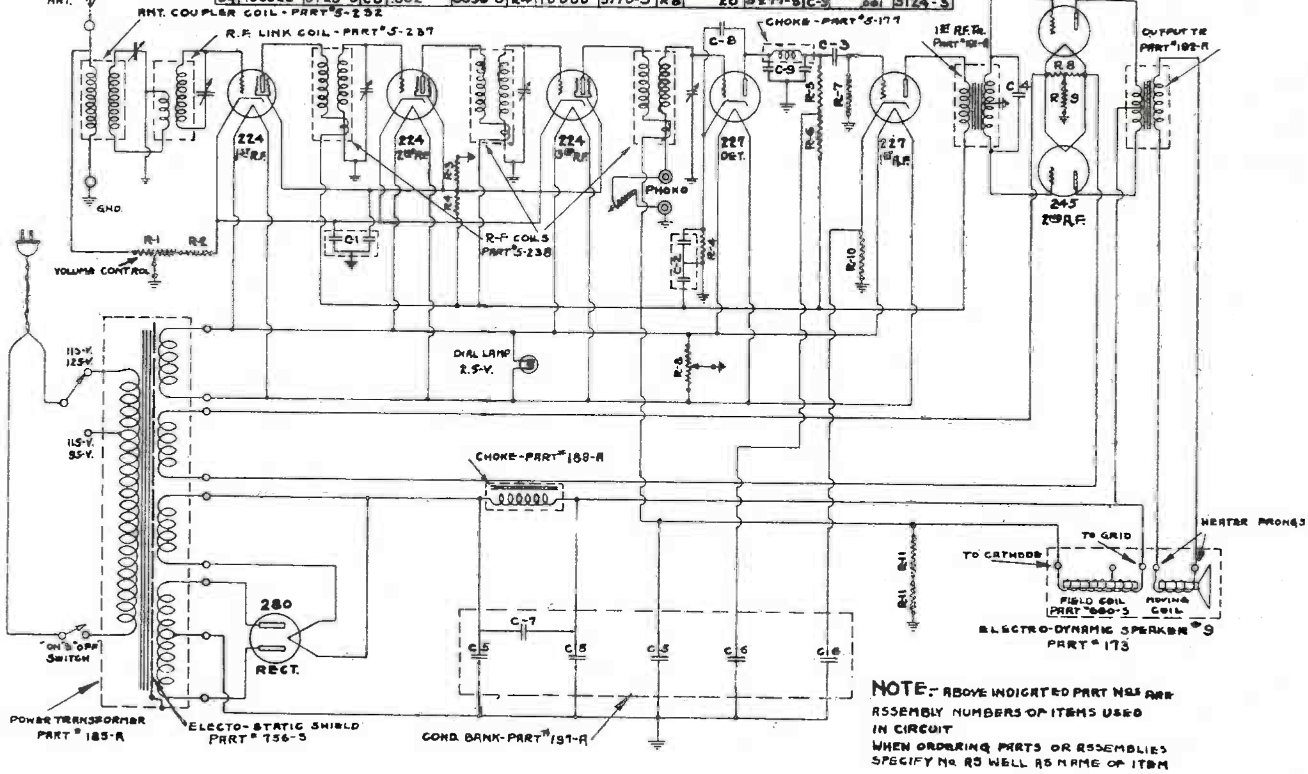


CIRCUIT DIAGRAM NO. 90 CHASSIS 25 CYCLE

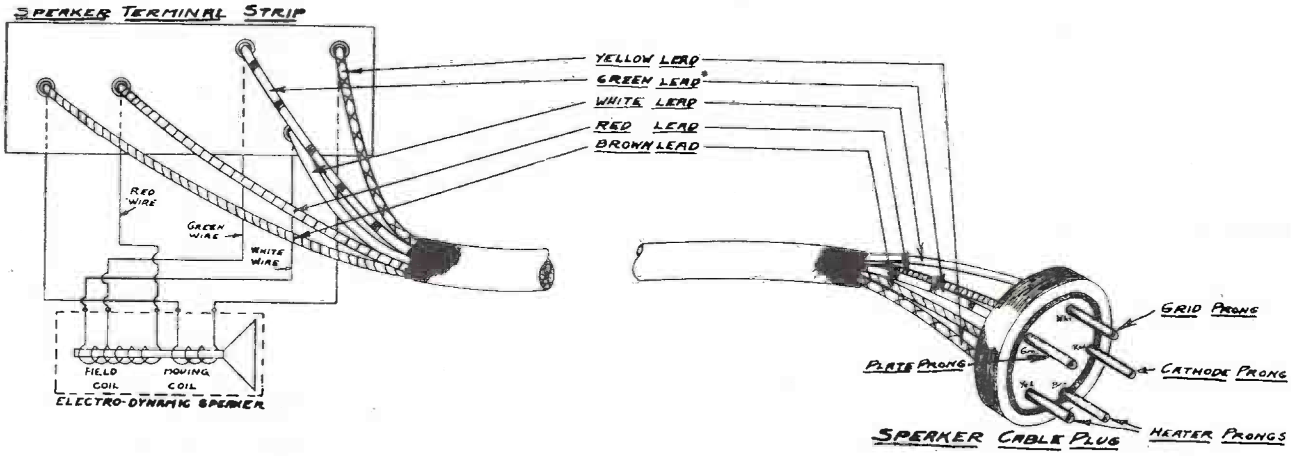
ALL-AMERICAN MOHAWK CORP.

VALUE AND PART No OF CIRCUIT ELEMENTS

UNIT	CAP. IN MFD	PART No	UNIT	CAP. IN MFD.	PART No	UNIT	RES. IN OHMS	PART No	UNIT	RES. IN OHMS	PART No	UNIT	RES. IN OHMS	PART No
C1	Two-.5	5328-5	C5	2	Cond.	R1	10000	731-5	R5	70000	5295-5	R9	1000	5559-5
C2	Two-.5	5392-5	C6	1	Bank 187-A	R2	300	5562-5	R6	25000	5172-5	R10	2000	5595-5
C3	.01	5603-5	C7	.1		R3	25000	5172-5	R7	5 MEG.	3273-5	R11	6000	5588-5
C4	.00025	5125-5	C8	.002	3596-5	R4	10000	5170-5	R8	20	5277-5	C-5	.001	5124-5

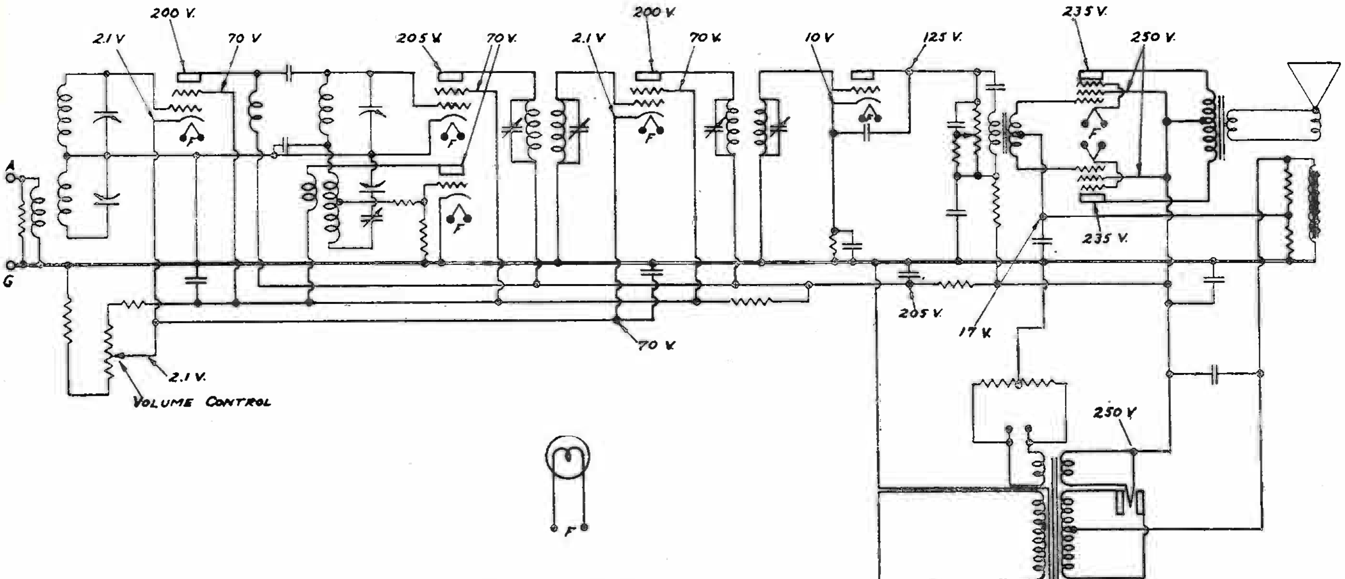


CIRCUIT DIAGRAM NO. 96 CHASSIS
60 CYCLE

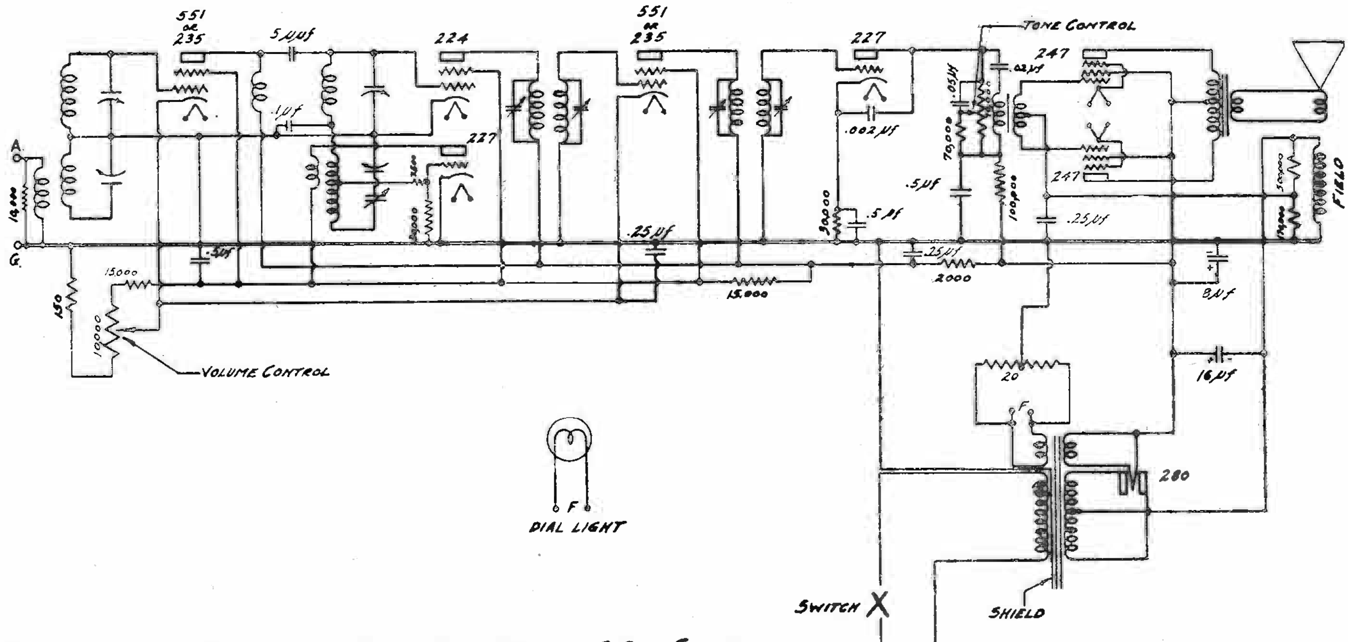


LOUDSPEAKER AND PLUG
CIRCUIT DIAGRAM NO. 90 CHASSIS

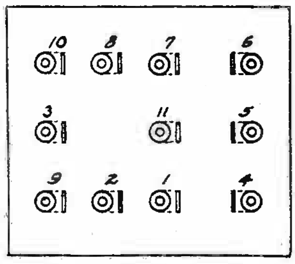
ALL-AMERICAN MOHAWK CORP.



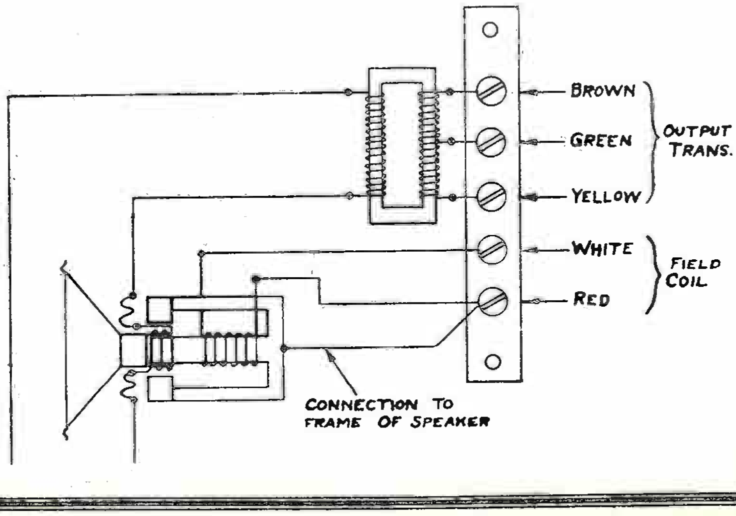
Circuit Diagram of Model S-8 Showing Normal Voltages With Volume Control in Full "On" Position.



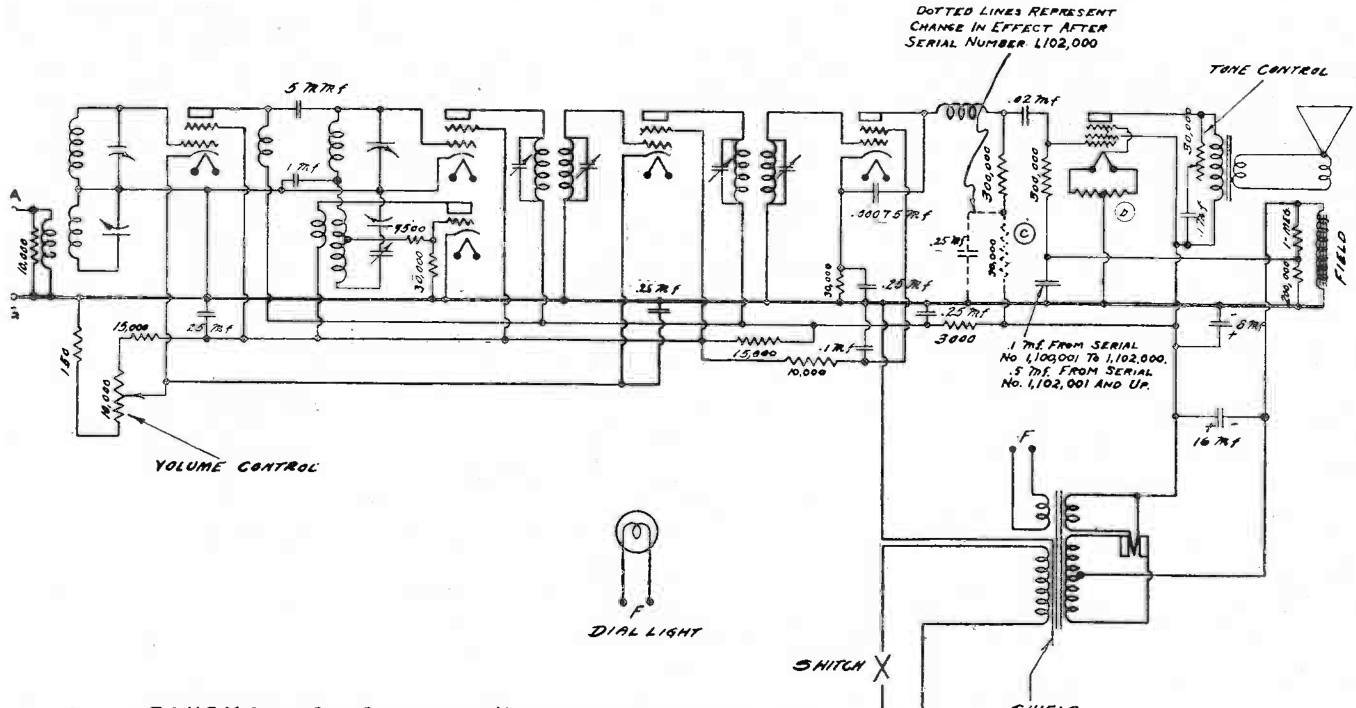
Schematic Diagram of Lyric Model S-8 Chassis.



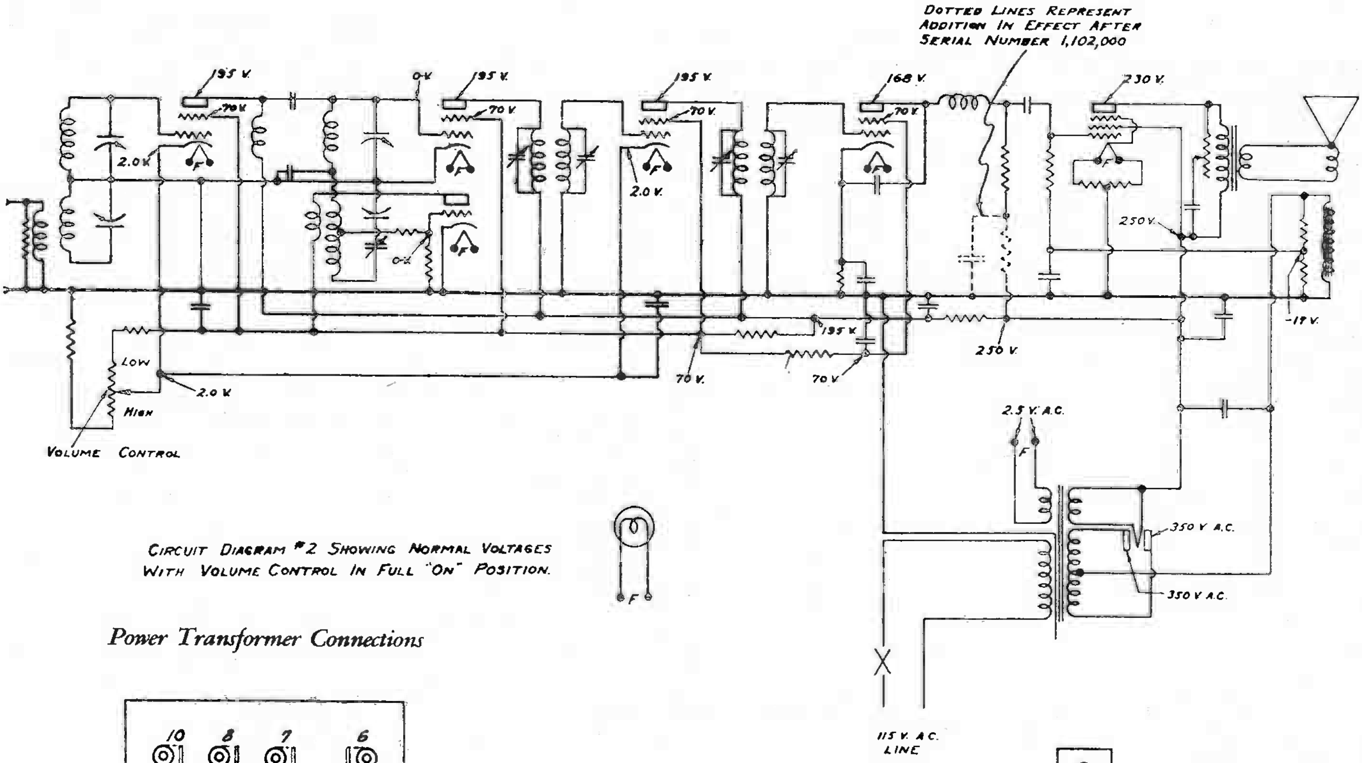
1—110 volt Primary Start
2—110 volt Primary Finish
3—Shield
4—High Voltage Secondary Start
5—High Voltage Secondary Tap
6—High Voltage Secondary Finish
7—'80 Filament Winding Start
8—'80 Filament Winding Finish
9—Heater and '47 Filament Winding Start
10—Heater and '47 Filament Winding Finish
11—No Connection



ALL-AMERICAN MOHAWK CORP.

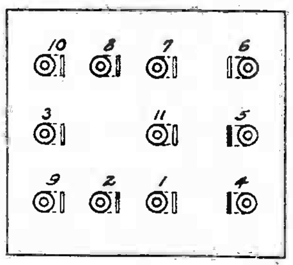


SCHEMATIC DIAGRAM OF LYRIC MODEL S-7 CHASSIS

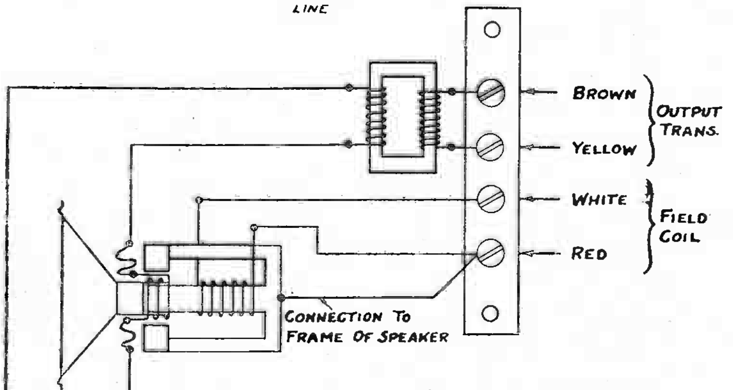


CIRCUIT DIAGRAM #2 SHOWING NORMAL VOLTAGES WITH VOLUME CONTROL IN FULL "ON" POSITION.

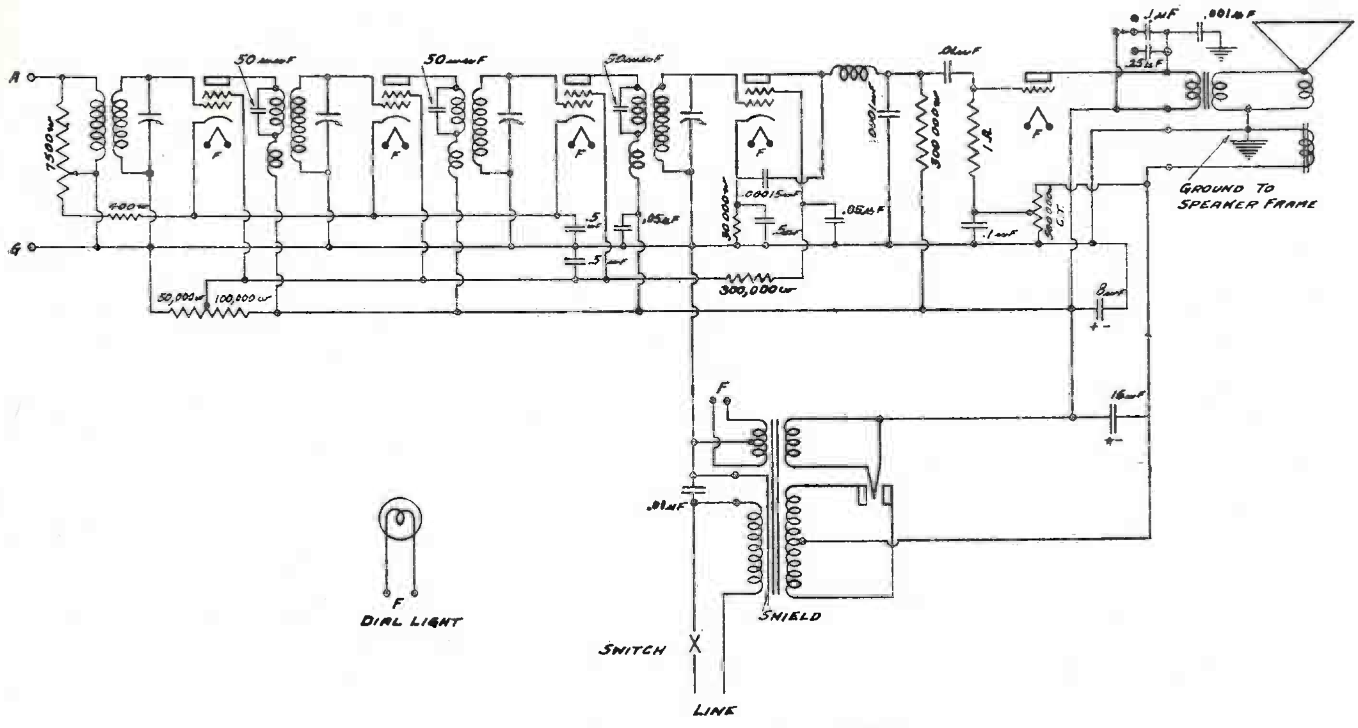
Power Transformer Connections



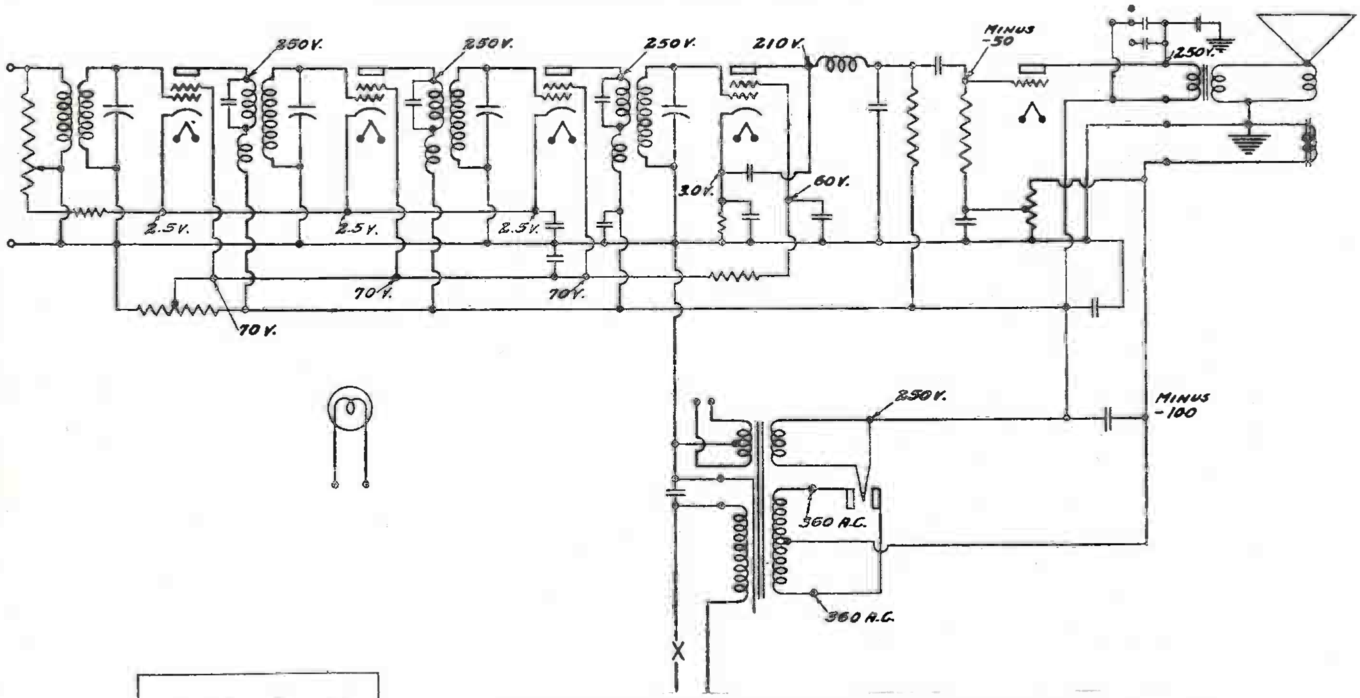
1—110 volt Primary Start
2—110 volt Primary Finish
3—Shield
4—High Voltage Secondary Start
5—High Voltage Secondary Tap
6—High Voltage Secondary Finish
7—'80 Filament Winding Start
8—'80 Filament Winding Finish
9—Heater and '47 Filament Winding Start
10—Heater and '47 Filament Winding Finish
11—No Connection



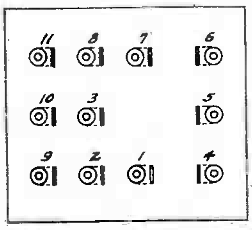
ALL-AMERICAN MOHAWK CORP.



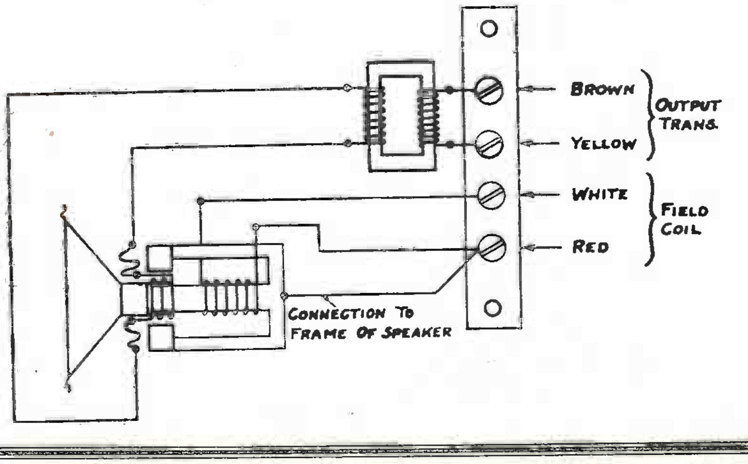
SCHEMATIC DIAGRAM OF LYRIC MODEL "J" CHASSIS



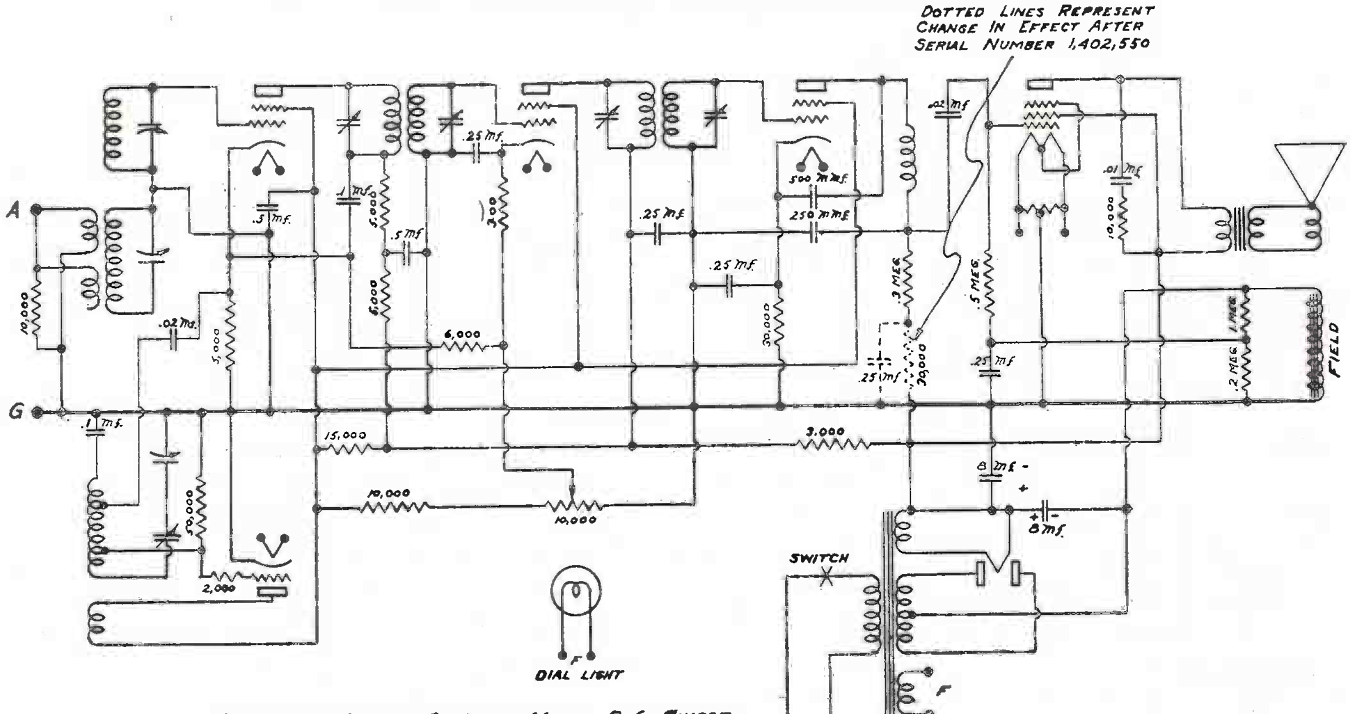
NOMINAL VOLTAGE CHART OF LYRIC MODEL "J" CHASSIS



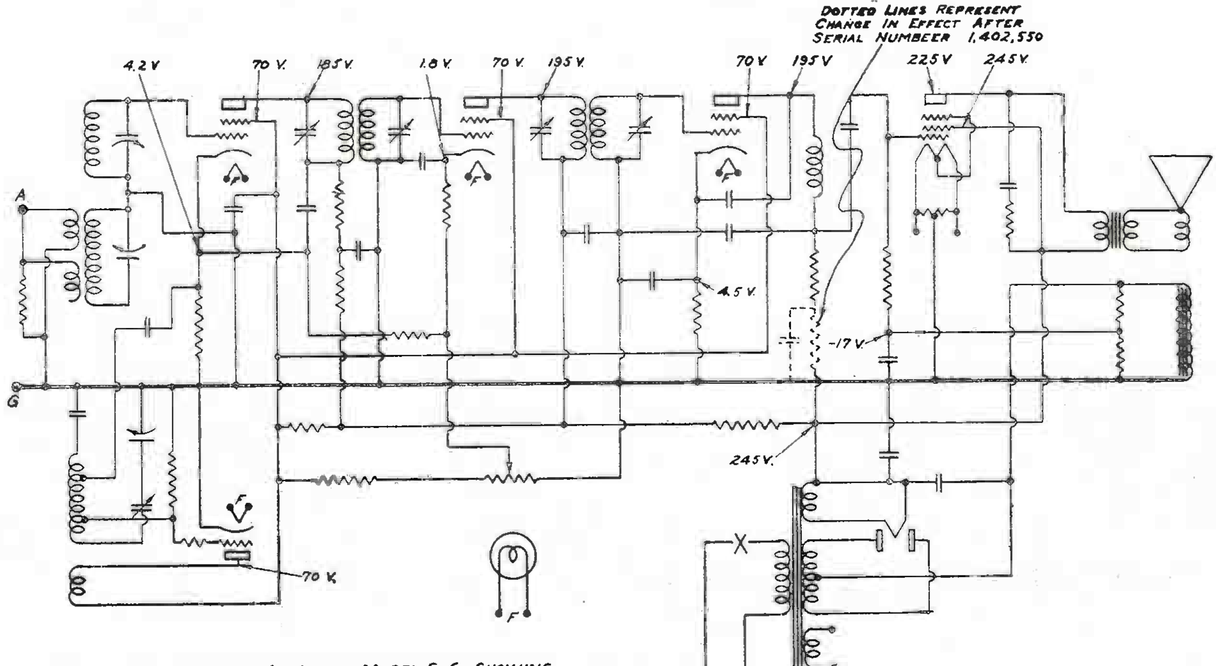
1—110 Volt Primary Start.
2—110 Volt Primary Finish.
3—Shield.
4—High Voltage Secondary Start.
5—High Voltage Secondary Tap.
6—High Voltage Secondary Finish.
7—'80 Filament Winding Start.
8—'80 Filament Winding Finish.
9—'24 and '45 Filament Winding Start.
10—'24 and '45 Filament Winding Tap.
11—'24 and '45 Filament Winding Finish.



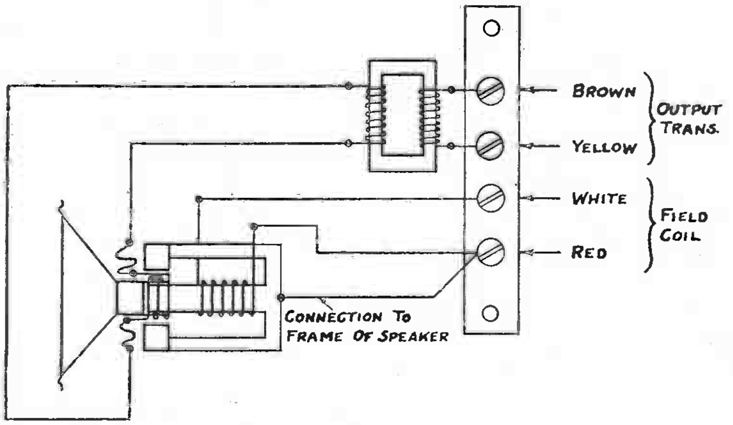
ALL-AMERICAN MOHAWK CORP.

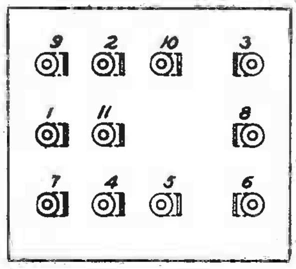


SCHEMATIC DIAGRAM OF LYRIC MODEL S-6 CHASSIS



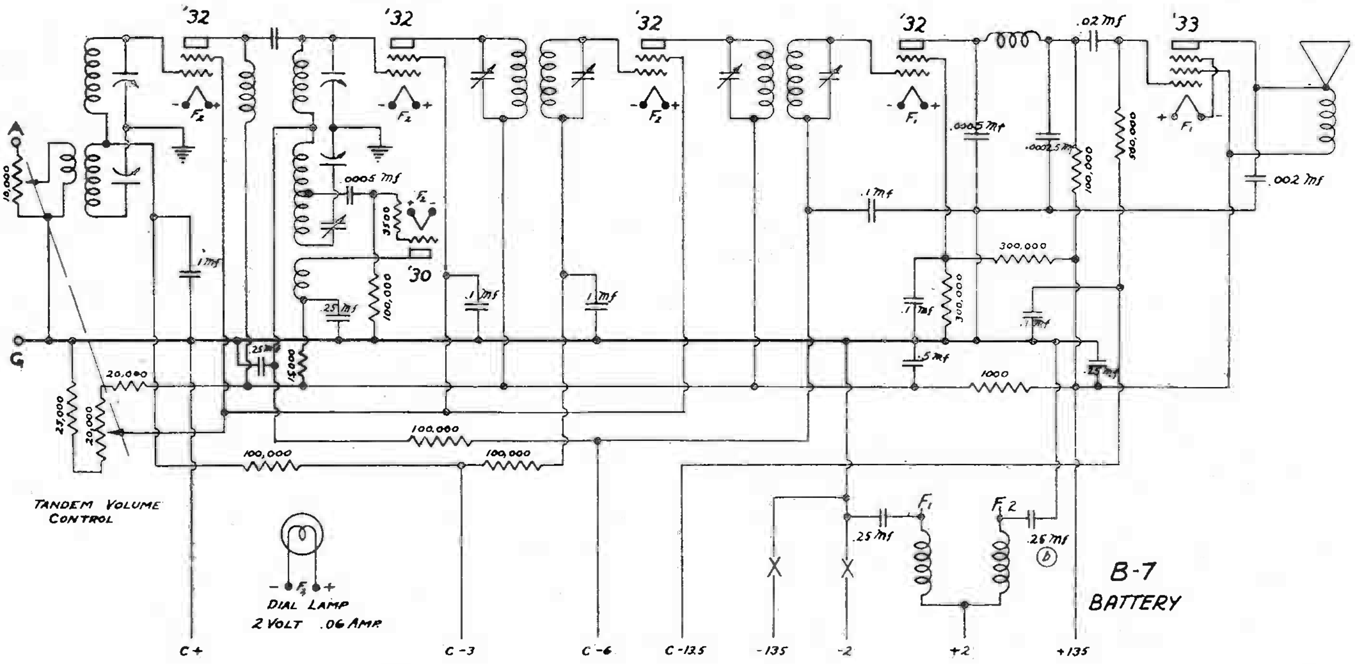
SCHEMATIC DIAGRAM OF LYRIC MODEL S-6 SHOWING NORMAL VOLTAGES WITH VOLUME CONTROL IN FULL "ON" POSITION.



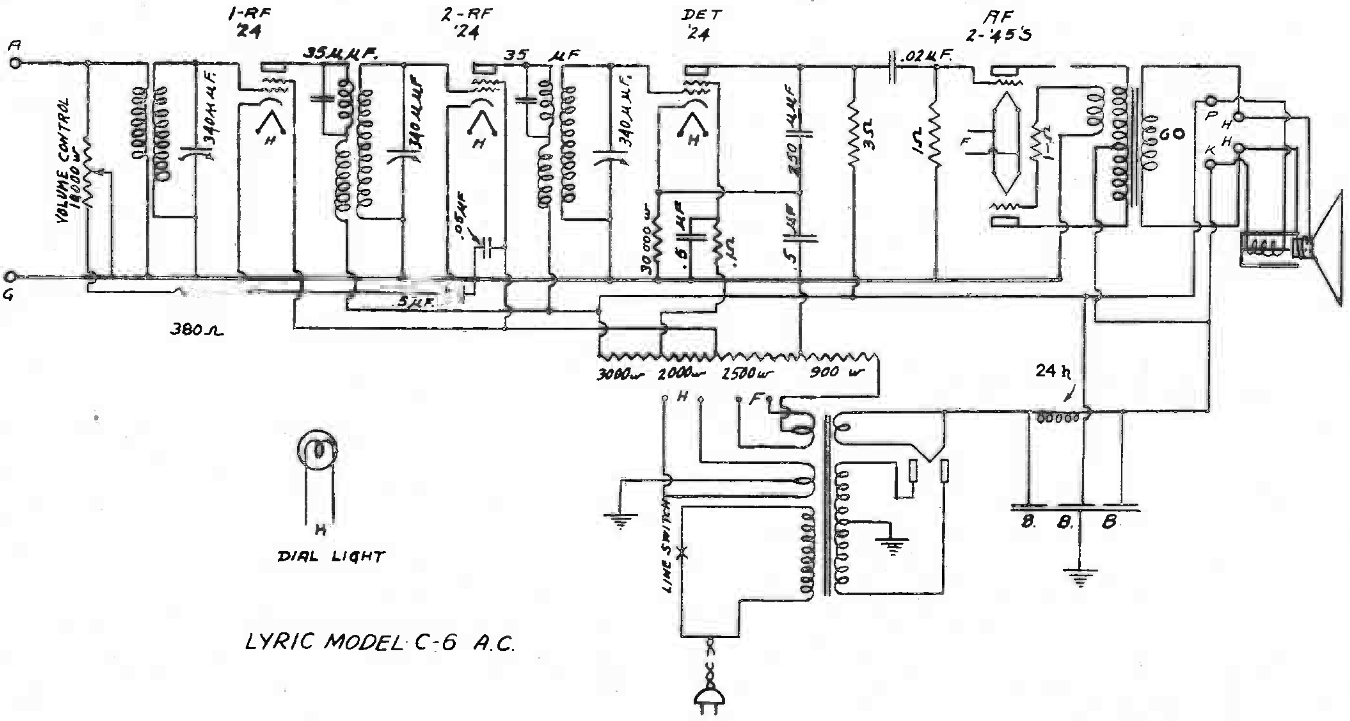


1—110 volt Primary Start
2—110 volt Primary Finish
3—Shield
4—High Voltage Secondary Start
5—High Voltage Secondary Tap
6—High Voltage Secondary Finish
7—'80 Filament Winding Start
8—'80 Filament Winding Finish
9—Heater Winding Start
10—Heater Winding Finish
11—No Connection

ALL-AMERICAN MOHAWK CORP.

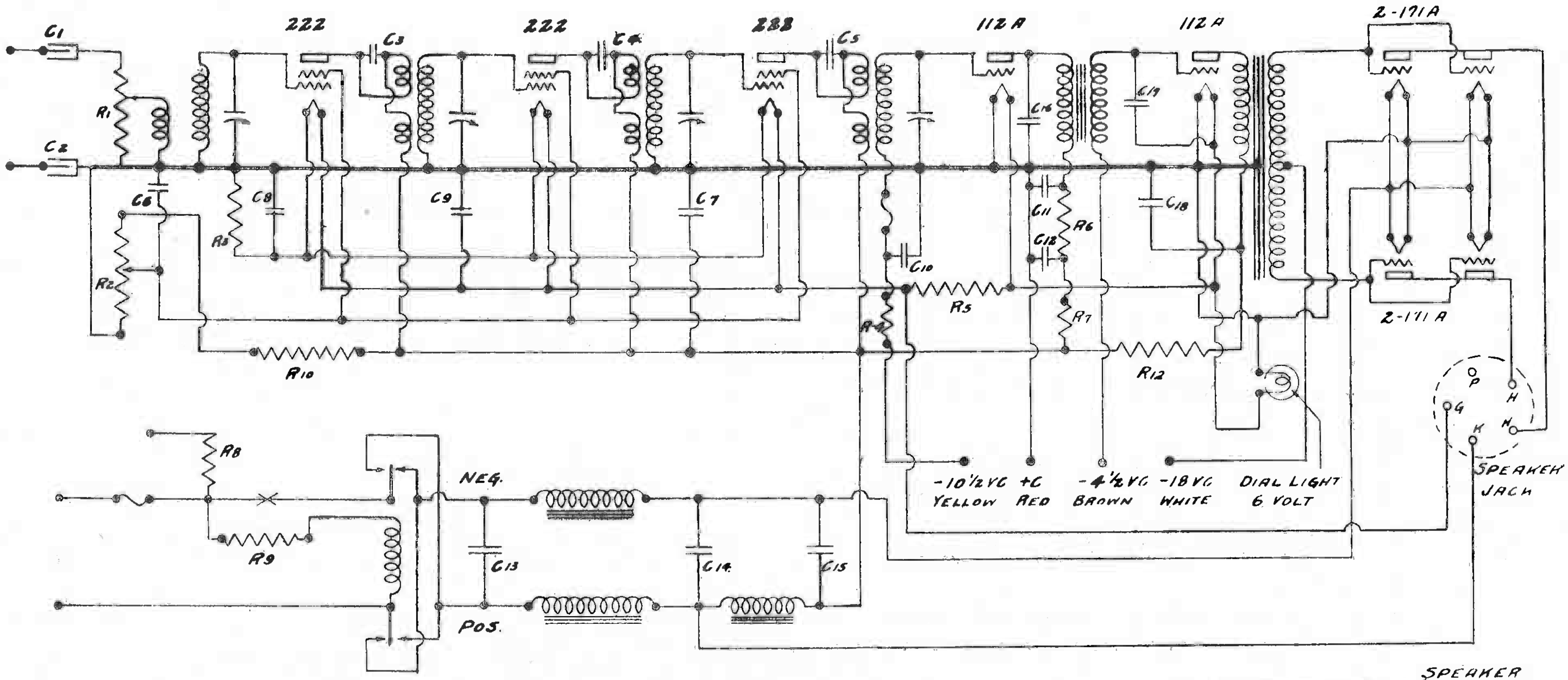


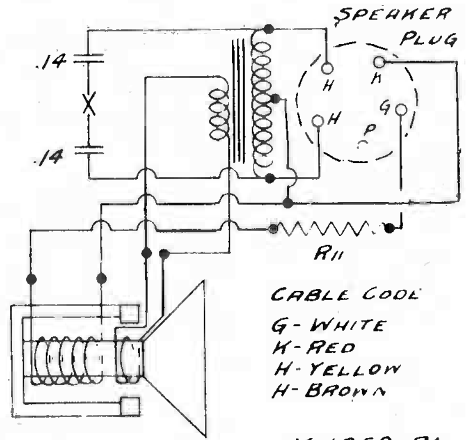
B-7 BATTERY



LYRIC MODEL C-6 A.C.

ALL-AMERICAN MOHAWK CORP.





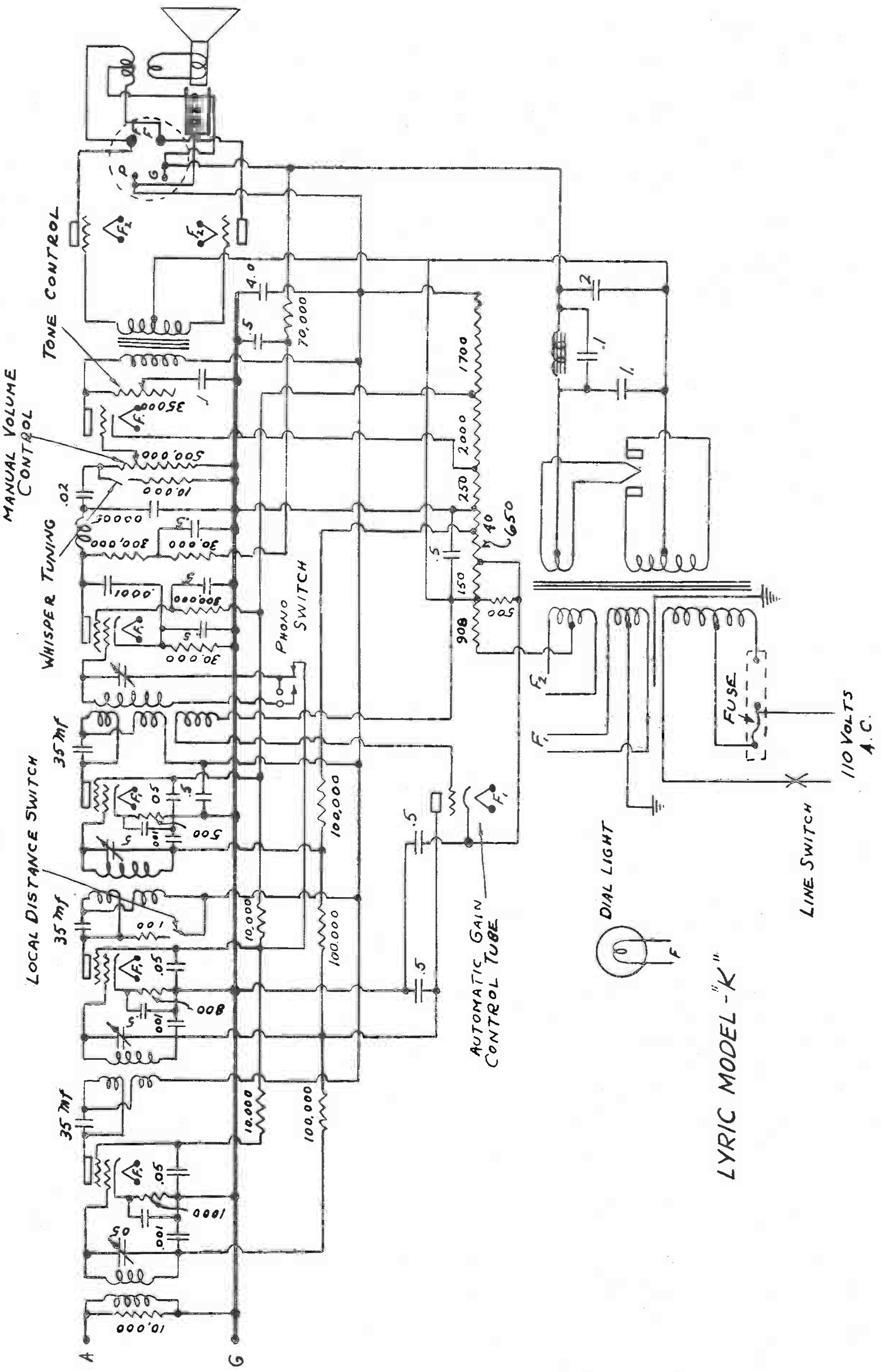
C1	.02 mF
C2	.05 mF
C3	35 mmF
C4	35 mmF
C5	35 mmF
C6	.5 mF
C7	.5 mF
C8	.5 mF
C9	.05 mF
C10	.1 mF (2 .05's IN PARALLEL)
C11	1.0 mF (2 .5's IN PARALLEL)
C12	.5 mF
C13	1.0 mF
C14	8 mF (ELECTROLYTIC)
C15	8 mF (ELECTROLYTIC)
C16	.001 mF
C17	.00025 mF
ⓑ C18	5 mF

R1	10000 w	VOLUME CONTROL
R2	7500 w	VOLUME CONTROL
R3	8.6 w	WIRE WOUND
R4	10000 w	CARBON
R5	2.25 w	WIRE WOUND
R6	4500 w	CARBON
R7	4500 w	CARBON
R8	10 w	VITREOUS ENAMELLED (IN CHASSIS)
R9	700 w	CARBON
R10	4500 w	CARBON
R11	85 w	VITREOUS ENAMELLED (ON SPEAKER)
ⓑ R12	2400 w	CARBON

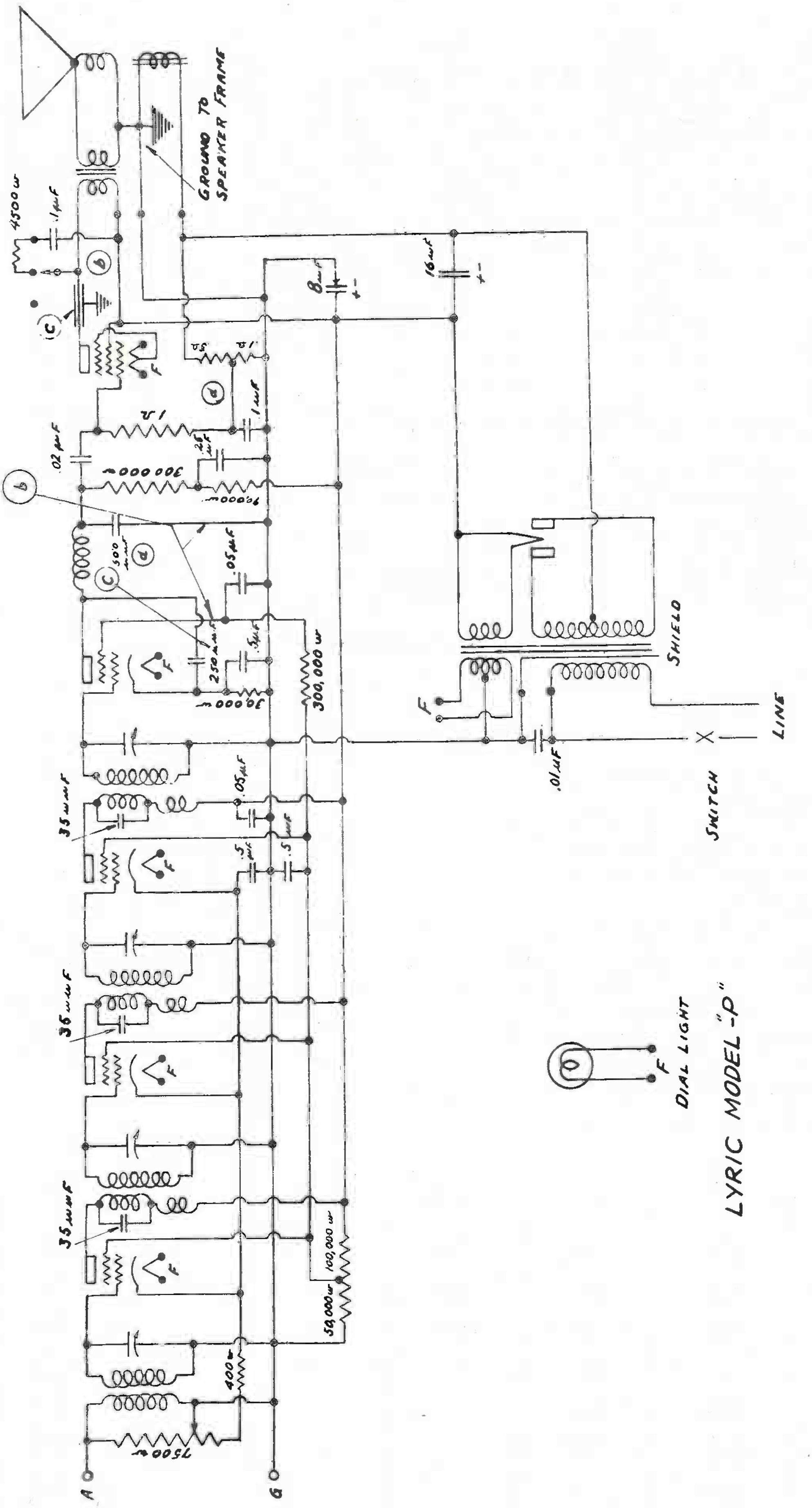
LYRIC D.C.

Y-1059 R1

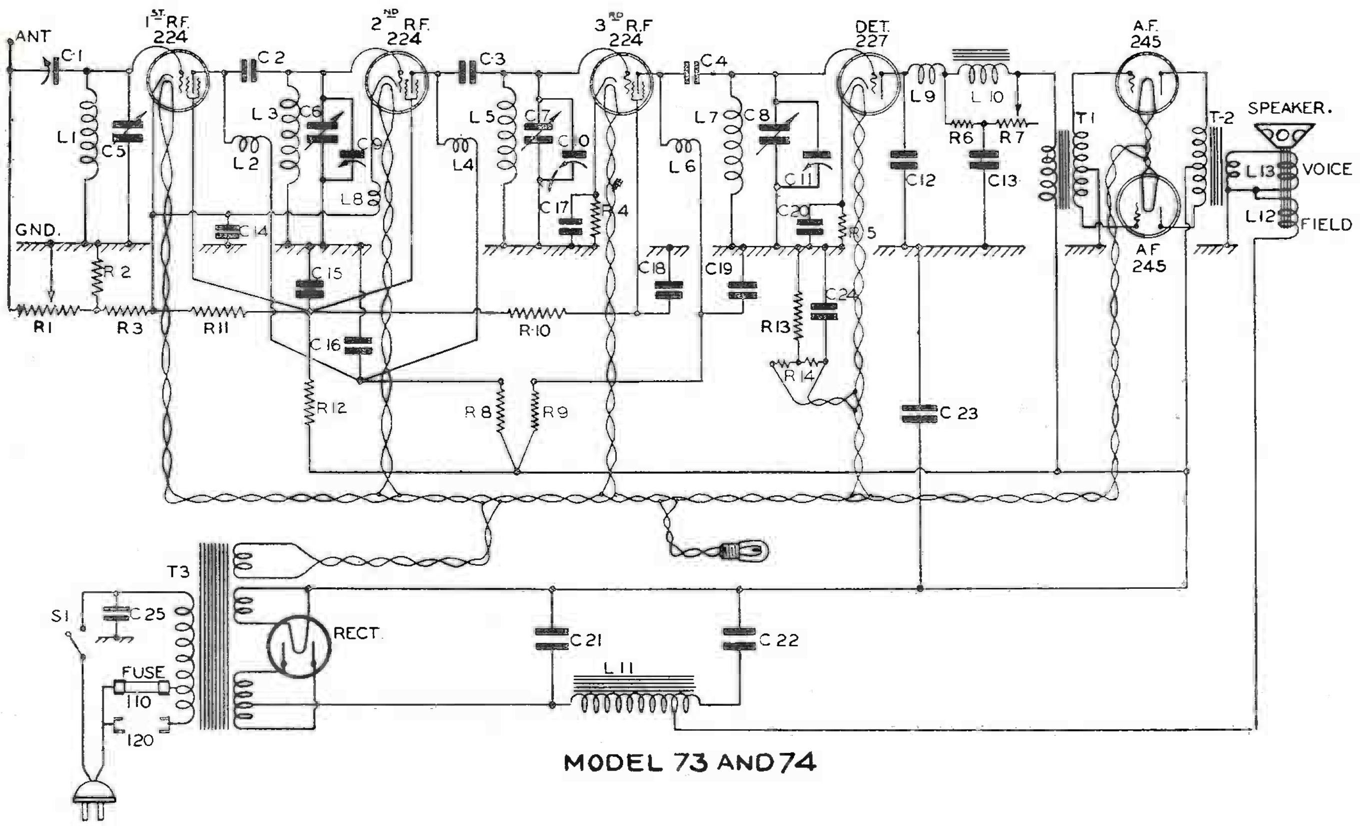
ALL-AMERICAN MOHAWK CORP.



ALL-AMERICAN MOHAWK CORP.



AMERICAN BOSCH MAGNETO CORP.



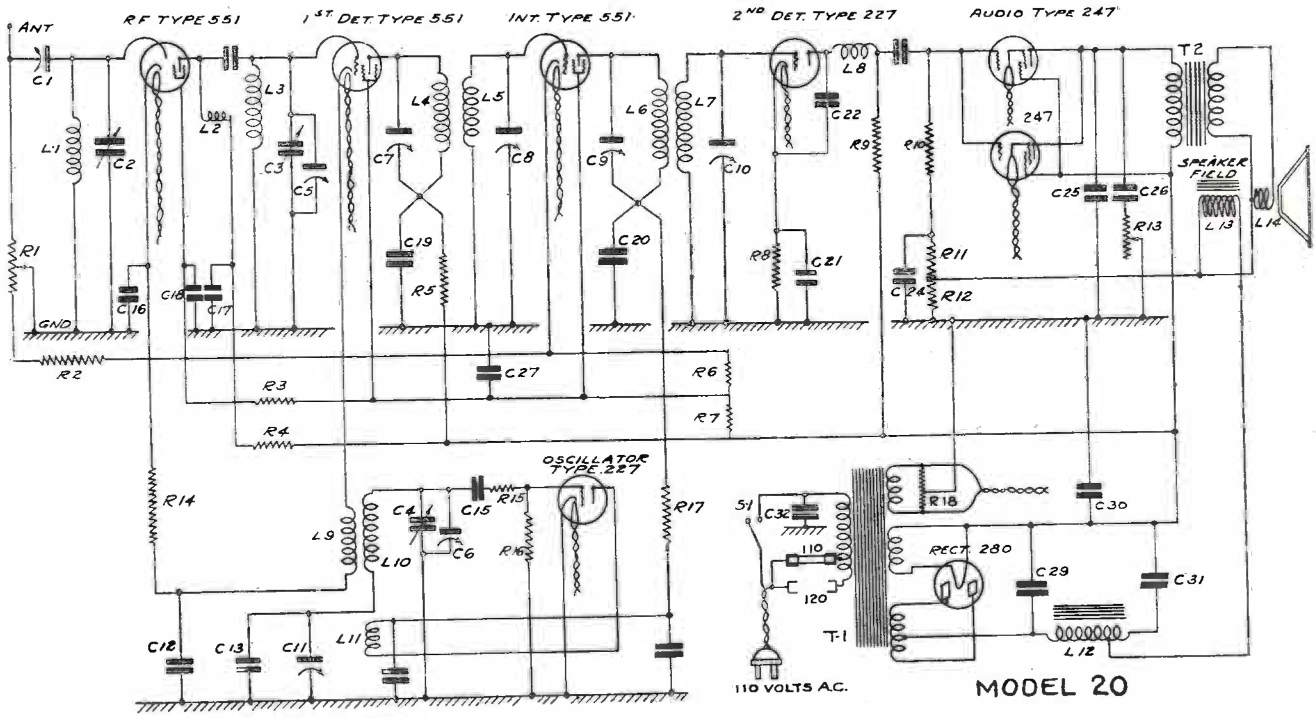
MODEL 73 AND 74

R 1—Volume Control 10,000 ohms
R 2—2750 ohms } Tapped unit
R 3— 250 ohms }
R 4—Cathode Resistor 750 ohms
R 5—Cathode Resistor 25,000 ohms
R 6—50,000 ohms
R 7—Tone Control 50,000 ohms
R 8—Plate Supply Resistor 5,000 ohms
R 9—Plate Supply Resistor 10,000 ohms
R 10—Screen Supply Resistor 750 ohms
R 11—Cathode Resistor 25,000 ohms
R 12—Screen Supply Resistor 30,000 ohms
R 13—Audio Bias Resistor 800 ohms
R 14—Center Tap Resistor 4.1 ohms

C 14—Cathode By-pass .05 mfd.
C 15—Screen By-pass .05 mfd.
C 16—Plate By-pass .05 mfd.
C 17—Cathode By-pass .05 mfd.
C 18—Screen By-pass .05 mfd.
C 19—Plate By-pass .05 mfd.
C 20—Det. Cathode By-pass .25 mfd.
C 21—Filter Condenser 2. mfd. }
C 22—Filter Condenser 2. mfd. } top unit
C 23—Filter Condenser 4. mfd. }
C 24—Audio Bias By-pass .05 mfd.
C 25—Buffer Condenser .1 mfd. (top unit)

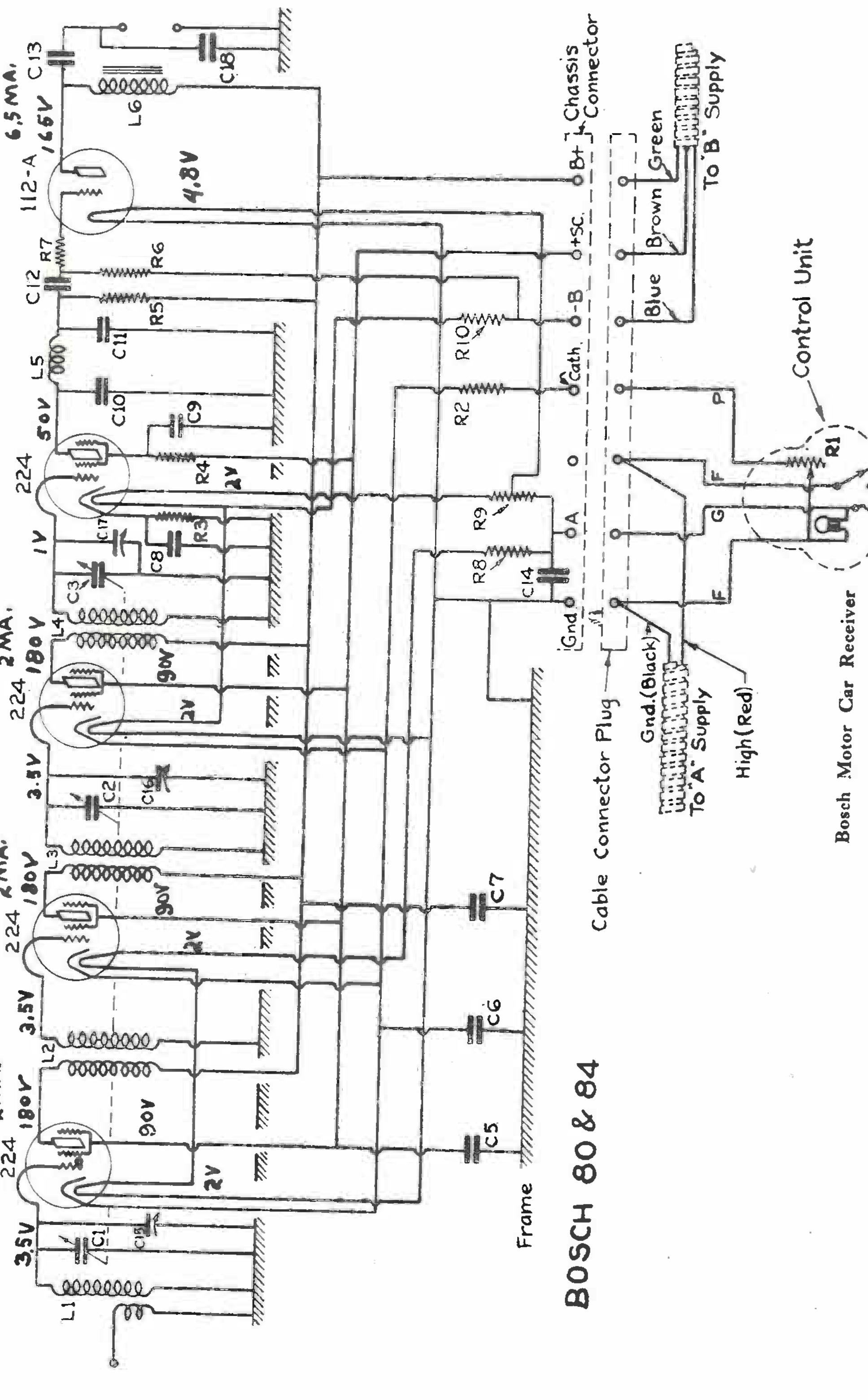
Stage	Tube	Plate	Screen	Cathode	Grid	Fil.	Plate Current
1st RF	224	240	90	44	3	2.2	4
2nd RF	224	240	90	44	3	2.2	4
3rd RF	224	240	90	44	3	2.2	4
Det.	227	250	....	20	25	2.2	1
Audio	245	230	....	....	44	2.3	25
Audio	245	230	....	....	44	2.3	25
Rect.	280	......	....	....	....	4.8	30-30

AMERICAN BOSCH MAGNETO CORP.



Stage	Tube	Plate	Screen	Cathode	Grid	Fil.	Plate	Current
RF	551	225	90	18	3	2.2	3.5	MA
Oscillator	227	60	......	0	0	2.2	5	MA
1st Det.	551	225	80	8	7	2.2	2	MA
I.F.	551	240	80	4	3	2.2	4	MA
2nd Det.	227	130	......	0	15	2.2	1	MA
Audio	247	240	240	......	16	2.2	30	MA
Audio	247	240	240	......	16	2.2	30	MA
Rectifier	280	......	......	......	......	5	38	MA

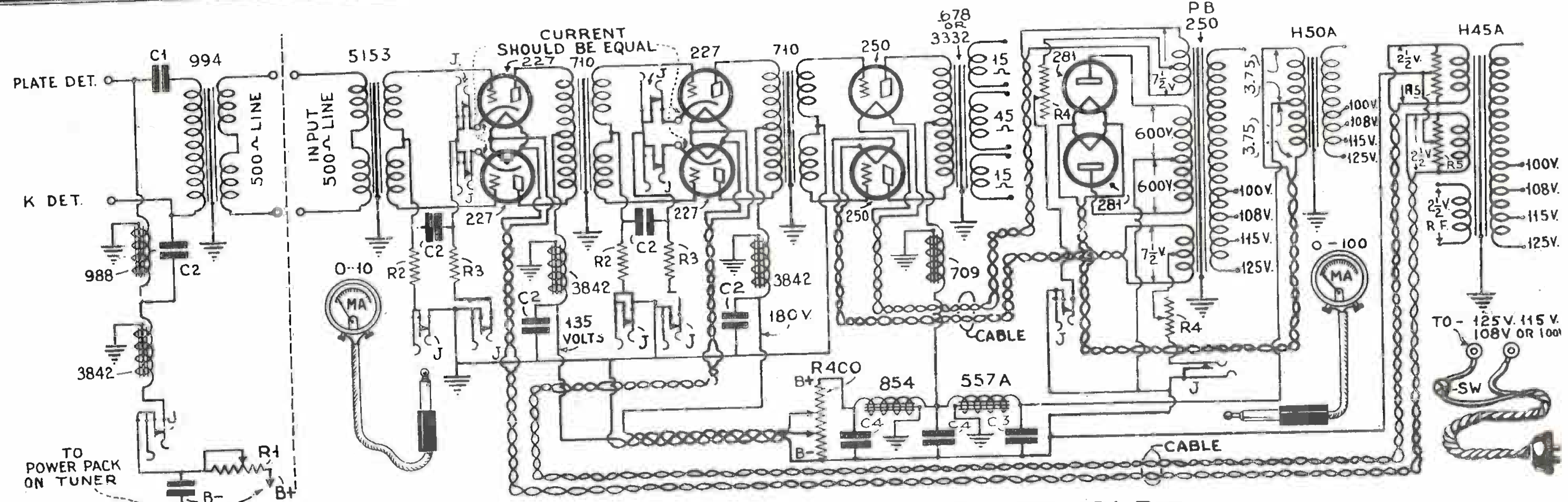
AMERICAN BOSCH MAGNETO CORP.



Bosch Motor Car Receiver

R-1—Volume Control 18,000 ohms
R-2—1st RF Bias Resistor 500 ohms
R-3—Detector Bias Resistor 25,000 ohms
R-4—Detector Screen Resistor 500,000 ohms
R-5—Detector Plate Resistor 500,000 ohms
R-6—Audio Grid Resistor 2 meg.
R-7—Series Grid Resistor 250,000 ohms
R-8—Filament Resistor 1.3 ohms
R-9—Filament Resistor 1.1 ohms
R-10—Audio Bias Resistor 900 ohms
C-1—1st RF Tuning Condenser
C-2—2nd RF Tuning Condenser
C-3—3rd RF Tuning Condenser
C-5—Screen By-pass Condenser .5mf.
C-6—Cathode By pass Condenser .5mf.
C-7—Plate By-pass Condenser 1.mf.
C-8—Detector Cathode Condenser .5mf.
C-9—Detector Screen Condenser .5mf.
C-10—Detector Plate Condenser .0001mf.
C-11—Detector Plate Condenser .0001mf.
C-12—Coupling Condenser .002mf.
C-13—Output Condenser 1.mf.
C-14—Filament By-pass Condenser
C-15—1st RF Alignment Condenser
C-16—3rd RF Alignment Condenser
C-17—Det. Alignment Condenser
C-18—Speaker Condenser

AMERICAN TRANSFORMER CO. (AMERTRAN)



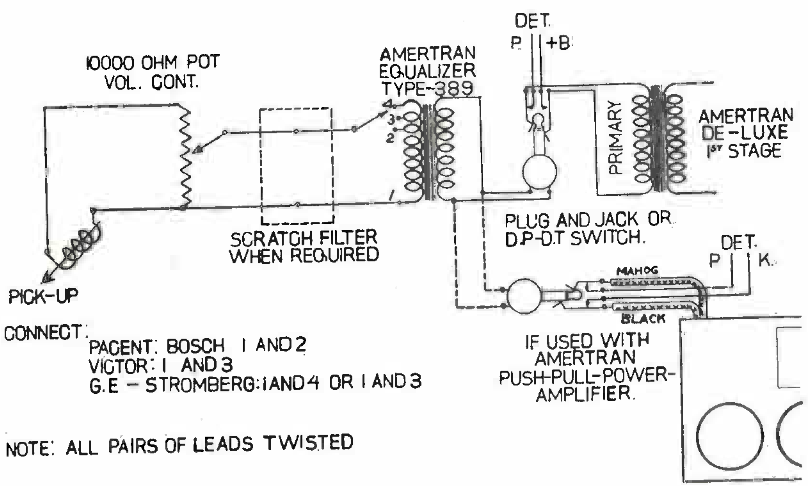
~ DE LUXE RECORDING AMPLIFIER ~

I...	994	AMERTRAN TRANSFORMER FROM DETECTOR TO 500 OHM LINE
I...	5I53	AMERTRAN TRANSFORMER FROM 500 OHM LINE TO GRIDS OF TUBES
2...	7I0	AMERTRAN TRANSFORMER BETWEEN OUTPUT OF 2 TUBES AND 2 GRIDS
I...	678	AMERTRAN TRANSFORMER TO 200 OHM LINE OR TO 9 I5-OHM VOICE COILS
	OR	
I...	3332	AMERTRAN TRANSFORMER TO 500 OHM LINE AND I5 OHM MONITOR
I...	988	AMERTRAN PARALLEL FEED ALLOY CORE CHOKE
3...	3842	AMERTRAN ALLOY CORE AUDIO CHOKES
I...	577A	AMERTRAN FILTER CHOKE
I...	250A	AMERTRAN POWER BLOCK; 709,854 FILTER CHOKES INCLUDED
I...	H50A	AMERTRAN 7½ VOLT FILAMENT TRANSFORMER
I...	H45A	AMERTRAN 2½ VOLT FILAMENT TRANSFORMER
I...	R400	AMERTRAN VOLTAGE DIVIDER
CI	¼MFD	AEROVOX 307 TYPE CONDENSER
C2	2MFD	AEROVOX 307 TYPE CONDENSER
C3	2MFD	AEROVOX I002TYPE CONDENSER
C4	4MFD	AEROVOX 802 TYPE CONDENSER

OR

C2, C3, C4, IN AEROVOX B-I000 CONDENSER BLOCK

RI	I00,000 OHM VARIABLE, ELECTRAD OR CENTRALAB
R2	50,000 OHM DURHAM, AEROVOX OR EL-MENCO 3 WATT RATING
R3	I000 OHM VARIABLE CENTRALAB
R4	2000 OHM VARIABLE WARD LEONARD ADJUSTAT
R5	20 OHM CENTER TAPPED AEROVOX OR CLAROSTAT HUMDINGER
J	CLOSED CIRCUIT JACKS

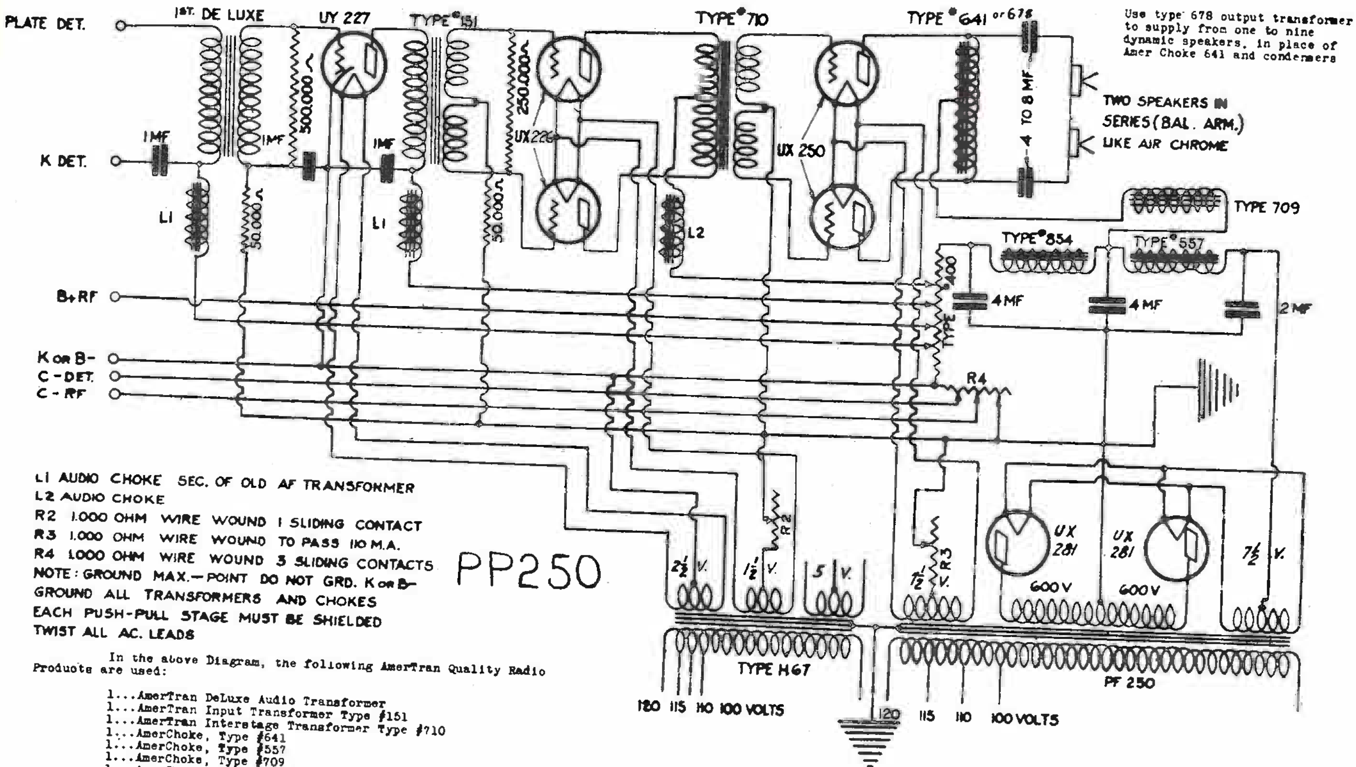


CONNECT: PACENT: BOSCH I AND 2
VICTOR: I AND 3
G.E – STROMBERG: I AND 4 OR I AND 3

NOTE: ALL PAIRS OF LEADS TWISTED

PHONOGRAPH-PICK-UP- CIRCUIT DIAGRAM

AMERICAN TRANSFORMER CO. (AMERTRAN)



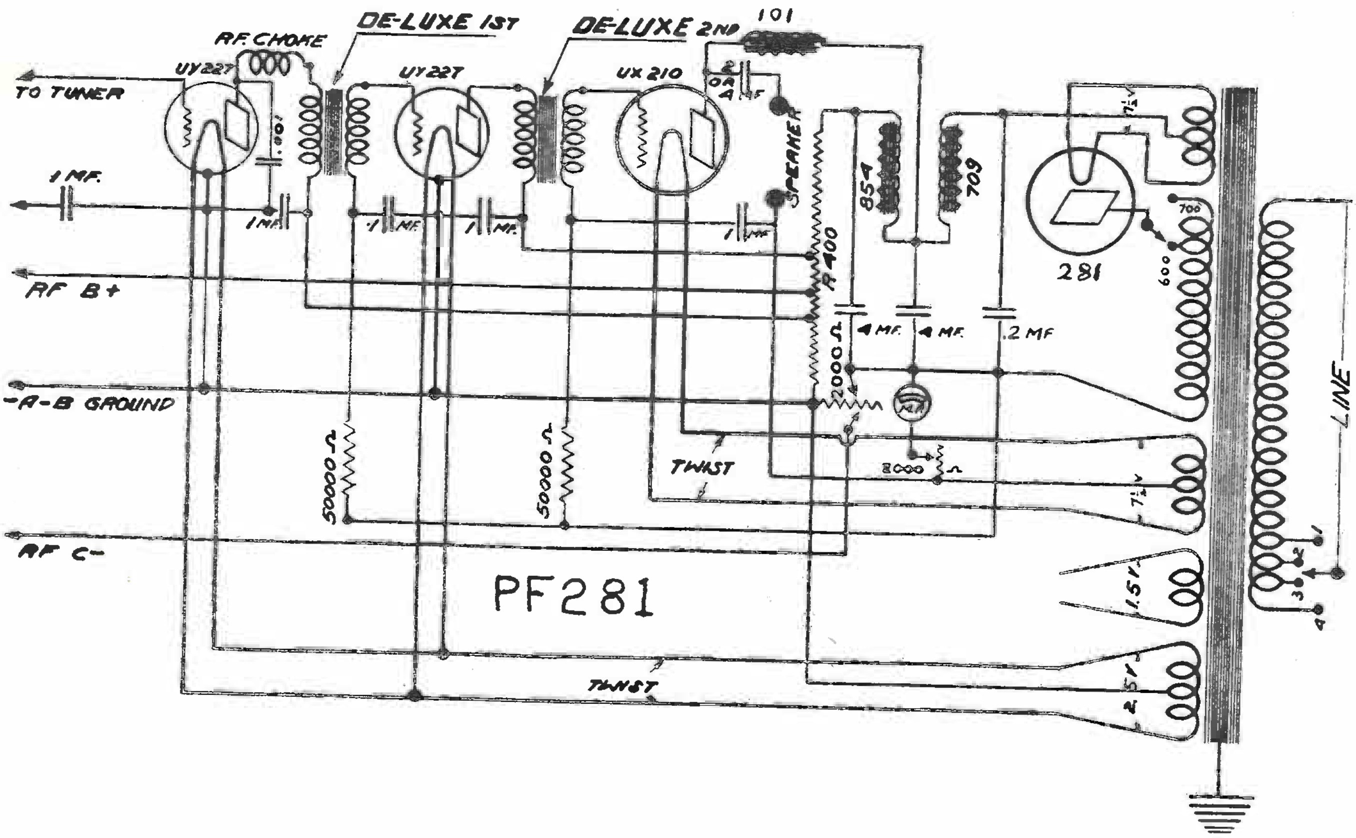
L1 AUDIO CHOKE SEC. OF OLD AF TRANSFORMER
L2 AUDIO CHOKE
R2 1.000 OHM WIRE WOUND 1 SLIDING CONTACT
R3 1.000 OHM WIRE WOUND TO PASS 110 M.A.
R4 1.000 OHM WIRE WOUND 3 SLIDING CONTACTS
NOTE: GROUND MAX.—POINT DO NOT GRD. K OR B-
GROUND ALL TRANSFORMERS AND CHOKES
EACH PUSH-PULL STAGE MUST BE SHIELDED
TWIST ALL AC. LEADS

In the above Diagram, the following AmerTran Quality Radio Products are used:

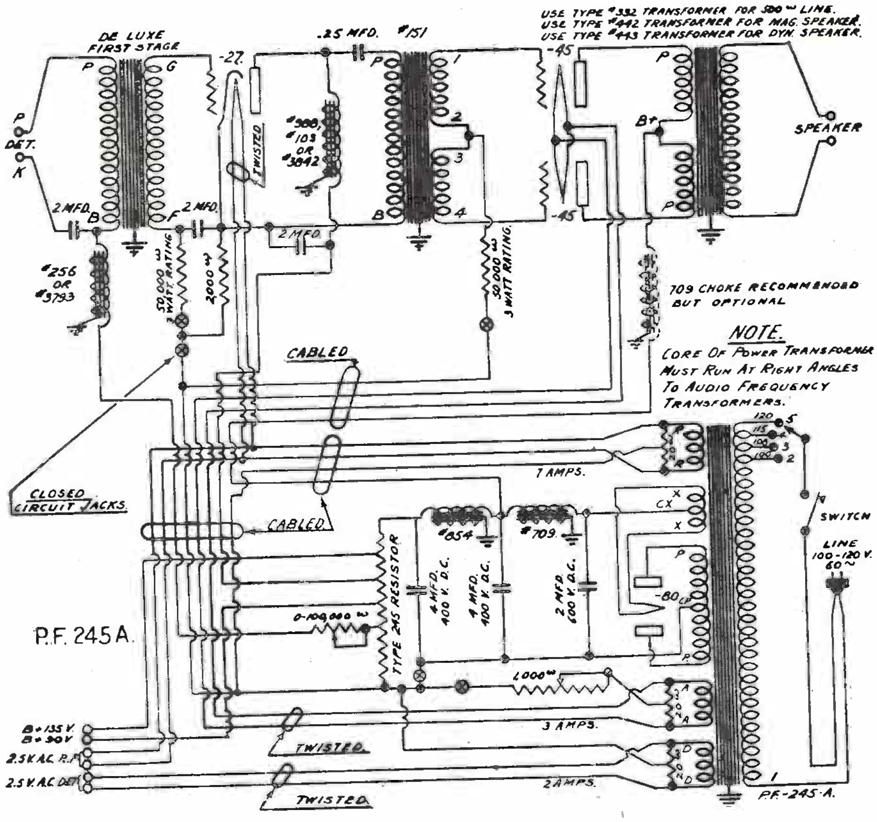
1...AmerTran DeLuxe Audio Transformer
1...AmerTran Input Transformer Type #151
1...AmerTran Interstage Transformer Type #710
1...AmerChoke, Type #641
1...AmerChoke, Type #557
1...AmerChoke, Type #709
1...AmerChoke, Type #854
1...AmerTran Voltage Divider, Type R400
1...AmerTran Power Transformer, Type PF 250
1...AmerTran Heater Transformer, Type H 67

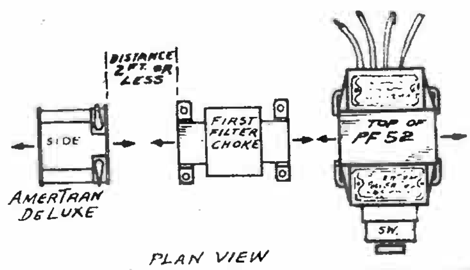
The Output from the two UX 250 tubes to dynamic type speakers should be through an AmerTran special output transformer designed to operate the type and number of speakers to be used.

Further information on request.



AMERICAN TRANSFORMER CO. (AMERTRAN)





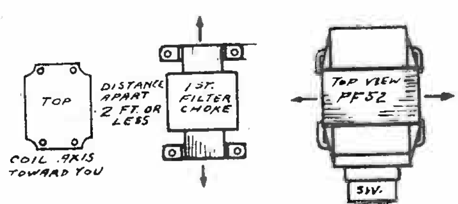
PLAN VIEW

INCORRECT

(THIS IS POSITION OF MAXIMUM COUPLING AND HUM)

AXES OF ALL COILS COINCIDE

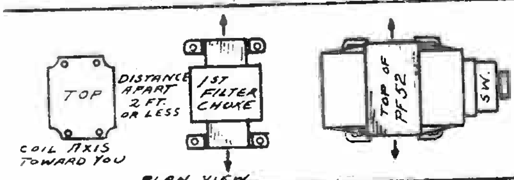
ARROWS SHOW DIRECTION OF MAGNETIC FIELD.



PLAN VIEW

INCORRECT BUT BETTER THAN ABOVE

AXIS OF COIL IN PF52 IS STILL POINTING TOWARD DE LUXE, ALTHO DE LUXE AXIS VERTICAL AND AT RIGHT ANGLES.

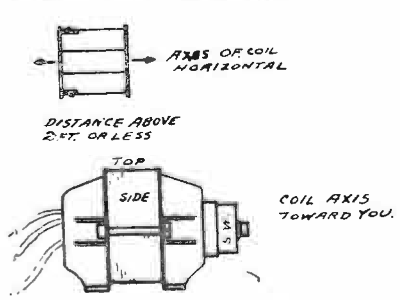


PLAN VIEW

CORRECT

POSITION OF LEAST COUPLING. LITTLE OR NO HUM.

AXIS OF PF52 COIL AND CHOKE ARE BOTH AT RIGHT ANGLES TO DE LUXE COIL FROM ALL VIEW POINTS.



ELEVATION VIEW

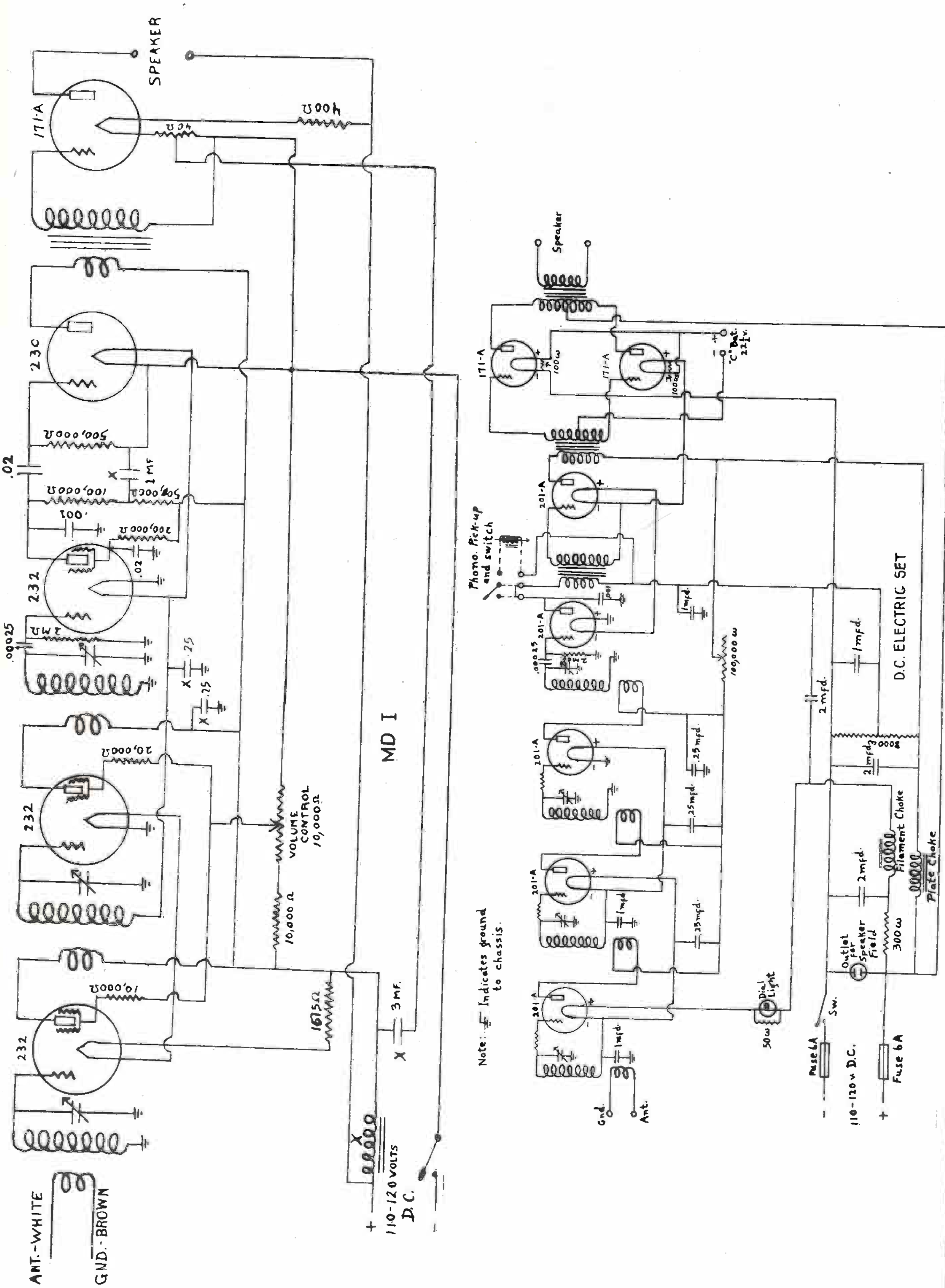
CORRECT POSITION IF AMPLIFIER MOUNTED DIRECTLY ABOVE PF52

ELIMINATION OF HUM CAUSED BY 60 CYCLE MAGNETIC FIELD FROM POWER TRANSFORMER AND FIRST FILTER CHOKE.

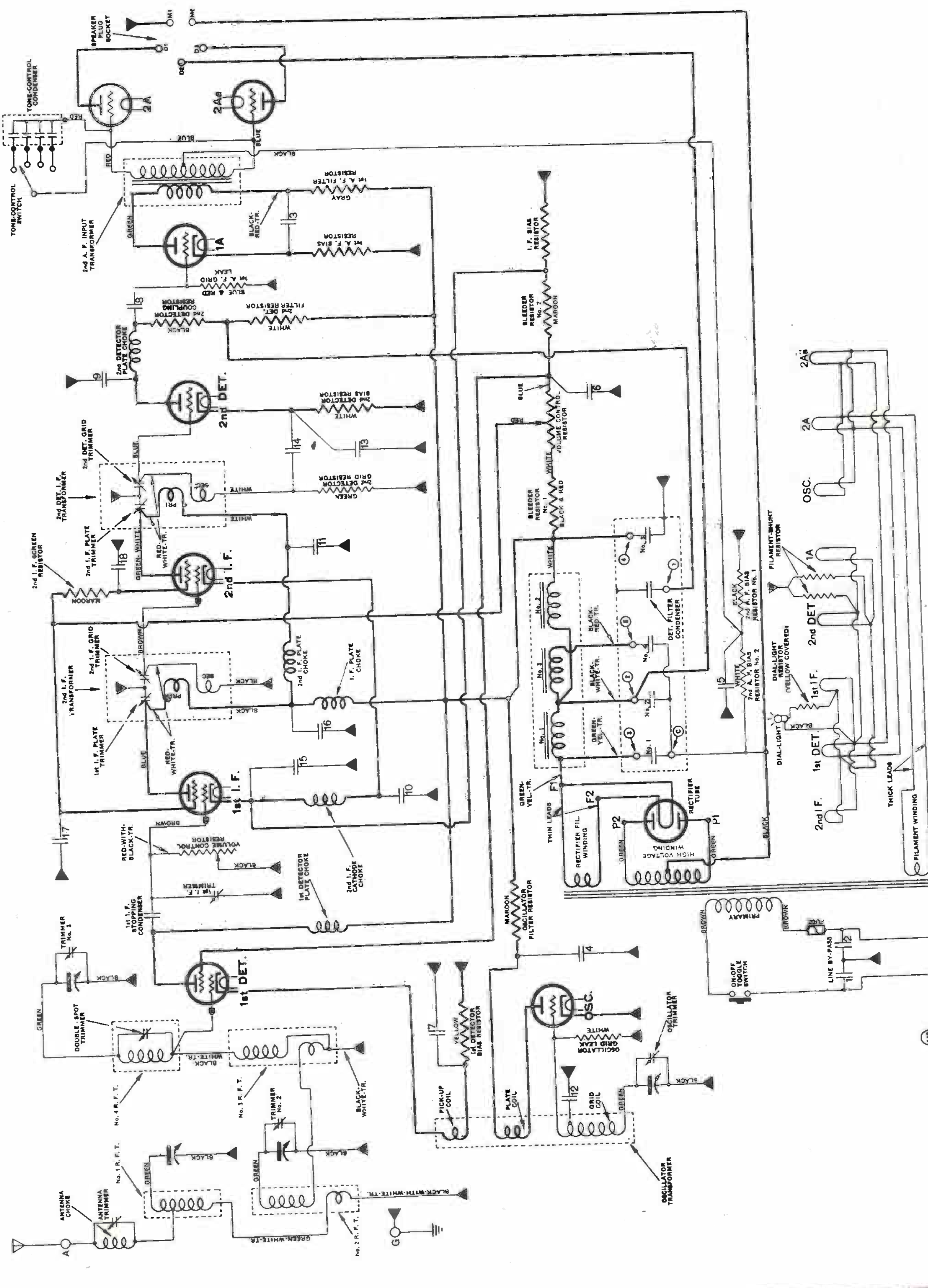
THE MOST EFFECTIVE SHIELDING IS THAT PRODUCED BY A HEAVY COPPER OR BRASS BOX AROUND THE POWER TRANSFORMER AND FIRST FILTER CHOKE. THE SECOND CHOKE SHOULD BE OUTSIDE OF THIS BOX. THE DISTANCE APART OF CHOKES AND BETWEEN FIRST CHOKE AND POWER TRANS. SHOULD NOT BE LESS THAN 1½" TO 2"

HUM MAY ALSO BE CAUSED BY INTERSTAGE COUPLING IN THE AUDIO AMPLIFIER, DEFECTIVE TUBES, IMPROPER GAPS IN CHOKES, AND MUST NOT BE CONFUSED WITH HUM FROM FIELD SURROUNDING POWER TRANSFORMER

ANSLEY RADIO LABORATORIES

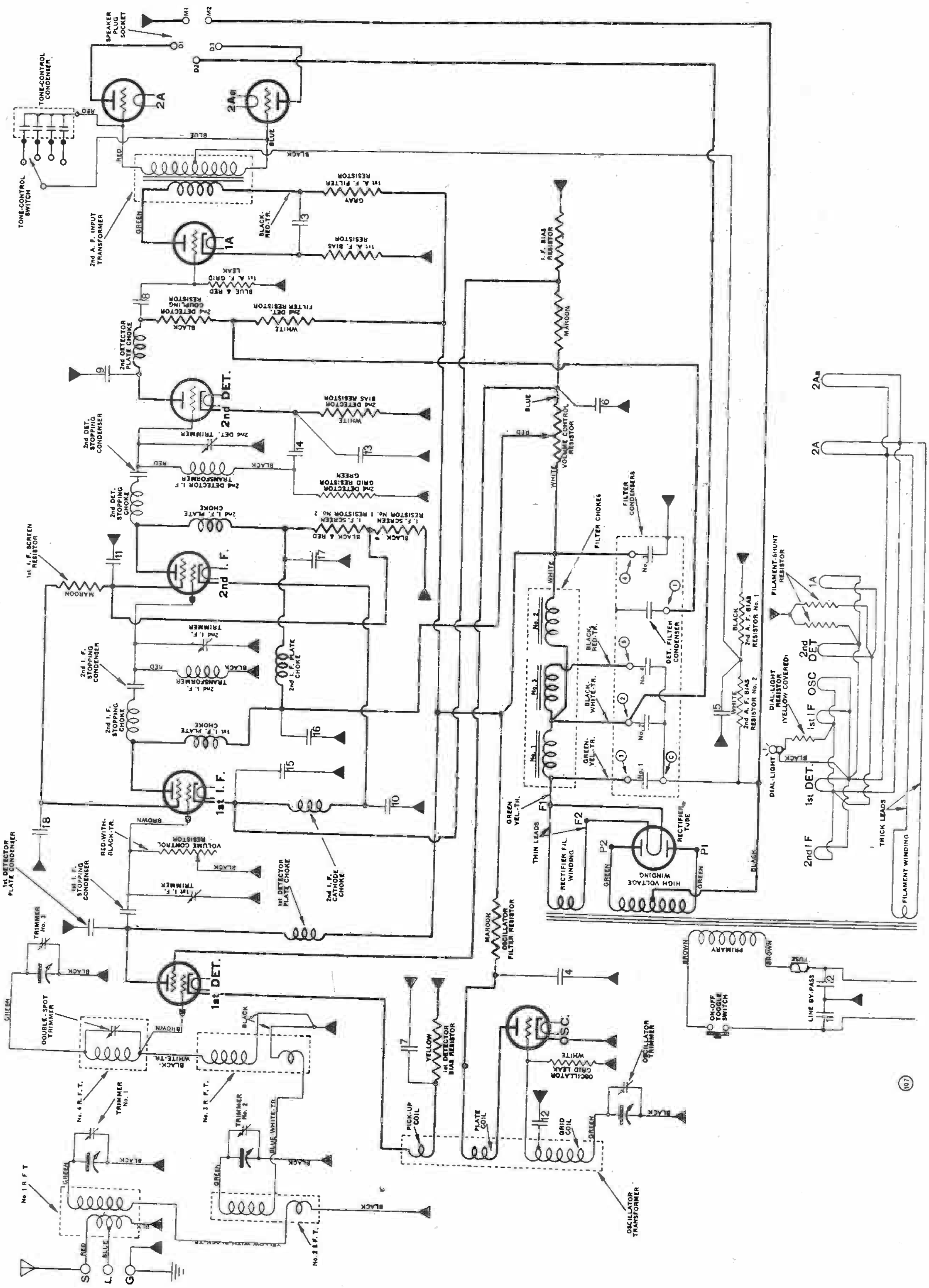


ATWATER KENT MANUFACTURING CO.



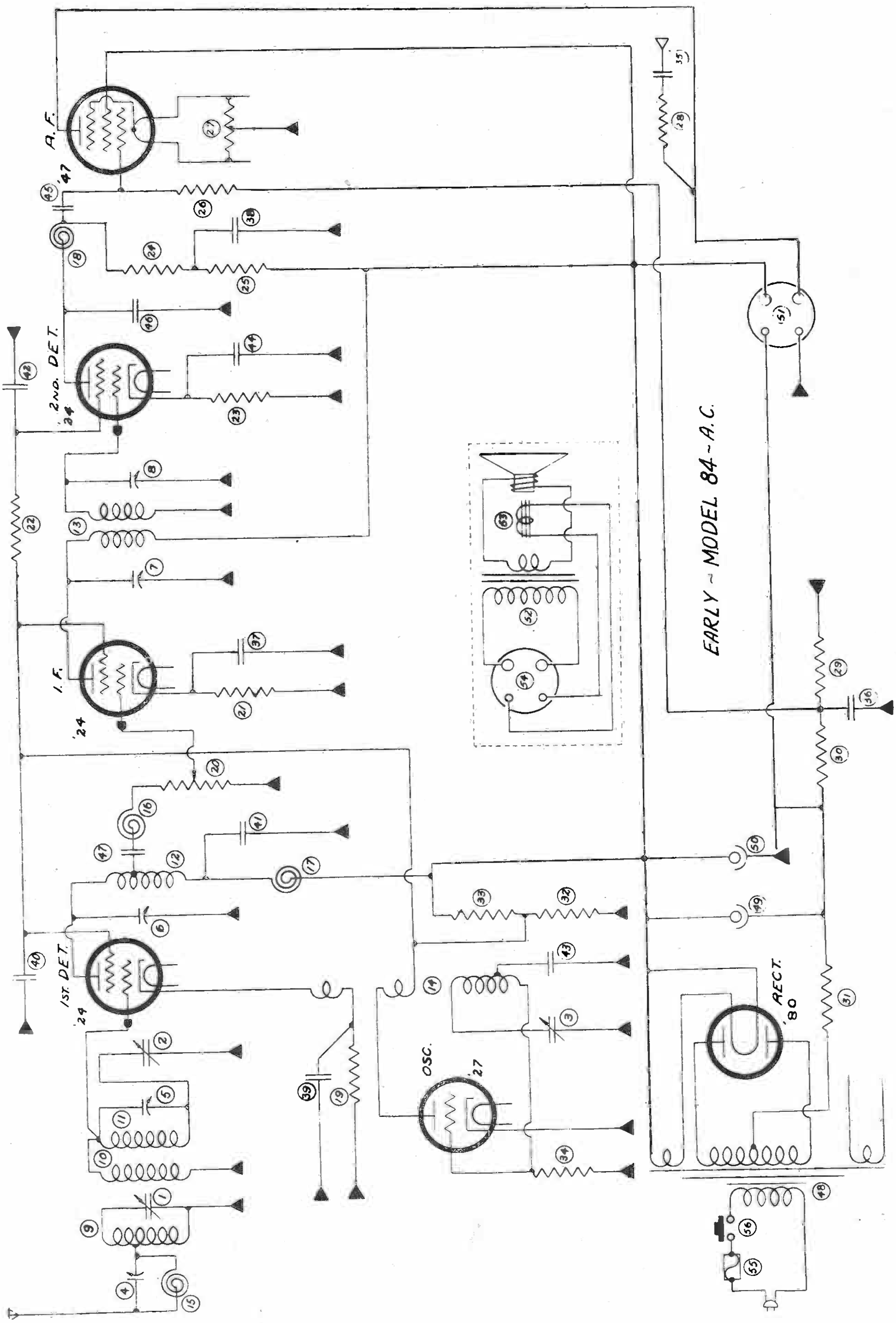
SCHEMATIC DIAGRAM OF TYPE H-2 CHASSIS

ATWATER KENT MANUFACTURING CO.

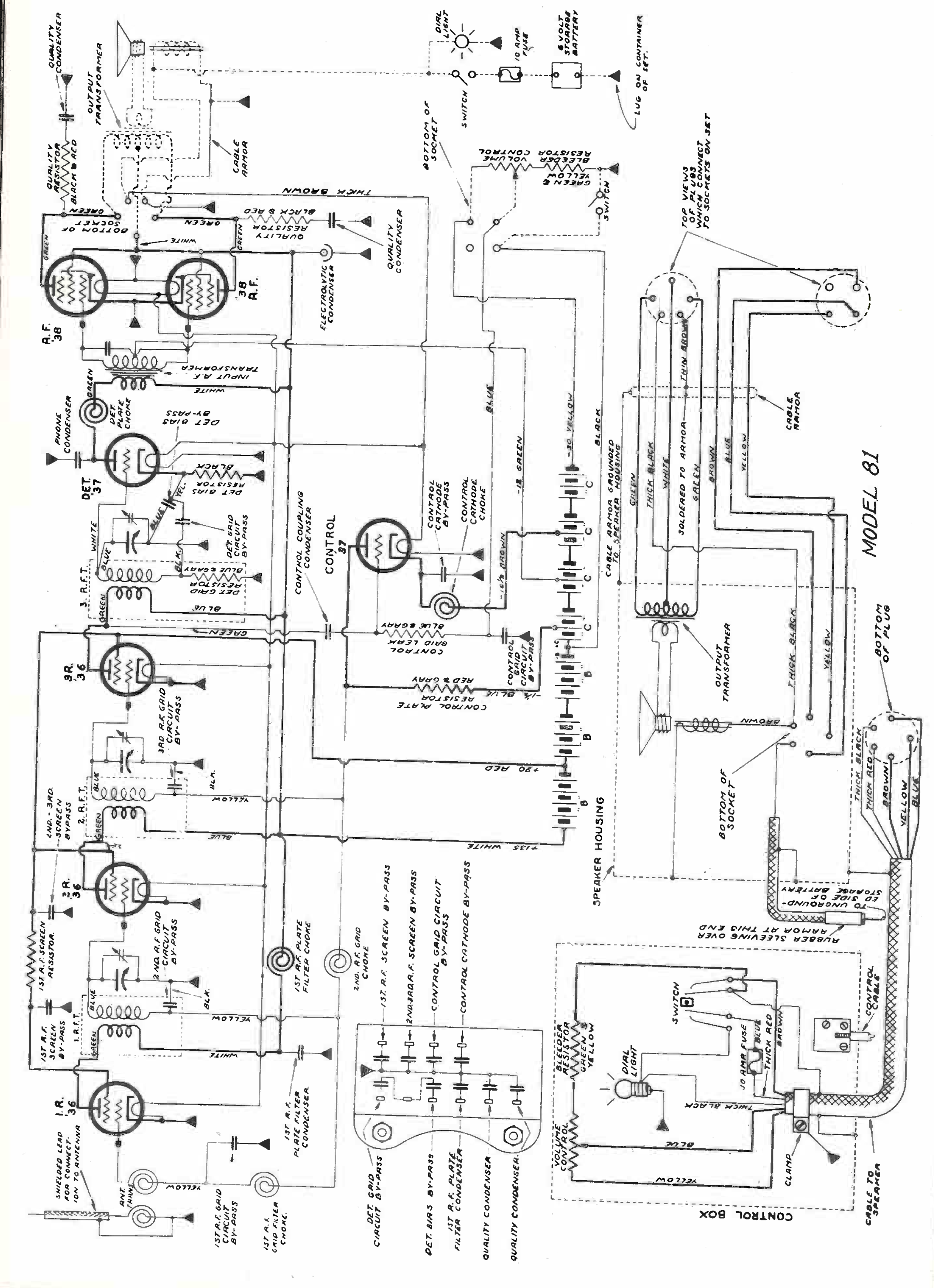


Schematic Diagram of Type H-1 Chassis

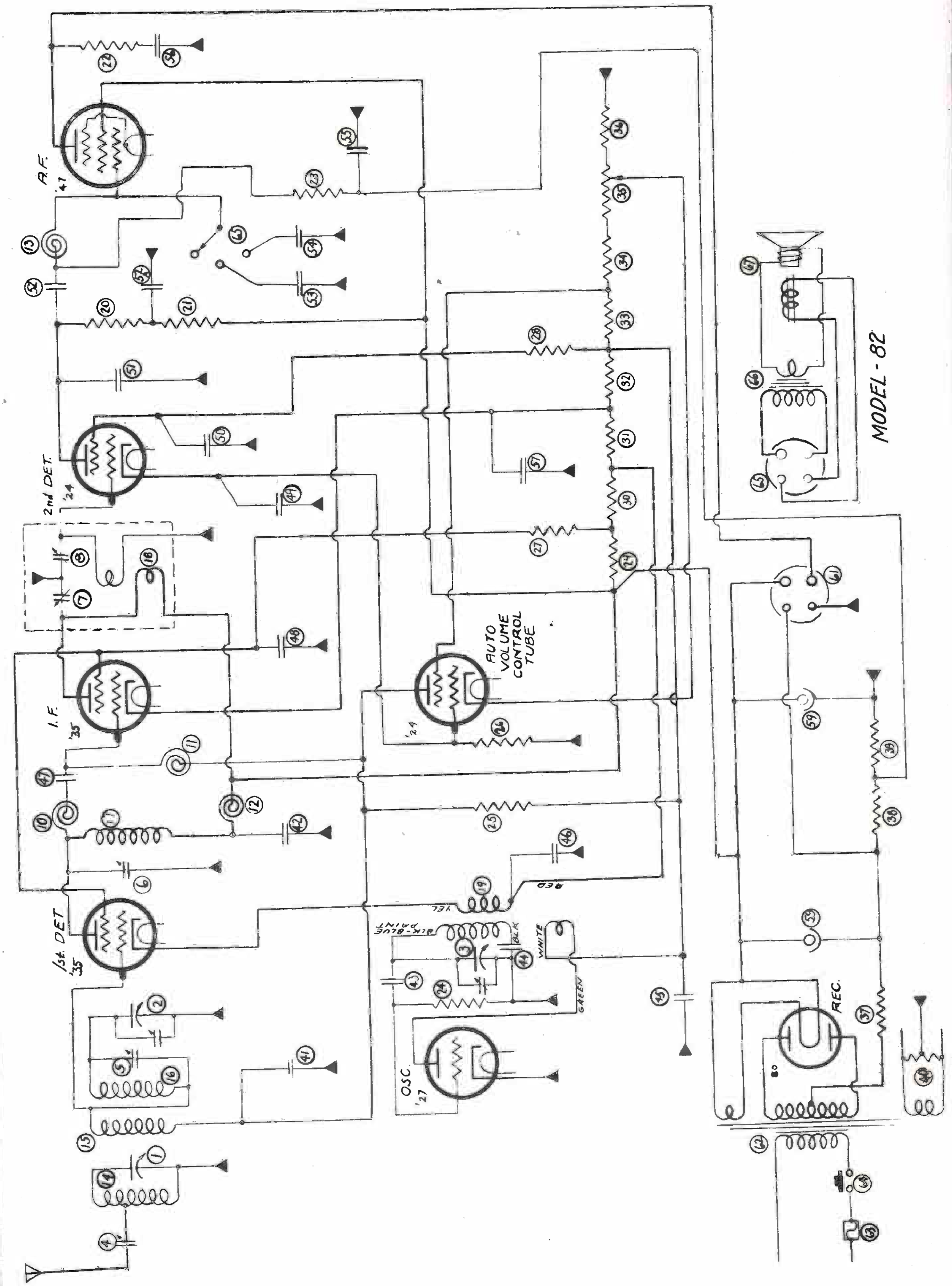
ATWATER KENT MANUFACTURING CO.



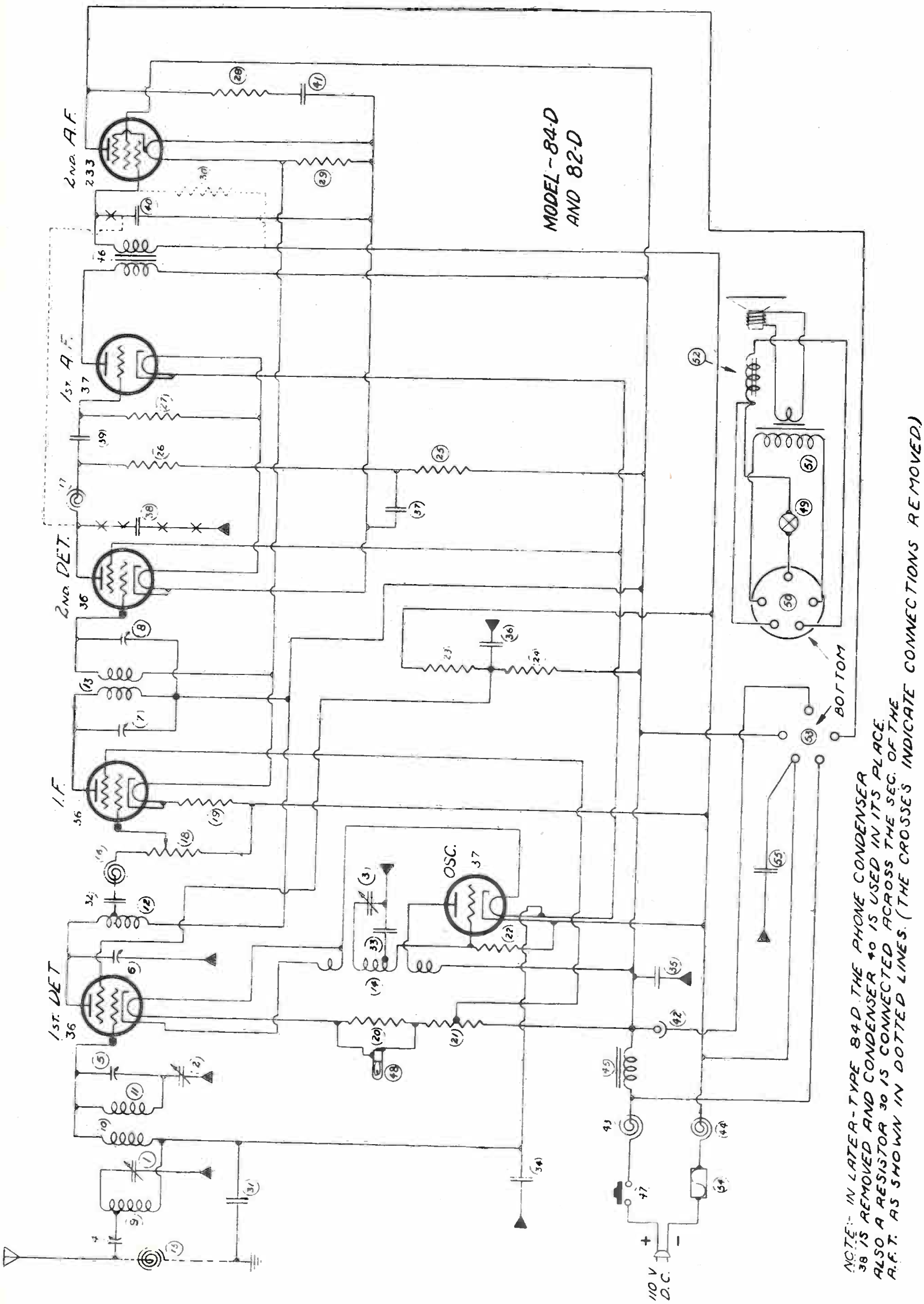
ATWATER KENT MANUFACTURING CO.



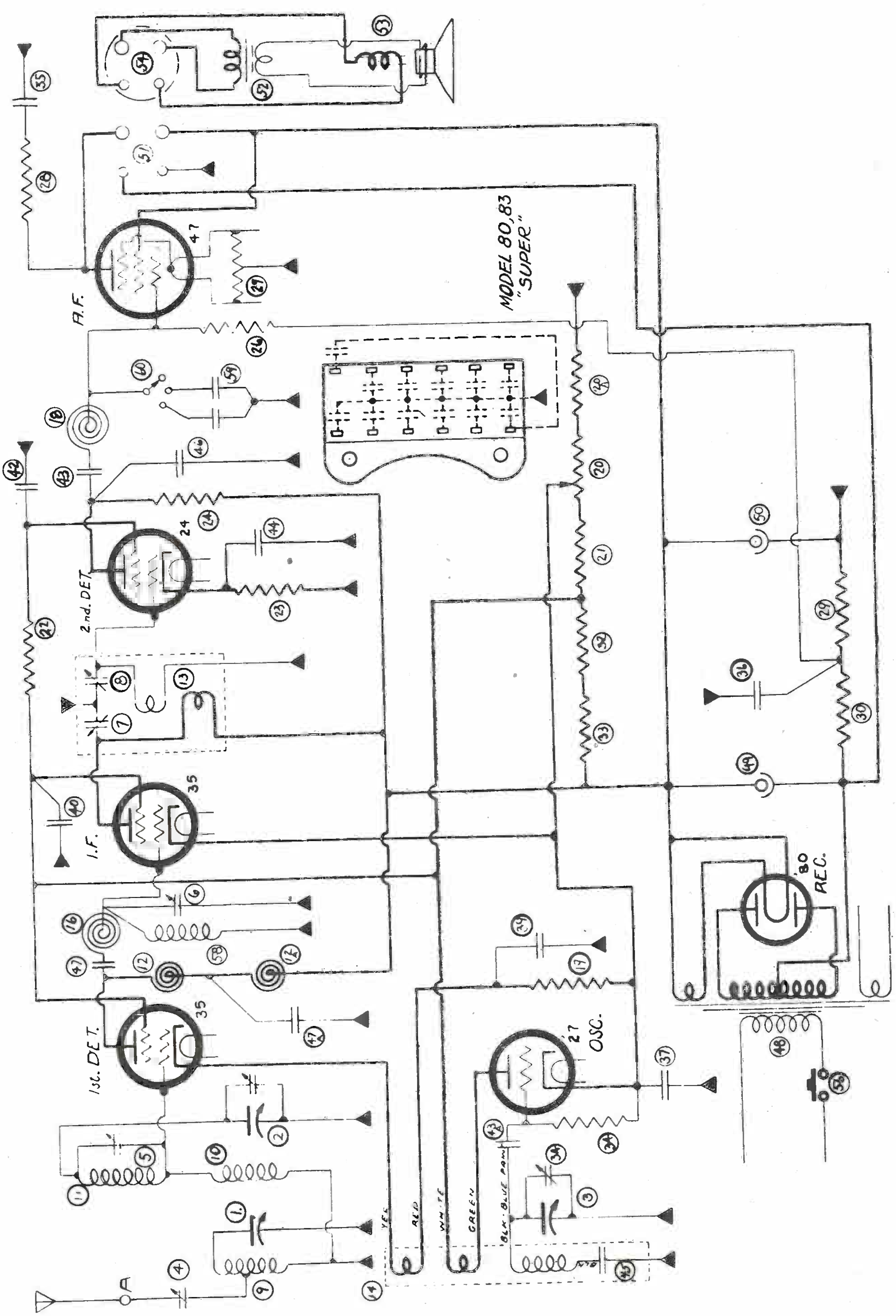
ATWATER KENT MANUFACTURING CO.



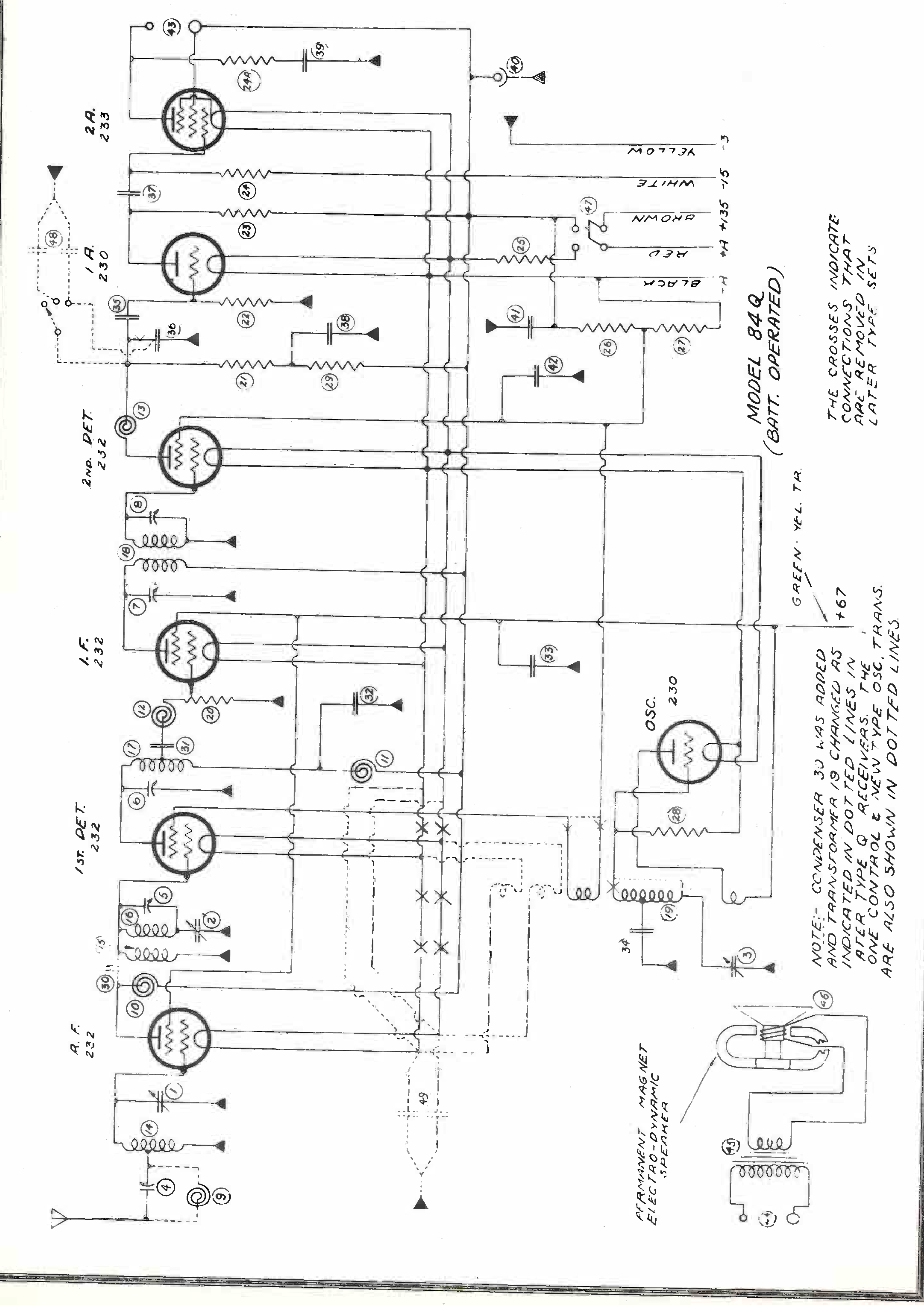
ATWATER KENT MANUFACTURING CO.



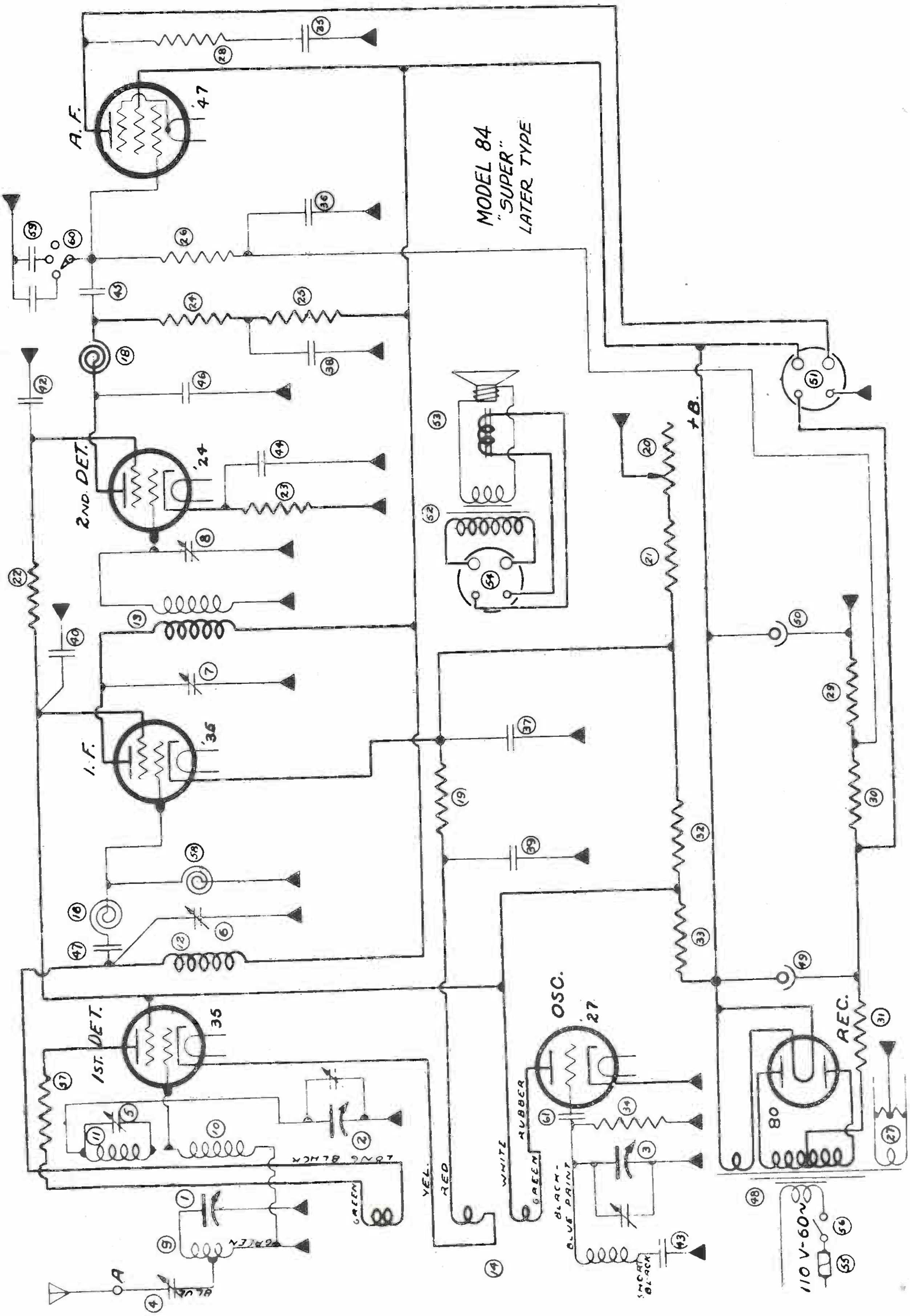
ATWATER KENT MANUFACTURING CO.



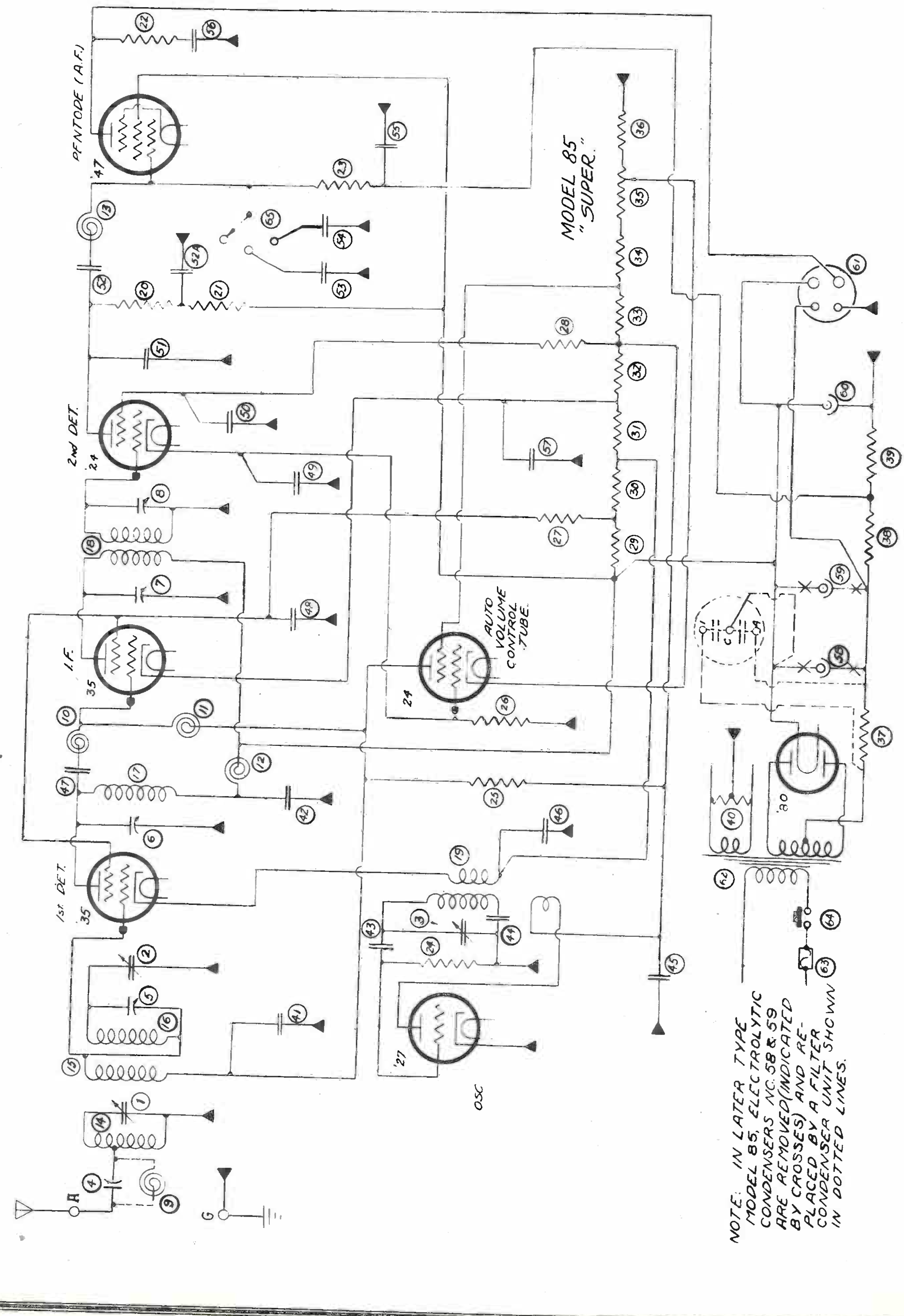
ATWATER KENT MANUFACTURING CO.



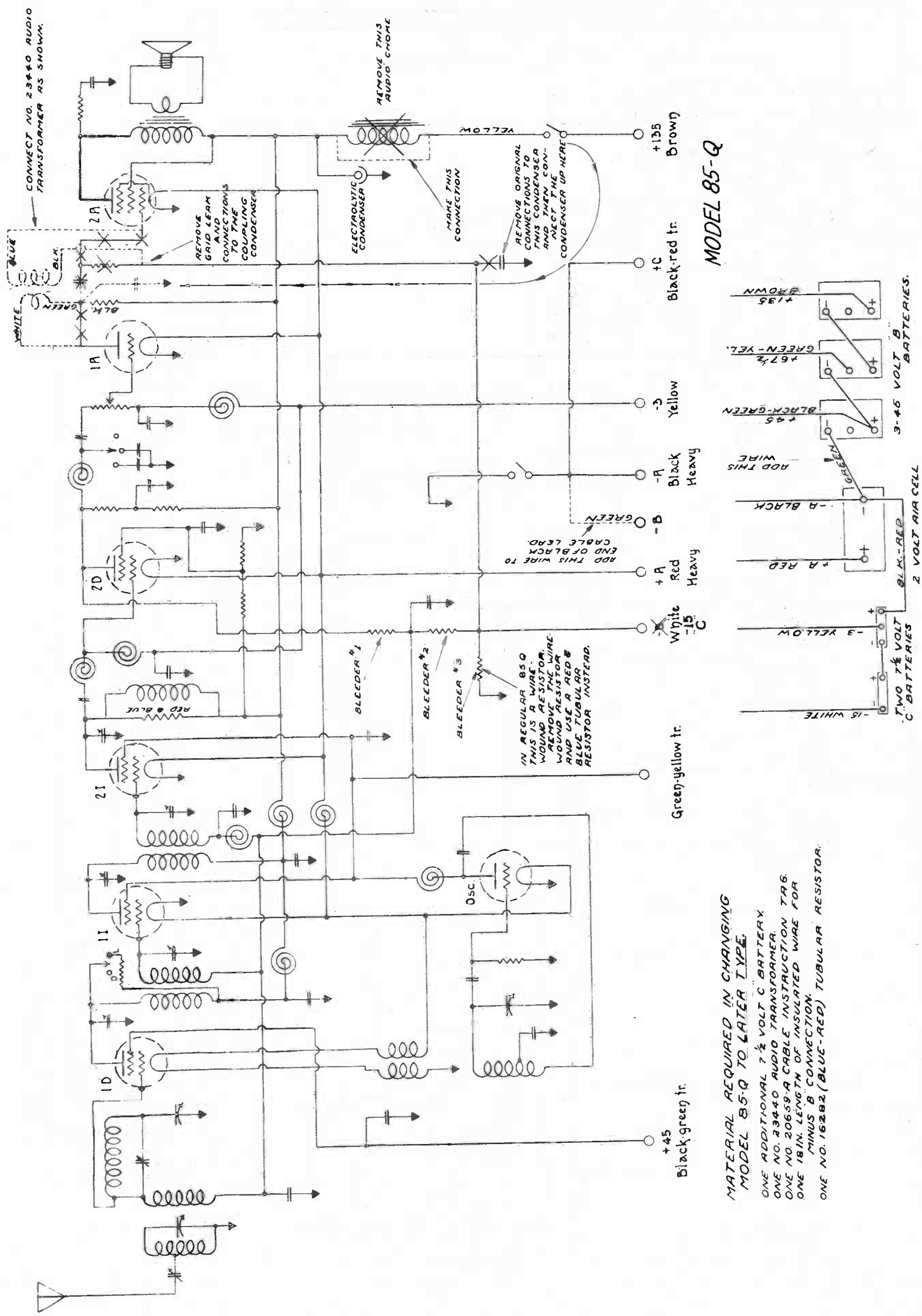
ATWATER KENT MANUFACTURING CO.



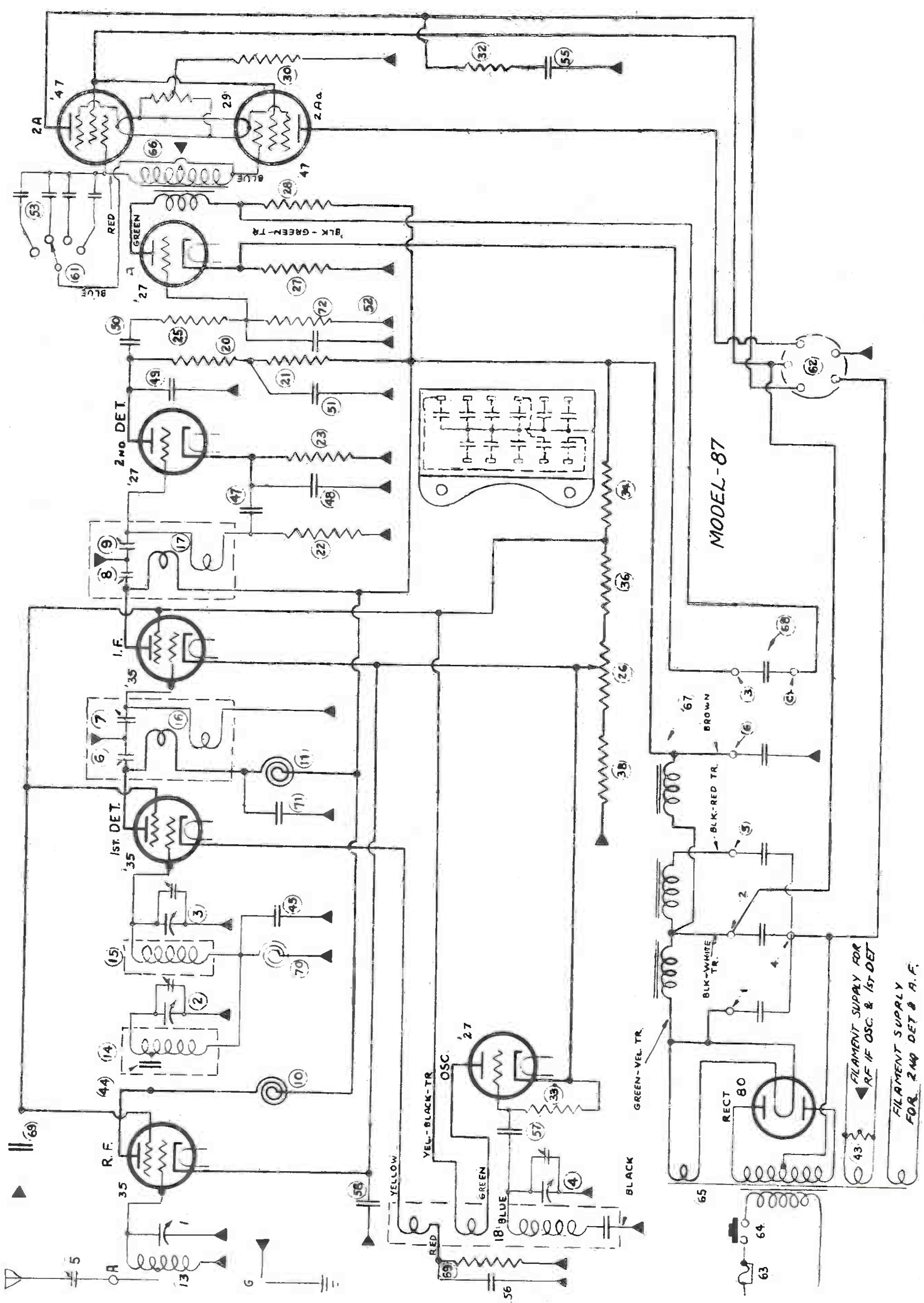
ATWATER KENT MANUFACTURING CO.



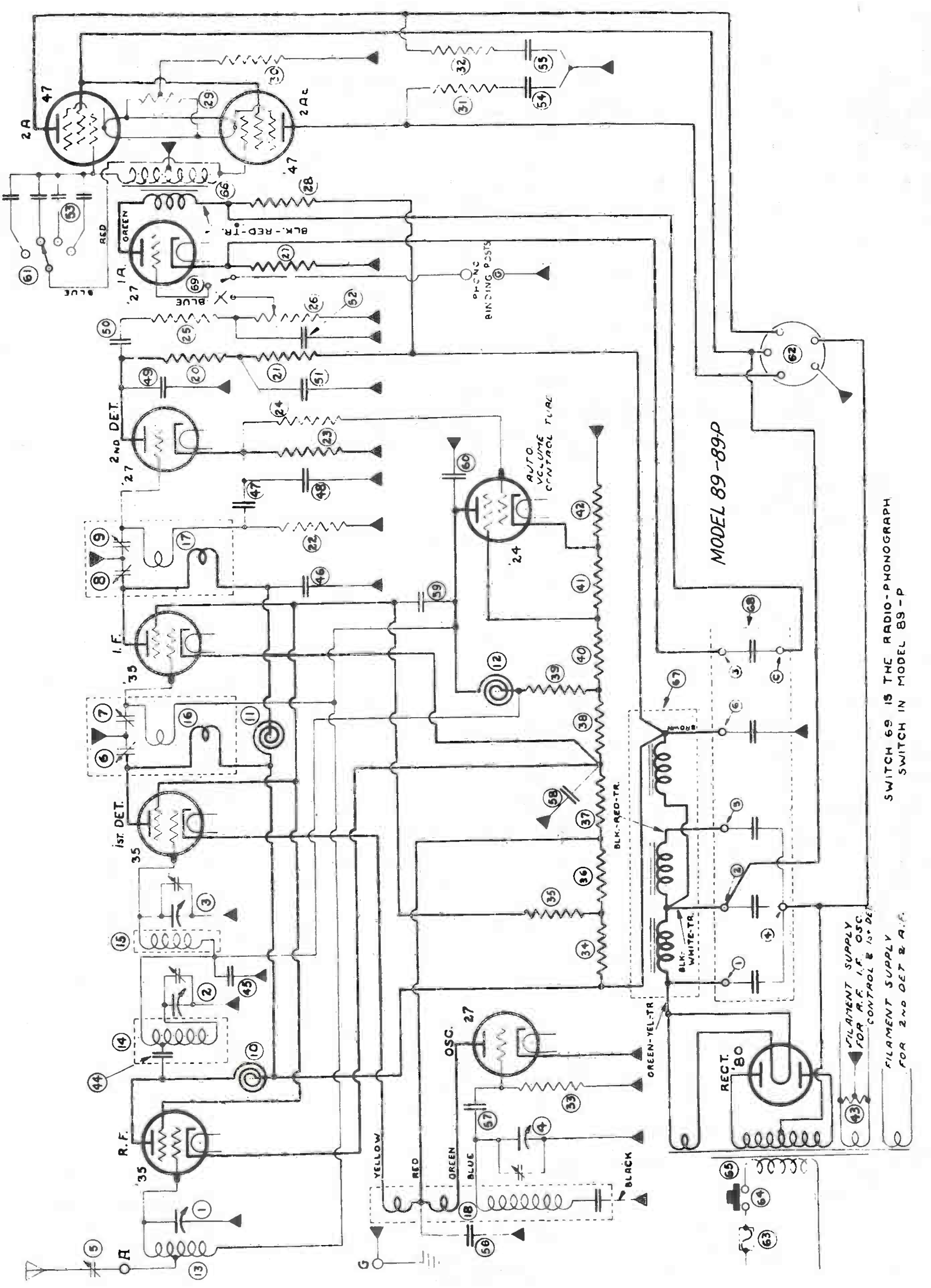
ATWATER KENT MANUFACTURING CO.



ATWATER KENT MANUFACTURING CO.



ATWATER KENT MANUFACTURING CO.



ATWATER KENT MANUFACTURING CO.

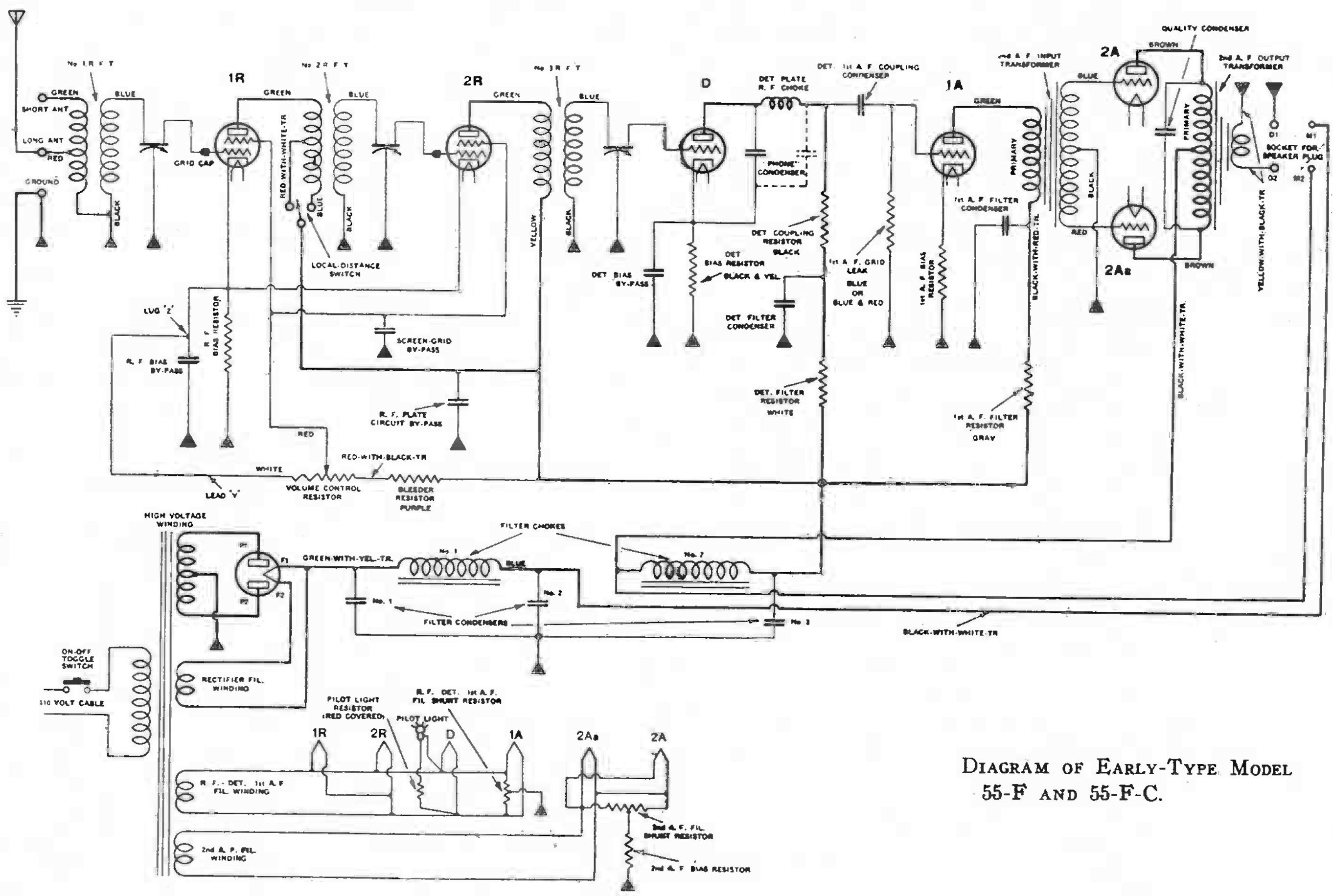


Diagram of Early-Type Model 55-F and 55-F-C.

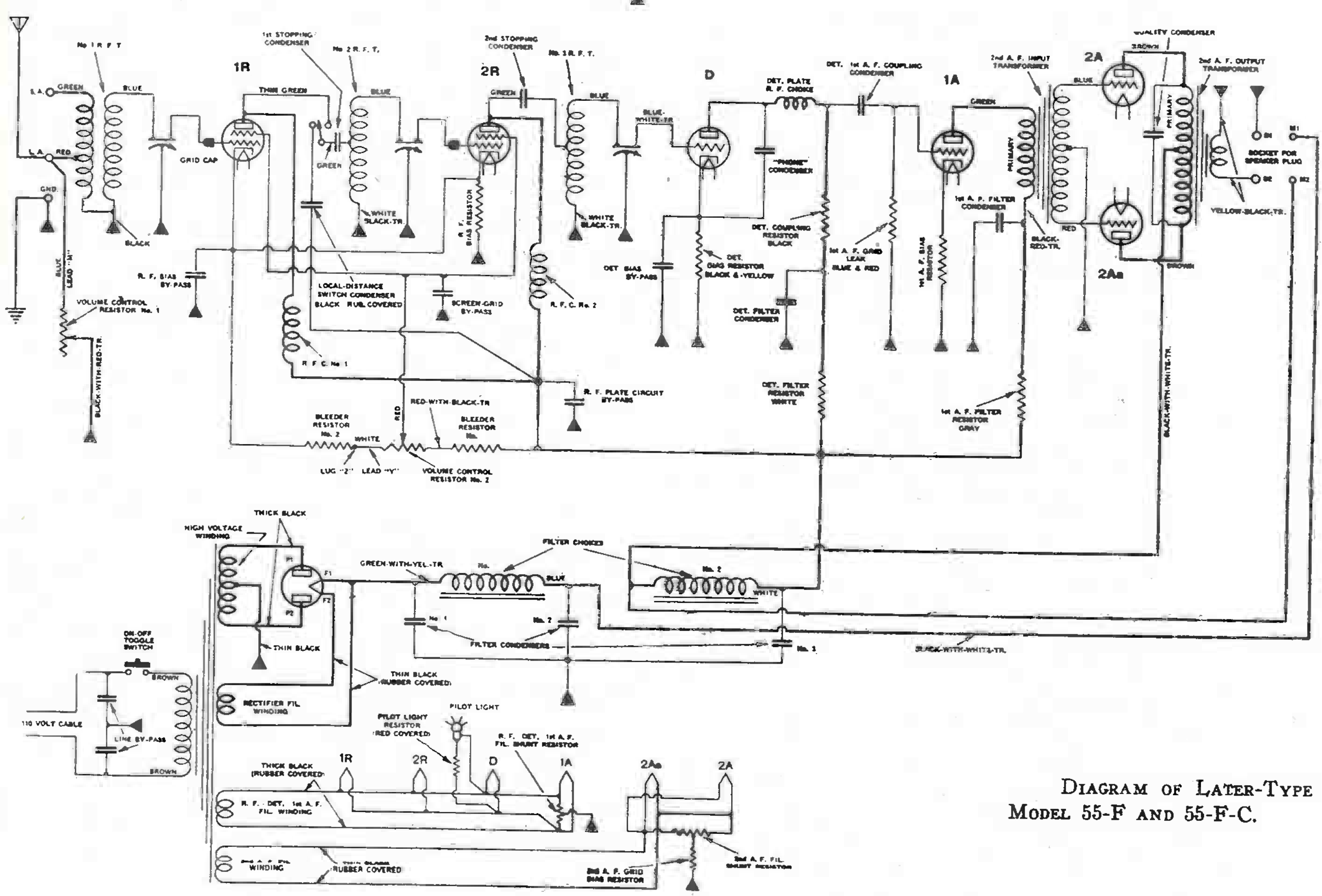


Diagram of Later-Type Model 55-F and 55-F-C.

ATWATER KENT MANUFACTURING CO.

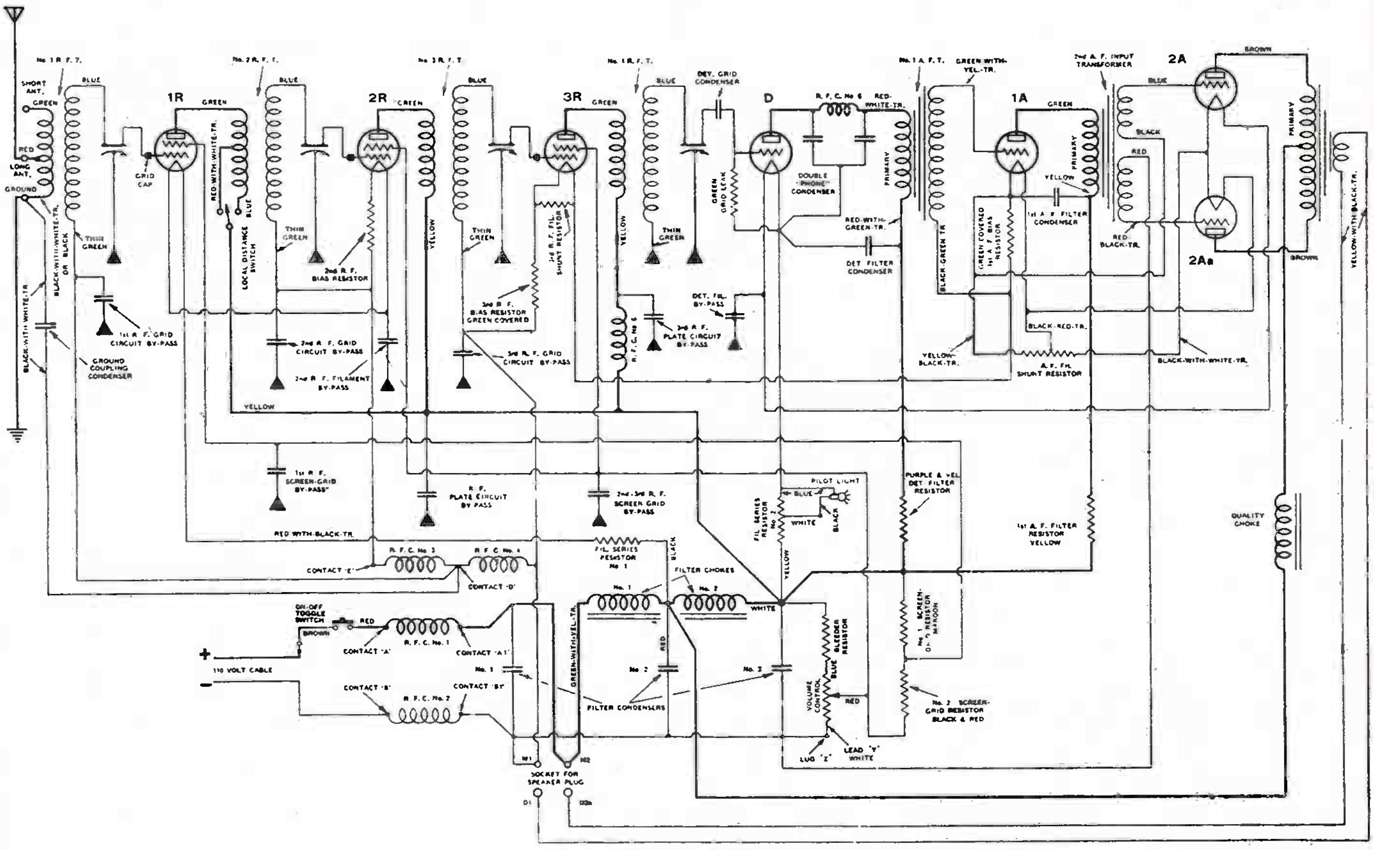
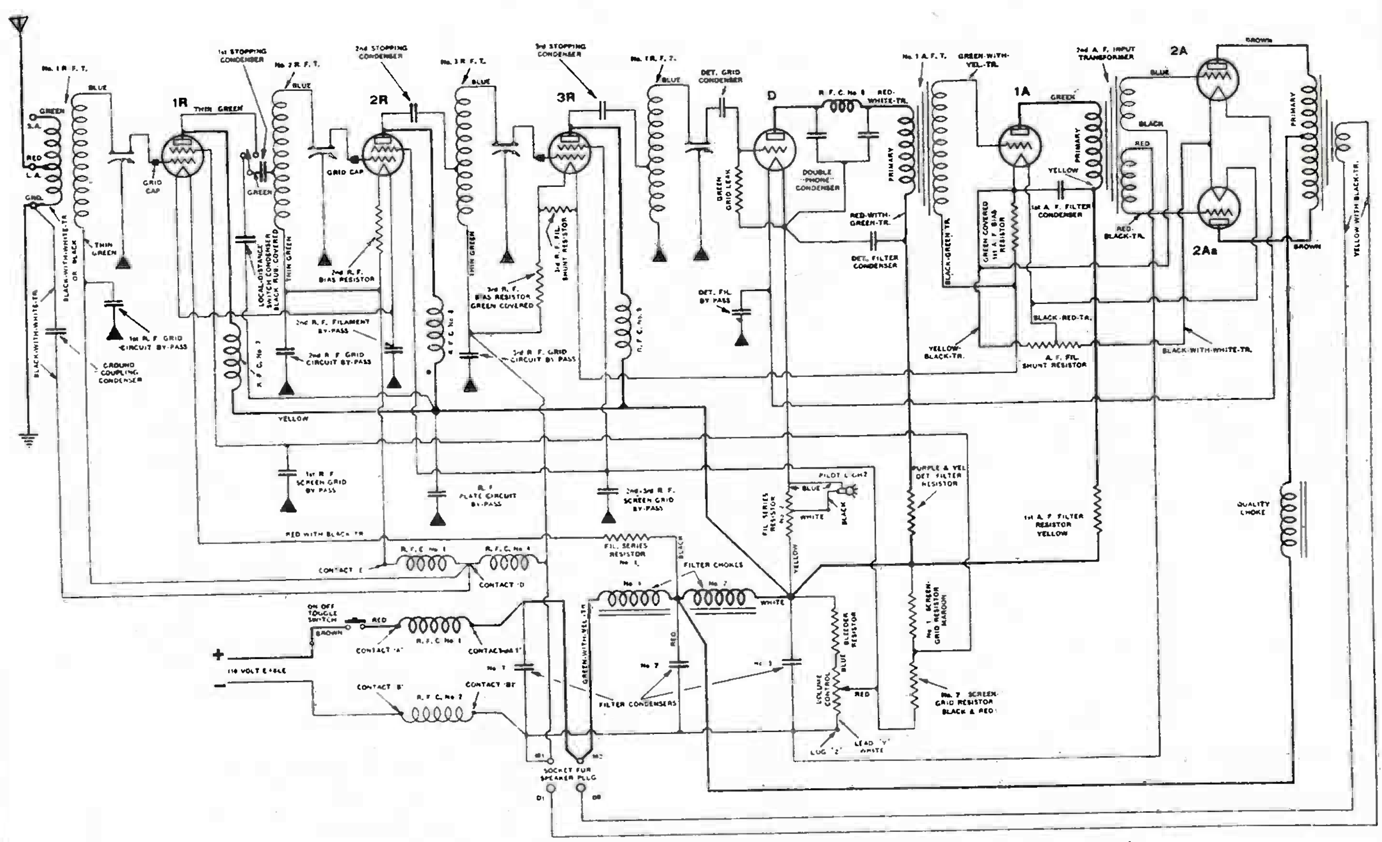
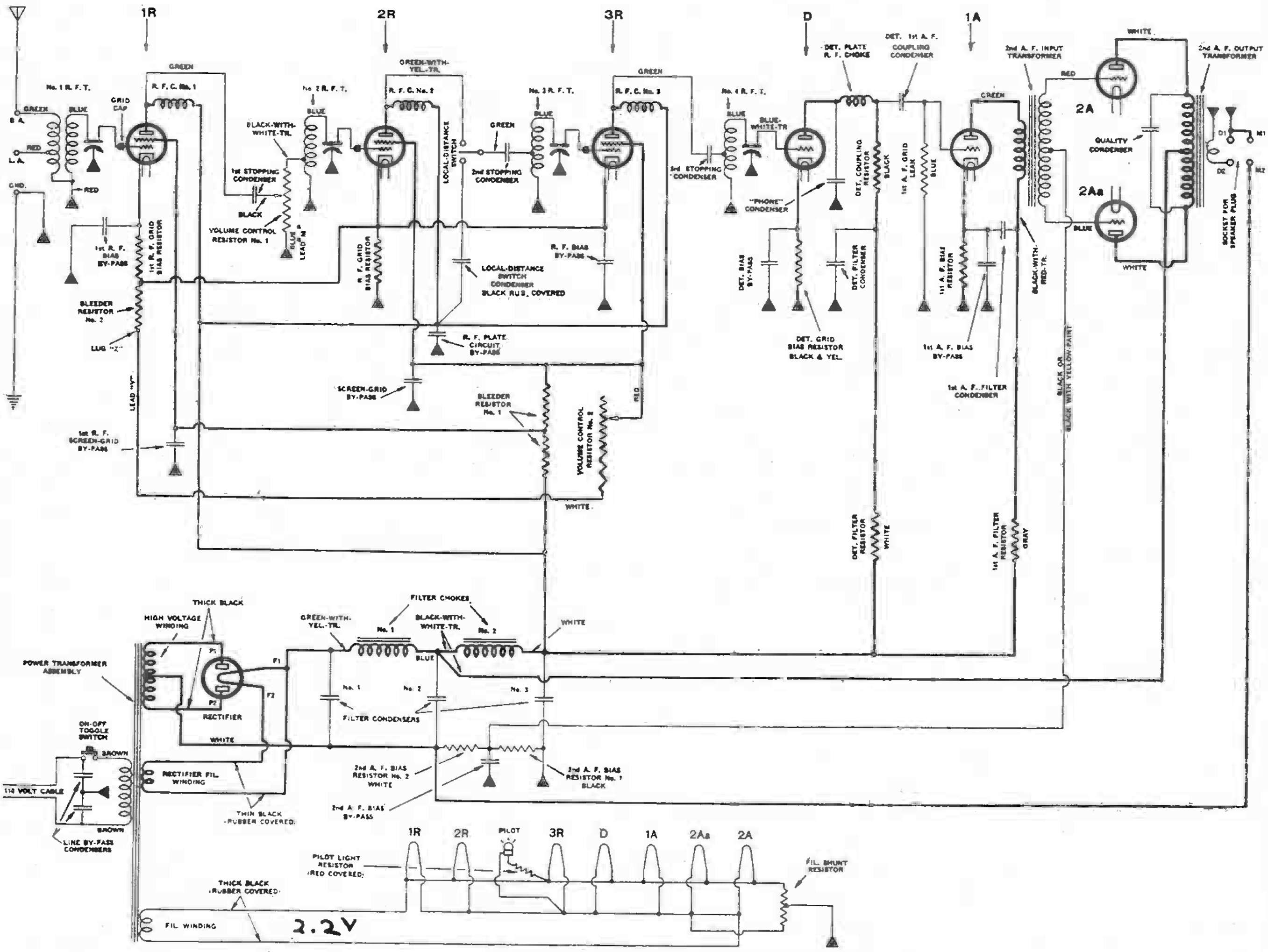


Diagram of Early Model 61 and 61-C (Direct Current).



Schematic Diagram of Later Model 61 and 61-C (Direct Current).

ATWATER KENT MANUFACTURING CO.



Circuit of Later Model 60 and 60-C.

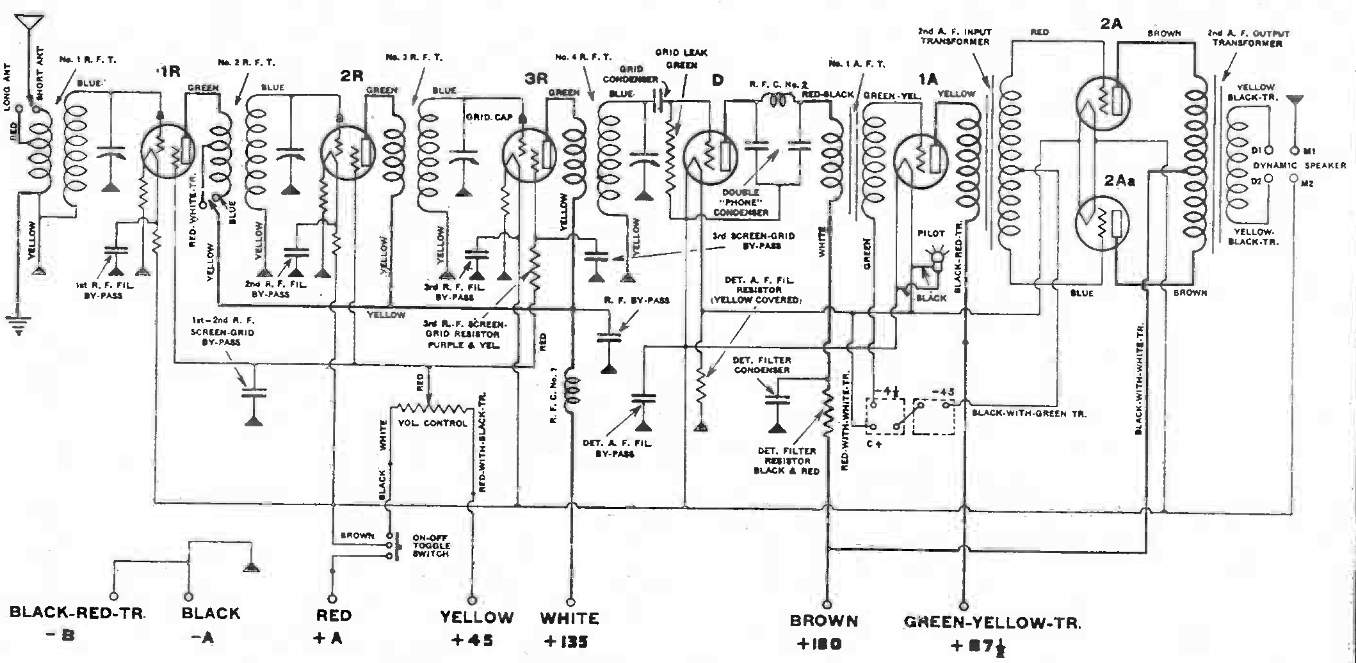
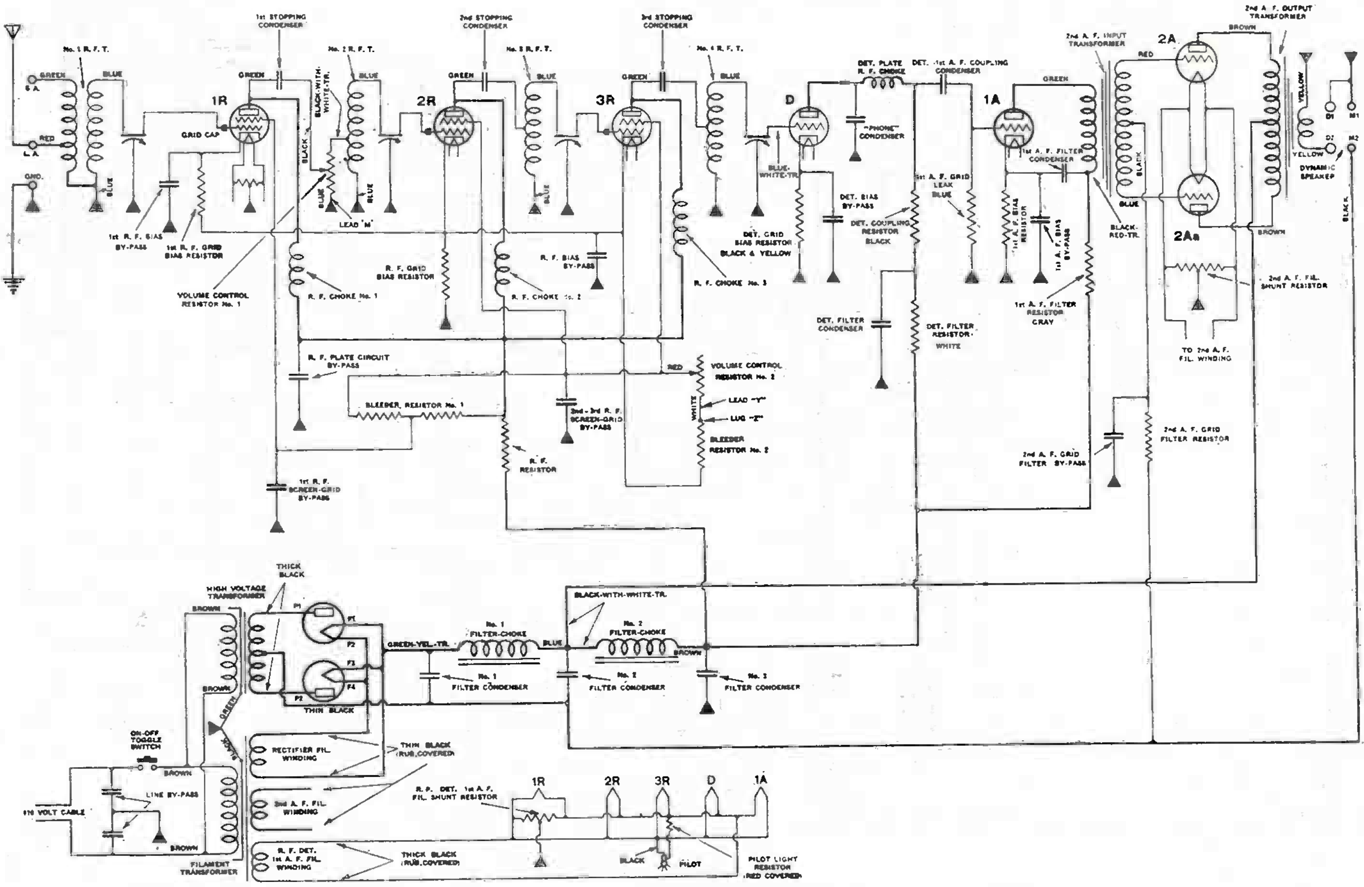


Diagram of Early Model 67 and 67-C (Battery Operated).

ATWATER KENT MANUFACTURING CO.



CIRCUIT OF MODEL 66.

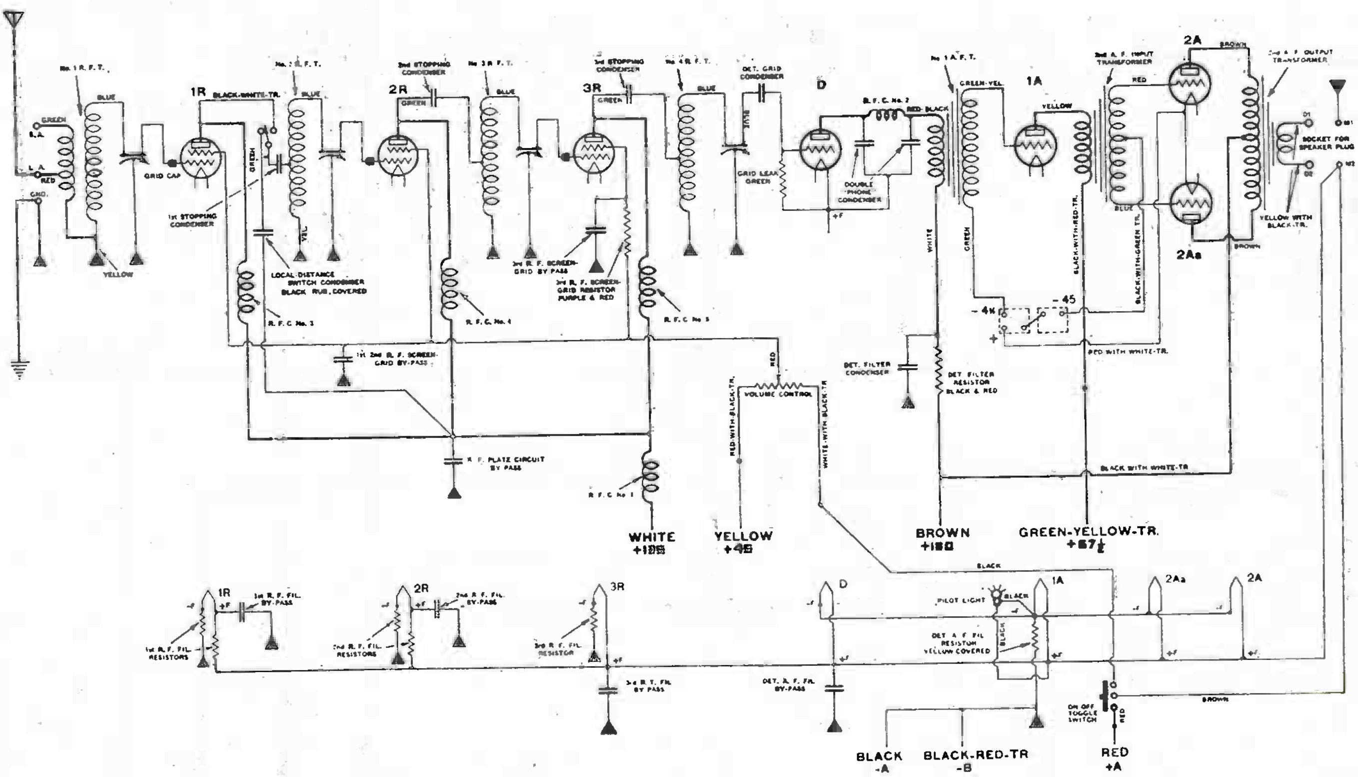


DIAGRAM OF LATER MODEL 67 AND 67-C (BATTERY OPERATED).

ATWATER KENT MANUFACTURING CO.

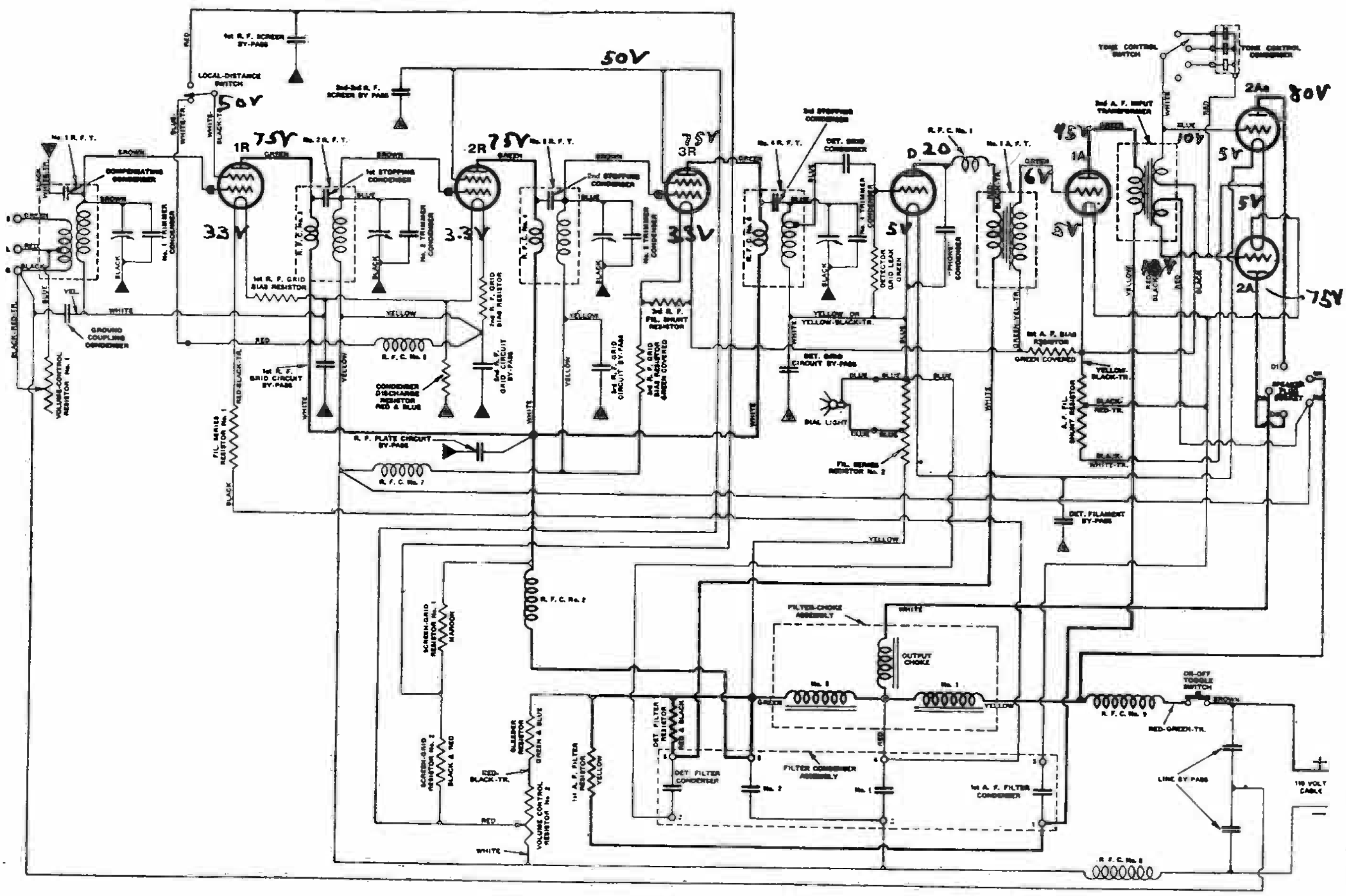


Diagram of D-1 Chassis.

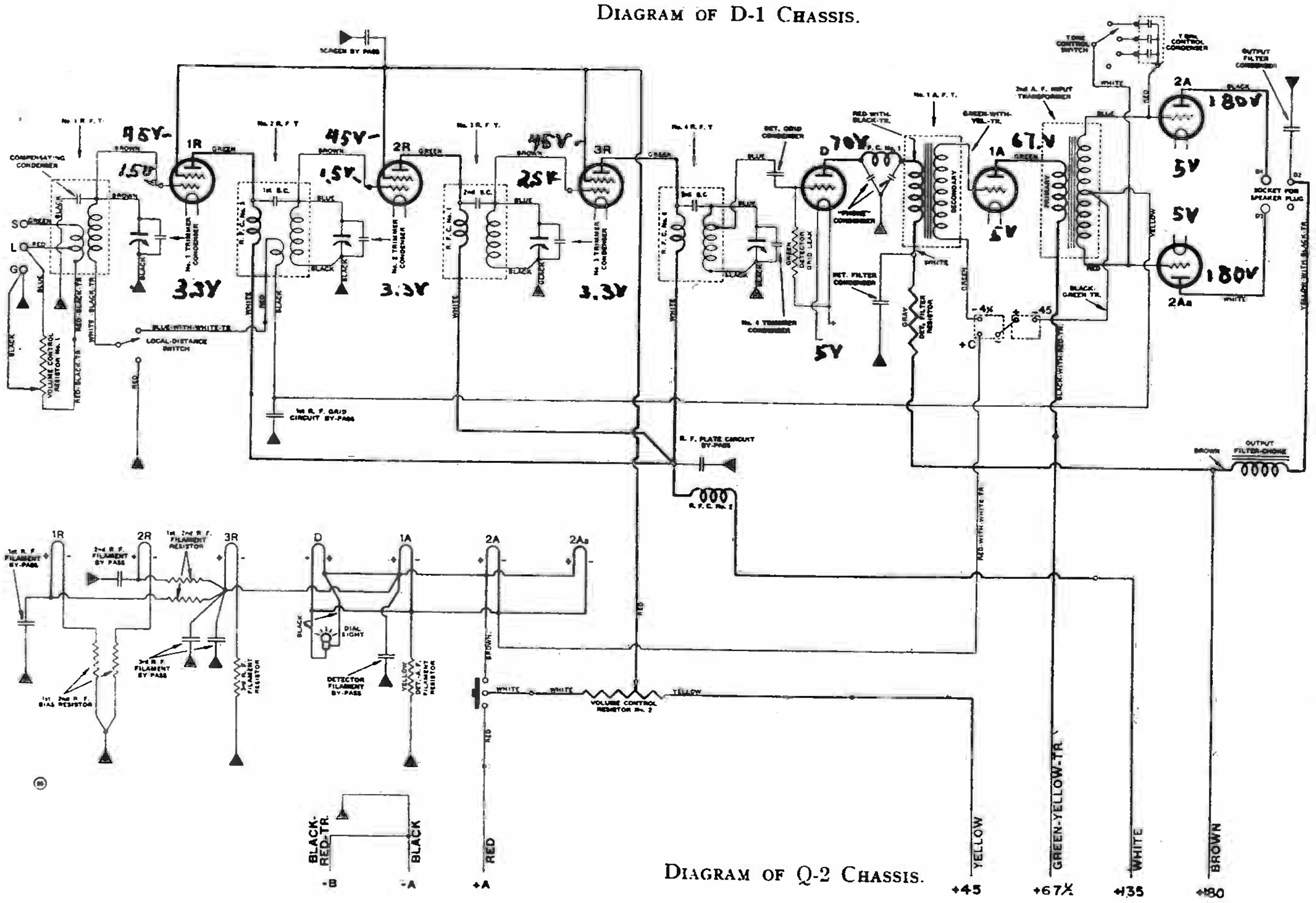


Diagram of Q-2 Chassis.

ATWATER KENT MANUFACTURING CO.

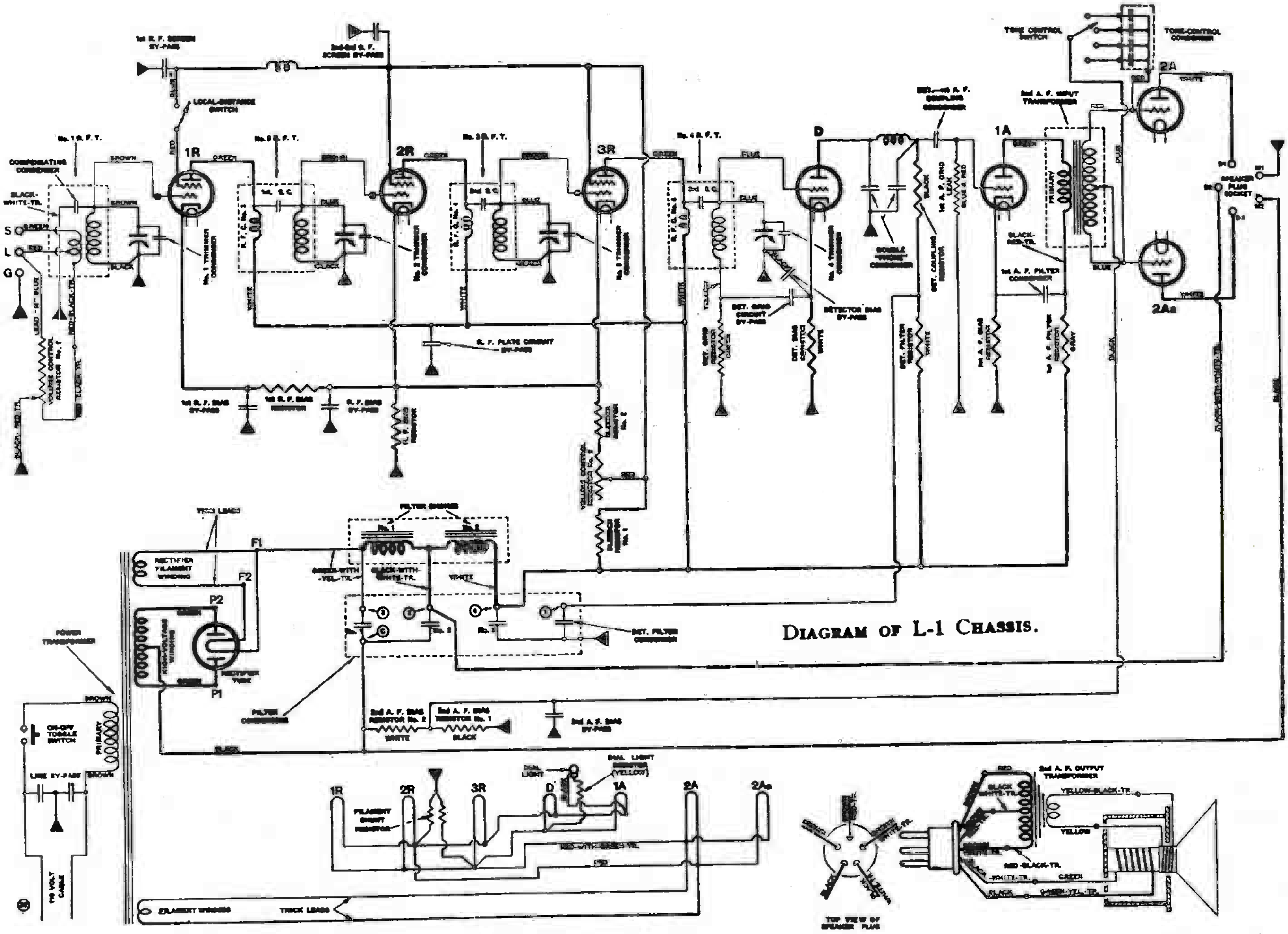
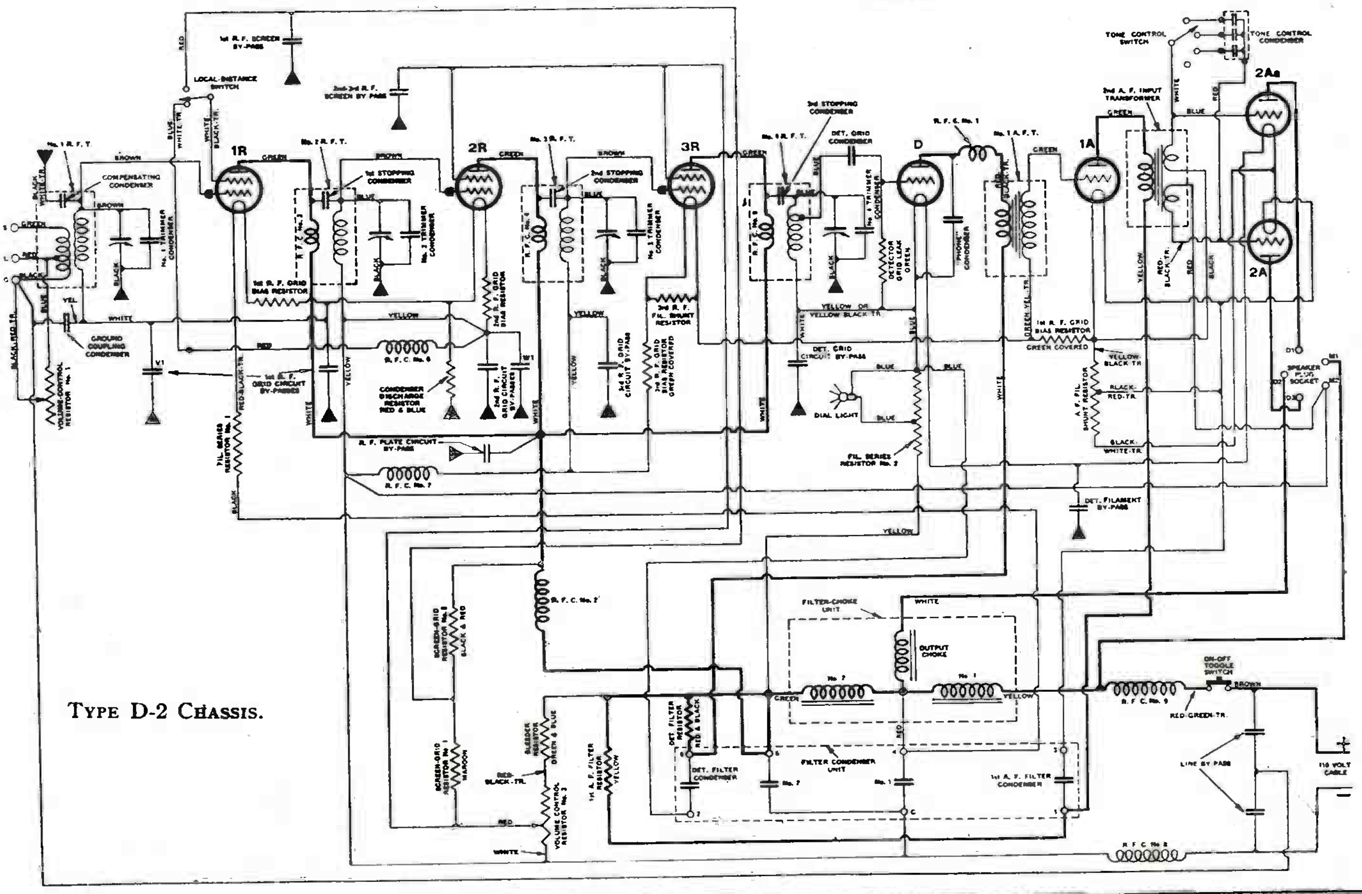
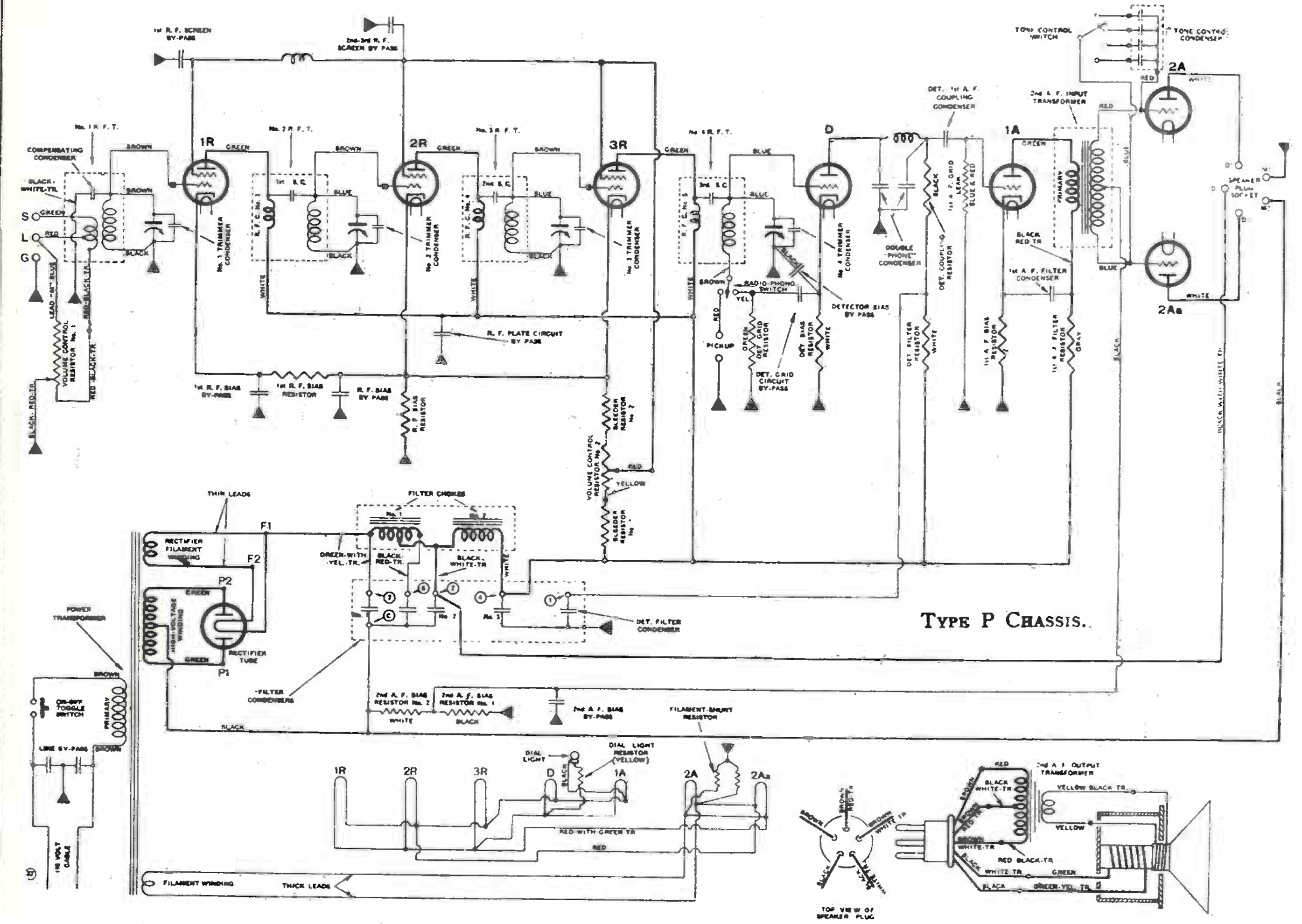


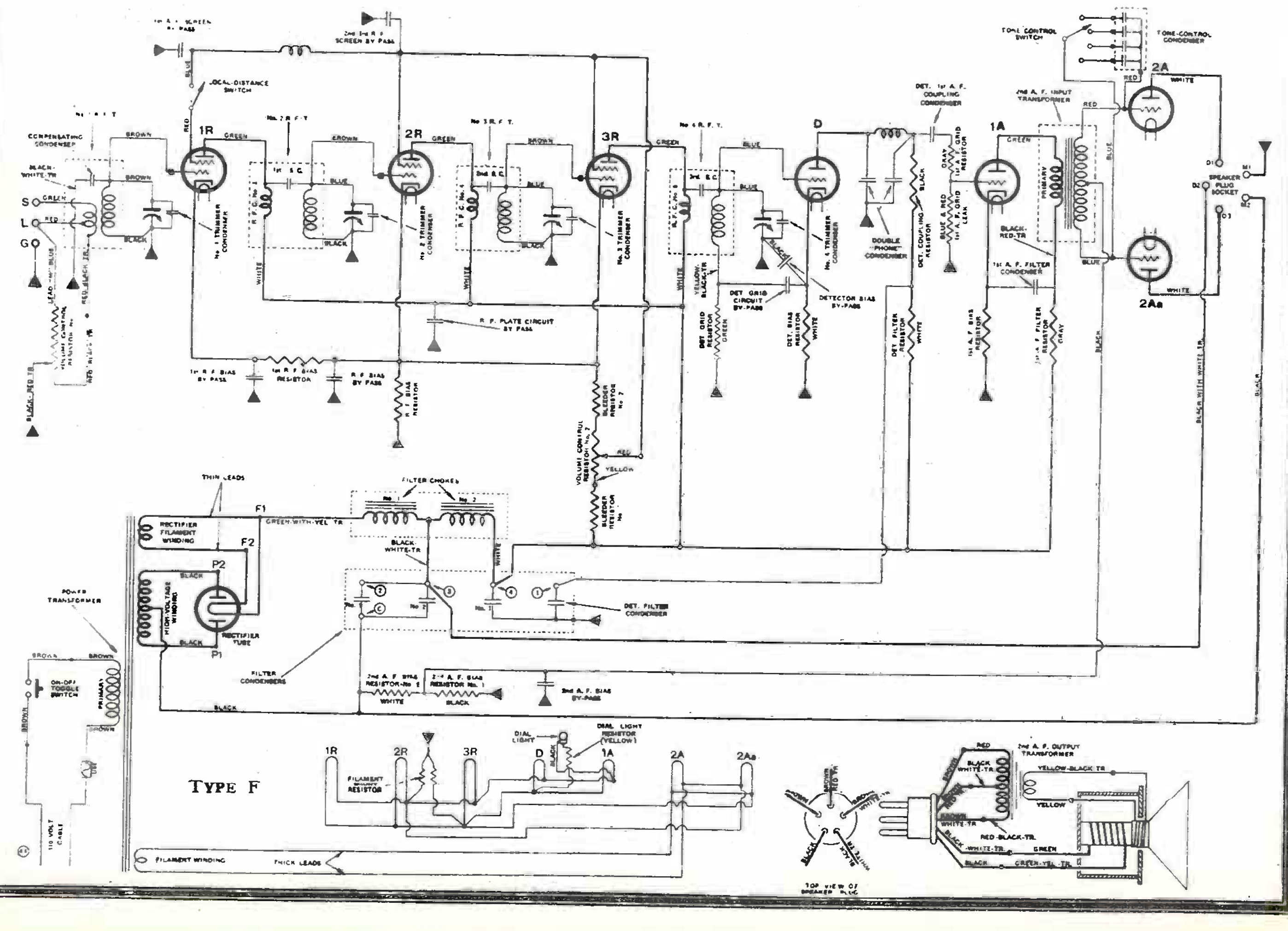
Diagram of L-1 Chassis.



Type D-2 Chassis.

ATWATER KENT MANUFACTURING CO.





ATWATER KENT MANUFACTURING CO.

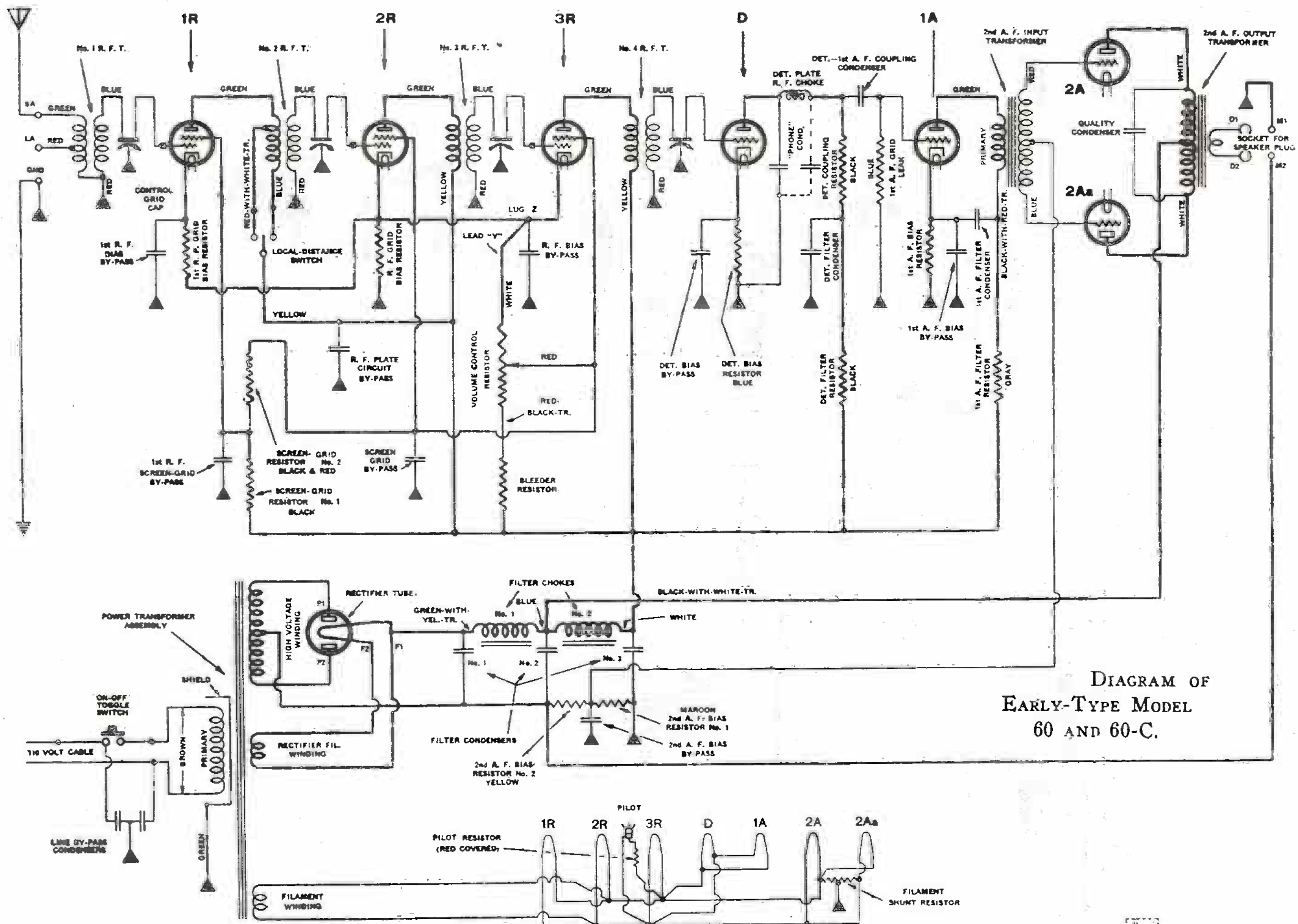


DIAGRAM OF EARLY-TYPE MODEL 60 AND 60-C.

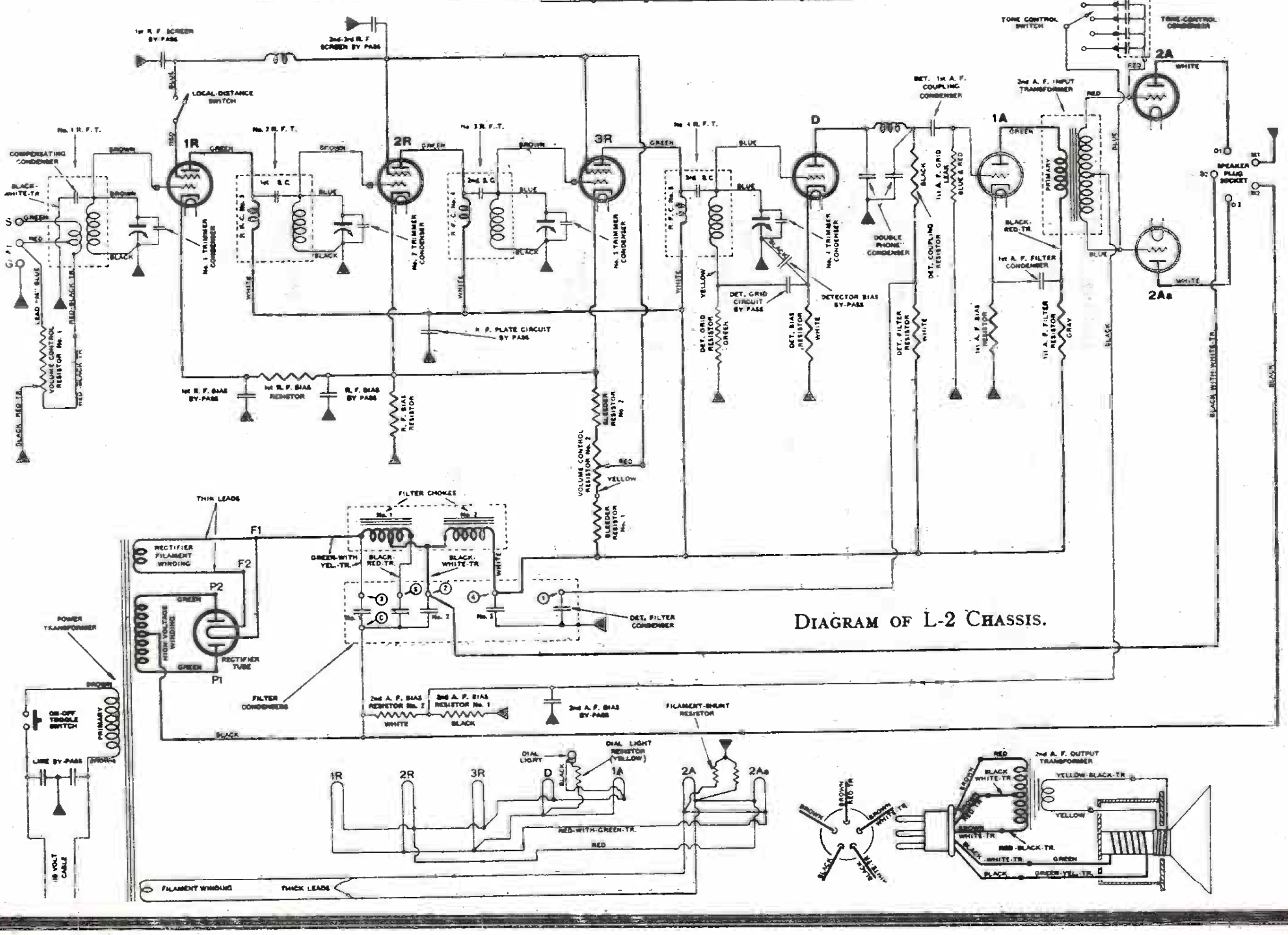
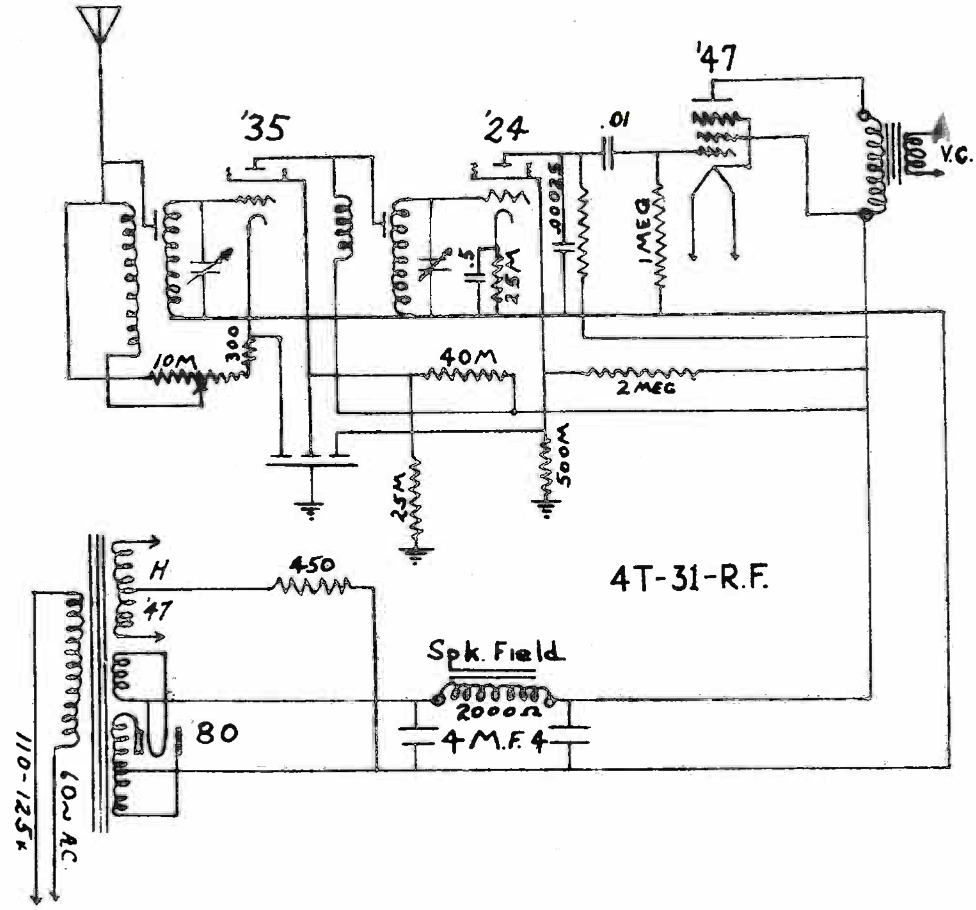
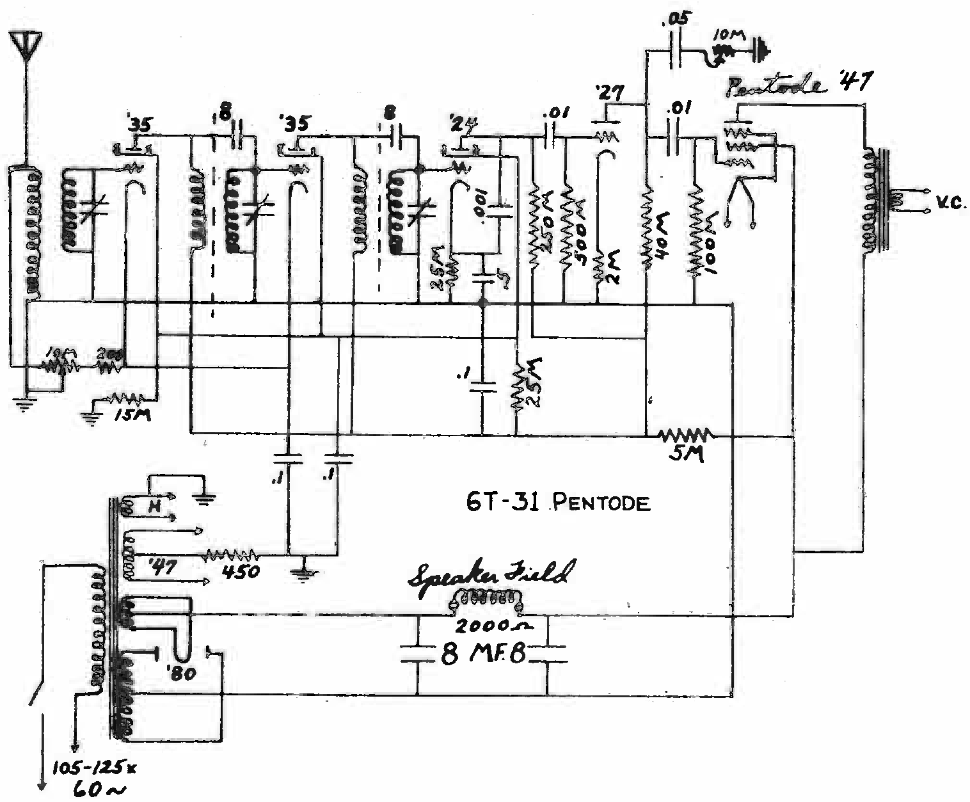


DIAGRAM OF L-2 CHASSIS.

AUDIOLA RADIO CO.

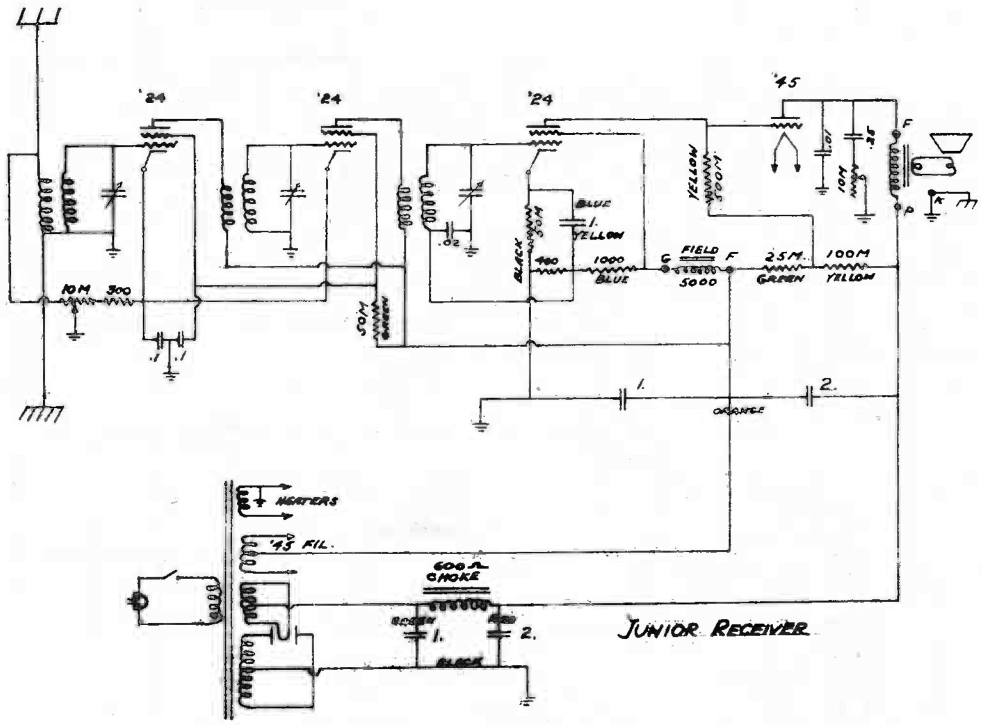


4T-31-R.F.

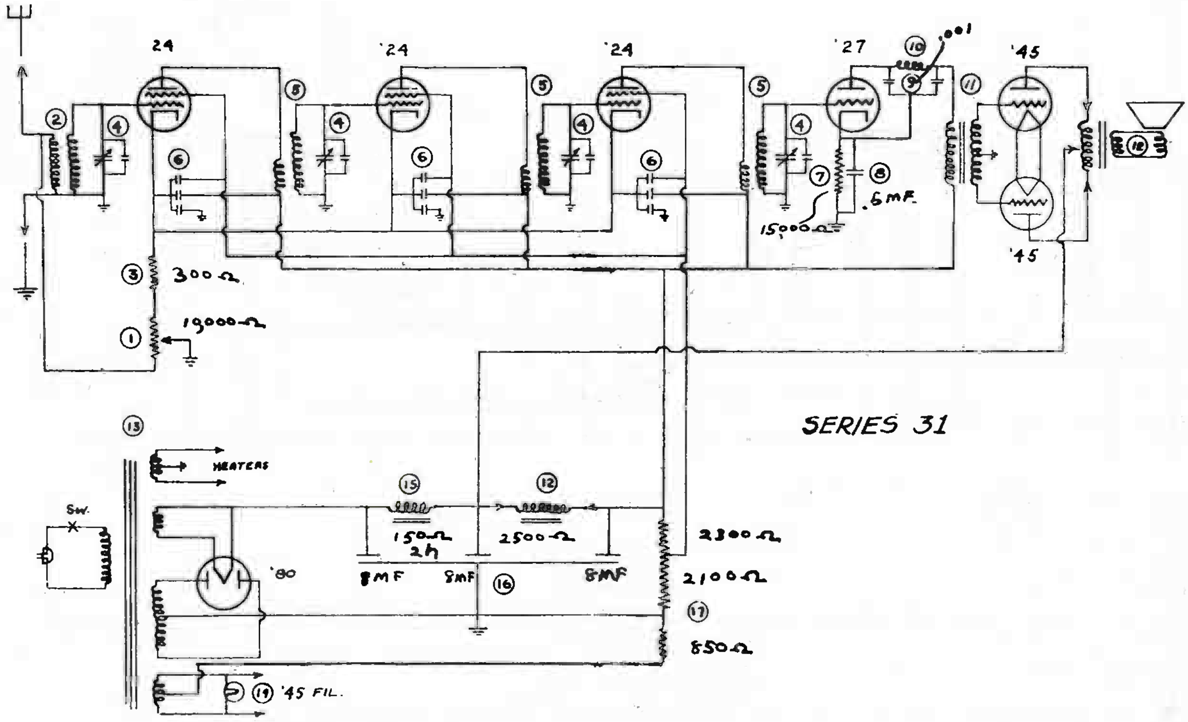


6T-31 Pentode

AUDIOLA RADIO CO.

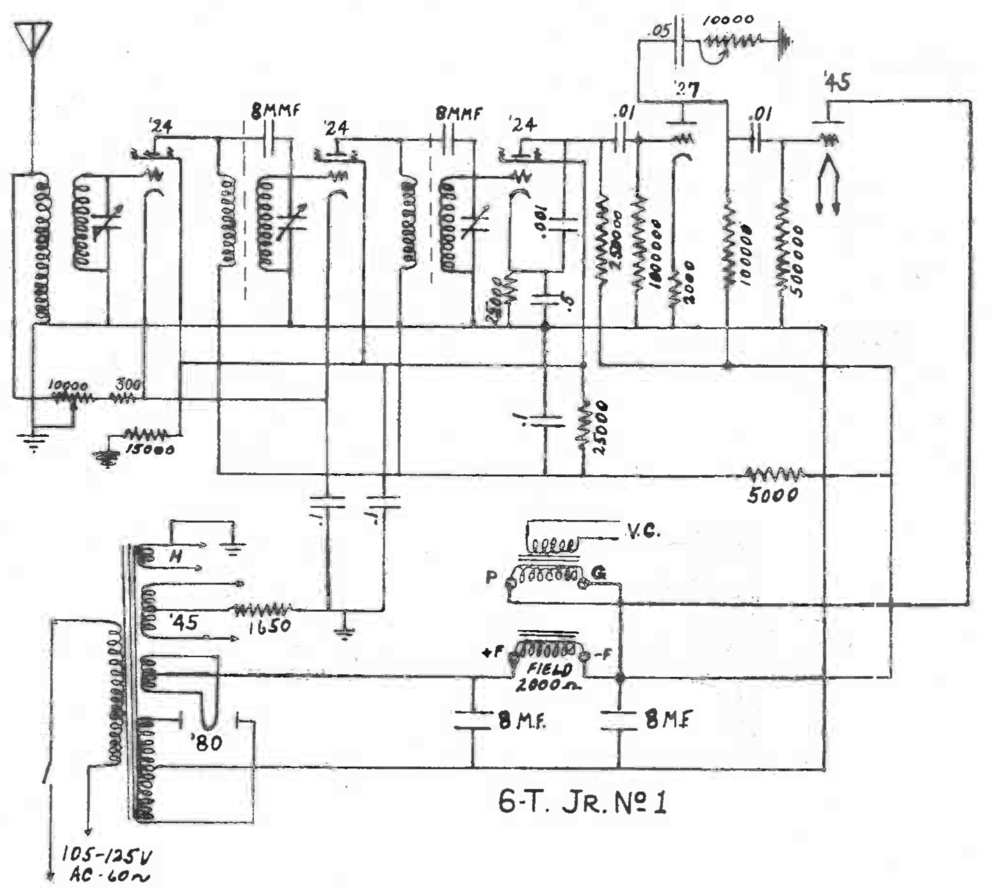


JUNIOR RECEIVER

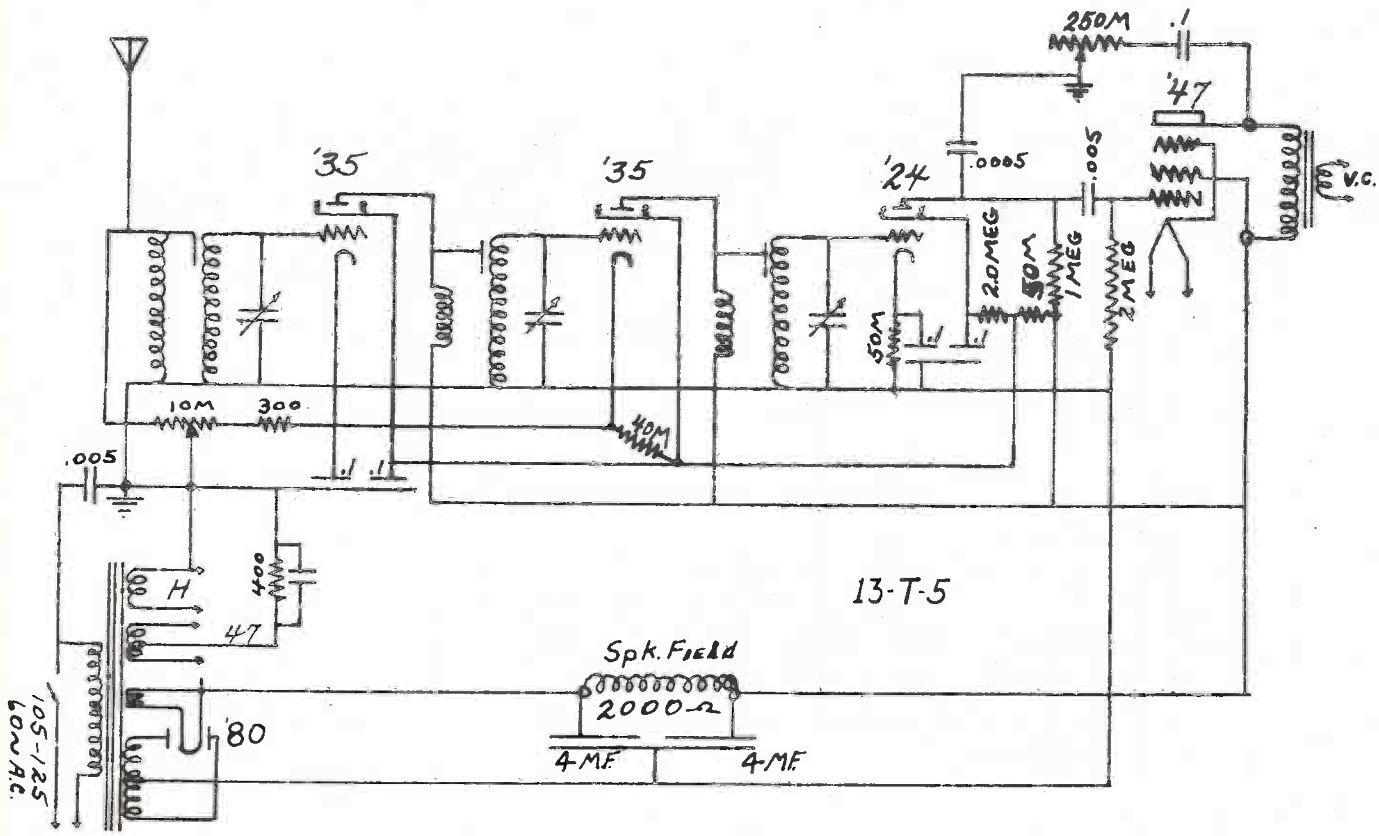


SERIES 31

AUDIOLA RADIO CO.

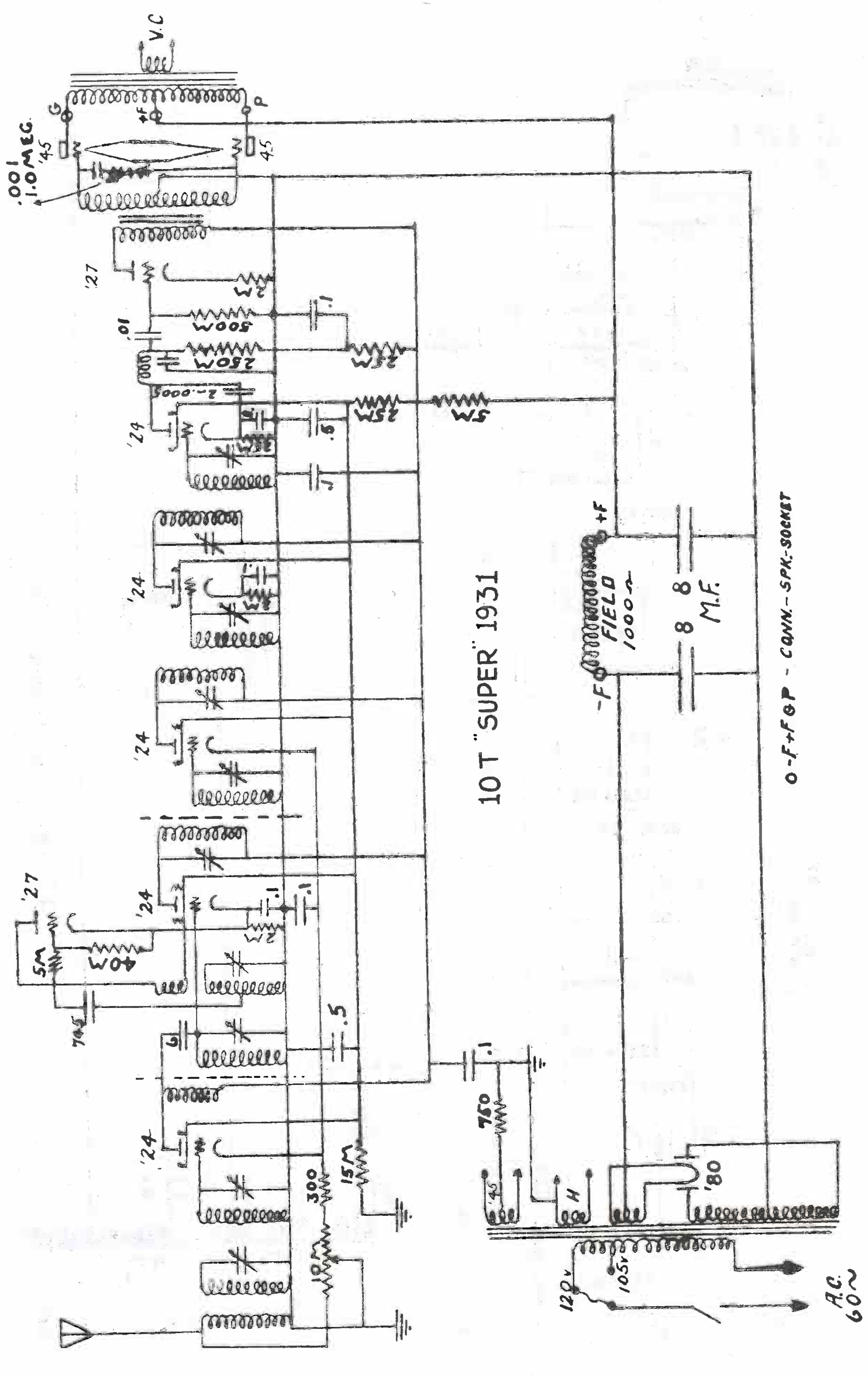


6-T. JR. No 1

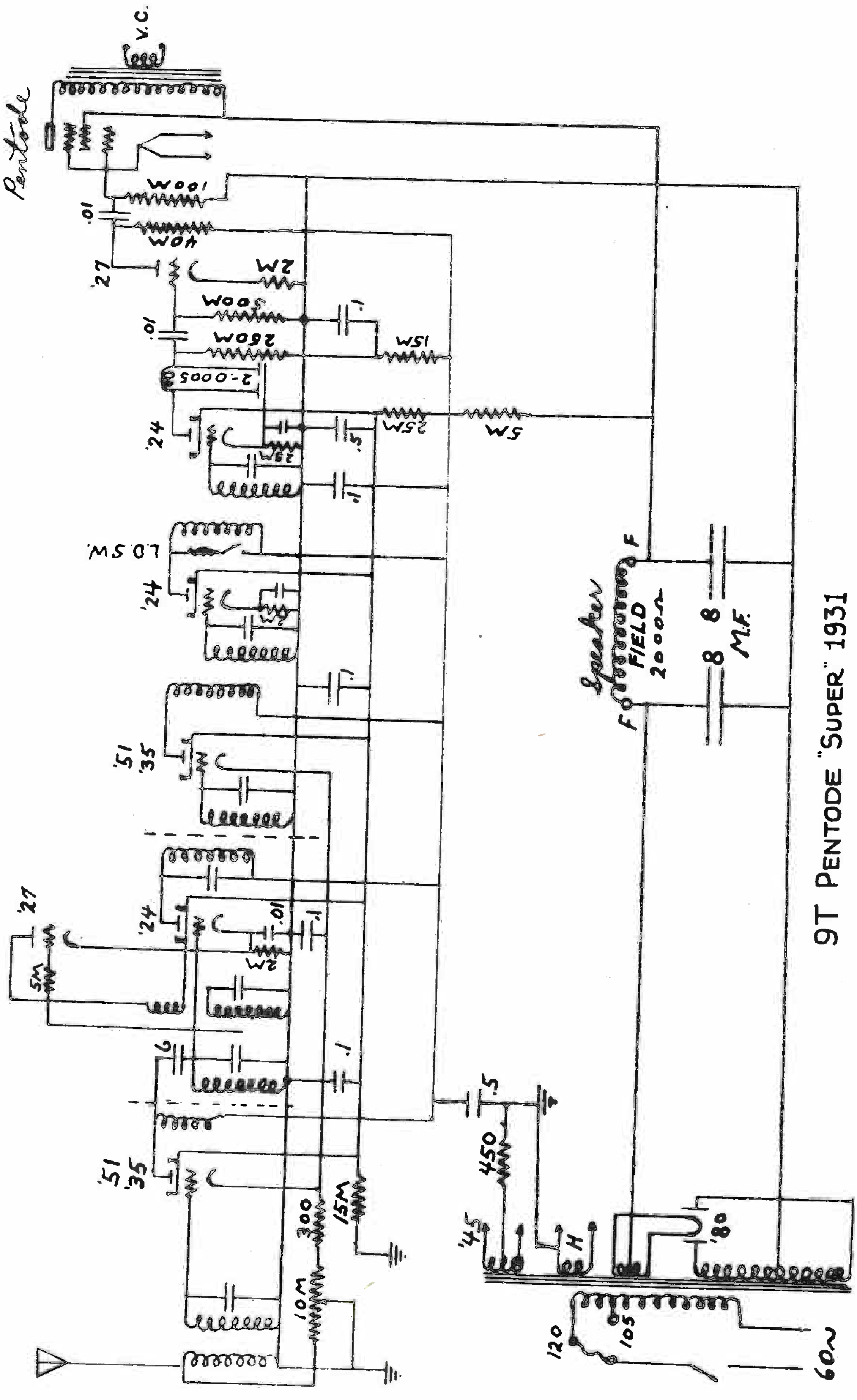


13-T-5

AUDIOLA RADIO CO.

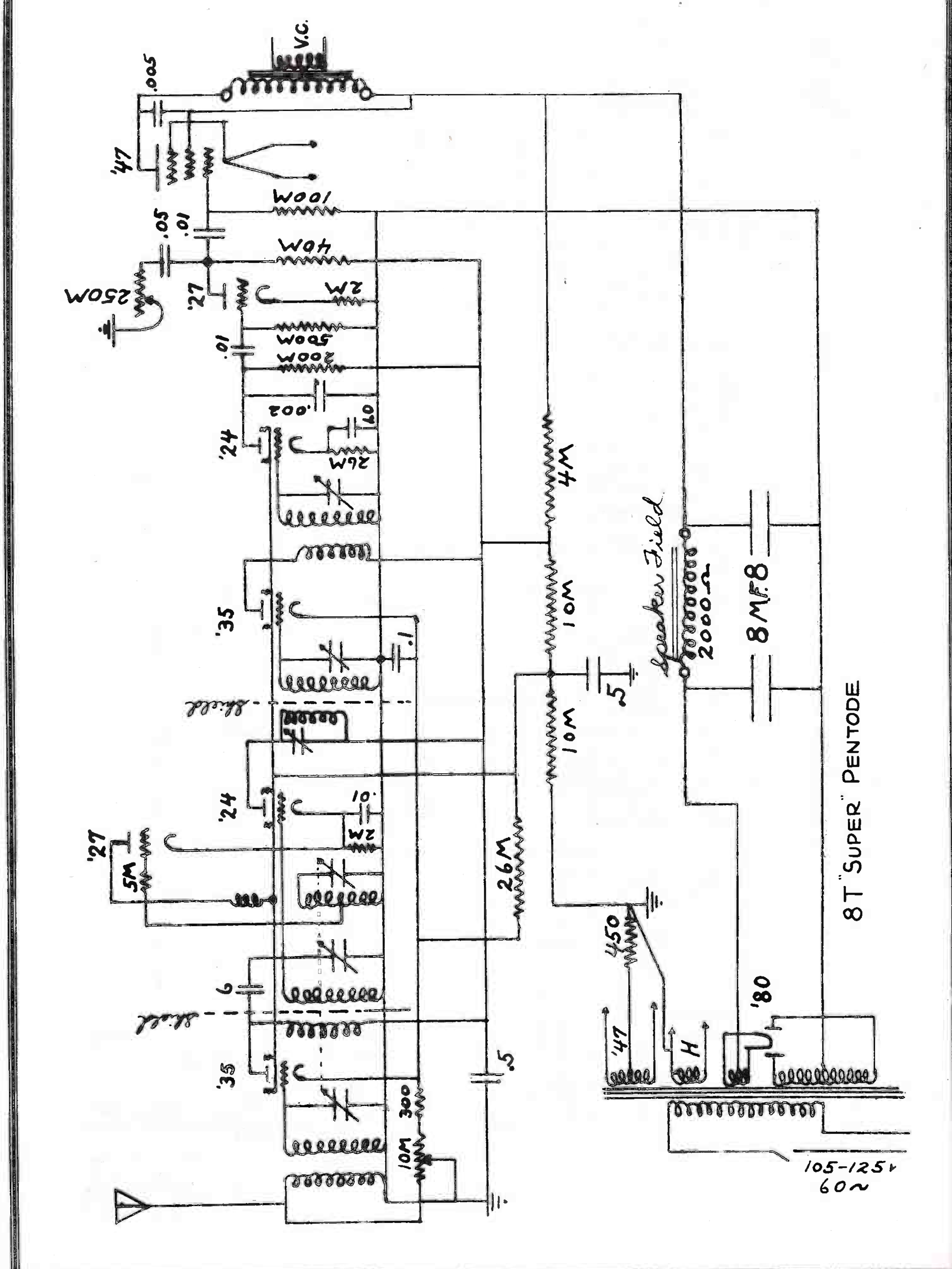


AUDIOLA RADIO CO.

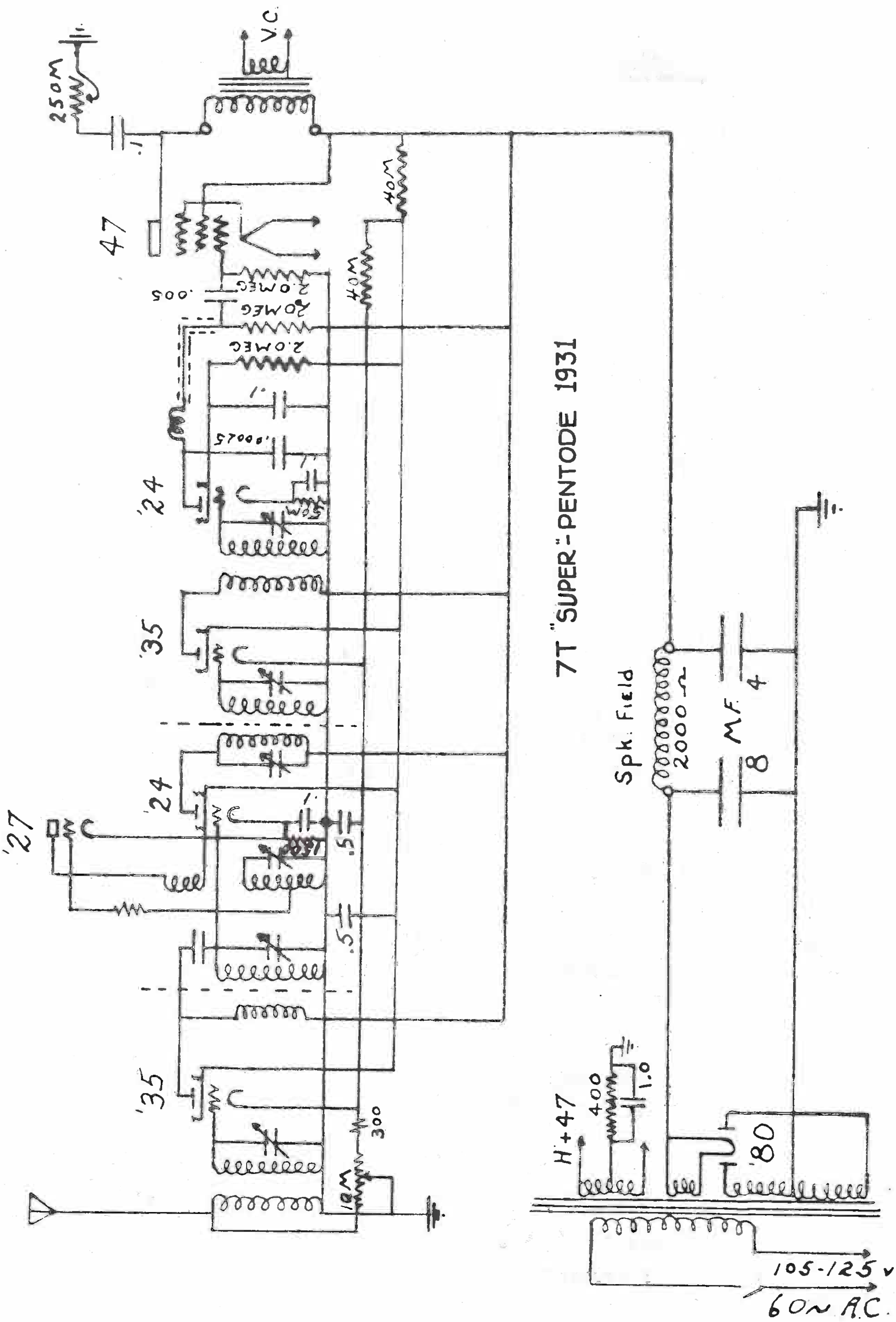


9T Pentode "Super" 1931

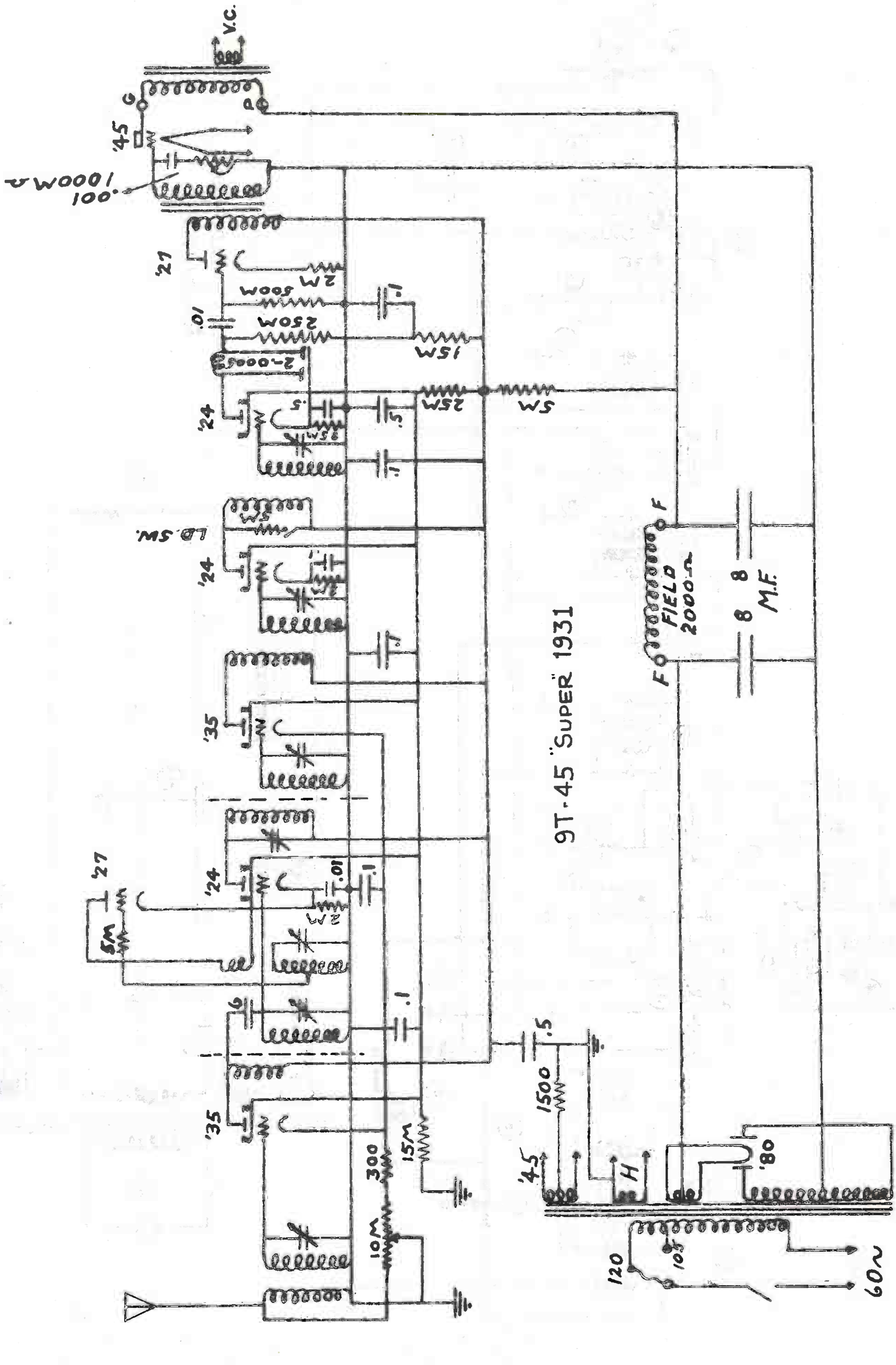
AUDIOLA RADIO CO.



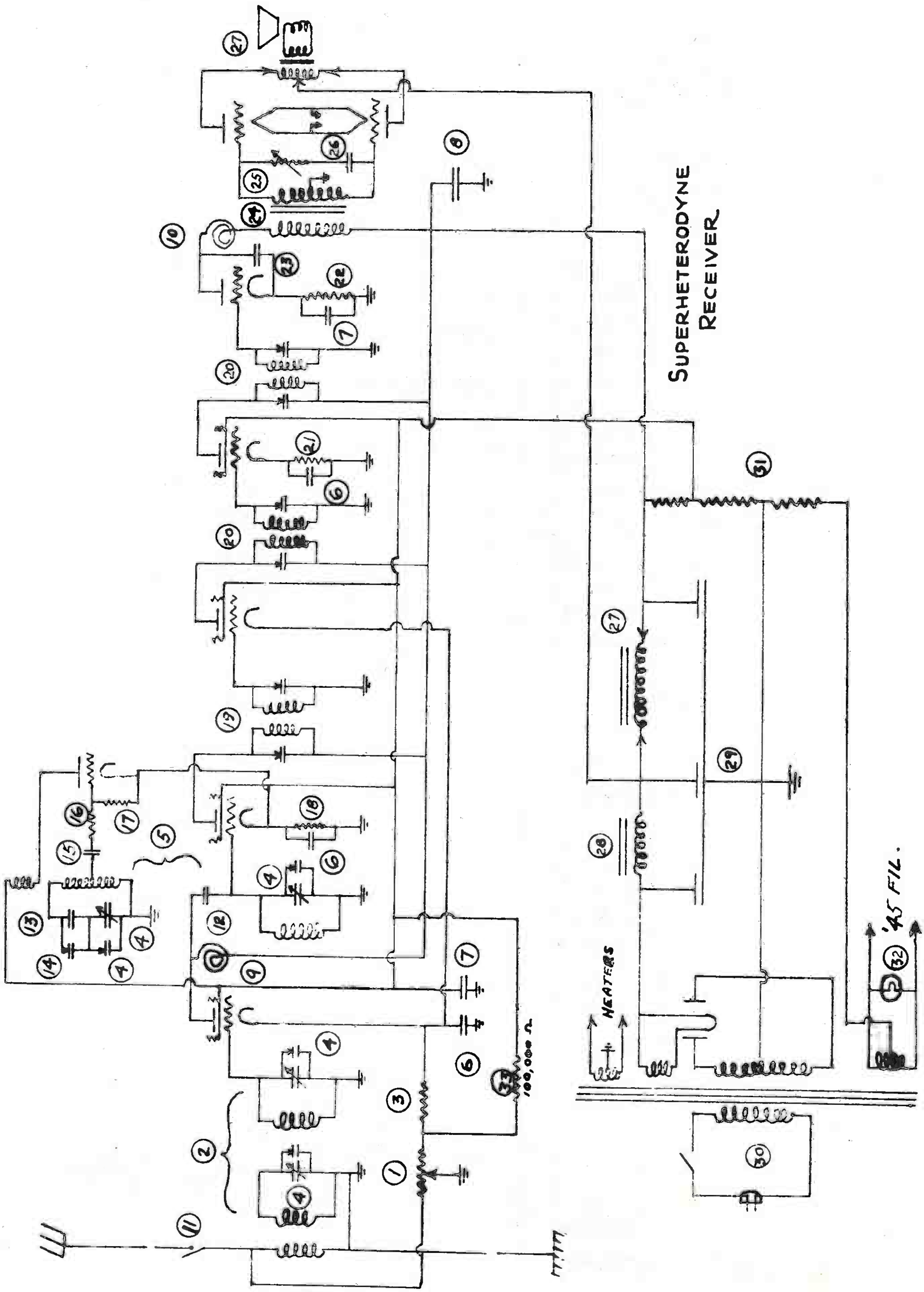
AUDIOLA RADIO CO.



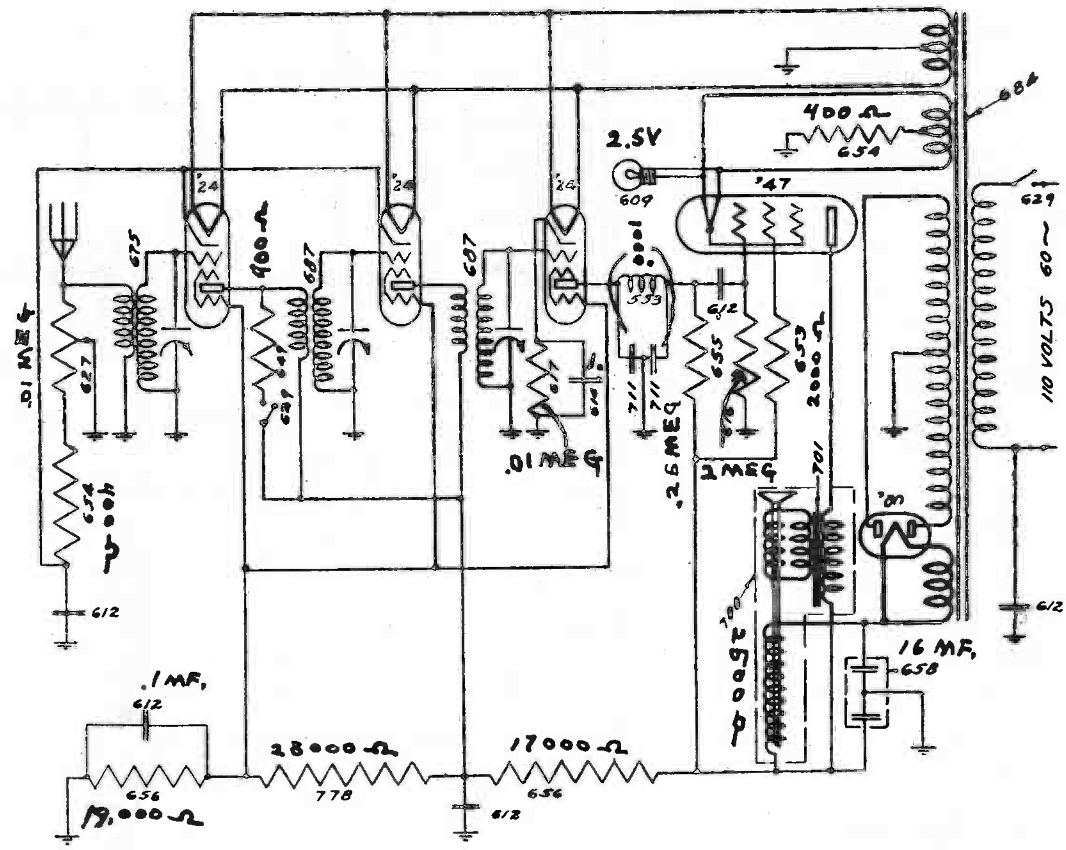
AUDIOLA RADIO CO.



AUDIOLA RADIO CO.



AZTEC RADIO CO.



D. C. Voltages

READING FROM—

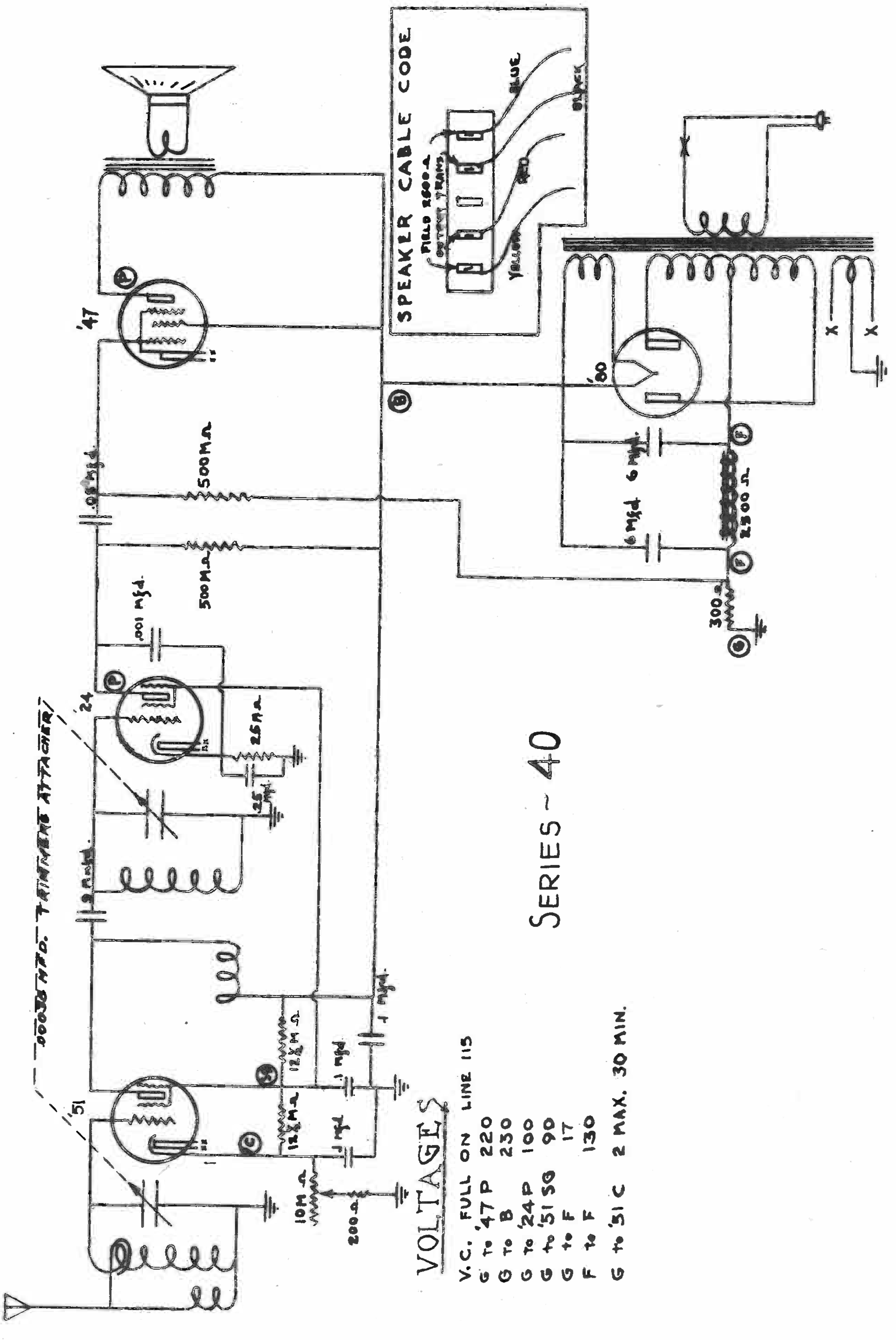
Chassis (ground)	to plates of R. F. tubes	130 to 150 volts
" "	to plate of Detector	75 to 95 volts
" "	to plate of Pentode	215 to 235 volts
" "	to screen of R. F. tubes	45 to 65 volts
" "	to screen of Detector	45 to 65 volts
" "	to screen of Pentode	215 to 235 volts
" "	to cathode of R. F. tubes	1.5 to 2.5 volts
" "	to Cathode of Detector	4 to 6 volts
" "	to pentode Filament Center Tap	14 to 18 volts

A. C. Voltages

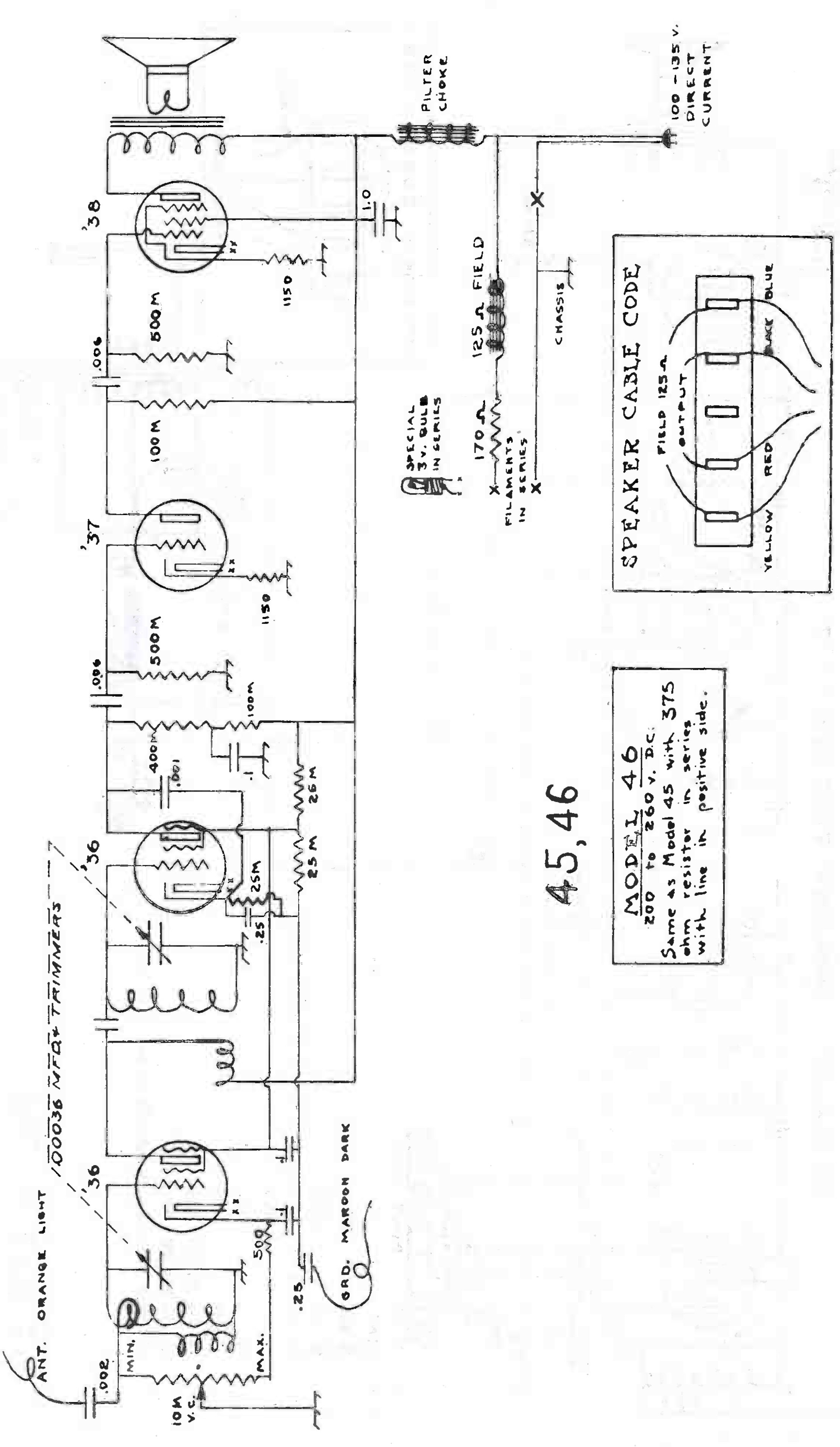
1st R. F., 2nd R. F., Detector and Pentode Filaments	2.3 to 2.5 volts
Rectifier Filament	4.8 to 5.1 volts
Ground to plates of 280	approximately 375 volts

NOTE: Filament Voltages may be measured with a Weston Triple Range (0-4, 0-8, 0-150) Type 528 AC Voltmeter. The high voltage on the Rectifier Plates should be measured with a double range (300, 0-600) Type Weston AC Voltmeter.

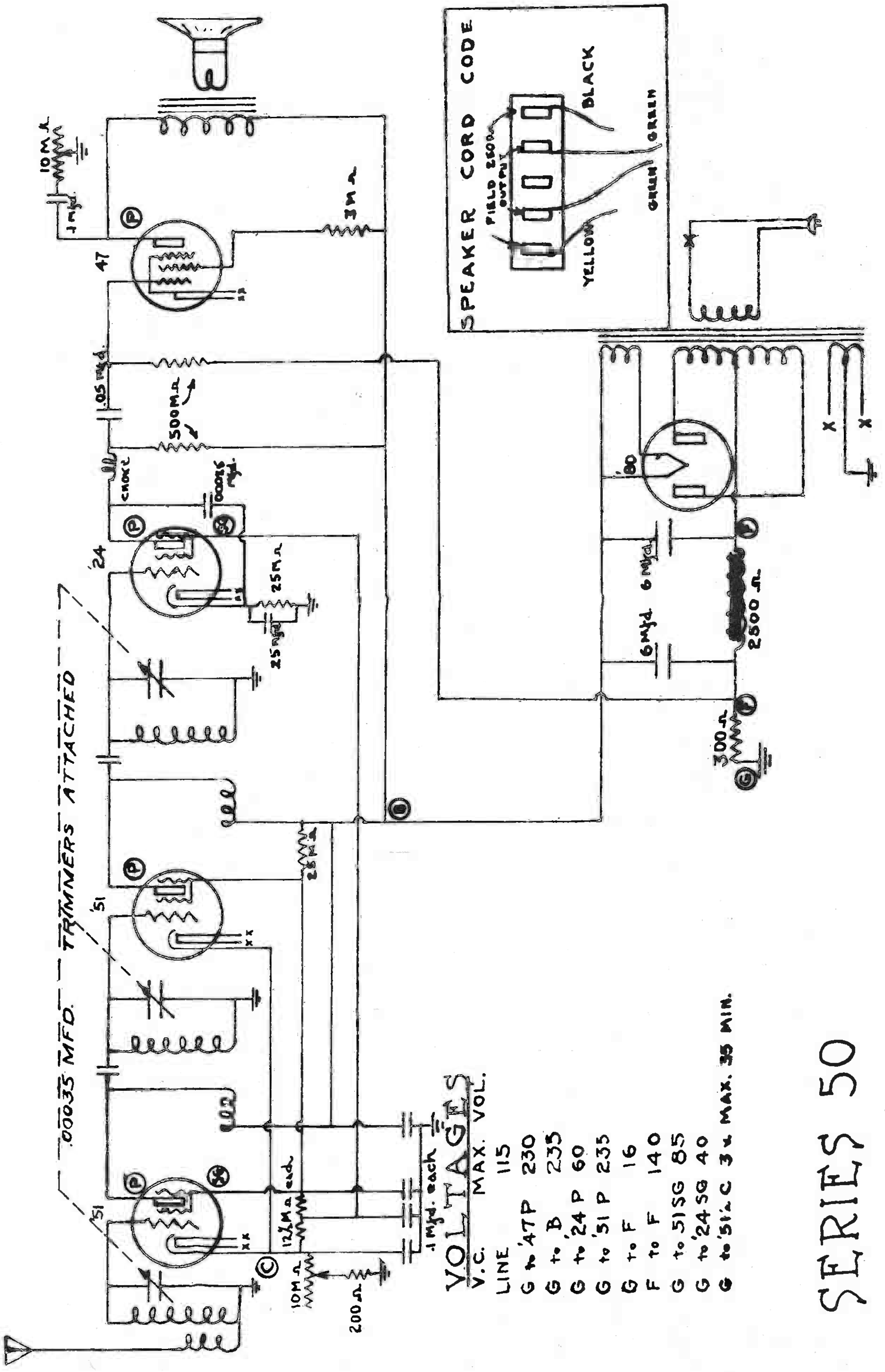
BELMONT RADIO CORP.



BELMONT RADIO CORP.



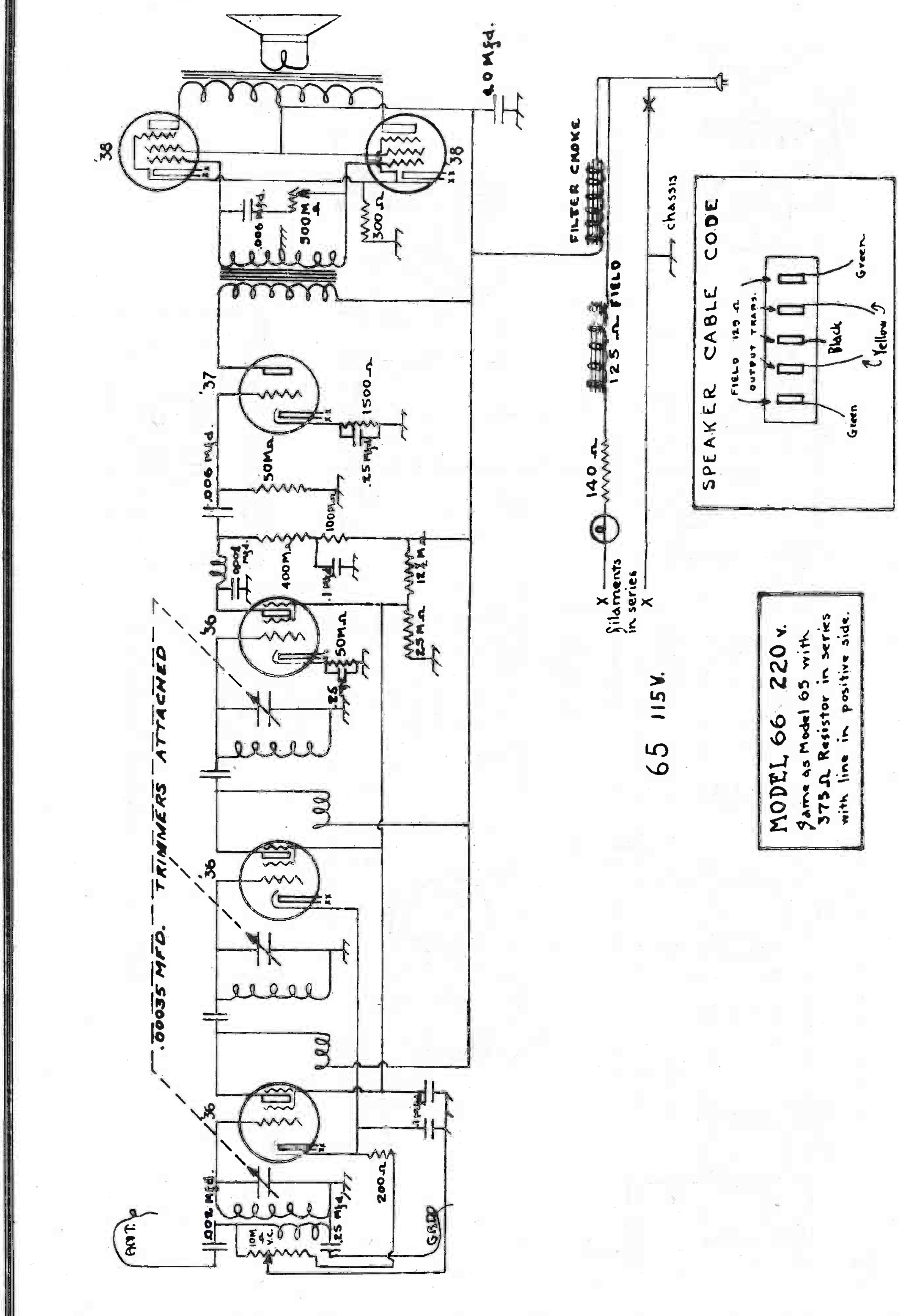
BELMONT RADIO CORP.



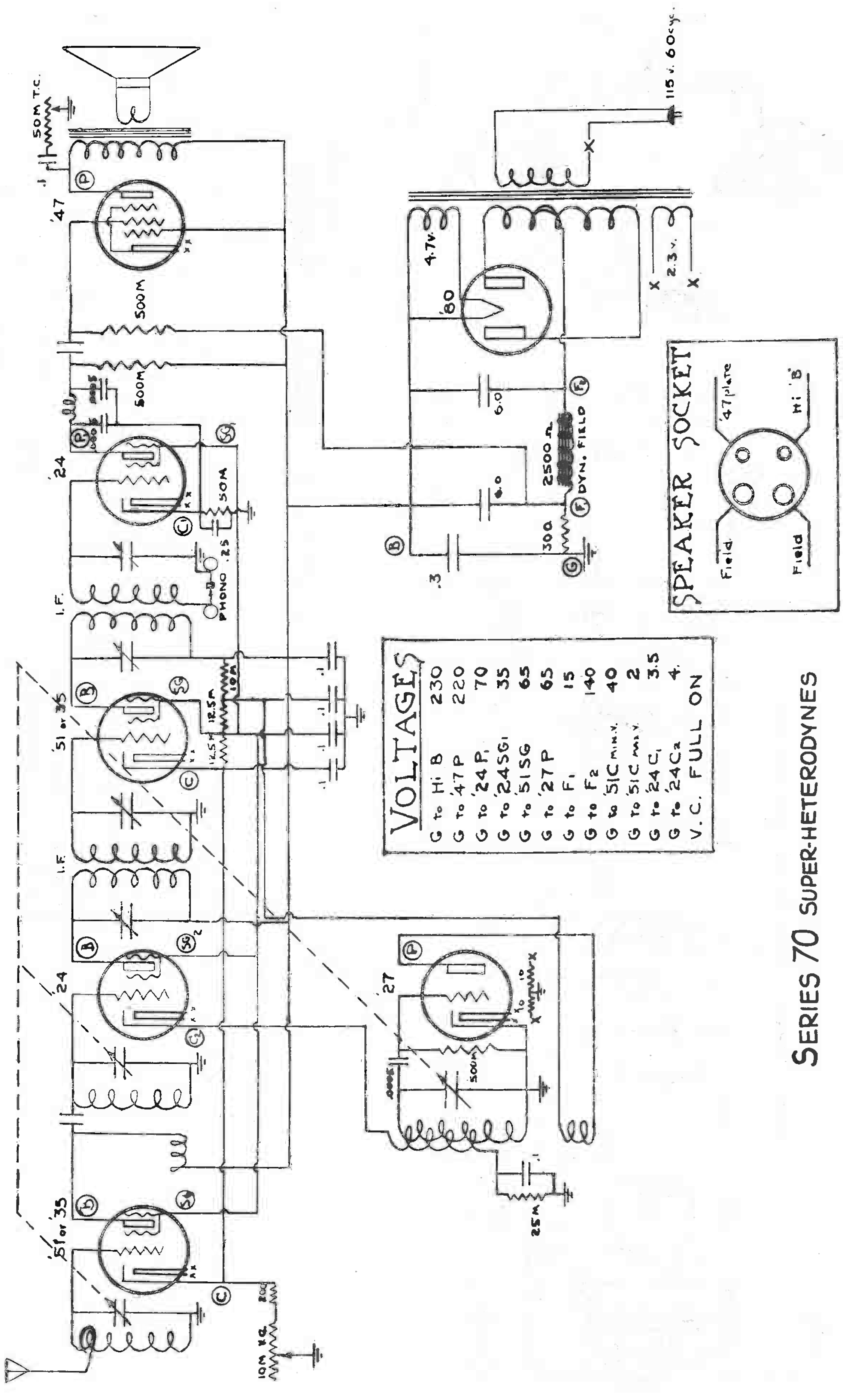
V.C.	MAX. VOL.
LINE	115
G to '47P	230
G to B	235
G to '24 P	60
G to '51 P	235
G to F	16
F to F	140
G to '51SG	85
G to '24 SG	40
G to '51 & C	3 & MAX. 35 MIN.

SERIES 50

BELMONT RADIO CORP.



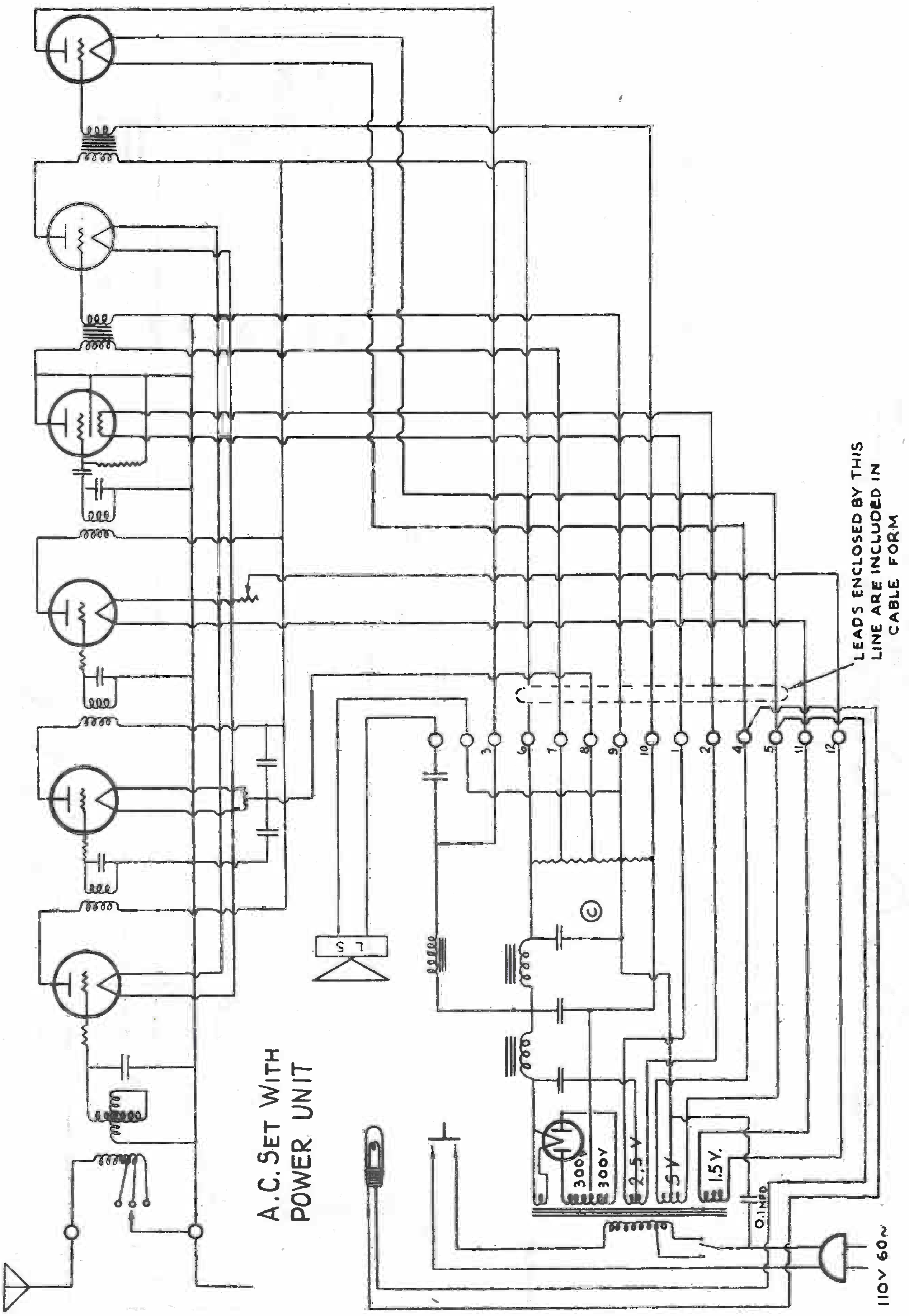
BELMONT RADIO CORP.



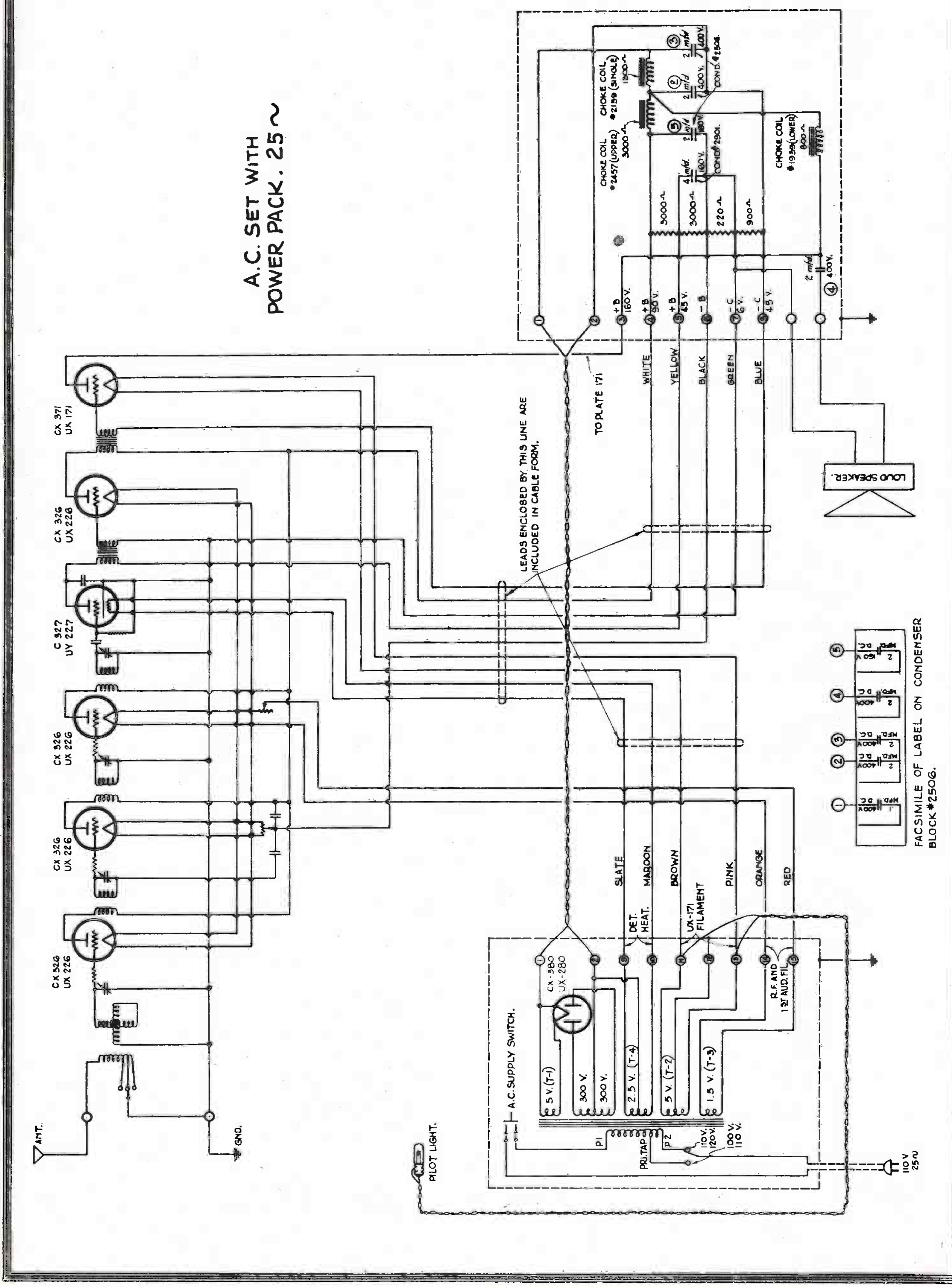
VOLTAGES	
G to Hi B	230
G to '47P	220
G to '24P	70
G to '24SG	35
G to '51SG	65
G to '27P	65
G to F_1	15
G to F_2	140
G to '51C min. v.	40
G to '51C max. v.	2
G to '24C_1	3.5
G to '24C_2	4.
V.C. FULL ON	

SERIES 70 SUPER-HETERODYNES

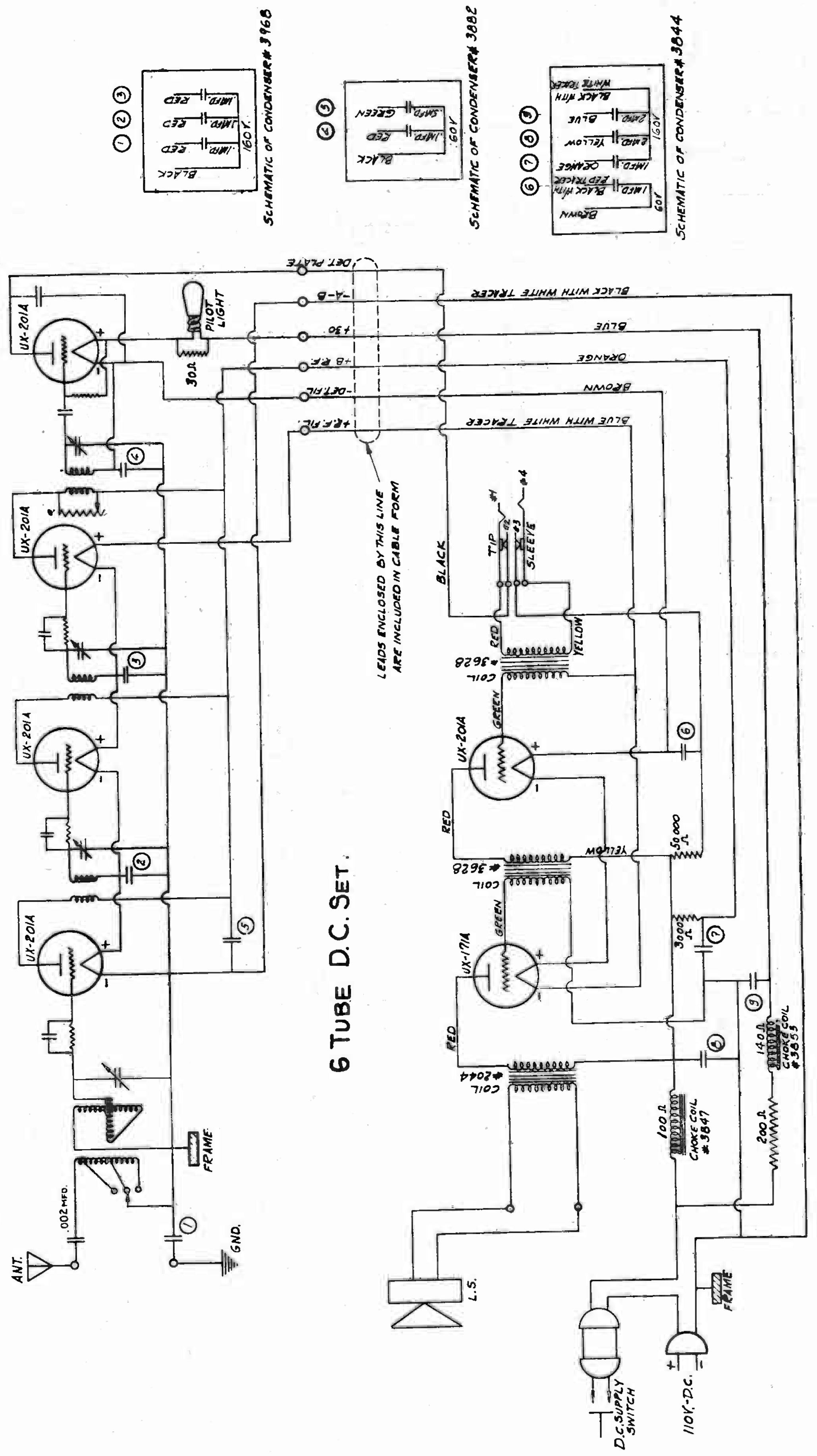
BRANDES PRODUCTS CORP.



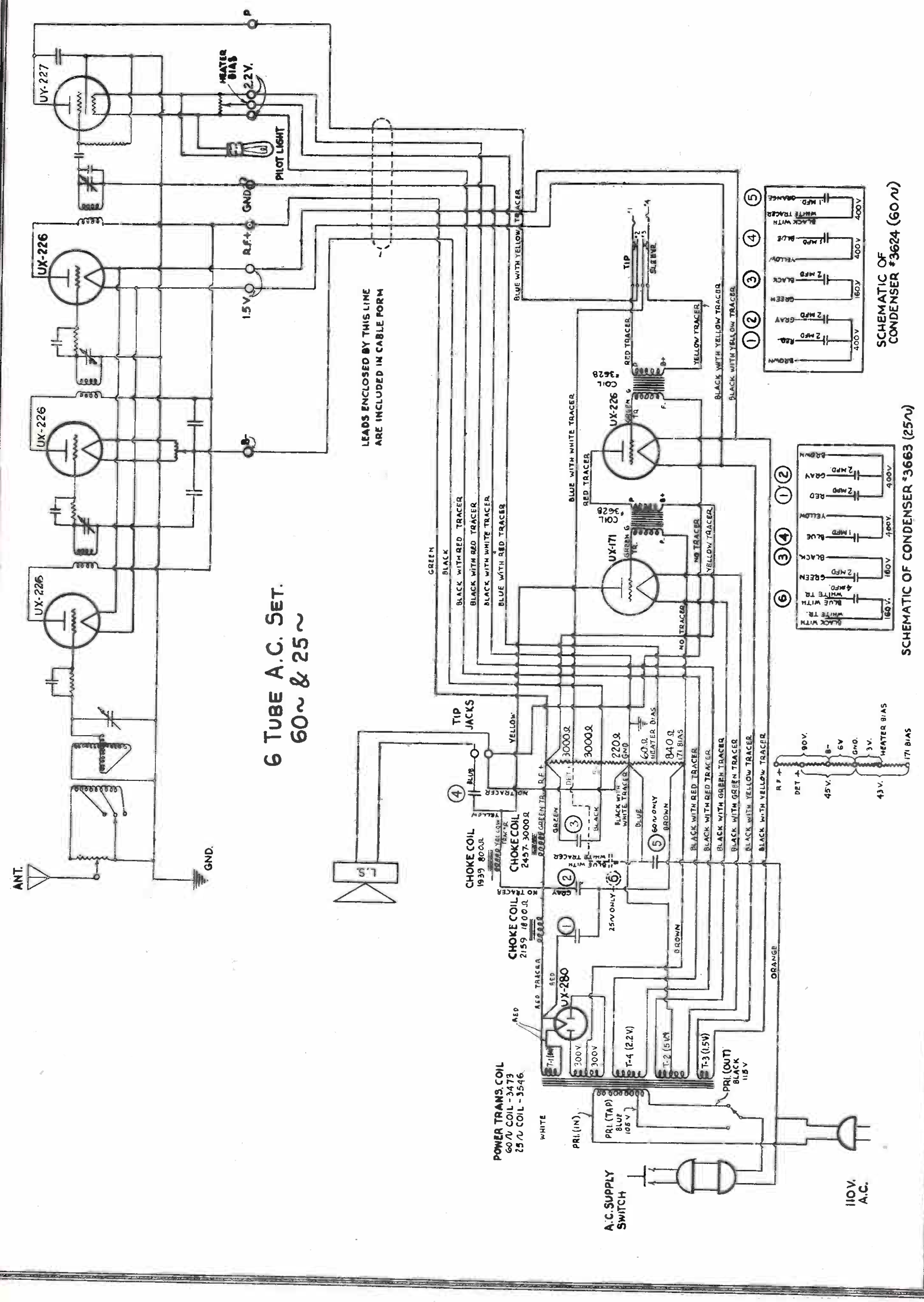
BRANDES PRODUCTS CORP.



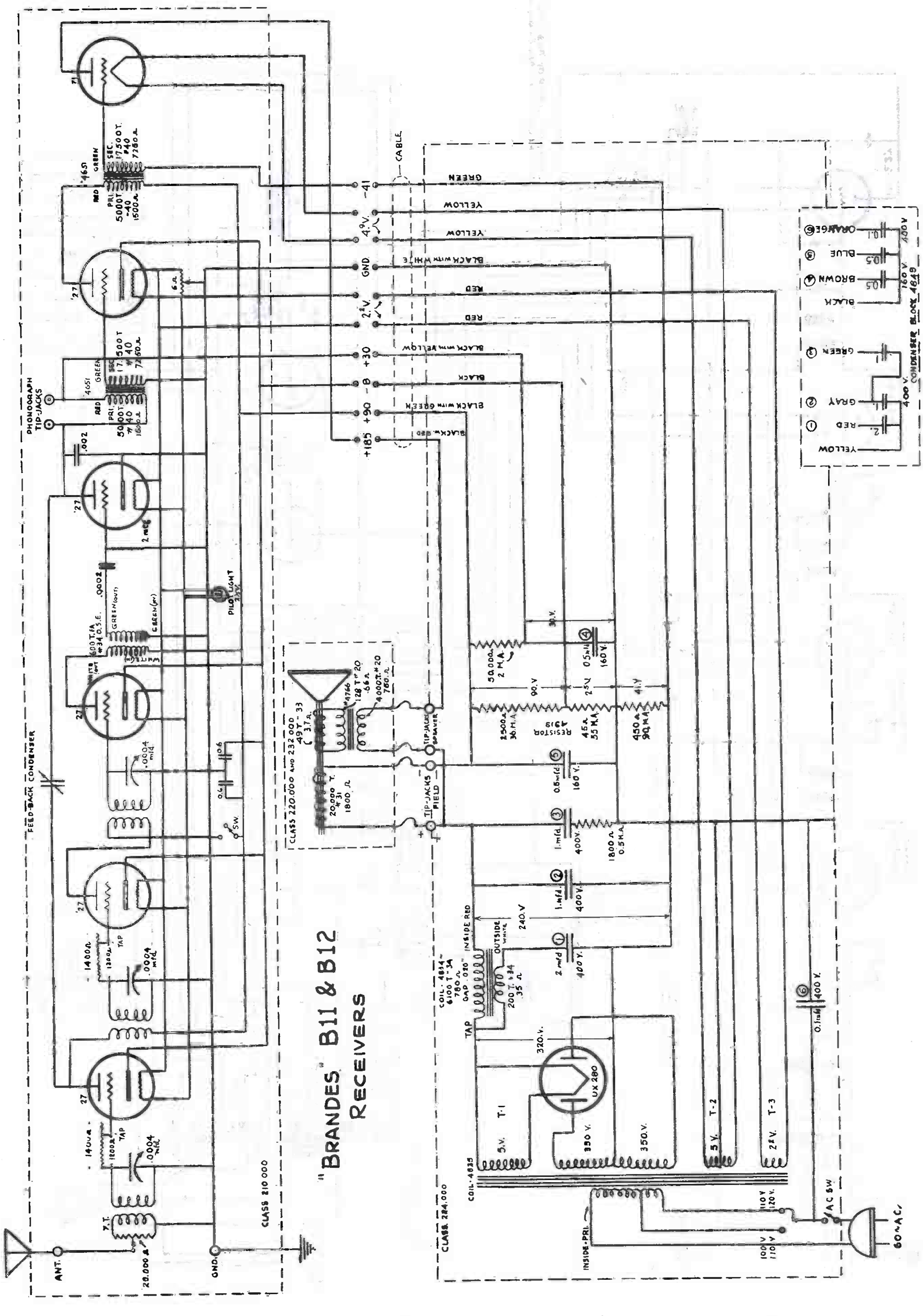
BRANDES PRODUCTS CORP.



BRANDES PRODUCTS CORP.

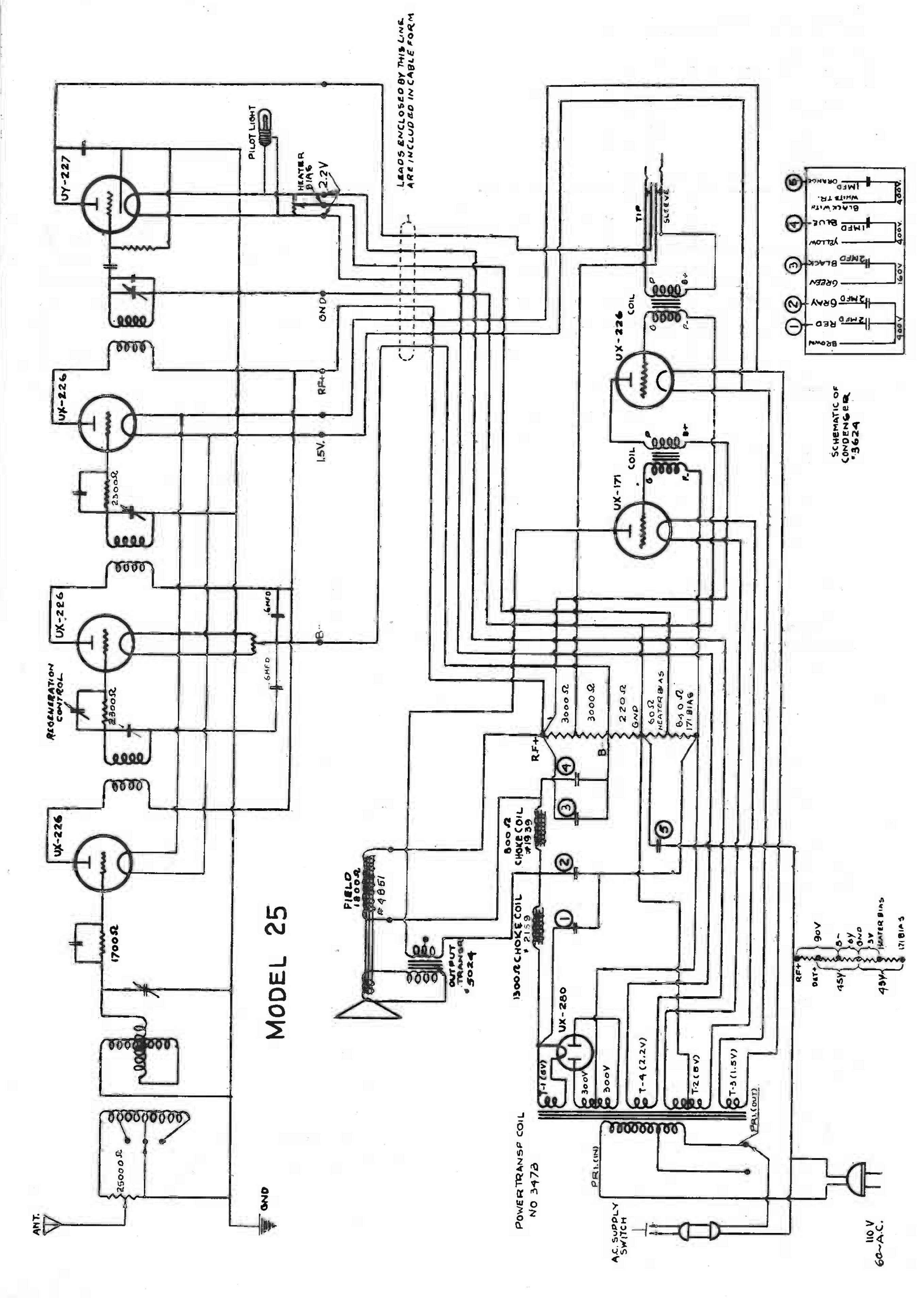


BRANDES PRODUCTS CORP.

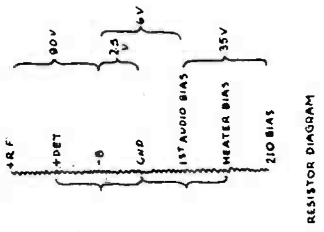


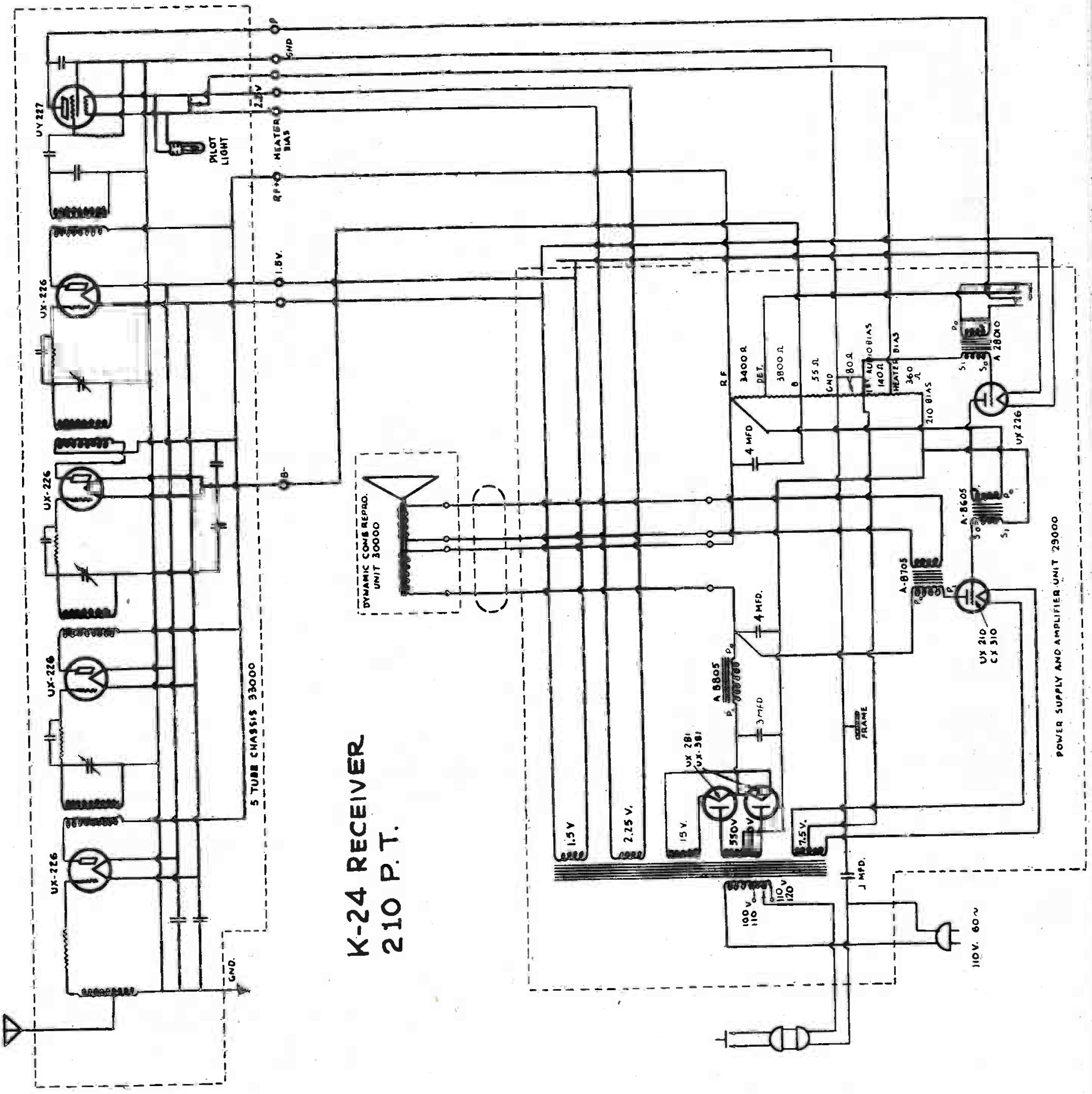
"BRANDES" B11 & B12 RECEIVERS

BRANDES PRODUCTS CORP.

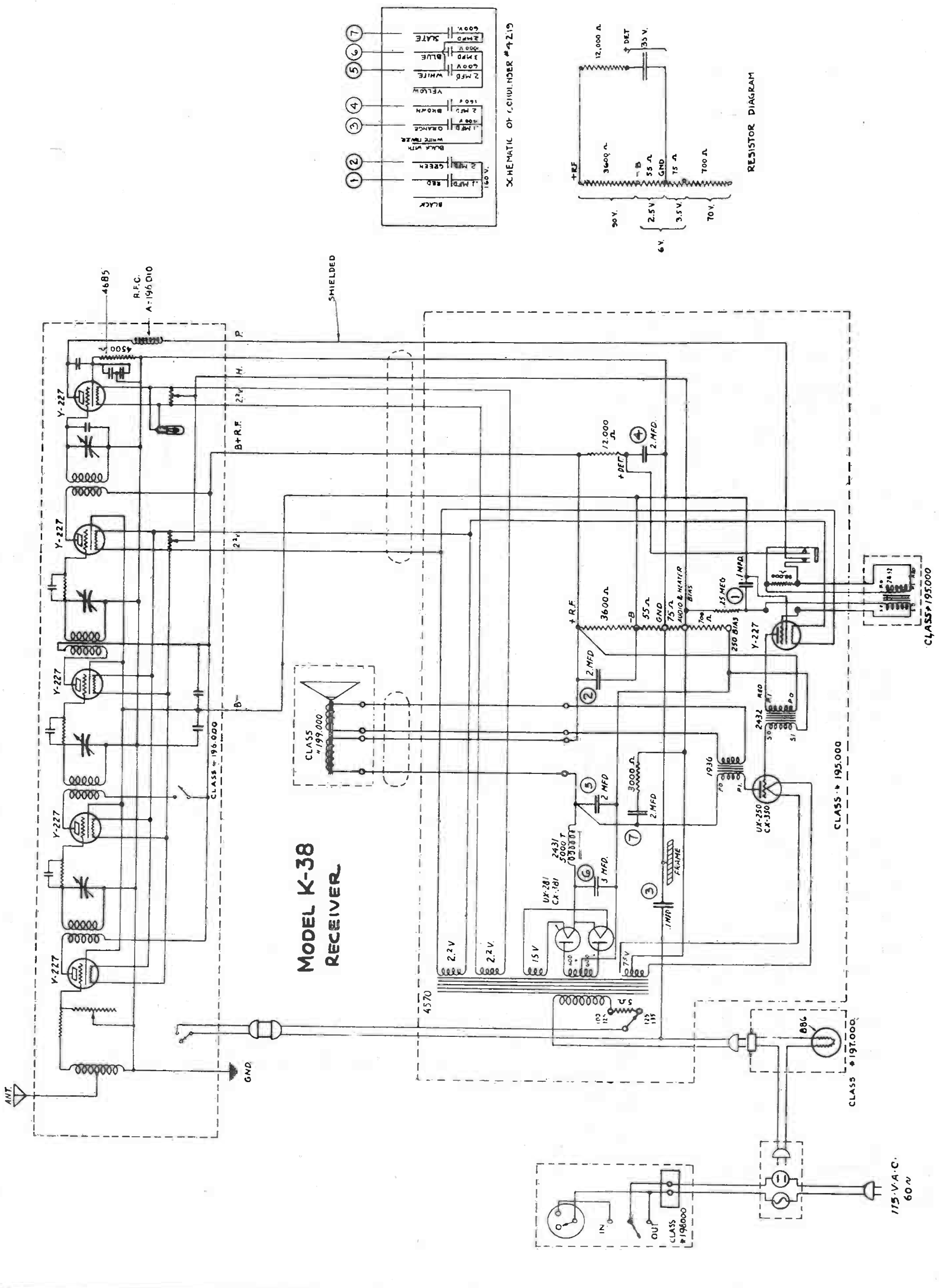


BRANDES PRODUCTS CORP.

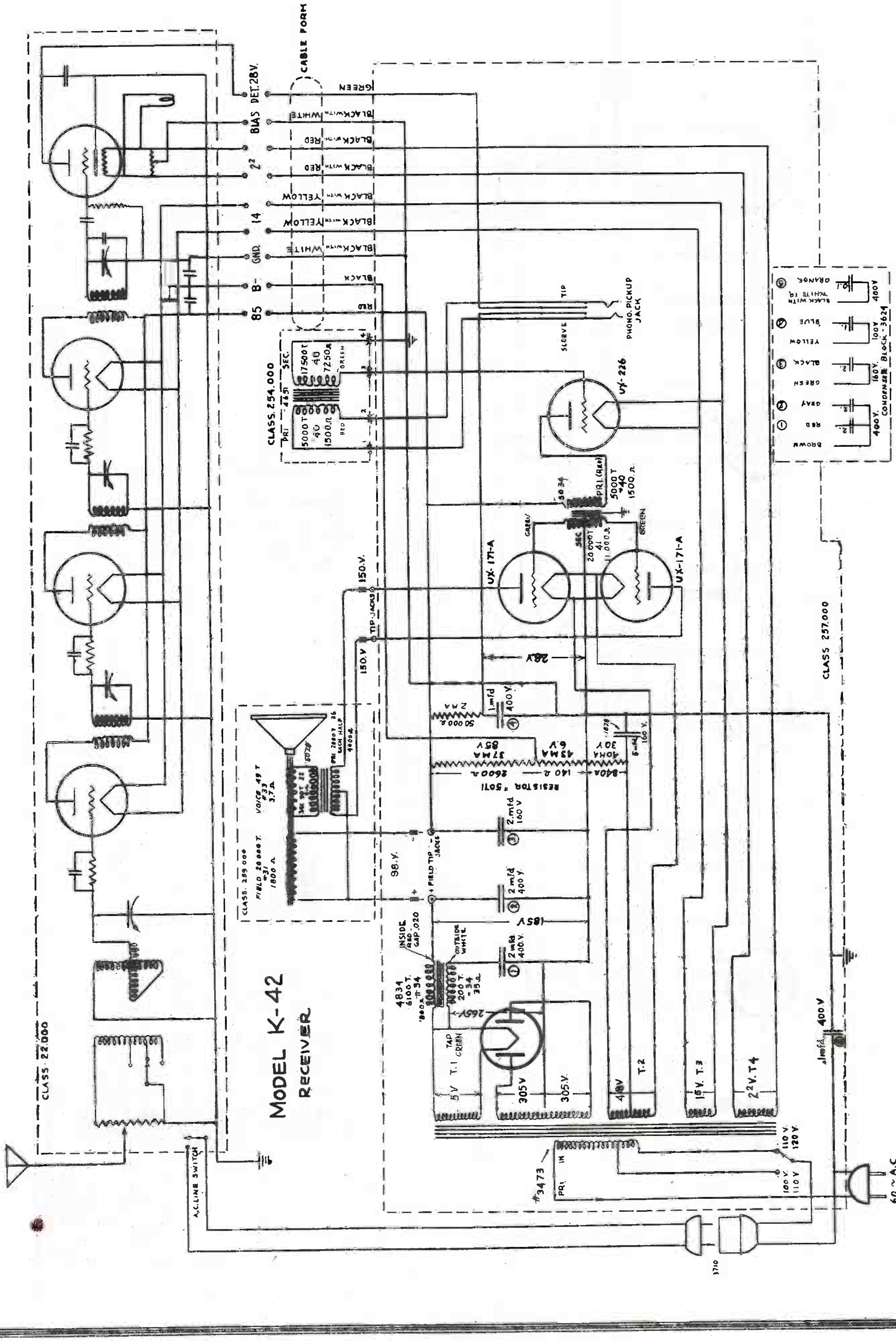




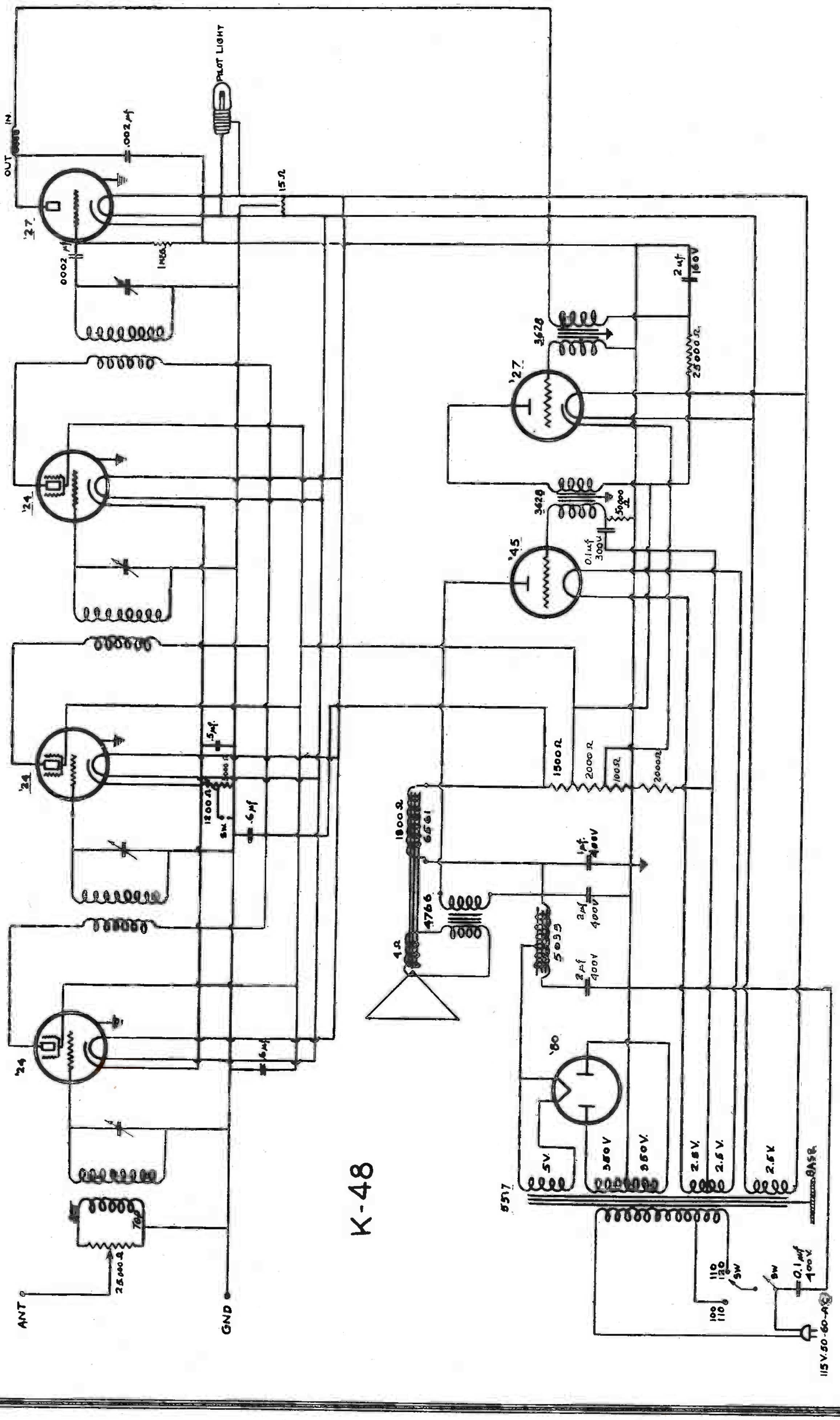
BRANDES PRODUCTS CORP.



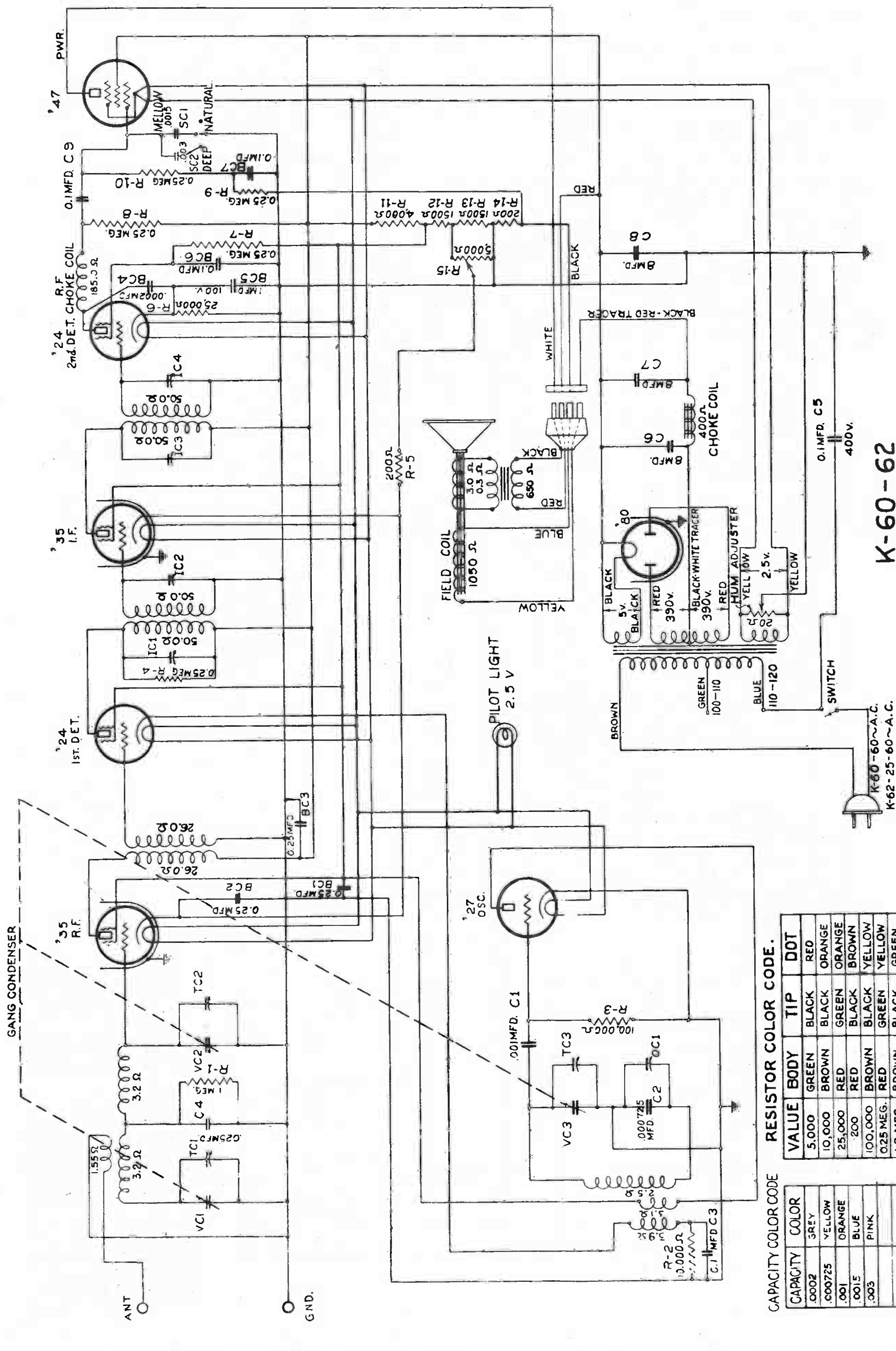
BRANDES PRODUCTS CORP.



BRANDES PRODUCTS CORP.



BRANDES PRODUCTS CORP.



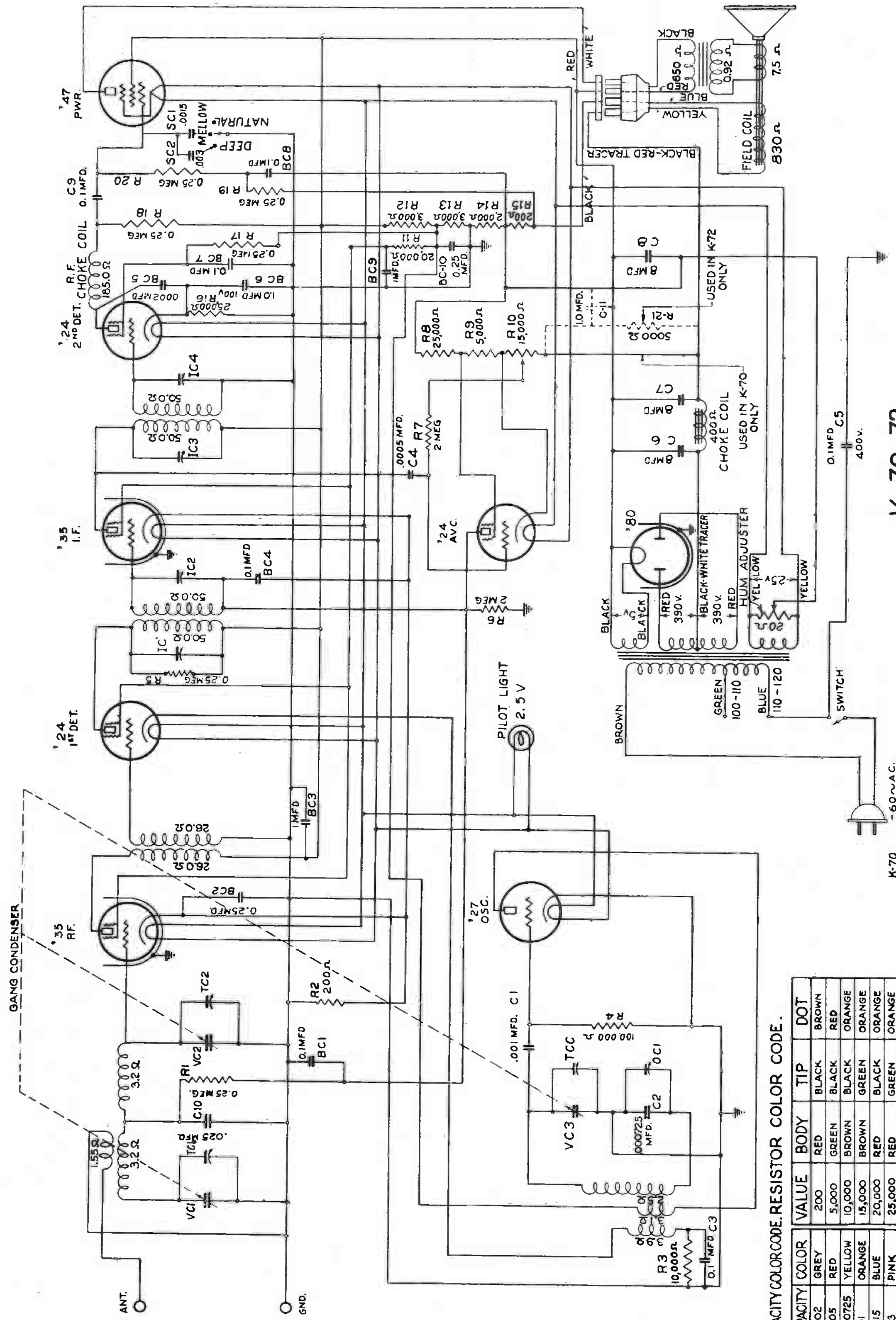
RESISTOR COLOR CODE.

VALUE	BODY	TIP	DOT
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
200	RED	BLACK	BROWN
100,000	BROWN	BLACK	YELLOW
0.25 MEG.	RED	GREEN	YELLOW
1.0 MEG.	BROWN	BLACK	GREEN

CAPACITY COLOR CODE

CAPACITY	COLOR
.0002	GREY
.000725	YELLOW
.001	ORANGE
.0015	BLUE
.003	PINK

BRANDES PRODUCTS CORP.



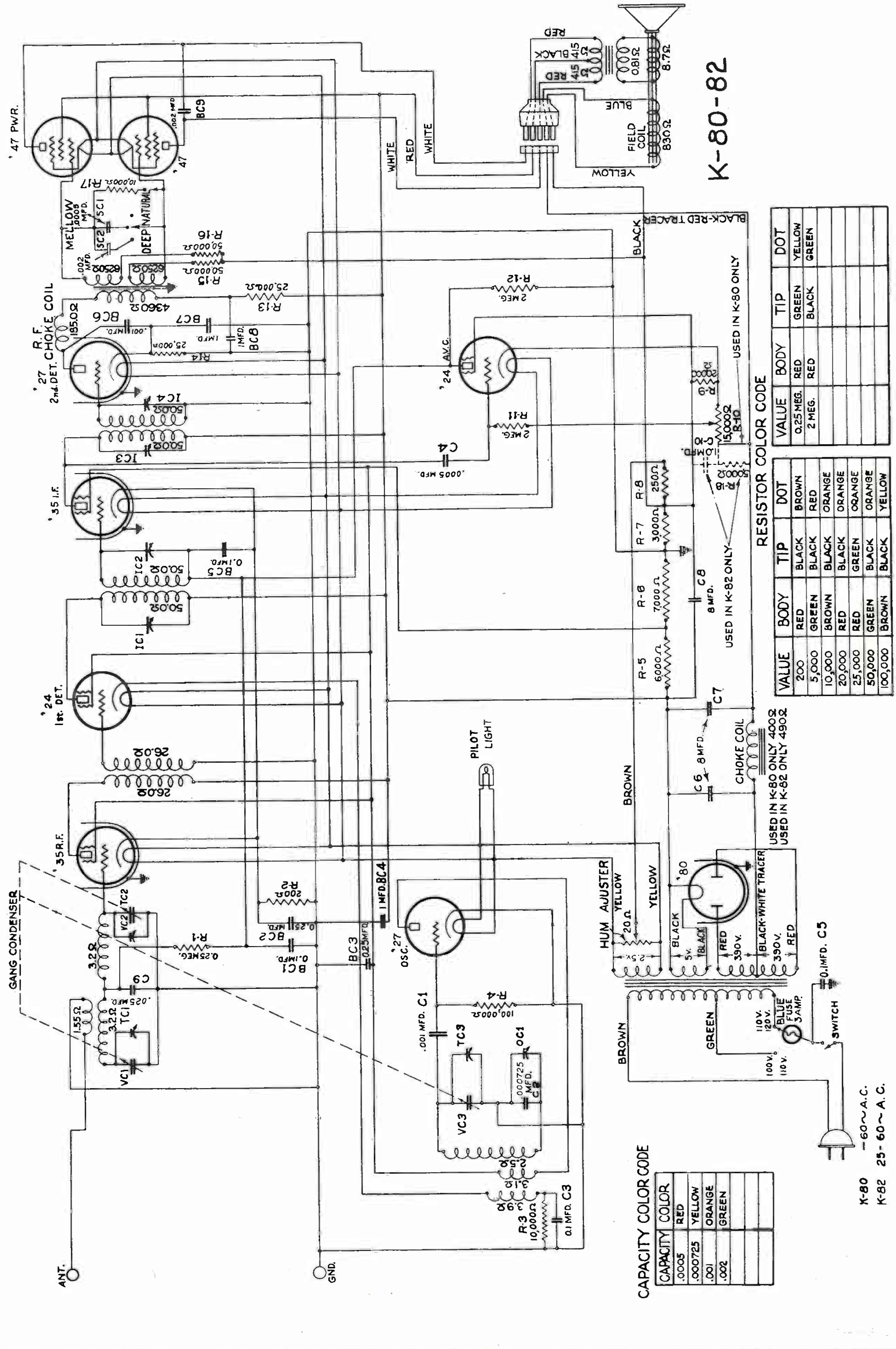
CAPACITY COLOR CODE.

CAPACITY	COLOR
.0002	GREY
.0005	RED
.000725	YELLOW
.001	ORANGE
.0015	BLUE
.003	PINK

RESISTOR COLOR CODE.

VALUE	BODY	TIP	DOT
200	RED	BLACK	BROWN
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
15,000	BROWN	GREEN	ORANGE
20,000	RED	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
100,000	BROWN	BLACK	YELLOW
0.25 MEG.	RED	GREEN	YELLOW
2 MEG.	RED	BLACK	GREEN

BRANDES PRODUCTS CORP.



RESISTOR COLOR CODE

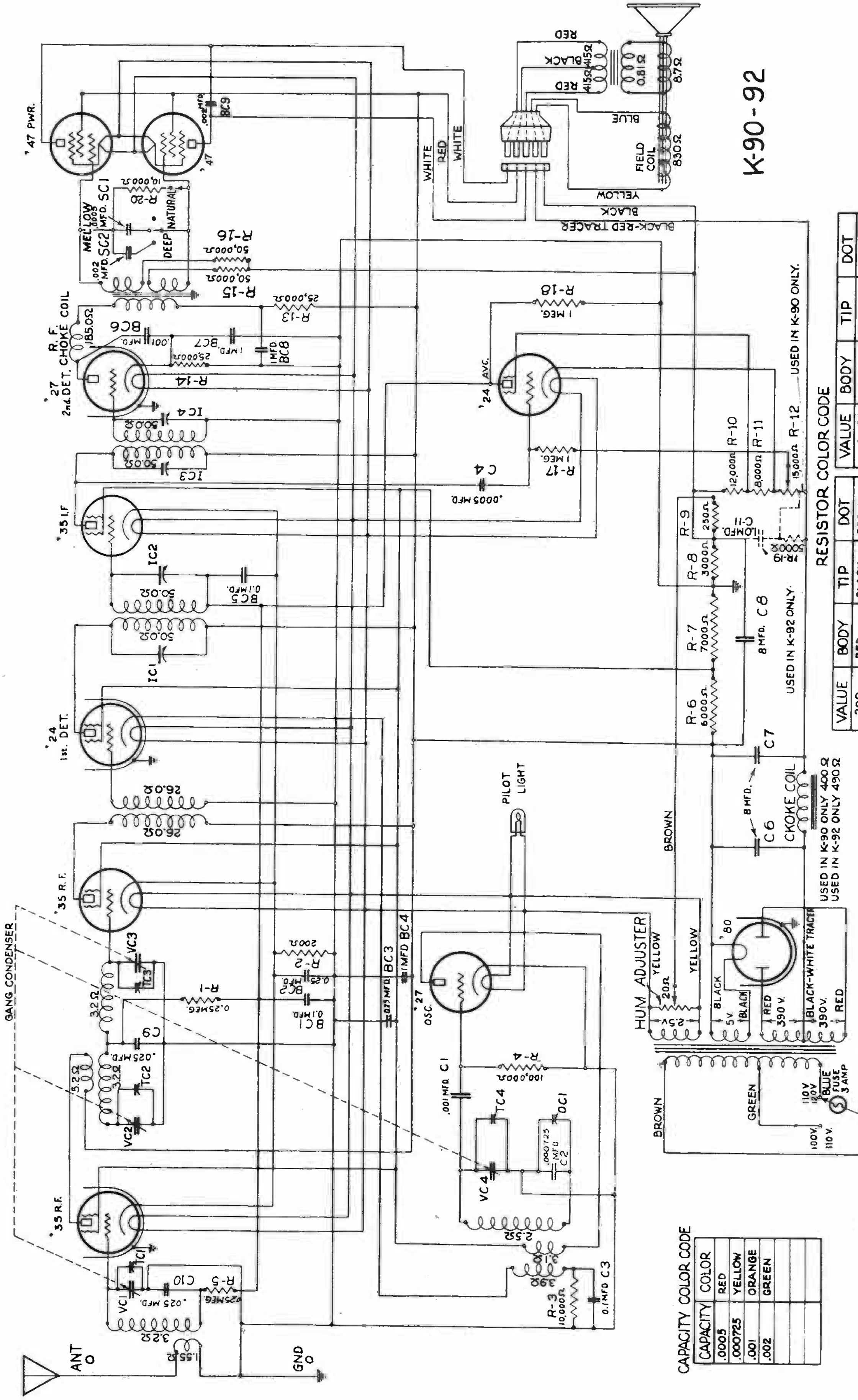
VALUE	BODY	TIP	DOT
200	RED	BLACK	BROWN
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
20,000	RED	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
50,000	GREEN	BLACK	ORANGE
100,000	BROWN	BLACK	YELLOW

VALUE	BODY	TIP	DOT
0.25 MEG.	RED	GREEN	YELLOW
2 MEG.	RED	BLACK	GREEN

CAPACITY COLOR CODE

CAPACITY	COLOR
.0005	RED
.000725	YELLOW
.001	ORANGE
.002	GREEN

BRANDES PRODUCTS CORP.



RESISTOR COLOR CODE

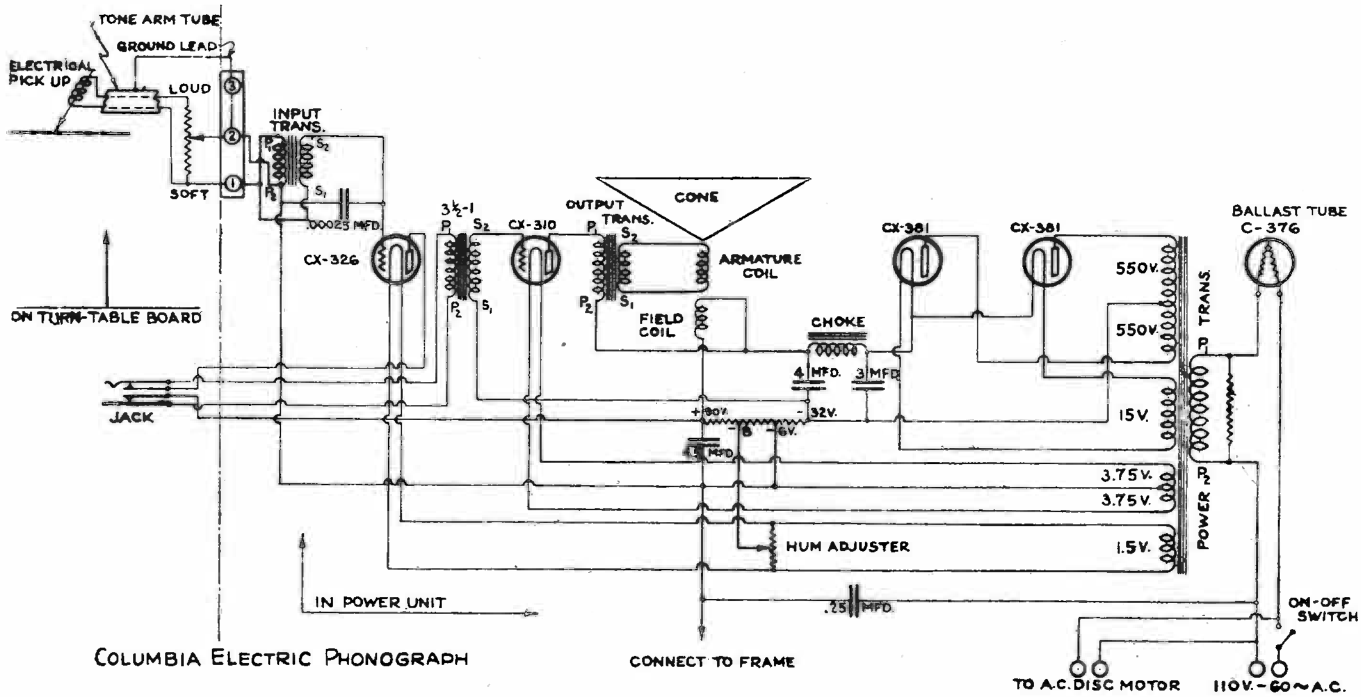
VALUE	BODY	TIP	DOT
200	RED	BLACK	BROWN
8,000	GRAY	BLACK	RED
10,000	BROWN	BLACK	ORANGE
12,000	BROWN	RED	ORANGE
25,000	RED	GREEN	ORANGE
50,000	GREEN	BLACK	ORANGE
100,000	BROWN	BLACK	YELLOW

VALUE	BODY	TIP	DOT
0.25 MEG.	RED	GREEN	YELLOW
1 MEG.	BROWN	BLACK	GREEN
5000	GREEN	BLACK	RED

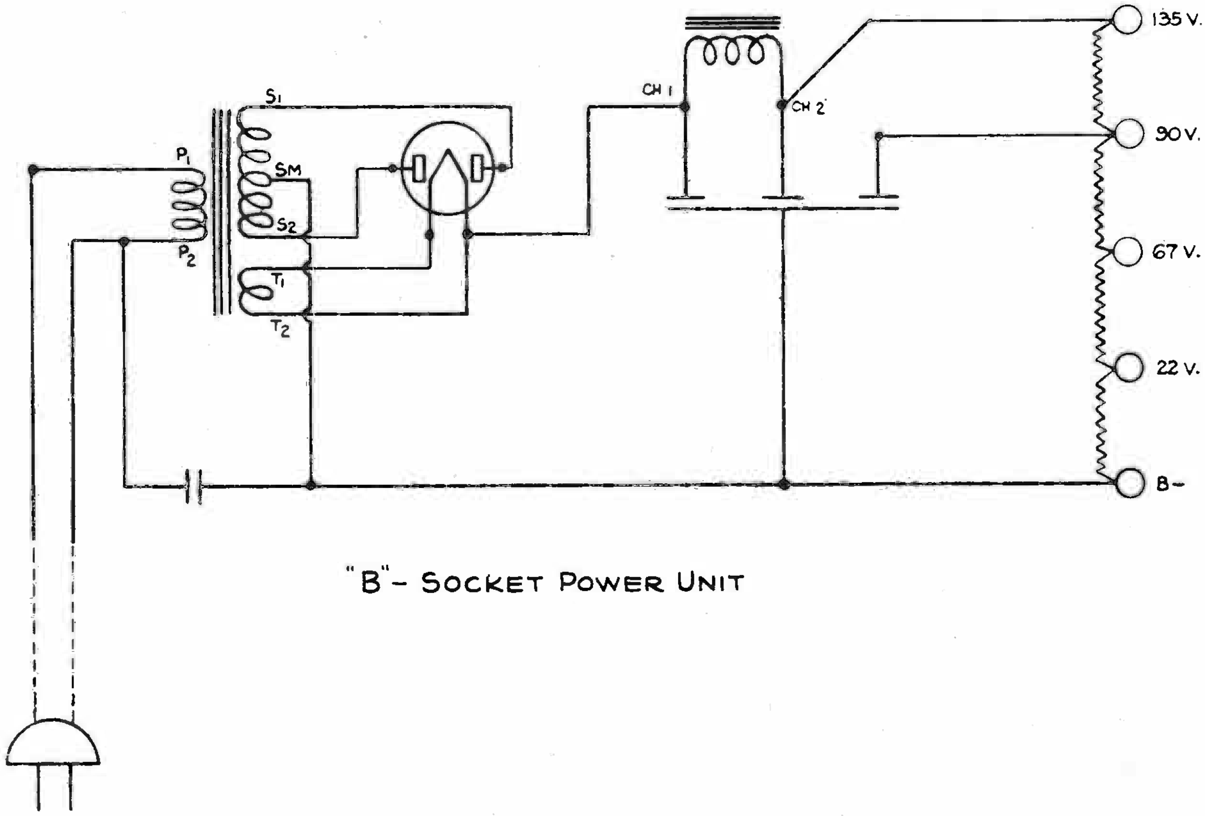
CAPACITY COLOR CODE

CAPACITY	COLOR
.0005	RED
.000725	YELLOW
.001	ORANGE
.002	GREEN

BRANDES PRODUCTS CORP.

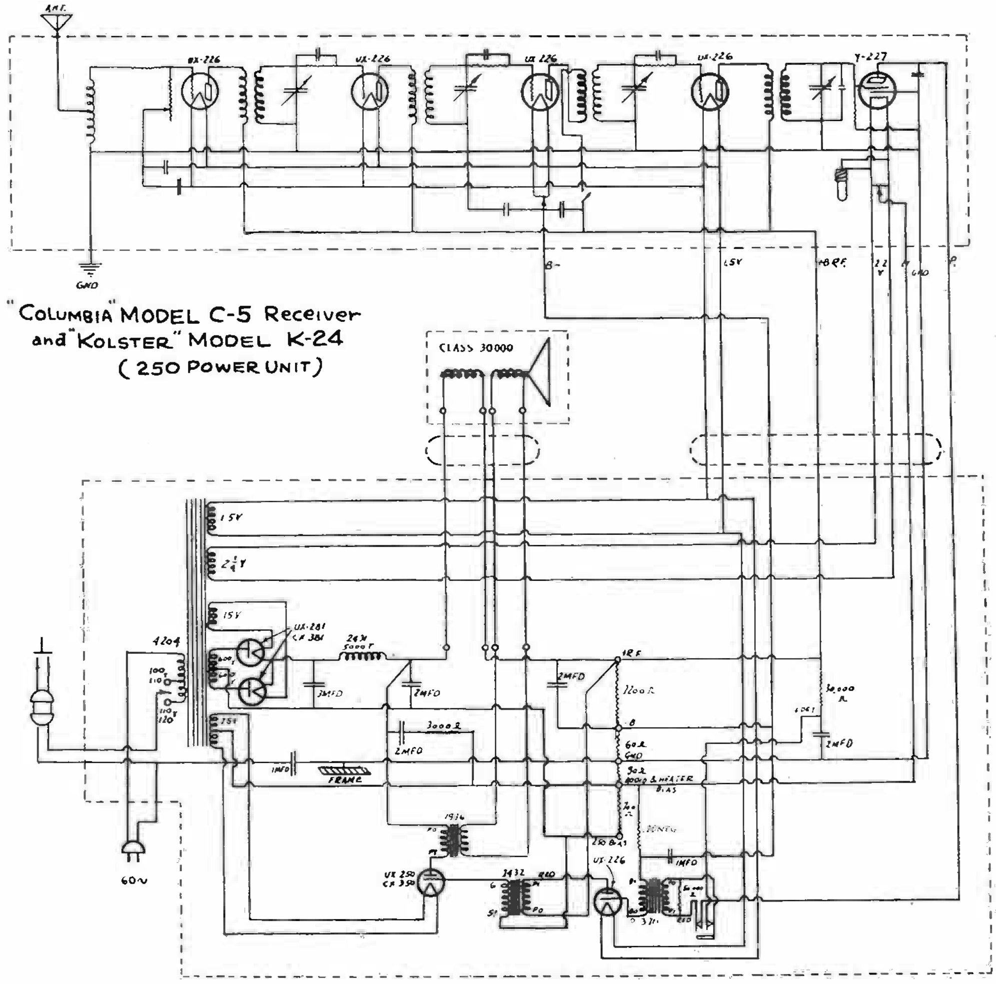


Columbia Electric Phonograph

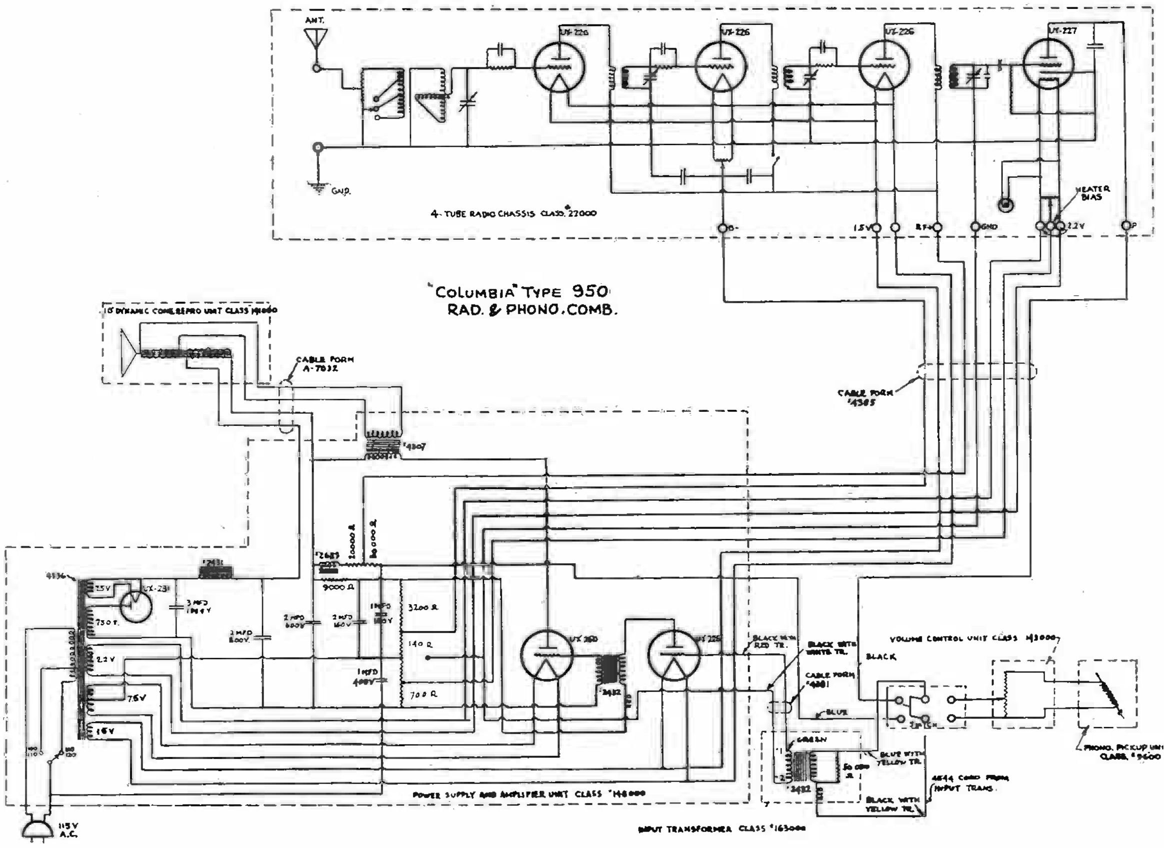


"B"- Socket Power Unit

BRANDES PRODUCTS CORP.

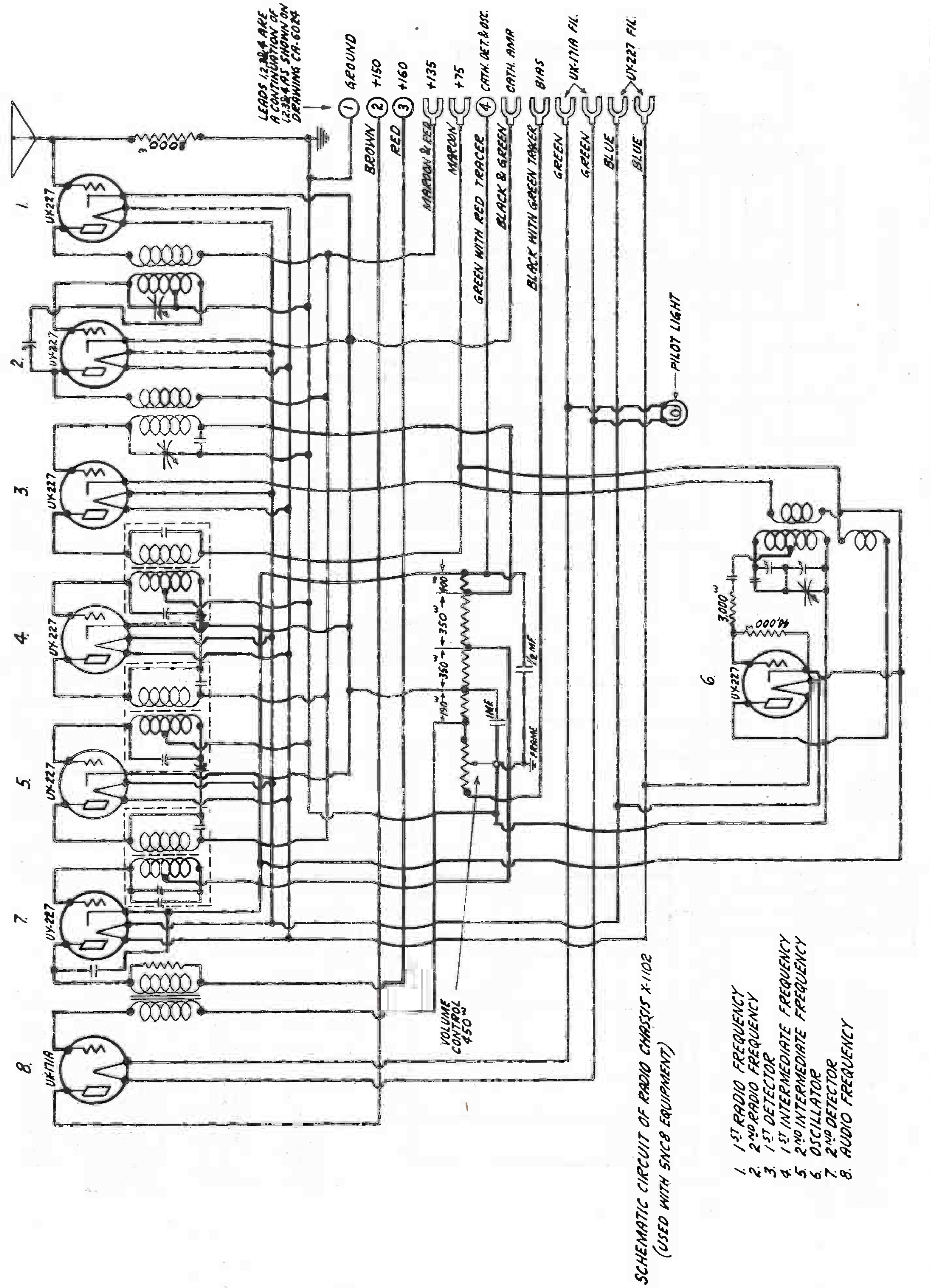


"Columbia" Model C-5 Receiver and "Kolster" Model K-24 (250 Power Unit)



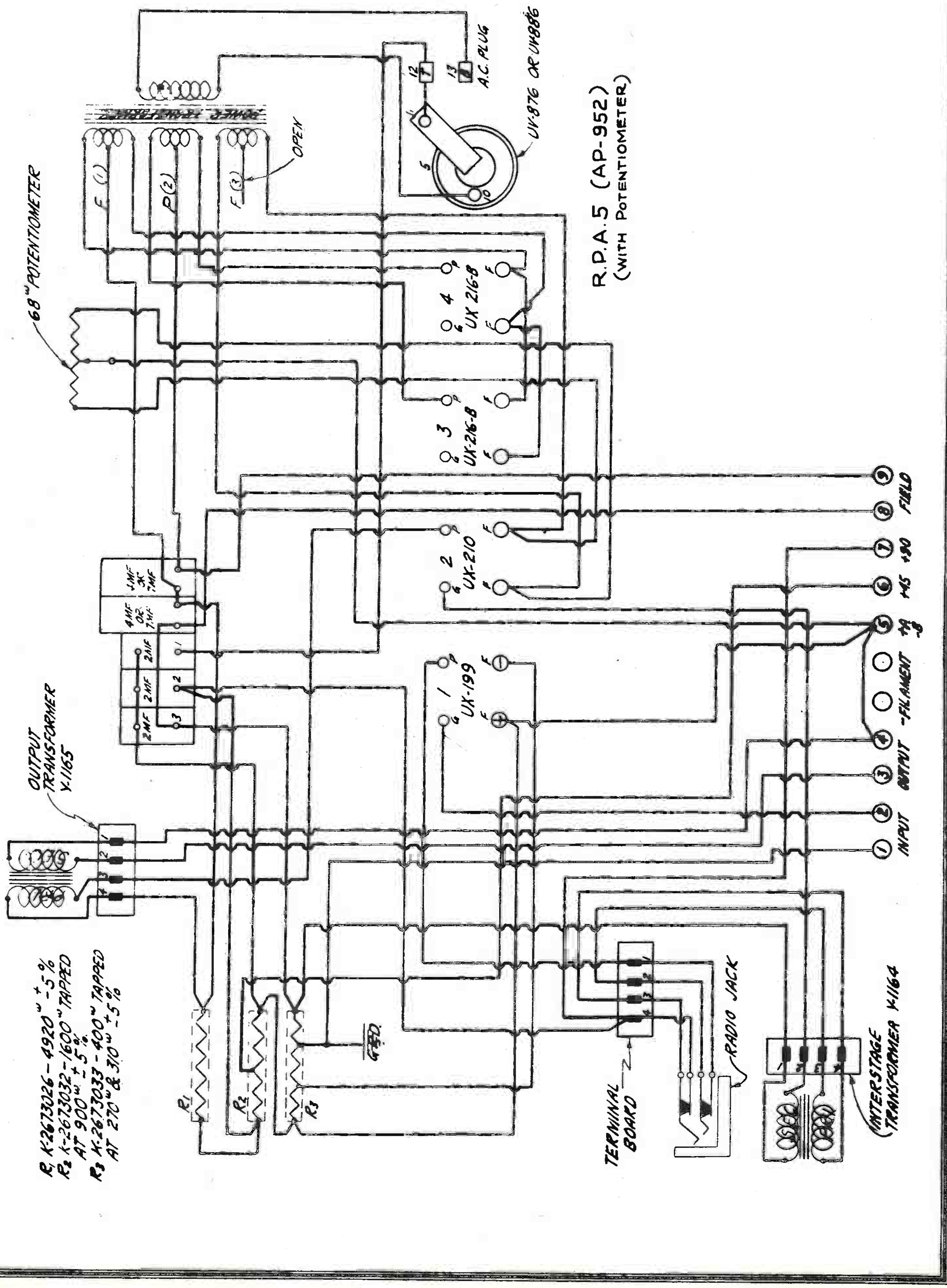
"Columbia" Type 950 Rad. & Phono. Comb.

BRUNSWICK-BALKE-COLLENDER CO.

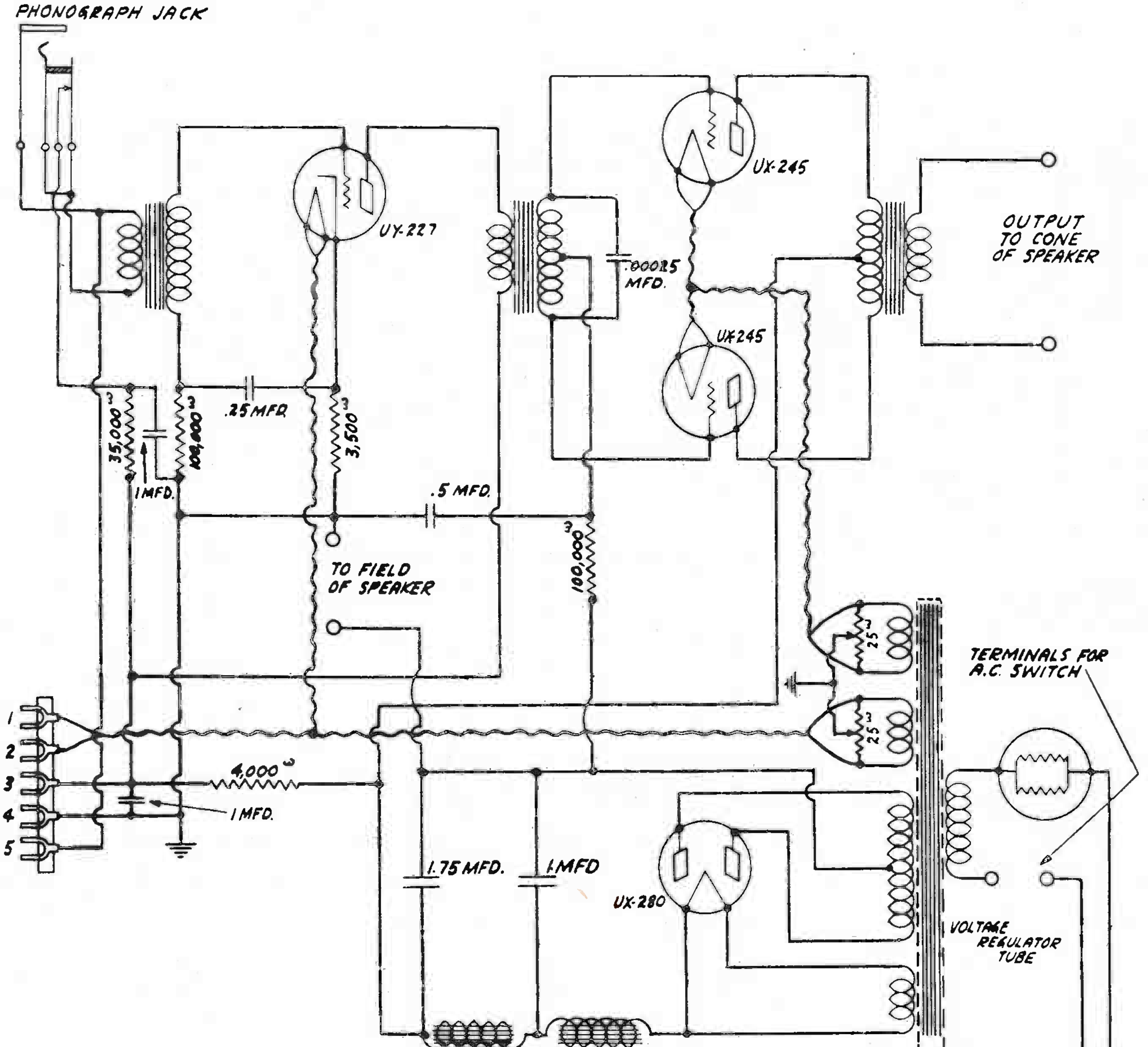


SCHEMATIC CIRCUIT OF RADIO CHASSIS X-1102
(USED WITH SNC8 EQUIPMENT)

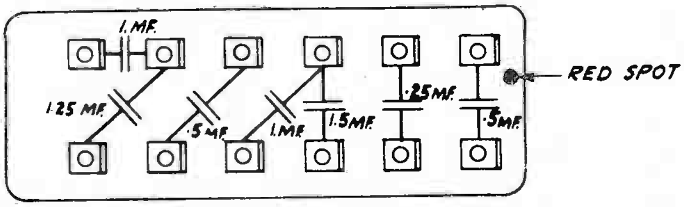
BRUNSWICK-BALKE-COLLENDER CO.



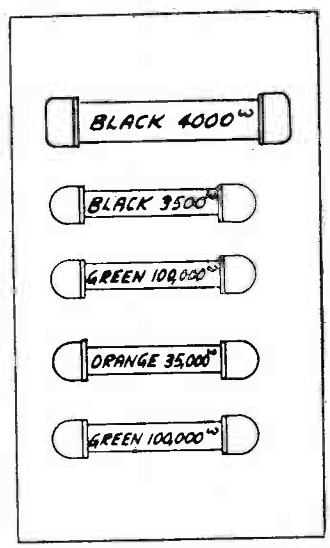
BRUNSWICK-BALKE-COLLENDER CO.



SCHEMATIC CIRCUIT OF SOCKET POWER UNIT
(USED ON #14 & #21 RADIOS)

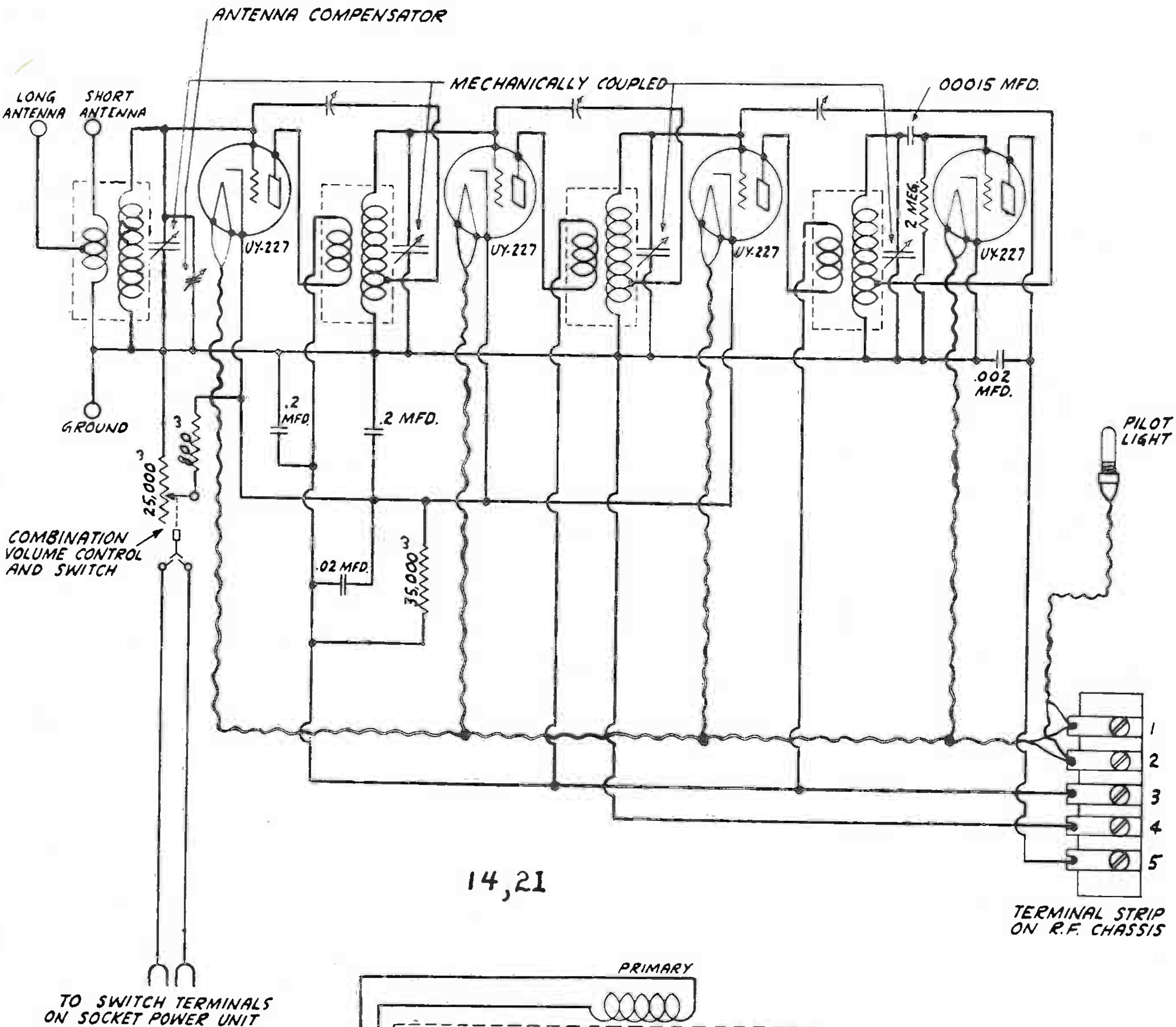


INTERNAL CONNECTIONS OF FILTER AND BY-PASS CONDENSERS

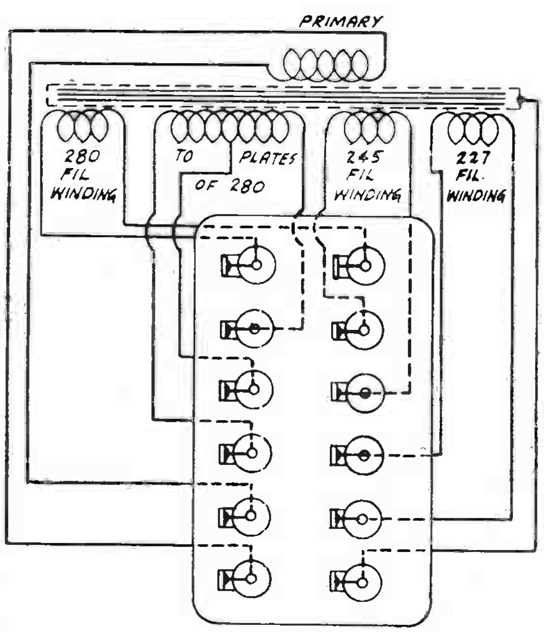


ARRANGEMENT OF RESISTORS ON TERMINAL BOARD

BRUNSWICK-BALKE-COLLENDER CO.

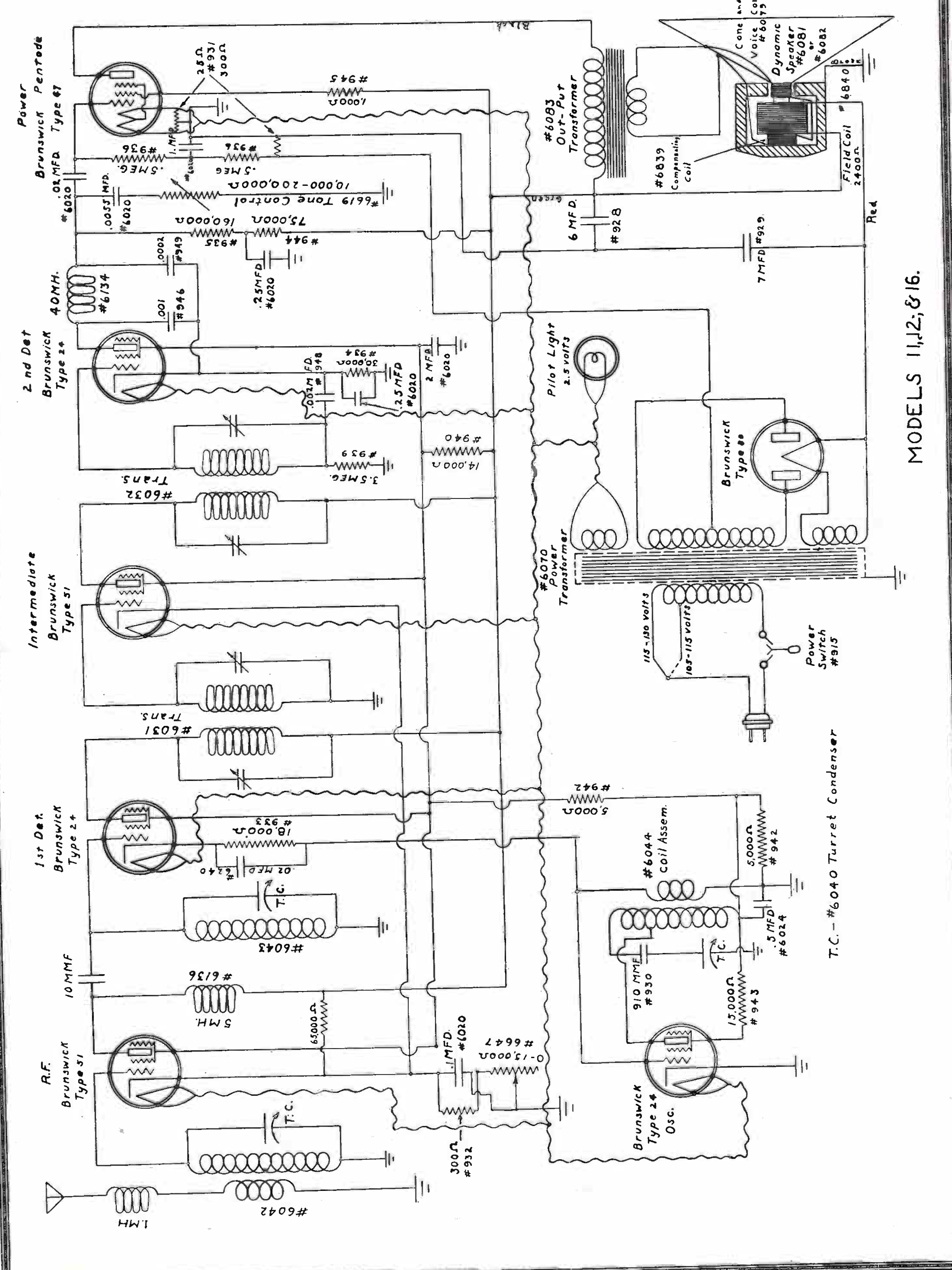


14,21



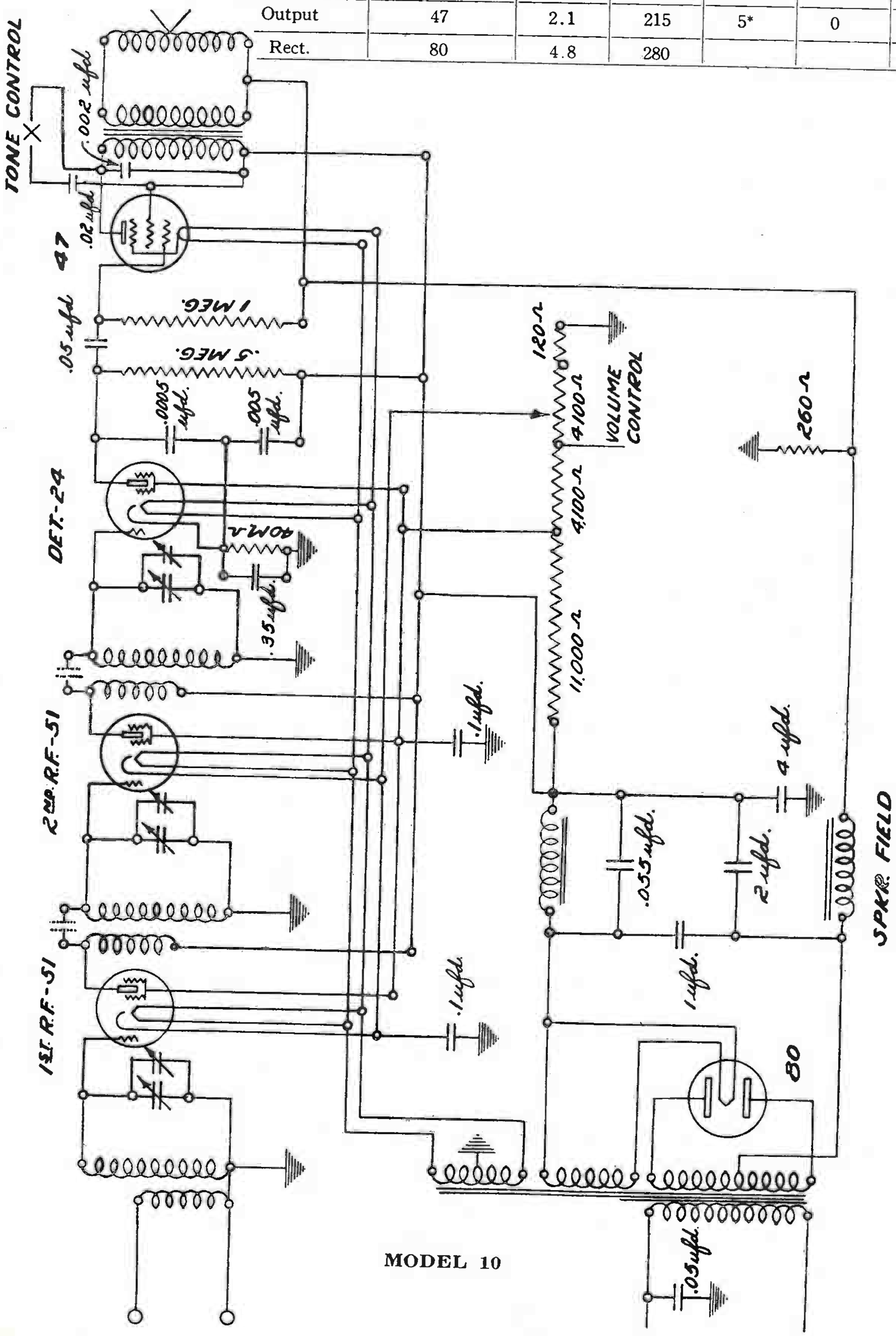
INTERNAL CONNECTIONS OF POWER TRANSFORMER

BRUNSWICK RADIO CORP.



BRUNSWICK RADIO CORP.

Stage	Type Tube	Fil. Volts	Plate Volts	Cont. Grid Volts	Cath. Volts	S. G. Volts	Ip. Normal
1st R. F.	51	2.1	225	2.1	2	75	5
2nd R. F.	51	2.1	230	2.2	2	75	4.5
Det.	24	2.1	160*	7	7.5	75	.02
Output	47	2.1	215	5*	0	225	26.5
Rect.	80	4.8	280				†30



MODEL 10

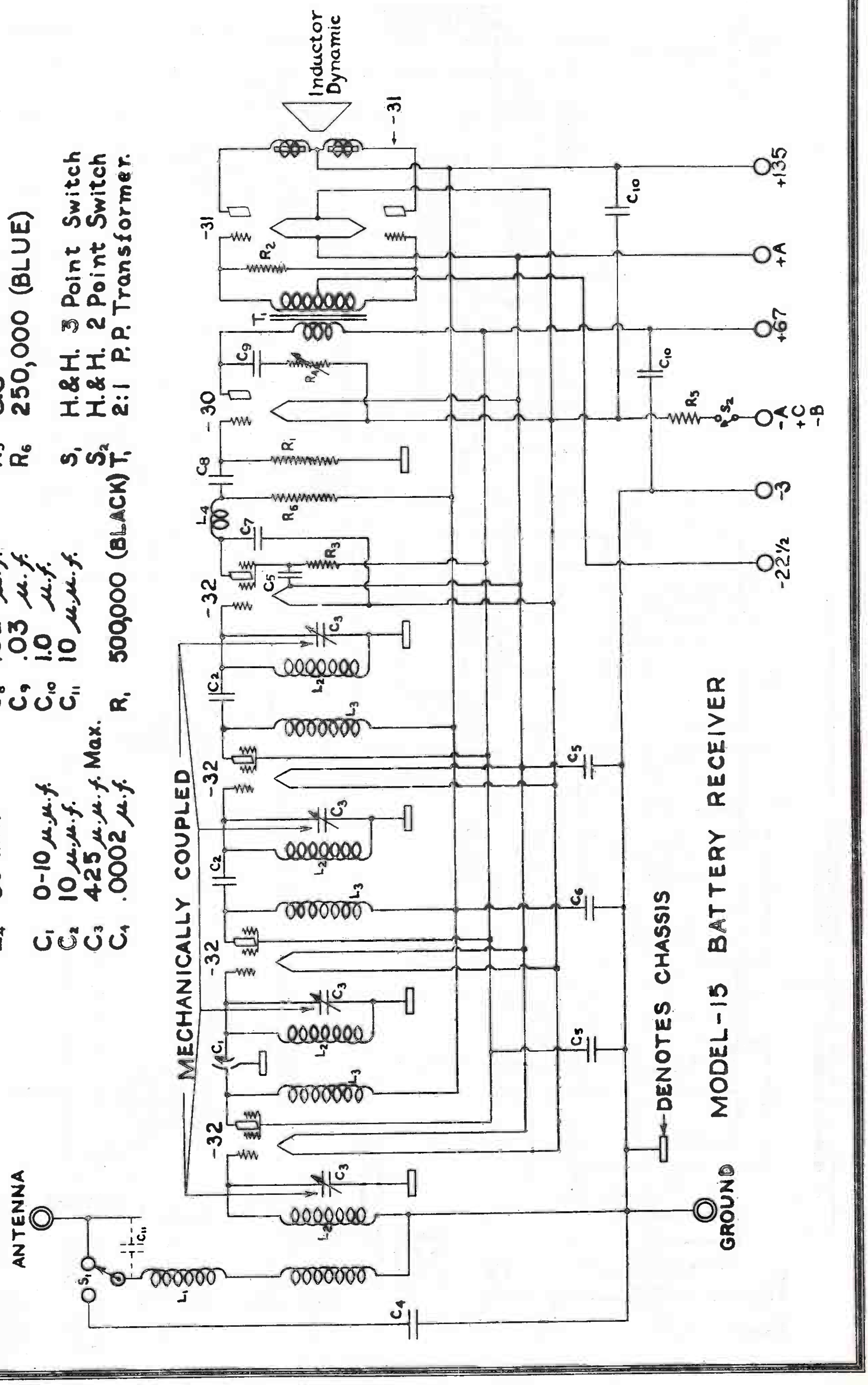
*Reading dependent upon resistance of meter.

†Reading taken for one anode only: 60 milliamperes would be about correct.

Volume control position full. Line voltage 115—60 cycle.

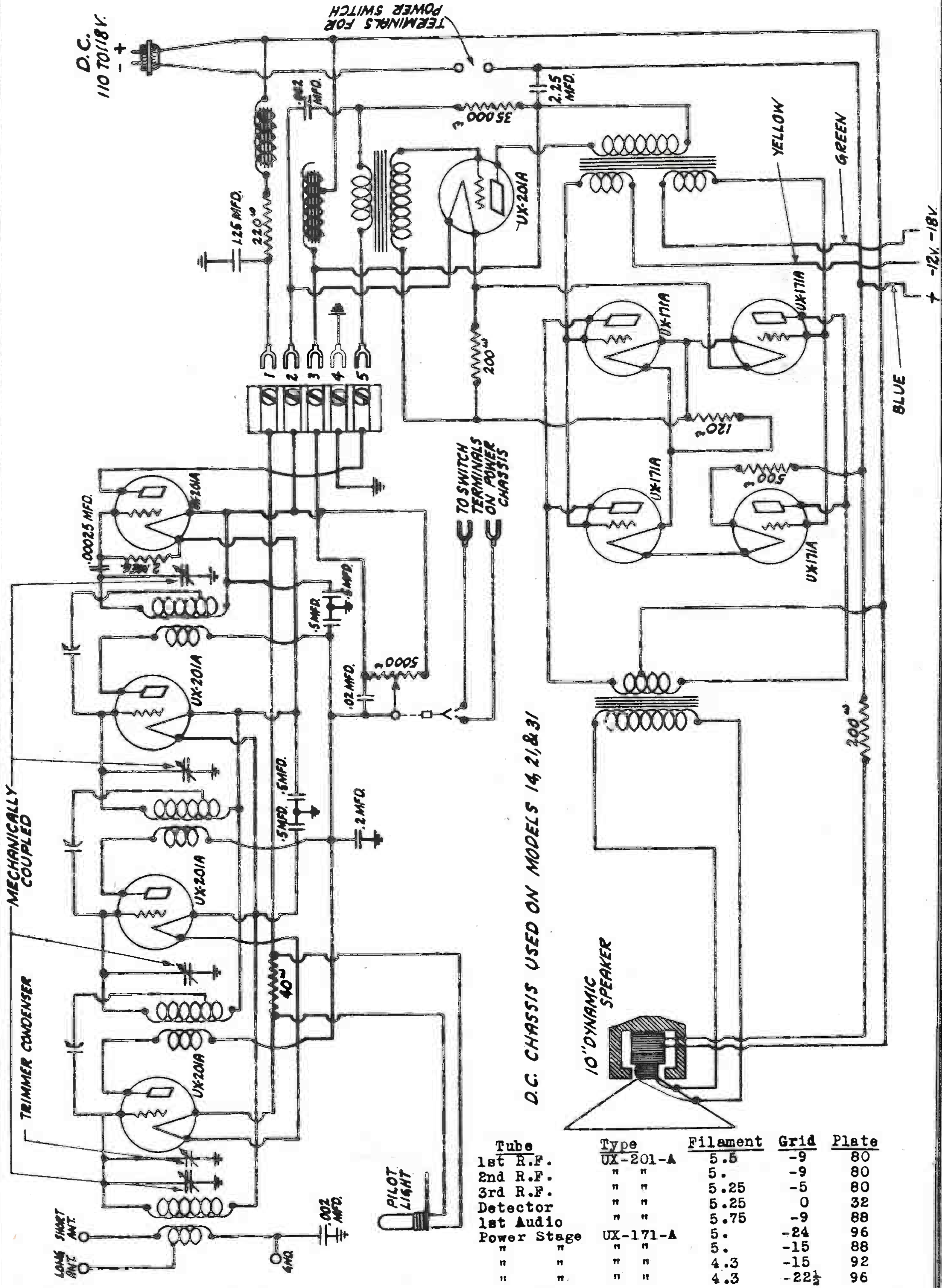
BRUNSWICK RADIO CORP.

L_1	1.0 m.h.	
L_2	205 μ.h.	
L_3	4.5 m.h.	
L_4	65 m.h.	
C_1	0-10 μ.μ.f.	
C_2	10 μ.μ.f.	
C_3	425 μ.μ.f. Max.	
C_4	.0002 μ.f.	
C_5	.25 μ.f.	
C_6	.14 μ.f.	
C_7	.0002 μ.f.	
C_8	.02 μ.f.	
C_9	.03 μ.f.	
C_{10}	1.0 μ.f.	
C_{11}	10 μ.μ.f.	
R_1	500,000 (BLACK)	
R_2	2 Meg. (GREEN)	
R_3	750,000 (PURPLE)	
R_4	0-50,000	
R_5	0.6	
R_6	250,000 (BLUE)	
S_1	H.&H. 3 Point Switch	
S_2	H.&H. 2 Point Switch	
T_1	2:1 P.P. Transformer.	



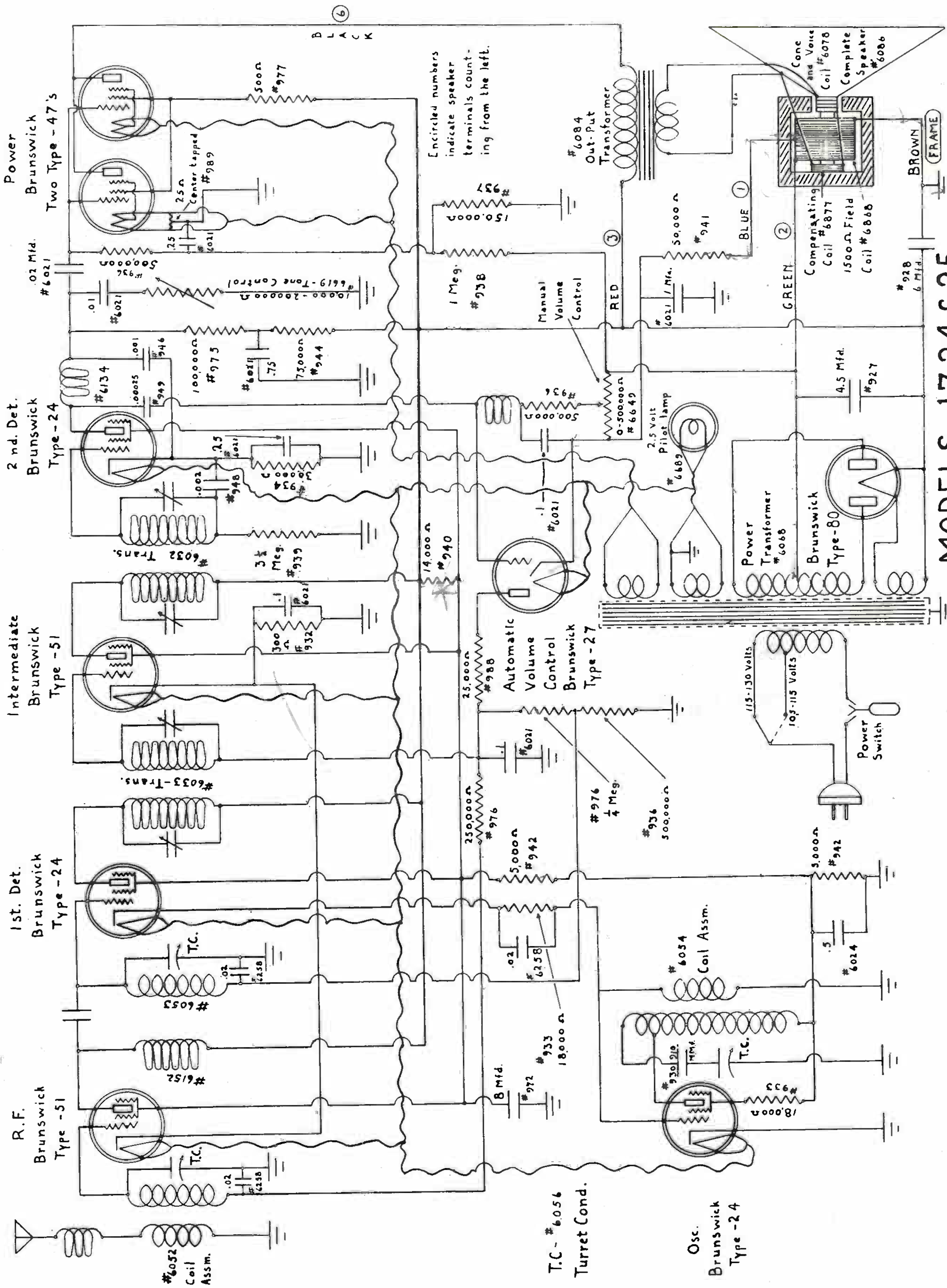
MODEL-15 BATTERY RECEIVER

BRUNSWICK RADIO CORP.

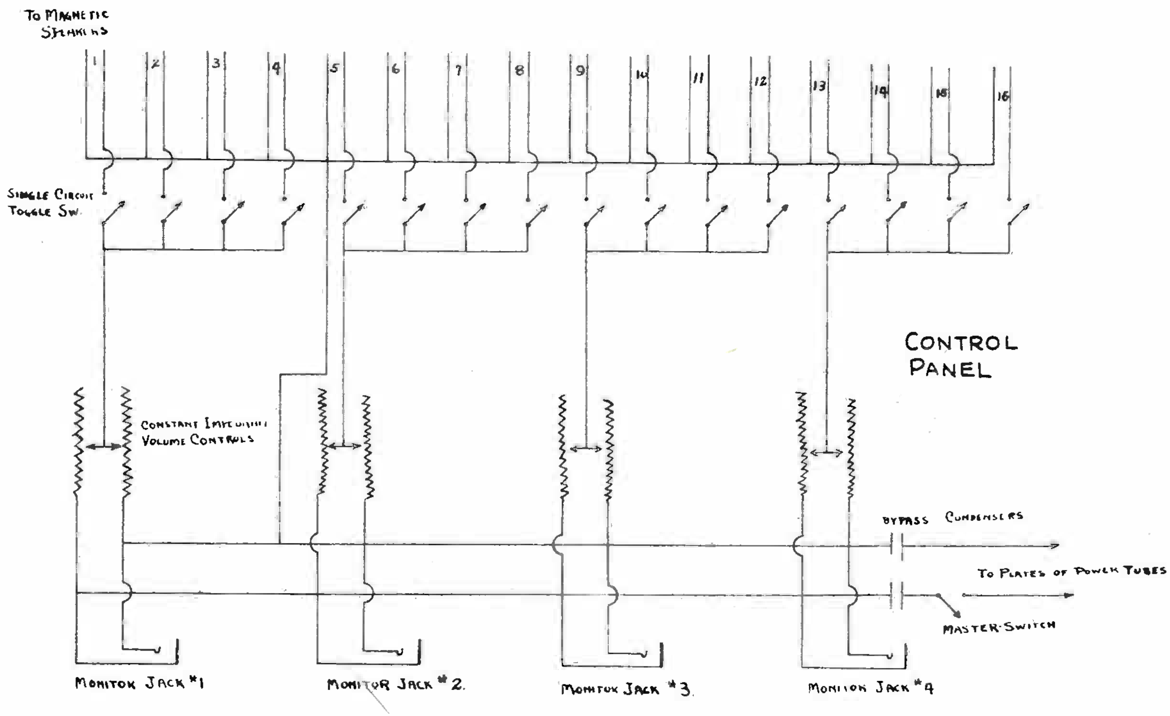


Tube	Type	Filament	Grid	Plate
1st R.F.	UX-201-A	5.5	-9	80
2nd R.F.	" "	5.	-9	80
3rd R.F.	" "	5.25	-5	80
Detector	" "	5.25	0	32
1st Audio	" "	5.75	-9	88
Power Stage	UX-171-A	5.	-24	96
" "	" "	5.	-15	88
" "	" "	4.3	-15	92
" "	" "	4.3	-22½	96

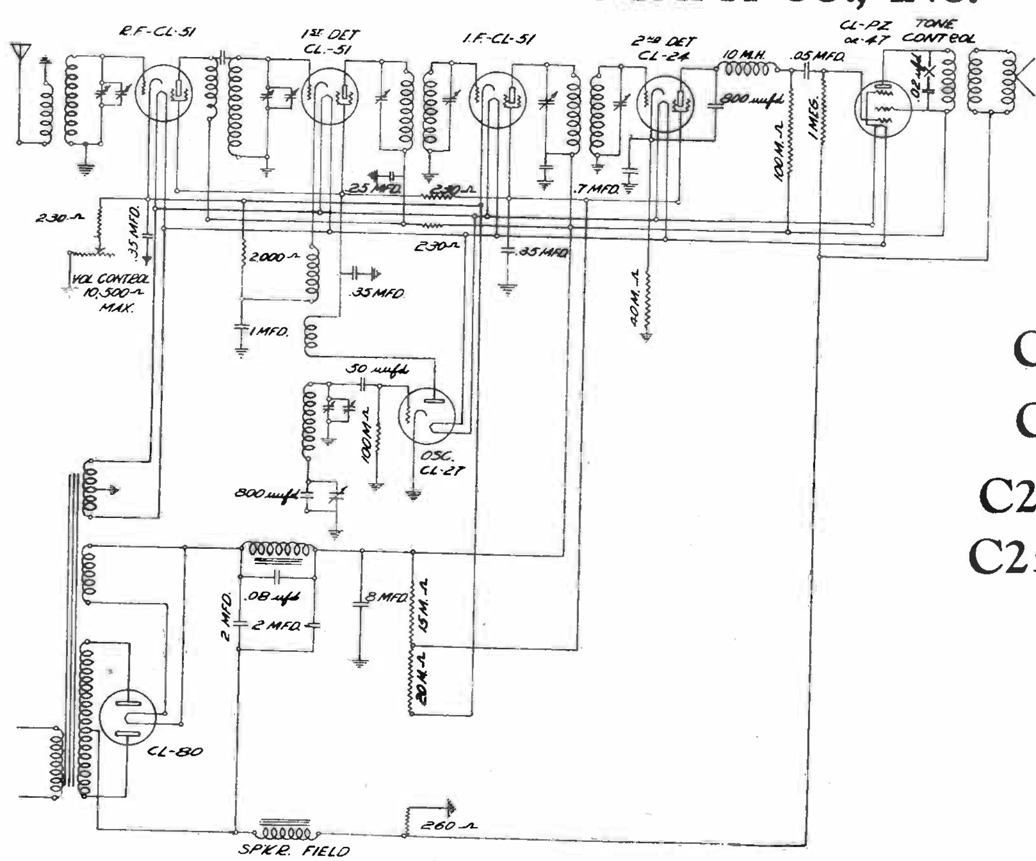
BRUNSWICK RADIO CORP.



BUD MANUFACTURING CO.



COLUMBIA PHONOGAPH CO., INC.



C33

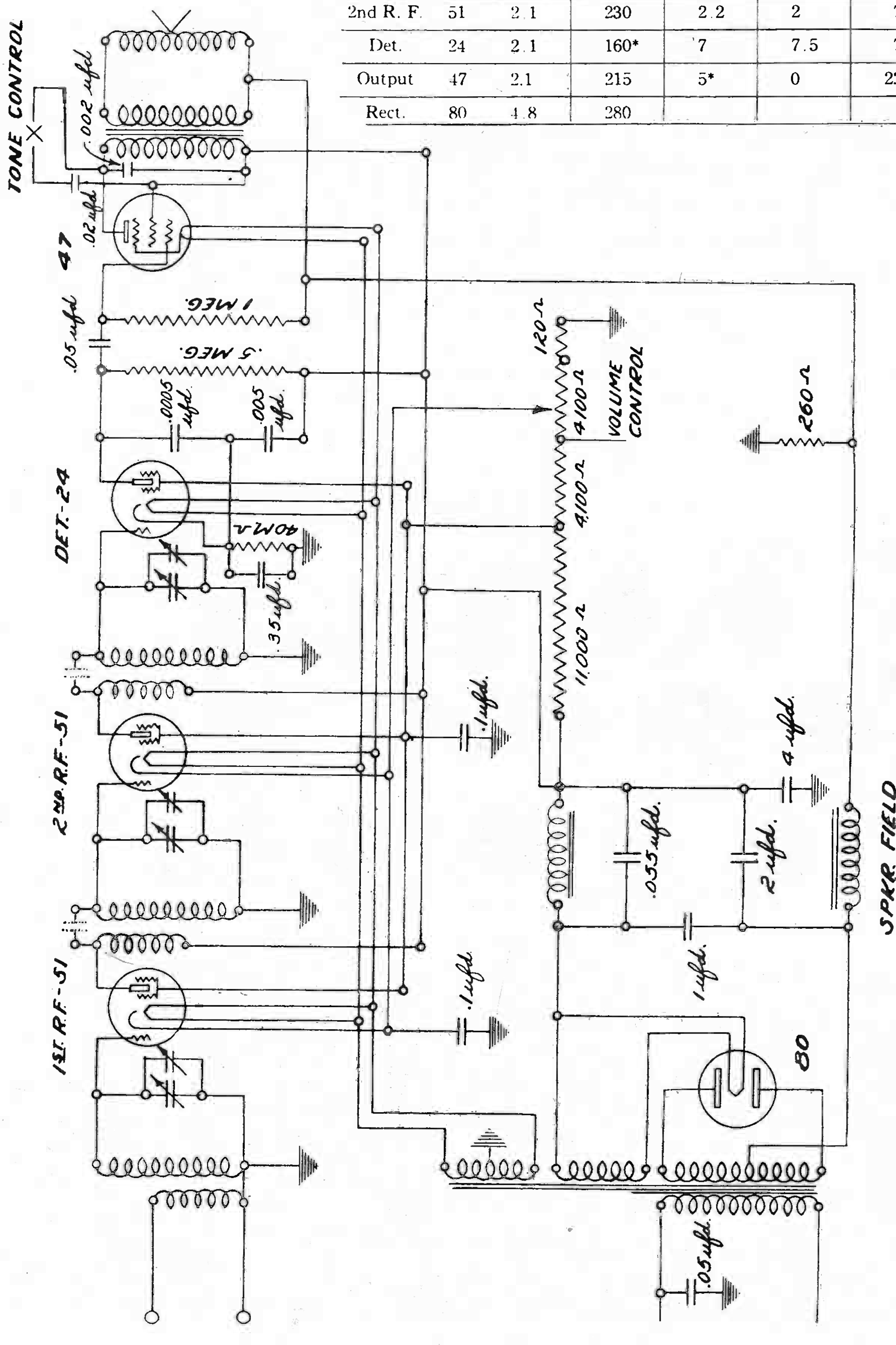
C34

C25-33

C25-34

COLUMBIA PHONOGAPH CO., INC.

Stage	Type Tube	Fil. Volts	Plate Volts	Cont. Grid Volts	Cath. Volts	S. G. Volts	Ip. Normal
1st R. F.	51	2.1	225	2.1	2	75	5
2nd R. F.	51	2.1	230	2.2	2	75	4.5
Det.	24	2.1	160*	7	7.5	75	.02
Output	47	2.1	215	5*	0	225	26.5
Rect.	80	4.8	280				†30



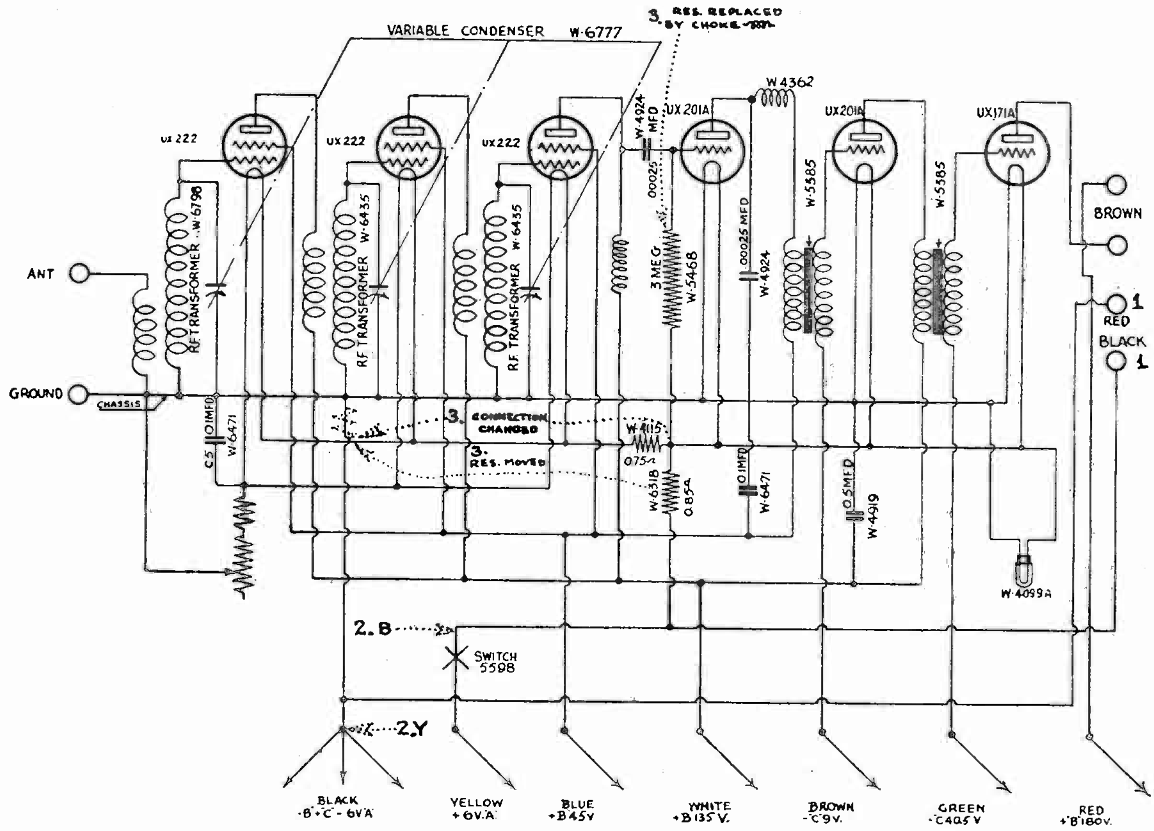
*Reading dependent upon resistance of meter.

†Reading taken for one anode only: 60 milliamperes would be about correct.

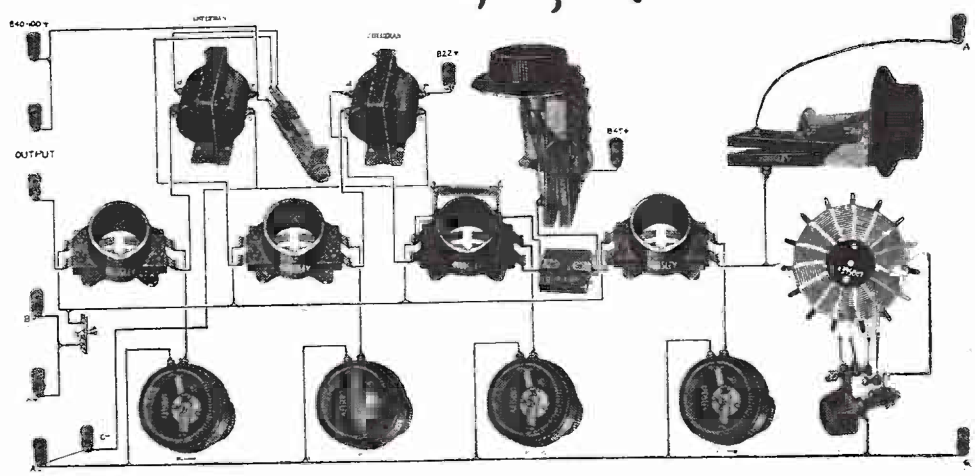
Volume control position full. Line voltage 115—60 cycle.

C-31, C32, C 25-31, C 25-32

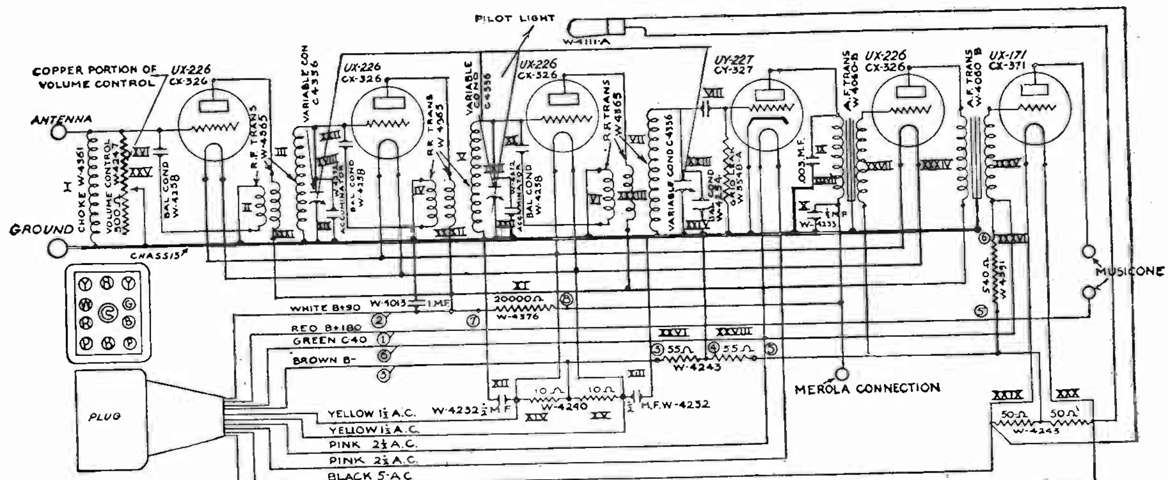
CROSLEY RADIO CORP.



20, 21, 22.

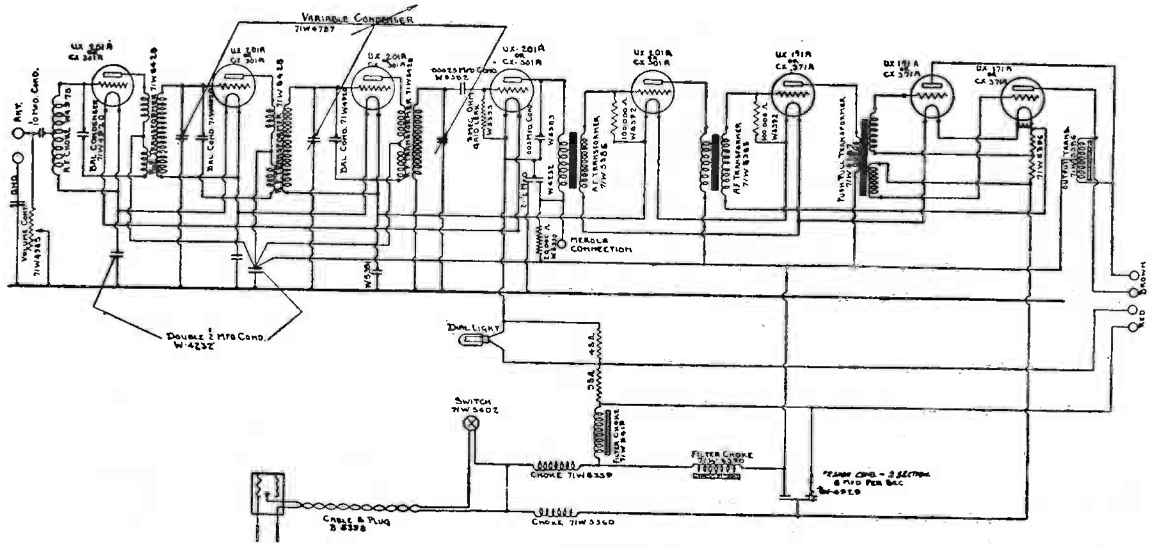


Crosley Models XJ and XL Circuit

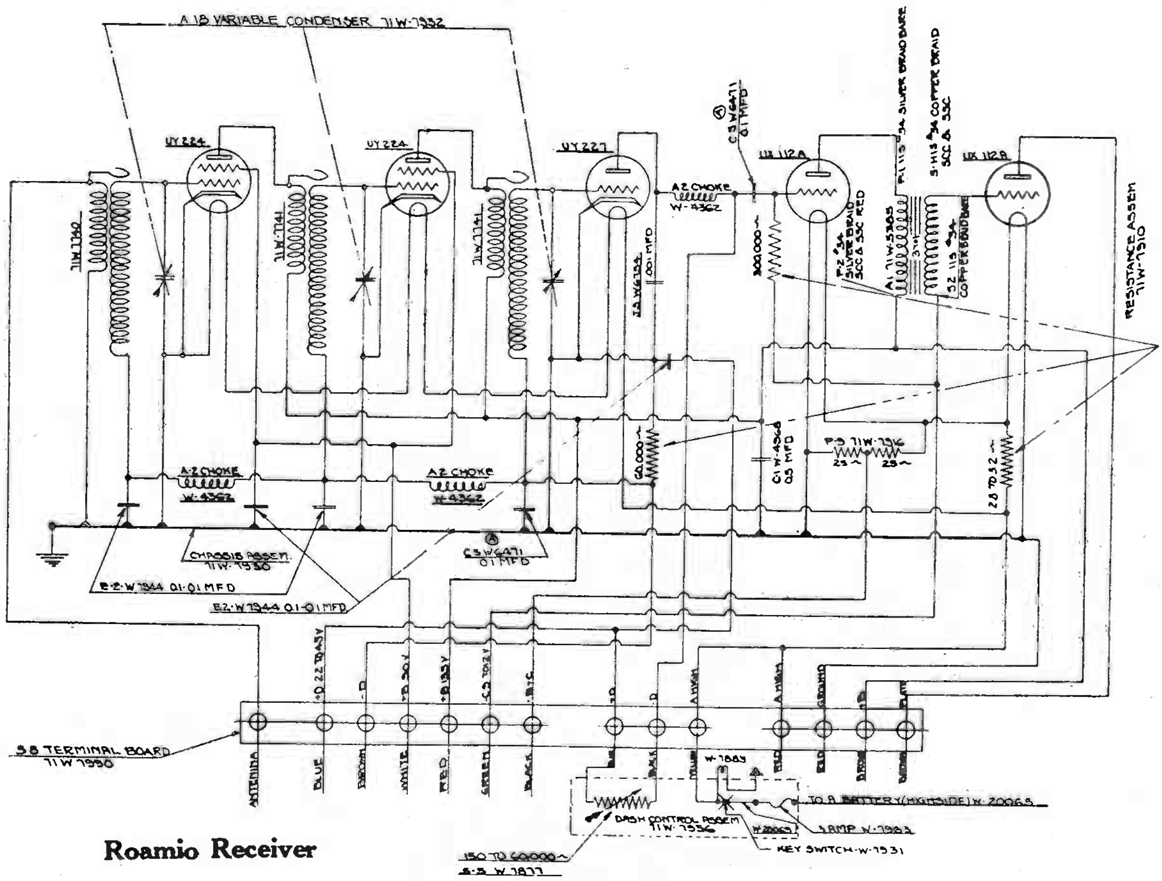


602 CIRCUIT

CROSLEY RADIO CORP.

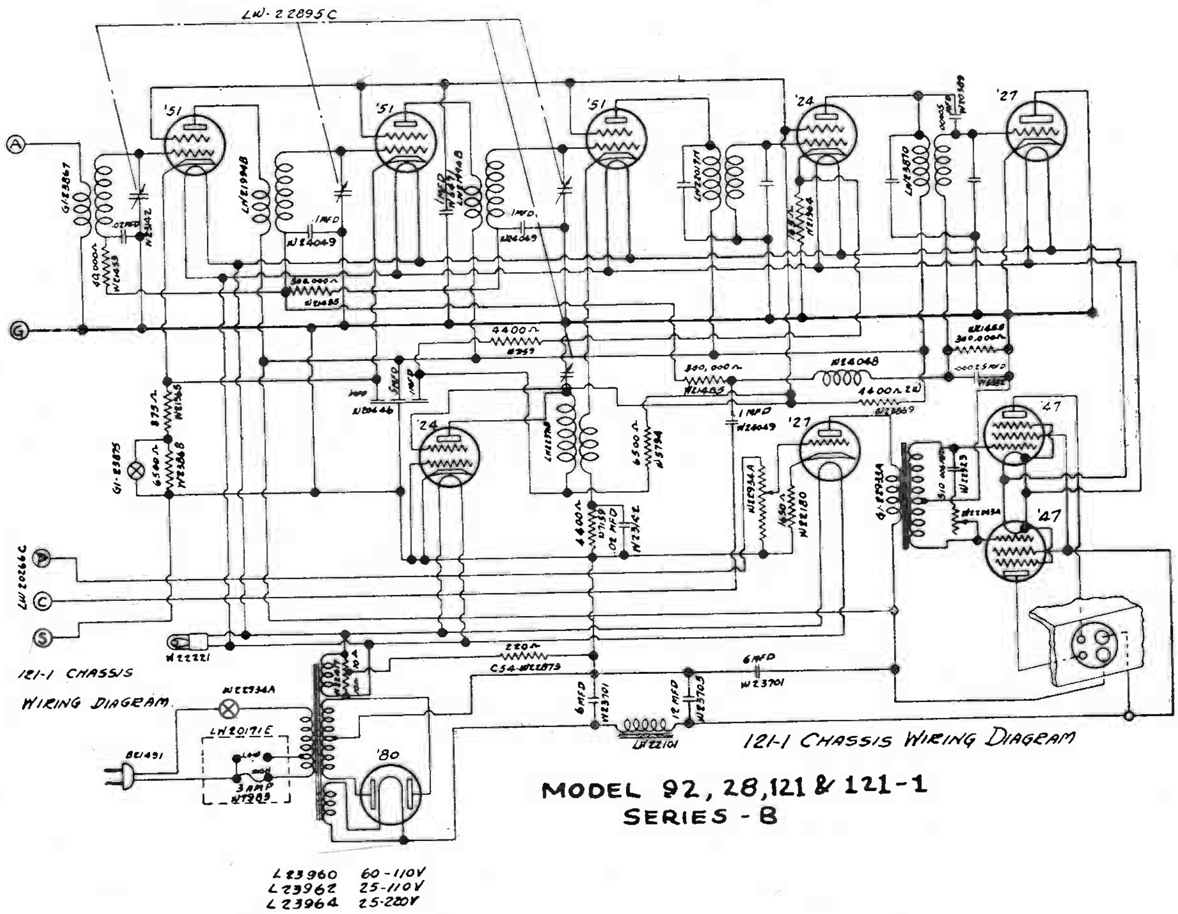


MODEL 705

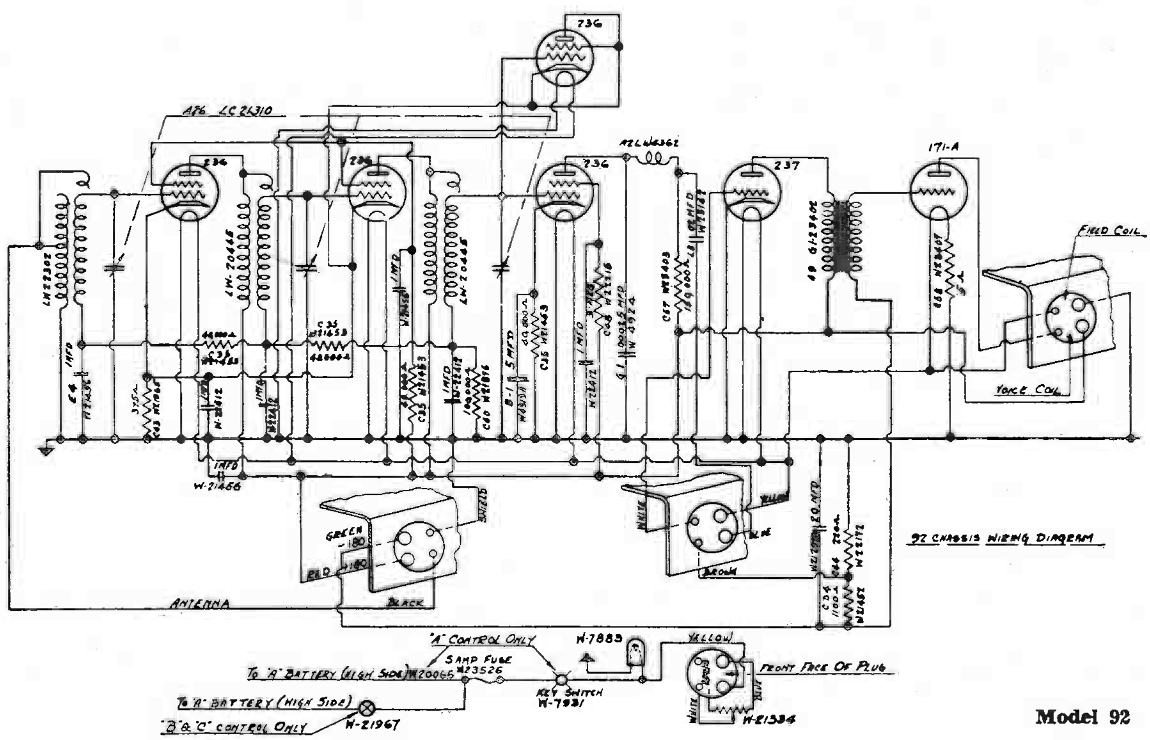


Roamio Receiver

CROSLEY RADIO CORP.

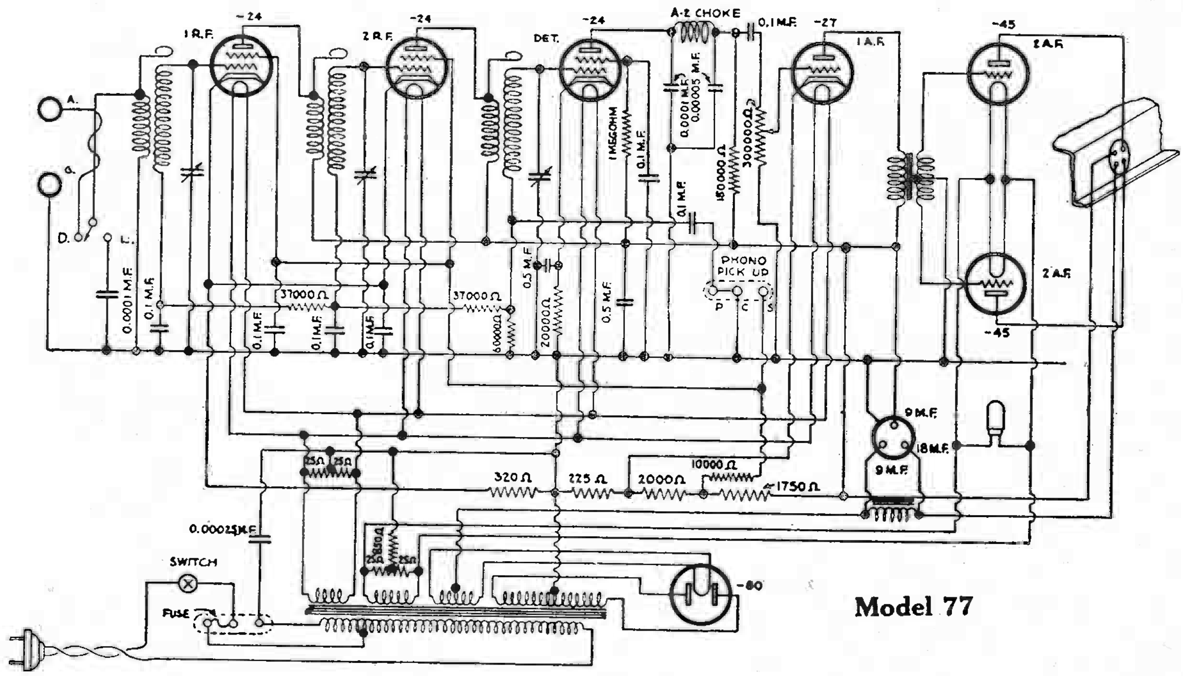


MODEL 92, 28, 121 & 121-1
SERIES - B

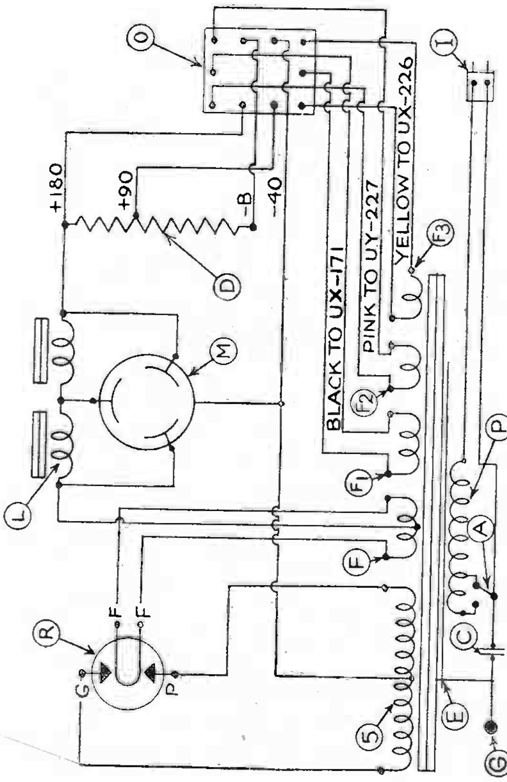


Model 92

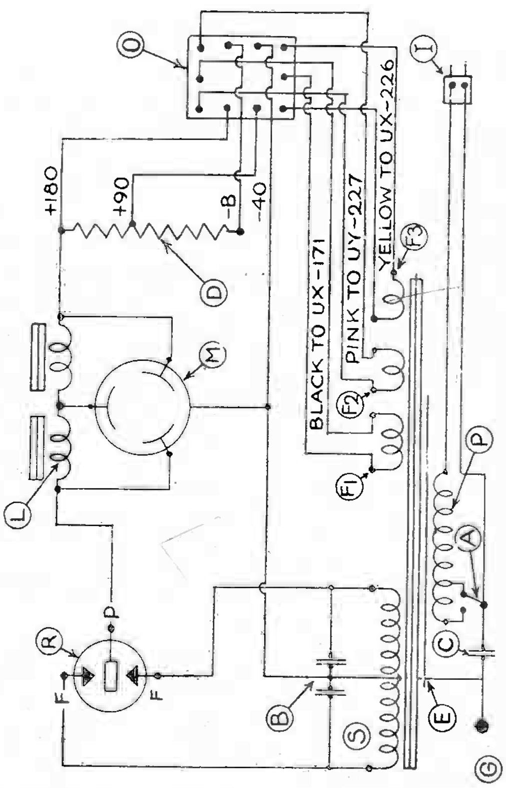
CROSLEY RADIO CORP.



Model 77

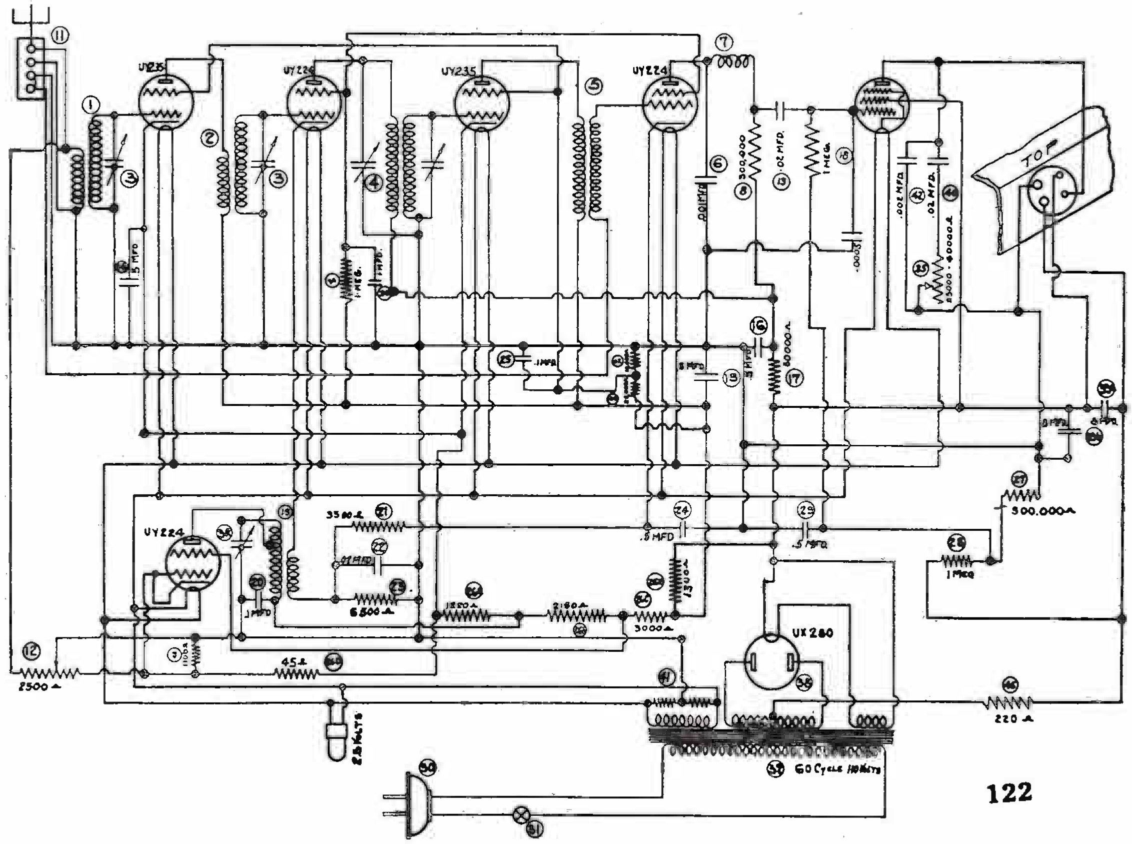


CIRCUIT DIAGRAM OF MODELS 104, 105, AND 106 POWER CONVERTER

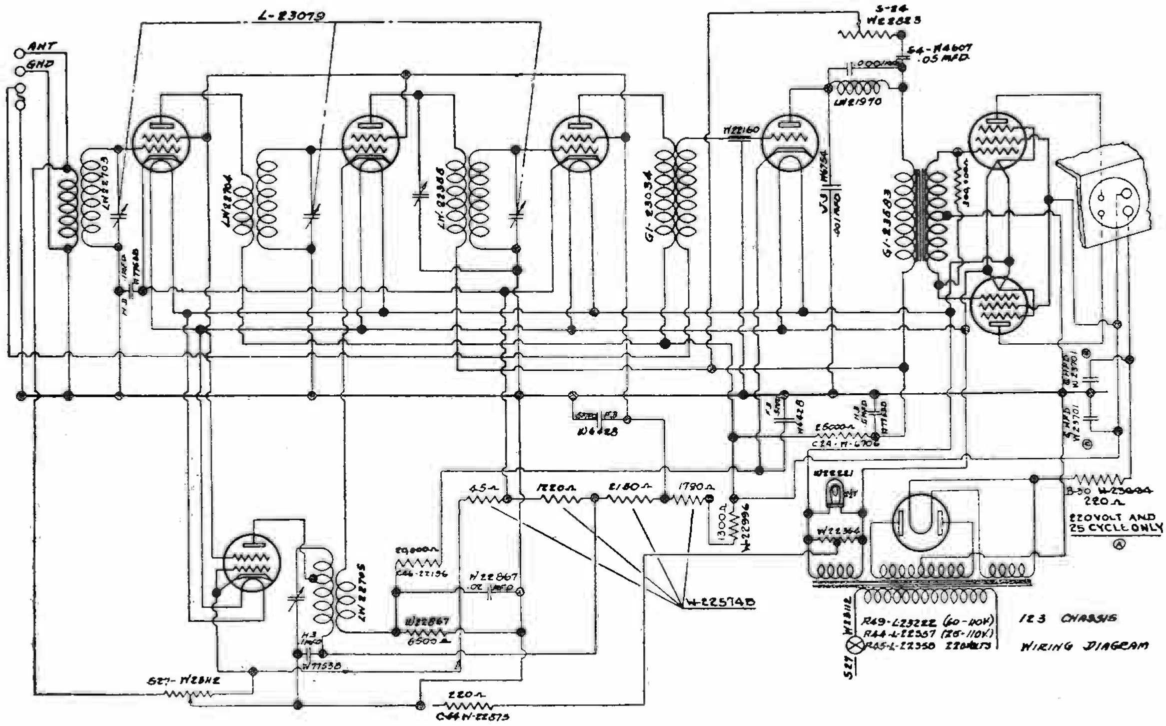


CIRCUIT DIAGRAM OF MODELS 104R AND 105R POWER CONVERTER

CROSLEY RADIO CORP.

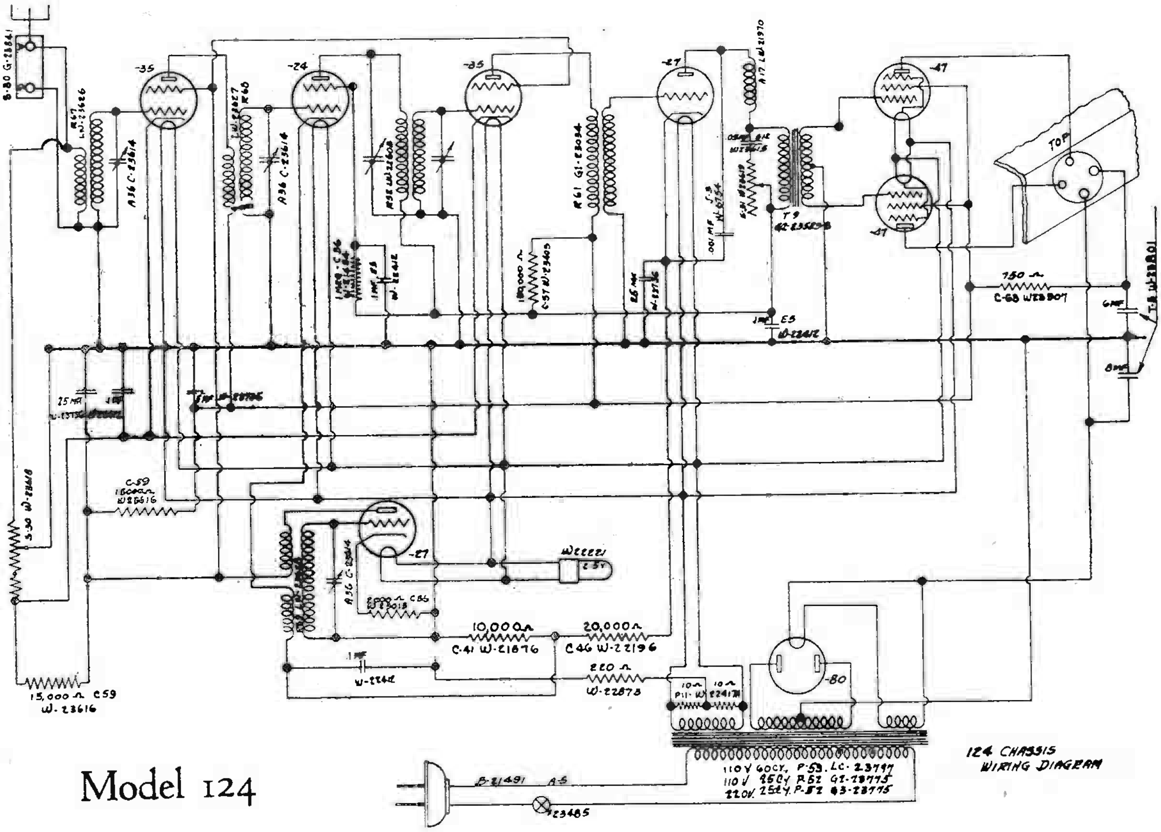


122



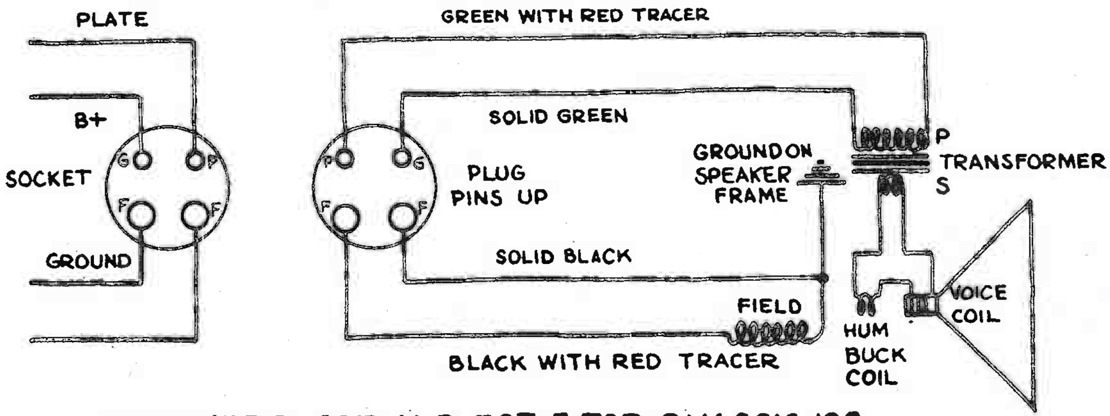
Model 123

CROSLEY RADIO CORP.

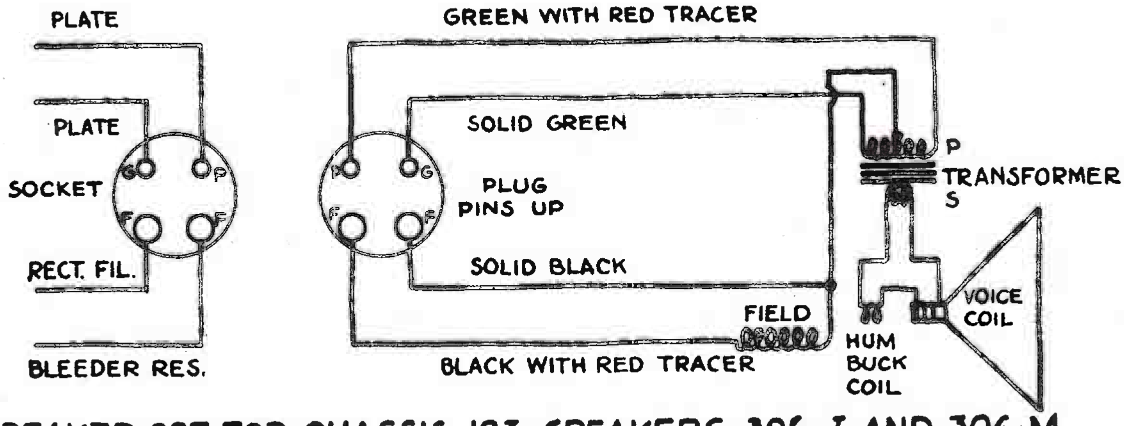


Model 124

Diagrams of Speaker Connections Models 122, 123, 124

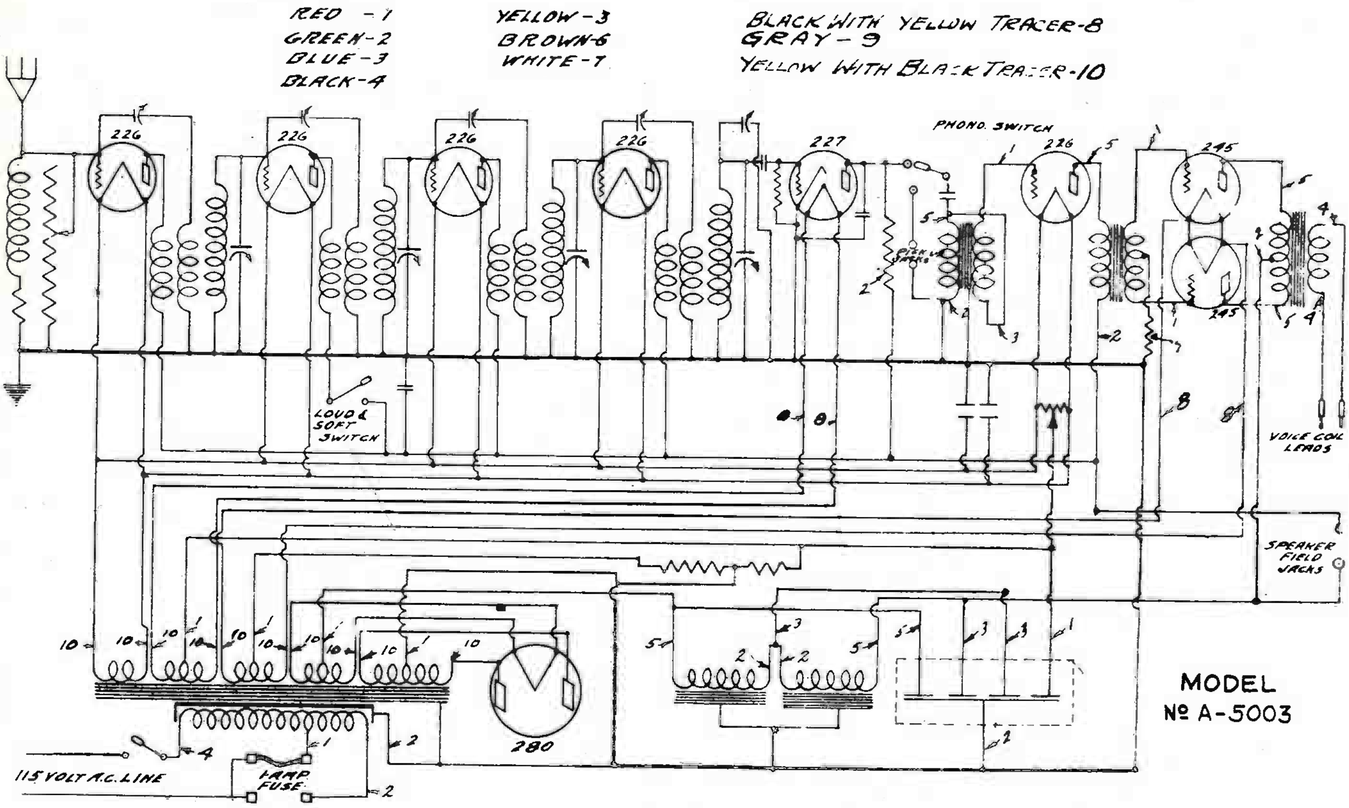


SPEAKERS 297 AND 305-J FOR CHASSIS 122

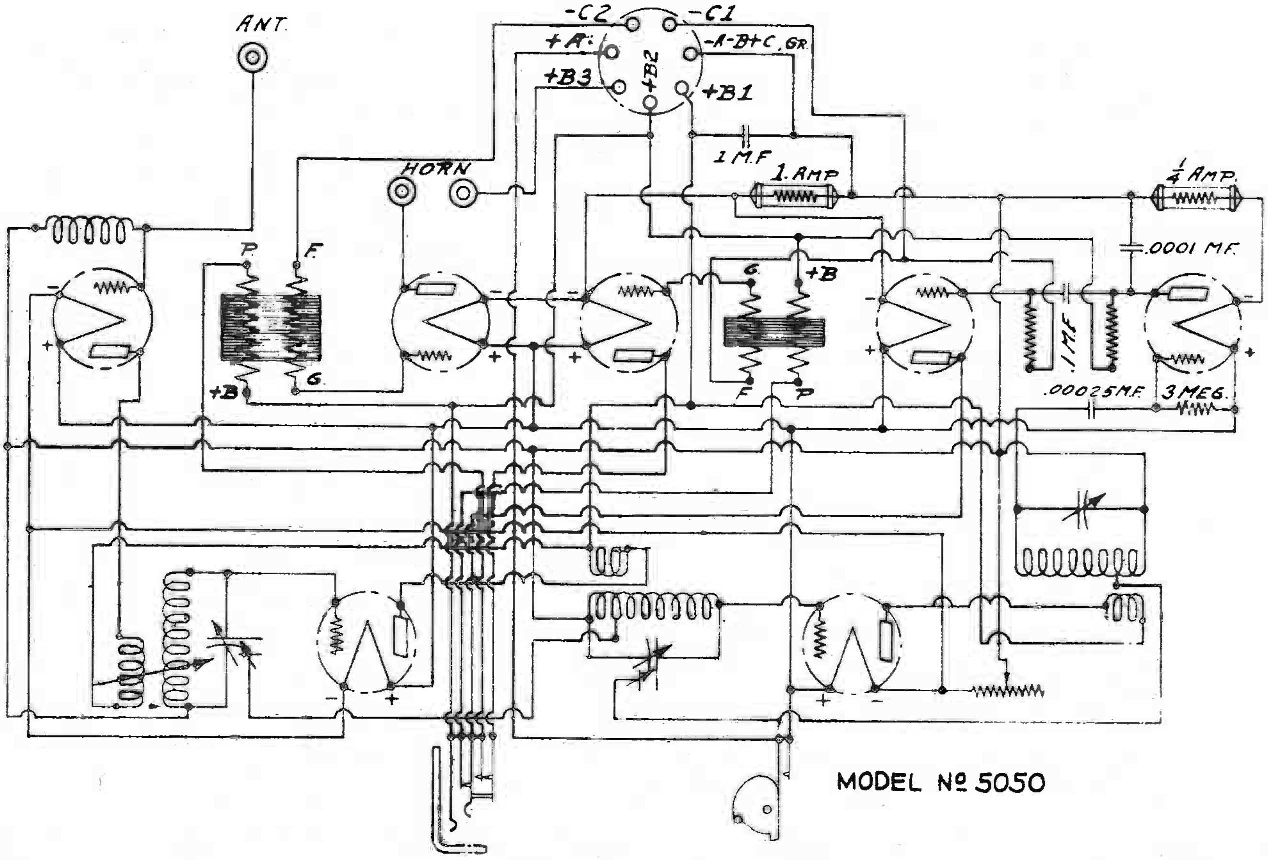


SPEAKER 287 FOR CHASSIS 123; SPEAKERS 306-J AND 306-M
FOR CHASSIS 124

DAY-FAN ELECTRIC CO.

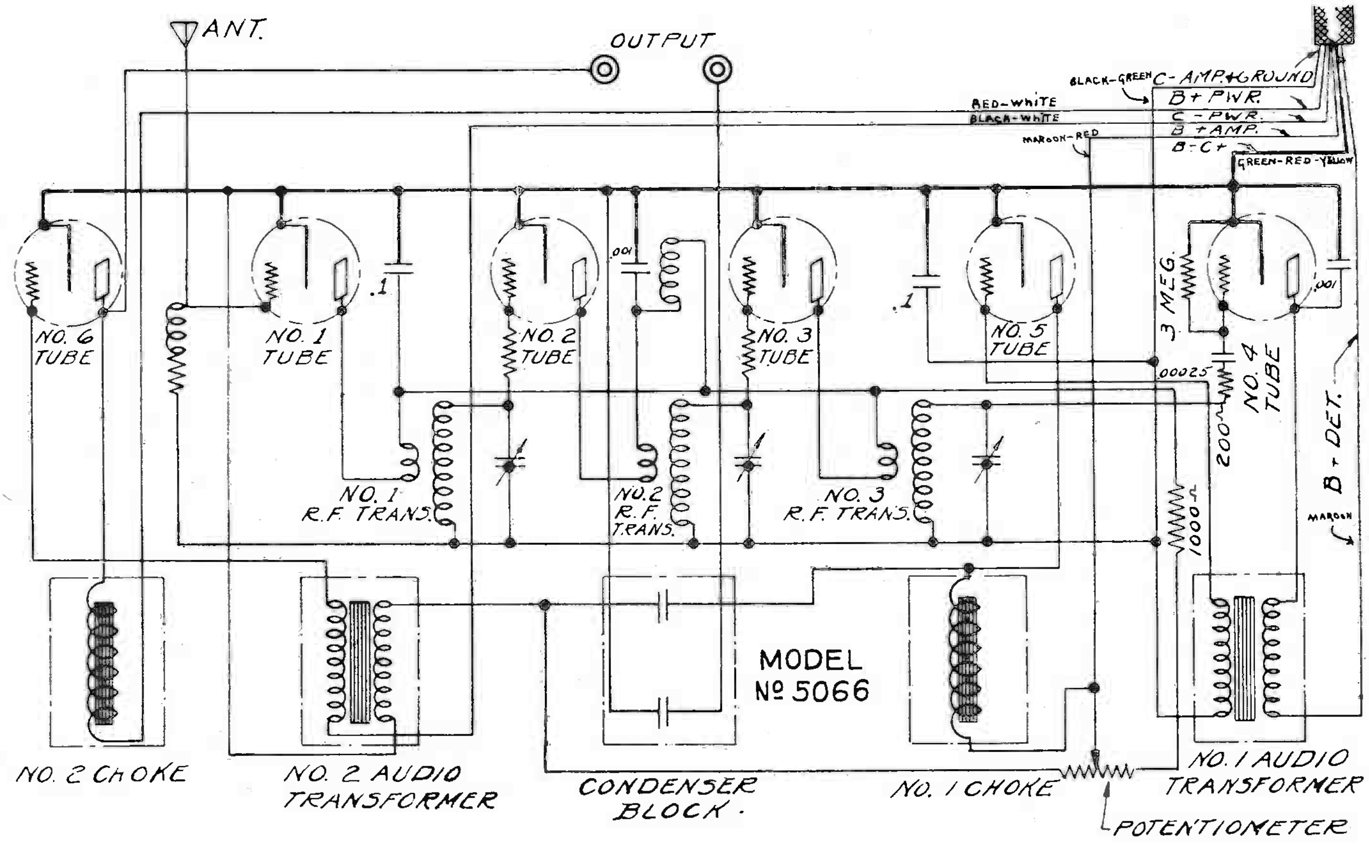


MODEL
№ A-5003

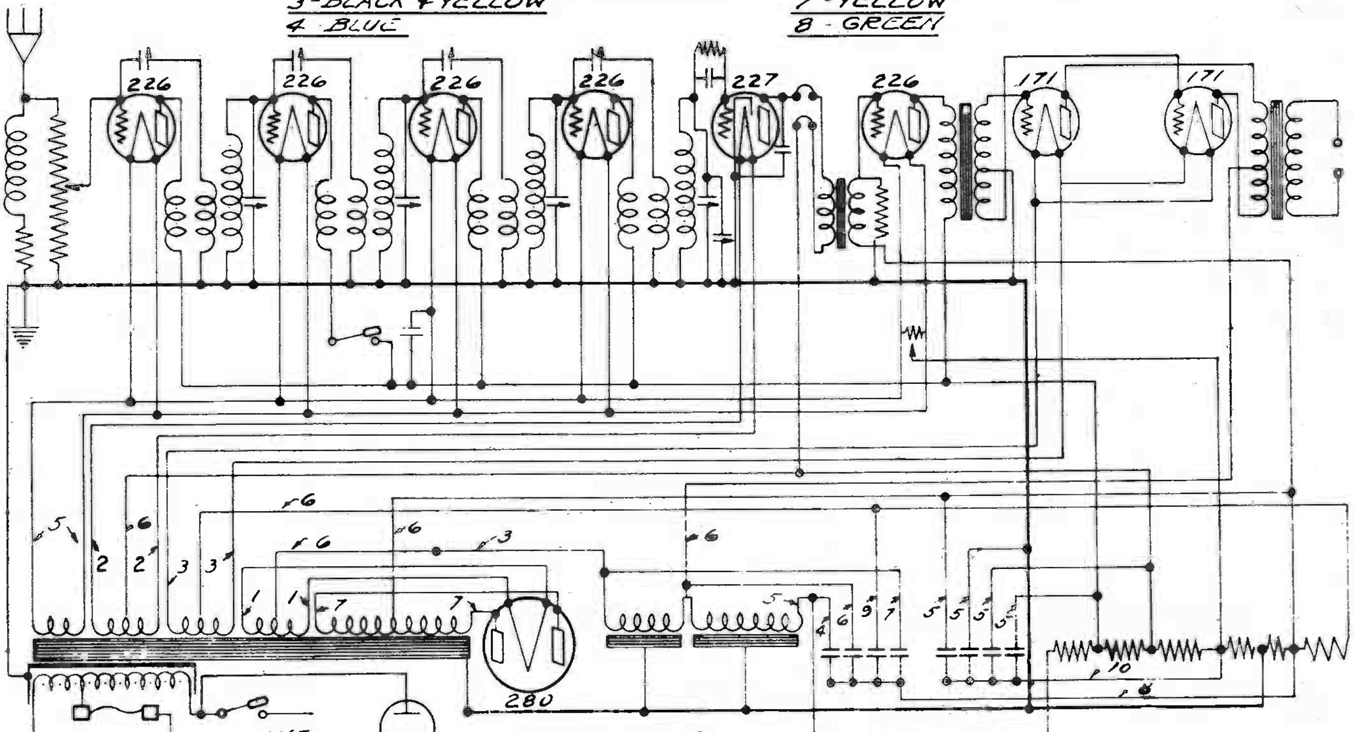


MODEL № 5050

DAY-FAN ELECTRIC CO.

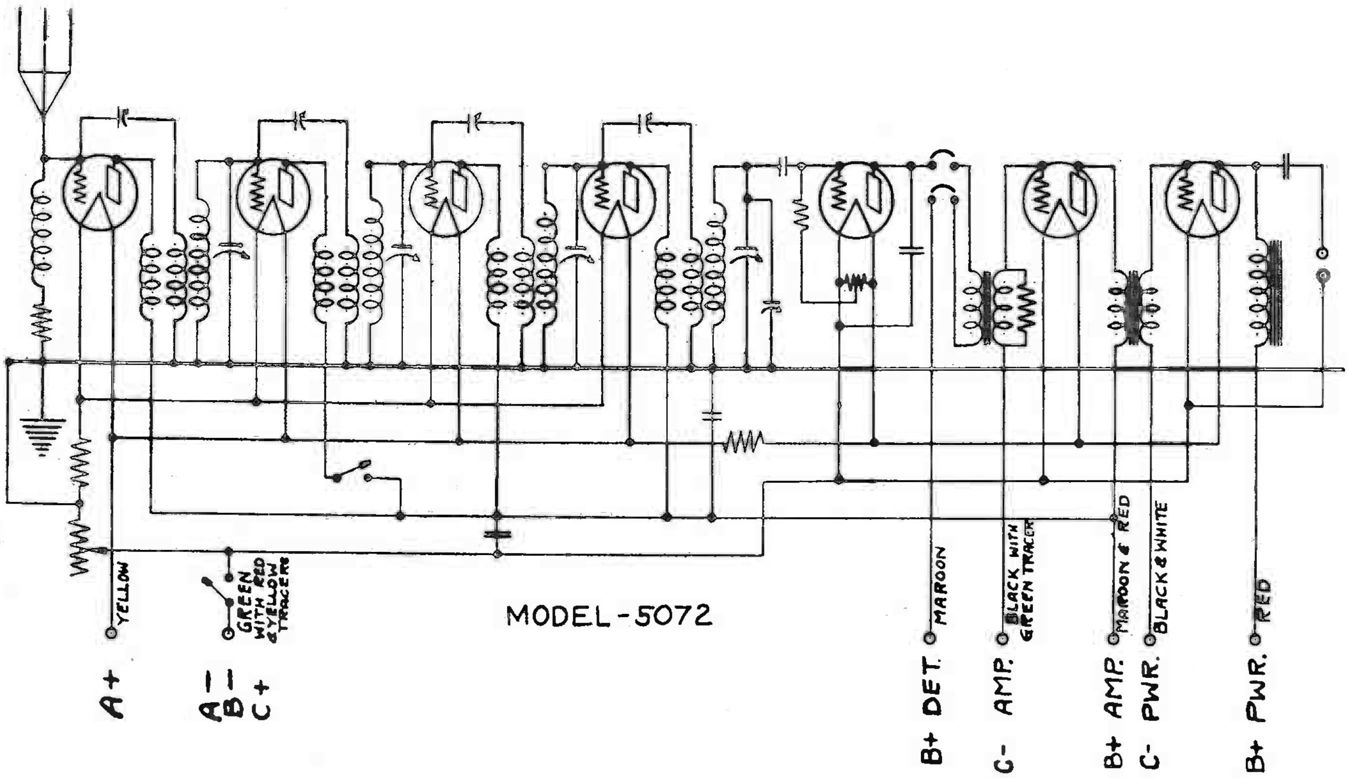


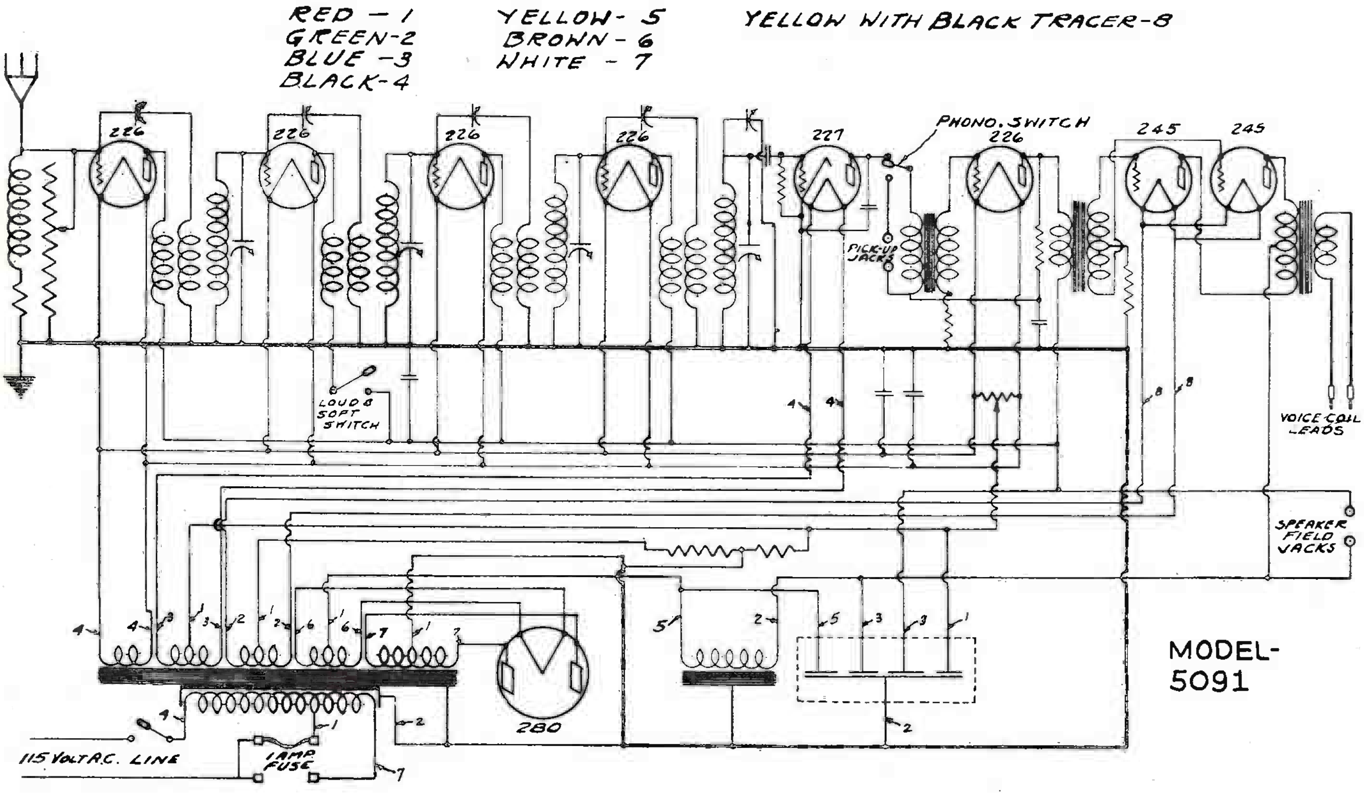
1 - YELLOW WITH BLACK TRACER
2 - BLACK WITH YELLOW TRACER
3 - BLACK + YELLOW
4 BLUE
5 - BLACK
6 - RED
7 - YELLOW
8 - GREEN
9 - SLATE
10 BROWN



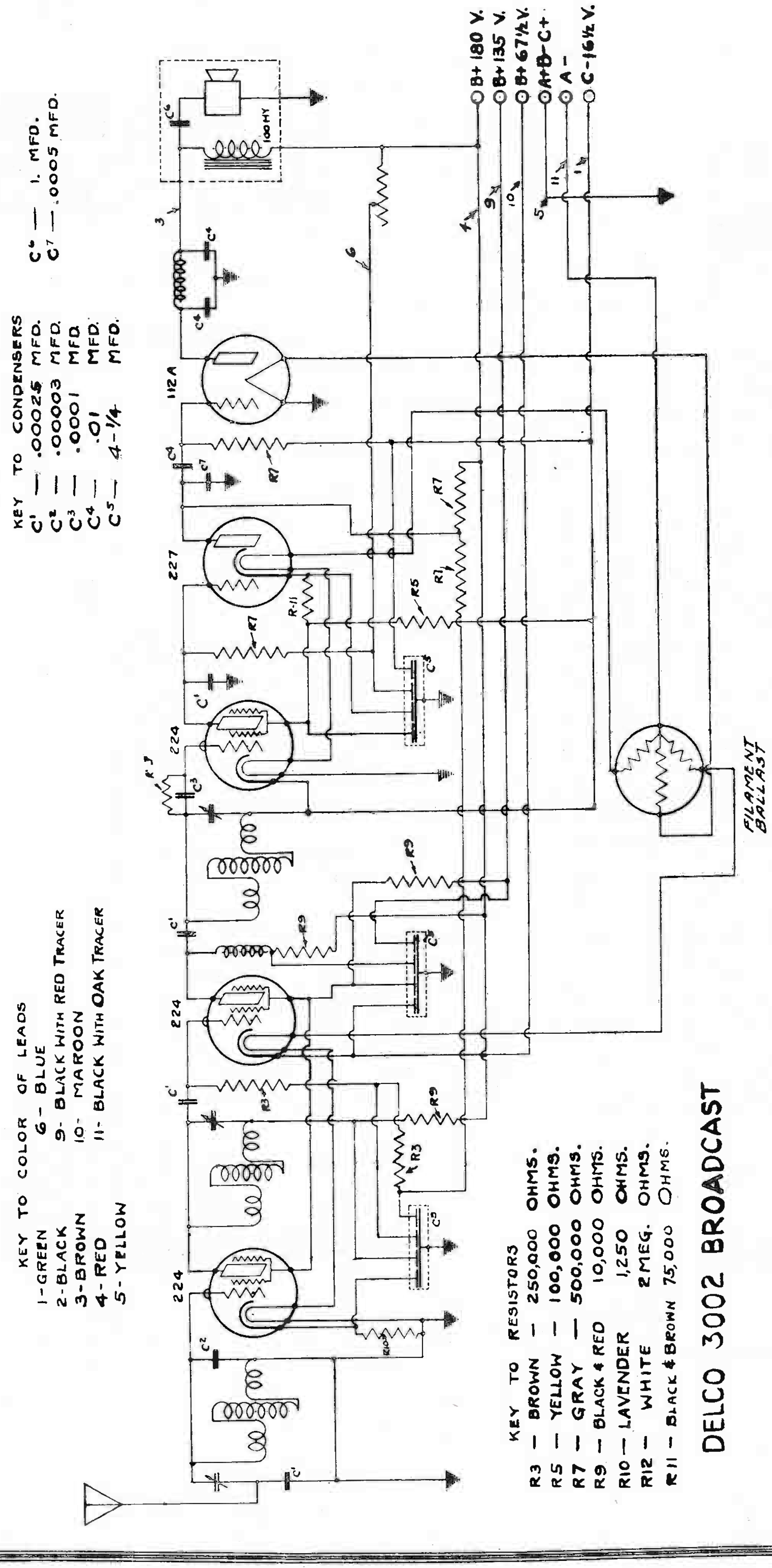
MODEL- 5069

DAY-FAN ELECTRIC CO.



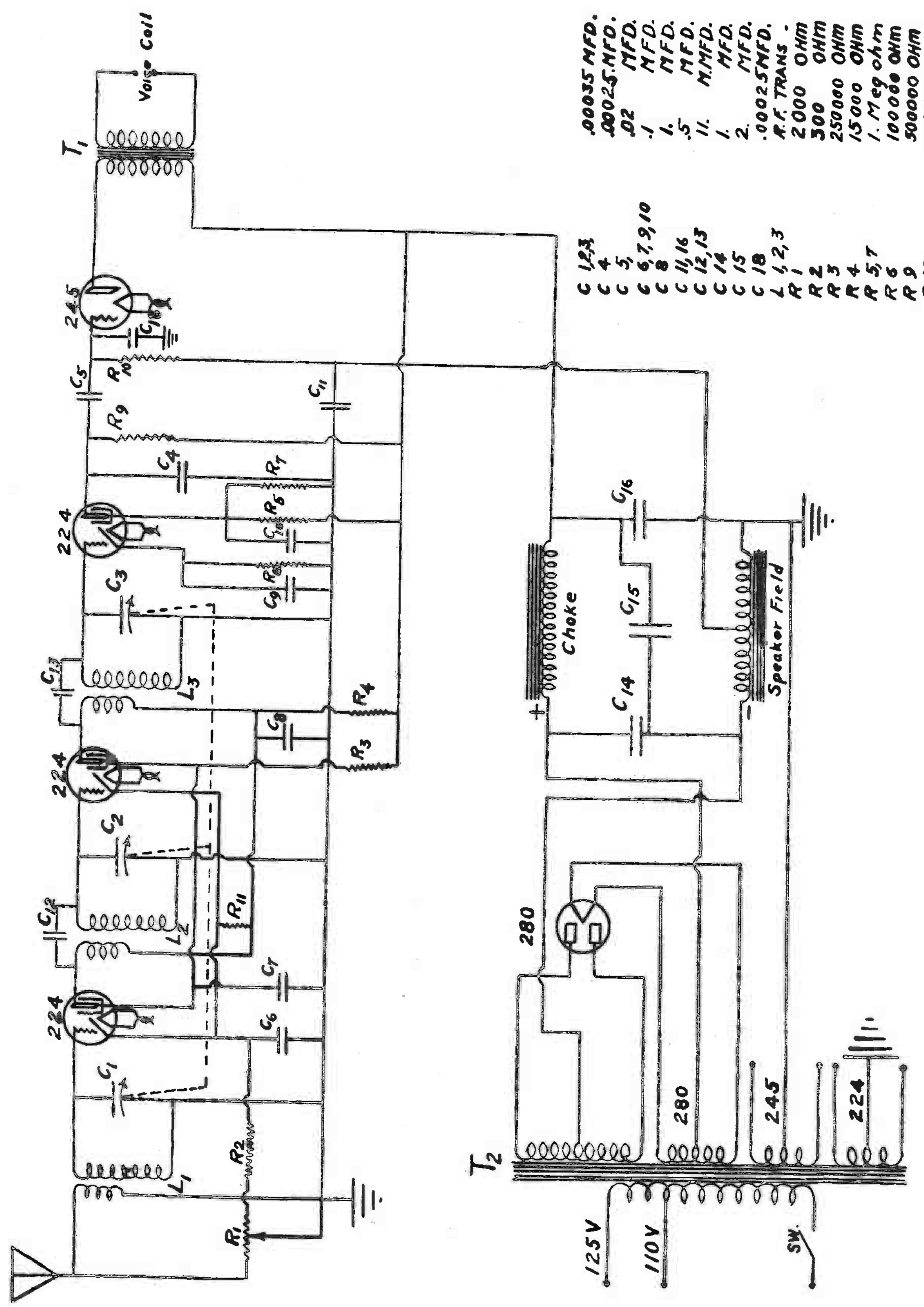


DELCO



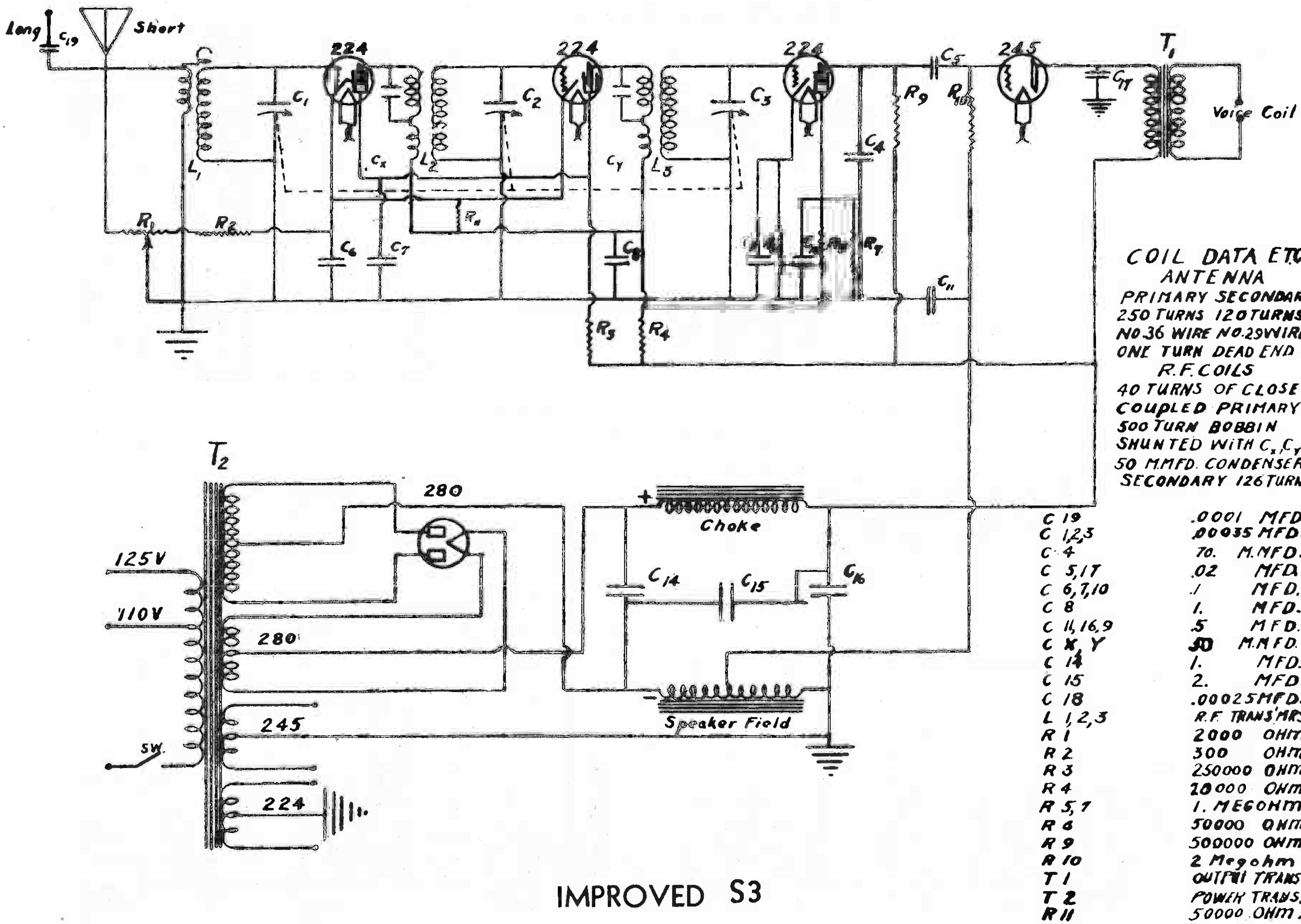
DELCO 3002 BROADCAST

ECHOPHONE RADIO MANUFACTURING CO. LTD.



C 1,2,3	.00035 MFD.
C 4	.00025 MFD.
C 5,	.02 MFD.
C 6,7,9,10	.1 MFD.
C 8	1. MFD.
C 11,16	.5 MFD.
C 12,13	11. M.MFD.
C 14	1. MFD.
C 15	2. MFD.
C 18	.00025 MFD.
L 1,2,3	R.F. TRANS.
R 1	2,000 OHM
R 2	300 OHM
R 3	250000 OHM
R 4	15000 OHM
R 5,7	1. Meg ohm
R 6	100000 OHM
R 9	500000 OHM
R 10	2 MEGOHM
T 1	OUTPUT TRANS.
T 2	POWER TRANS.
R 11	50000 OHM

ECHOPHONE RADIO MANUFACTURING CO. LTD.



COIL DATA ETC.

ANTENNA

PRIMARY SECONDARY

250 TURNS 120 TURNS

NO.36 WIRE NO.29 WIRE

ONE TURN DEAD END

R.F. COILS

40 TURNS OF CLOSE-COUPLED PRIMARY

500 TURN BOBBIN

SHUNTED WITH C_X, C_Y

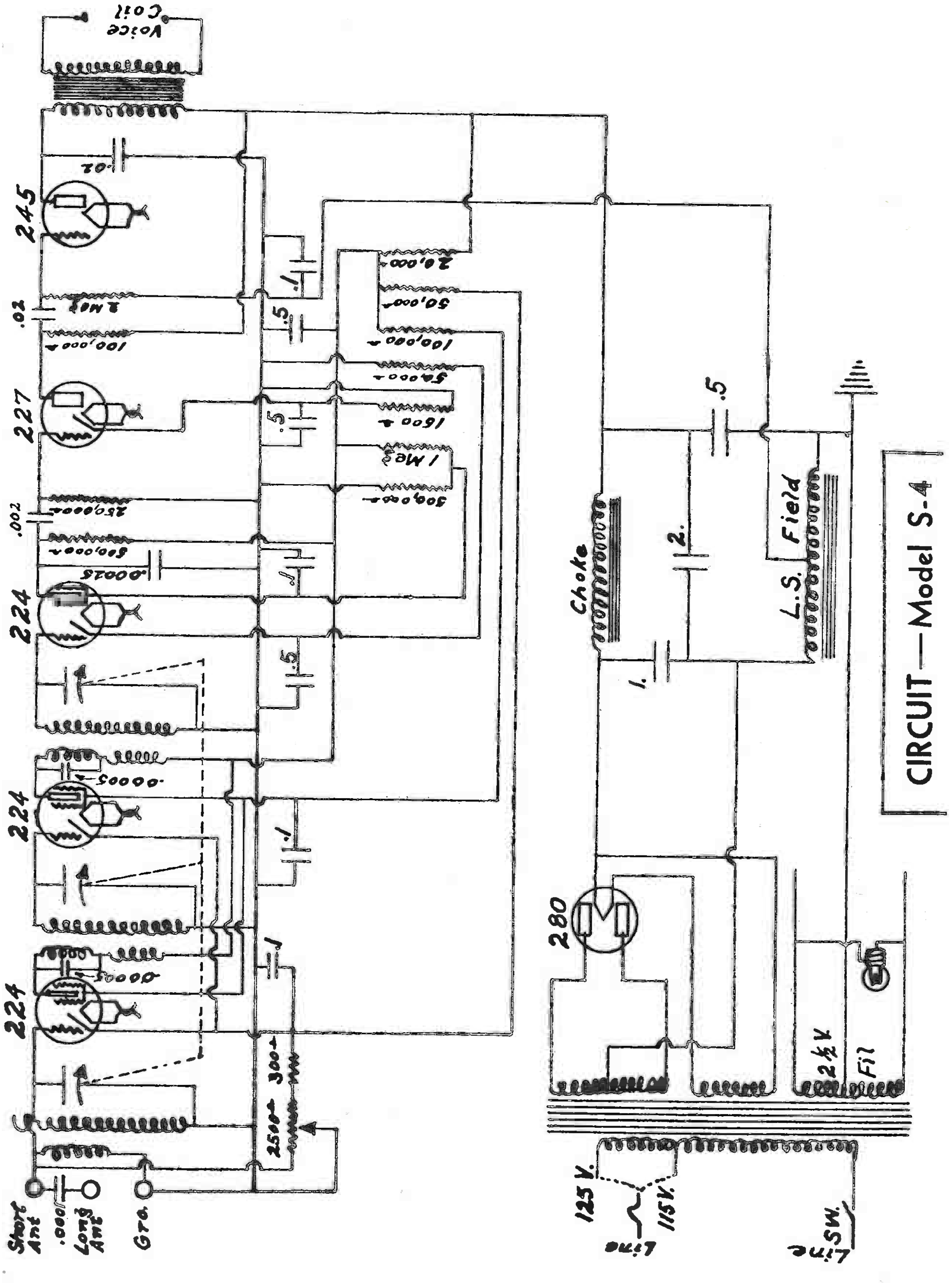
50 M.MFD. CONDENSER

SECONDARY 126 TURNS

C 19	.0001 MFD.
C 1,2,3	.00035 MFD.
C 4	70. M.MFD.
C 5,17	.02 MFD.
C 6,7,10	.1 MFD.
C 8	1. MFD.
C 11,16,9	.5 MFD.
C X, Y	50 M.MFD.
C 14	1. MFD.
C 15	2. MFD.
C 18	.00025 MFD.
L 1,2,3	R.F. TRANS'MRS.
R 1	2000 OHM.
R 2	300 OHM.
R 3	250000 OHM.
R 4	20000 OHM.
R 5,7	1. MEGOHM.
R 6	50000 OHM.
R 9	500000 OHM.
R 10	2 Megohm.
T 1	OUTPUT TRANS.
T 2	POWER TRANS.
R 11	50000 OHM.

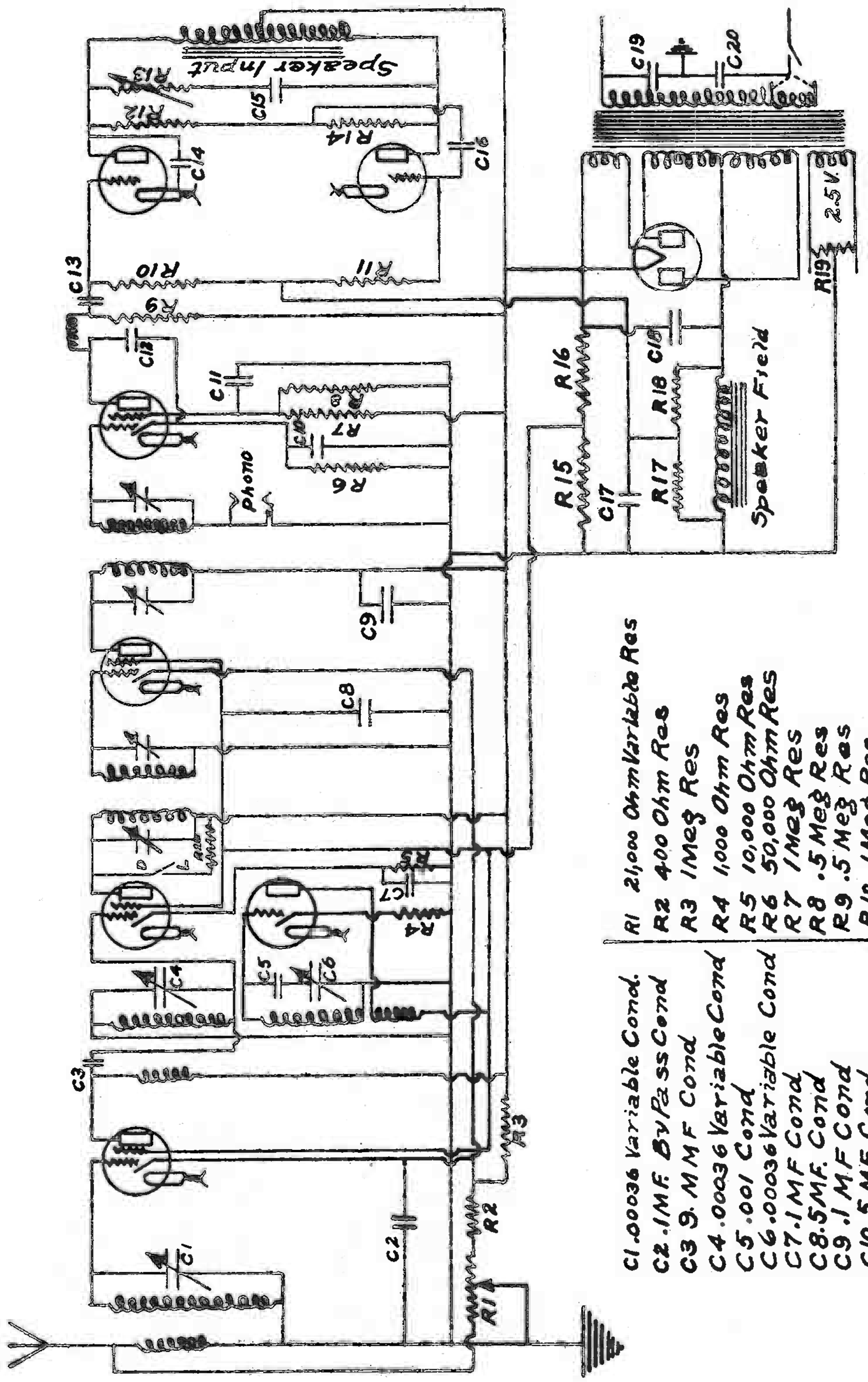
IMPROVED S3

ECHOPHONE RADIO MANUFACTURING CO. LTD.



CIRCUIT—Model S-4

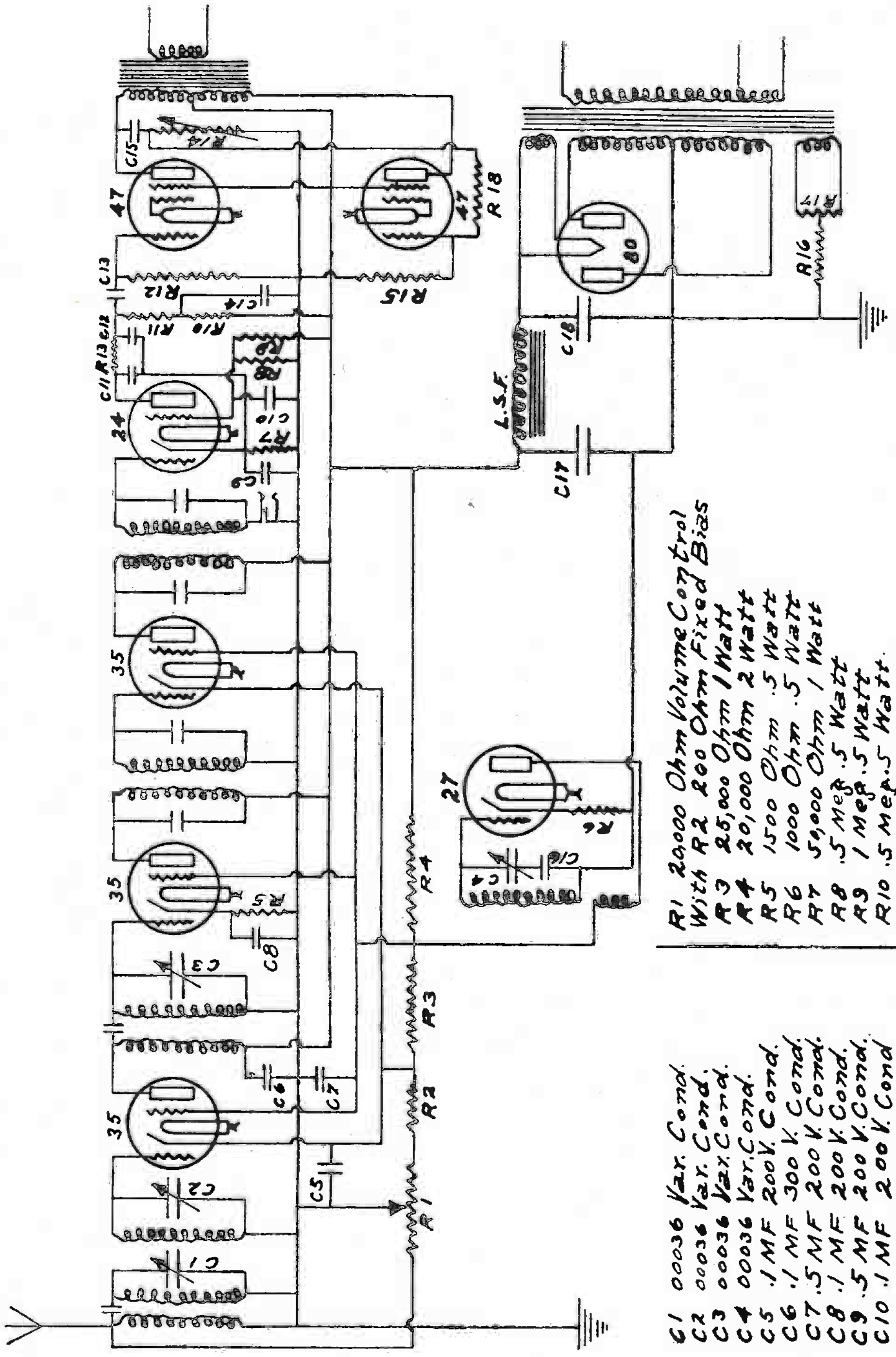
ECHOPHONE RADIO MANUFACTURING CO. LTD.



Model S-5

C1 .00036 Variable Cond.	R1 21,000 Ohm Variable Res
C2 .1 M.F. By Pass Cond	R2 400 Ohm Res
C3 9. M M F Cond	R3 1 Meg Res
C4 .00036 Variable Cond	R4 1,000 Ohm Res
C5 .001 Cond	R5 10,000 Ohm Res
C6 .00036 Variable Cond	R6 50,000 Ohm Res
C7 .1 MF Cond	R7 1 Meg Res
C8 .5 MF. Cond	R8 .5 Meg Res
C9 .1 M.F. Cond	R9 .5 Meg Res
C10 .5 MF Cond	R10 1 Meg Res
C11 .1 MF Cond	R11 1 Meg Res
C12 .00025 Cond	R12 .25 Meg Res
C13 .02 M.F. Cond	R13 15,000 Ohm Variable Res
C14 .02 MF Cond	R14 1 Meg Res
C15 .1 MF Cond	R15 50,000 Ohm Res
C16 .02 MF Cond	R16 20,000 Ohm Res
C17 .02 MF Cond	R17 1 Meg Res
C18 8. MF Cond	R18 1 Meg Res
C19 .05 MF Cond	R19 20 Ohm Center Tapped Res
C20 .05 MF Cond	R20 6,000 Ohm Res.

ECHOPHONE RADIO MANUFACTURING CO. LTD.

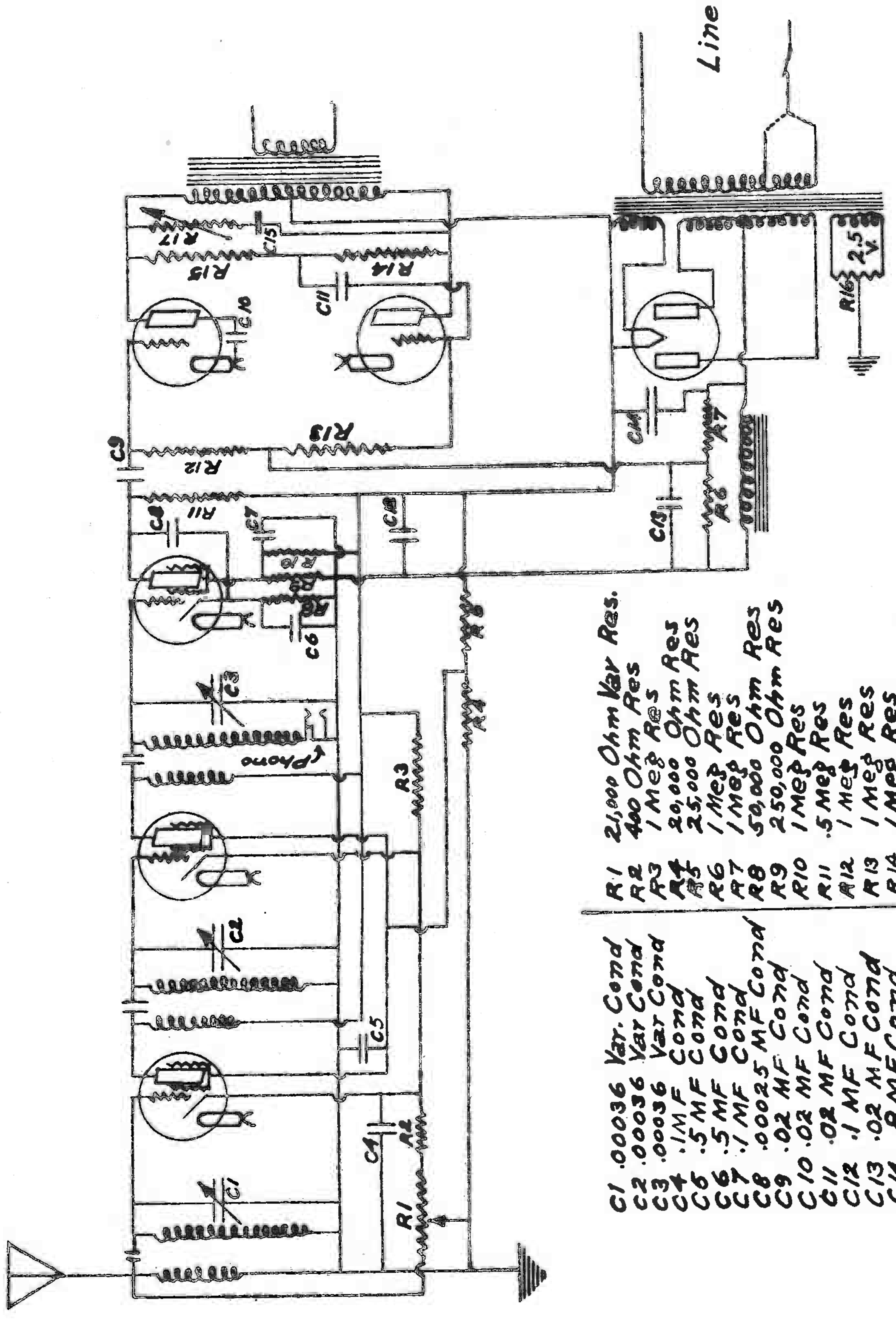


Model 80 Superheterodyne

C1 .00036 Var. Cond.
C2 .00036 Var. Cond.
C3 .00036 Var. Cond.
C4 .00036 Var. Cond.
C5 .1 MF 200 V. Cond.
C6 .1 MF 300 V. Cond.
C7 .5 MF 200 V. Cond.
C8 .1 MF 200 V. Cond.
C9 .5 MF 200 V. Cond.
C10 .1 MF 200 V. Cond
C11 .00025 Cond.
C12 .0001 Cond.
C13 .006 MF 400 V. Cond.
C14 .1 MF 200 V. Cond.
C15 .05 MF 400 V. Cond
C16 .001 Cond. +- 3%
C17 4 MF 450 V. Cond.
C18 8 MF 450 V. Cond
All Cond. +- 10%
Unless Otherwise Specified.

R1 20000 Ohm Volume Control
With R2 200 Ohm Fixed Bias
R3 25,000 Ohm 1 Watt
R4 20,000 Ohm 2 Watt
R5 1500 Ohm .5 Watt
R6 1000 Ohm .5 Watt
R7 50,000 Ohm 1 Watt
R8 .5 Meg .5 Watt
R9 1 Meg .5 Watt
R10 .5 Meg .5 Watt
R11 .5 Meg .5 Watt
R12 .5 Meg .5 Watt
R13 150,000 Ohm .5 Watt
R14 20,000 Ohm Tone Control
R15 10,000 Ohm .5 Watt
R16 250 Ohm 2 Watt
R17 20 Ohm Center Tapped Res
R18 .25 Meg 1 Watt
All Resistors +- 10%
Unless Otherwise Specified.

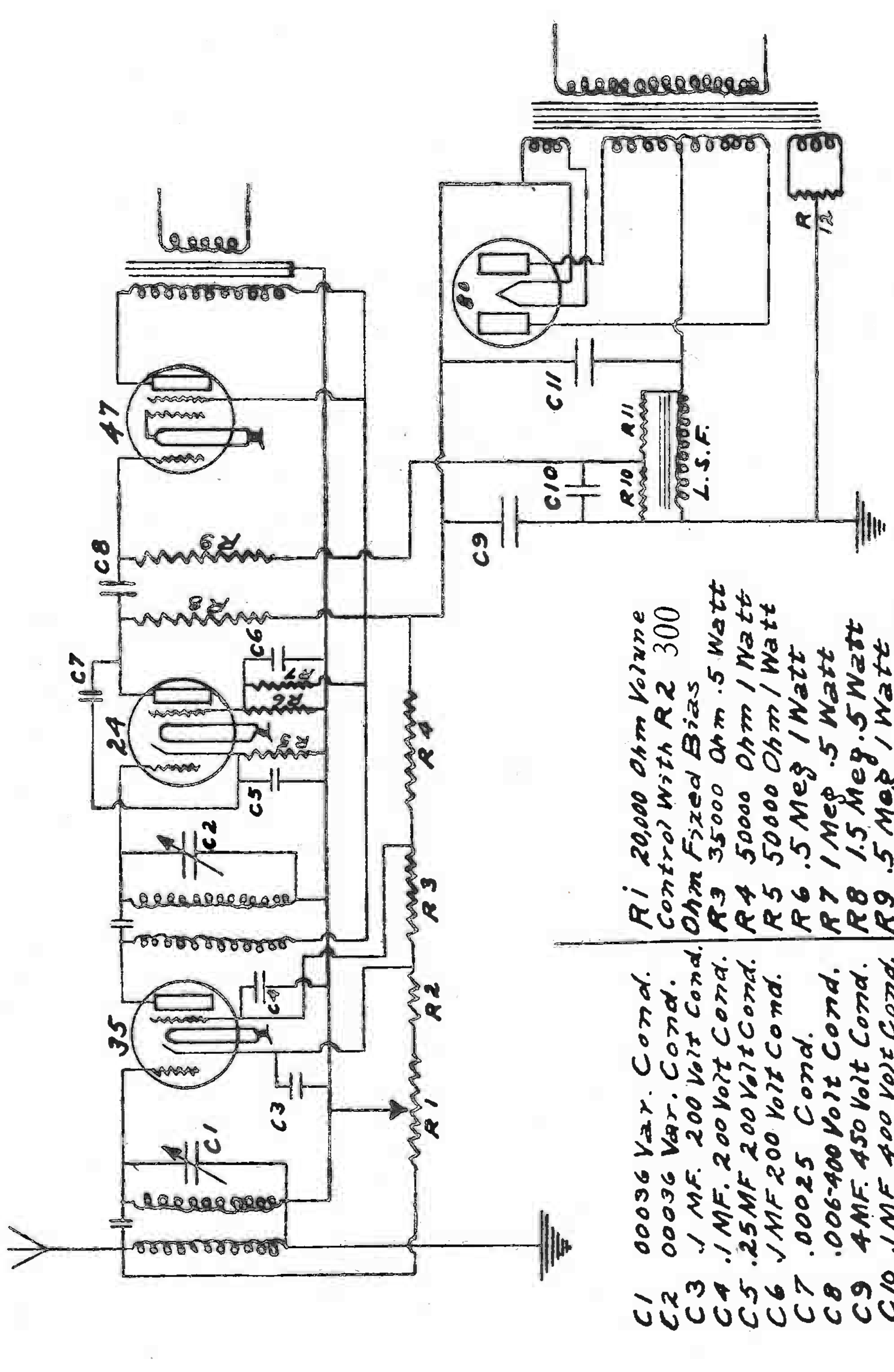
ECHOPHONE RADIO MANUFACTURING CO. LTD.



Model F

C1	.00036 Var. Cond	R1	21,000 Ohm Var Res.
C2	.00036 Var Cond	R2	400 Ohm Res
C3	.00036 Var Cond	R3	1 Meg Res
C4	.1 MF Cond	R4	20,000 Ohm Res
C5	.5 MF Cond	R5	25,000 Ohm Res
C6	.5 MF Cond	R6	1 Meg Res
C7	.1 MF Cond	R7	1 Meg Res
C8	.00025 MF Cond	R8	50,000 Ohm Res
C9	.02 MF Cond	R9	250,000 Ohm Res
C10	.02 MF Cond	R10	1 Meg Res
C11	.02 MF Cond	R11	.5 Meg Res
C12	.1 MF Cond	R12	1 Meg Res
C13	.02 MF Cond	R13	1 Meg Res
C14	8 MF Cond	R14	1 Meg Res
C15	.1 M.F. Cond.	R15	250,000 Ohm Res
		R-16	20 Ohm C.T. Res
		R17	15,000 Ohm Var Res

ECHOPHONE RADIO MANUFACTURING CO. LTD.



Model 40 Echoette

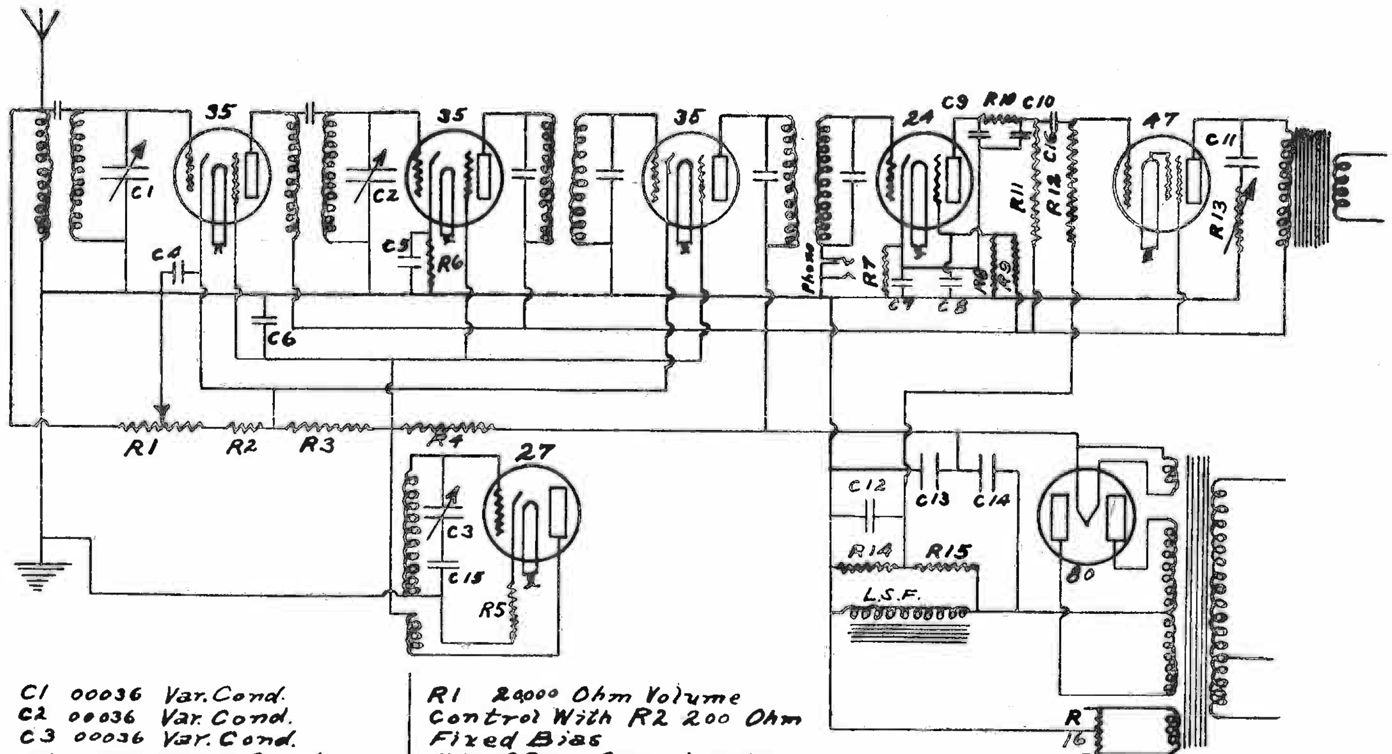
C1 .00036 Var. Cond.
C2 .00036 Var. Cond.
C3 .1 MF. 200 Volt Cond.
C4 .1 MF. 200 Volt Cond.
C5 .25 MF 200 Volt Cond.
C6 .1 MF 200 Volt Cond.
C7 .00025 Cond.
C8 .006-400 Volt Cond.
C9 4 MF. 450 Volt Cond.
C10 .1 MF 400 Volt Cond.
C11 8 MF 450 Volt Cond.

All Cond. +- 10% Unless Otherwise Specified

R1 20,000 Ohm Volume Control With R2 300 Ohm Fixed Bias
R3 35000 Ohm .5 Watt
R4 50000 Ohm 1 Watt
R5 50000 Ohm 1 Watt
R6 .5 Meg 1 Watt
R7 1 Meg .5 Watt
R8 1.5 Meg .5 Watt
R9 .5 Meg 1 Watt
R10 .2 Meg .5 Watt
R11 1 Meg .5 Watt
R12 20 Ohm C.T. Resistor

All Resistors +- 10% Unless Otherwise Specified

ECHOPHONE RADIO MANUFACTURING CO. LTD.



C1 00036 Var. Cond.
C2 00036 Var. Cond.
C3 00036 Var. Cond.
C4 .1 MF 200 V. Cond.
C5 .1 MF 200 V. Cond.
C6 .1 MF 200 V. Cond.
C7 .5 MF 200 V. Cond.
C8 .1 MF 200 V. Cond.
C9 .00025 Cond.
C10 .0001 Cond.
C11 .05 MF 400 V. Cond.
C12 .1 MF 400 V. Cond.
C13 8 MF 450 V. Cond.
C14 8 MF 450 V. Cond.
C15 .001 Cond +− 3%
C16 .006 MF 400 V. Cond.

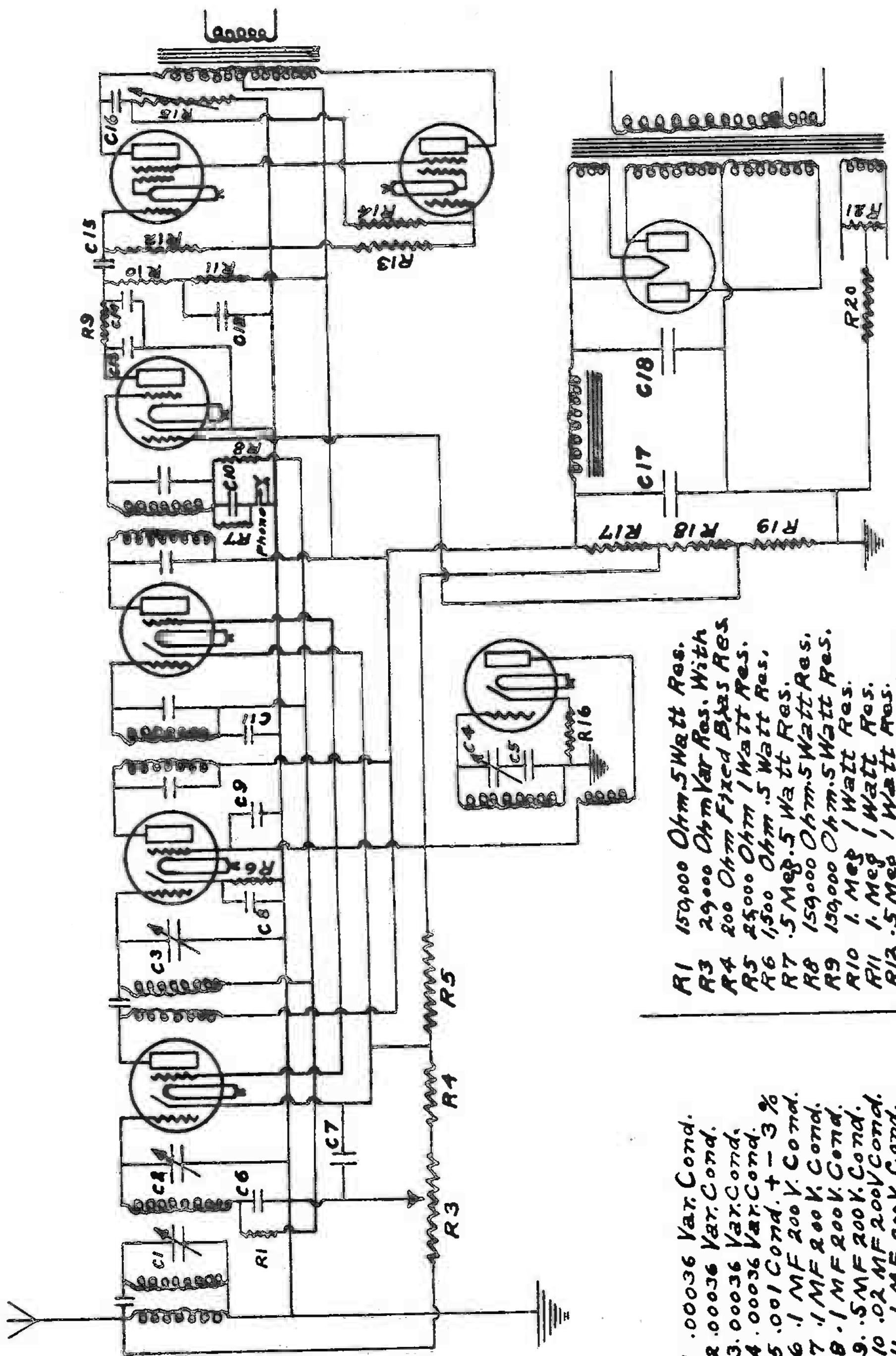
All Condensers +− 10%
Unless Otherwise
Specified

R1 20,000 Ohm Volume
Control With R2 200 Ohm
Fixed Bias
R3 25,000 Ohm 1 Watt
R4 20,000 Ohm 2 Watt
R5 1000 Ohm .5 Watt
R6 1500 Ohm .5 Watt
R7 50,000 Ohm .5 Watt
R8 .5 Meg .5 Watt
R9 1. Meg .5 Watt
R10 150,000 Ohm .5 Watt
R11 .5 Meg 1 Watt
R12 .5 Meg 1 Watt
R13 20,000 Ohm Tone Control
R14 200,000 Ohm .5 Watt
R15 1. Meg .5 Watt
R16 20 Ohm Center tapped Res.

All Resistors +− 10%
Unless Otherwise Speosfied

Model 60 Superheterodyne

ECHOPHONE RADIO MANUFACTURING CO. LTD.



Model 90 Superheterodyne

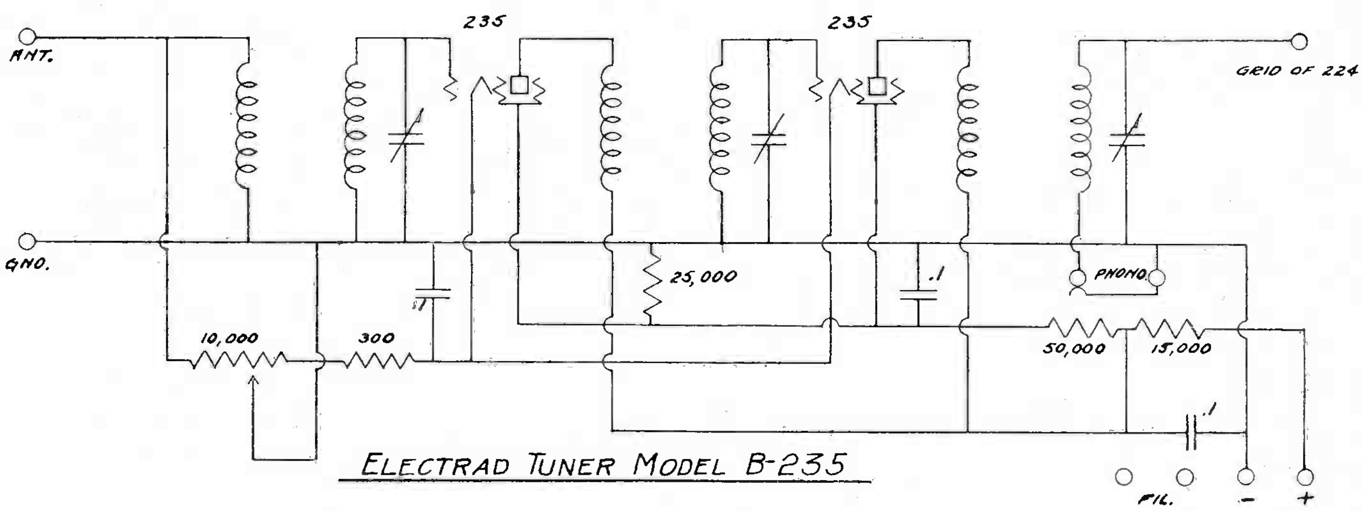
C1 .00036 Var. Cond.
C2 .00036 Var. Cond.
C3 .00036 Var. Cond.
C4 .00036 Var. Cond.
C5 .001 Cond. +− 3%
C6 .1 MF 200 V. Cond.
C7 .1 MF 200 V. Cond.
C8 .1 MF 200 V. Cond.
C9 .5 MF 200 V. Cond.
C10 .02 MF 200 V Cond.
C11 .1 MF 200 V. Cond.
C12 .1 MF 200 V. Cond.
C13 .00025 Cond.
C14 .0001 Cond.
C15 .02 MF 400 V. Cond.
C16 .05 MF 400 V. Cond.
C17 8 MF 450 V. Cond.
C18 12 MF 450 V. Cond.

All Condensers +− 10% Unless Otherwise Specified

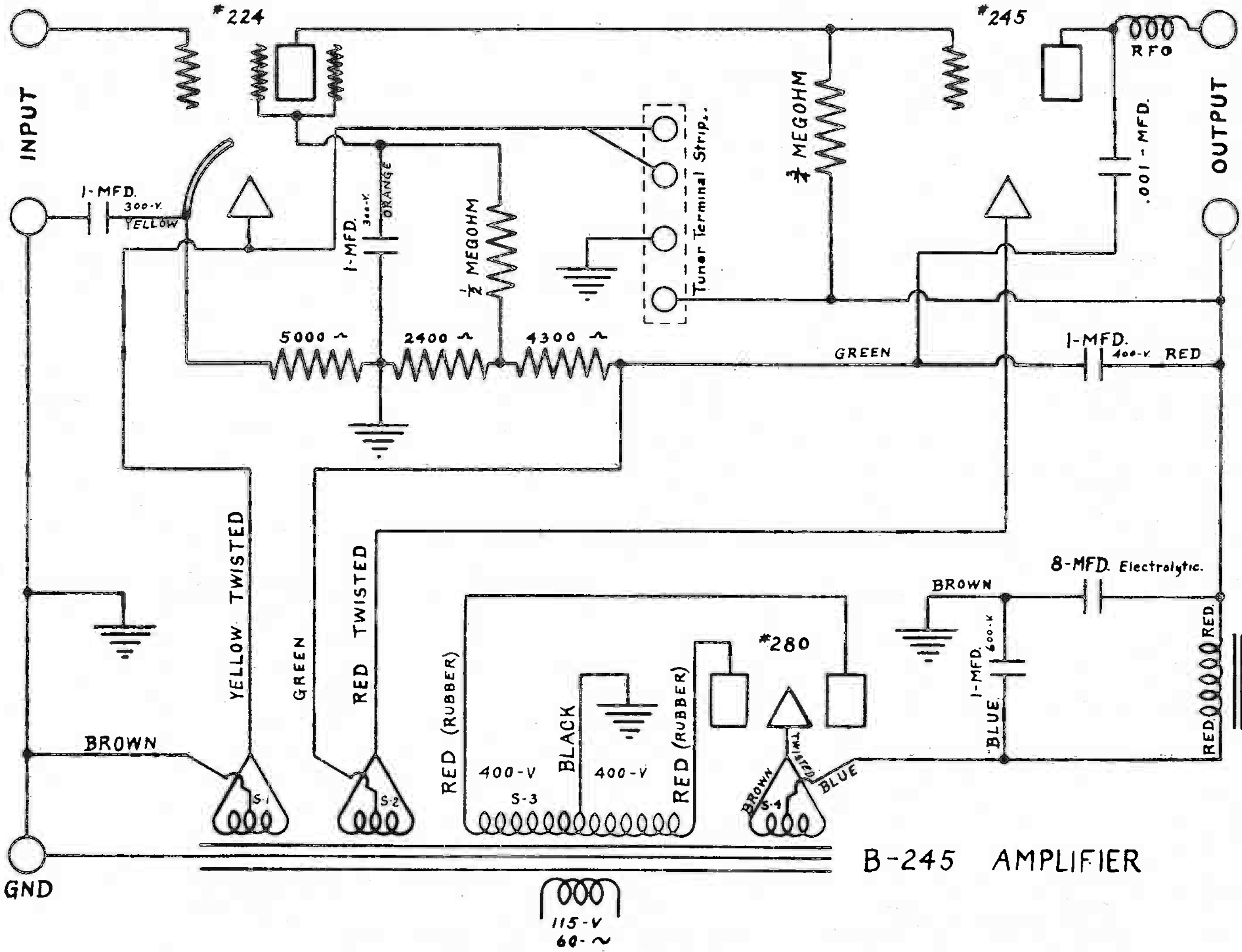
R1 150,000 Ohm .5 Watt Res.
R3 29,000 Ohm Var. Res. With
R4 200 Ohm Fixed Bias Res.
R5 25,000 Ohm 1 Watt Res.
R6 1,500 Ohm .5 Watt Res.
R7 .5 Meg. .5 Watt Res.
R8 150,000 Ohm .5 Watt Res.
R9 150,000 Ohm .5 Watt Res.
R10 1. Meg 1 Watt Res.
R11 1. Meg 1 Watt Res.
R12 .5 Meg 1 Watt Res.
R13 10,000 Ohm 1 Watt Res.
R14 .25 Meg 1 Watt Res.
R15 20,000 Ohm Tone Control
R16 1,000 Ohm .5 Watt Res.
R17 15,000 Ohm 1 Watt Res.
R18 50,000 Ohm 1 Watt Res.
R19 2,000 Ohm 1 Watt Res.
R20 250 Ohm 2 Watt Res.
R21 20 Ohm Center Tapped Res.

All Resisstors +− 10% Unless Otherwise Specified

ELECTRAD INC.

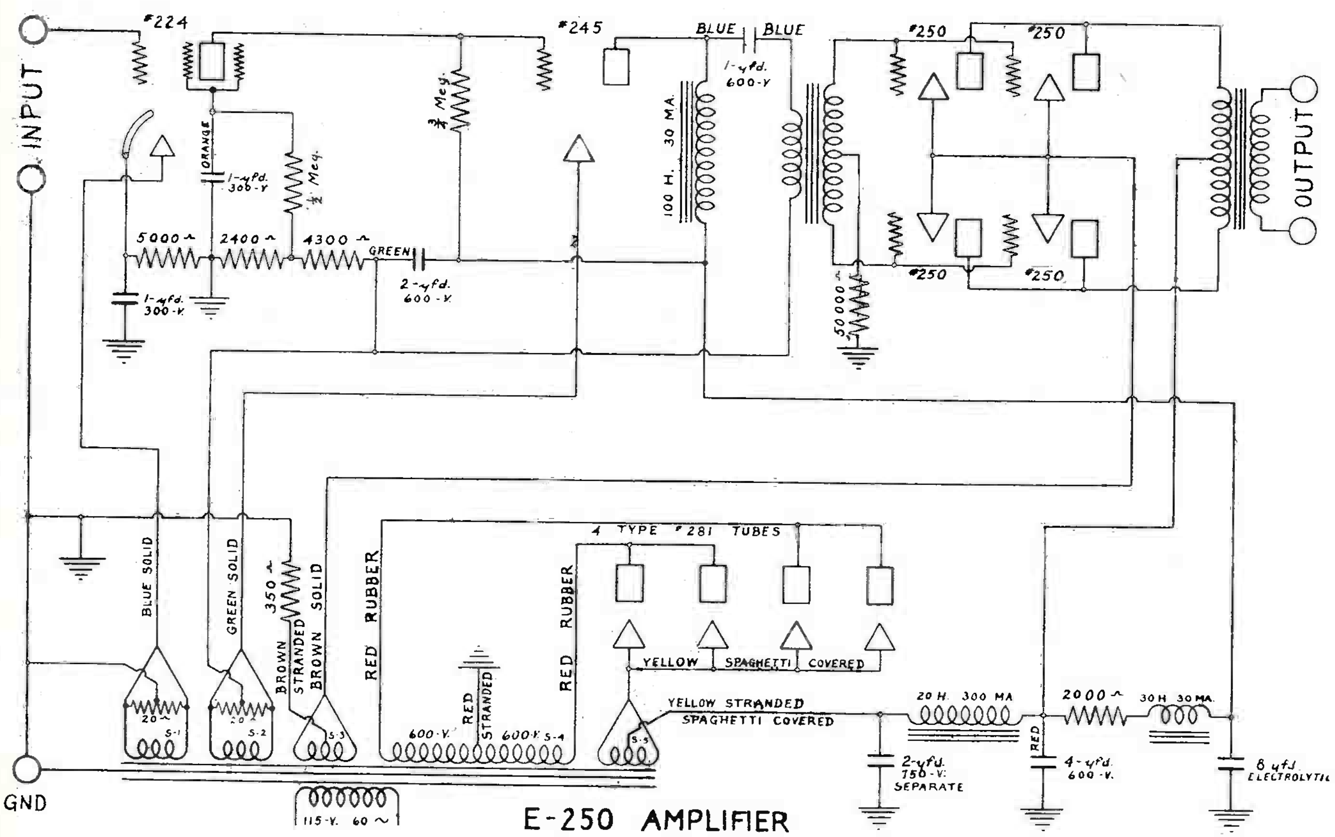


ELECTRAD TUNER MODEL B-235

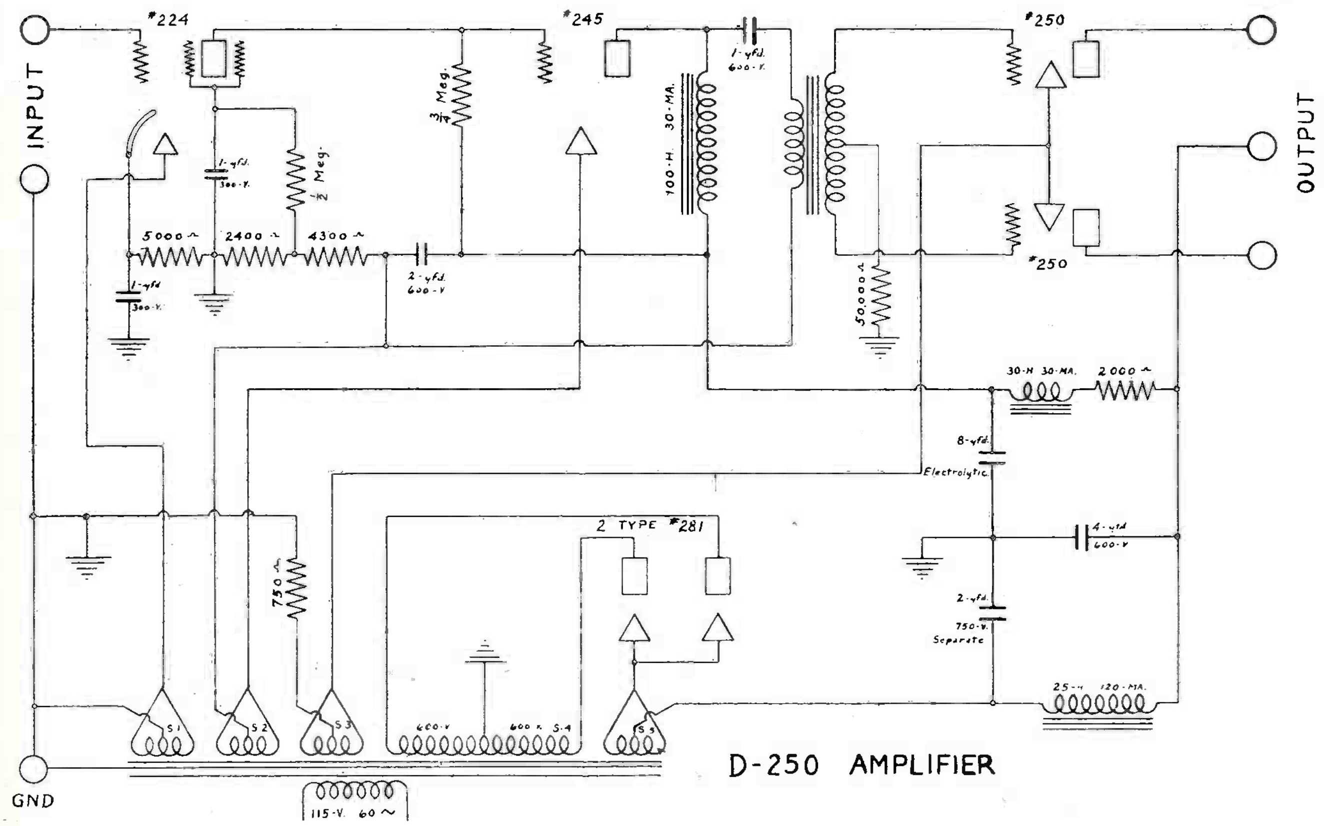


B-245 AMPLIFIER

ELECTRAD INC.

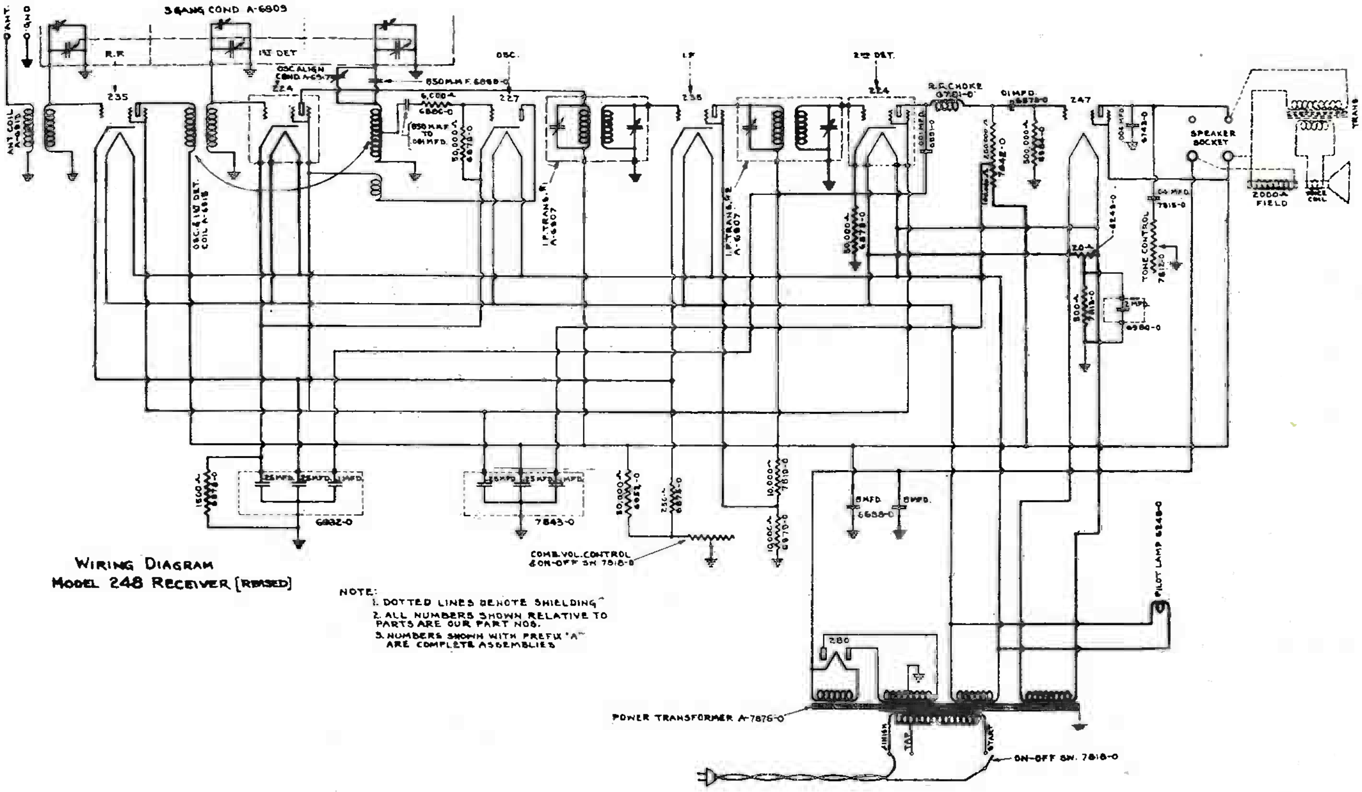


E-250 AMPLIFIER



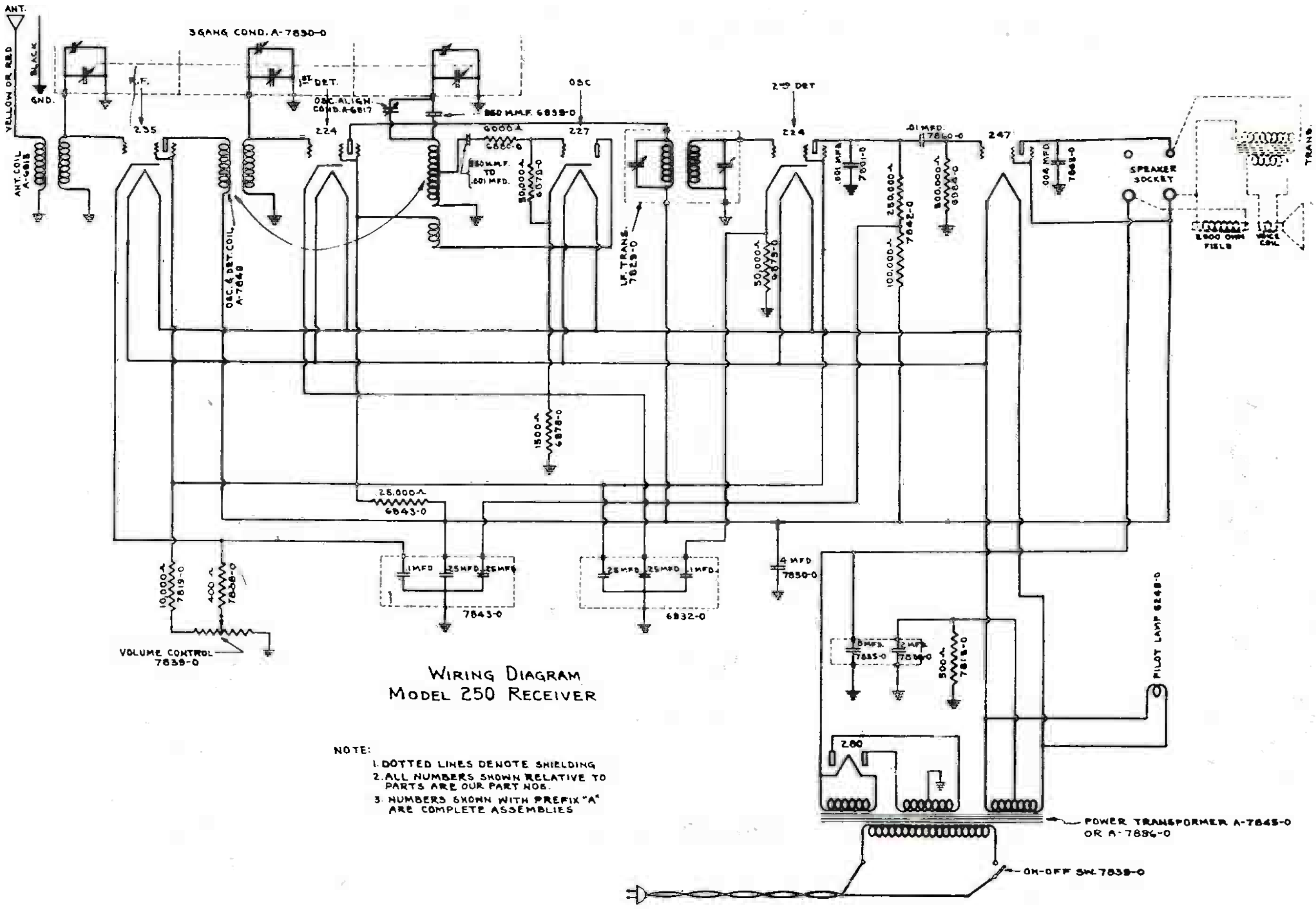
D-250 AMPLIFIER

ELECTRICAL RESEARCH LABORATORIES, INC.



Wiring Diagram
Model 248 Receiver (Revised)

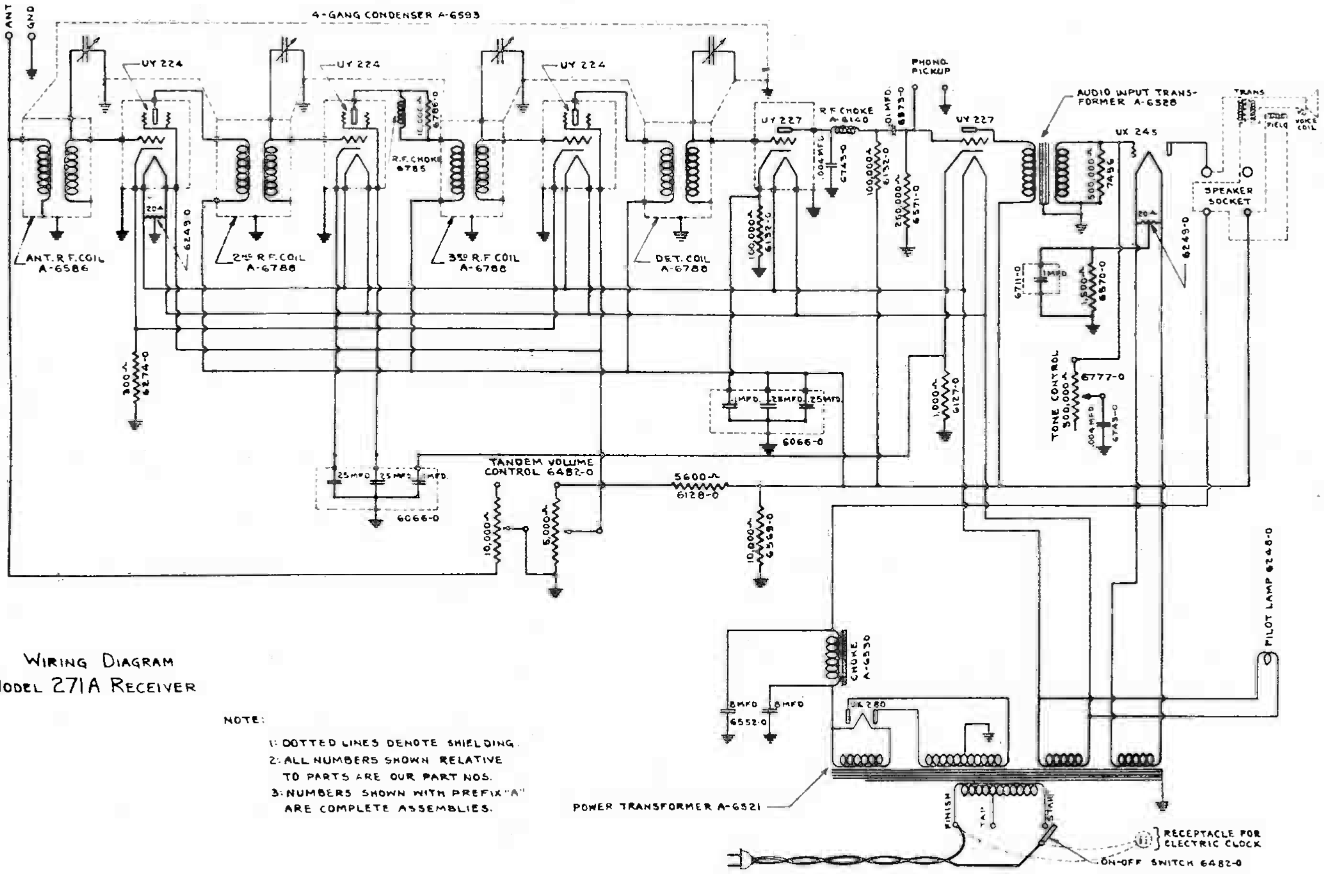
NOTE:
1. DOTTED LINES DENOTE SHIELDING
2. ALL NUMBERS SHOWN RELATIVE TO PARTS ARE OUR PART NOS.
3. NUMBERS SHOWN WITH PREFIX "A" ARE COMPLETE ASSEMBLIES



Wiring Diagram
Model 250 Receiver

NOTE:
1. DOTTED LINES DENOTE SHIELDING
2. ALL NUMBERS SHOWN RELATIVE TO PARTS ARE OUR PART NOS.
3. NUMBERS SHOWN WITH PREFIX "A" ARE COMPLETE ASSEMBLIES

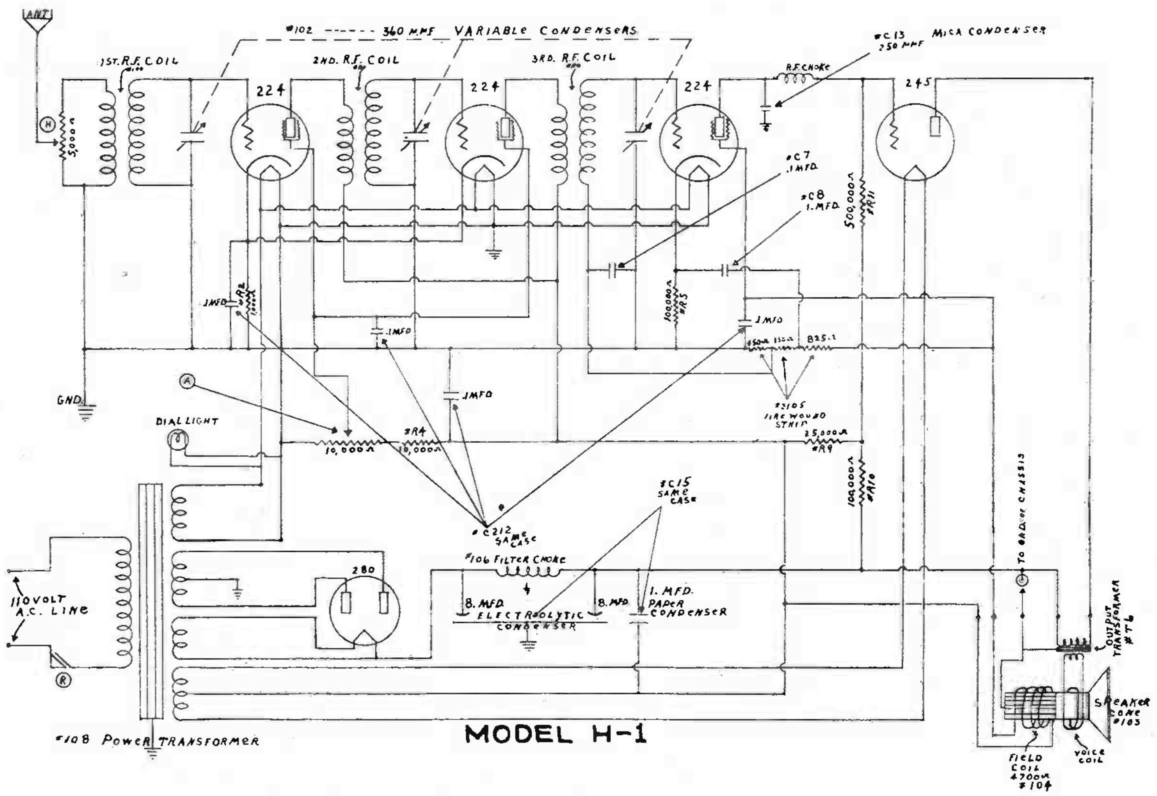
ELECTRICAL RESEARCH LABORATORIES, INC.



WIRING DIAGRAM
MODEL 271A RECEIVER

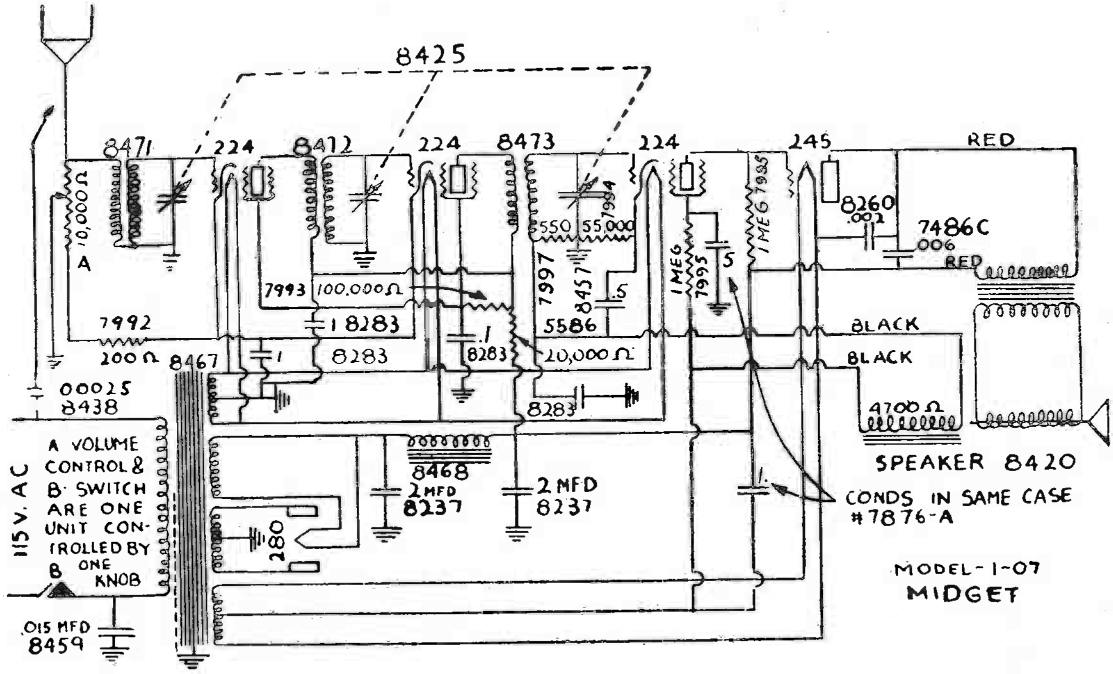
NOTE:
1: DOTTED LINES DENOTE SHIELDING.
2: ALL NUMBERS SHOWN RELATIVE TO PARTS ARE OUR PART NOS.
3: NUMBERS SHOWN WITH PREFIX "A" ARE COMPLETE ASSEMBLIES.

JESSE FRENCH AND SONS PIANO CO.

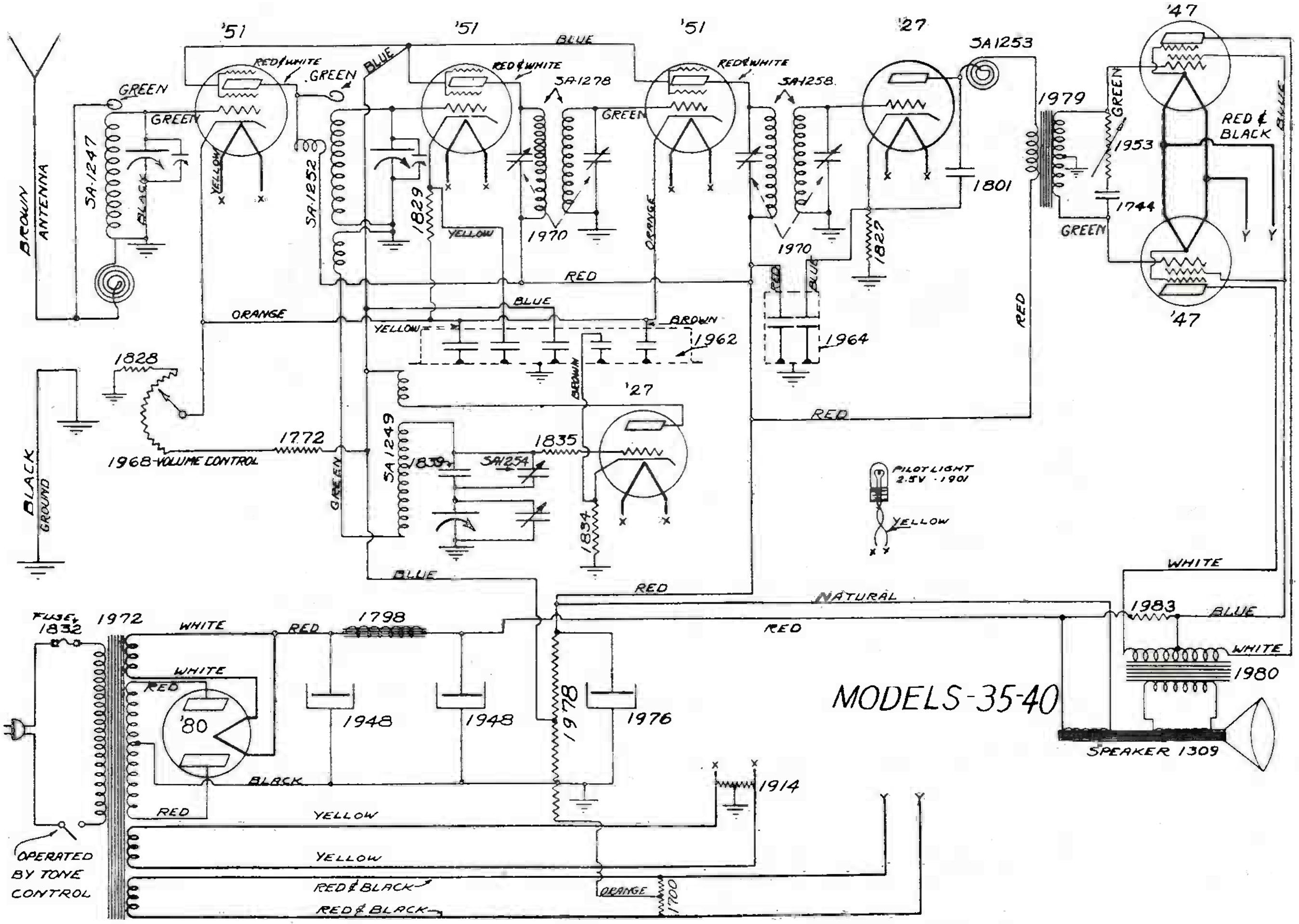


MODEL H-1

FEDERATED PURCHASER

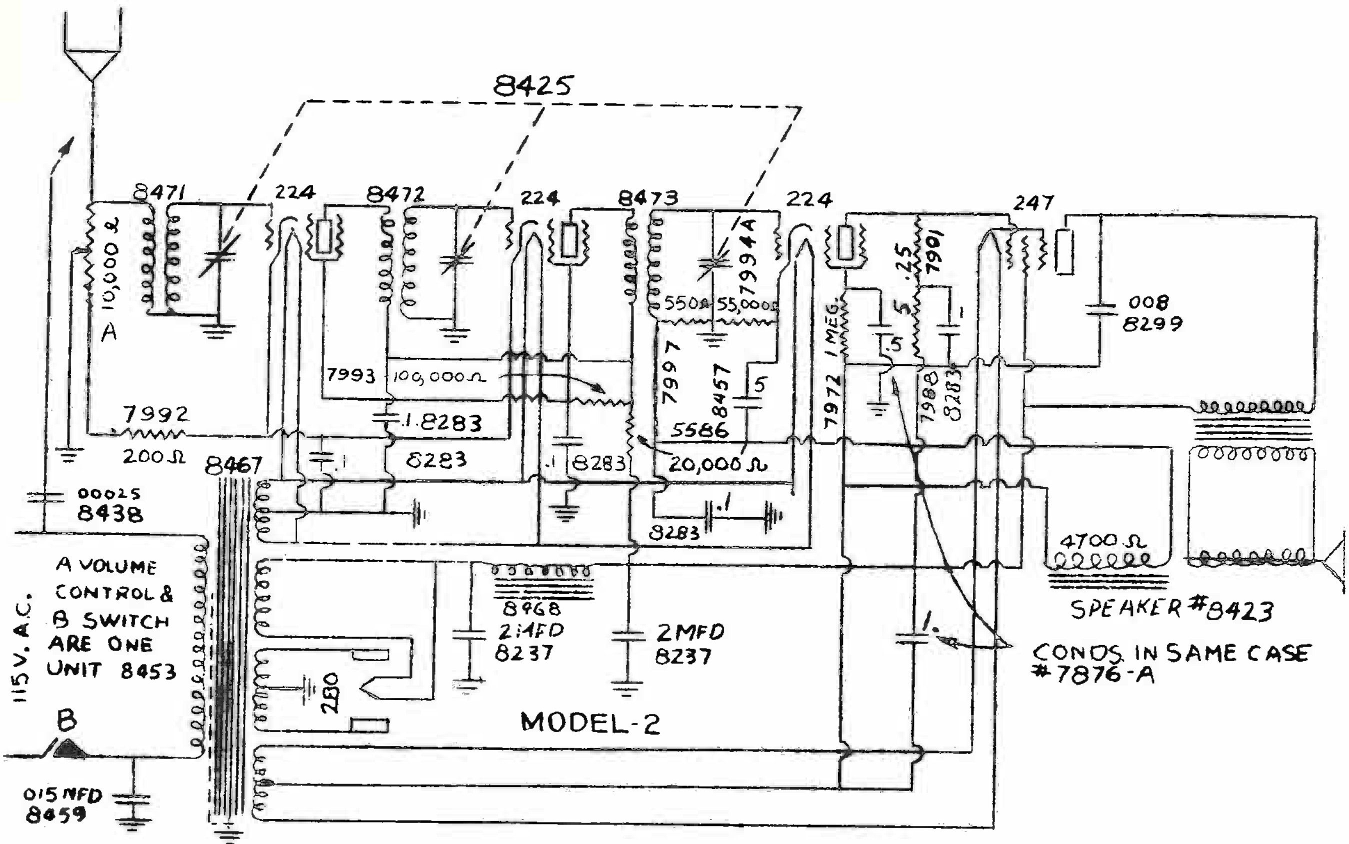


MODEL-1-07 MIDGET

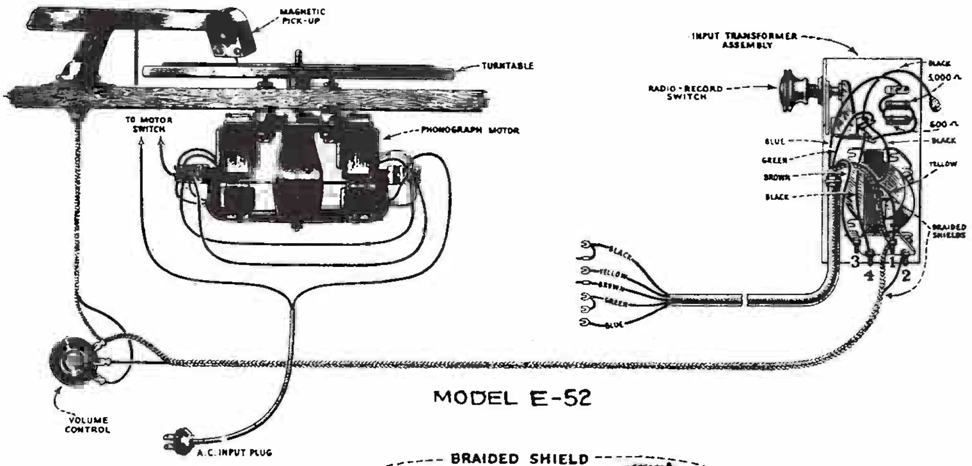


MODELS-35-40

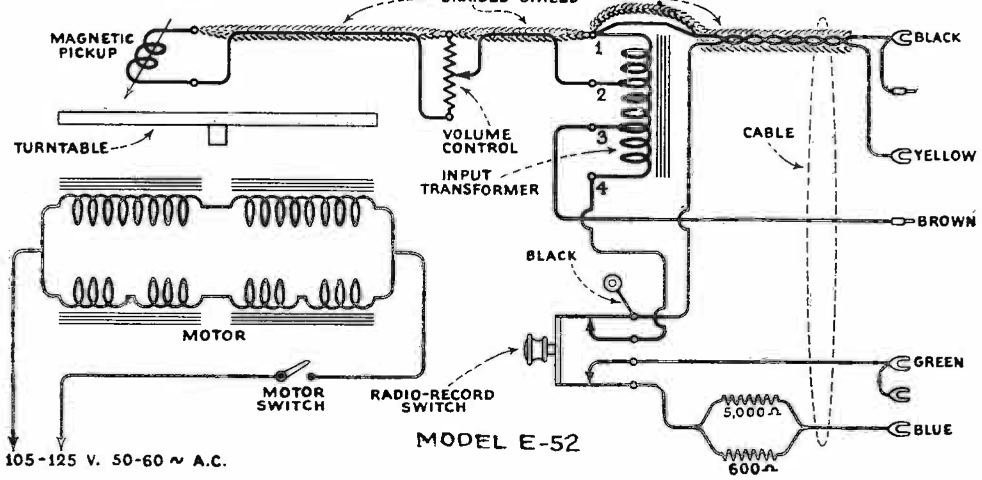
FEDERATED PURCHASER



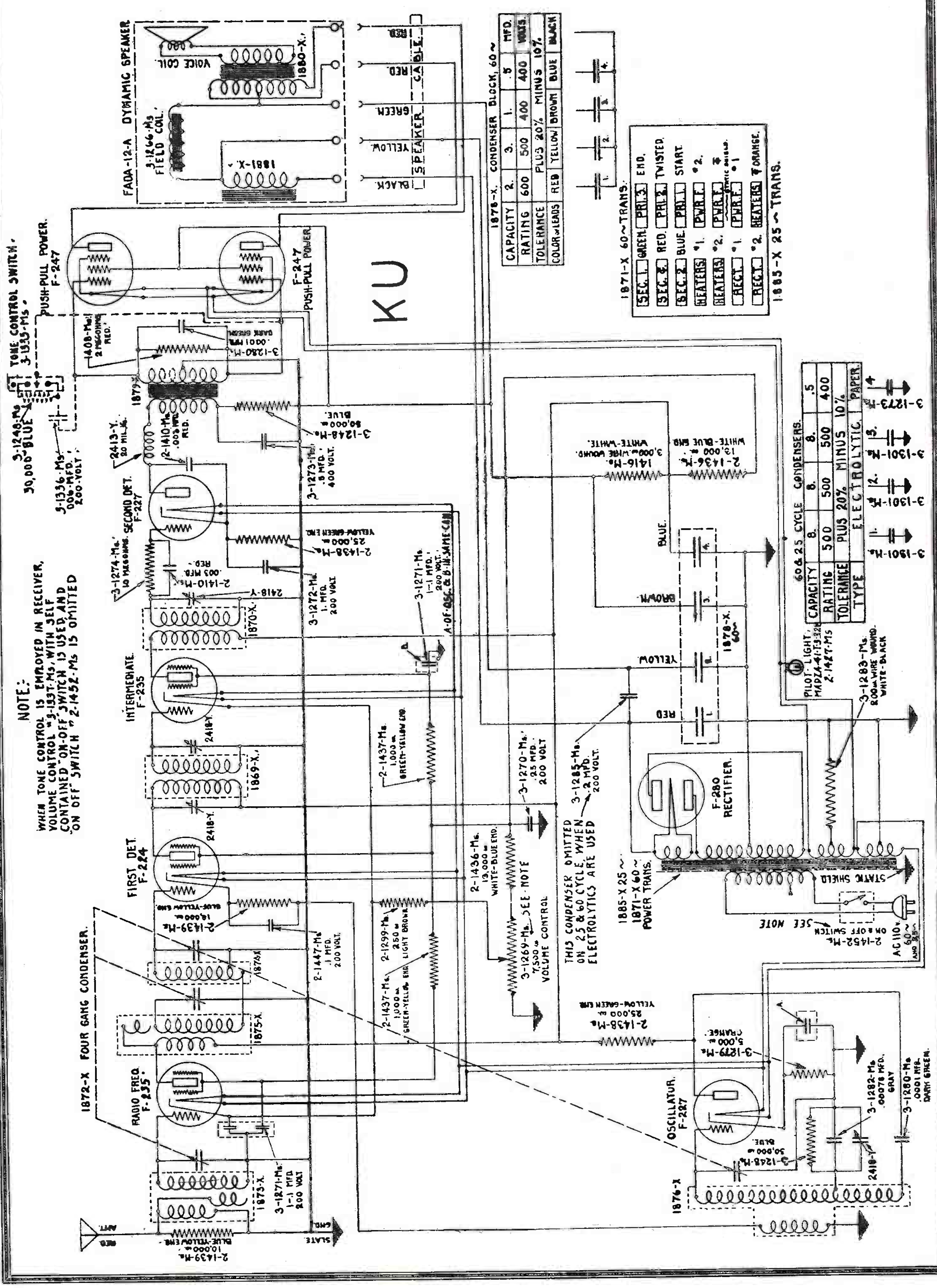
GENERAL ELECTRIC CO.



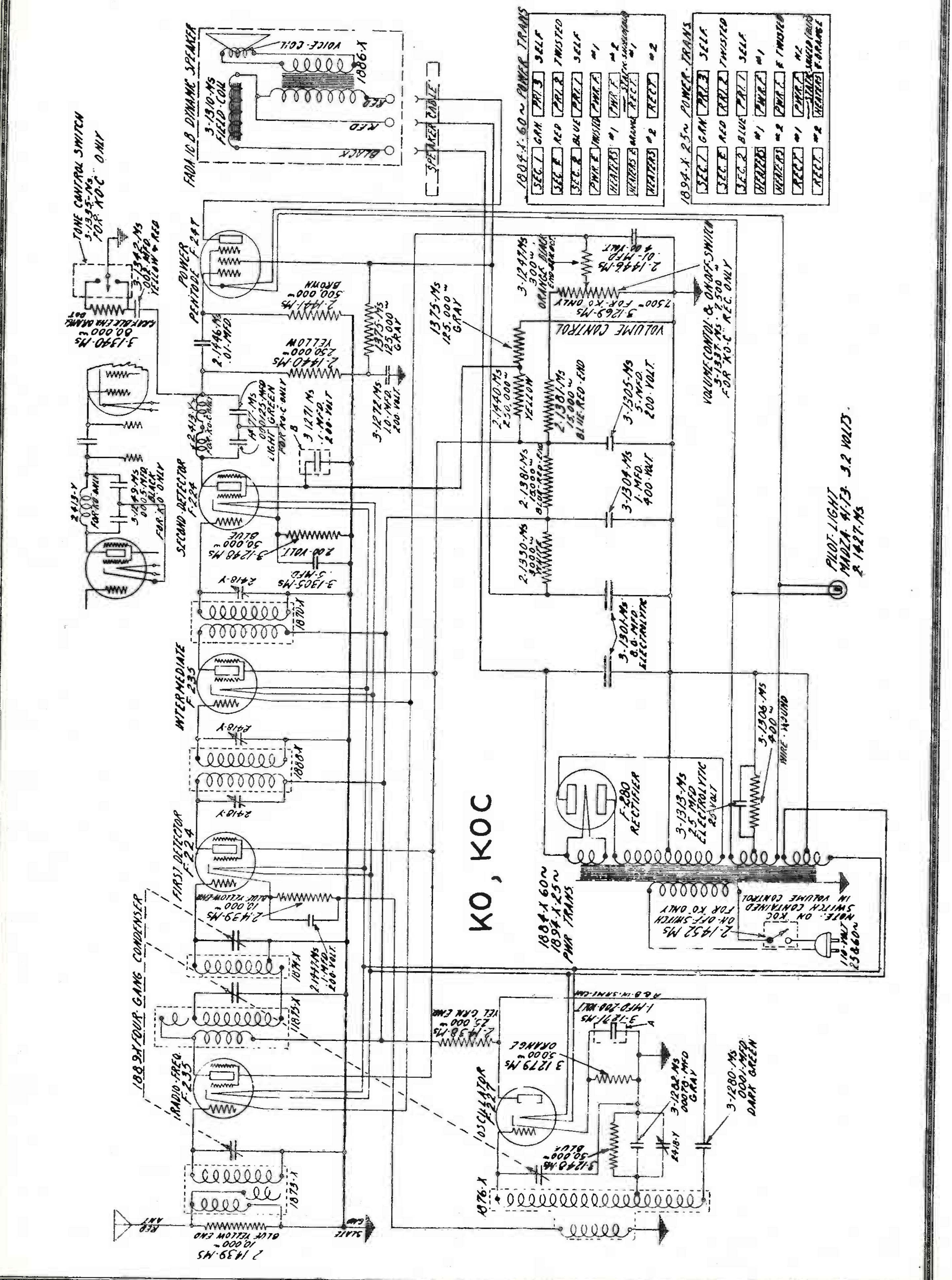
MODEL E-52



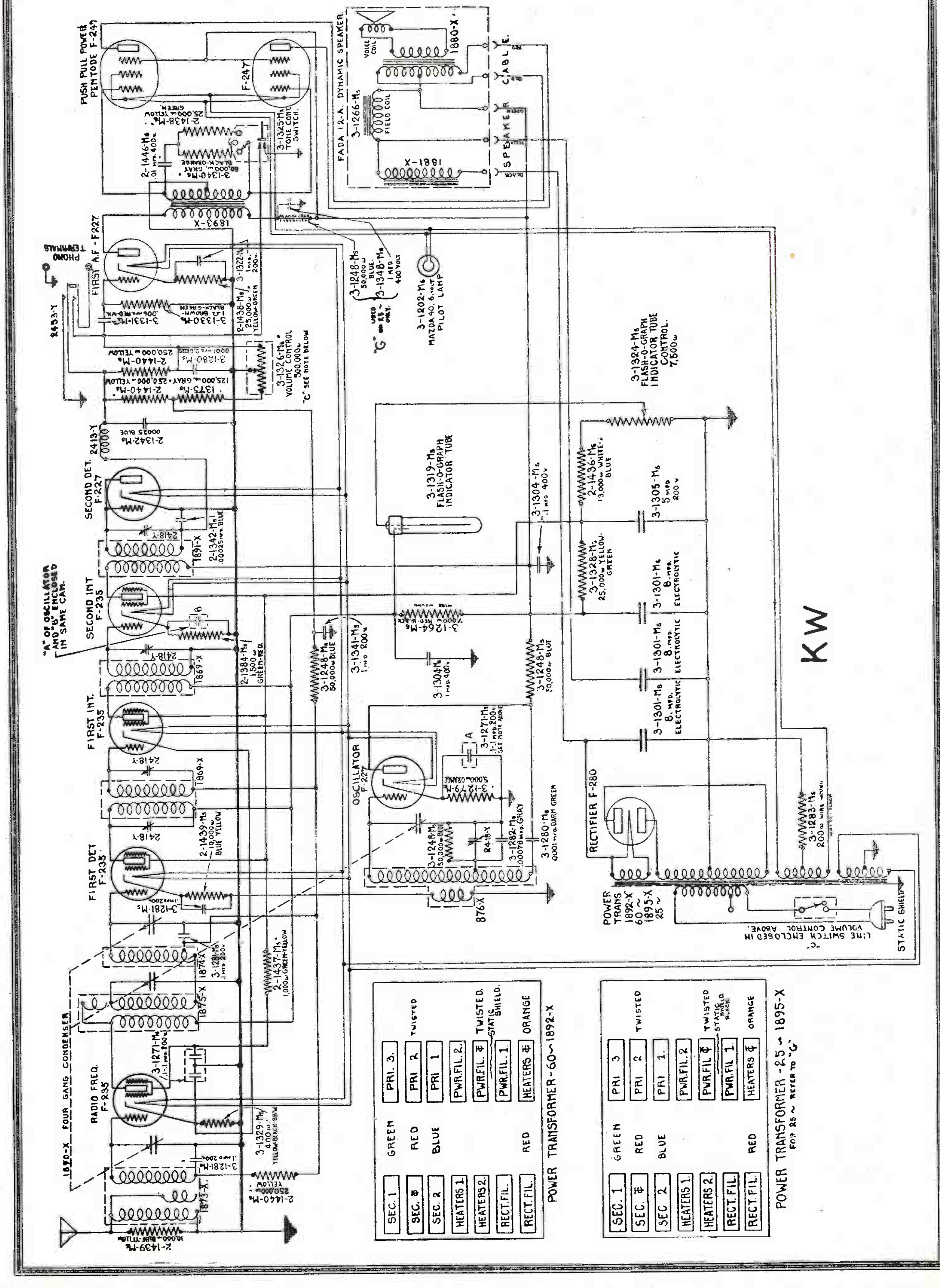
F. A. D. ANDREA INC.



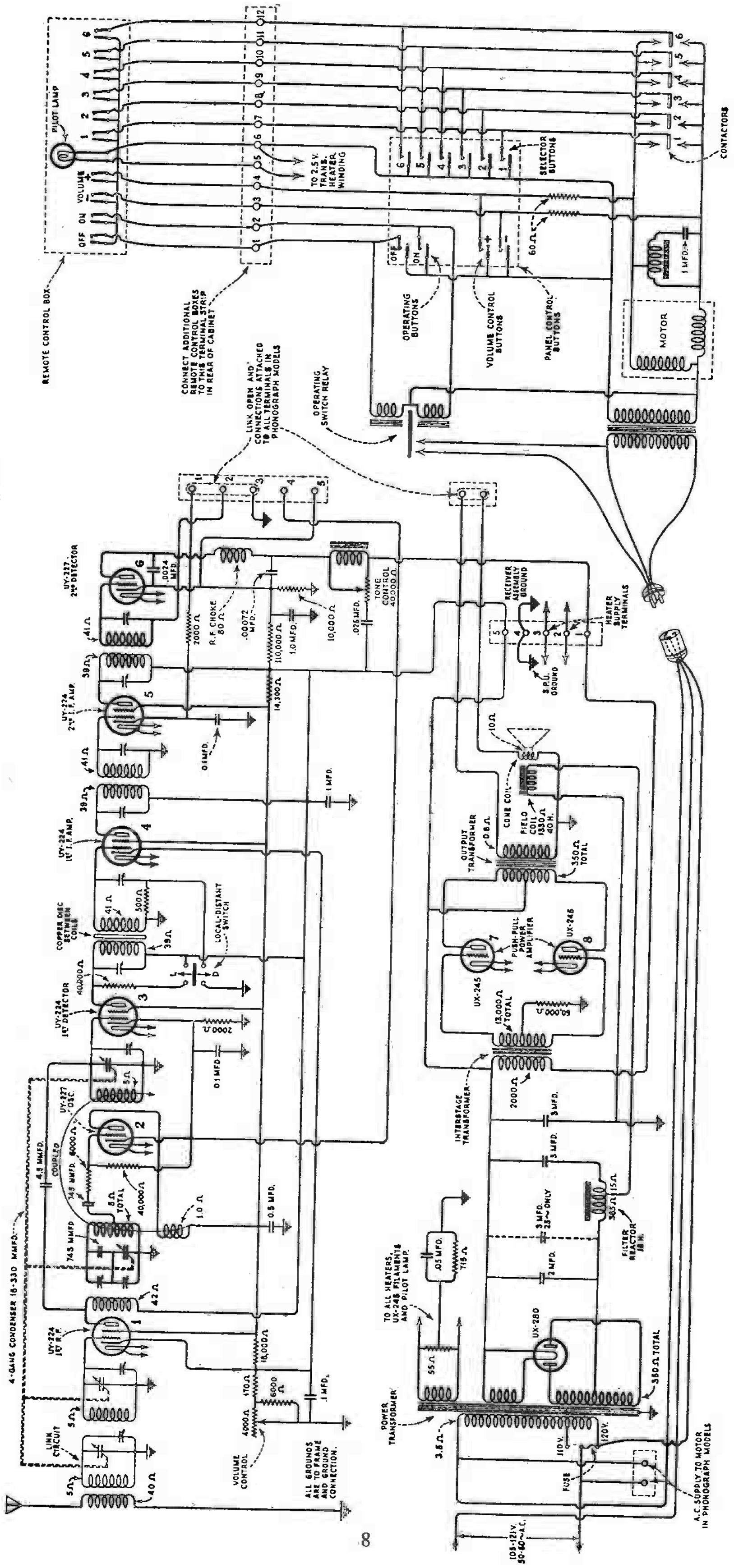
F. A. D. ANDREA INC.



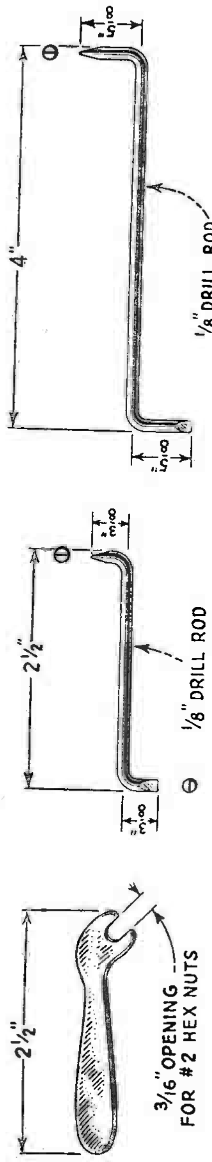
F. A. D. ANDREA INC.



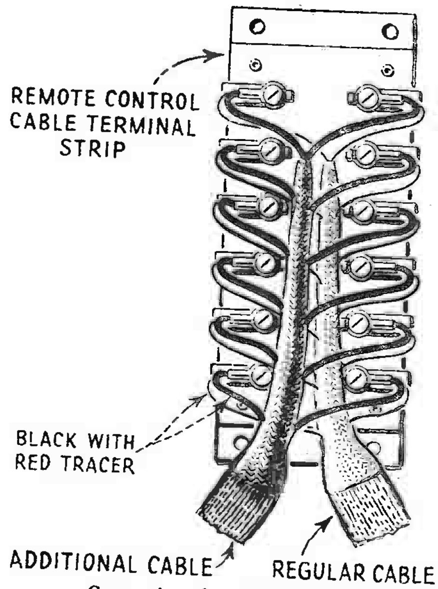
GENERAL ELECTRIC CO.



H-51-R AND H-71-R



Constructional details of special tools used with remote control models

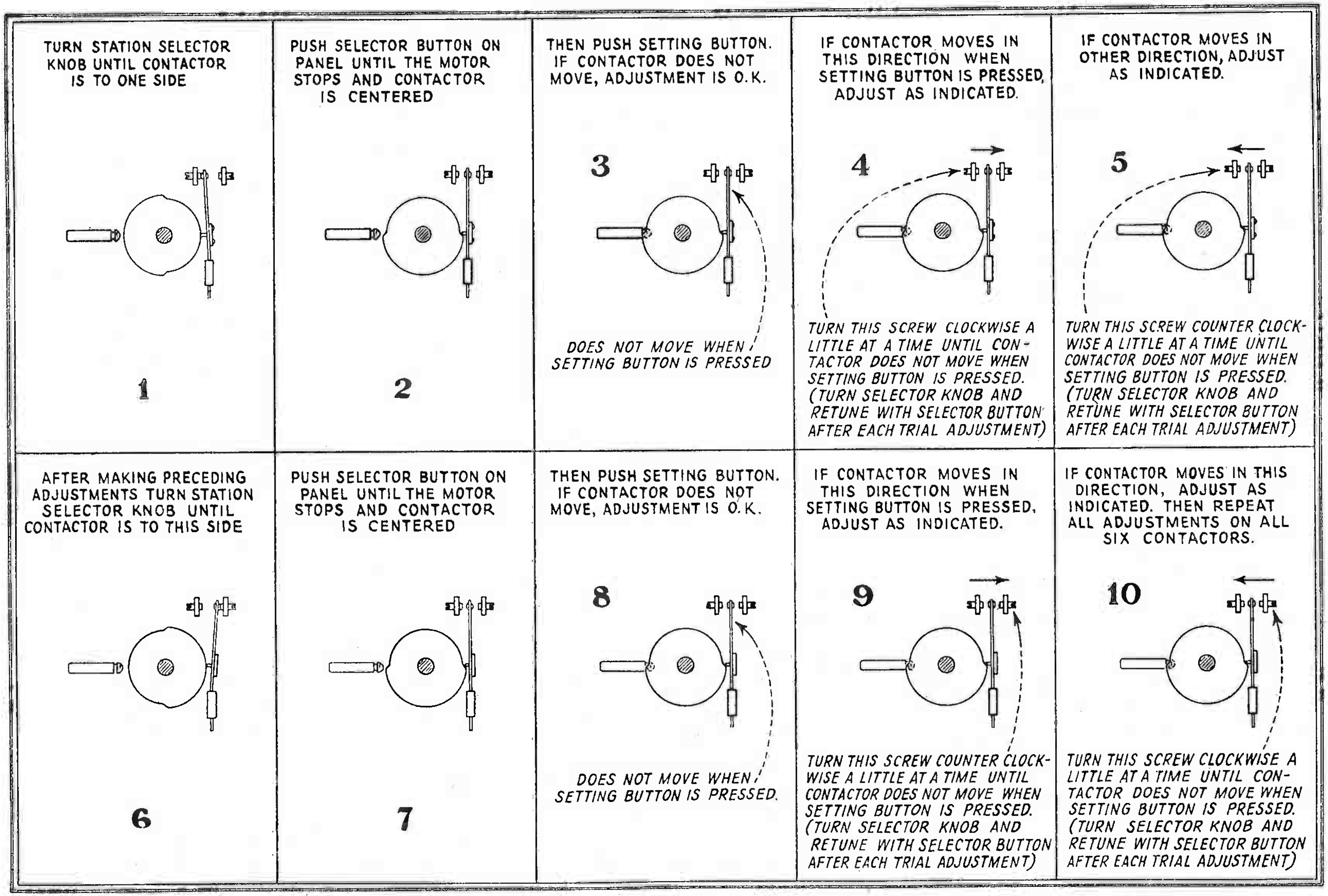


Connections for adding additional boxes

GENERAL ELECTRIC CO.

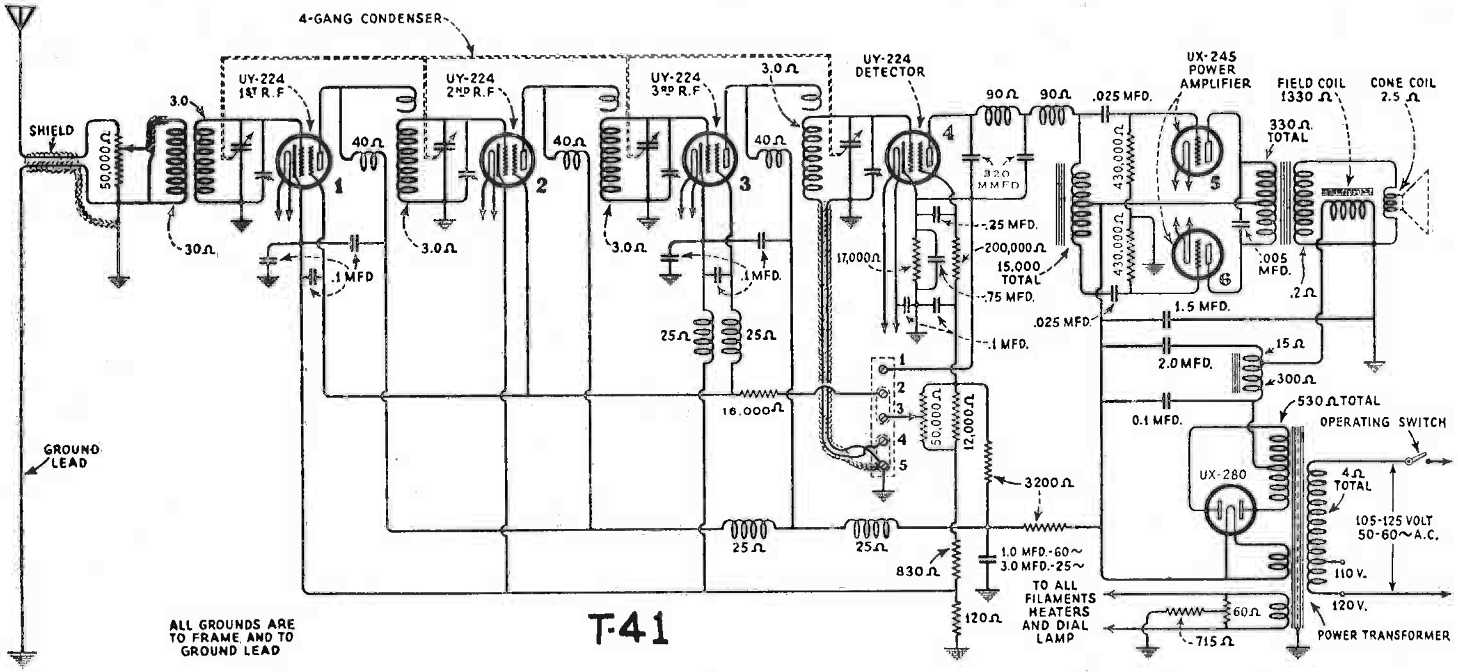
MOTOR CONTACTOR ADJUSTMENT CHART

Repeat Entire Procedure For All Contactors



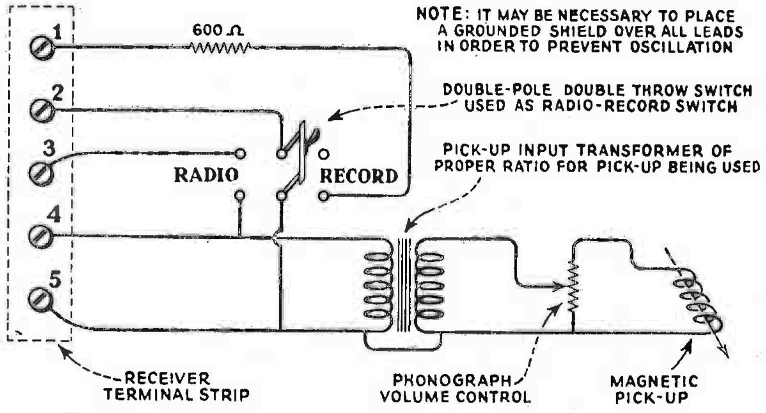
H-51-R AND H-71-R

GENERAL ELECTRIC CO.

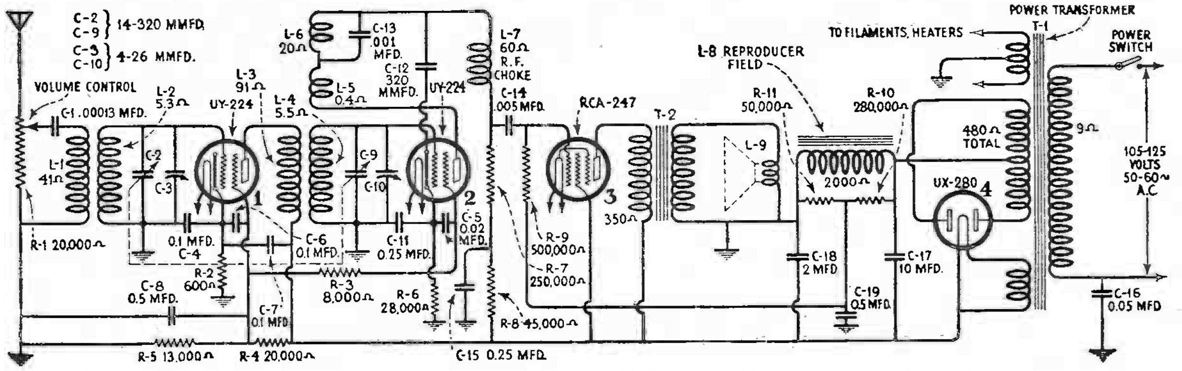


T-41

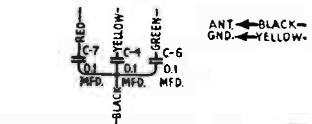
Tube No.	Cathode to Heater Volts D.C.	Cathode or Filament to Control Grid-Volts D.C.	Cathode to Screen Grid Volts D.C.	Cathode or Filament to Plate Volts D.C.	Plate Current M. A.	Screen Grid Current M. A.	Heater or Filament Volts
Volume Control at Maximum							
1	—40	—2.5	+85	160	3.0	0.2	2.3
2	—36	—2.5	+85	155	3.5	0.15	2.3
3	—36	—2.5	+75	155	3.5	0.15	2.3
4	—28	—7.5	+55	225	0.5	0.1	2.3
5	—	*—1.0	—	200	25.0	—	2.3
6	—	*—1.0	—	200	25.0	—	2.3
Volume Control at Minimum							
1	—40	—1.0	+ 6	200	0	0	2.3
2	—40	—1.4	+ 6	200	0	0	2.3
3	—40	—0.8	+ 6	200	0	0	2.3
4	—28	—8.4	+75	230	.6	0	2.3
5	—	*—1.0	—	205	25.0	—	2.3
6	—	*—1.0	—	205	25.0	—	2.3



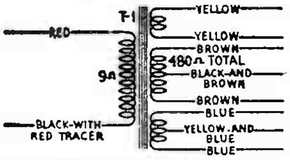
GENERAL ELECTRIC CO.



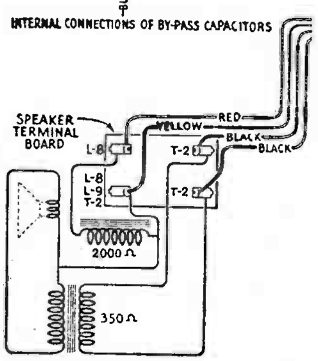
T-12



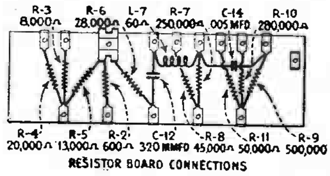
INTERNAL CONNECTIONS OF BY-PASS CAPACITORS



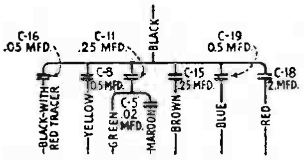
INTERNAL CONNECTIONS OF POWER TRANSFORMER



LOUD SPEAKER CONNECTIONS



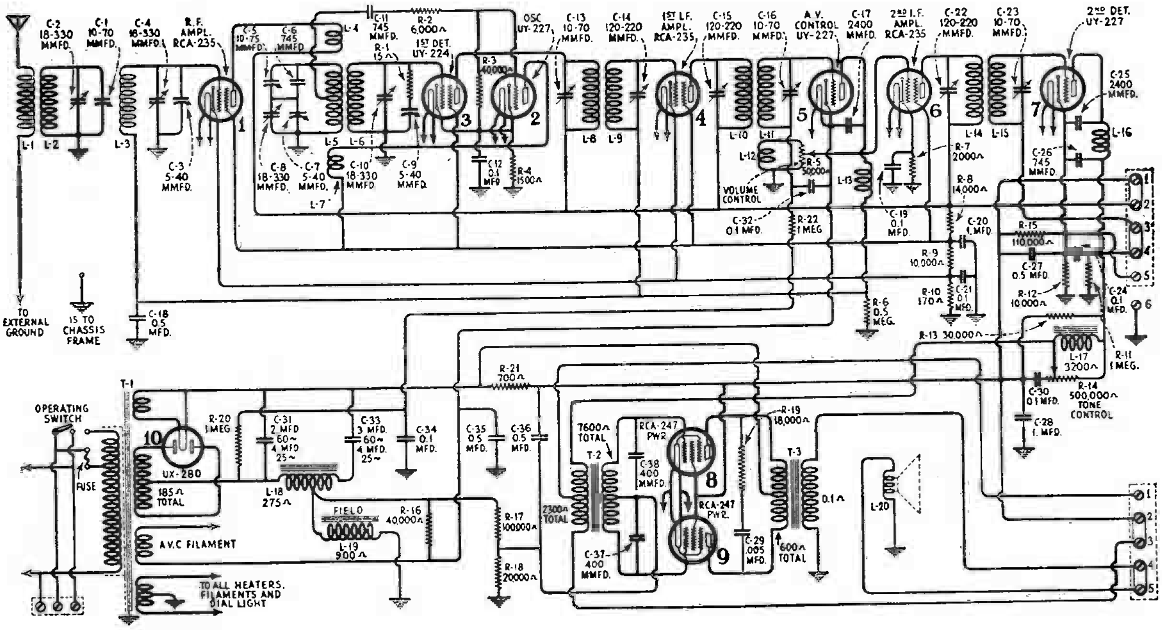
RESISTOR BOARD CONNECTIONS



INTERNAL CONNECTIONS OF BY-PASS CAPACITORS

Radiotron No.	Heater to Cathode Volts	Cathode or Filament to Control Grid Volts	Cathode or Filament to Screen Grid Volts	Cathode or Filament to Plate Volts	Plate Current M. A.	Heater Volts
1	3.0	3.0	85	225	4.0	2.2
2	7.0	7.0	65	100	0.25	2.2
3	——	2.0	225	215	30.0	2.2

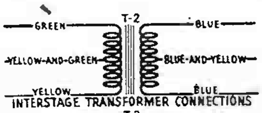
GENERAL ELECTRIC CO.



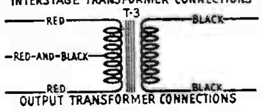
110 VOLT LINE

H-32

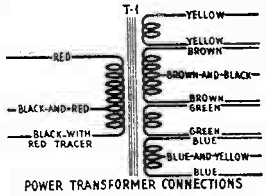
Radiotron No.	Heater to Cathode Volts	Cathode or Filament or Control Grid Volts	Cathode or Filament to Screen Grid Volts	Cathode or Filament to Plate Volts	Plate Current M. A.	Heater Volts
1. R.F.	2.0	*0.2	60	230	3.5	2.5
2. Osc.	5.0	0	—	50	4.0	2.5
3. 1st Det.	4.0	3.5	60	230	0.5	2.5
4. 1st I.F.	2.0	*0.2	60	230	3.5	2.5
5. A.V.C.	0	0	—	30	0.1	2.5
6. 2nd I.F.	2.0	3.5	60	230	2.5	2.5
7. 2nd Det.	20.0	*8.0	—	210	0.5	2.5
8. Pwr.	—	*10.0	250	235	25.0	2.5
9. Pwr.	—	*10.0	250	235	25.0	2.5



INTERSTAGE TRANSFORMER CONNECTIONS

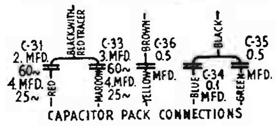


OUTPUT TRANSFORMER CONNECTIONS

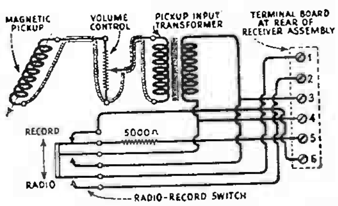


POWER TRANSFORMER CONNECTIONS

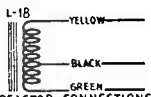
INTERNAL CONNECTIONS OF BY-PASS CAPACITOR PACK



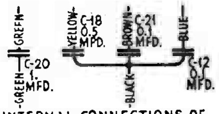
CAPACITOR PACK CONNECTIONS



—Magnetic Pickup connections

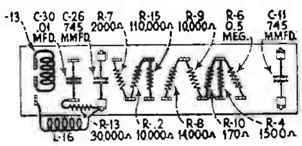


REACTOR CONNECTIONS



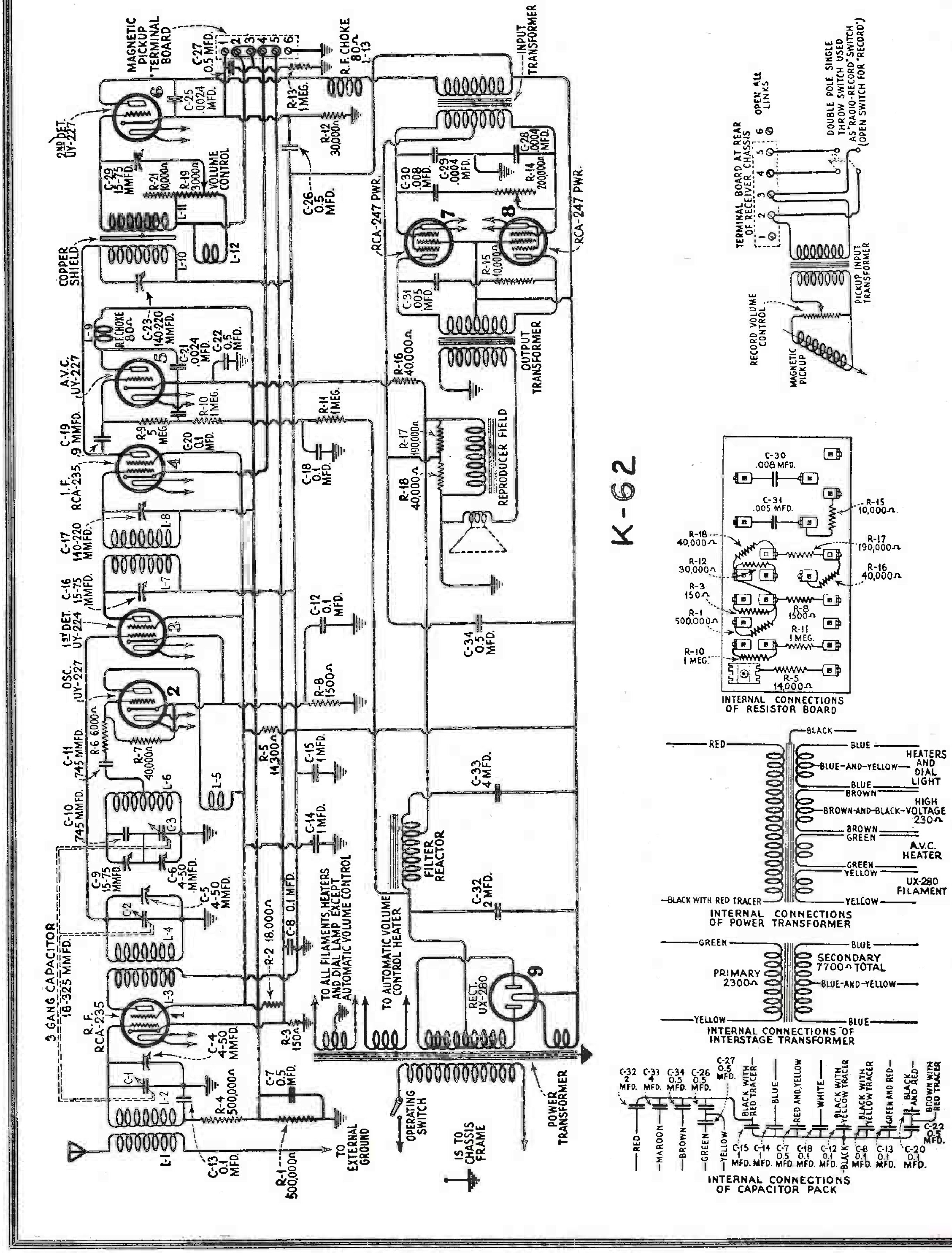
INTERNAL CONNECTIONS OF BY-PASS CAPACITOR PACK

Note: Place the Radio-Record switch and input transformer in the receiver cabinet. Try connecting a wire from receiver terminal No. 6 to input transformer frame or braided shield to pickup and use connection that gives minimum hum.

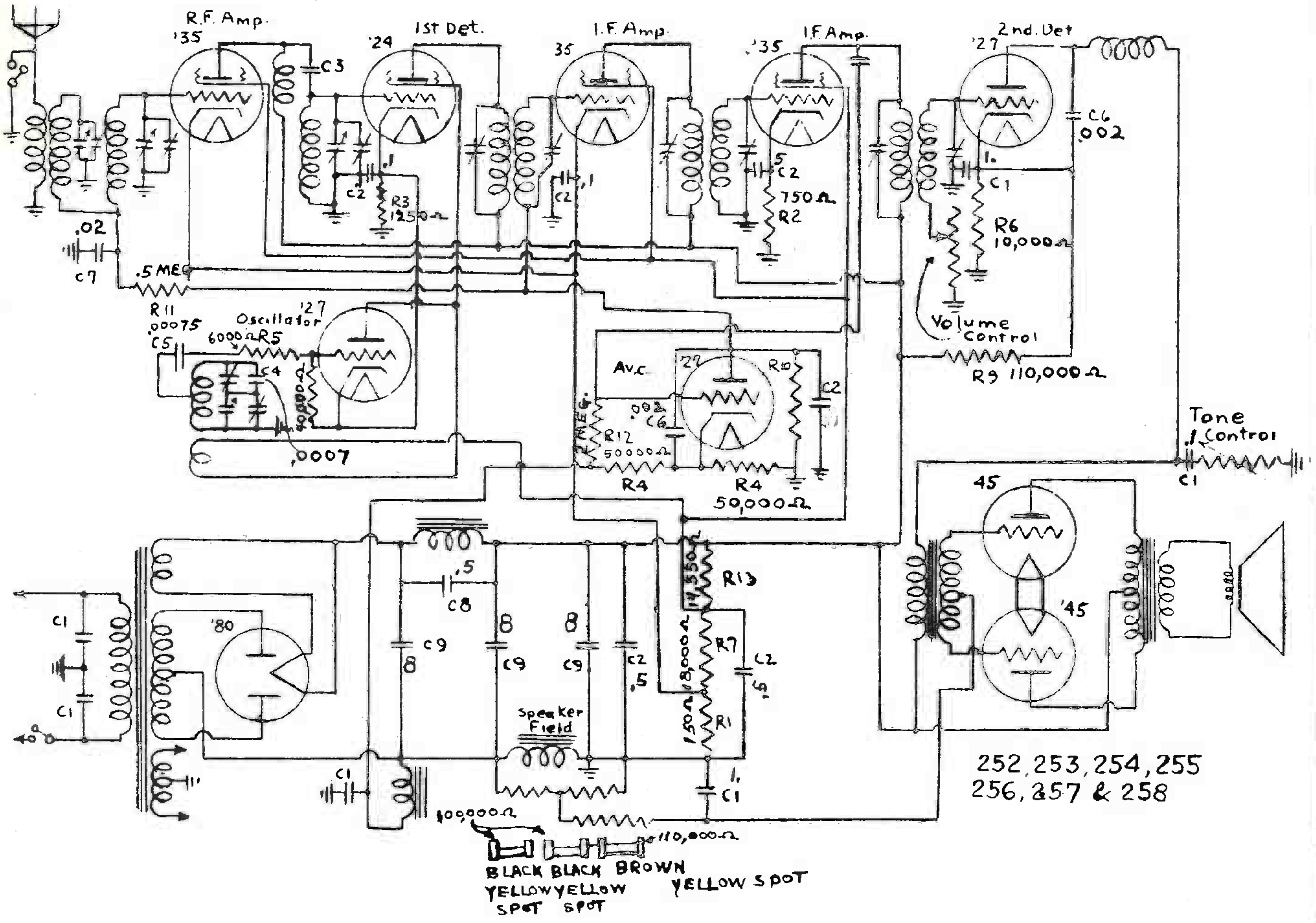


RESISTOR BOARD CONNECTIONS

GENERAL ELECTRIC CO.

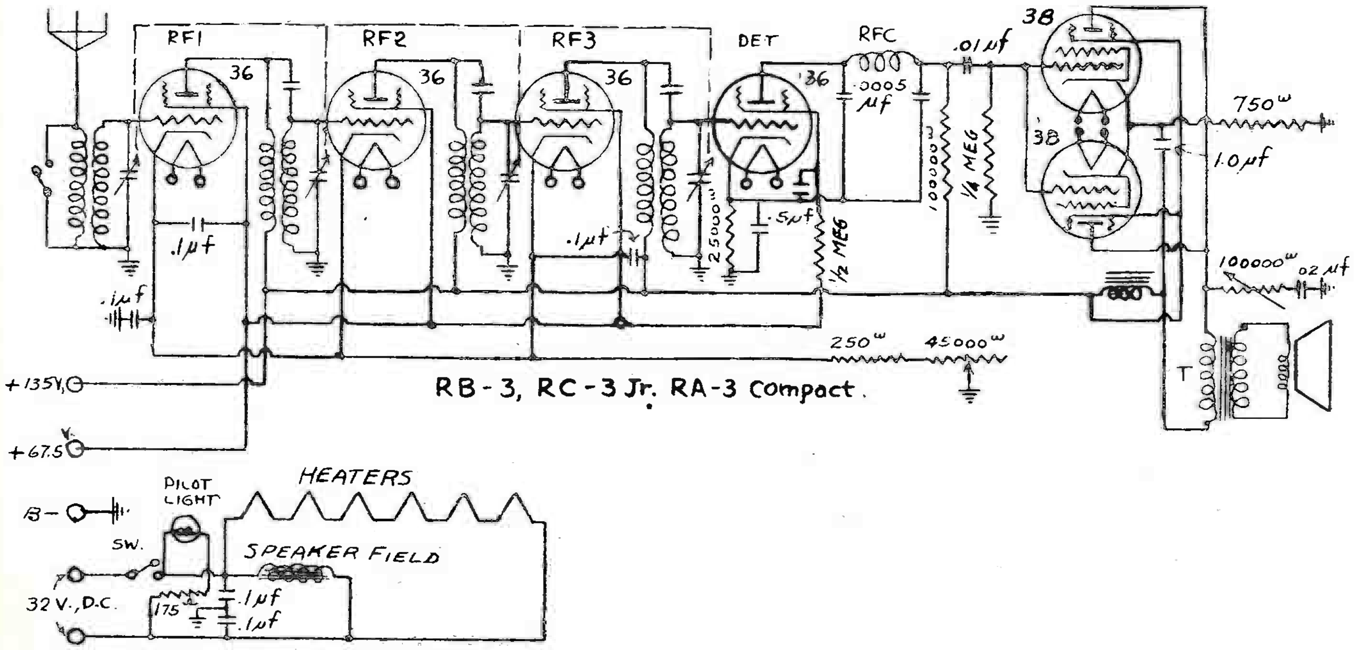


GENERAL MOTORS RADIO CORP.



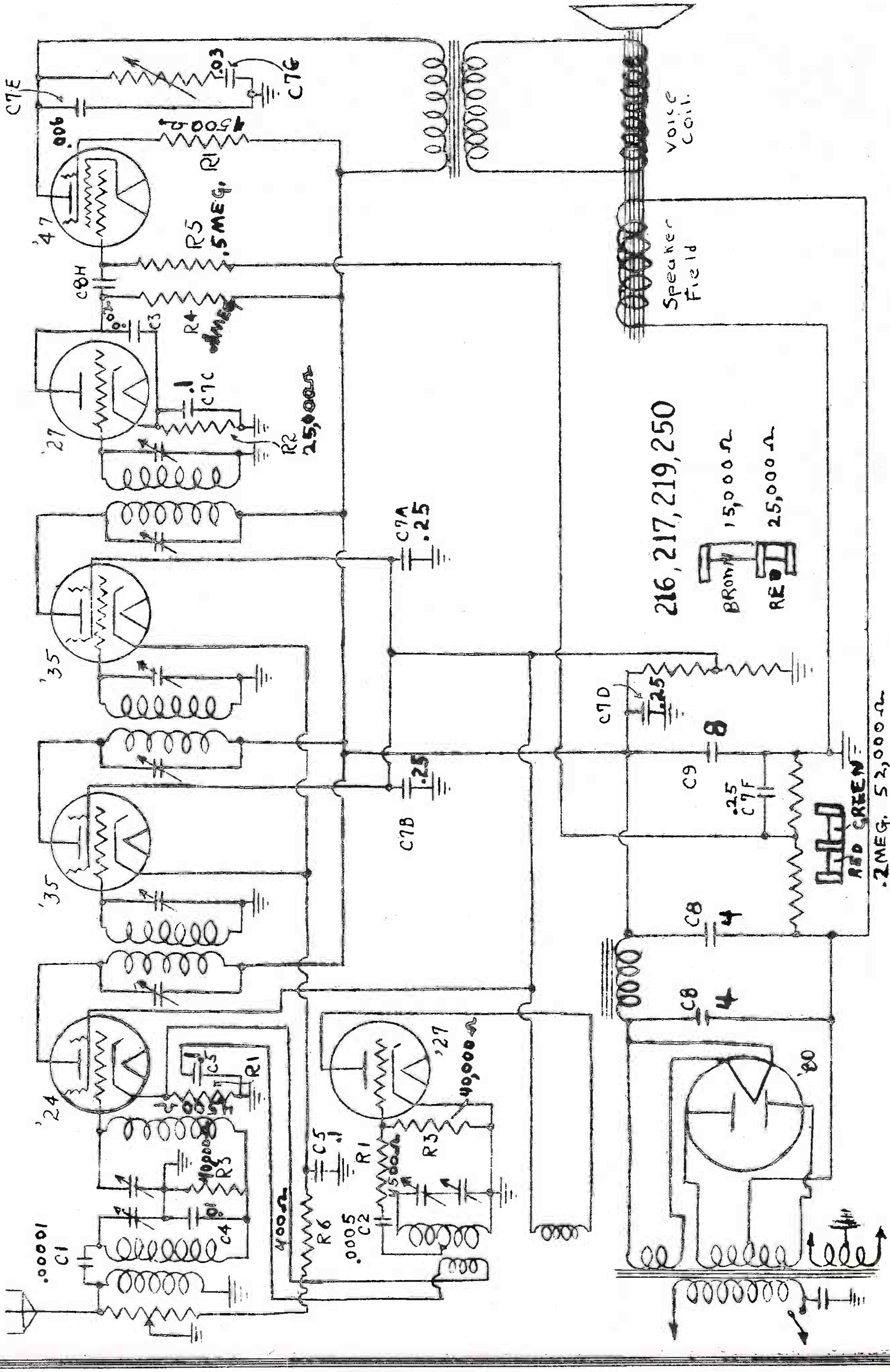
252, 253, 254, 255
256, 257 & 258

DELCO

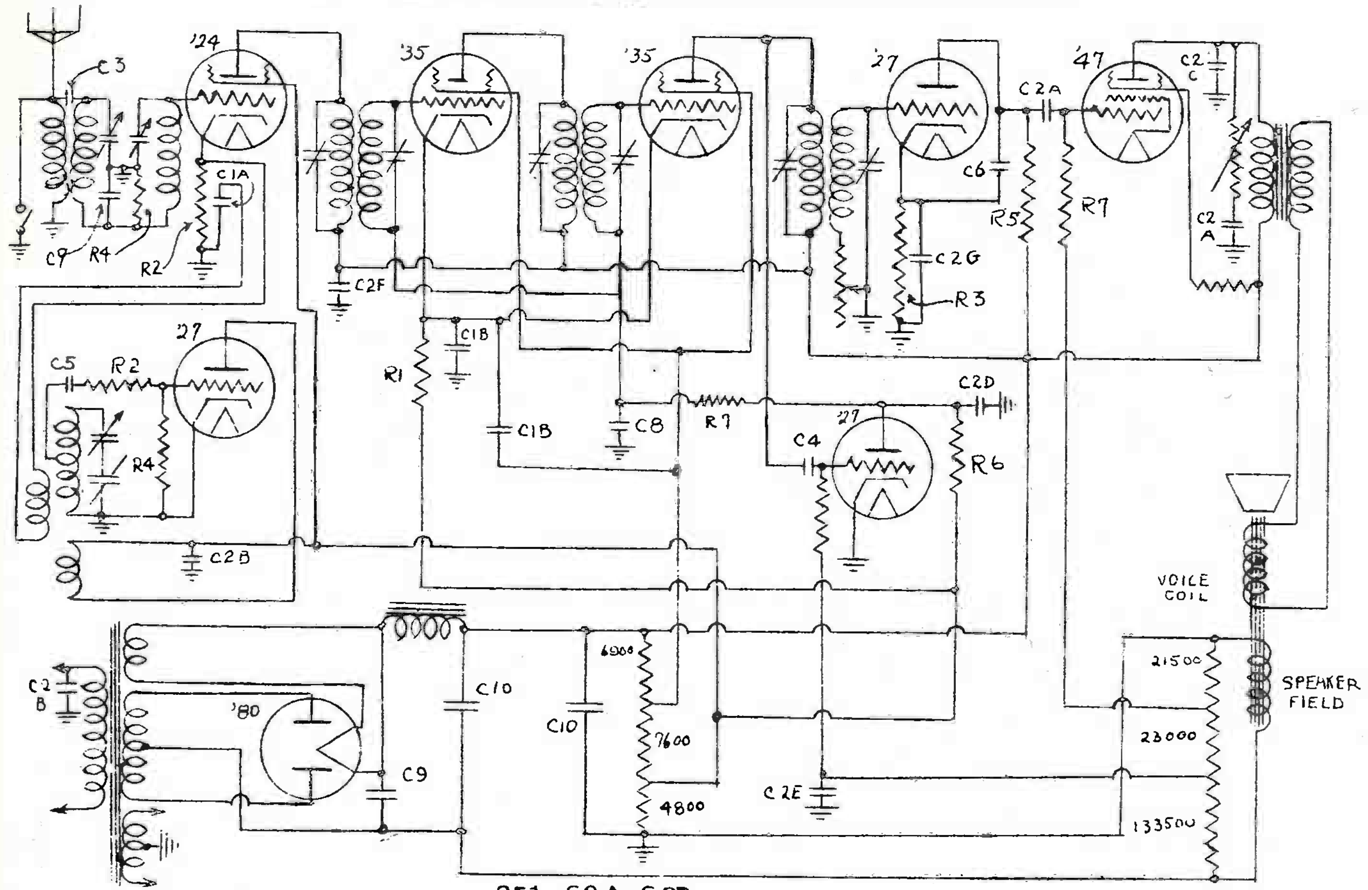


RB-3, RC-3 Jr. RA-3 Compact.

GENERAL MOTORS RADIO CORP.



GENERAL MOTORS RADIO CORP.



251, S2-A, S-2B

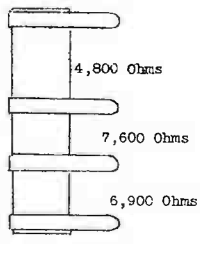
TABLE OF RESISTORS AND CONDENSERS:

251, S2-A, S2-B

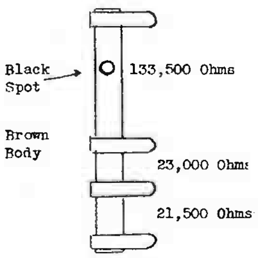
Resistors

No.	Body	End	Spot	Resistance	Watts
R1	Orange	Black	Brown	300	1/2
R2	Yellow	Green	Red	4,500	1/2
R3	Red	Green	Orange	25,000	1/2
R4	Yellow	Black	Orange	40,000	1/2
R5	Brown	Black	Yellow	100,000	1/2
R6	Red	Green	Yellow	250,000	1/2
R7	Green	Black	Yellow	500,000	1/2
R8	Red	Black	Green	2 Megohms	1/2

Voltage Divider



Pentode Bias



CONDENSERS

No.	Capacity	
C1A	.1 Mfd.	By-Pass Condenser Pack No. 1
C1B	1.0 Mfd.	
C2A	.03 Mfd.	By-Pass Condenser Pack No. 2
C2B	.1 Mfd.	
C2C	.006 Mfd.	
C2D	.25 Mfd.	
C2E	1.0 Mfd.	
C2F	.25 Mfd.	
C2G	.1 Mfd.	
C3	.00001 Mfd.	
C4	.00025 Mfd.	
C5	.00075 Mfd.	
C6	.002 Mfd.	
C7	.01 Mfd.	
C8	1.0 Mfd.	
C9	4.0 Mfd. (Electrolytic)	
C10	8.0 Mfd. (Electrolytic)	

TESTING WITH A SET ANALYZER: 251, S2-A, S-2-B

The following chart shows the approximate readings that should be obtained with any of the more reliable makes of set analyzers.

NOTE: Do Not attempt to take readings on the type 247 (Pentode) tube unless your set analyzer is equipped to test sets using this type of tube. Readings at the 247 tube socket will be misleading if the set analyzer is not adapted to test Pentode tubes.

TUBE IN SET ANALYZER

Type of Tube	Position of Tube	Fil. Volts	Plate Volts*	Control Grid Volts	Screen Grid Volts	Cathode Volts#	Pentode Screen Volts	Normal Plate MA	Rated Fil. Volts
224	1st Det.	2.1	255	1.9	77	6.0	--	1.0	2.20
235	1st I.F.	2.1	200	.3	100	95.0	--	1.6	2.20
235	2nd I.F.	2.1	200	.3	100	95.0	--	1.6	2.20
227	2nd Det.	2.15	145	.0	--	15.0	--	.5	2.25
227	Osc.	2.15	75	.0	--	0	--	7.0	2.25
227	A.V.C.	2.15	60	.0	--	0	--	.0	2.30
247	A.F.	2.15	235	1.0	--	--	215	30.0	2.30
280	Rect.	4.5	200	--	--	--	--	30-30	4.70

Line Volts 110 Volume on Full

* Use 600 Volt Scale. # Measured from Cathode to Heater.

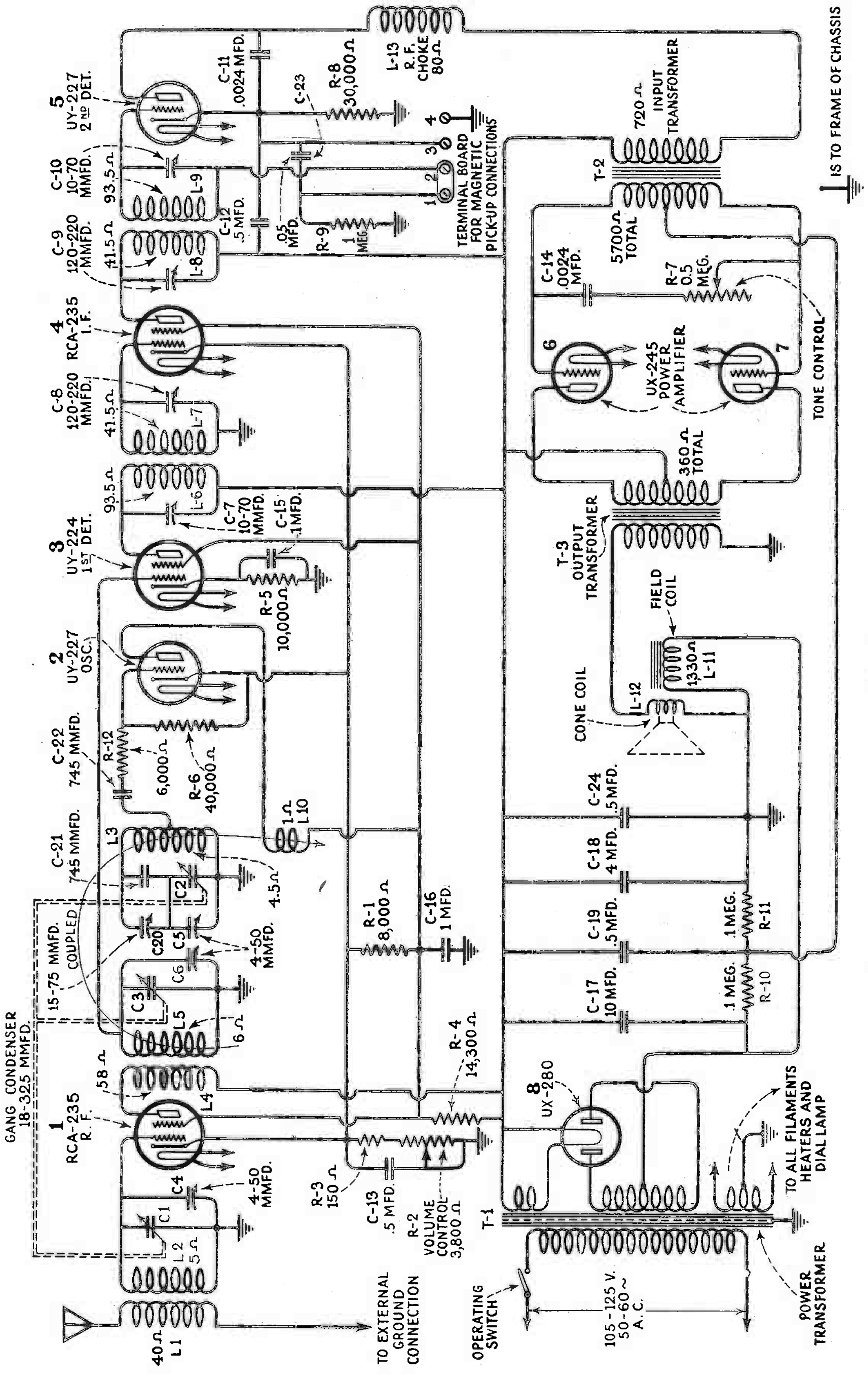
It should be noted that readings obtained with set analyzers will vary with different makes of analyzers, with different line voltages and with different tubes. The readings shown in the above table therefore, are only average values and for this reason, each service man should compile a chart similar to the one illustrated using his own set analyzer and a set that is known to be operating properly.

NOTE: (1) Use voltmeters having resistance of 1,000 Ohms per volt.

(2) Measure all plate voltages on 600 Volt Scale.

(3) Rated Filament voltages are those measured at the tube sockets with a high grade instrument. In general there is about a .1 volt drop in the set analyzer cable.

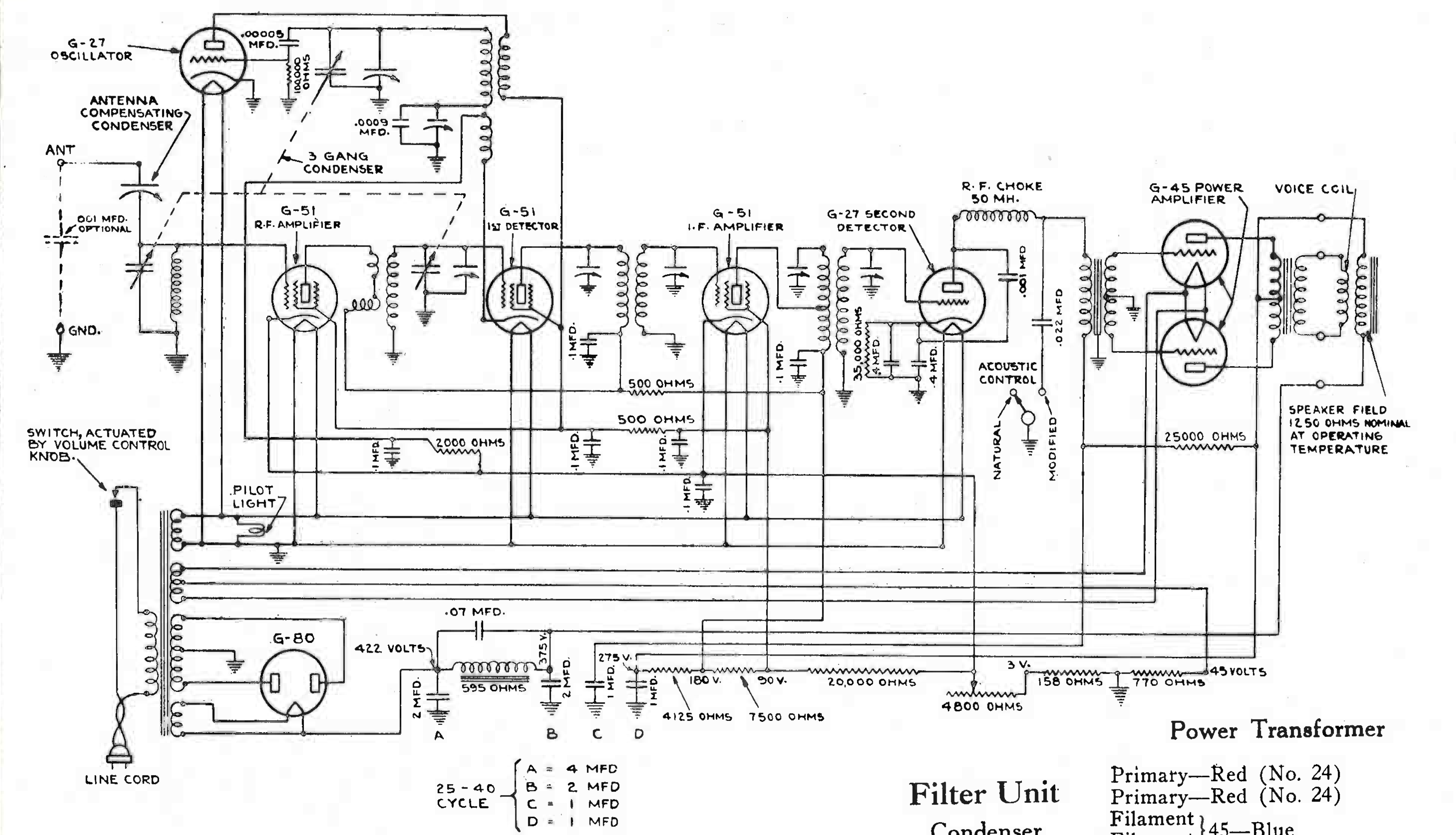
GRAYBAR ELECTRIC CO.



"8"

GRIGSBY-GRUNOW CO.

MODEL 20 CHASSIS 110 AND 220 VOLTS – 50-60 AND 25-40 CYCLE



Power Transformer

Primary—Red (No. 24)
Primary—Red (No. 24)
Filament } 45—Blue
Filament }
Heater } 51—Red (2 strands No. 18)
Heater }
Center Tap 45—Red (stranded)
Anode—Green (stranded)
C. T. Anode—Bare (stranded)
Anode—Green (stranded)
Filament } 80—Orange (No. 18)
Filament }

Filter Unit

Condenser

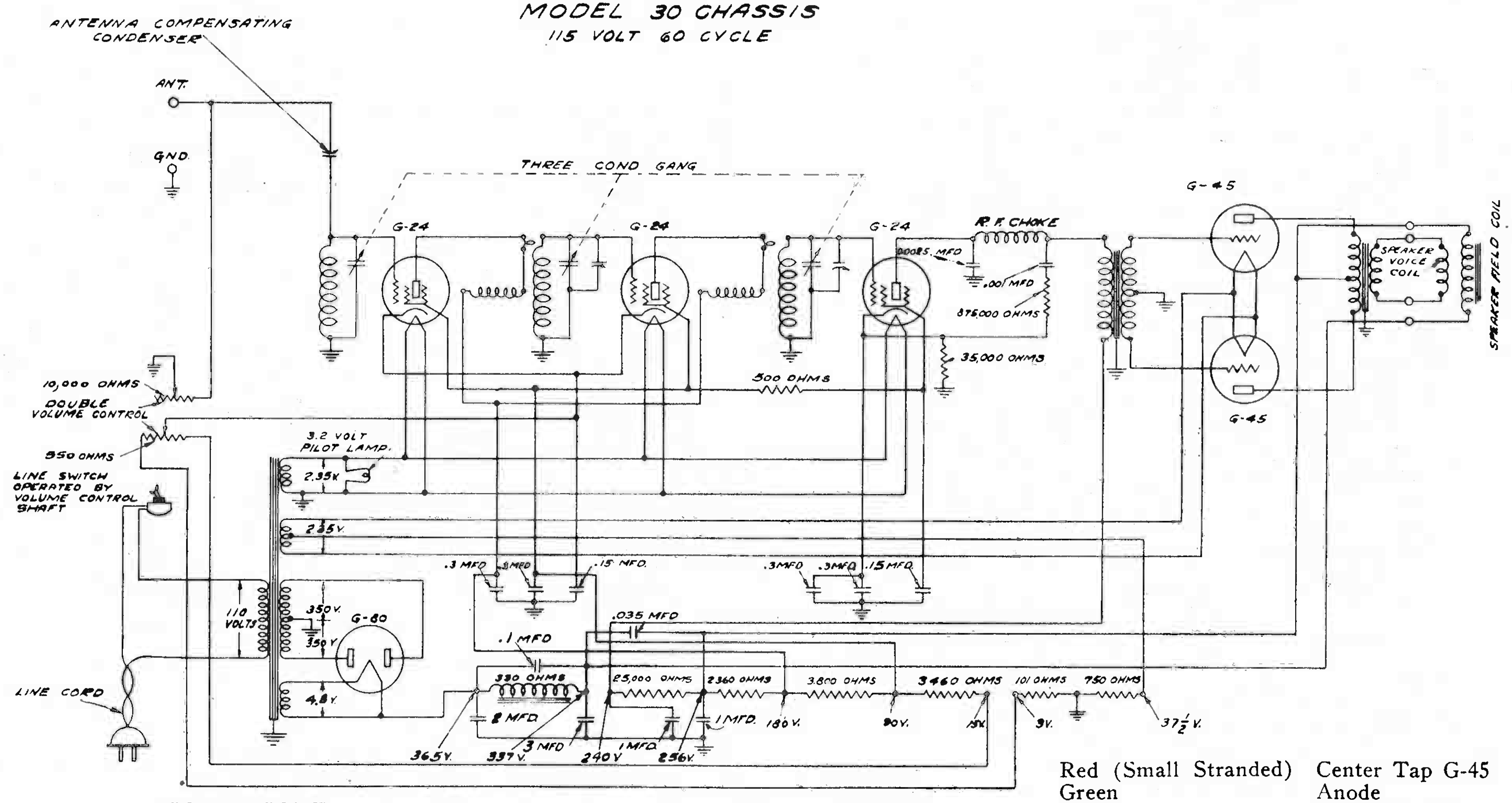
2 microfarad condenser—Orange (stranded)
2 microfarad condenser—Blue (stranded)
1 microfarad condenser—Red (stranded)
1 microfarad condenser—Green (stranded)
.07 microfarad condenser—White (stranded)
Condenser common—Black (stranded)

Choke

G-80 socket (Filament)—Orange (stranded)
Junction speaker Field and Choke—Blue (stranded)

GRIGSBY-GRUNOW CO.

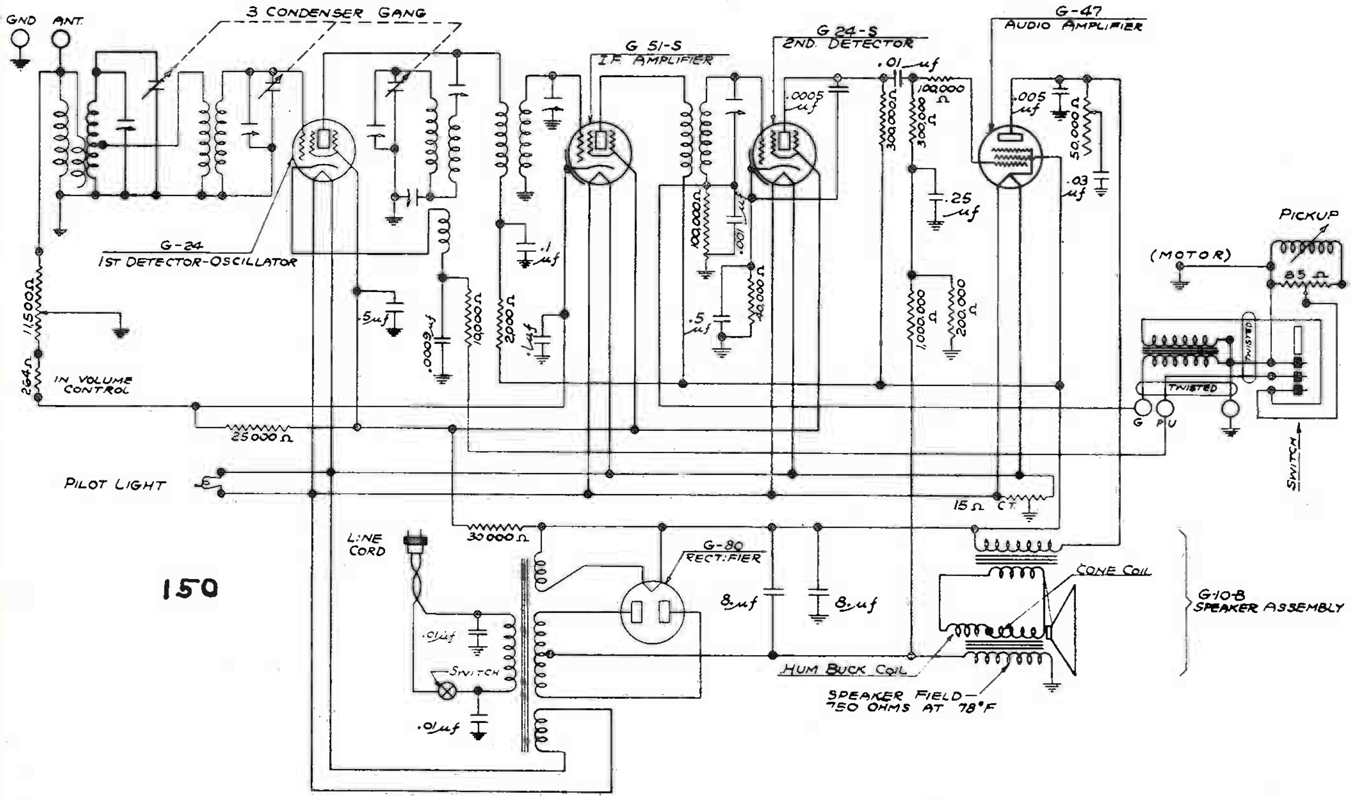
MODEL 30 CHASSIS
115 VOLT 60 CYCLE

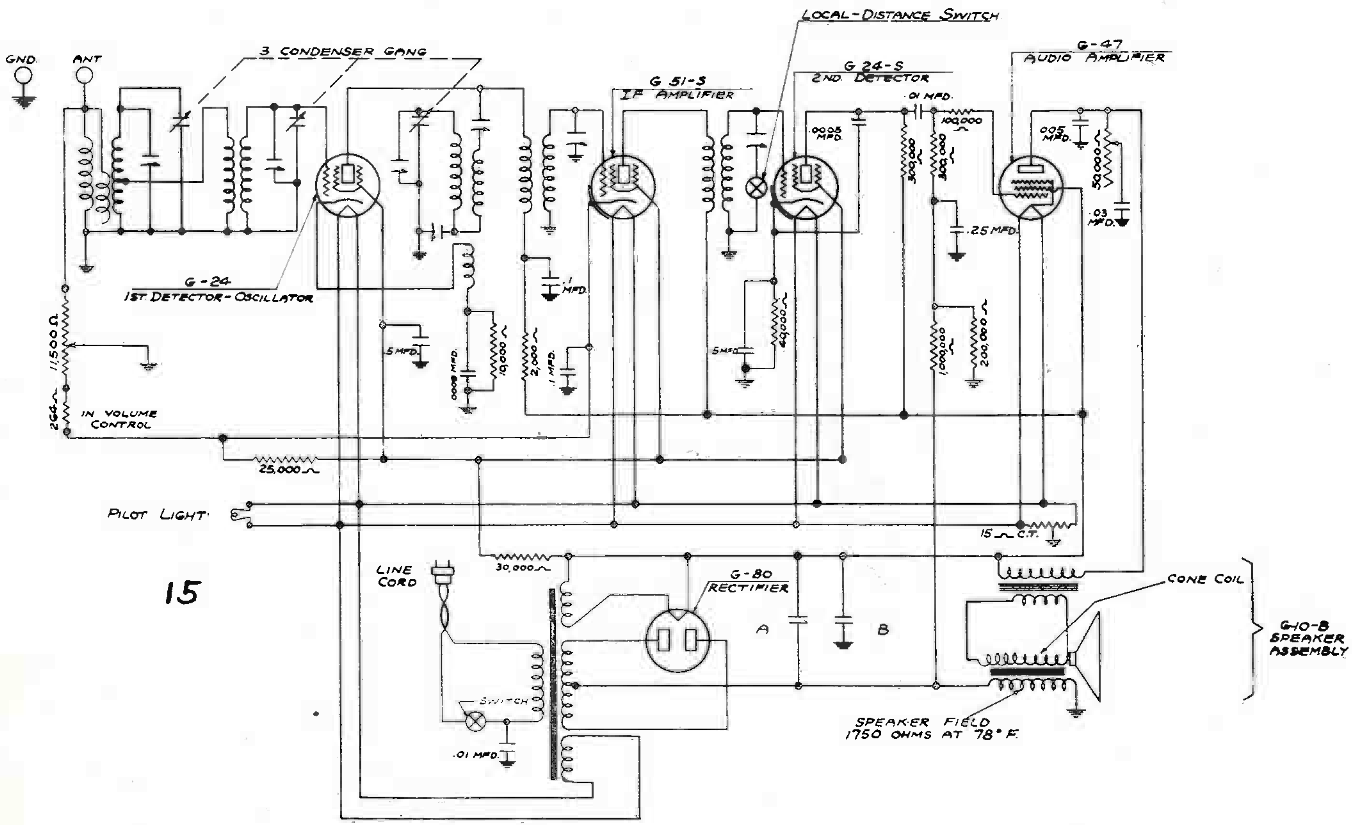


COLOR CODE
POWER TRANSFORMER

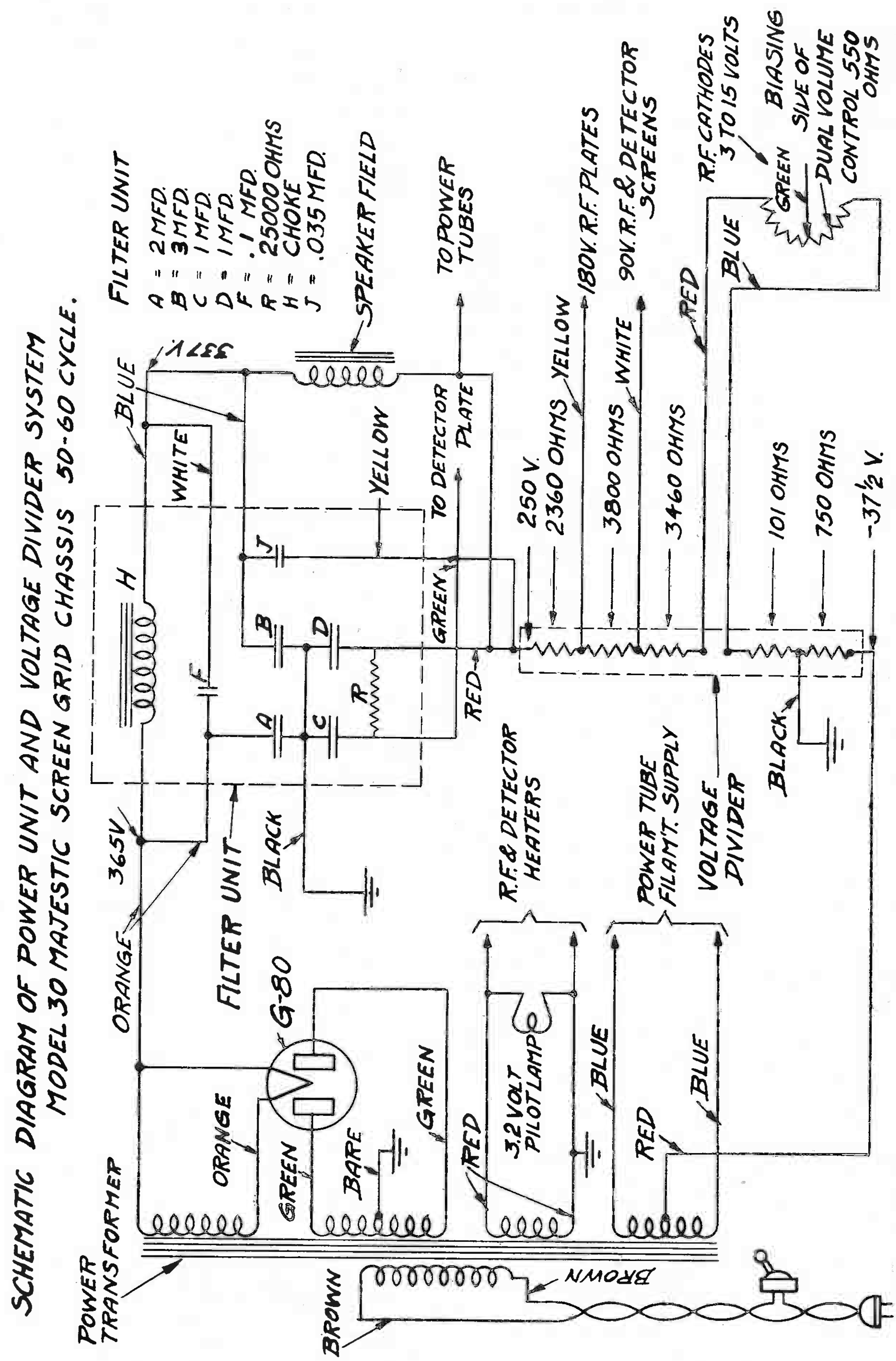
Brown (Small Solid)	Primary
Brown (Small Solid)	Primary
Blue	Filament (2) G-45
Blue	Filament (2) G-45
Red (Heavy Solid)	Heater (3) G-24
Red (Heavy Solid)	Heater (3) G-24
Red (Small Stranded)	Center Tap G-45
Green	Anode
Bare	C. T. Anode
Green	Anode
Orange	Filament (1) G-80
Orange	Filament (1) G-80

GRIGSBY-GRUNOW CO.





GRIGSBY-GRUNOW CO.



GRIGSBY-GRUNOW CO.

Filter Unit

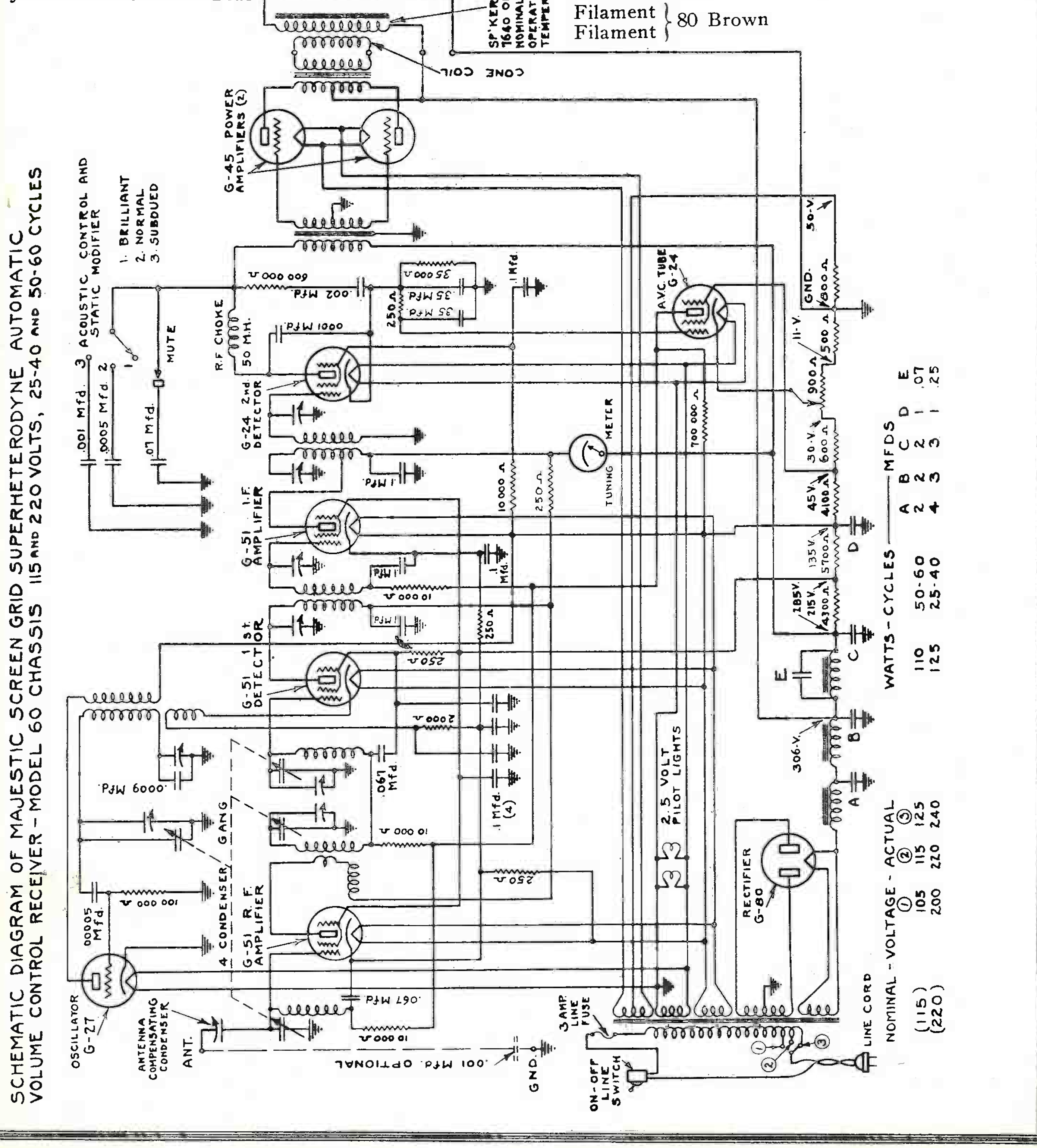
2 microfarad condenser—Green
2 microfarad condenser—Red
2 microfarad condenser—Blue
1 microfarad condenser—Yellow
.07 microfarad condenser—White
Condenser common—Black

Choke

Filter Output—Red
Detector Choke Low Side—Green
Junction of Chokes—Blue

Primary	Start of Winding	—Red
	105 volts	—Red and White
	115 volts	—Yellow
	125 volts	—Green

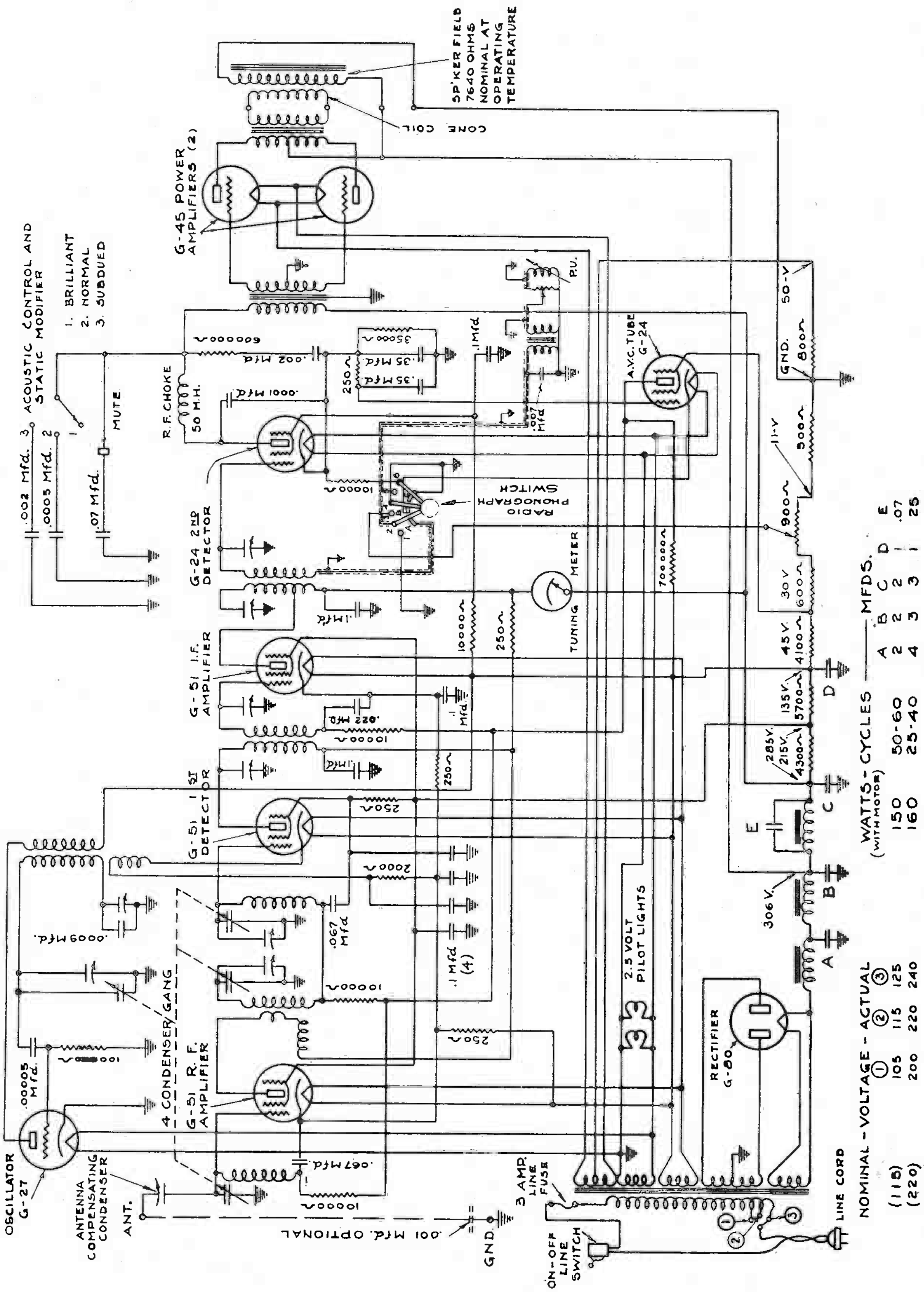
Filament } 45 Blue
Filament }
Heater }
Heater } White—(135 v. above ground)
Heater }
Heater—Red—(2nd Det. A. V. C. and Osc.)
Center Tap—45 Red
Anode—Green
C. T. Anode—Bare
Anode—Green
Filament } 80 Brown
Filament }



SCHEMATIC DIAGRAM OF MAJESTIC SCREEN GRID SUPERHETERODYNE AUTOMATIC VOLUME CONTROL RECEIVER - MODEL 60 CHASSIS 115 AND 220 VOLTS, 25-40 AND 50-60 CYCLES

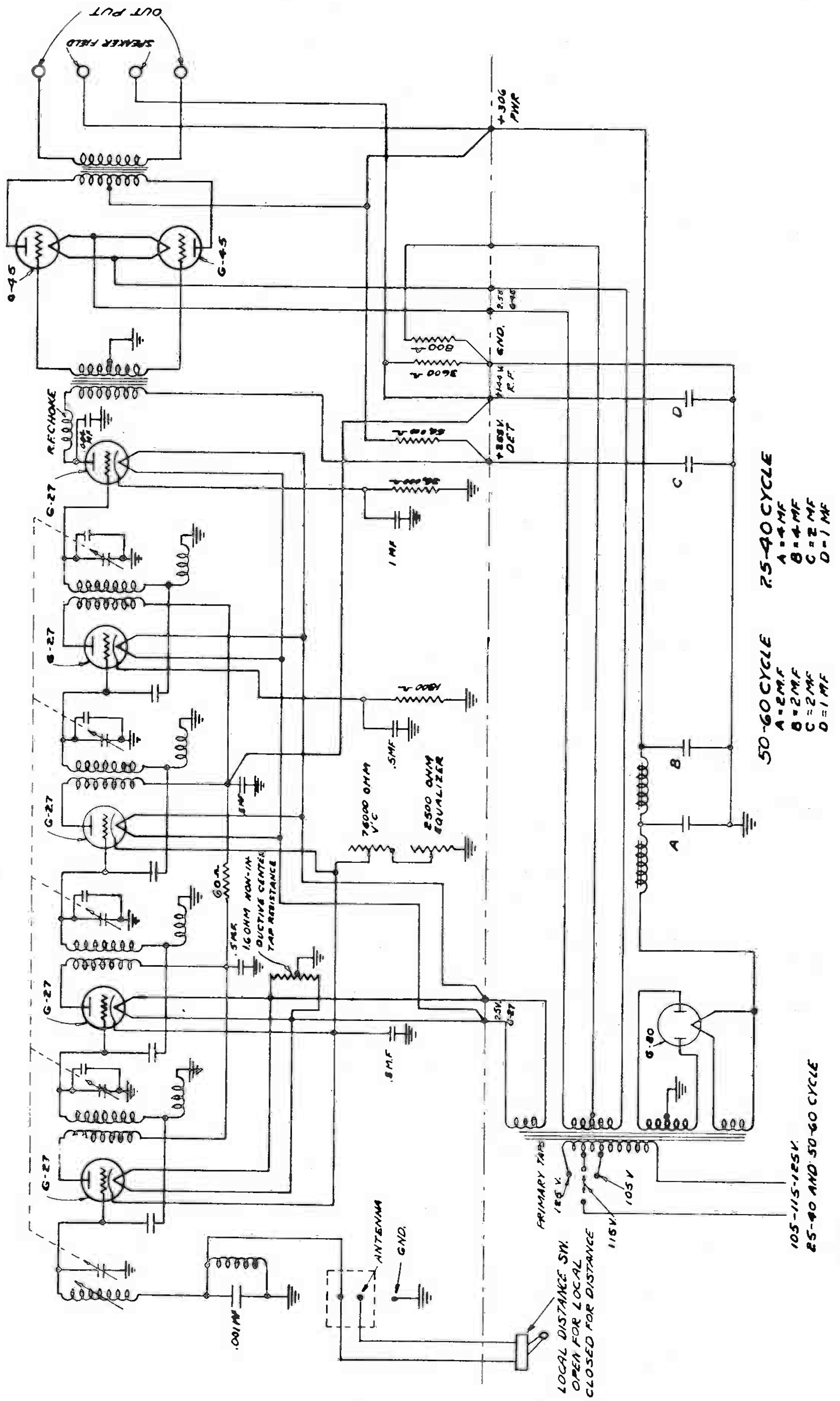
GRIGSBY-GRUNOW CO.

SCHEMATIC DIAGRAM OF MAJESTIC SCREEN GRID SUPERHETERODYNE AUTOMATIC VOLUME CONTROL RECEIVER AND ELECTRIC PHONOGRAPH COMBINATION MODEL 160 CHASSIS 115 AND 220 VOLTS, 25-40 AND 50-60 CYCLES.

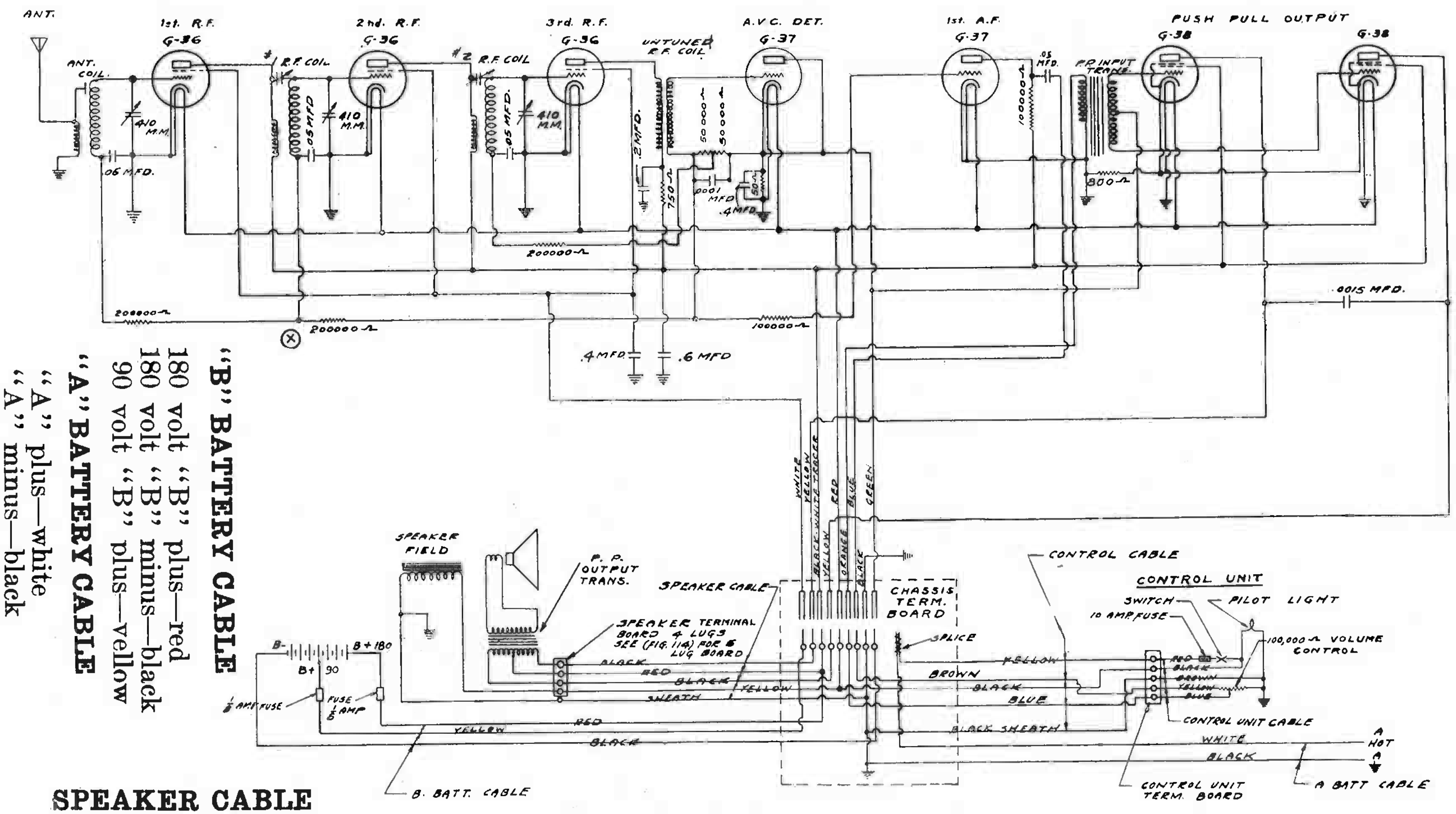


GRIGSBY-GRUNOW CO.

SCHEMATIC DIAGRAM FOR MODEL 90-B MAJESTIC CHASSIS
25-40 AND 50-60 CYCLE



GRIGSBY-GRUNOW CO.



"B" BATTERY CABLE

180 volt "B" plus—red
180 volt "B" minus—black
90 volt "B" plus—yellow

"A" BATTERY CABLE

"A" plus—white
"A" minus—black

SPEAKER CABLE

Field Supply "A" plus—yellow
Field Supply "A" minus—ground cable shield
Pentode Plates—black
Positive "B" center tap—red

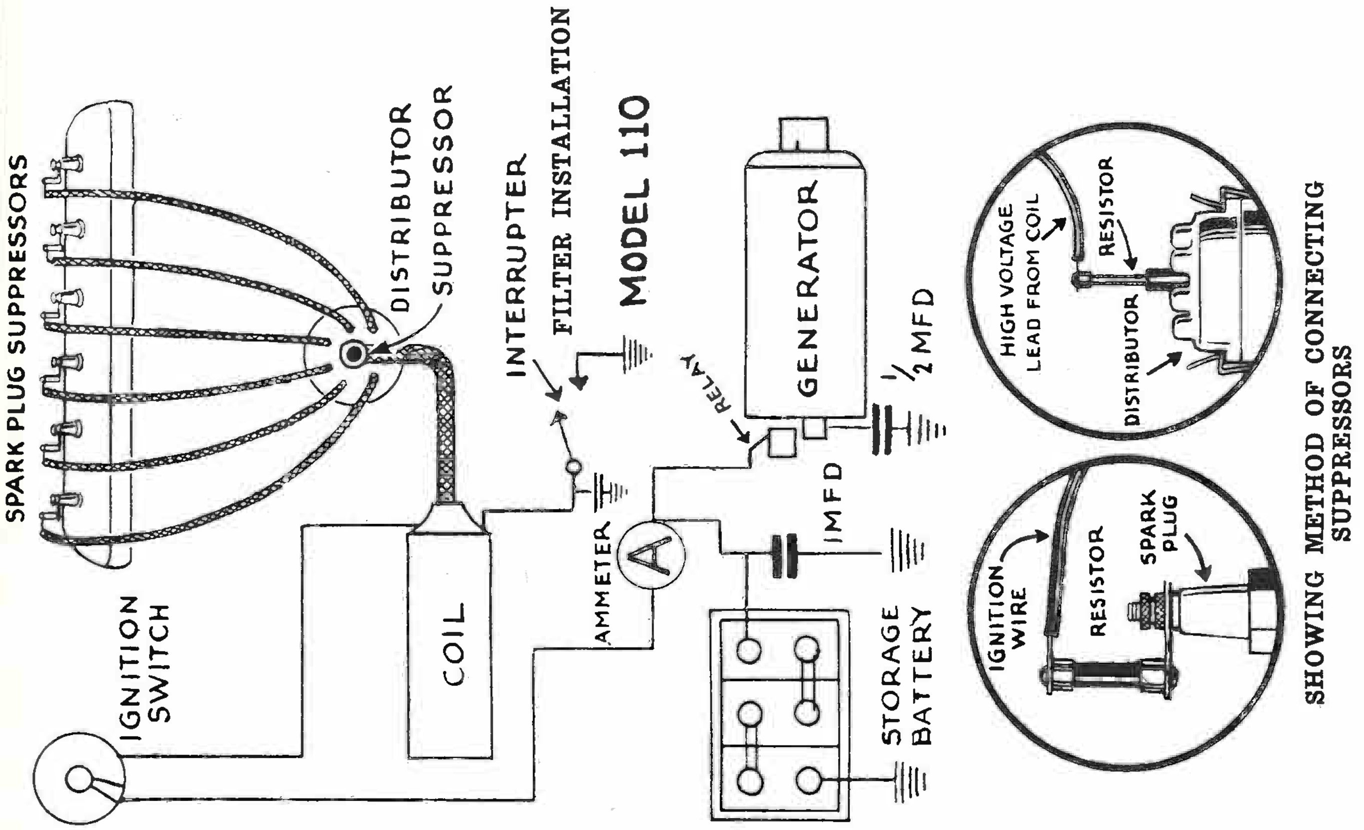
SCHEMATIC DIAGRAM MAJESTIC
AUTO RADIO
MODEL-110

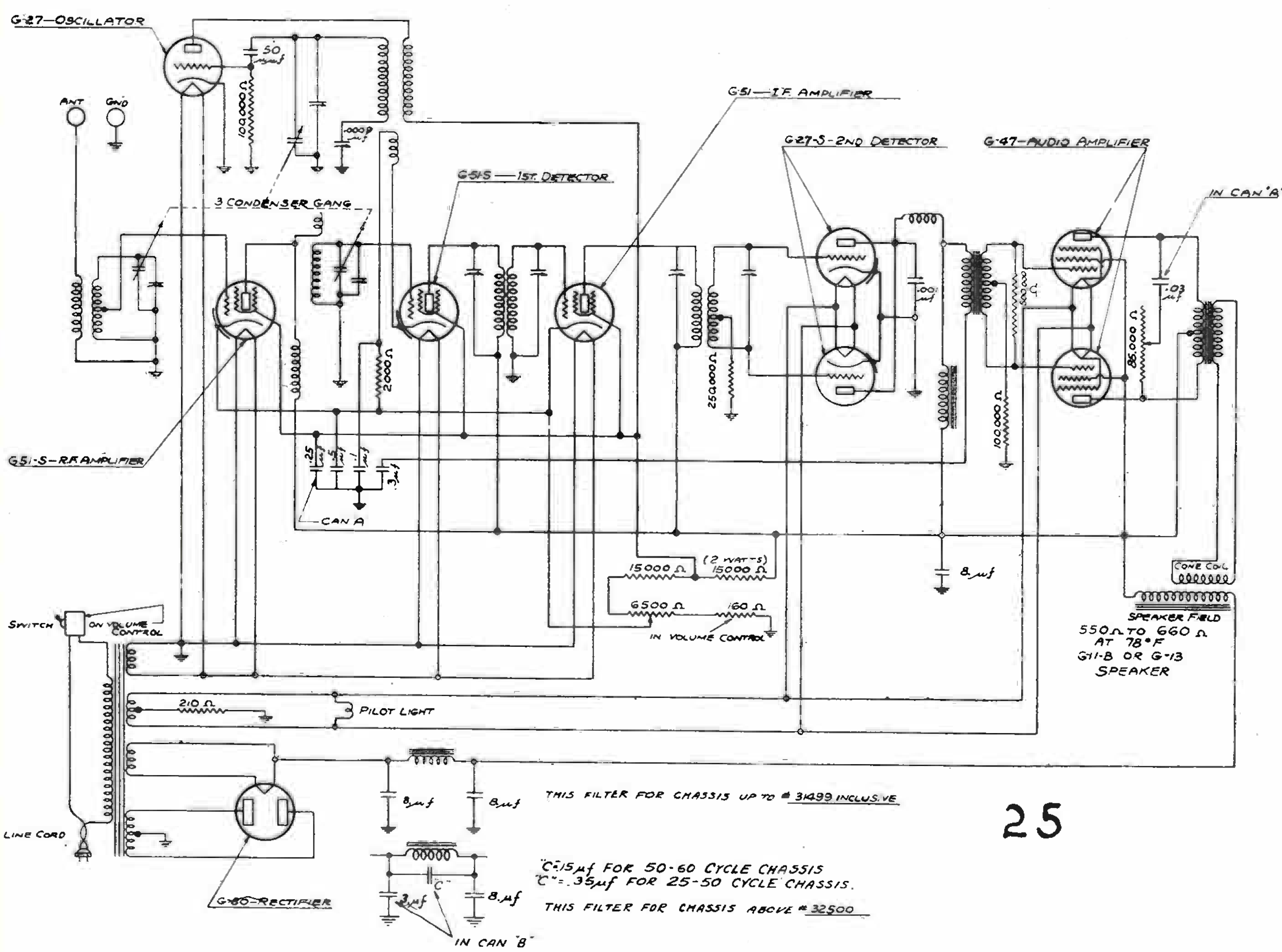
CONTROL CABLE

Switch—yellow from chassis to red from control cable.
Switch—black from chassis to black from control cable.
Volume control—Center Arm—blue from chassis to blue from control cable.
Right stop (high side)—brown from chassis to yellow from control cable.
Left Stop (low side)—Control cable shield ground.

All leads marked "A" plus in color code of the Service Manual signify the ungrounded side of the car battery, and not necessarily the positive side.

GRIGSBY-GRUNOW CO.

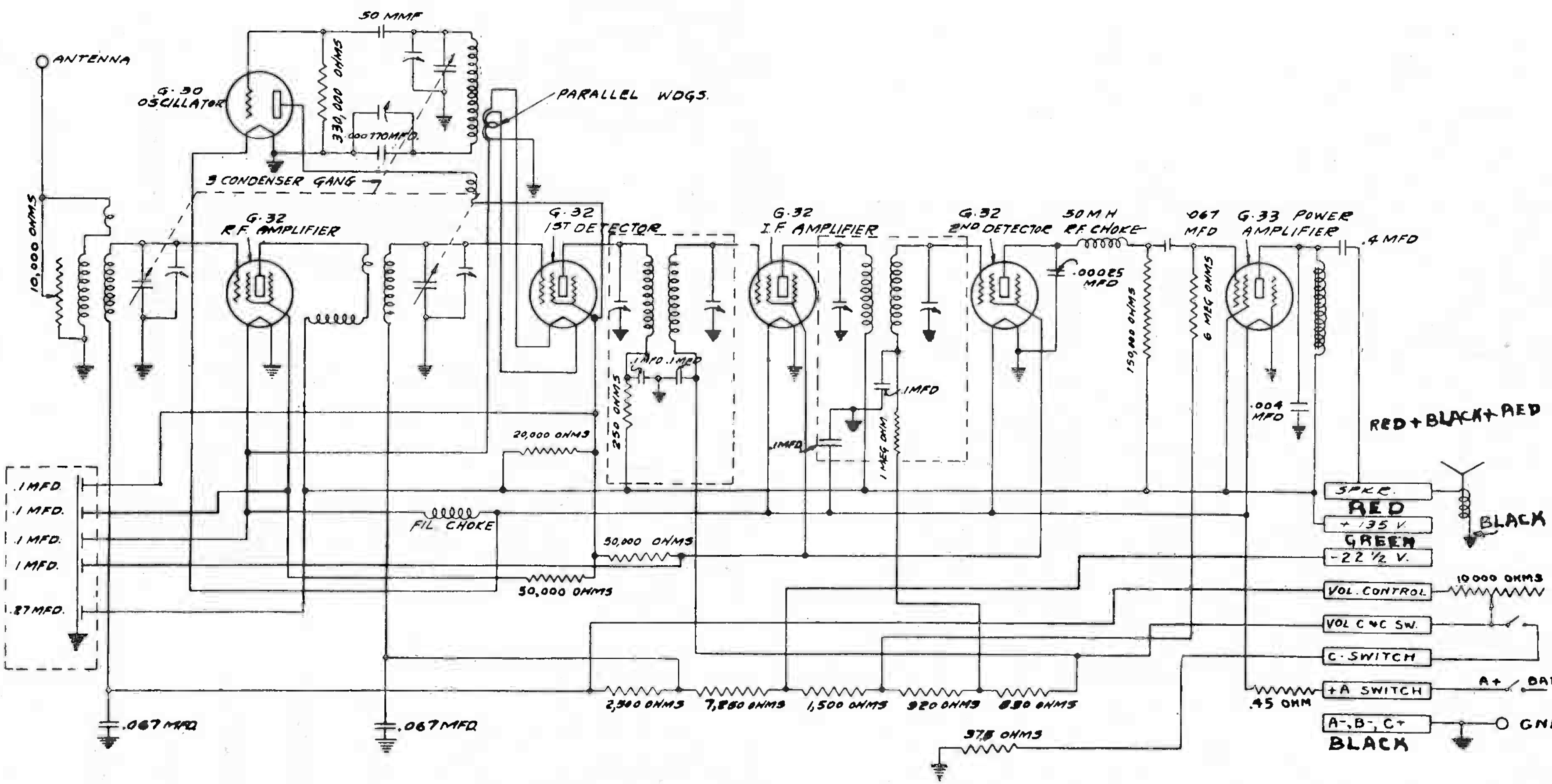




25

GRIGSBY-GRUNOW CO.

HOME BATTERY RECEIVER MODEL -120



BIAS VOLTAGES

Volume Control at Maximum	
R. F.	3 volts
Osc.	0 volts
1st Det.	8 volts
I. F.	3 volts
2nd Det.	8 volts
Pentode	13.5 volts

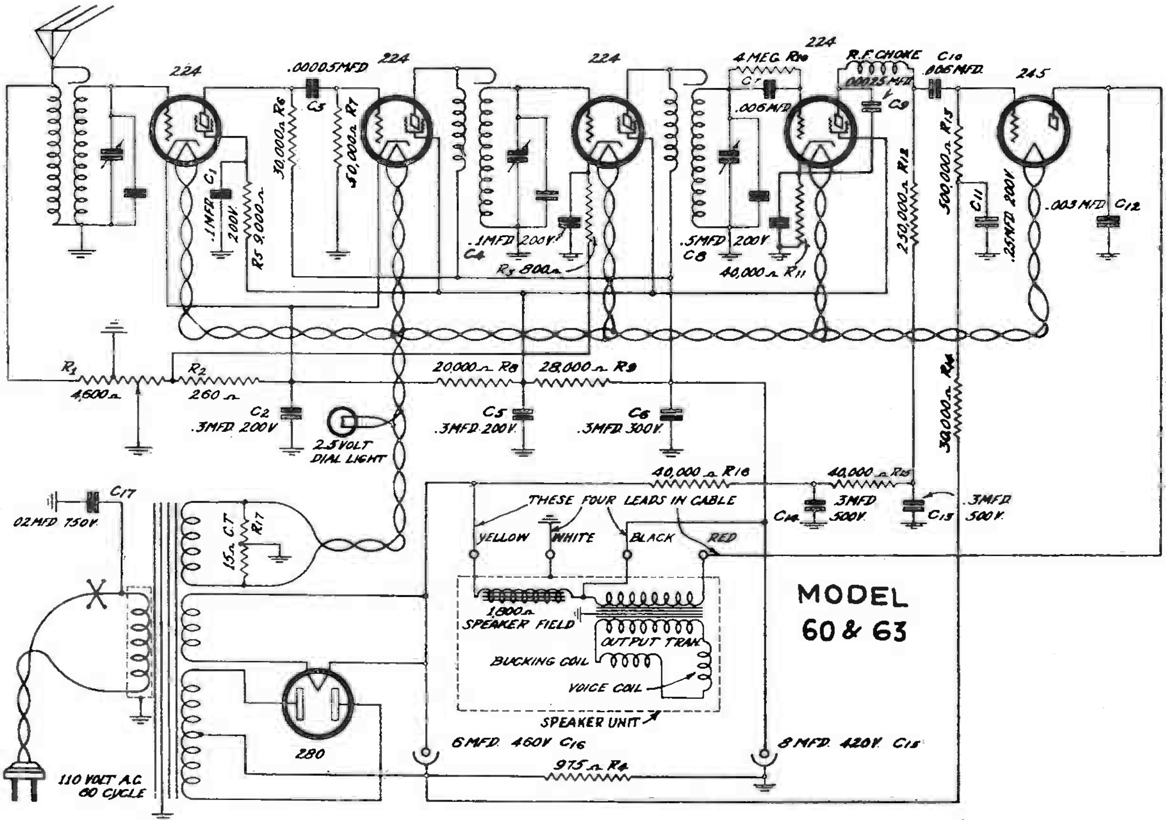
Volume Control at Minimum	
R. F.	11 volts
Osc.	0 volts
1st Det.	14 volts
I. F.	3 volts
2nd Det.	8 volts
Pentode	13.5 volts

COLOR CODE

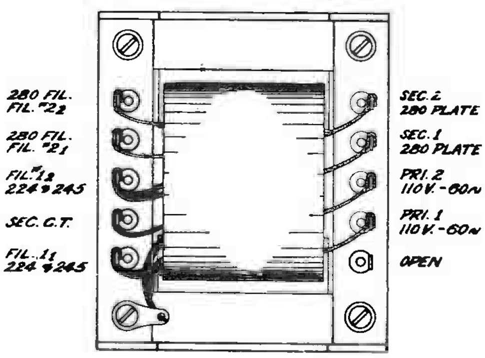
Volume Control and Switch Connections

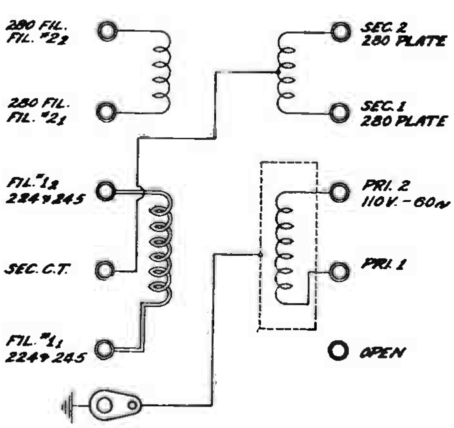
Antenna section of volume control—Red and Black.
"C" bias section of volume control—Blue and Yellow.
"A" battery side of switch—Red.
Jumper switch to volume control—Blue.
Switch to "C" bias—White.

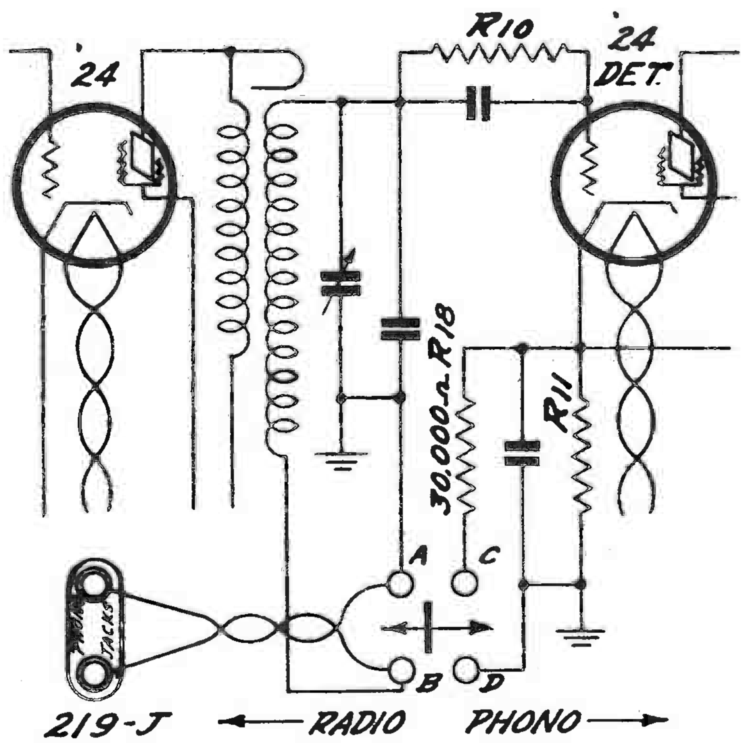
GULBRANSEN COMPANY



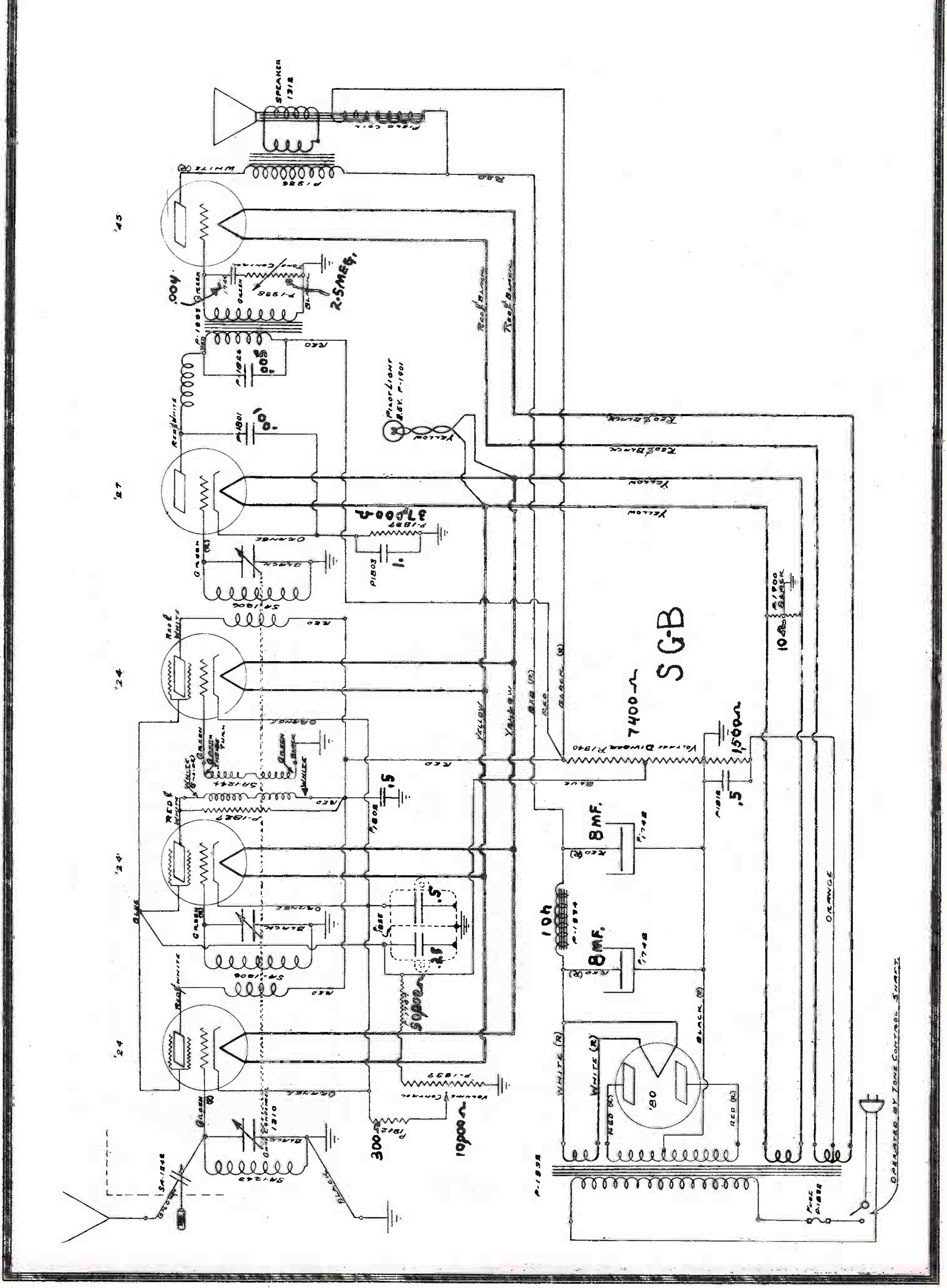
MODEL
60 & 63



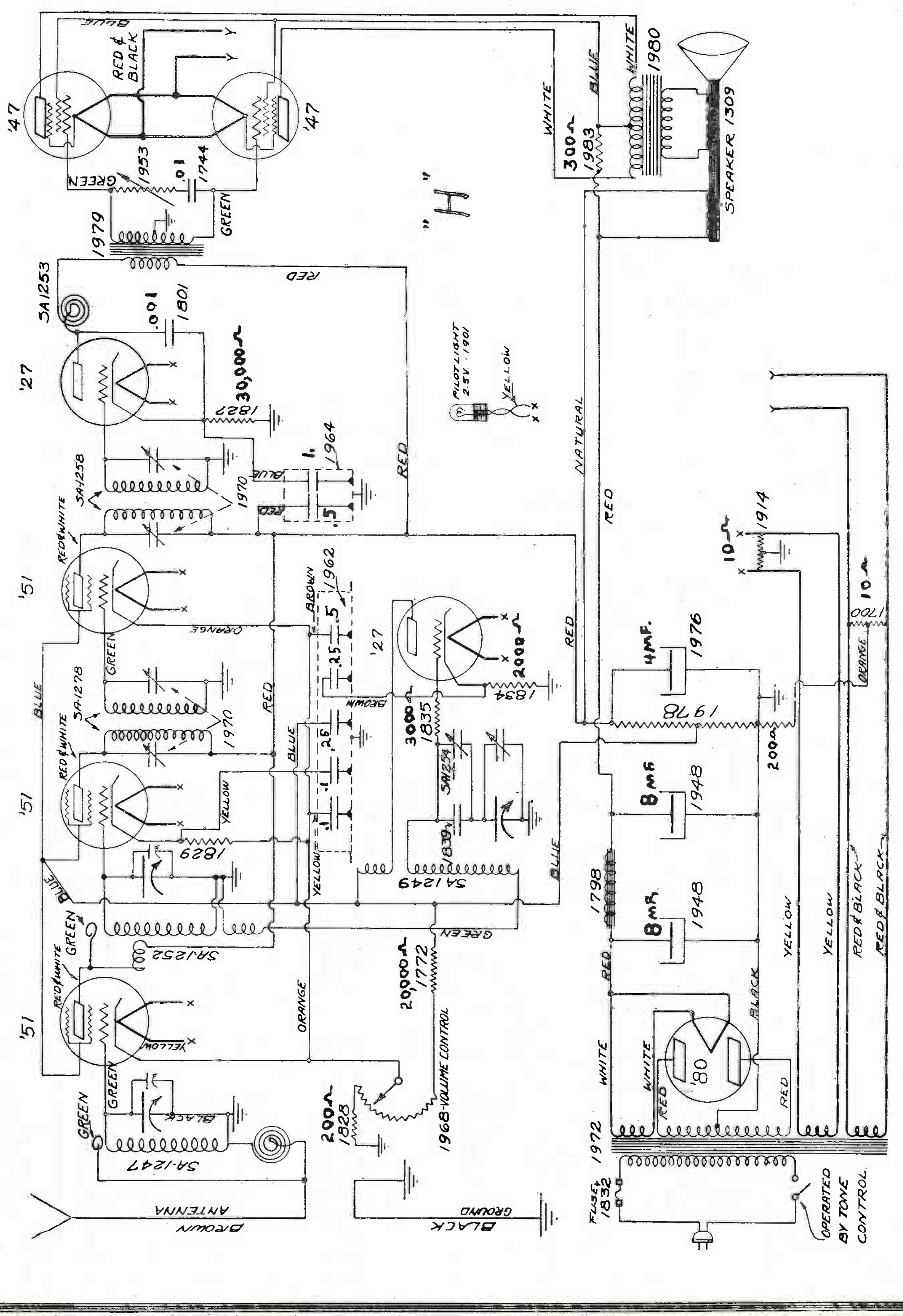




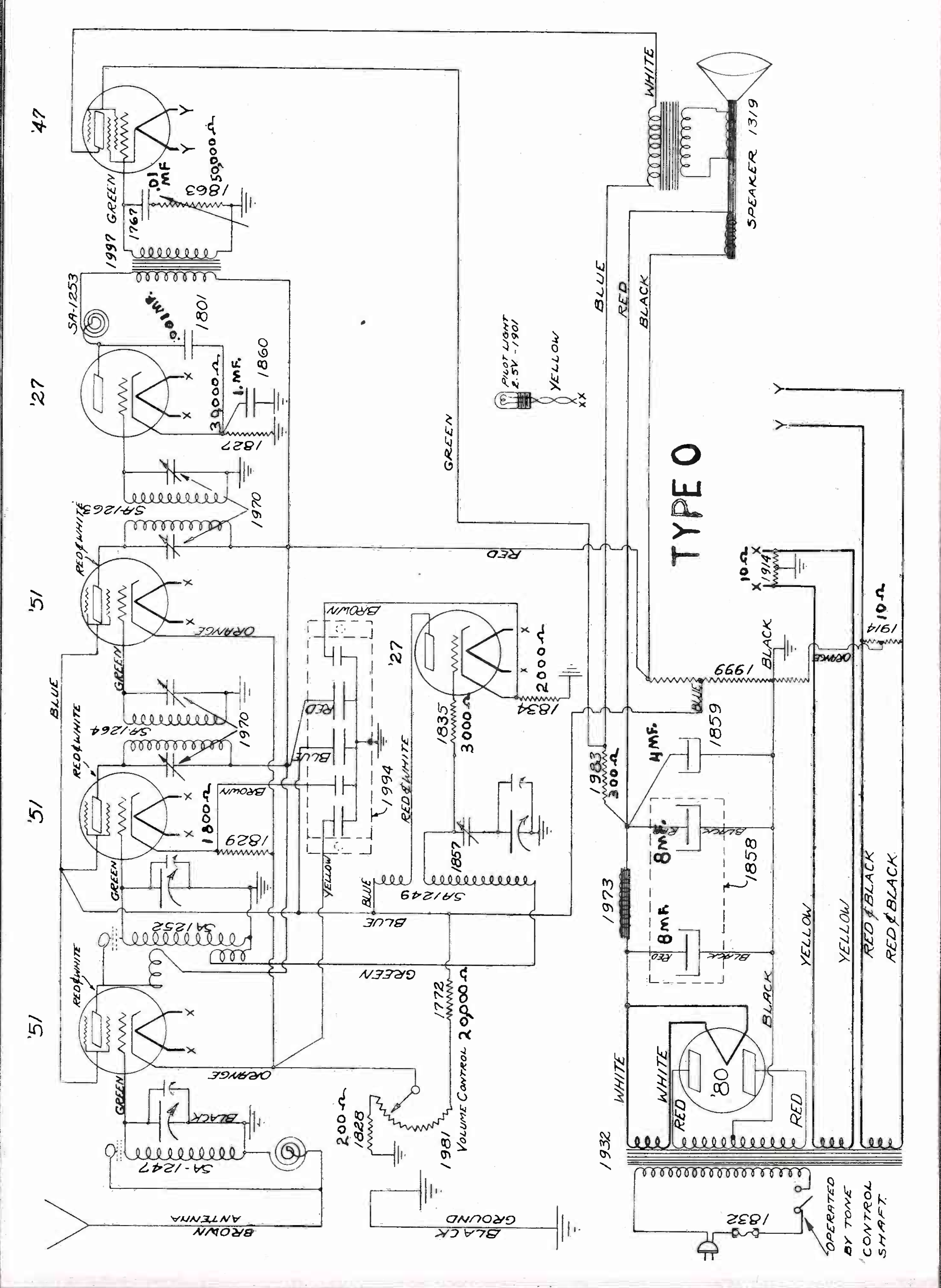
HOWARD RADIO COMPANY



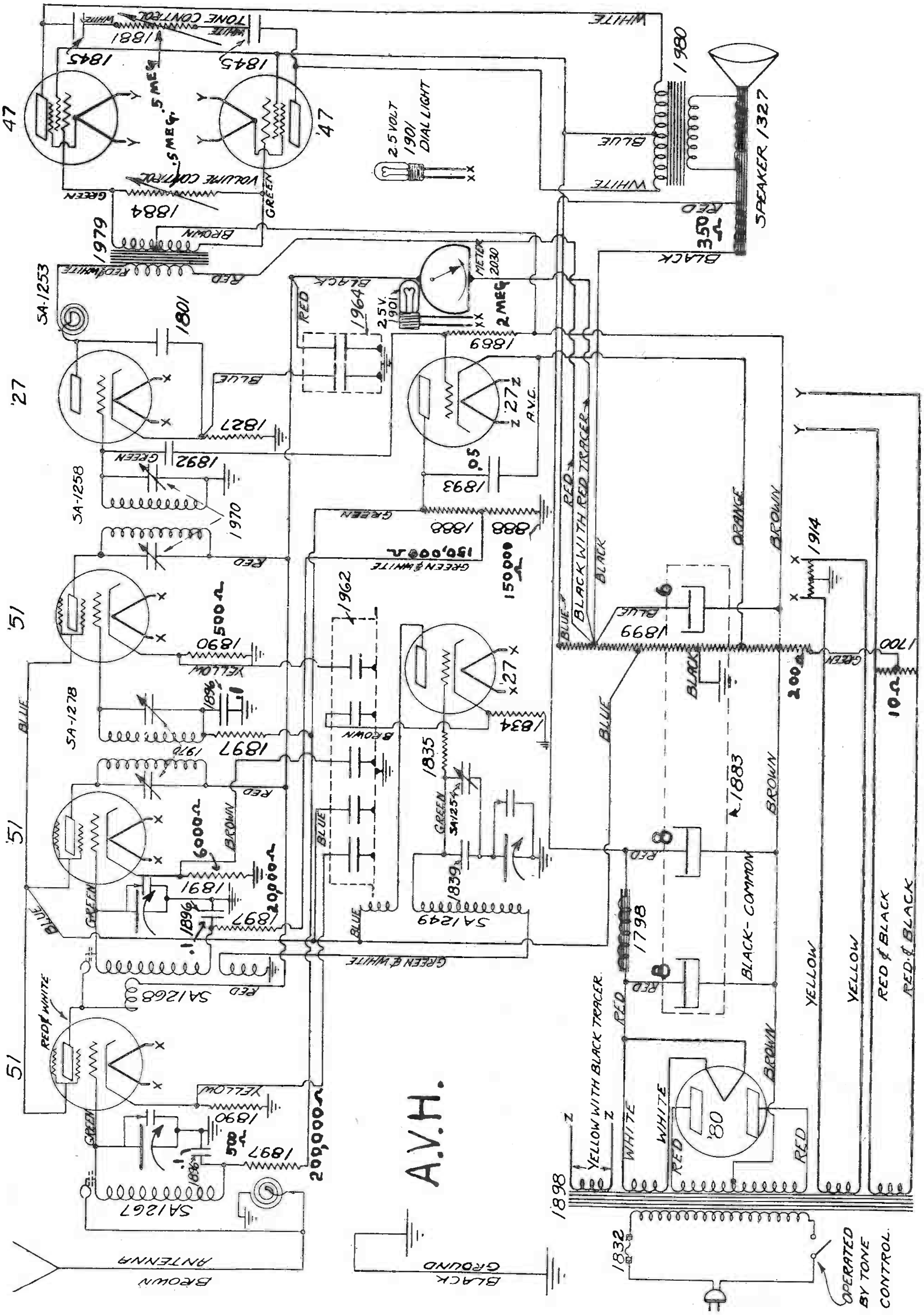
HOWARD RADIO COMPANY



HOWARD RADIO COMPANY



HOWARD RADIO COMPANY



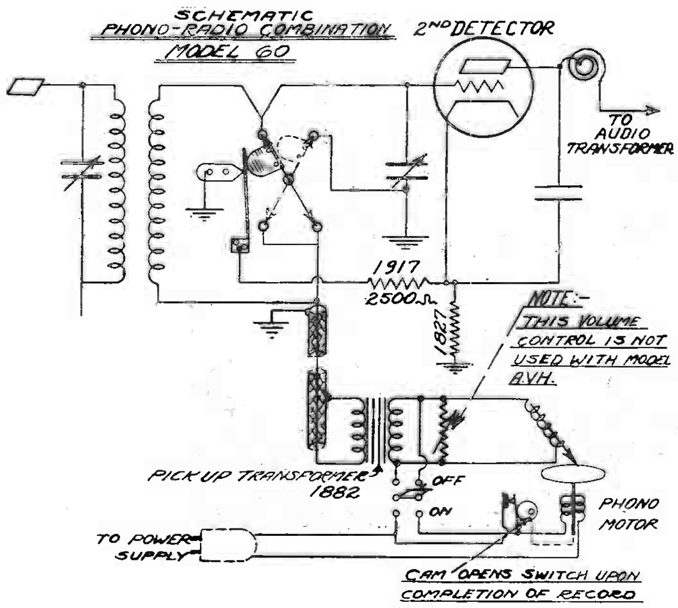
HOWARD RADIO COMPANY

HOWARD A.V.C. SERVICE NOTES FOR A.V.H. RECEIVER

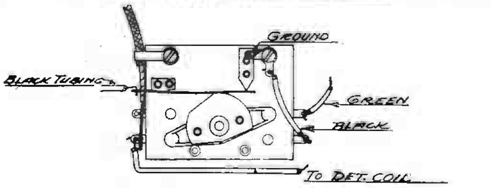
In the interest of obtaining best results with the Automatic Volume Control receiver it is important that the control tube (type 227) be a selected tube, -- one which has a definite plate current cutoff when tested at 180 volts plate and 20 volts bias on the grid. This cutoff should be less than 5 microamperes. If you do not have any means for checking the tube, in the form of a special tube tester, an immediate check for tube performance can be obtained in the set itself. For instance, disconnect the antenna and short circuit the aerial lead, leaving the control tube out of the socket, and note the swing of the tuning meter. Then insert the tube in the socket and if it is a good automatic volume control tube, there should be no change in the position of the pointer on the tuning meter. If there is a change in the position of the tuning meter pointer, namely, a swing toward the right, it is an indication that the automatic volume control tube does not have a definite plate cutoff, but it is drawing plate current and consequently, the bias voltage on the regular RF and IF tubes has been raised, with the consequent cutting down in plate current.

It might be a good point to mention at this time that the tuning meter in a 13 milliampere full scale reading meter and that it is connection in series with the B plus lead that furnishes voltage for the RF, first detector and IF tubes. In view of the fact that this tuning meter is in series with the plates of the amplifying tubes, you can very readily note whether or not the control tube is functioning in a proper manner, by noting the performance of said tube by its reaction on the plate current of the respective tubes as shown by the swing of the pointer on the tuning meter.

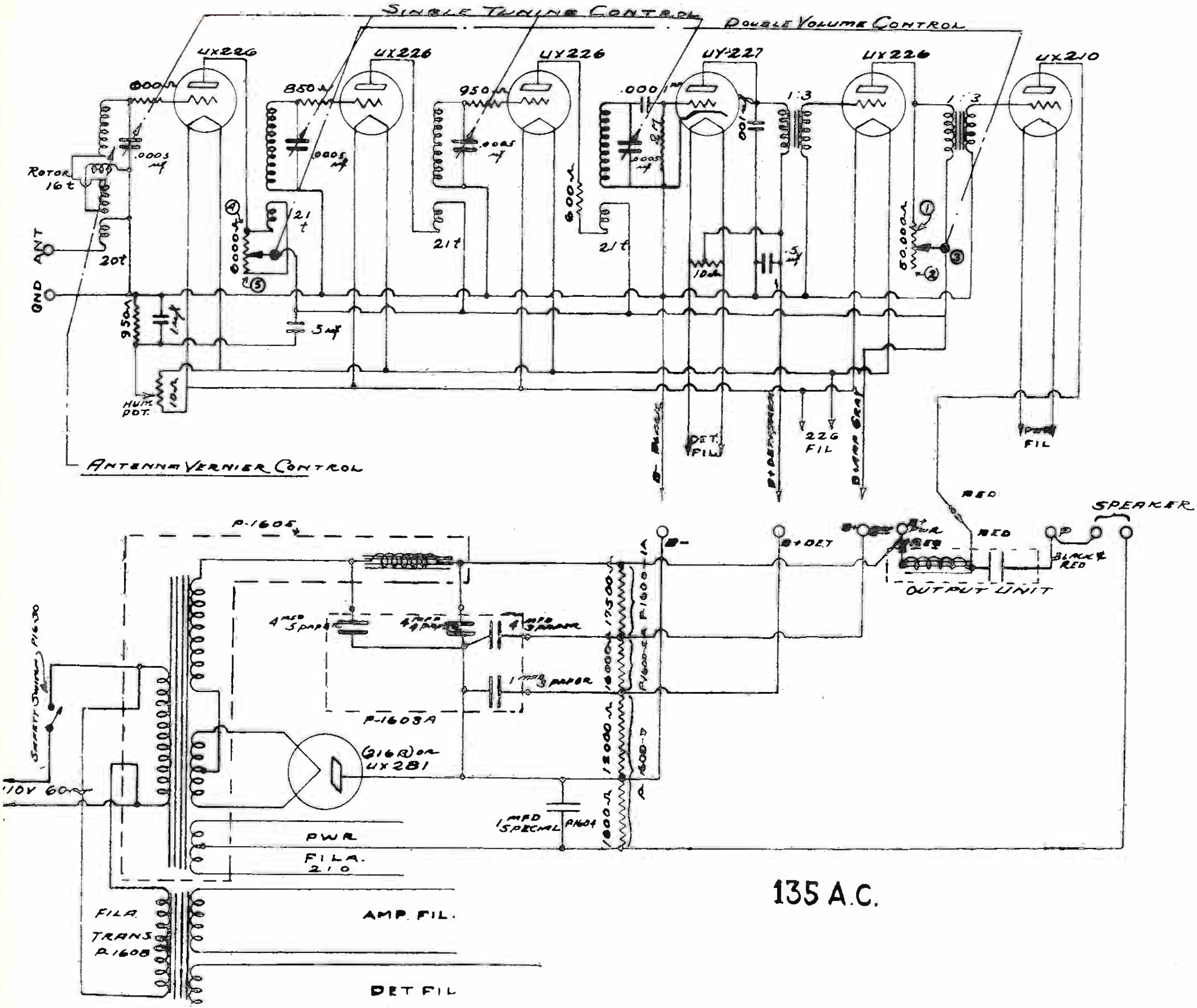
For further information with reference to this receiver, special mention is made of the fact that the speaker furnished with this receiver is different from the regular speaker furnished with the Model 35 and 40 receivers. The difference lies in the fact that the Model 45 speaker has a 350 ohm field, and as such it cannot be used with the Model 35 and 40 receivers. Please note this fact in order to prevent trouble in the future with reference to service troubles which may arise due to the use of the wrong type speaker.



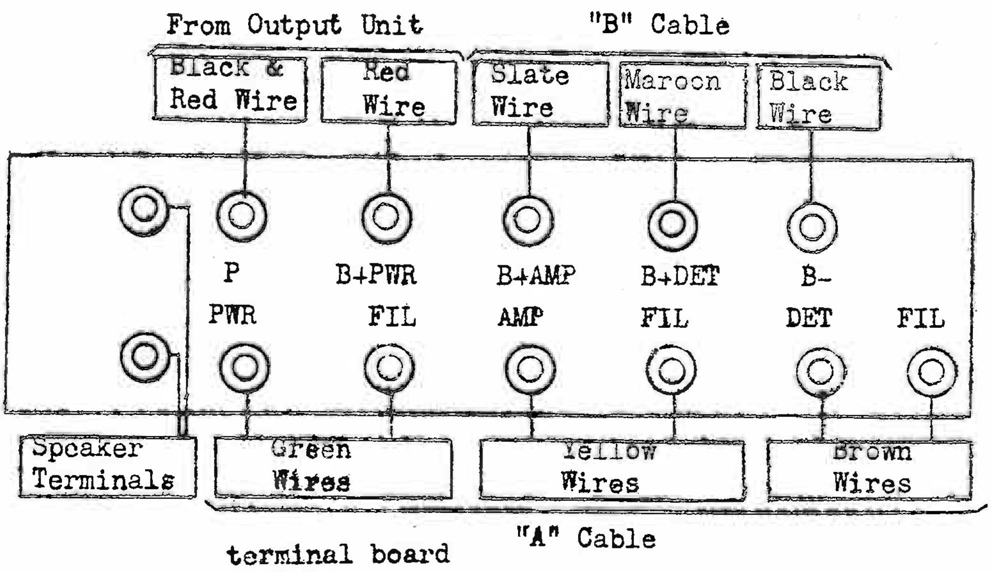
PICTORIAL VIEW OF THE ABOVE SWITCH ACTION.



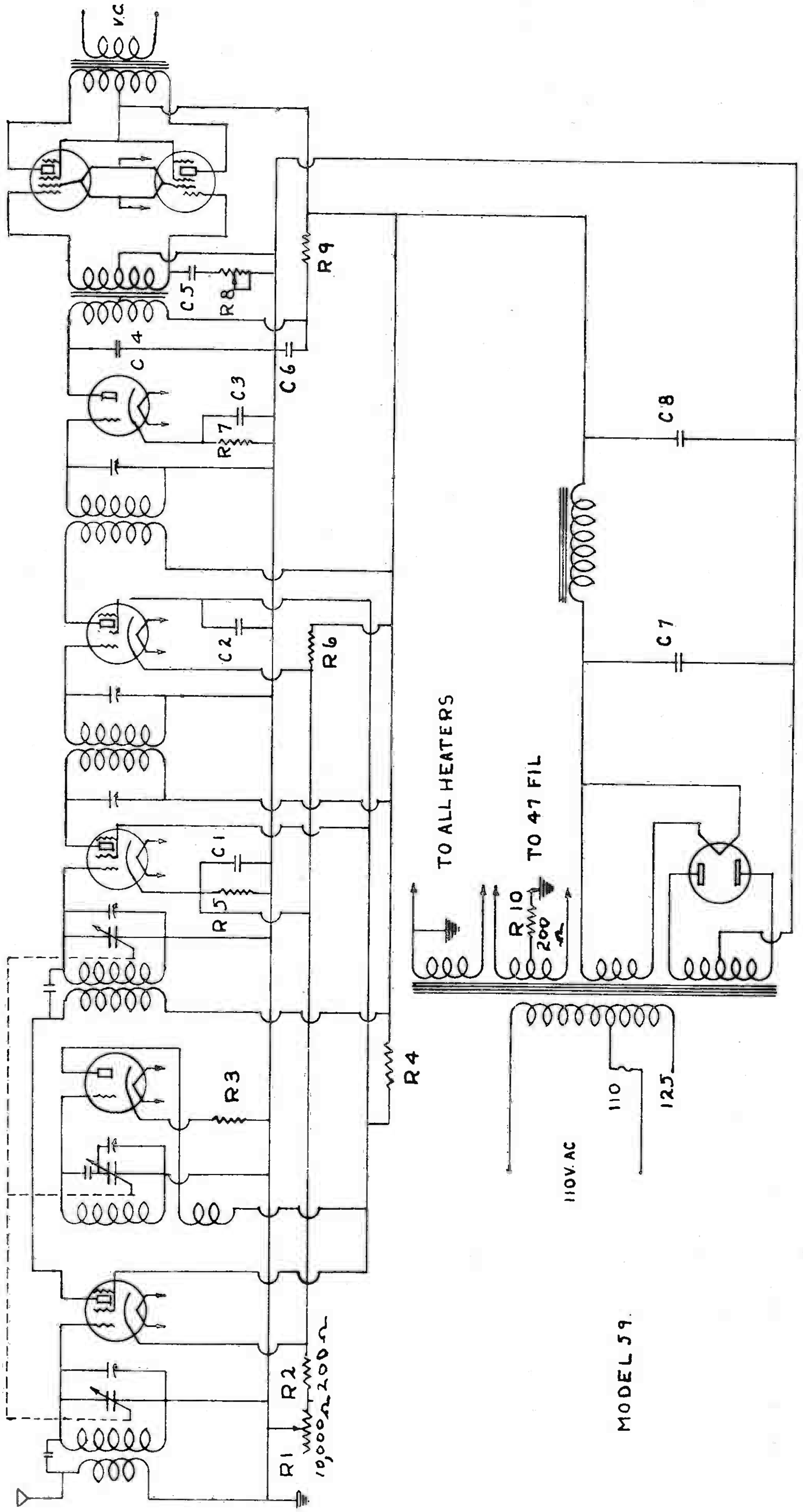
HOWARD RADIO COMPANY



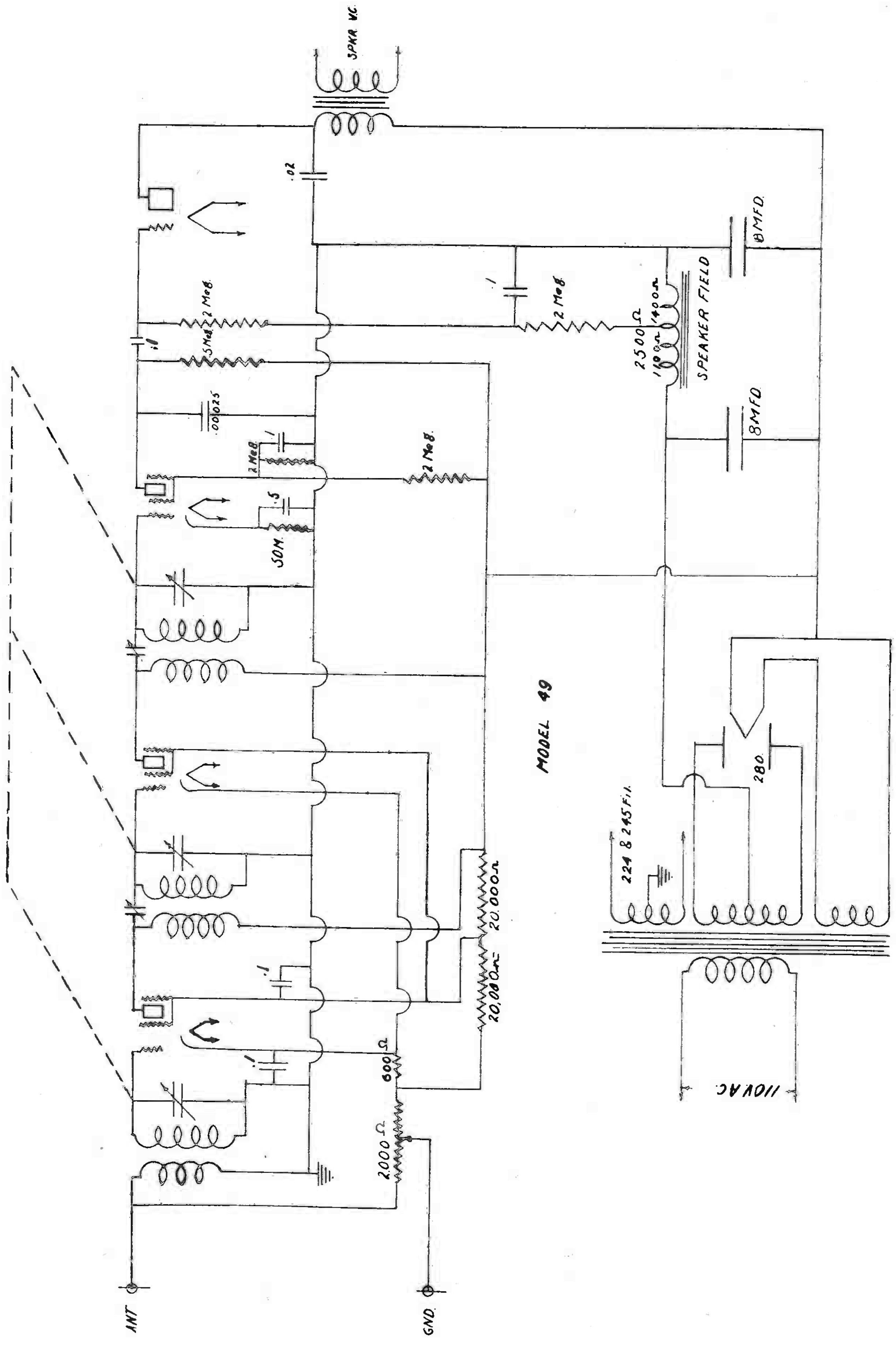
135 A.C.



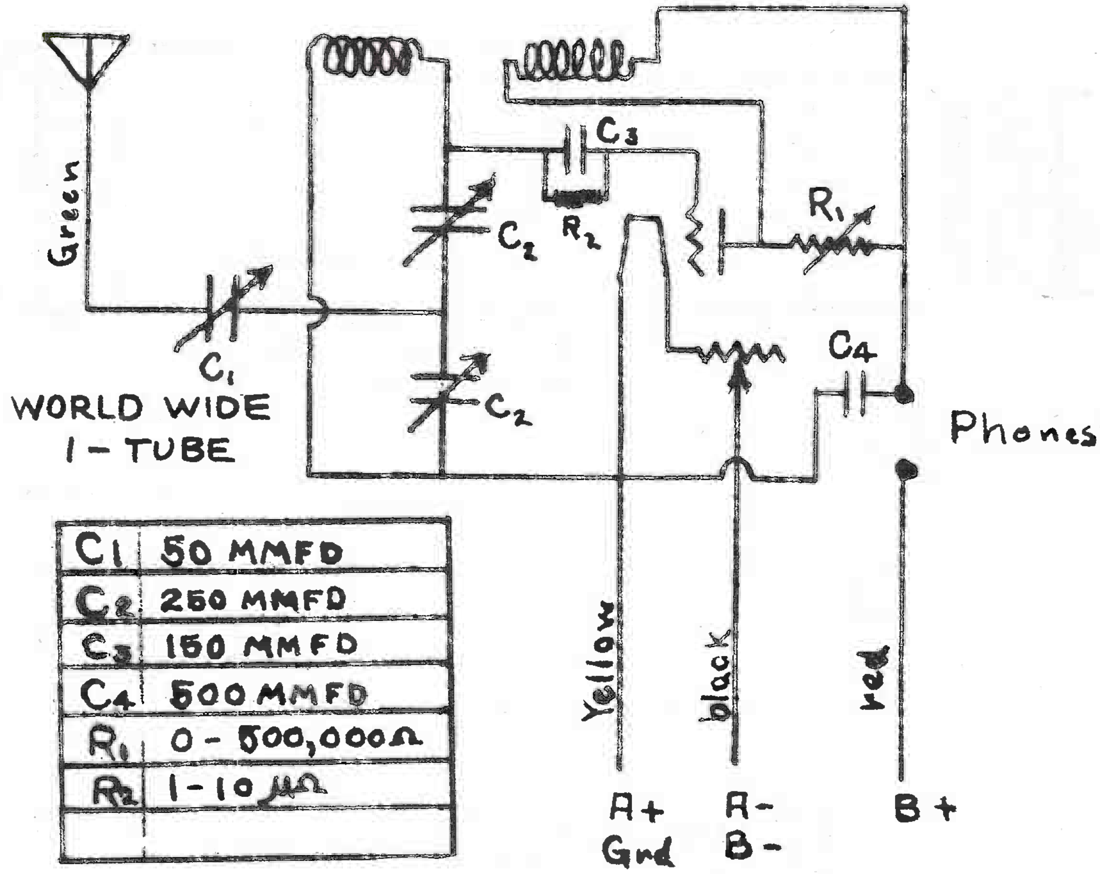
HORN RADIO CO.



HORN RADIO CO.

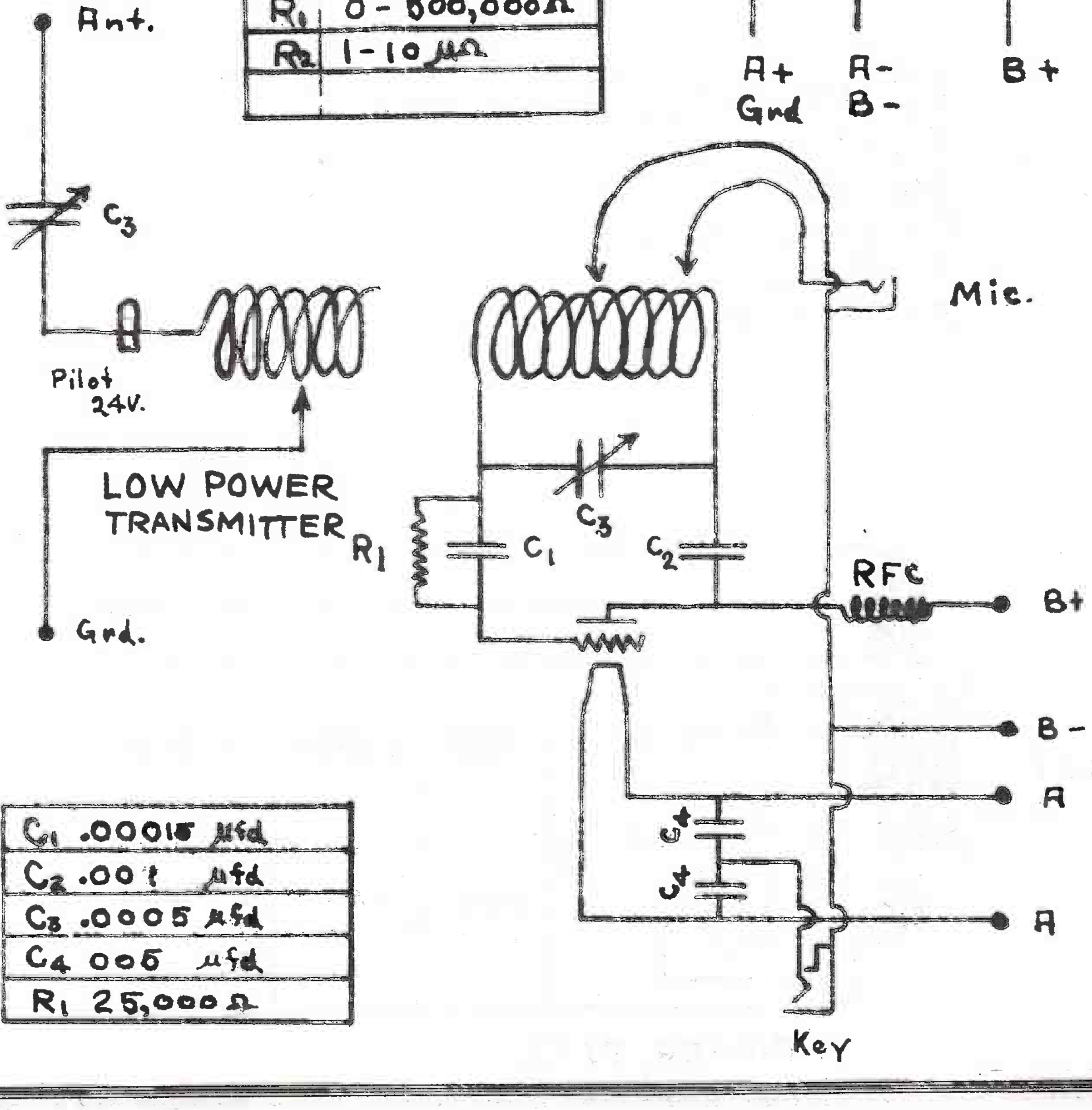


CHAS. HOODWIN CO.



WORLD WIDE
1-TUBE

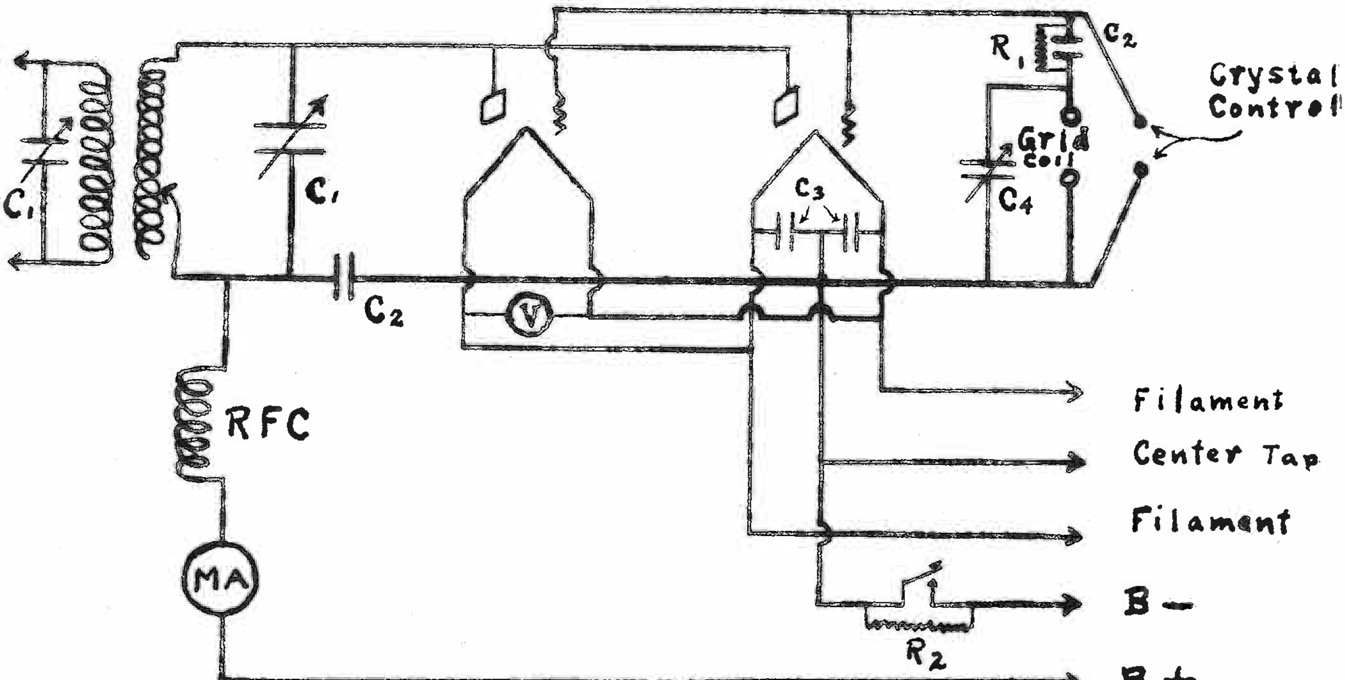
C1	50 MMFD
C2	250 MMFD
C3	150 MMFD
C4	500 MMFD
R1	0 - 500,000Ω
R2	1-10 μΩ



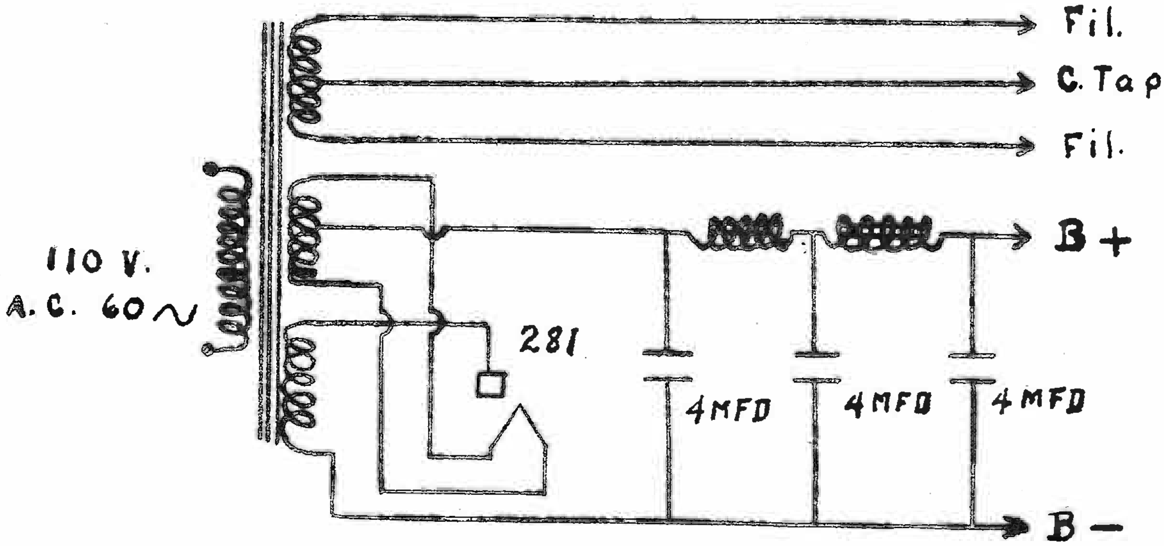
LOW POWER
TRANSMITTER

C1	.00015 μfd
C2	.001 μfd
C3	.0005 μfd
C4	005 μfd
R1	25,000 Ω

CHAS. HOODWIN CO.

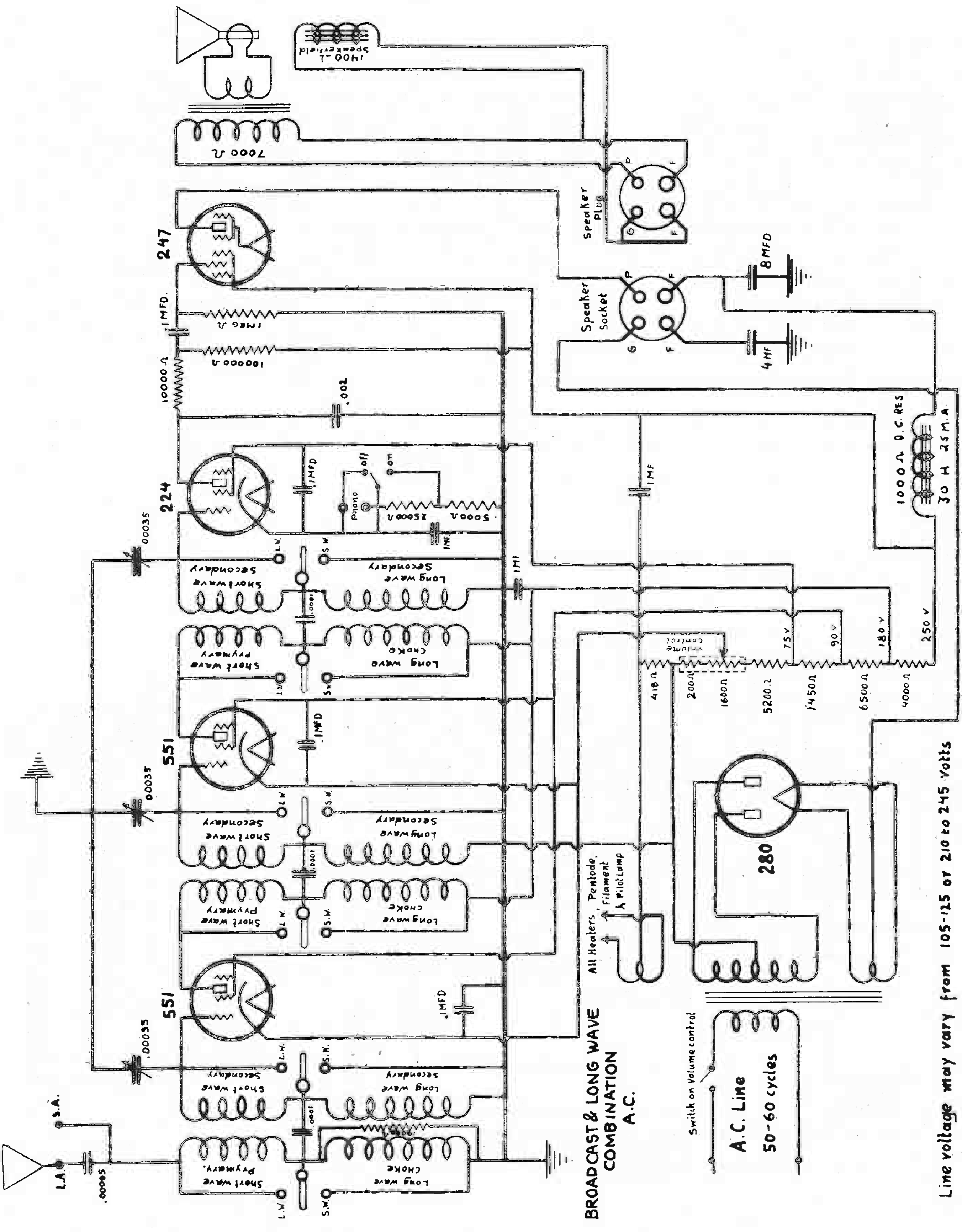


C_1	.0007 MFD
C_2	.00025 MFD
C_3	.005 MFD
C_4	.0001 MFD
R_1	25,000 Ω
R_2	20,000 Ω

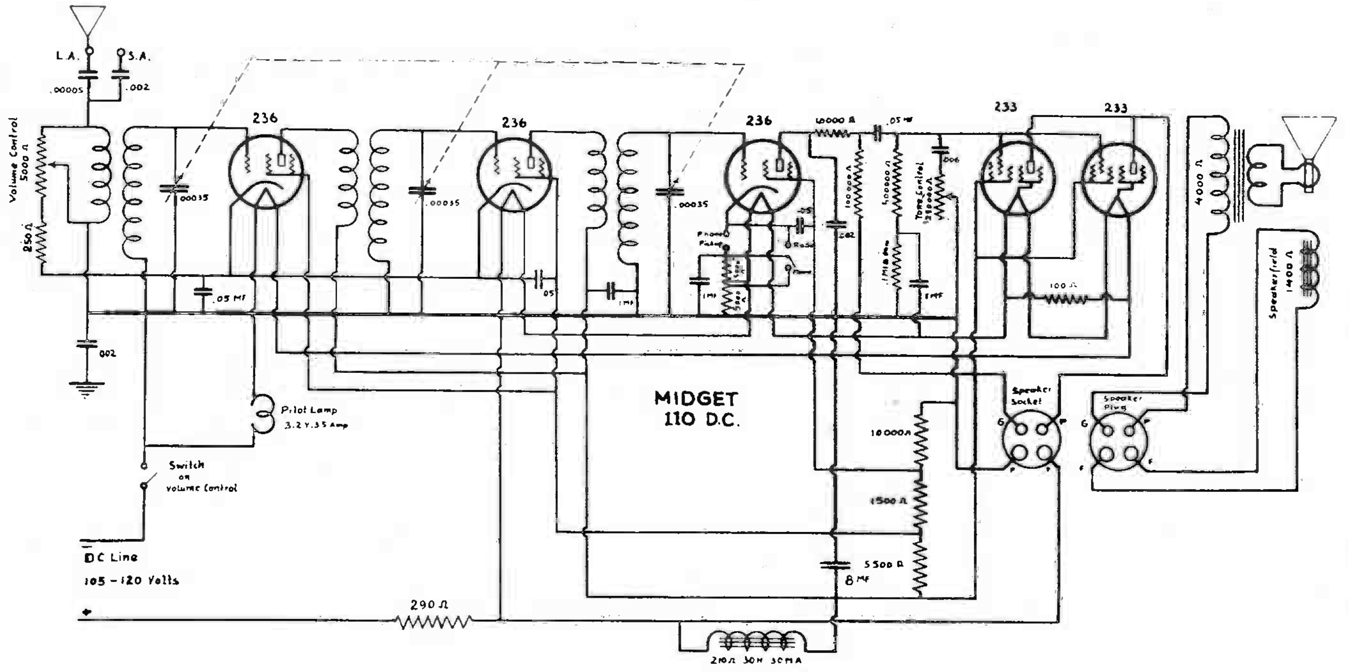


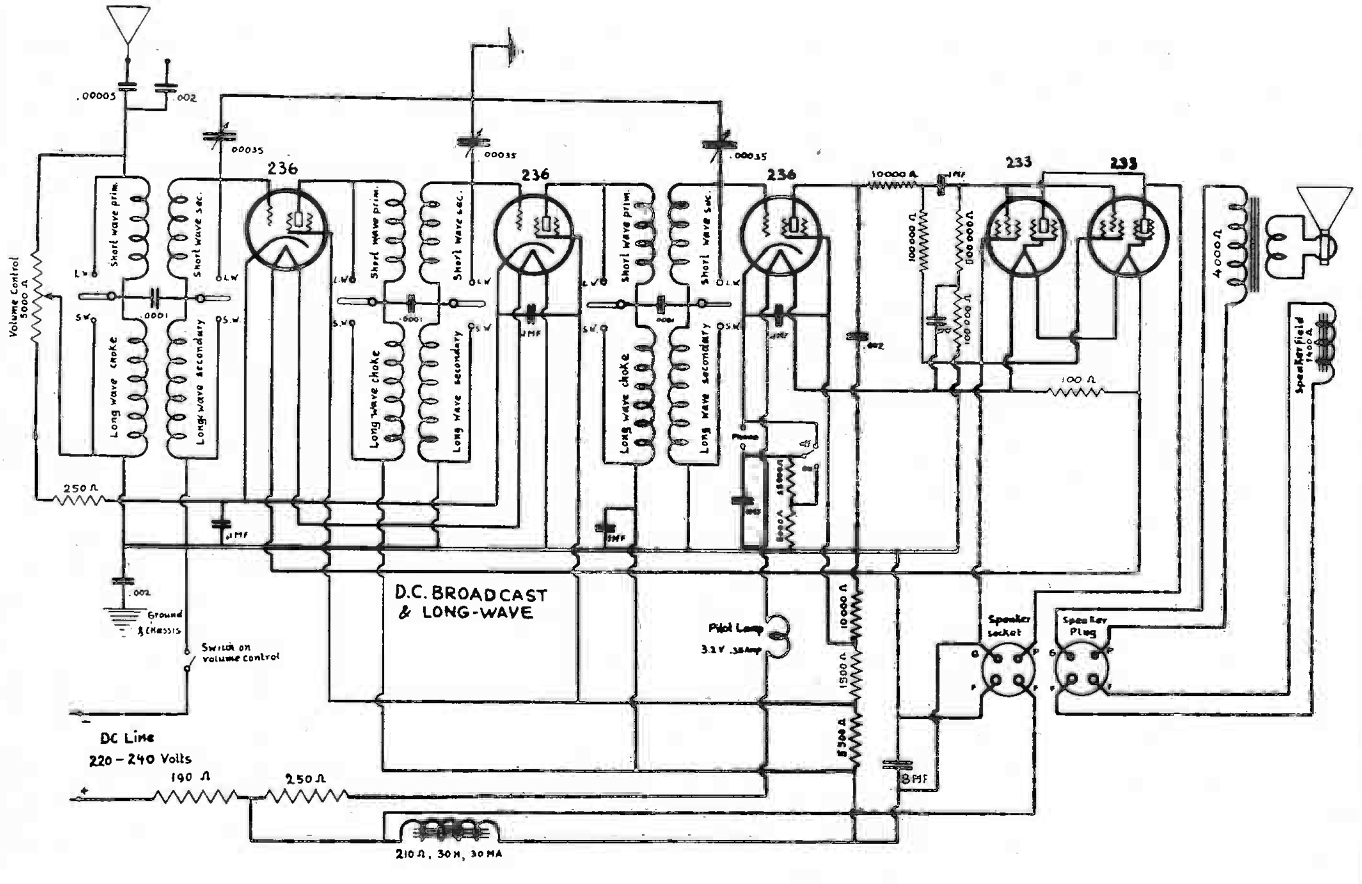
POWER PACK

INSULINE CORPORATION OF AMERICA

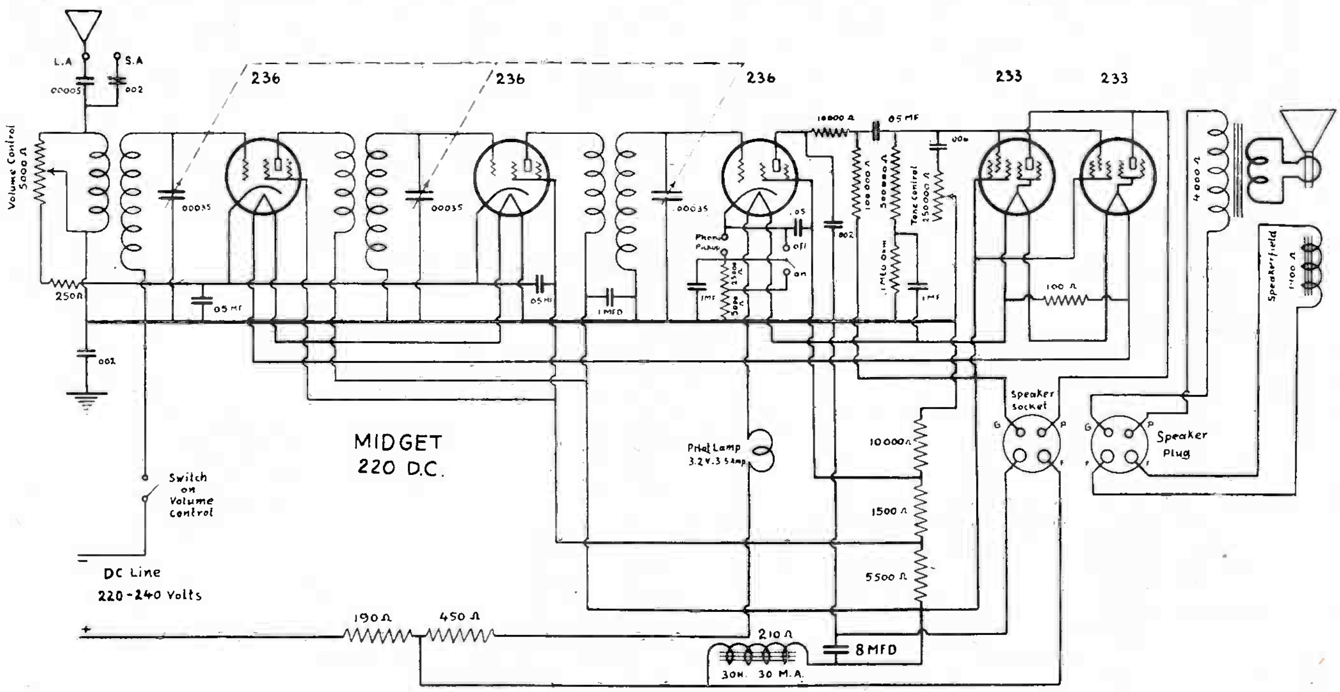


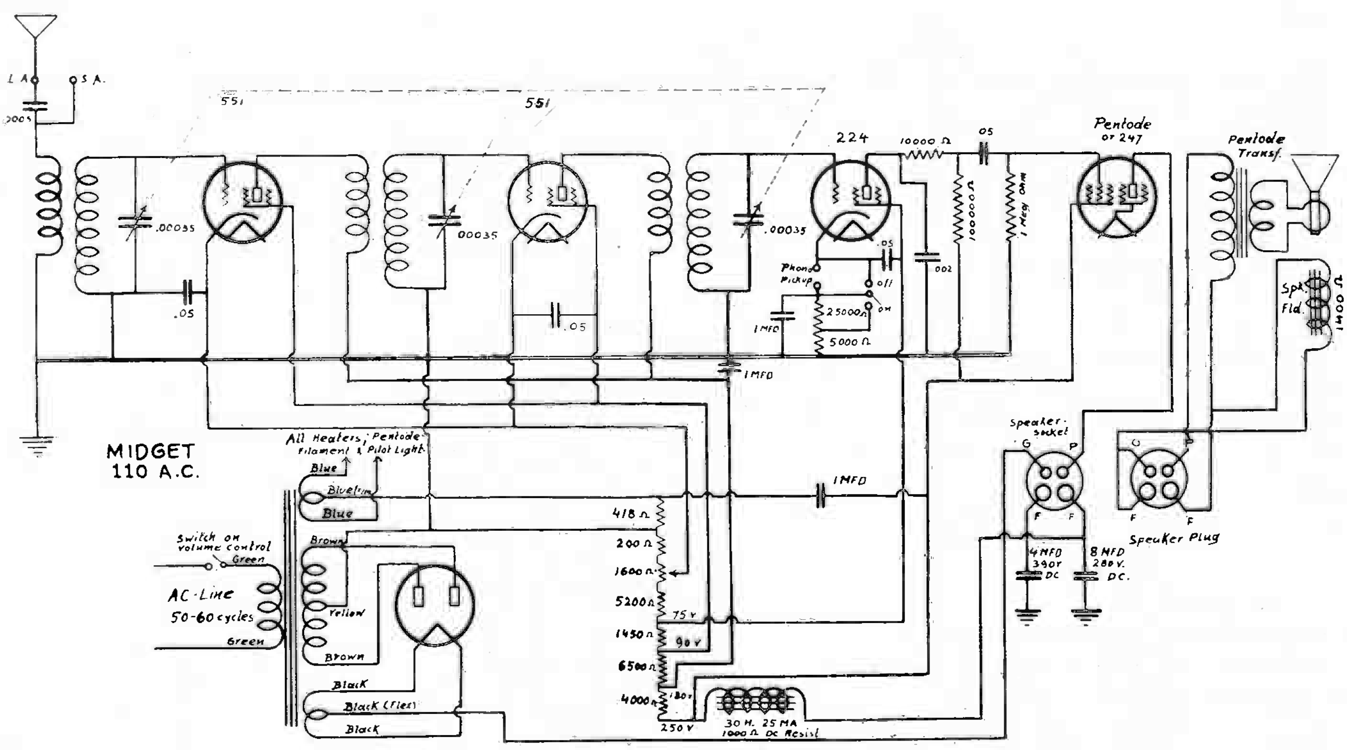
INSULINE CORPORATION OF AMERICA





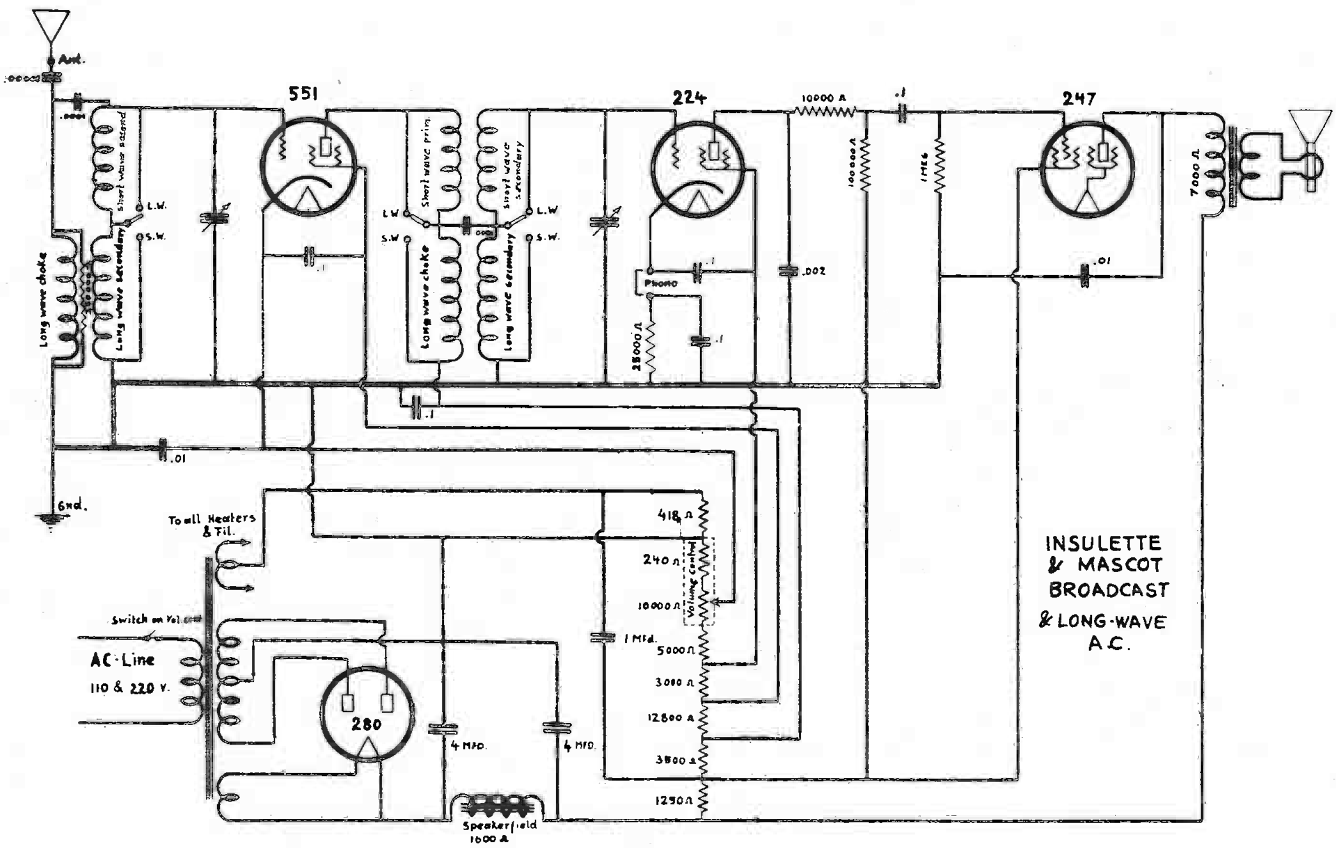
INSULINE CORPORATION OF AMERICA



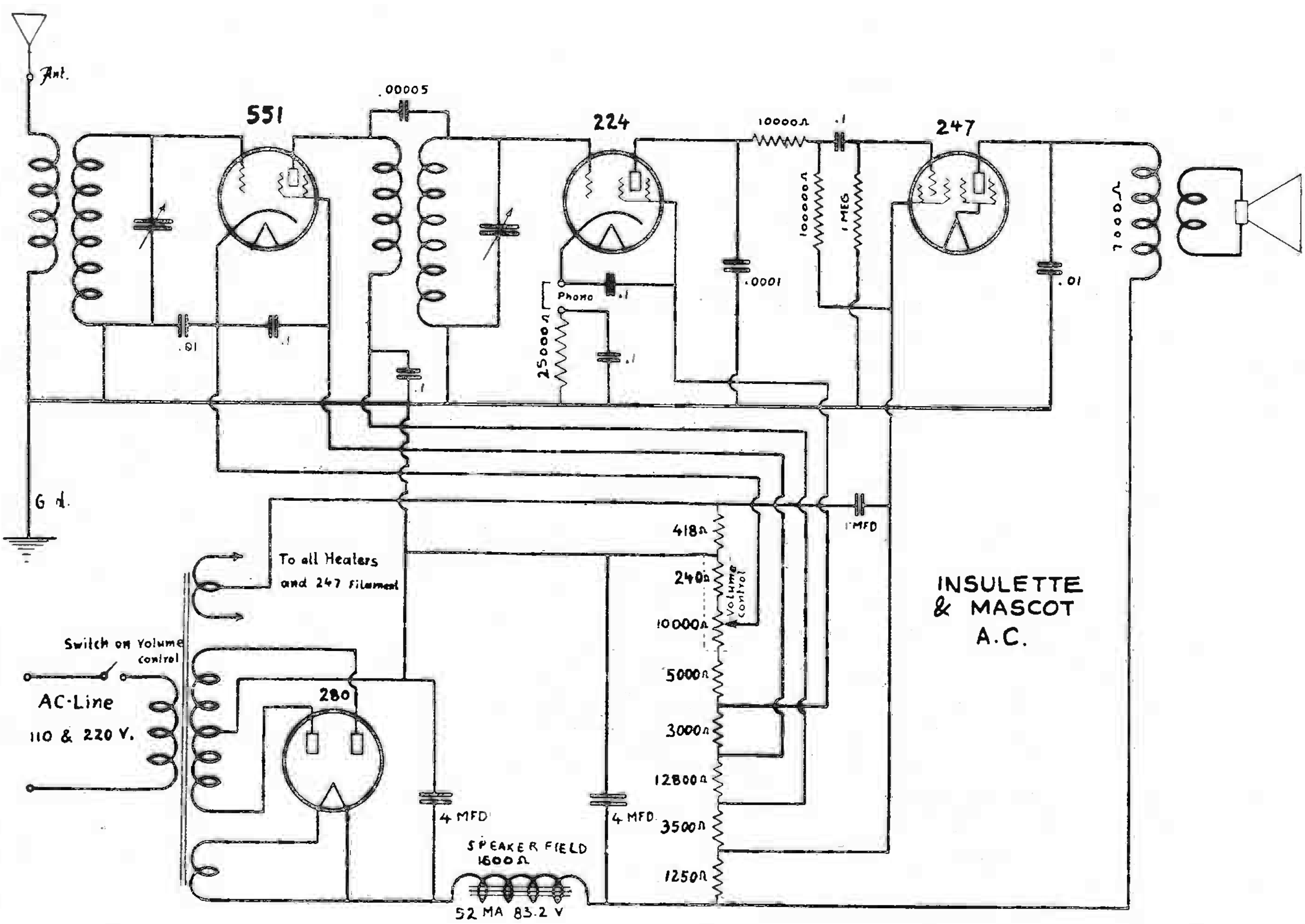


Line Voltage may safely vary between 105-120 Volts or 205-250 Volts

INSULINE CORPORATION OF AMERICA

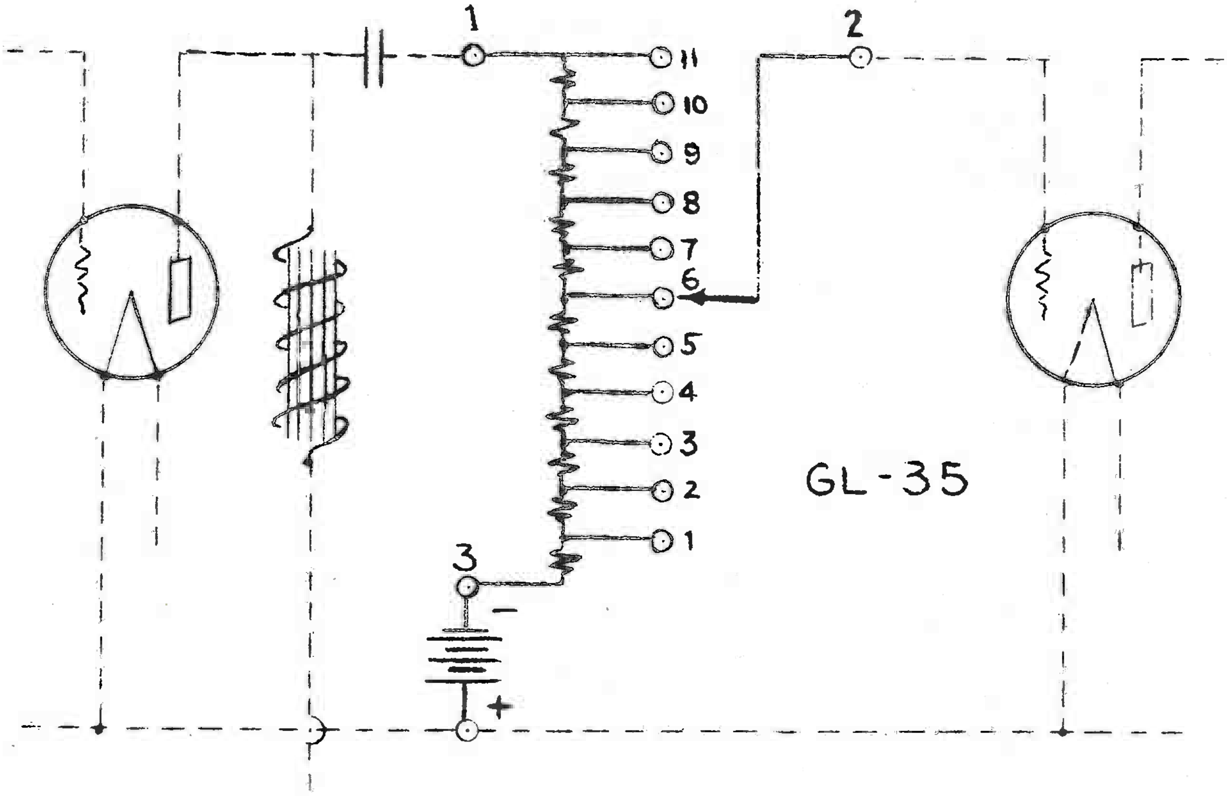


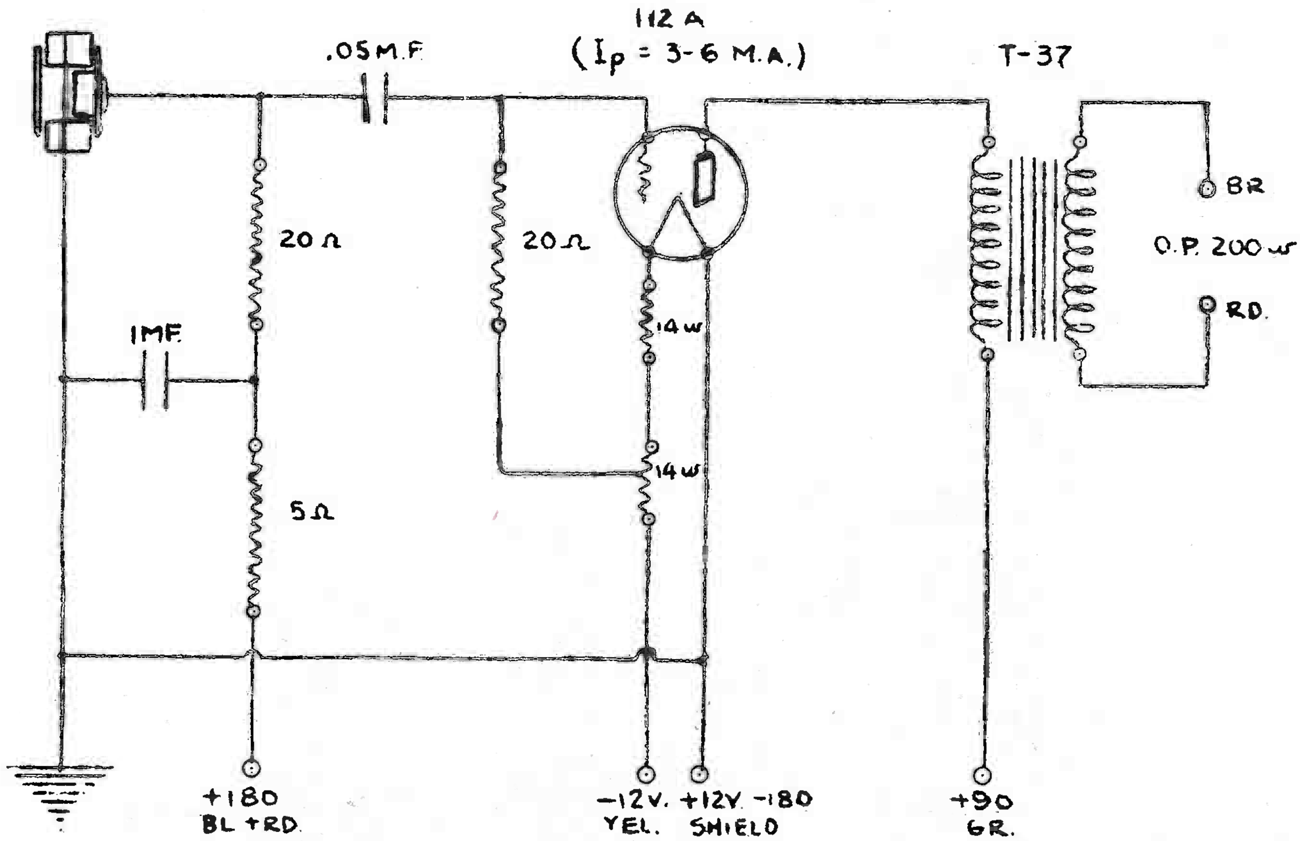
INSULETTE & MASCOT BROADCAST & LONG-WAVE A.C.



INSULETTE & MASCOT A.C.

JENKINS AND ADAIR, INC.

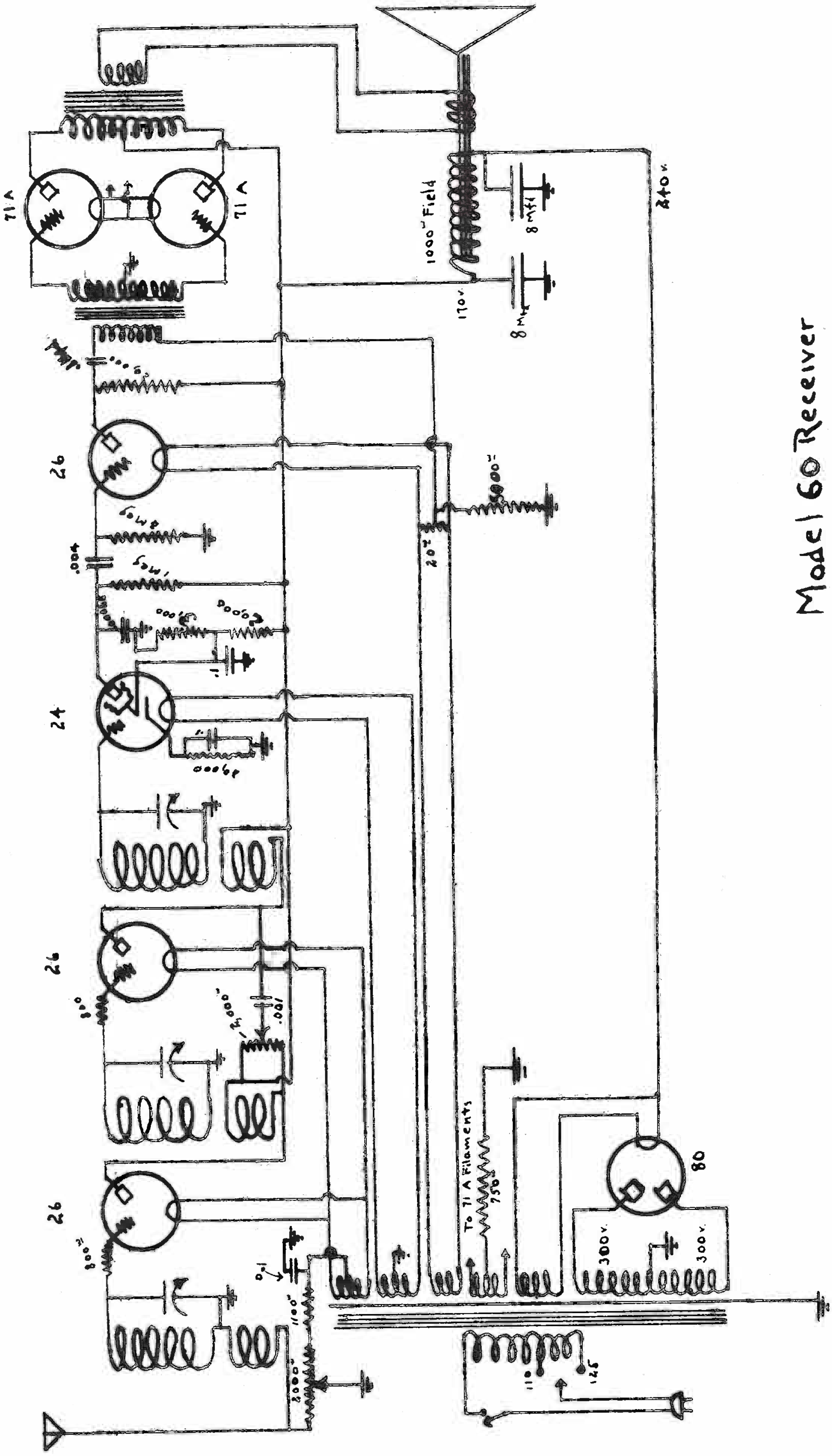




CONDENSER TRANSMITTER

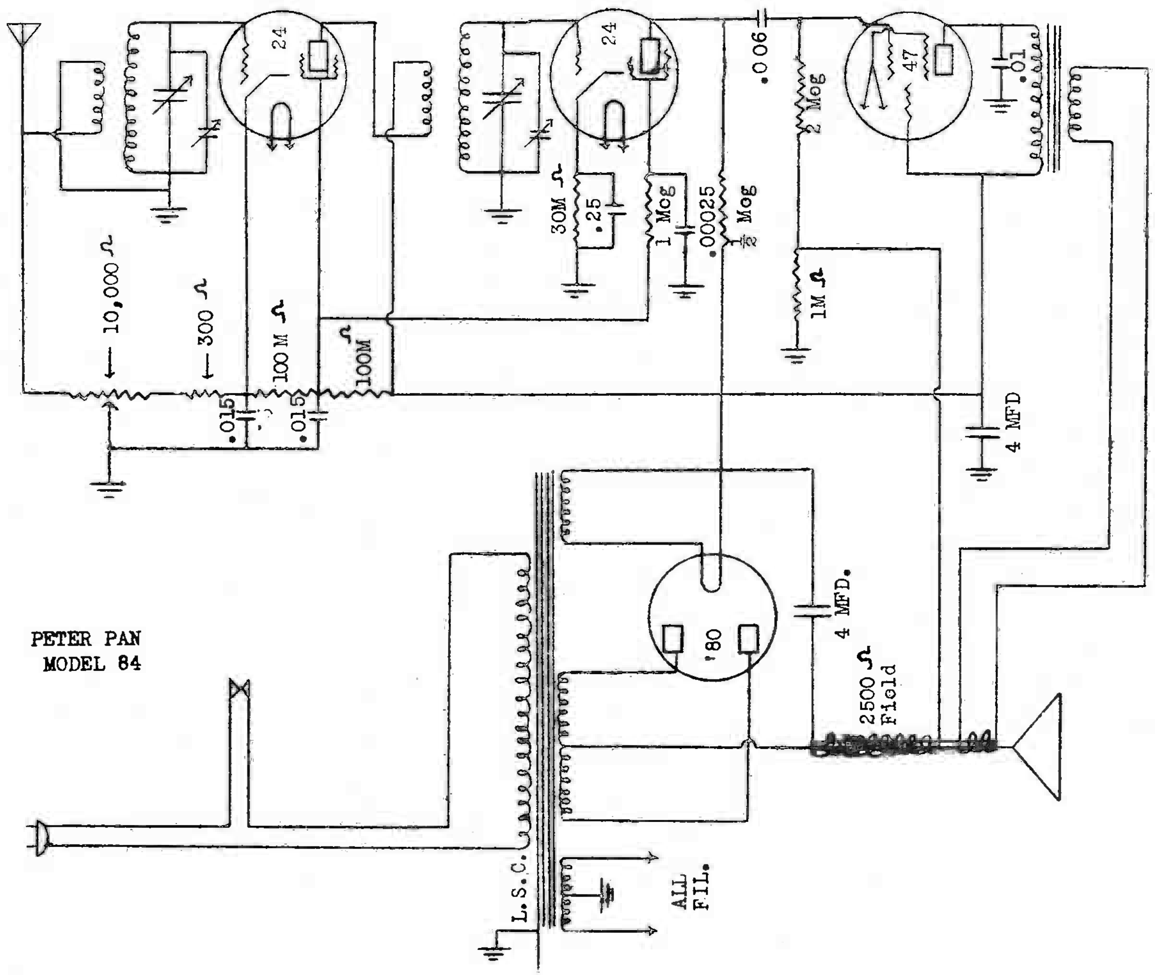
TYPE C-12

JACKSON-BELL CO.



Model 60 Receiver

JACKSON-BELL CO.



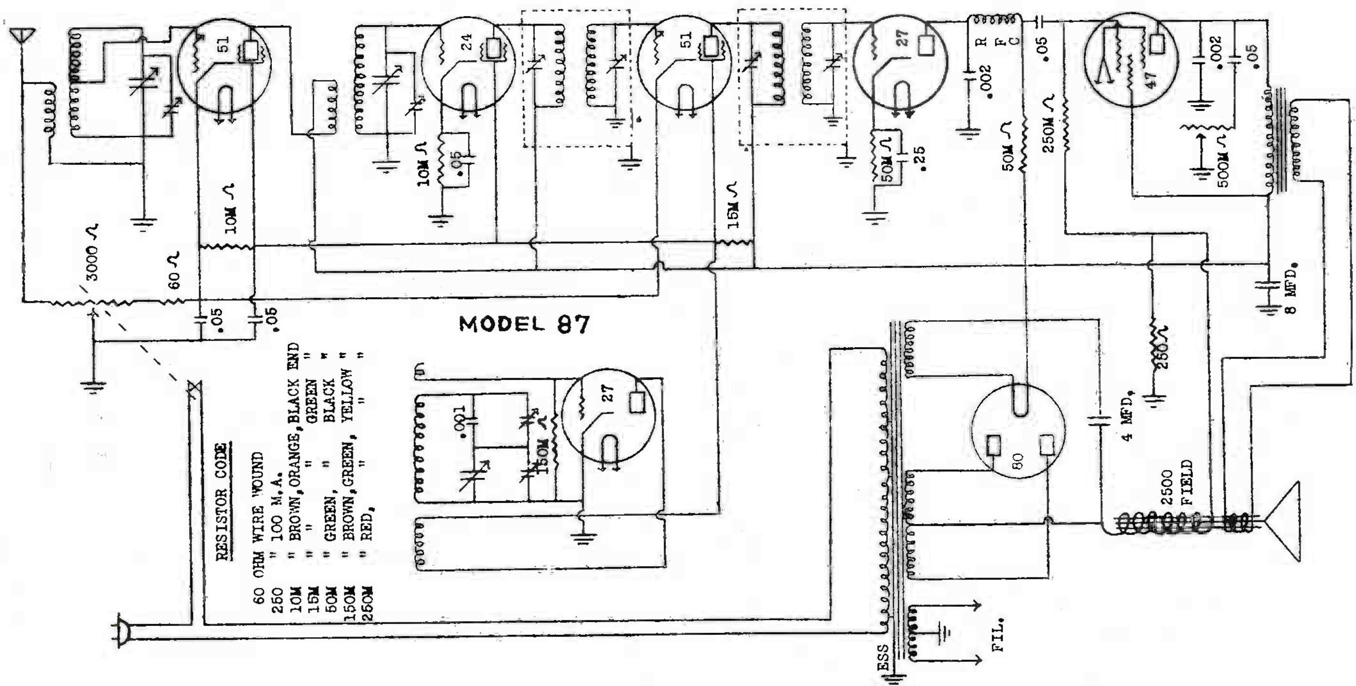
VOLTAGE AND CURRENT VALUES

With the volume control at maximum, the following readings should be obtained, with an allowable 10% variation:-

Line Voltage	110 V.
R.F.Plate Voltage	200 V.
R.F. Screen Voltage	60 V. *
R.F. Cathode Bias	1.5 V.
R.F. Plate Current	2.2 M.A.
Detector Plate Voltage	80 V.
Detector Screen Voltage	60 V.
Detector Cathode	5 V.
Detector Plate Current	0.15 M.A.
Pentode Plate Voltage	190 V.
Pentode Screen Voltage	200 V.
Pentode Grid Voltage	13 V.
Pentode Plate Current	24.0 M.A.
R.F.Filament	2.2 V.
Detector Filament	2.2 V.
Pentode Filament	2.2 V.
Rectifier Filament	4.1 V.

*These readings made with the 300,000 ohm voltmeter in a Jewel 199 Set Analyzer are not true readings, due to the high resistances in the receiver circuit.

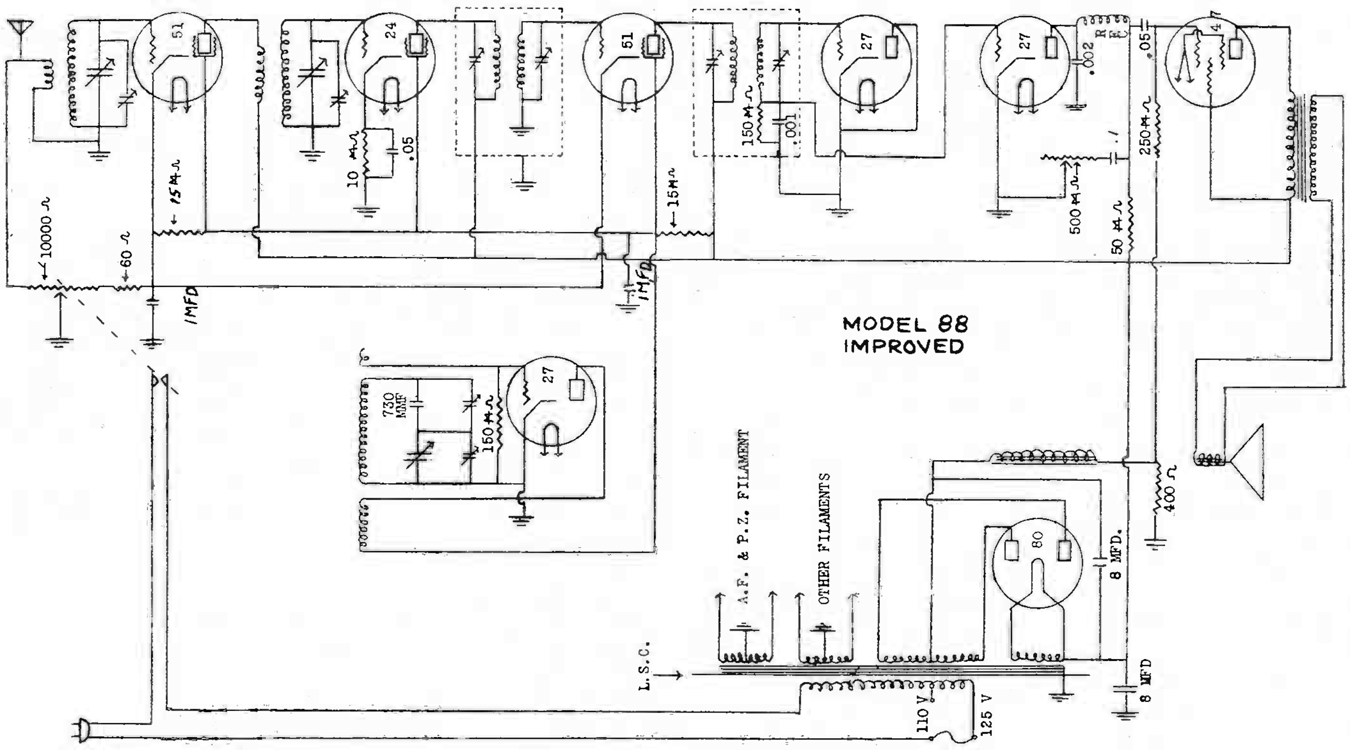
JACKSON-BELL CO.



AVERAGE VOLTAGES & CURRENTS:

	FIL. VOLTS	PLATE VOLTS	SCREEN VOLTS	VOLUME CONTROL MAXIMUM GRID VOLTS	CATHODE VOLTS	PLATE CURRENT
R.F. Tubes	2.25	195.	95	0	1.5	3.25 MILLS
First Detector Tube	2.25	195.	95	0	3.	.5 "
First I.F. Tube	2.25	195.	95	0	1.5	3.25 "
Second Detector Tube	2.25	145.	--	0	12.5	.5 "
Oscillator Tube	2.25	65.	--	0	--	3. "
Output Tube	2.25	185.	195	11	--	24. "
Rectifier Tube	4.5	260.	--	--	--	45. "

JACKSON-BELL CO.



VOLTAGES AND CURRENT VALUES

THE FOLLOWING VOLTAGES MUST BE CHECKED WITH VOLUME CONTROL AT MAXIMUM

** ** **

R.F. PLATE	200 V.
R.F. SCREEN GRID	75 V.
R.F. CATHODE	$1\frac{1}{2}$ V.
R.F. FILAMENT	2 V.
FIRST INTERMEDIATE FREQUENCY PLATE	200 V.
FIRST INTERMEDIATE FREQUENCY SCREEN GRID	75 V.
FIRST INTERMEDIATE FREQUENCY CATHODE	$1\frac{1}{2}$ V.
FIRST INTERMEDIATE FREQUENCY FILAMENT	2 V.
DETECTOR PLATE	0 V.
DETECTOR GRID	$\frac{1}{2}$ V.
DETECTOR CATHODE TO GROUND	0 V.
DETECTOR FILAMENT	$2\frac{1}{4}$ V.
TRANSILATOR PLATE	200 V.
TRANSILATOR SCREEN GRID	75 V.
TRANSILATOR CATHODE	$5\frac{1}{4}$ V.
TRANSILATOR FILAMENT	2 V.
OSCILLATOR PLATE	75 V.
OSCILLATOR GRID	$\frac{1}{4}$ V.
OSCILLATOR CATHODE TO GROUND	0 V.
FIRST AUDIO PLATE	40 V.
FIRST AUDIO GRID	$\frac{1}{2}$ V.
FIRST AUDIO CATHODE TO GROUND	0 V.
P.Z. OR '47 SPACE CHARGE GRID	200 V.
P.Z. OR '47 PLATE	195 V.
P.Z. OR '47 GRID	16 V.
P.Z. OR '47 FILAMENT	$2\frac{1}{4}$ V.
80 PLATE	25 MILLS DRAIN PER PLATE
80 FILAMENT	$4\frac{1}{2}$ V.

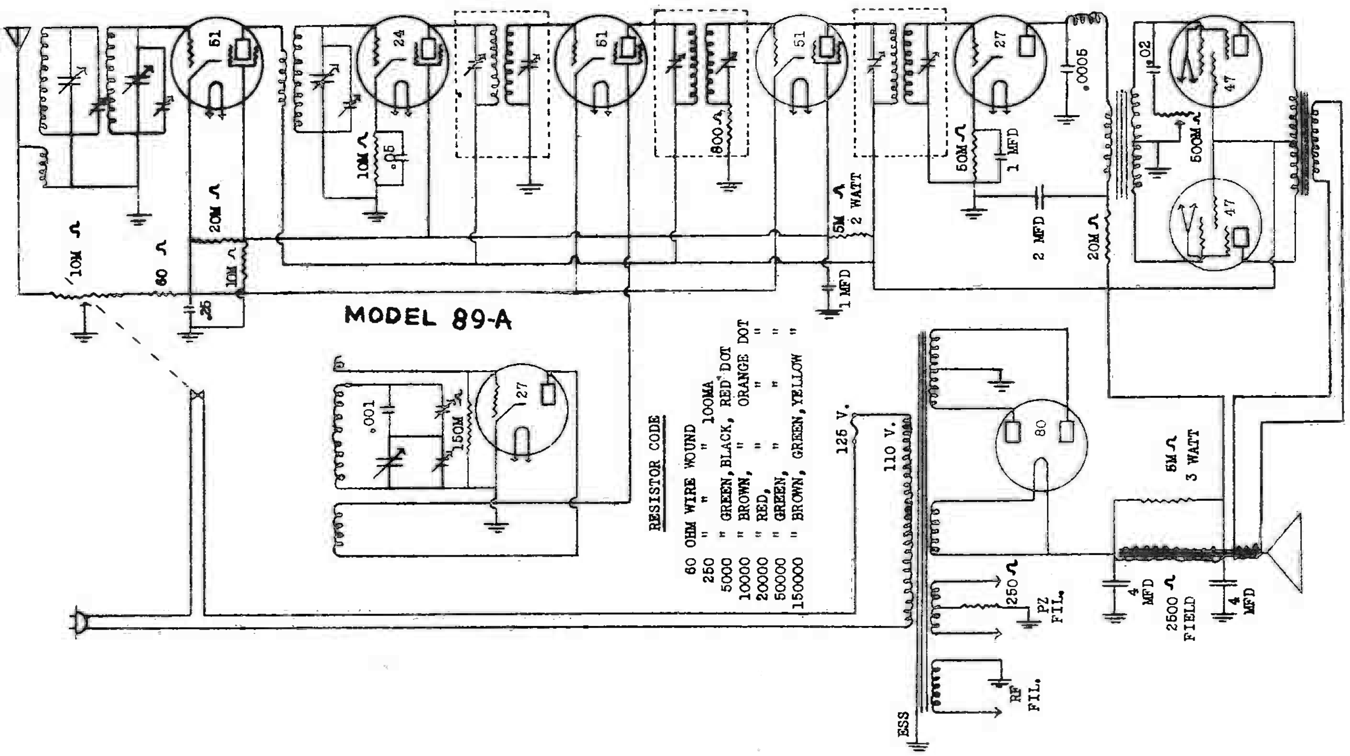
These voltages will be obtained with a 1000 Ohm per volt meter. Meters of different resistances will vary in voltage readings, due to high resistance in series with different potentials.

RESISTANCE COLOR CODE * CARBON RESISTORS

1 WATT

60 Ohm - Wire Wound
400 " - " Insulated, 3 Watt
10000 " - Brown - Black end - Orange Dot
15000 " - Brown - Green end - Orange Dot
50000 " - Green - Black end - Orange Dot
150000 " - Brown - Green end - Yellow Dot
1 Meg - Red - Green end - Yellow Dot
1 - - Small mica condenser
.00073 - Orange and Yellow Dot - 3% Tolerance

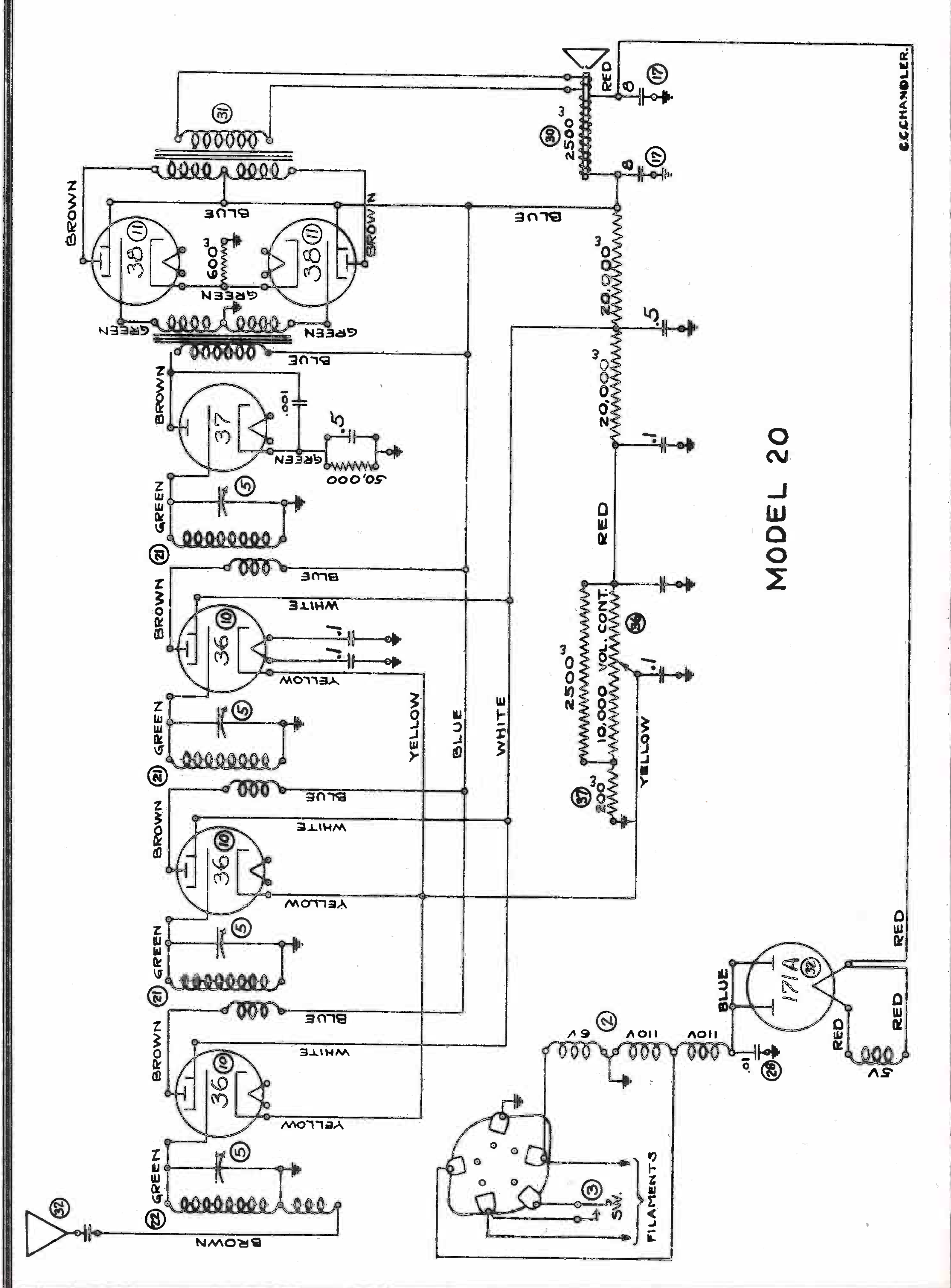
JACKSON-BELL CO.



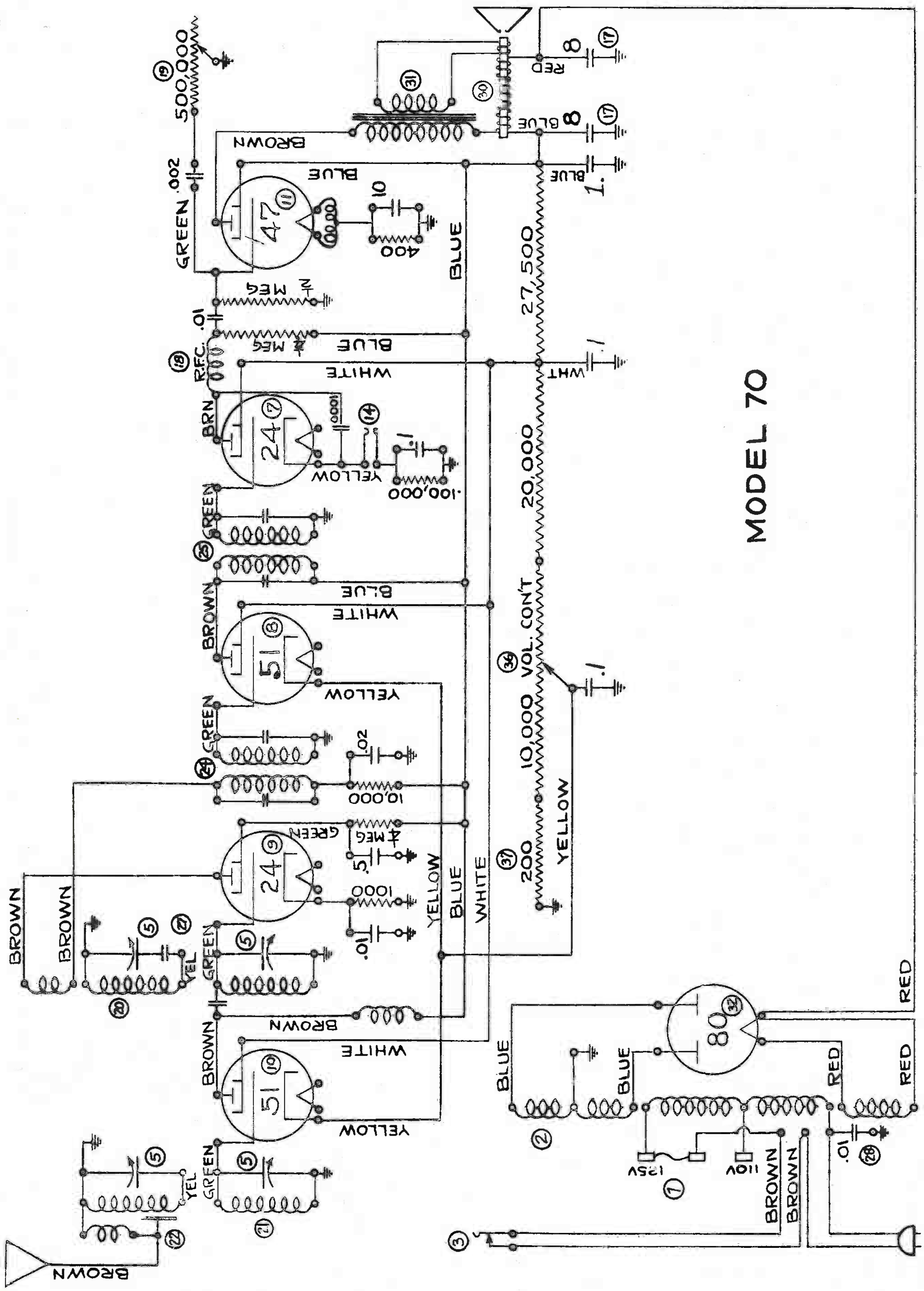
AVERAGE VOLTAGES & CURRENTS:

	FIL. VOLTS	PLATE VOLTS	SCREEN VOLTS	GRID VOLTS	CATHODE VOLTS	PLATE CURRENT
R.F. Amplifier Tube	2.3	200	100	0	2.0	3.5
First Detector Tube	2.3	200	100	0	4.0	.5 MA
First I. F. Tube	2.3	200	100	0	2.0	3.5
Second I. F. Tube	2.3	200	100	0	2.0	3.5
Second Detector Tube	2.3	180	---	-	8	.2 MA
Oscillator Tube	2.3	100	---	0	0	6 MA
Output Tube (1)	2.3	185	200	16	-	20 MA
Output Tube (2)	2.3	185	200	16	-	20 MA
Rectifier Tube	5.0	375	---	-	-	35 PER PLATE

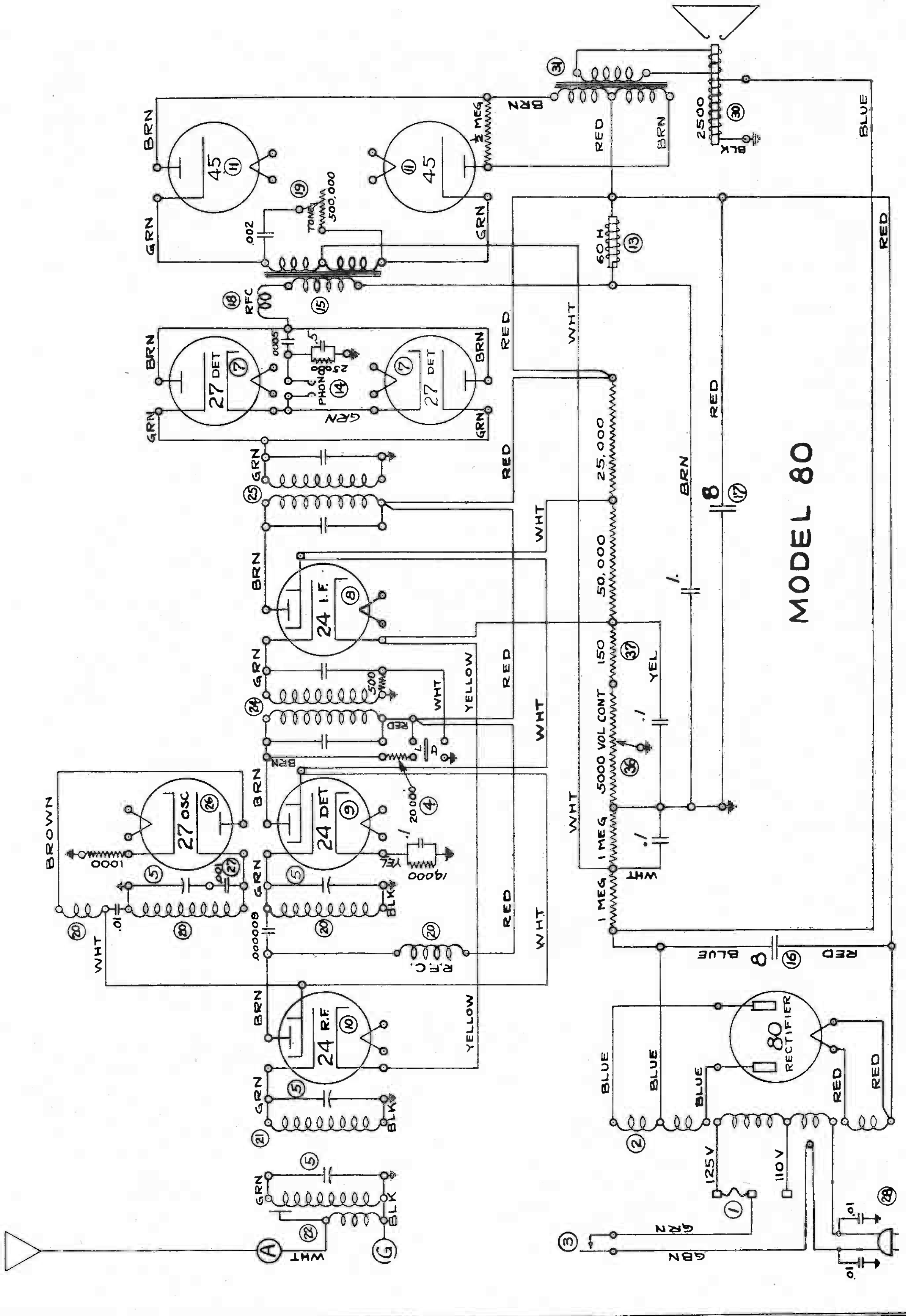
KELLER-FULLER MFG., CO. LTD.



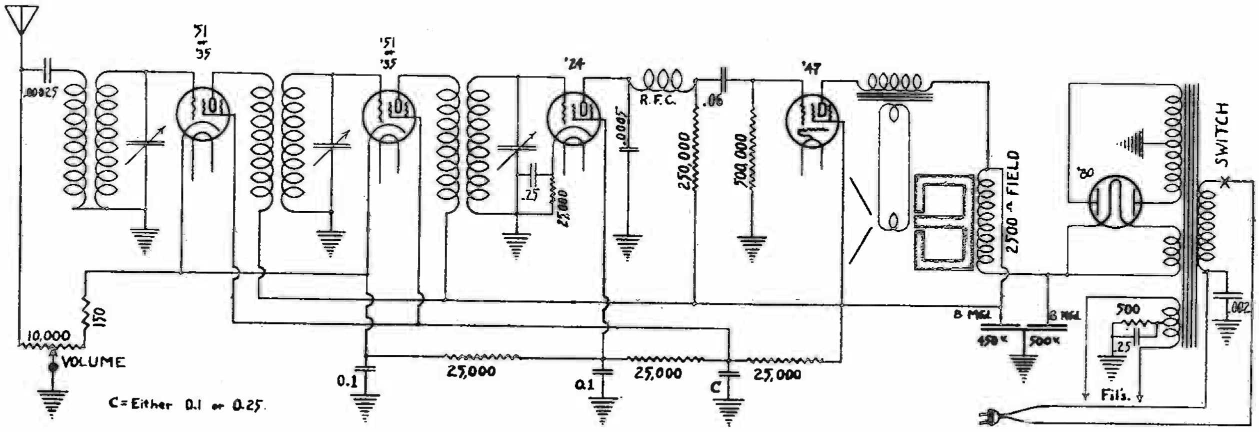
KELLER-FULLER MFG., CO. LTD.



KELLER-FULLER MFG., CO. LTD.



COLIN B. KENNEDY CORP.

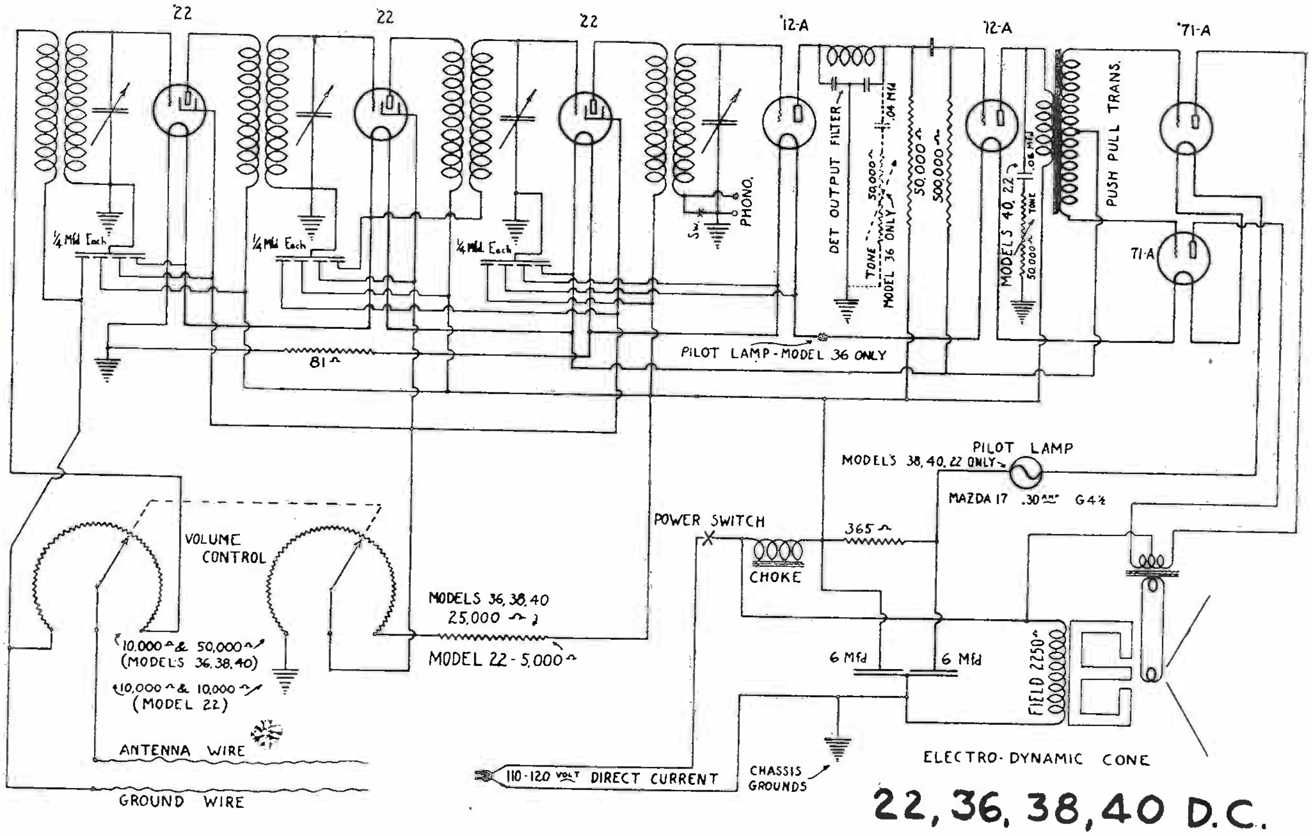


Tube	Type	Fil. A.C.	Plate	Screen	Bias
1st R.F.	551	2.3	250	175	2.5 to 39
2nd R.F.	551	2.3	250	175	2.5 to 39
Detector	224	2.3	155	......	4
Power Tube	247	2.3	235	235	16
Rectifier	280	4.8	340-340	......	....

Line voltage = 115. Volume full on.

A 1,000-ohm-per-volt meter used to obtain the above. Small deviations above or below the values given may be expected, due to variations in parts, tubes and meters.

MODEL-50



22, 36, 38, 40 D.C.

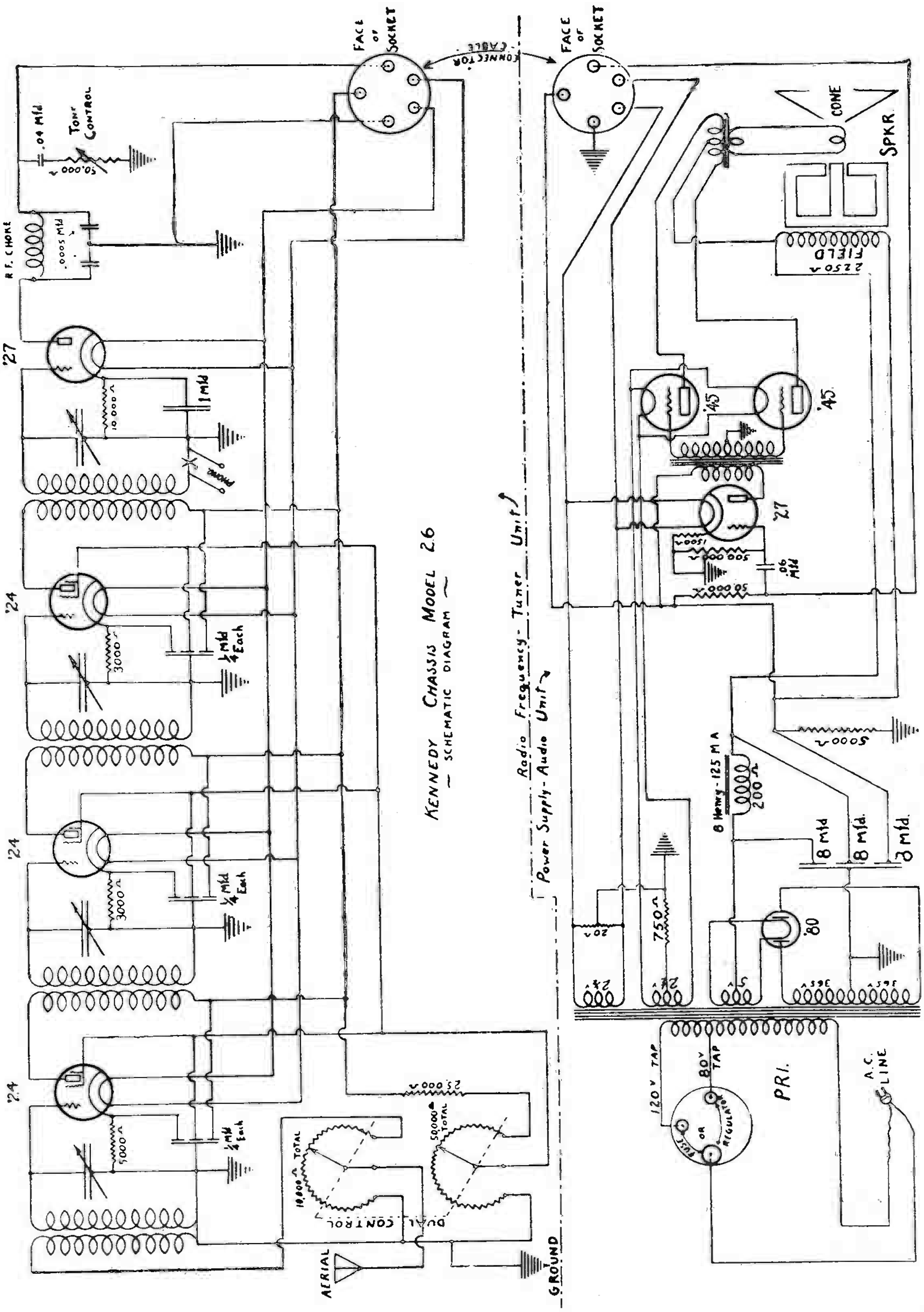
SPECIAL NOTICE

Due to the similarity of the D. C. and A. C. chassis and the fact that the circuits of the various D. C. models are almost identical, all current model D. C. servicing instructions are covered by this service manual.

The mechanical layout of the D. C. models corresponds to the equivalent A. C. model in each case except for the few variations noted below.

D. C. Model	*Corresponding A. C. Model*
36	26
38	30
40	32
22	20B

COLIN B. KENNEDY CORP.



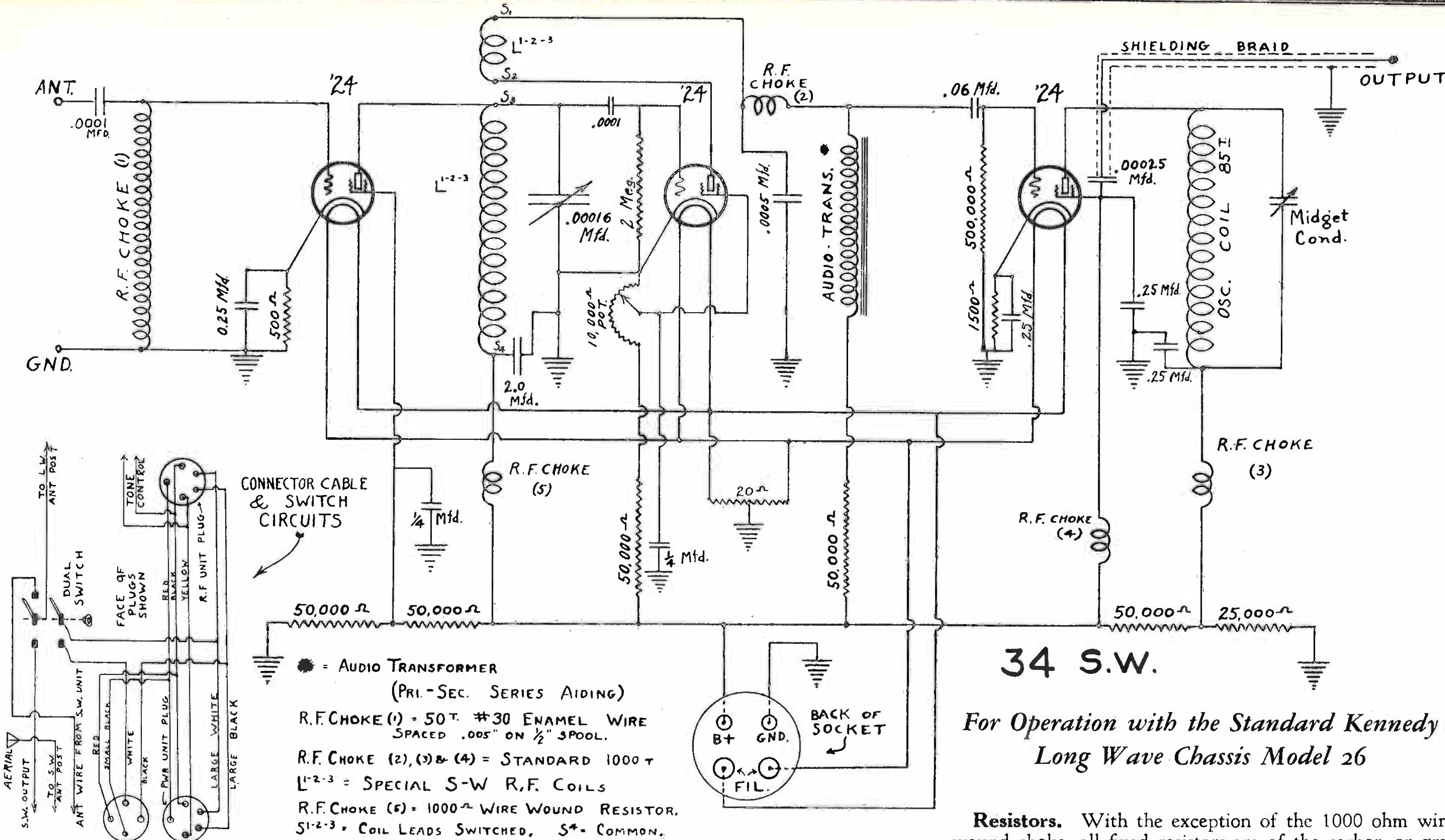
Resistors

The resistance values of the various colored biasing resistors employed are as follows:

Green	3,000 ohms.	Yellow	50,000 ohms.
Blue	5,000 ohms.	Brown	500,000 ohms.
Grey	10,000 ohms.	Red	1,500 ohms.

TUBE	FILAMENT	PLATE	BIAS	SCREEN
1st R. F.	2.3	160	3.5	85
2nd R. F.	2.3	160	3.5	85
3rd R. F.	2.3	160	3.5	85
Detector	2.3	125	10	....
1st A. F.	2.3	155	9	....
Power Tubes	2.3	230	45	....
Rectifier	4.8	....	....	....

COLIN B. KENNEDY CORP.



✱ = Audio Transformer (Pri.-Sec. Series Aiding)

R.F. Choke (1) - 50 T. #30 Enamel Wire Spaced .005" on ½" spool.

R.F. Choke (2), (3) & (4) = Standard 1000 T

L1-2-3 = Special S-W R.F. Coils

R.F. Choke (5) = 1000 Ω Wire Wound Resistor.

S1-2-3 - Coil Leads Switched, S4 - Common.

34 S.W.

For Operation with the Standard Kennedy Long Wave Chassis Model 26

Resistors. With the exception of the 1000 ohm wire wound choke, all fixed resistors are of the carbon or graphite type.

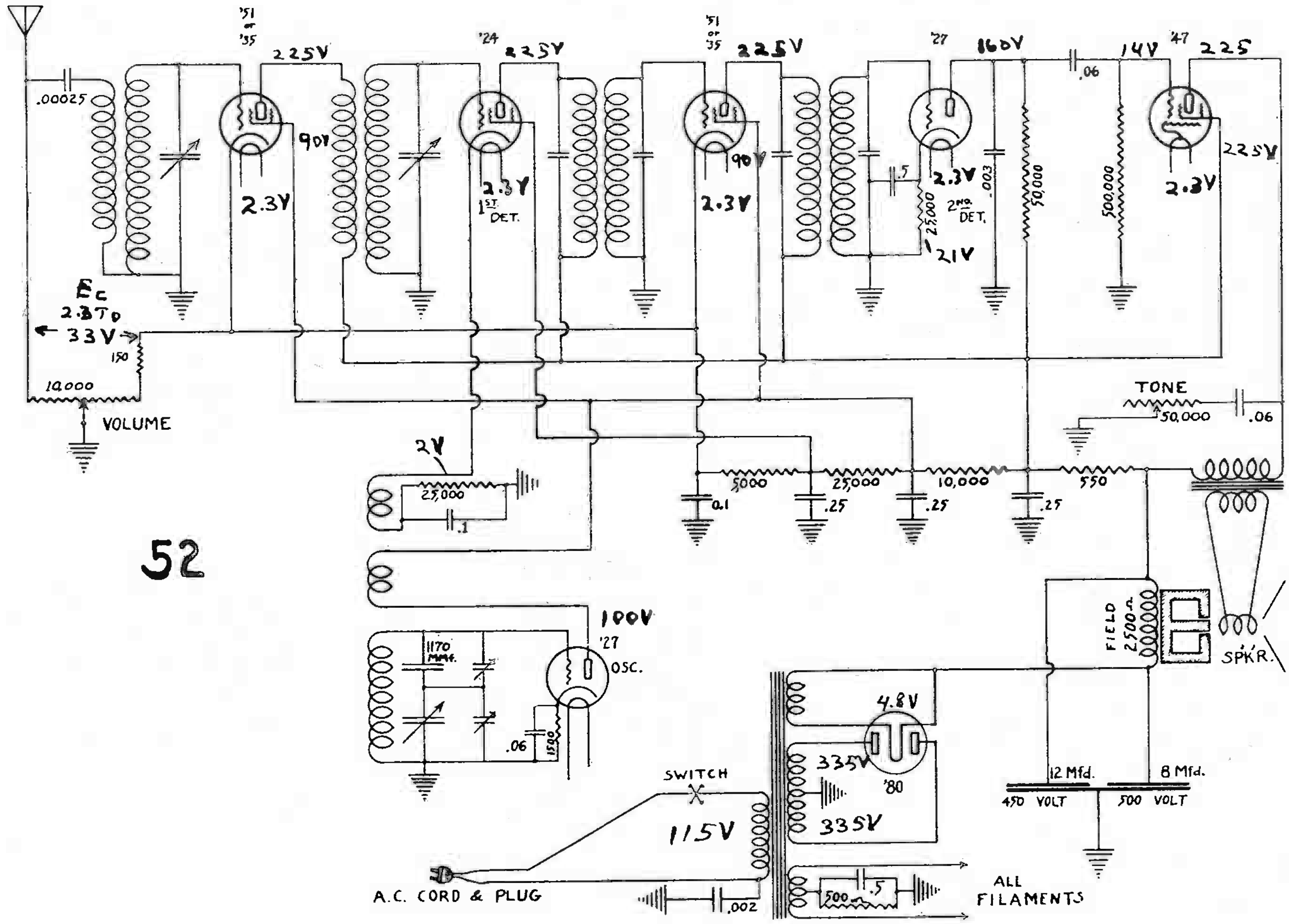
Yellow	50,000	ohms
Red	1,500	ohms
Red (large)	2	megohms
Grey	25,000	ohms
Brown	500,000	ohms
Black	500	ohm

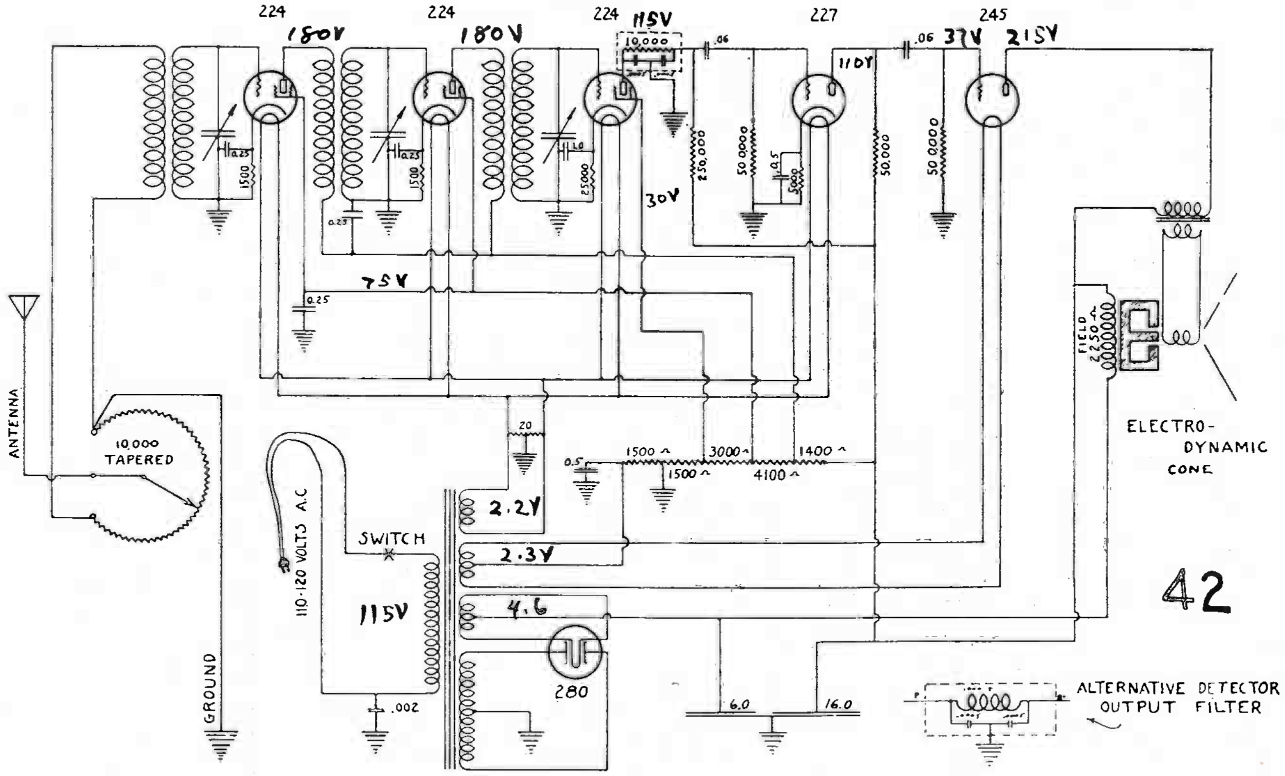
(Flexible covered resistor)

The volume and regeneration control is a 10,000 ohm wire wound potentiometer.

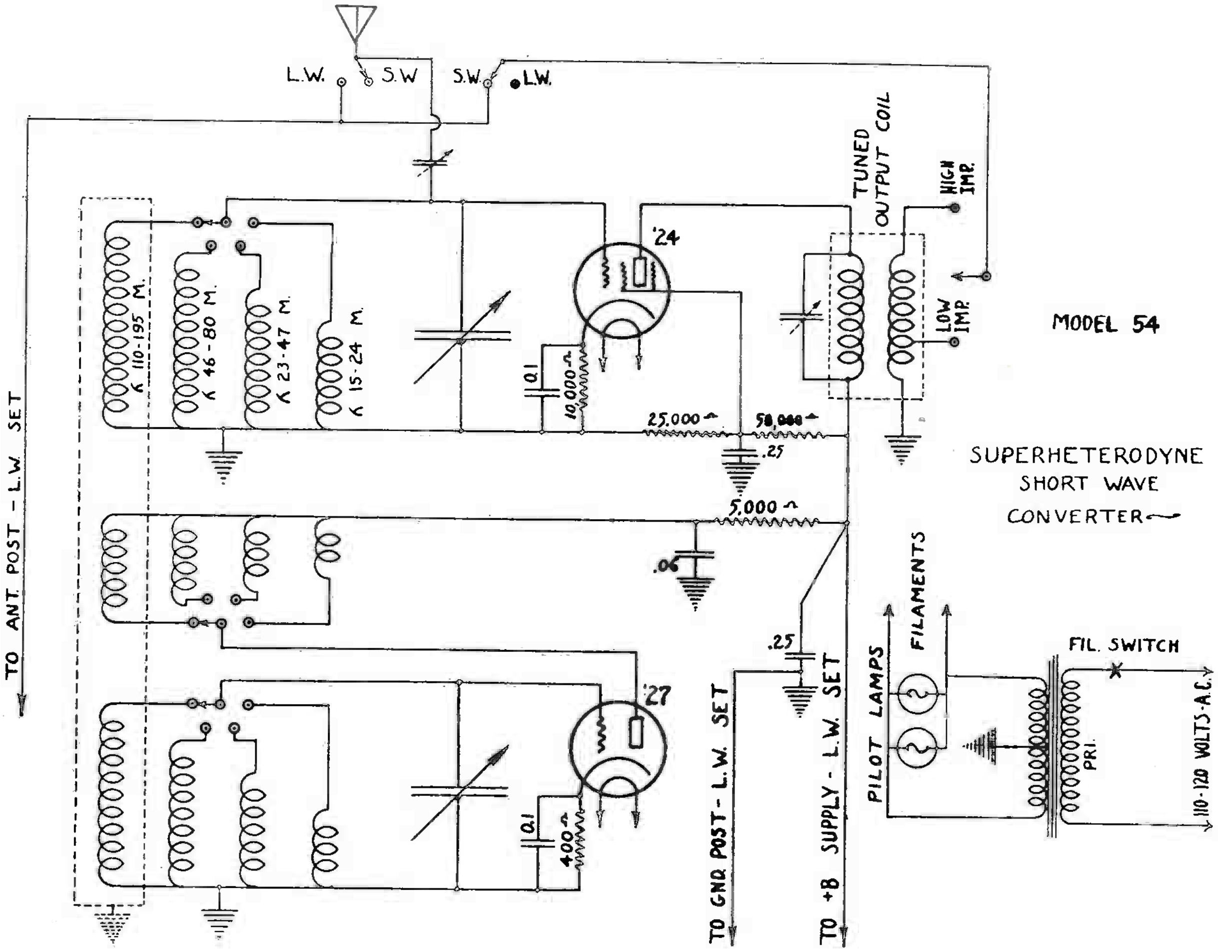
Radio frequency tube:	Plate 160 volts Screen 70 volts Cathode (bias) 1.1 volts
Detector tube:	Plate 140 volts Screen 30 volts (Volume on Maximum)
Oscillator tube:	Plate 55 volts Screen 160 volts Cathode (bias) 5 volts

COLIN B. KENNEDY CORP.



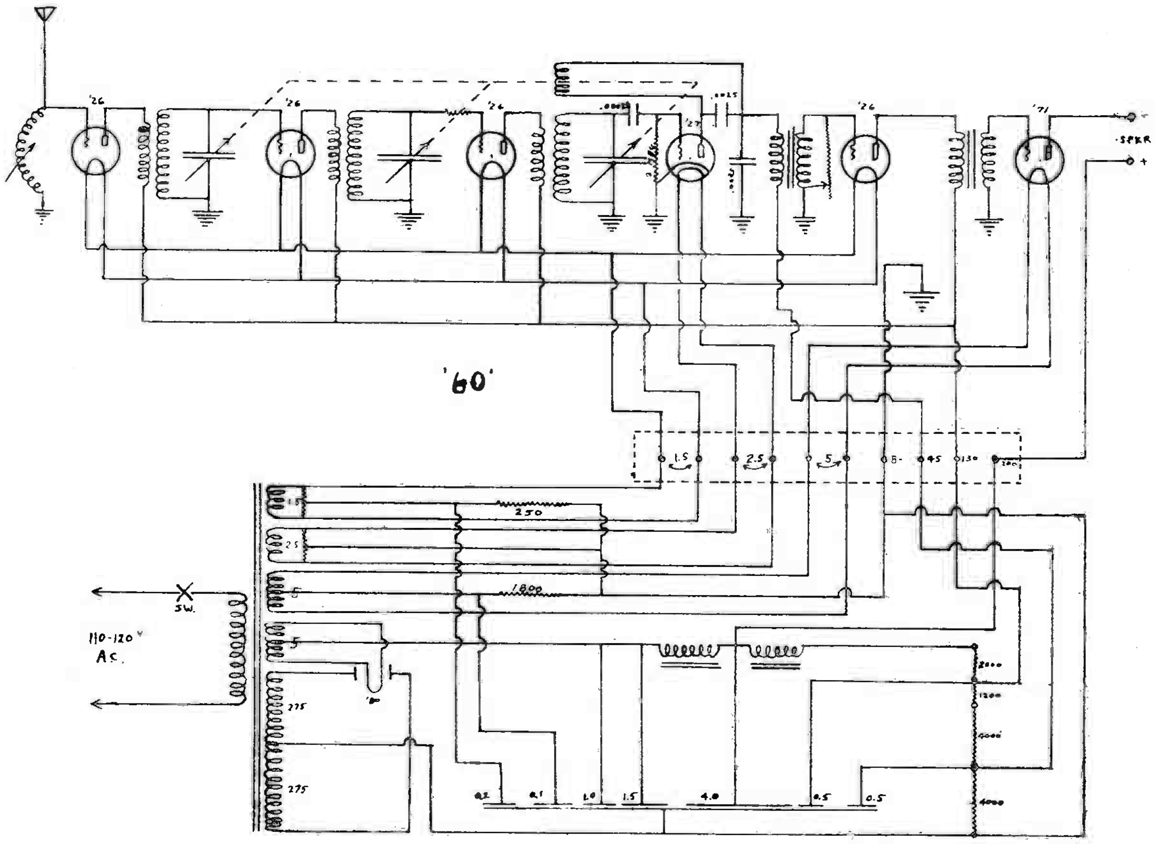


COLIN B. KENNEDY CORP.



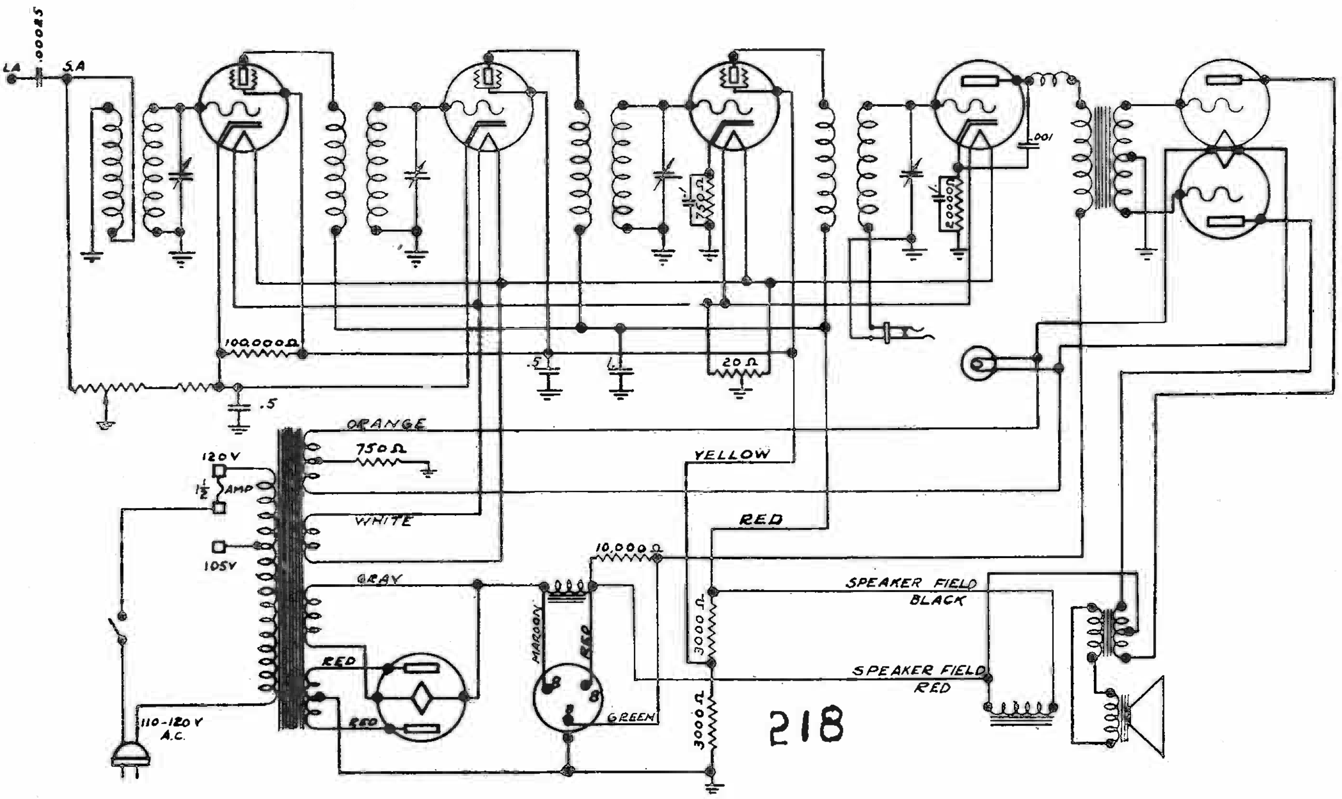
MODEL 54

SUPERHETERODYNE SHORT WAVE CONVERTER



'60'

KING MANUFACTURING CORP.

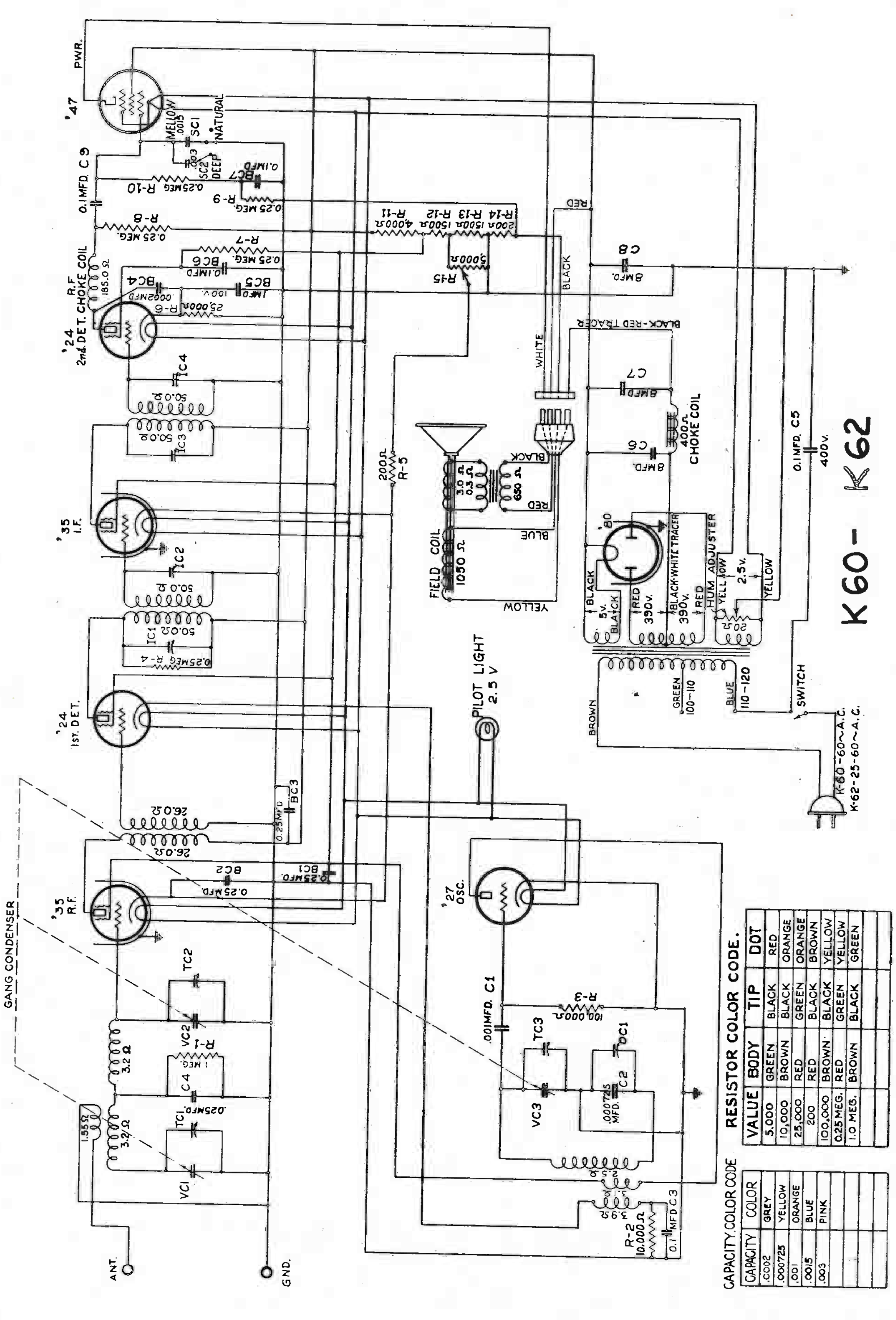


Readings with plug in set socket and tube in tester socket

Tube No. in order	Position of Tube	Type of Tube	A Volts	B Volts	C Volts	Cathode	Plate M.A.	Plate M.A. Grid Test	Plate Change M.A.	Screen Grid Volts
1	1st R.F.	224	2.4	178	3.4	3.4	3.5	7.1	3.6	85
2	2nd R.F.	224	2.4	178	3.4	3.4	3.5	7.1	3.6	85
3	3rd R.F.	224	2.4	178	3.4	3.4	3.5	7.1	3.6	85
4	DET.	227	2.4	240	23.	2.5	1.1	1.2	.1	
5	Push-Pull	245	2.4	235	45		27	32	5.	
6	Push-Pull	245	2.4	235	45		27	32	5.	
7	RECT.	280	5.	310						

Line Voltage 120 Set on 120 Volt Tap Volume Control FULL ON

KOLSTER RADIO, INC.



RESISTOR COLOR CODE.

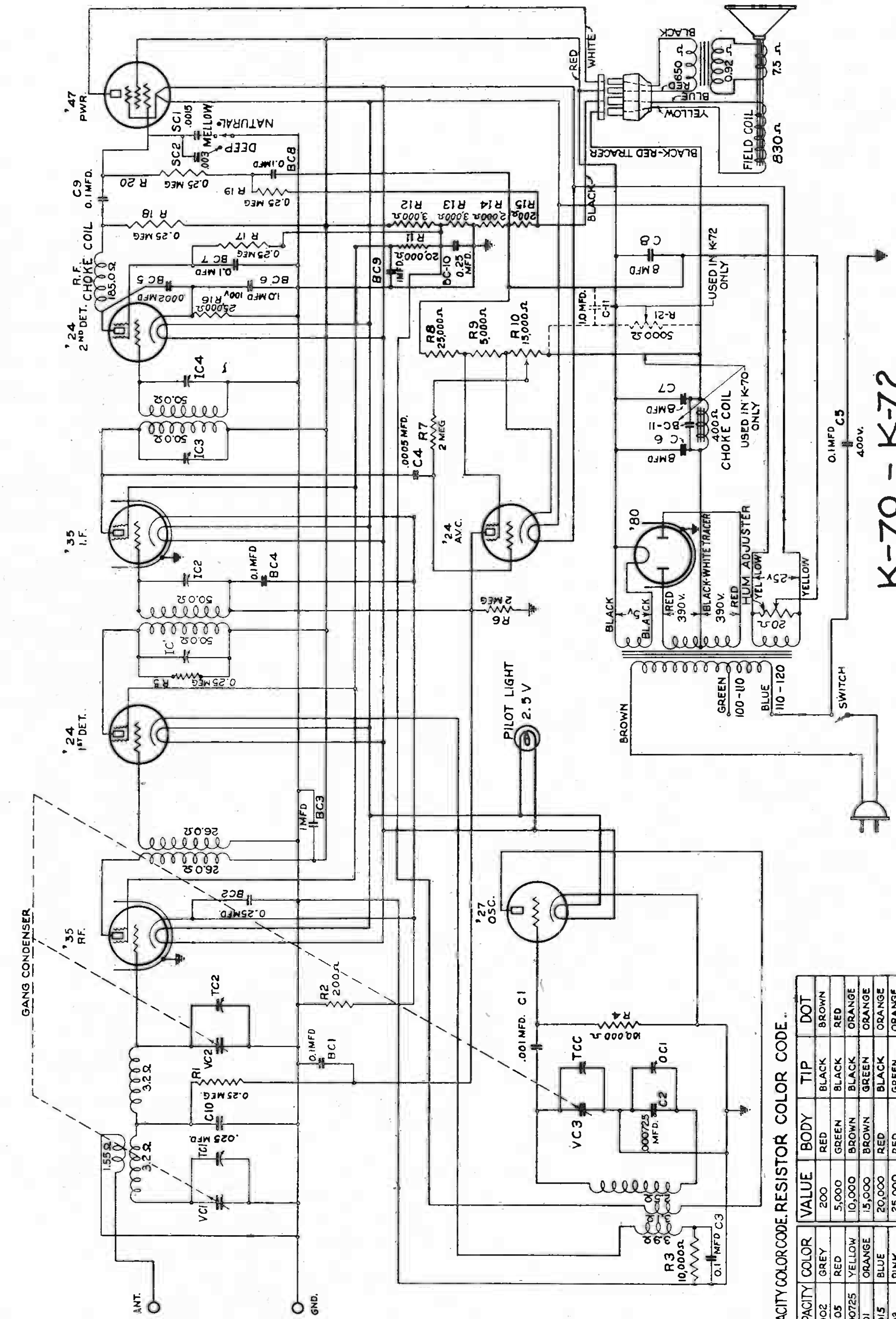
VALUE	BODY	TIP	DOT
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
200	RED	GREEN	BROWN
100,000	BROWN	BLACK	YELLOW
0.25 MEG.	RED	GREEN	YELLOW
1.0 MEG.	BROWN	BLACK	GREEN

CAPACITY COLOR CODE

CAPACITY	COLOR
.0002	GREY
.000725	YELLOW
.001	ORANGE
.0015	BLUE
.003	PINK

KOLSTER RADIO, INC.

K-70 - K-72



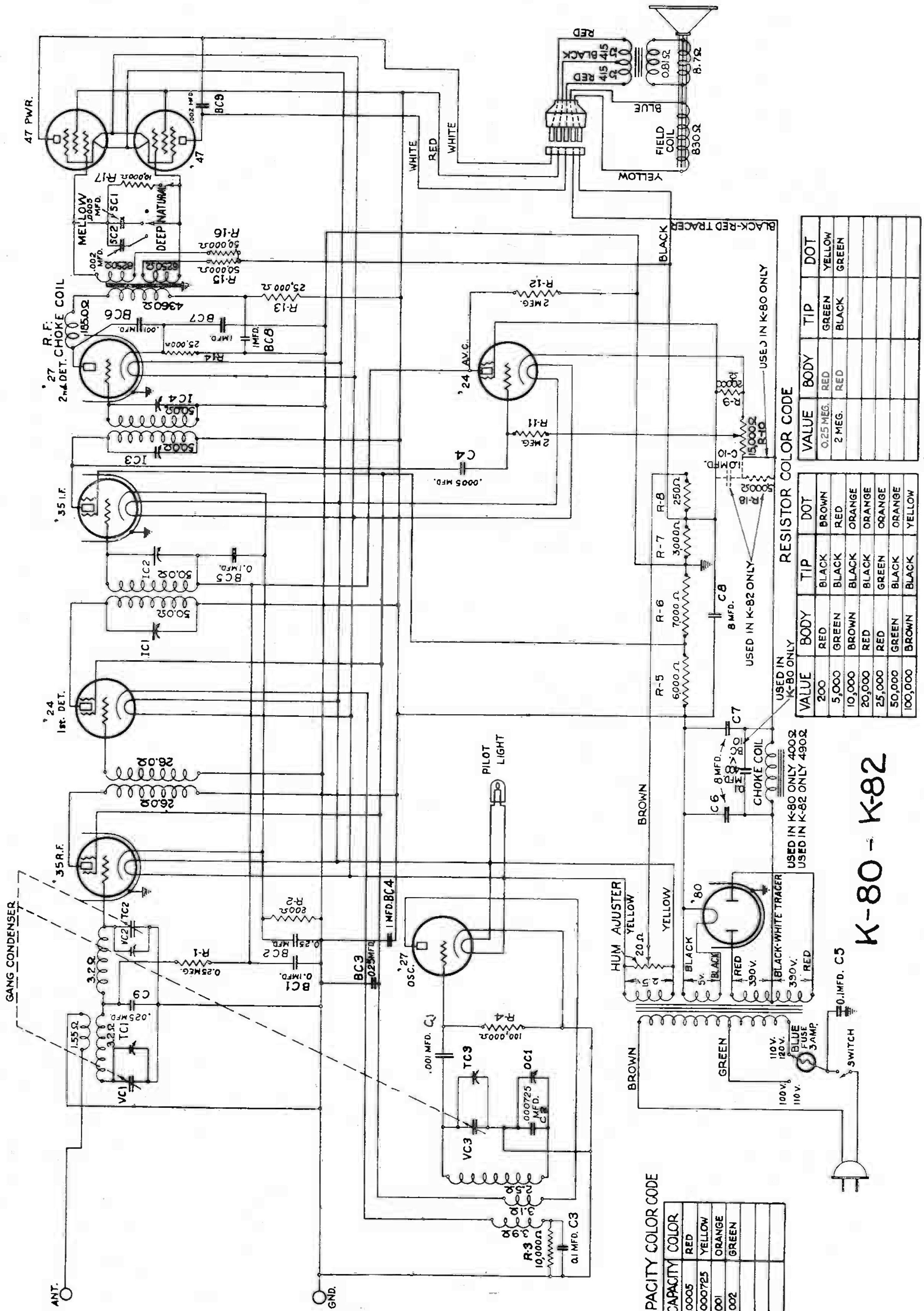
CAPACITY COLOR CODE.

CAPACITY	COLOR
.0002	GREY
.0005	RED
.000725	YELLOW
.001	ORANGE
.0015	BLUE
.003	PINK

RESISTOR COLOR CODE.

VALUE	BODY	TIP	DOT
200	RED	BLACK	BROWN
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
15,000	BROWN	GREEN	ORANGE
20,000	RED	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
100,000	BROWN	BLACK	YELLOW
0.25 MEG.	RED	GREEN	YELLOW
2 MEG.	RED	BLACK	GREEN

KOLSTER RADIO, INC.



RESISTOR COLOR CODE

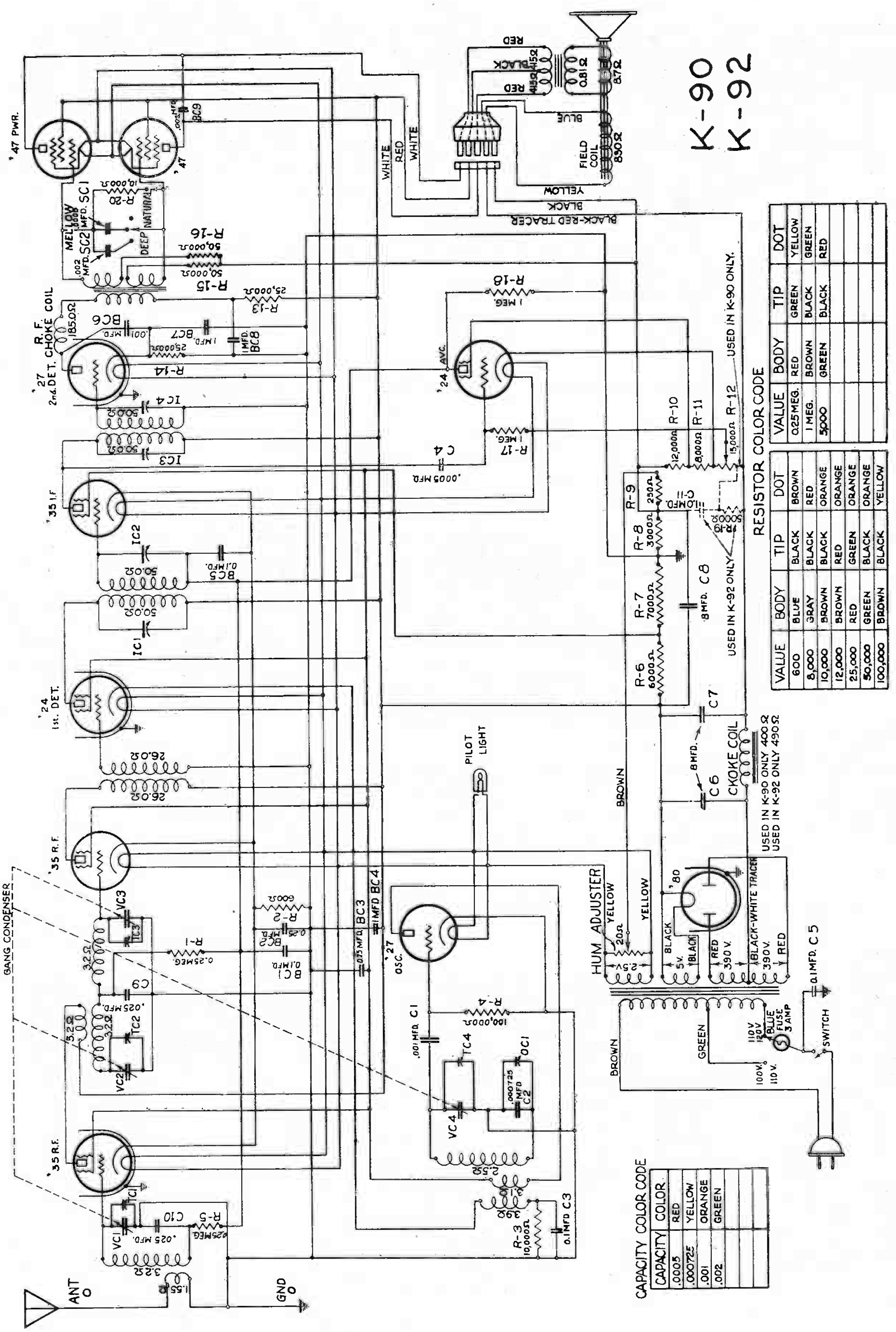
VALUE	BODY	TIP	DOT
200	RED	BLACK	BROWN
5,000	GREEN	BLACK	RED
10,000	BROWN	BLACK	ORANGE
20,000	RED	BLACK	ORANGE
25,000	RED	GREEN	ORANGE
50,000	GREEN	BLACK	ORANGE
100,000	BROWN	BLACK	YELLOW

VALUE	BODY	TIP	DOT
0.25 MEG.	RED	GREEN	YELLOW
2 MEG.	RED	BLACK	GREEN

CAPACITY COLOR CODE

CAPACITY	COLOR
.0005	RED
.000725	YELLOW
.001	ORANGE
.002	GREEN

KOLSTER RADIO, INC.



RESISTOR COLOR CODE

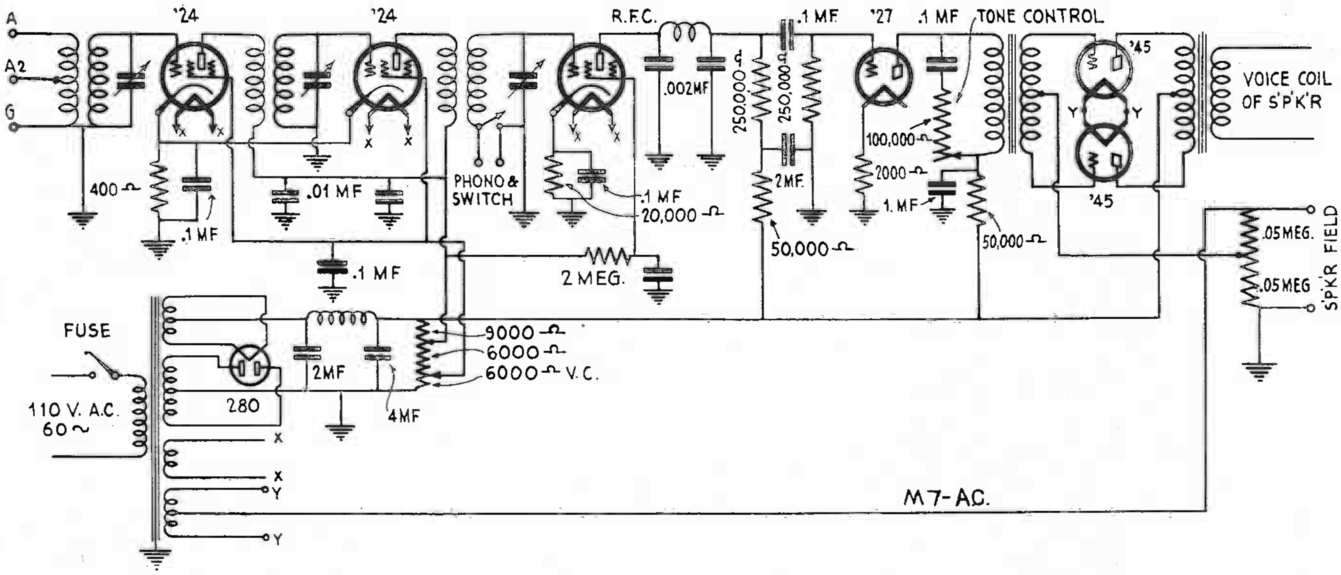
VALUE	BODY	TIP	DOT
600	BLUE	BLACK	BROWN
8,000	GRAY	BLACK	RED
10,000	BROWN	BLACK	ORANGE
12,000	BROWN	RED	ORANGE
25,000	RED	GREEN	ORANGE
50,000	GREEN	BLACK	ORANGE
100,000	BROWN	BLACK	YELLOW

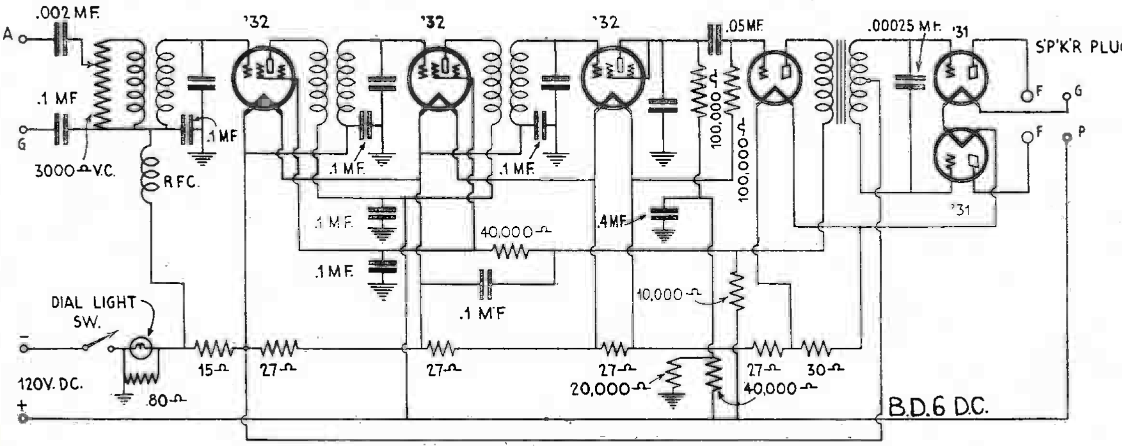
VALUE	BODY	TIP	DOT
0.25 MEG.	RED	GREEN	YELLOW
1 MEG.	BROWN	BLACK	GREEN
5000	GREEN	BLACK	RED

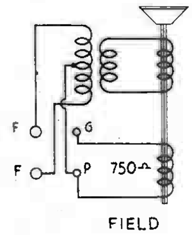
CAPACITY COLOR CODE

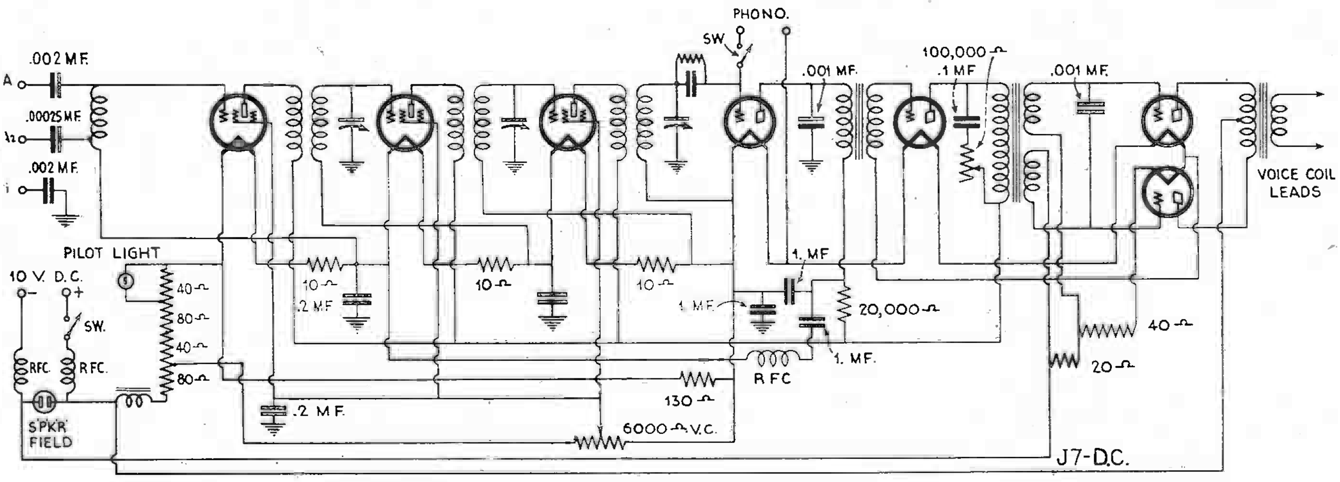
CAPACITY	COLOR
.0005	RED
.000725	YELLOW
.001	ORANGE
.002	GREEN

LANG RADIO CO.

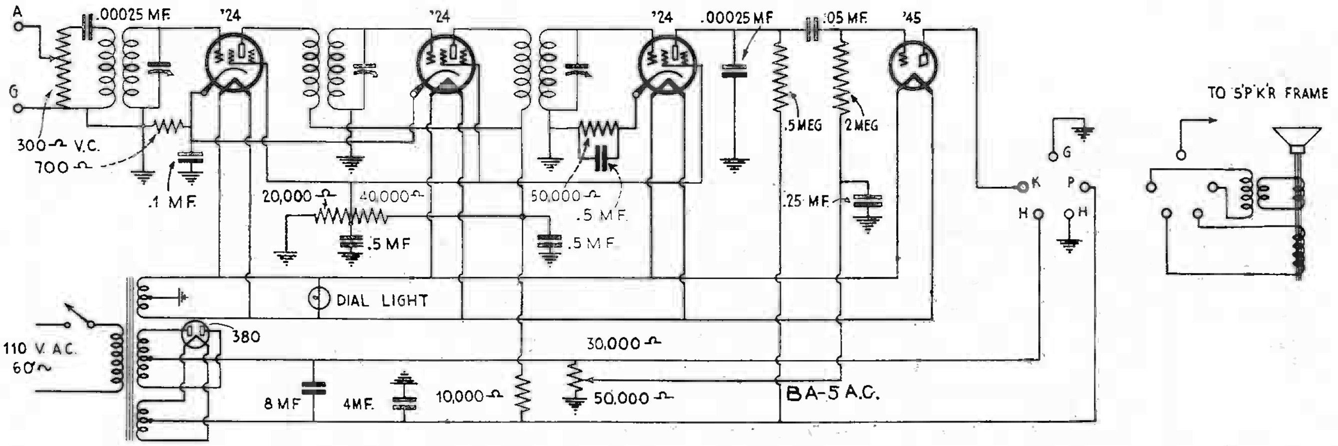


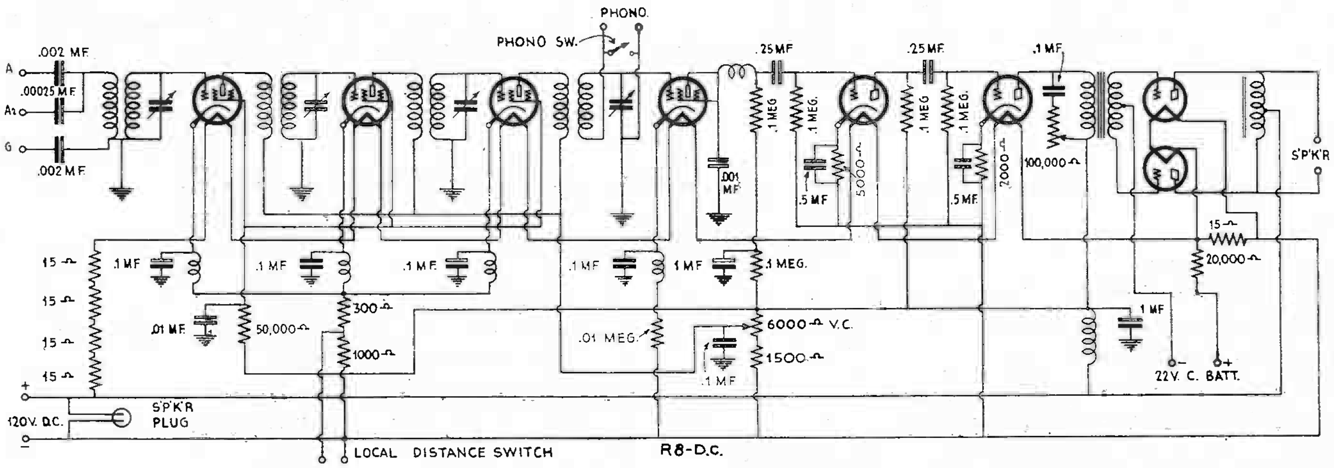


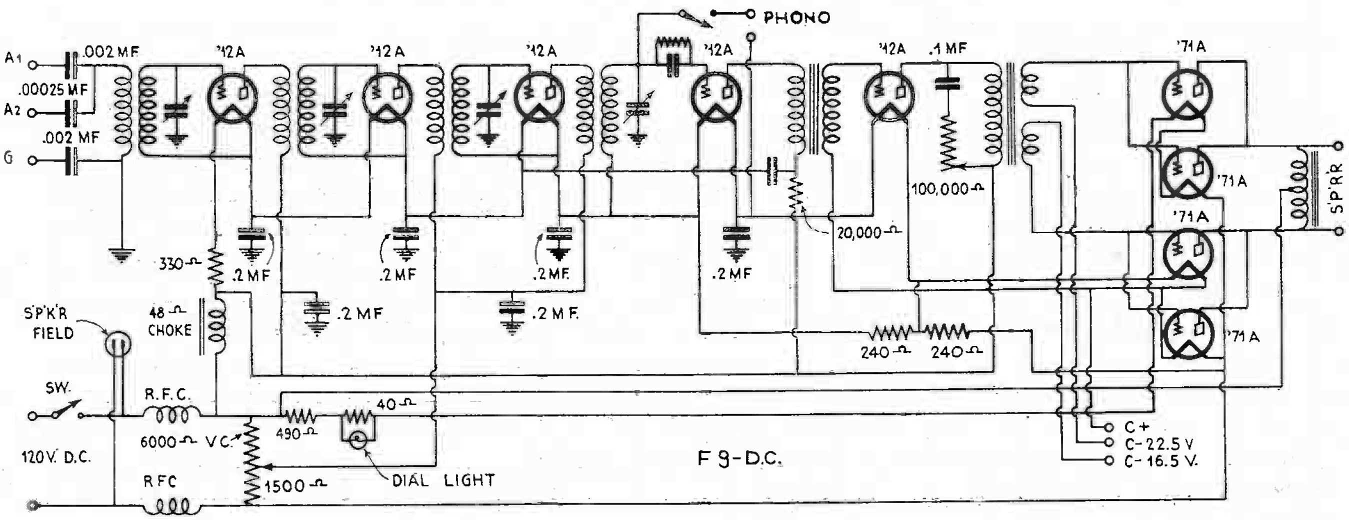




LANG RADIO CO.

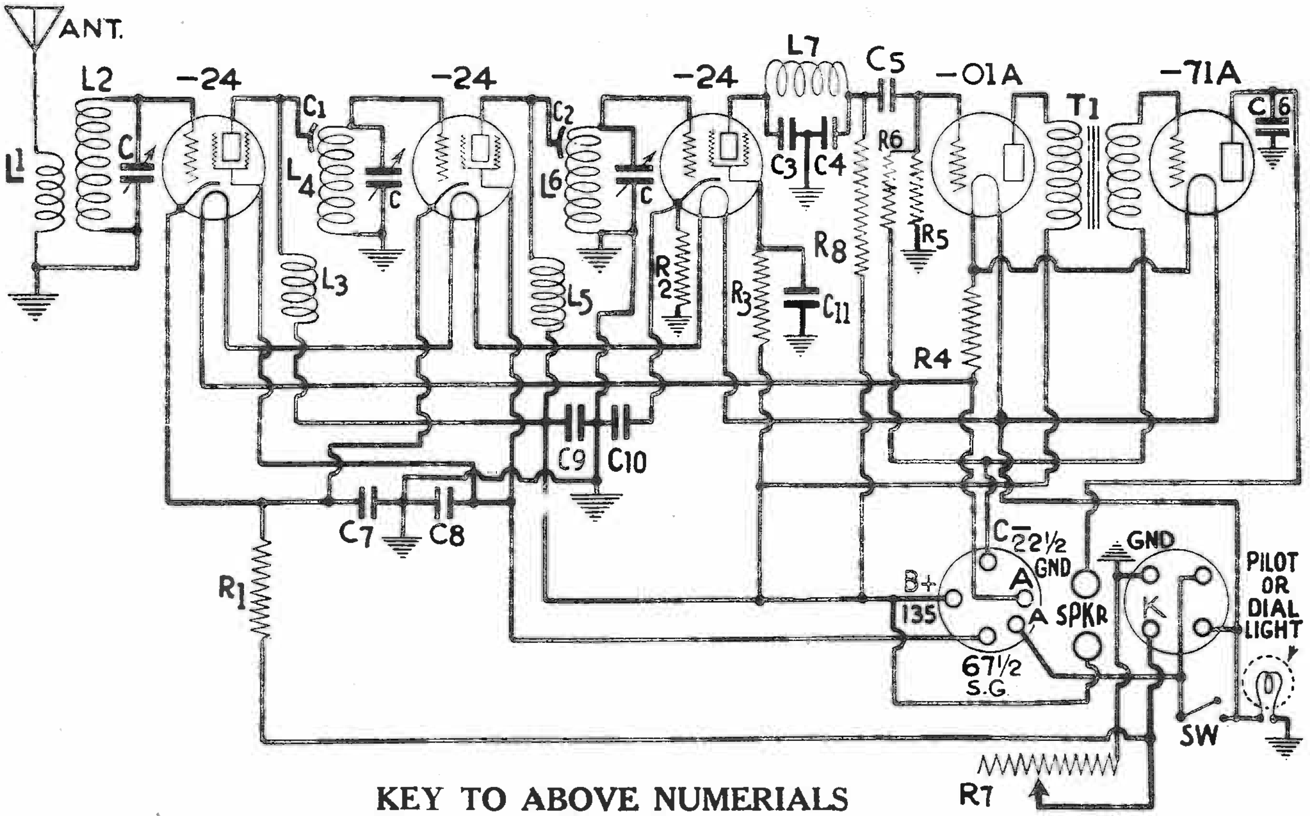






GALVIN MANUFACTURING CORP.

MOTOROLA



KEY TO ABOVE NUMERIALS

L1—Antenna primary
L2, L4, L6—R. F. secondarys
L3, L5—R. F. plate chokes
L7—Detector plate choke
C, C1, C2—Main tuning condensers
C1, C2—R. F. coupling condenser. Cap. 9.6 micro-microfarads
C3, C4—0001 mfd. condensers
C5, C6, C11—.003 mfd. condensers
C7, C8, C9, C10—.25 mfd. by pass condensers
R1—200 Ω (Gray) resistor
R2—25,000 Ω (Black) resistor
R3, R6—3 meg (Blue or Pink) resistor
R4—2 Ω wire wound resistor
R5, R8—1 meg (Lavender) resistor
R7—300,000 Ω Volume control

Voltage Readings at the Tube Socket

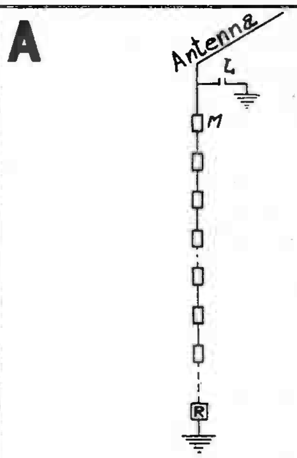
TUBE NO. IN ORDER ①	TYPE OF TUBE ②	POSITION OF TUBE 1 ST. R.F. DET., ETC. ③	READINGS, PLUG IN SOCKET OF SET									
			TUBE OUT		TUBE IN TESTER							
			A VOLTS ④	B VOLTS ⑤	A VOLTS ⑥	B VOLTS ⑦	C VOLTS (CONTROL ⑧ GRID)	CATHODE - HEATER ⑨ VOLTS	NORMAL PLATE ⑩ M.A.	PLATE M.A. GRID ⑪ TEST	PLATE CHANGE ⑫ M.A.	SCREEN GRID ⑬ VOLTS
1	24	1st R.F.		112.5	2	110	1	1.	2.2	3.2	1.	67.5
2	24	2nd R.F.		"	2	110	1	1.	2.2	3.2	1	67.5
3	24	Det		"	2	38	.3	.6	.6	1.6	1	6
4	01-A	1st Aud.		"	5	100	2		2.5	7.5	5	
5	71-A	2nd Aud.		"	5		22.5		5	18.	13	
6												
7												
8												
9												
10												

NOTE—These readings were made with the negative terminal of the "A" Battery grounded.

(MULTICUPLER) AMY, ACEVES AND KING INC.

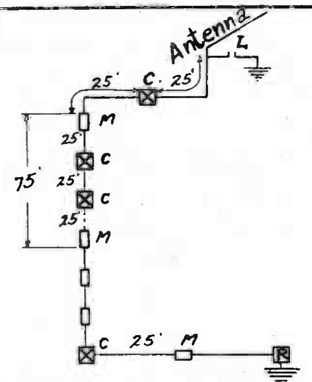
TYPICAL RISER DIAGRAMS FOR MULTICOUPLER ANTENNA SYSTEM INSTALLED IN CONDUIT

A



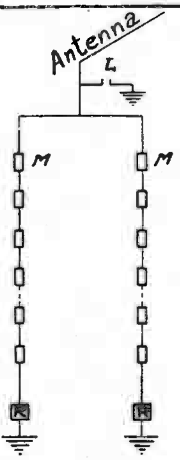
Typical straight vertical riser with radio outlet on each floor, using one aerial. Terminal resistance shown at end of line, in series with aerial download to ground.

B



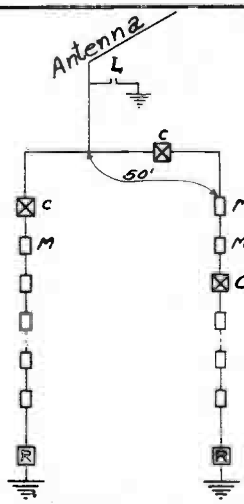
Riser with distance from aerial entrance bushing to first multicoupler or radio outlet approximately 50 feet. Note loading coil inserted approximately mid-way, then two loading coils in run approximately 75 feet without any outlets. Distance between two last outlets is approximately 50ft., requiring loading coil.

C



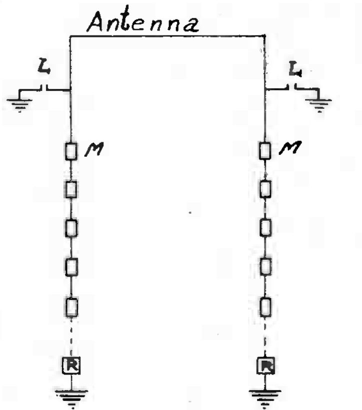
Two straight branch risers, connected to one aerial each with terminal resistance

D



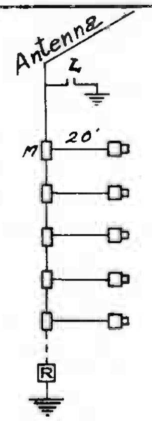
Two typical branch risers on one aerial, off set requiring loading coils.

E



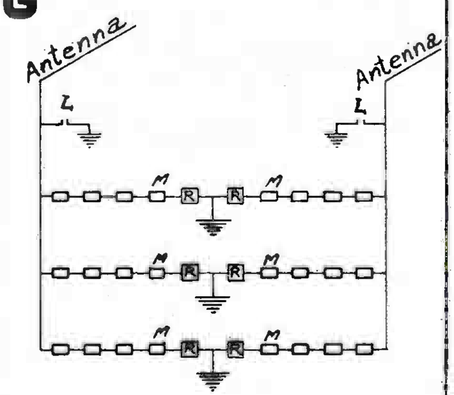
Another variation of two branch risers on one aerial showing one branch connected to one end of aerial and one to other end.

F



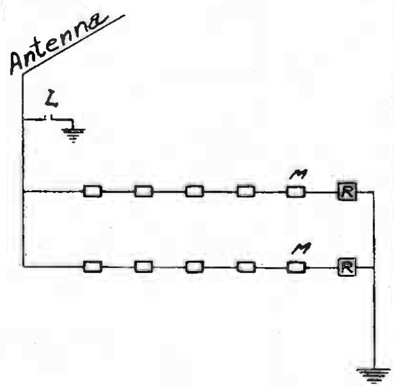
Showing radio outlets in different location from riser. Multicoupler is installed in 4"×4" box with 3/4" cover and blank plate usually in closets. Branch to outlet plate can be run in 1/2" conduit but not over 20 ft. from multicoupler.

G



Typical riser for three story building, three branches for one aerial, Not over four outlets on each branch. Riser shown for 24 suite building.

H



Typical riser for two story building two branches for one aerial.

Legend

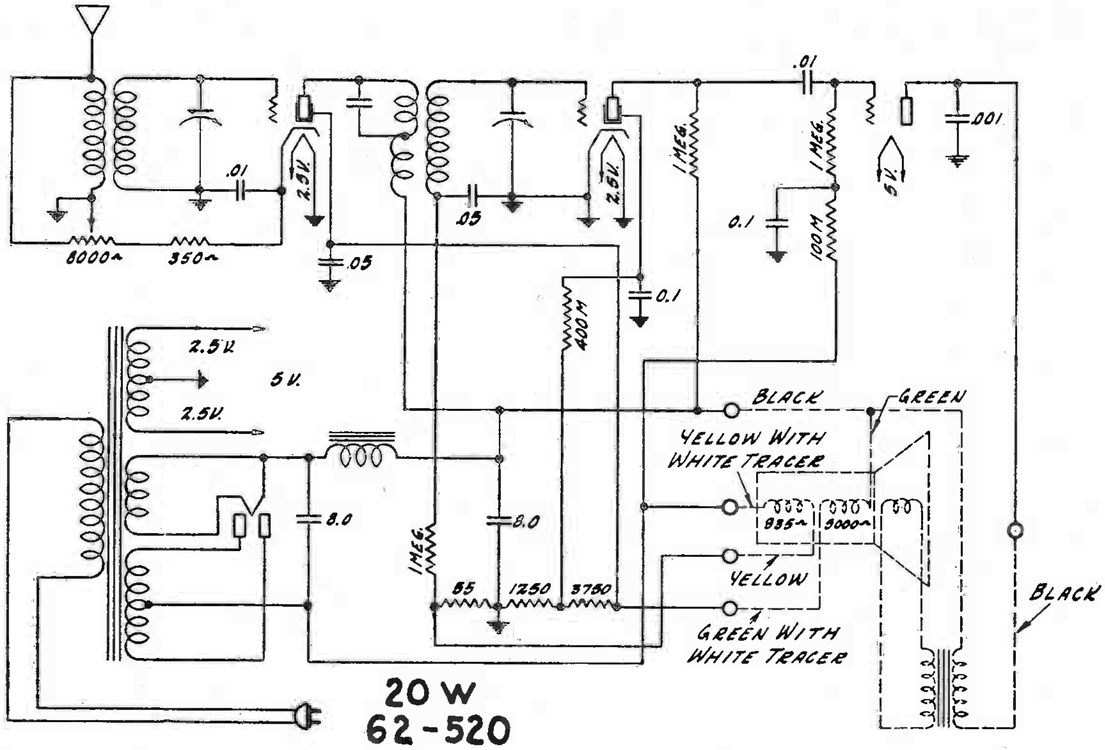
M ▯ Multicoupler radio outlet
C ☒ Load Coil
L Lightning Arrester
Branch Radio Outlet
R Terminal Resistance
Water pipe ground

Note:
When two risers are connected to one antenna the number of outlets on each branch should be kept as nearly equal as possible. Maximum difference should not exeed four. An aerial not less than 75 feet long is required when two branch risers are operated from one aerial.

Types of Risers for Various Buildings

A and B for buildings 3 to 30 stories, maximum outlets 30; Antenna 75′ long.
C and D for buildings 6 to 10 stories, maximum outlets 20; Antenna 75′ long.
E and F for buildings 3 to 10 stories, maximum outlets 20; Antenna 75′ long.
H for buildings two stories high, maximum outlets 12; Antenna 75′ long.

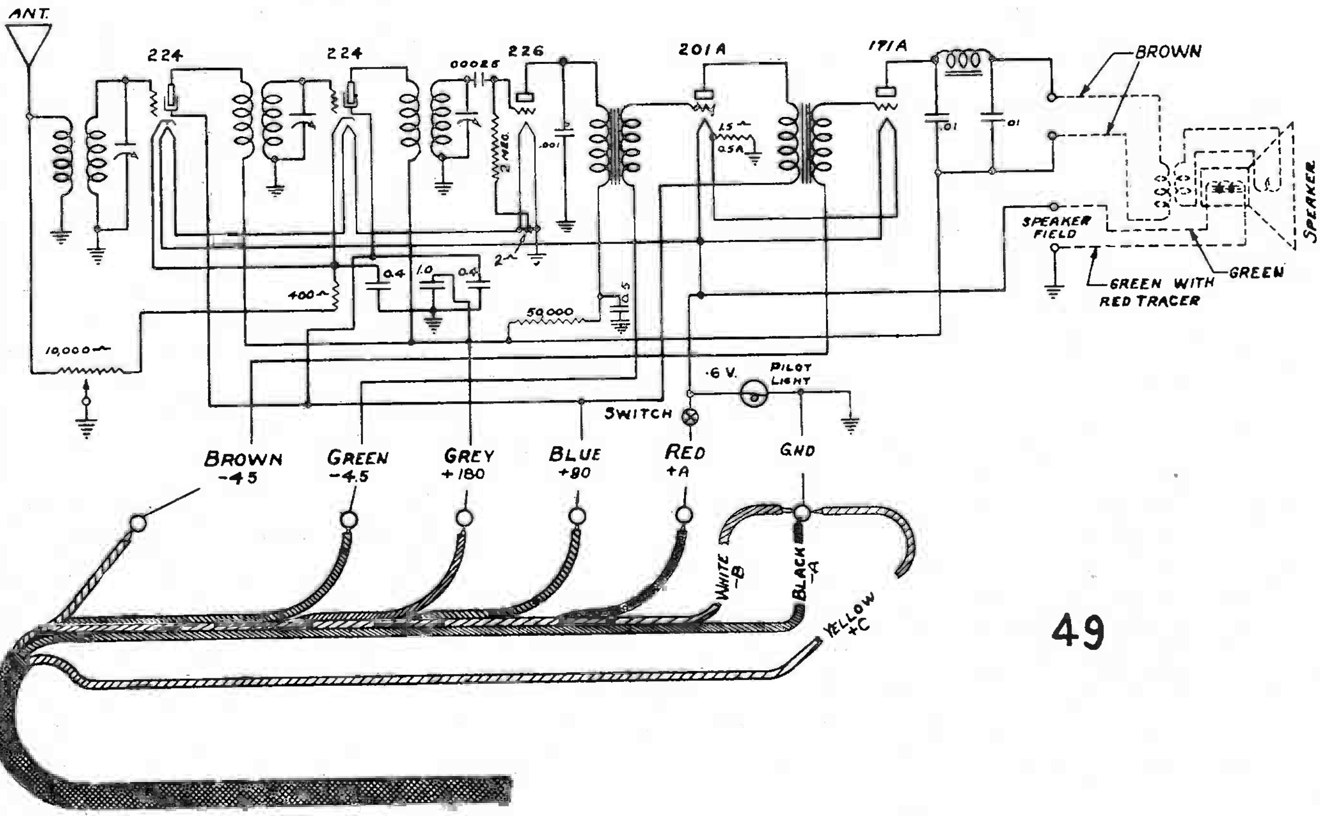
MONTGOMERY WARD AND CO.



20 W
62-520

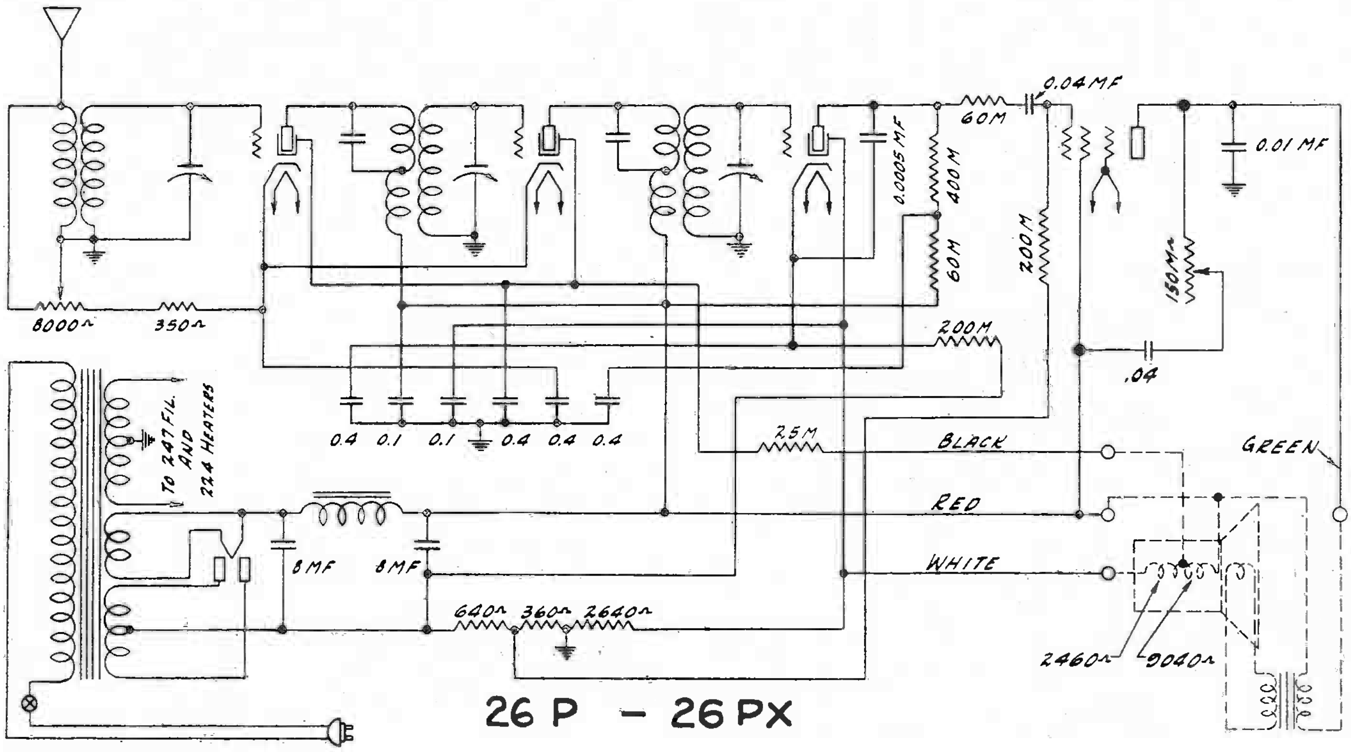
DOTTED LINES SHOWN ARE IN SPEAKER.

Type of Tube	Position of Tube	Function	"A" Volts	"B" Volts	Control Grid "C" Volts	Screen Volts	Screen Current MA	Cathode Volts	Plate MA	Grid Test MA
224	1	1st Radio	2.5	196	2.2	85	1.4	2.2	5.	7.1
224	2	Detector	2.5	95	2.3	17	.015		.1	.2
171A	3	1st Audio	5.1	191	43.				18.	20.
280	4	Rectifier	5.1						23. Per Plate	

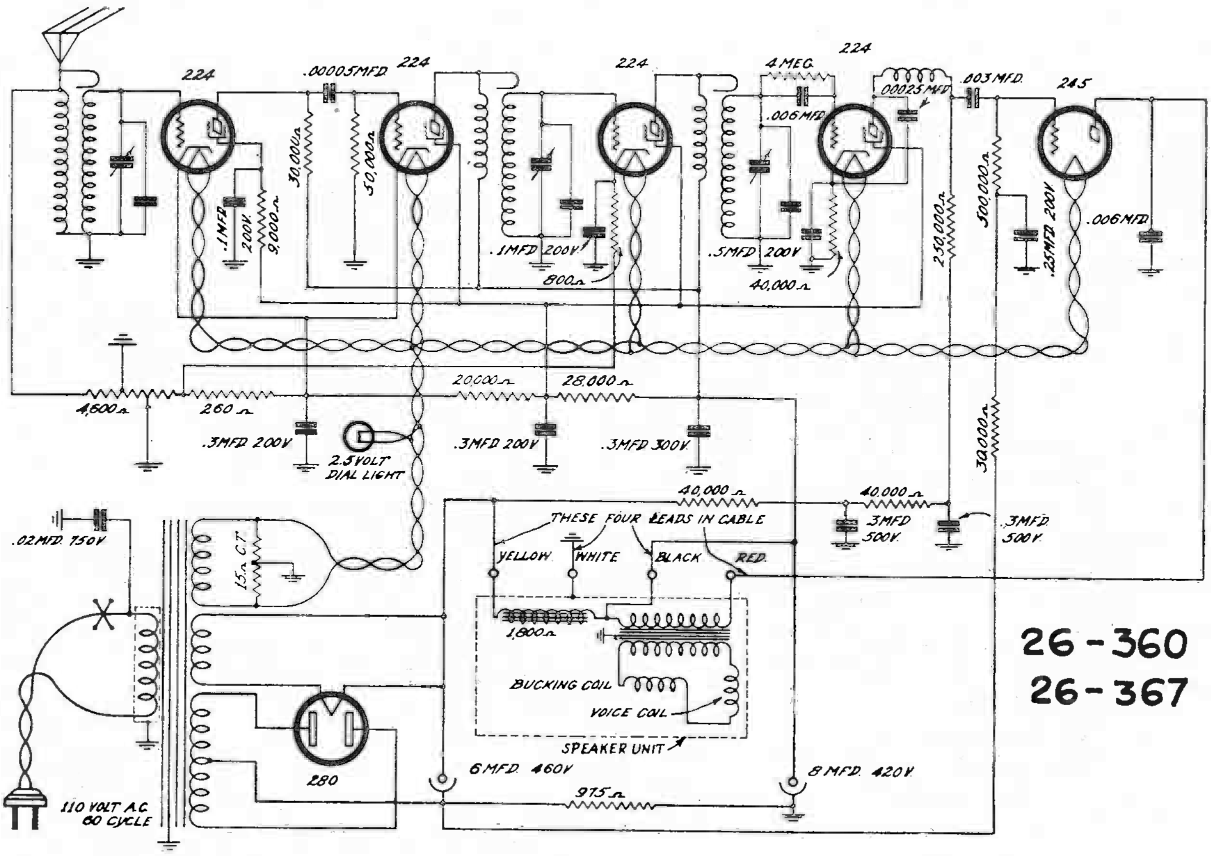


49

MONTGOMERY WARD AND CO.

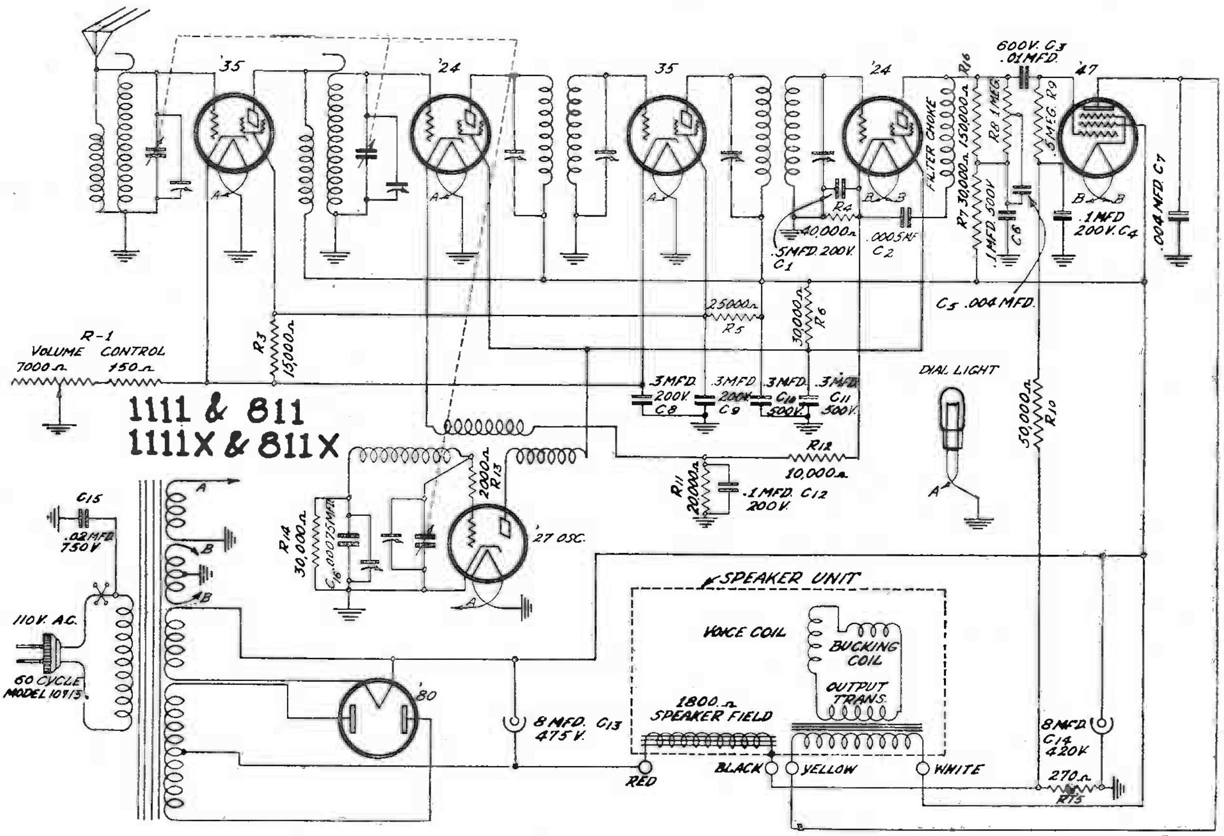


26 P - 26 PX

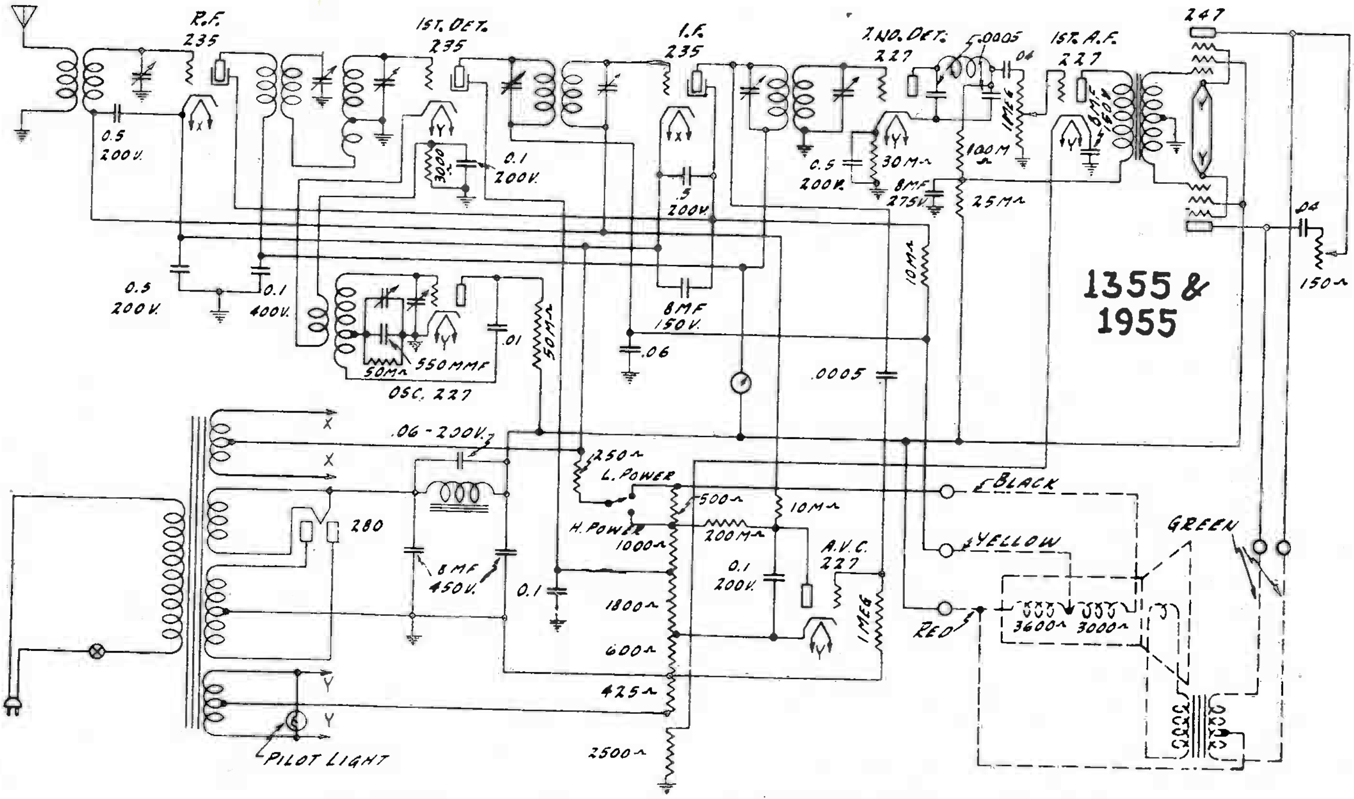


26-360
26-367

MONTGOMERY WARD AND CO.



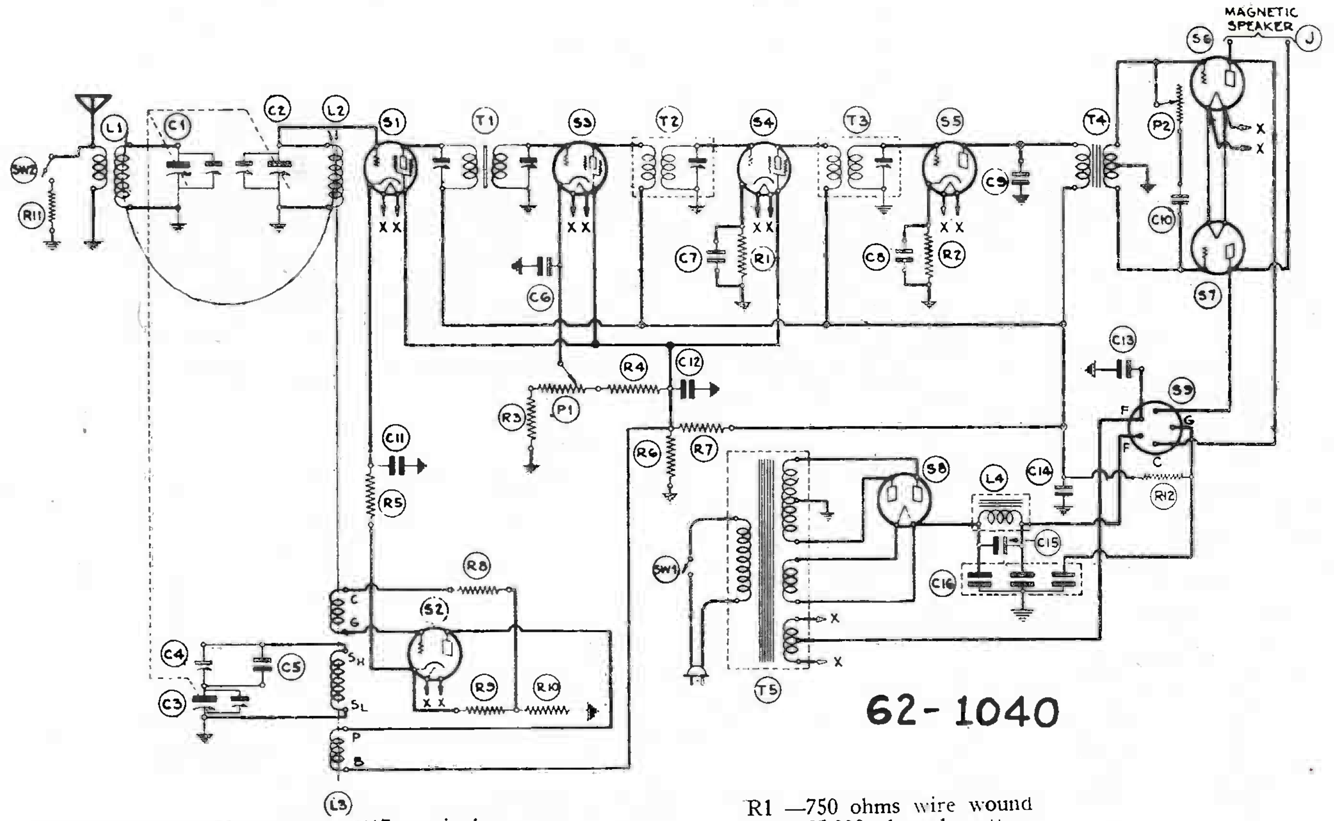
1111 & 811
1111X & 811X



1355 & 1955

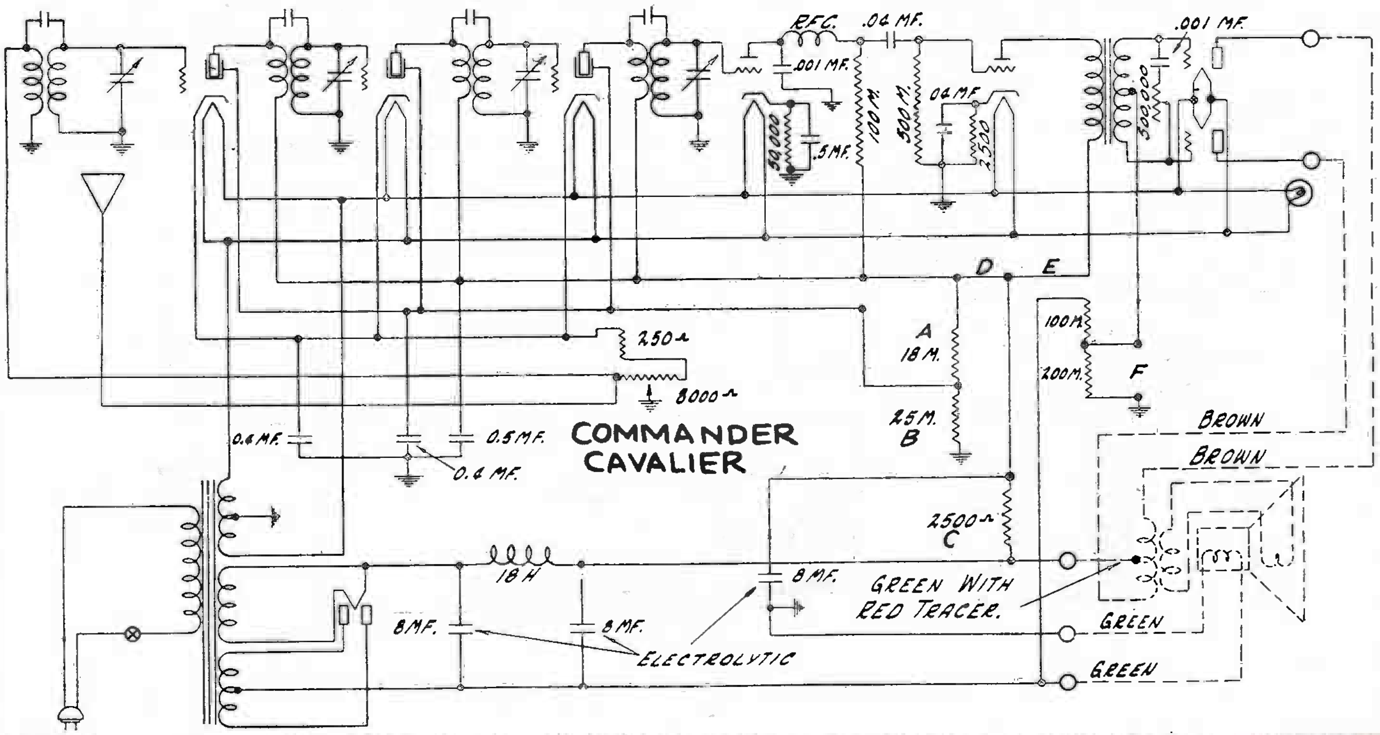
DOTTED LINES SHOWN ARE IN SPEAKER

MONTGOMERY WARD AND CO.

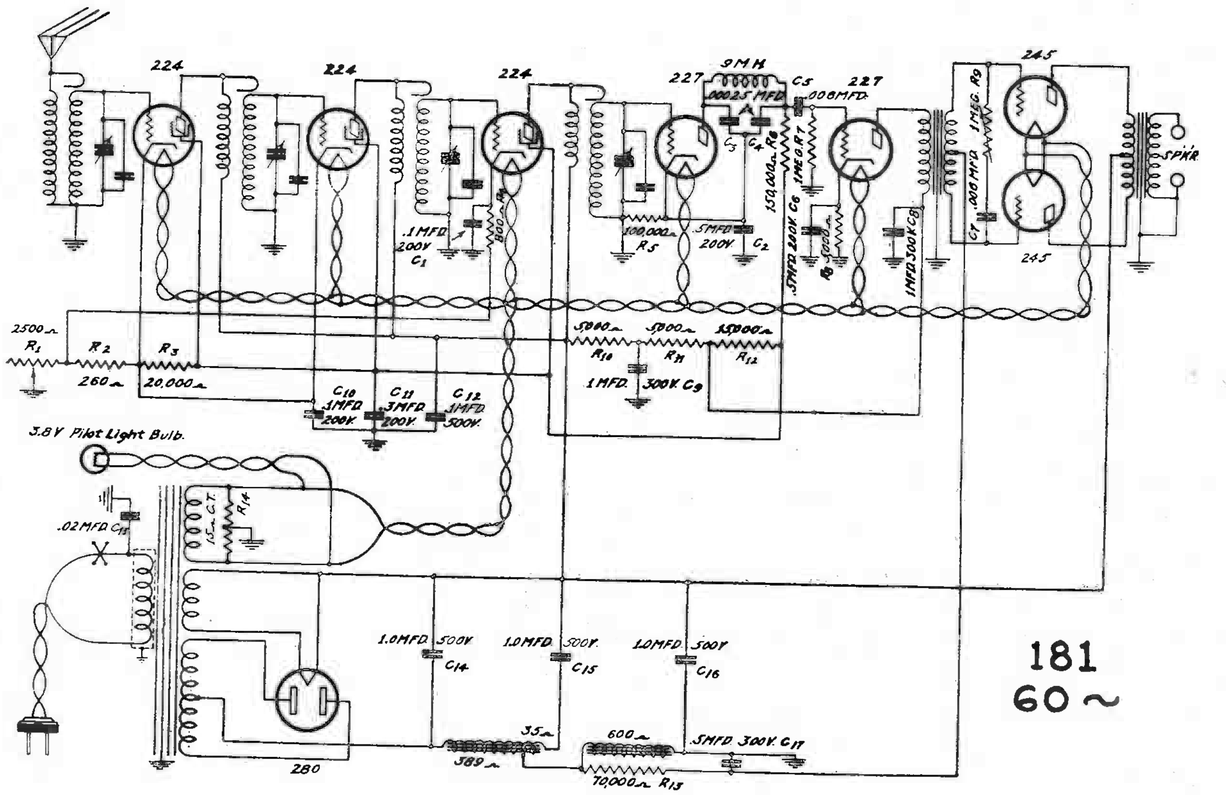


C1-C2-C3 —425 Mmfd. Max., 417 nominal
C4 —Variable 250-600 Mmfd.
C5 —750 Mmfd. Nominal 10% (Mica)
C6 —0.1 Mfd.
C7 —0.1 Mfd.
C8 —1.0 Mfd. 150 V.
C9 —.001 Mfd. Mica
C10—.003 Mfd.
C11—0.1 Mfd.
C12—1.0 Mfd. 150 V.
C13—0.1 Mfd.
C14—1.0 Mfd. 300 V.
C15—.25 Mfd.
C16—Three 4 Mfd. Units (Dry Electrolytic)

R1 —750 ohms wire wound
R2 —25,000 ohms 1 watt
R3 —200 ohms wire wound
R4 —25,000 ohms 1 watt
R5 —10,000 ohms 1 watt
R6 —10,000 ohms 1 watt
R7 —3500 ohms 3 watt
R8 —400 ohms wire wound
R9 —100 ohms—wire wound, tapped at 100 ohms
R10—1000 ohms
R11—100 ohms
R12—4000 ohms 2 watt
P1—10,000 ohm wire wound pot.
P2—½ megohm variable tapered res.



MONTGOMERY WARD AND CO.



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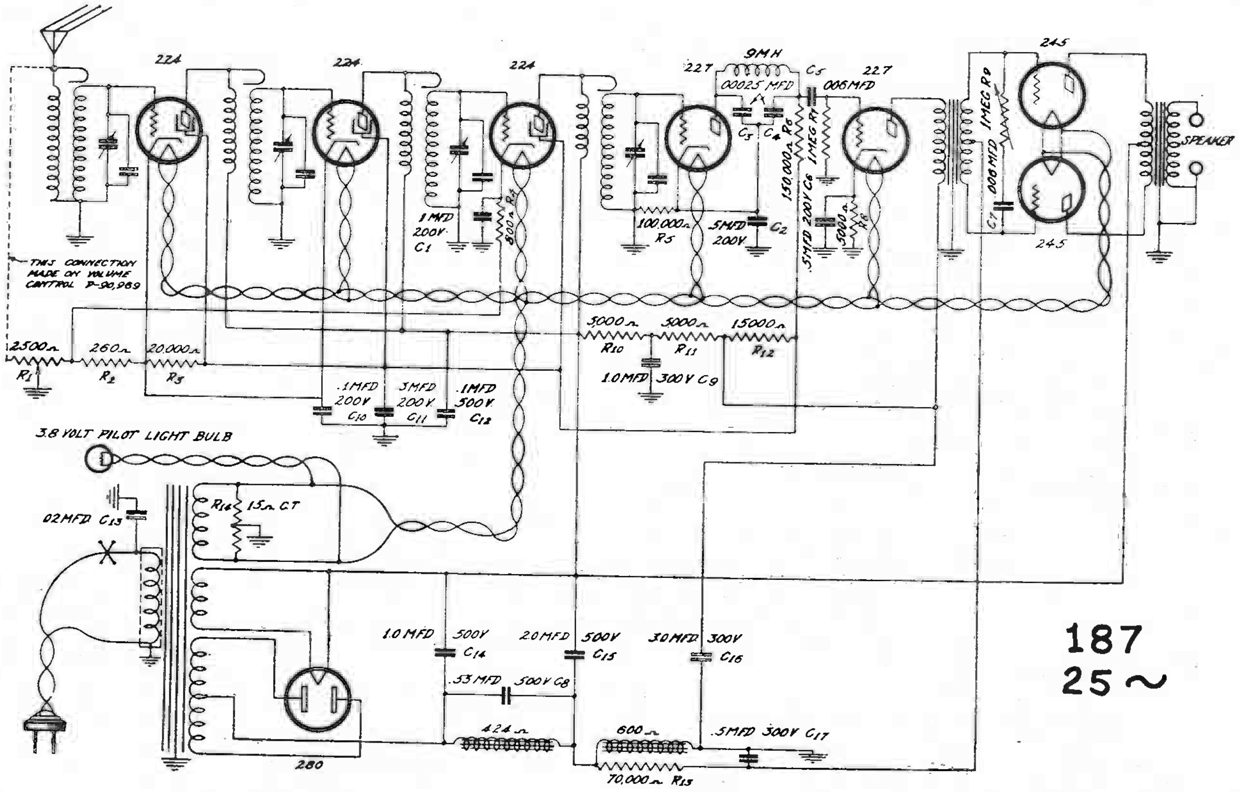
60 ~

Figure 1



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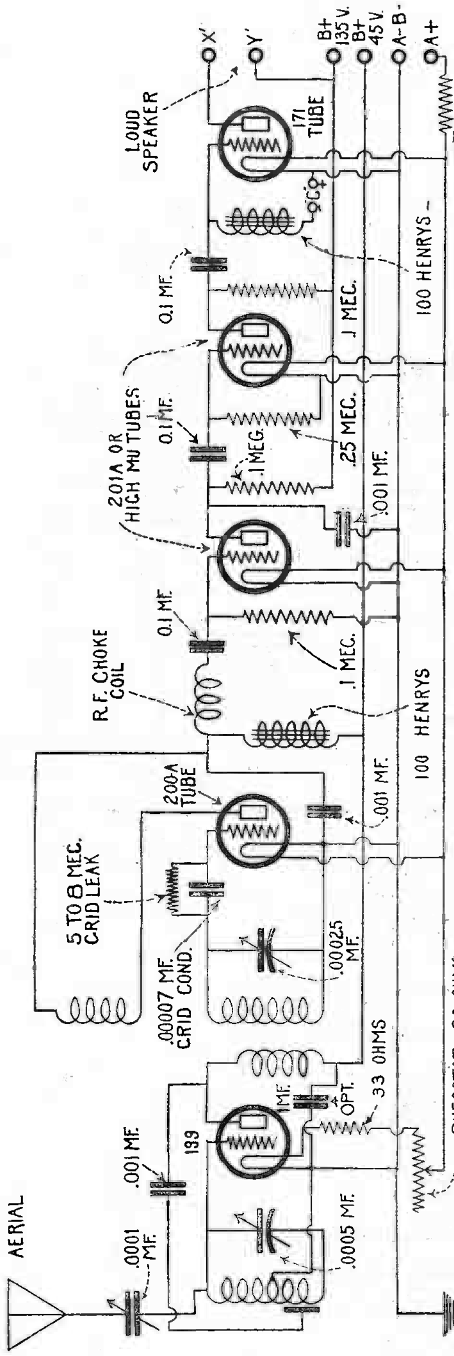
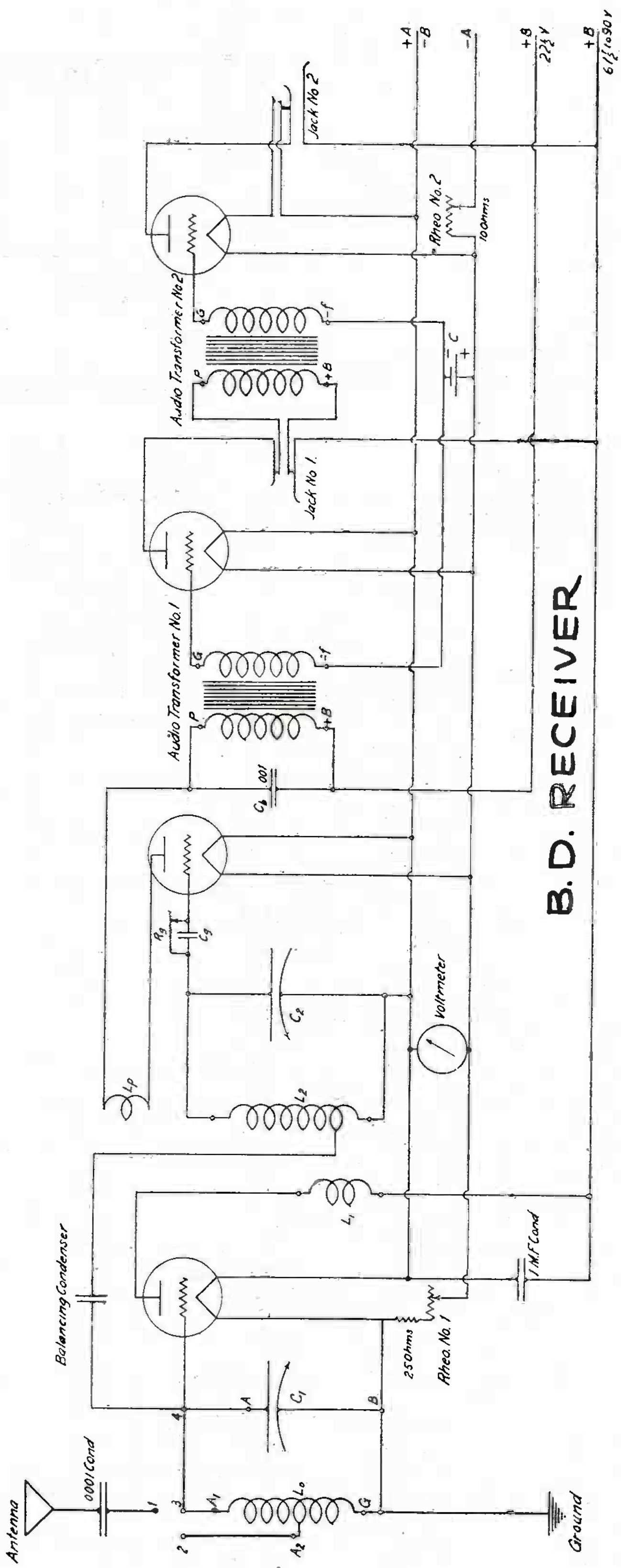
25 ~

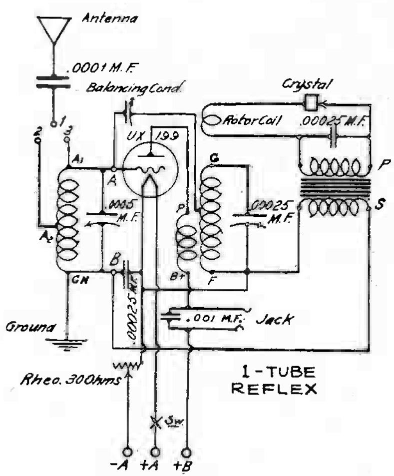
NATIONAL



OFFICIAL B.D.

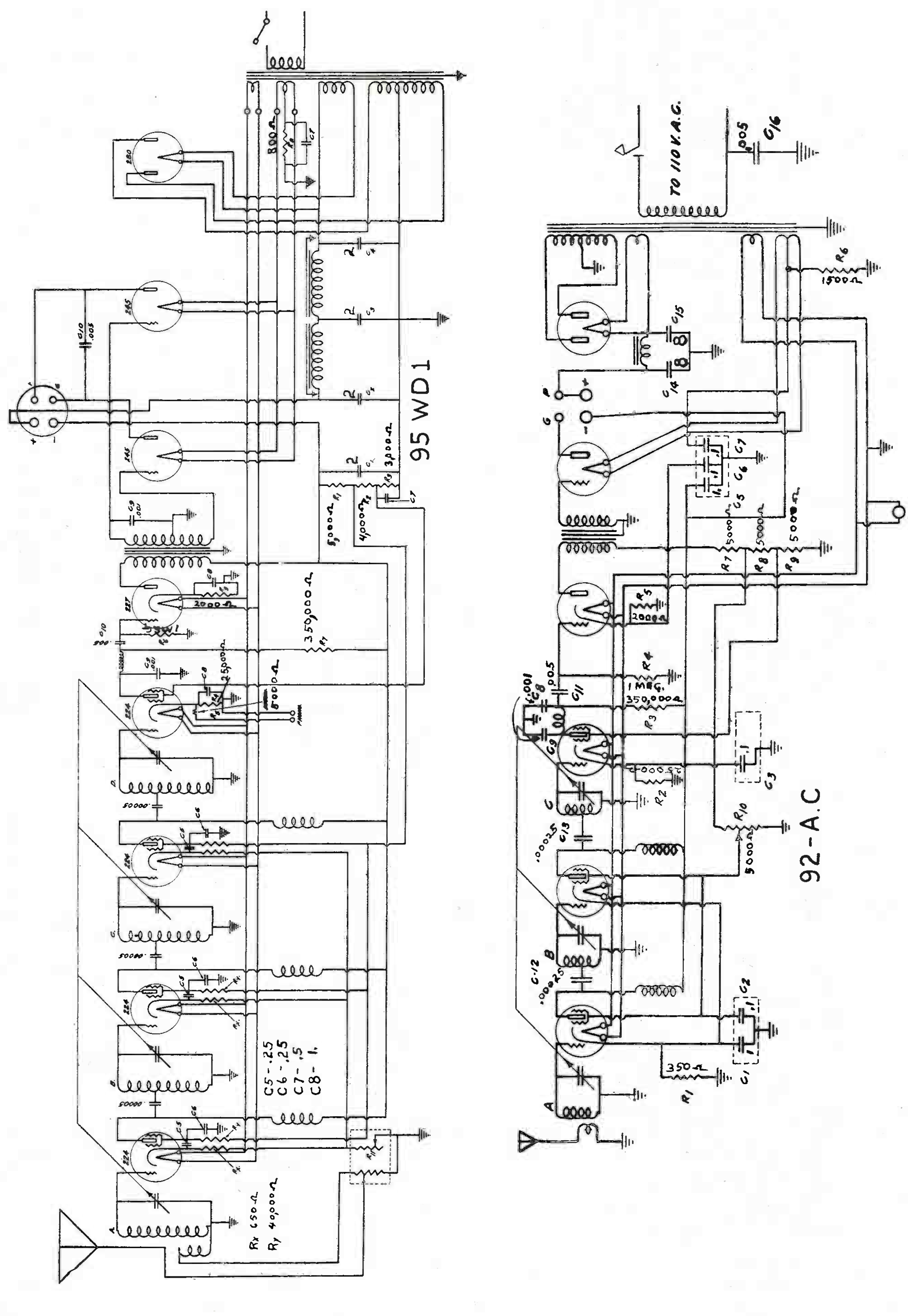


B.D. RECEIVER

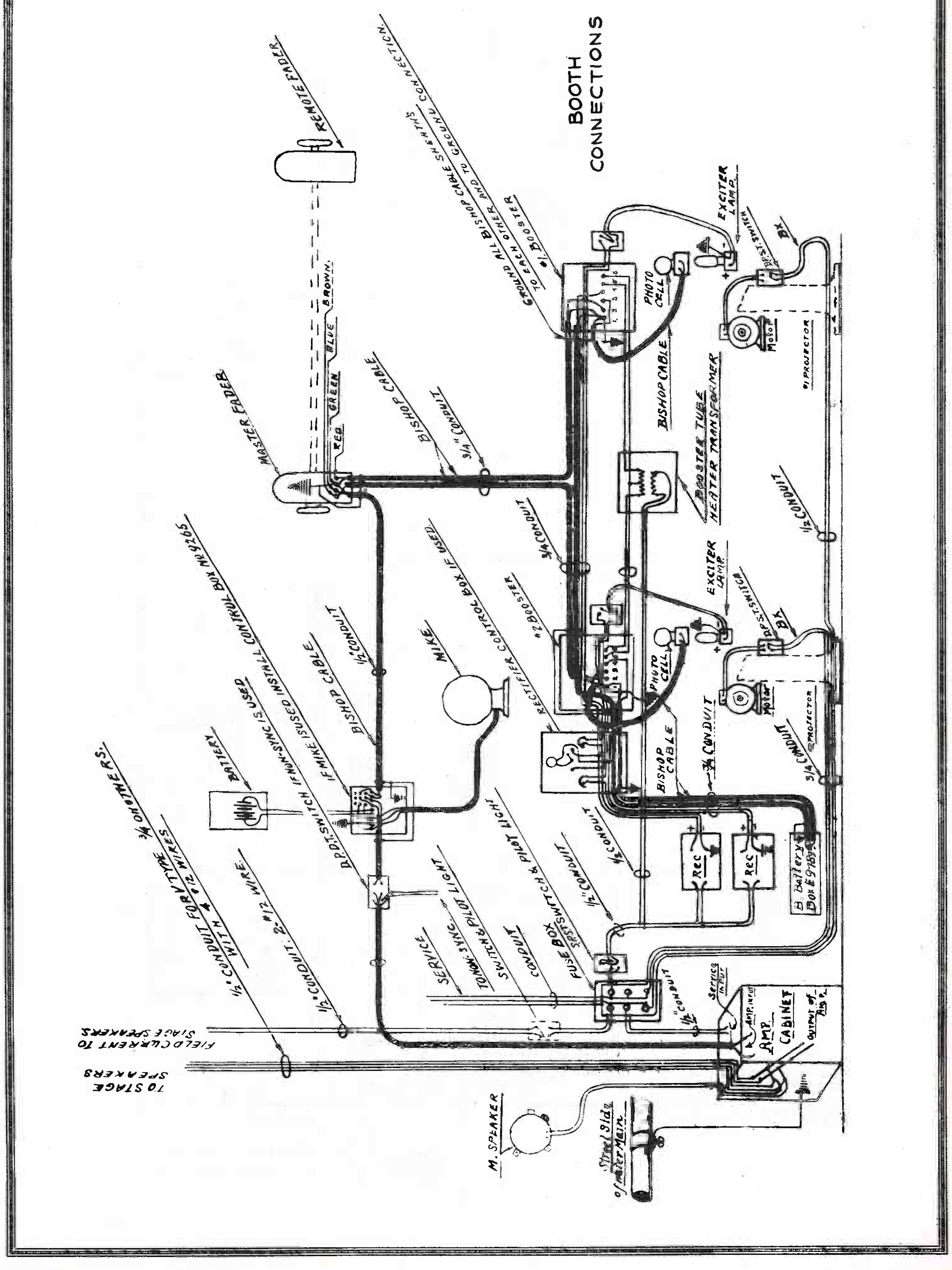


1-TUBE REFLEX

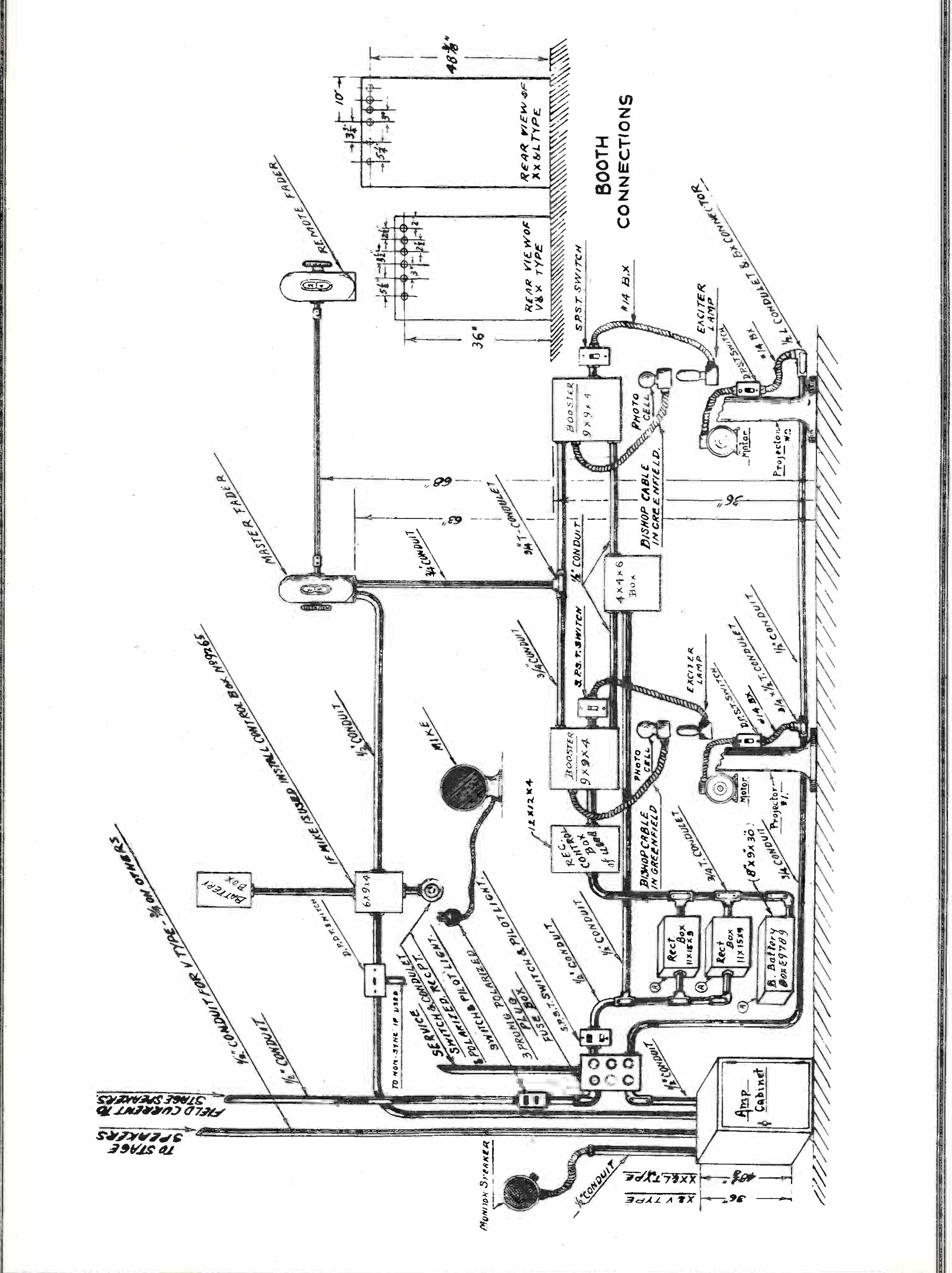
OZARKA, INC.



PACENT ELECTRIC CO. INC.



PACENT ELECTRIC CO. INC.



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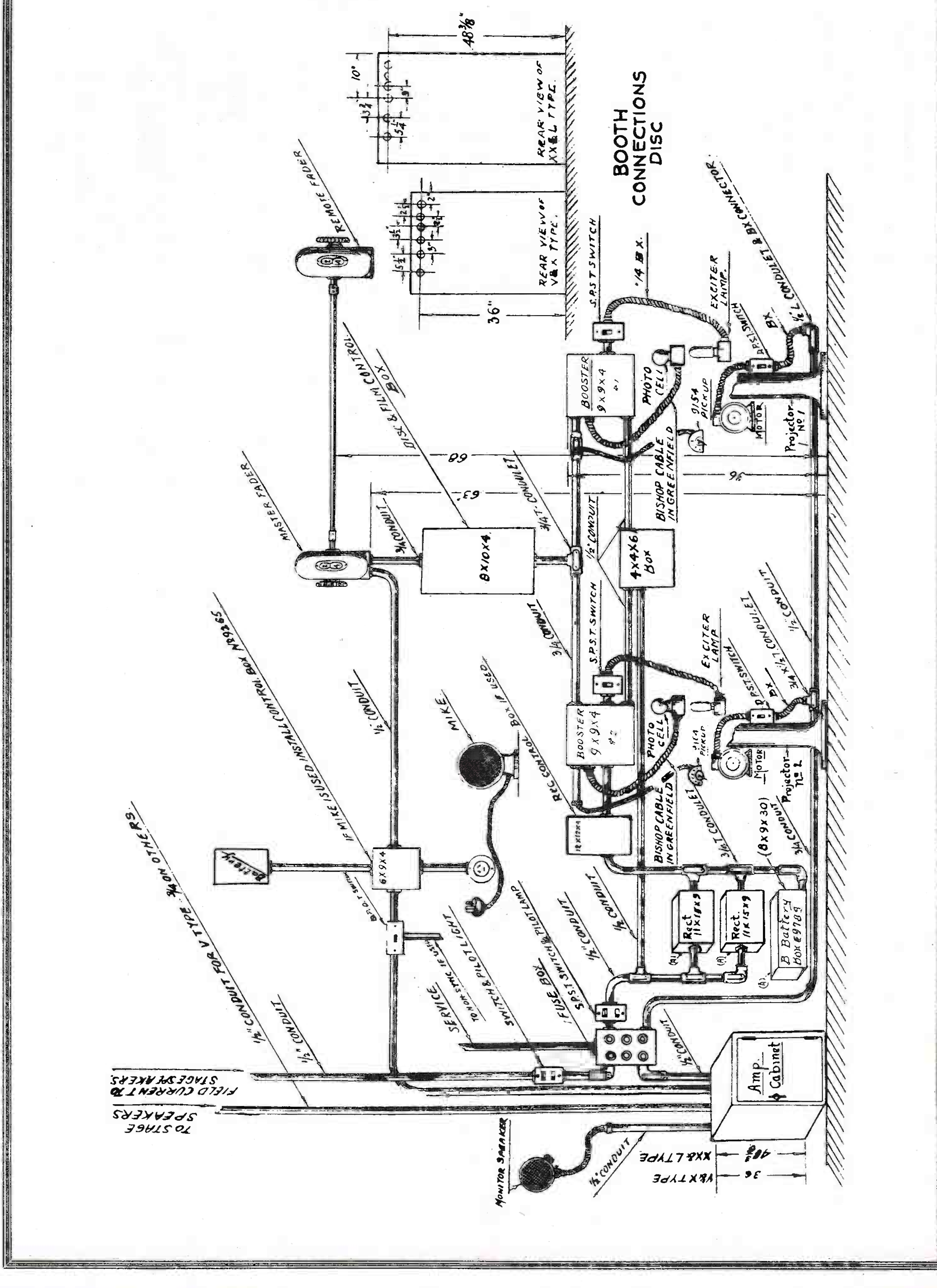


PHILA. STORAGE BATTERY CO.

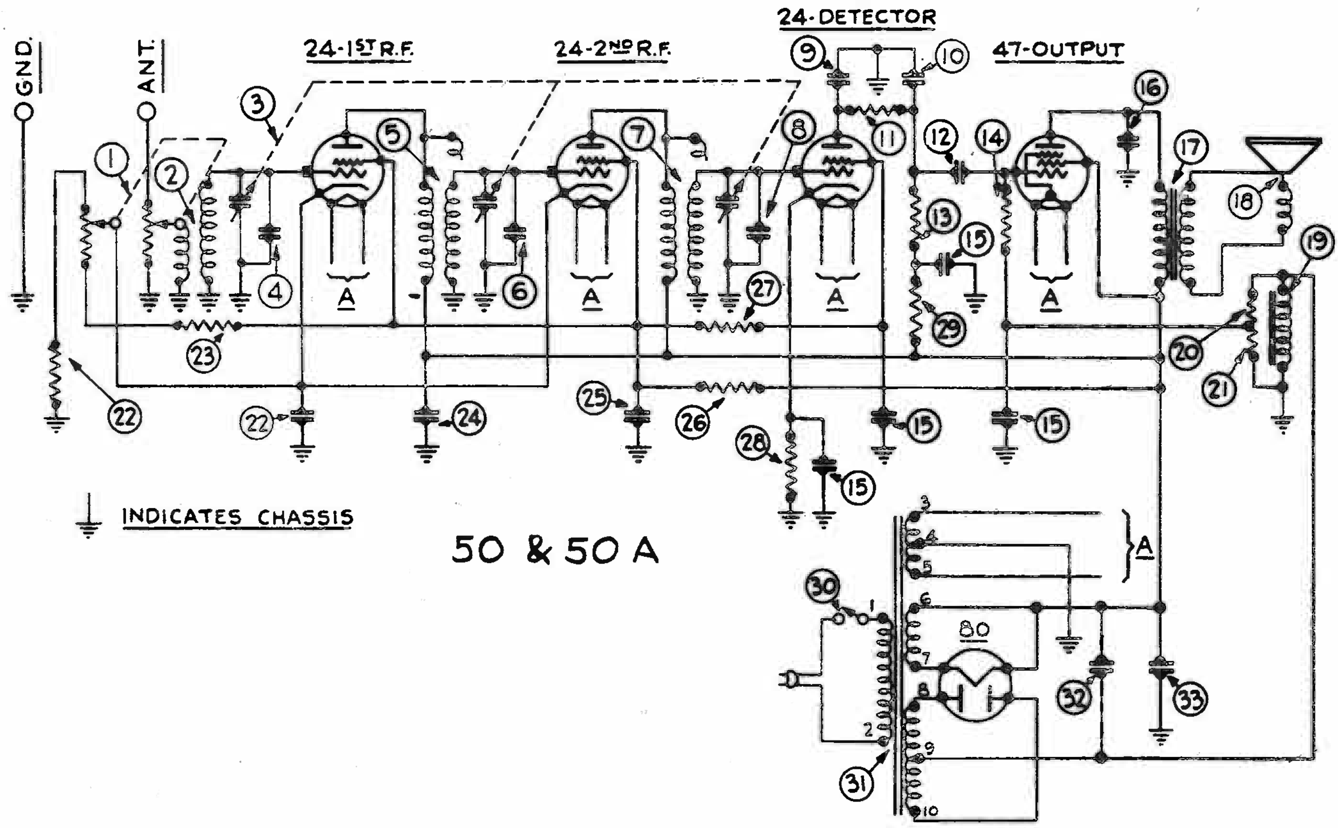


Table 1—Tube Socket Readings Taken with AC Set Tester AC Line—115 volts

Tube Type	Tube Circuit	Filament Volts	Plate Volts	Screen Grid Volts	Control Grid Volts	Cathode Volts	Plate Milli-amperes
24	1st R.F.	2.4	245	90	2.5	3.0	4.5
24	2nd R.F.	2.4	250	90	2.5	3.0	5.5
24	Det.	2.4	100	42	8.0	8.0	0
47	Output	2.4	175*	190*	1.0*	...	2.7*
80	Rect.	5.0	...	...	...	...	30/

Note—Volume Control on full; Station Selector turned to Low Frequency End.
*These readings must be taken from the underside of the chassis, using test prods and leads unless the set checker is specially equipped for testing pentode tubes.

Table 2—Power Transformer Voltages

Terminals	A.C. Volts		Color
1-2	105 to 125	Primary	Black (Small Gauge)
3-5	2.5	Filament of 24 and 47	Black
6-7	5.	Filament of 80	Light Blue
8-10	700.	Plates of 80	Yellow
4	.....	Center Tap of 3-5	Black, Yellow Tracer
9	.....	Center Tap of 8-10	Yellow, Green Tracer

Table 3—Condenser Data

No. on Figs. 2 and 3	Capacity MFD	Container
9 10	.00025	Yellow
12 16	.01	Black Bakelite Container
25	.05	Black Bakelite Container
22	.05 and 150 Ohm resistor	Black Bakelite Container
15	.1, .15, .25, 2-.5 (50-60 cycles) .05, .15, .25, 2-.5 (25-40 cycles)	Metal Container
24	.05	
33	(50 to 60 cycles) 6. (25 to 40 cycles) 10.	Electrolytic Electrolytic
34	6.	Electrolytic

Table 4—Resistor Data

No. on Figs. 3 and 4	Power (Watts)	Resistance	Color Body	Color Tip	Color Dot
22		150 and .05 Mfd.	Black Bakelite Container		
11	.5	10,000	Brown	Black	Orange
23	1.	15,000	Brown	Green	Orange
26	1.	25,000	Red	Green	Orange
28	.5	32,000	Orange	Red	Orange
27 29	.5	99,000	White	White	Orange
21	.5	160,000	Brown	Blue	Yellow
13	.5	240,000	Red	Yellow	Yellow
14 20	.5	490,000	Yellow	White	Yellow

PHILA. STORAGE BATTERY CO.

"TRANSITONE MODEL 3"

Automotive Battery-Operated Receiver with Automatic Volume Control)

This model, manufactured by Transitone Automobile Radio Corporation, Philadelphia, Pa., bears no resemblance to previous "Transitone" models described in past issues of RADIO-CRAFT.

Of exceptional interest is the inclusion of automatic volume control; a two-element or diode detector is used. "C" bias is obtained by resistor-drop, as in socket-power sets; as the schematic circuit indicates, there are 20 resistors in this battery-model receiver.

The values of the various components are as follows: resistor R1, 10,000 ohms; R2, R7, R8, R13, 0.1-meg.; R3, R4, R6, 250 ohms; R5, R12, R20, 1. meg.; R9, R10, 30 ohms; R11, R15, 0.25-meg.; R14, volume control; R16, 25,000 ohms; R17, 50,000 ohms; R18, 500 ohms; R19, 300 ohms.

Condensers C1, C2, C3 are the usual tuning units; C4, C5, C6, C9, C10, .05-mf.; C7, C18, 1 mf.; C8, C16, 0.25-mf.; C11, C13, C14, .00025-mf.; C12, .0005-mf.; C15, .015-mf.; C17, 2 mf.

Resistors R6, R9, R10 and R20 are contained in one unit; and resistors R18 and R19 in another. Resistors R3 and R4 are combined with condensers C9 and C10.

It should be obvious that the most important single factor in correct operation of this model receiver, aside from tubes of correct characteristic, is the use of resistors of correct constants. The wattage ratings of the resistors are as follows: R1, R5, R7, R8, R11, R13, R15, 0.5-watt; R2, R12, R16, R17, 1 watt. The resistor color code is as follows: R1, black; R2, R7, R8, R13, silver gray, yellow tip; R5, R12, green, white tip; R11, R15, white; R16, brown, yellow tip; R17, orange; R18-R19, and R20, flat wire-wound.

Tube average operating characteristics are as follows: filament potentials, V1, V2, V3, 2 volts; V4, V5, V6, V7, 5 volts. Plate potentials: V1, V2, V3, 150 volts; V4, zero; V5, 45 volts; V6, 140 volts; V7, 142 volts. Control-grid potentials (negative): V5, 1.0 volt; V6, 2.5 volts; V7, 32 volts. Cathode potentials: V1, V2, V3, 2 volts. Screen-grid potentials: V1, V2, V3, 80 volts. Plate currents: V1, V2, V3, 1.5 ma.; V4, zero; V5, 1.0 ma.; V6, 3 ma.; V7, 16 ma.

If it becomes necessary to re-align the tuned circuits to obtain greater selectivity and volume, use a fiber wrench and adjust the trimmers for a signal between 1,000 and 1,200 kc.; starting first at C3.

Noisy operation may be due to a poor bond between the receiver chassis and the car chassis. A partial test for this possible source of trouble is to remove the antenna leads when noise due to this cause will continue unabated.

Lack of sensitivity, or noisy operation, may be due to close proximity of the antenna in the top of the car to the metal-work; the aerial should be spaced from *all* such conductors (for instance, the dome light) by a distance of at least 3 inches.

There is only one "A" lead; it is black, and terminates in a lug. Connect this to one of the ammeter terminals on the instrument panel, so that the current drain of the radio set does not show on the meter. The charging rate of the car storage battery should be increased about 2 amps., to compensate for the average amount of current consumed by the radio set.

After servicing an automotive receiver it is important to see that all metal parts—shielding, cable sheaths, etc.—are well grounded to the chassis of the car. Tubes and batteries after replacement must be securely fastened in place.

If it becomes necessary to replace the flexible tuning shaft, the procedure is as follows: push the free end of the flexible shaft through the bracket on the receiver so that the tip of the shaft is seated in the coupler. Tighten the two set-screws on the coupler, and then tighten the set-screw on the bracket just enough to hold the casing in place. Tune in a station of known frequency, adjusting the receiver exactly. Loosen the two set-screws on the coupler which lock the shaft in place. The flexible tuning shaft can then be turned without affecting the setting of the tuning condenser in the receiver. Set the dial scale accurately to the channel number corresponding to the station frequency, and re-tighten the two set screws on the coupler. Check at several points the relation between dial reading and station frequency.

The best material for an aerial is No. 14 or 16 copper screening, 36 in. wide. It should be used to replace all galvanized iron poultry-screen, where the twisted parts are not bonded; cutting and lacing back the latter to make room for the copper screen. Most car tops are of wooden-bow and cloth construction, with perhaps poultry-screen; but, where steel bows are used, instead, greater sensitivity sometimes is obtained by lacing in an antenna of stranded rubber-covered wire.

Poor tone quality may be due to an air space between the reproducer and the baffle (Part No. 2697-A) which should be used with it.

Standard interference suppression includes the use of standard spark-plug series resistors, a distributor (high-tension-lead) series resistor, and interference bypass condensers on the brush side of the generator cutout, and the battery or ammeter side of the ignition coil.

If this procedure (described in detail in past issues of RADIO-CRAFT magazine) does not result in sufficient suppression, it may be necessary to try the following: move the ignition coil from inside of dash to engine side of partition; shield the high- and low-tension leads from the ignition coil to the dash; and securely ground the shielding, or mount the coil on the engine side of the dash. (In some instances the construction of coil and switch may render this impossible; when it will be necessary to use a separate coil and mount it in the engine compartment). Note particularly that only in rare instances should high-tension leads be shielded; for which purpose "shielded high-tension cable" *must* not be used.

It may be necessary, in some cases, to connect the "A—" black-with-white lead to the battery instead of the battery-side of the ammeter; and perhaps shield the lead, grounding the shield (copper braid over loom) in several places—a procedure which is particularly efficacious. Improved reception then indicates that further correction should be applied: shielding of the speaker cable, and the battery cable between set and control-unit. All shielding should be grounded. (Commercial shielded-cable is preferable to separate shielding.) In some cases it is desirable to shield the lead from antenna to set; using only "shielded high-tension cable."

Interference due to dome-light coupling may be eliminated by connecting bypass condensers where these wires enter the corner post. Dirty distributor contacts may cause noisy operation; over-wide separation of its contacts may cause the same effect. Reversing the ignition coil's primary leads sometimes reduces interference. Rubbing metal parts of the car chassis occasionally require bonding to the body of the car to reduce crackling sounds; cables, rods and pipes unless grounded may act as ignition-noise carriers. Pay particular attention to the temperature-indicator tube and the oil lines.

Fender, seat, and door pads are available, for use to prevent marring the finish of a car when installing or servicing the radio installation.

Dome-light and switch wiring must be run along the side of the top frame, and along the top edge of the side of a bow to the dome-light fixture.

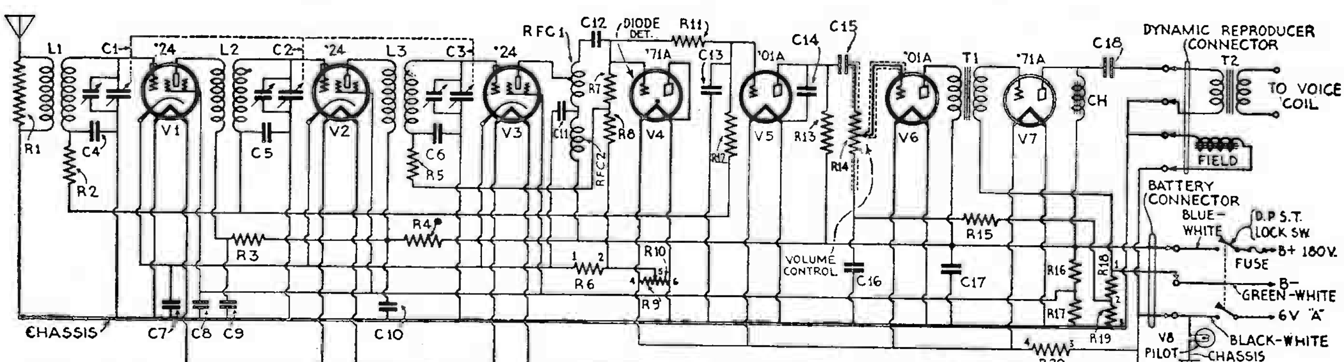
Lack of signals, or weak signals, may be an indication of a grounded antenna.

All conductors should be well insulated from the car chassis, to prevent short-circuit; while fuses in the "B—" and "A" leads adds a safety factor.

It is suggested that a complaint of poor service from the "B" batteries may be checked by reference to the speedometer's mileage indication for the period of the installation of the batteries. This figure, divided by 25, gives approximately the number of hours the radio set has been used; which, divided by the figure for the elapsed time, in days, since the installation of the batteries, indicates the number of hours per day the radio set has been in use. Heavy-duty "B" blocks should last about 600 operating days (1 hour per day), to 150 days (4 hours per day).

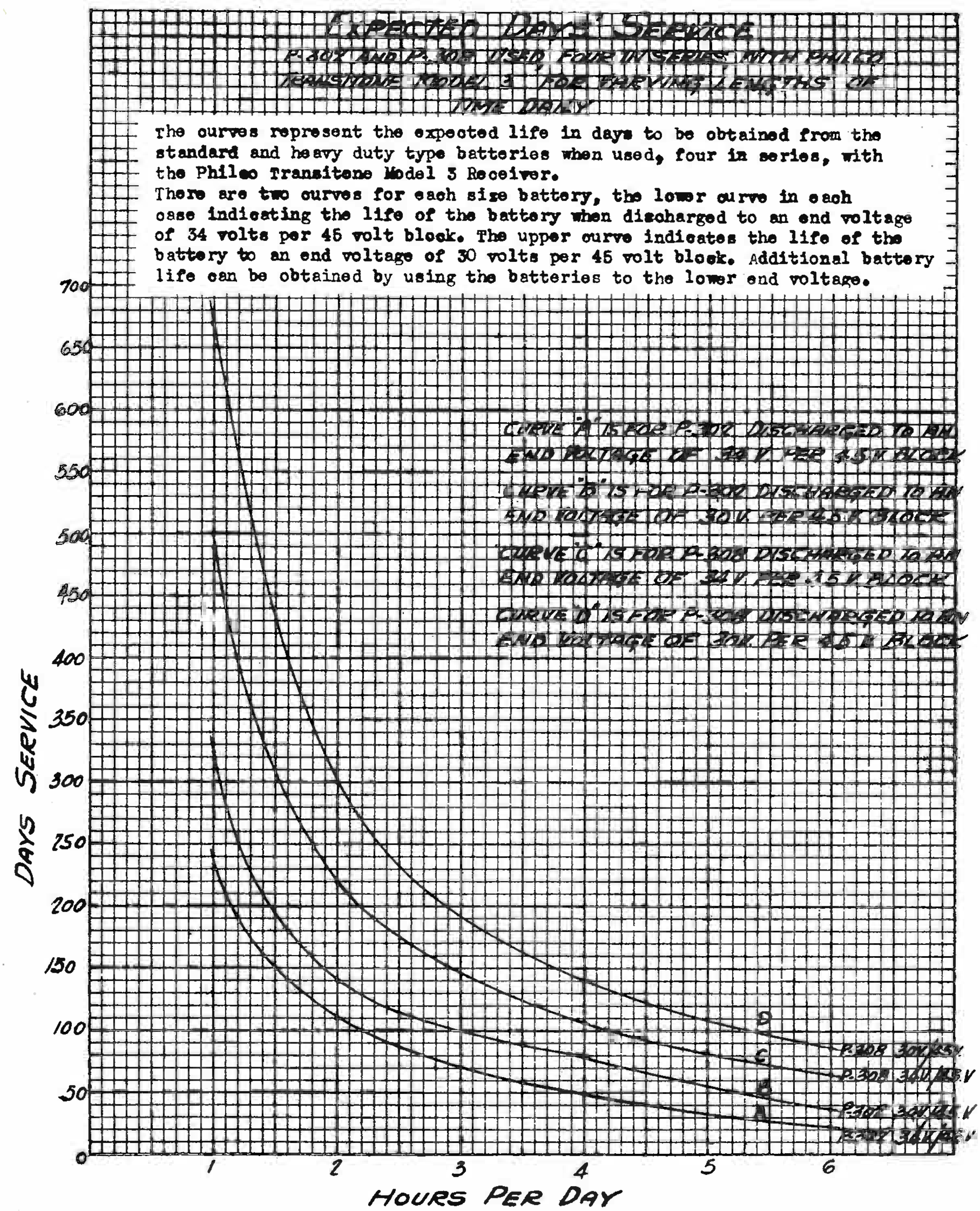
The distributor rotor should just clear all stator contacts (test chalk marks on these contacts should remain undisturbed); file the contacts; or file or peen the rotor, as may be required.

Credit for these data is hereby extended to Messrs. Robert F. Herry and Robert Long, Jr., of the manufacturer's service department.



Schematic circuit of the Philco "Transitone Model 3" receiver, incorporating automatic volume control, a necessity in automotive radio sets to overcome the effects of changing location; the total current consumption is 4 amps. The reproducer is catalogued as the "Transitone Model 3 Dynamic Loud Speaker." Resistor R14 is of standard 0.5-meg. rating.

PHILA. STORAGE BATTERY CO.



PHILA. STORAGE BATTERY CO.

Model 30

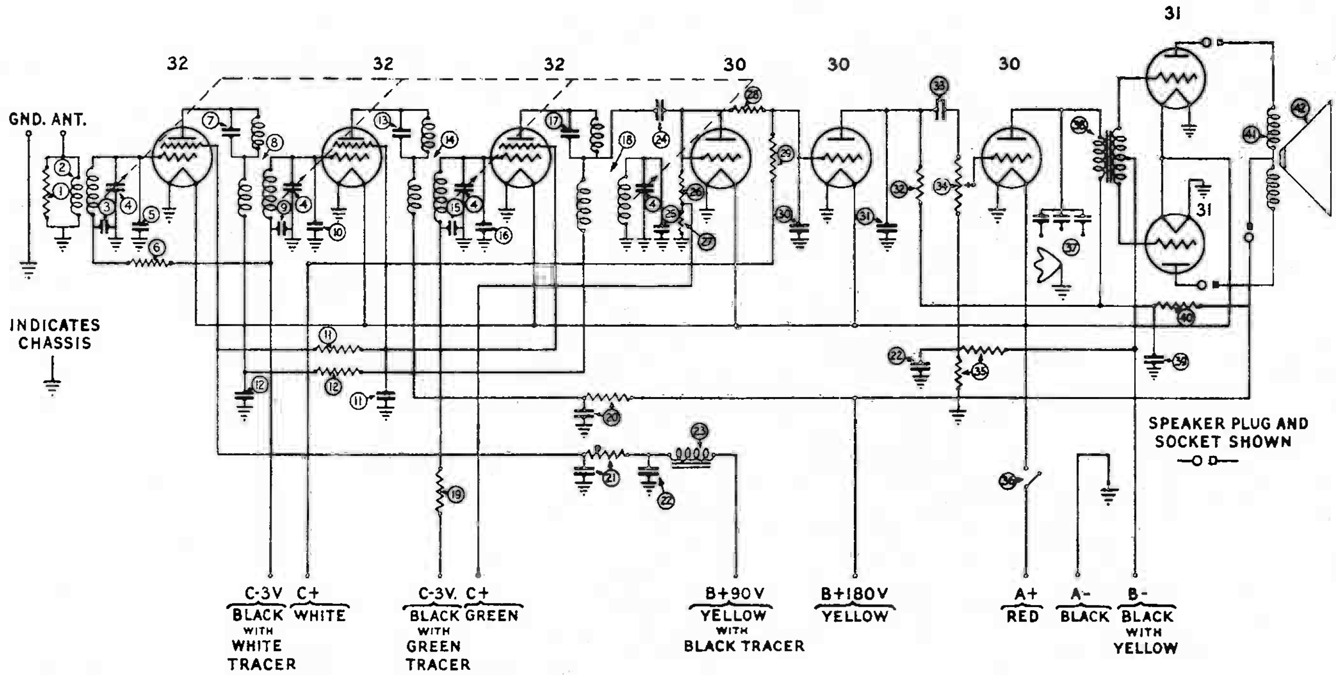


Table 1—Tube Socket Readings Taken with Average Set Checker

Tube	Circuit	Filament Volts	Plate Volts	Grid Volts	Plate Current Milliamperes	Screen Grid Volts
32	1st R. F.	2.0	150	. .	.0015	60
32	2d R. F.	2.0	150	. .	.0015	58
32	3d R. F.	2.0	150	. .	.0015	58
30	Detector Rectifier	2.0	. . .	. .	. . . .	. .
30	Detector Amplifier	2.0	15	. .	. . . .	. .
30	1st Audio	2.0	90	Note 1	.002	. .
31	2d Audio Push-Pull	2.0*	150	24	.008	. .
31	2d Audio Push-Pull	2.0*	150	24	.008	. .

*These readings reversed with respect to other Filament Voltage readings.

Note 1. With volume control in "Off" position, approximately 4 volts; with volume control full on, less than 1 volt.

Always use high-resistance voltmeter, preferably 1000 ohms per volt, when checking voltages in the Receiver. For reading plate and screen voltages, use a 250- or 300-volt scale. Voltage readings taken with meters having less than 250,000 ohms resistance will be lower than voltages given in the table.

When testing a Model 30 Receiver, all tubes must be in their proper sockets. The speaker must be connected and the tube shield must be fastened in place. The readings in Table 1 were taken using "A," "B" and "C" batteries.

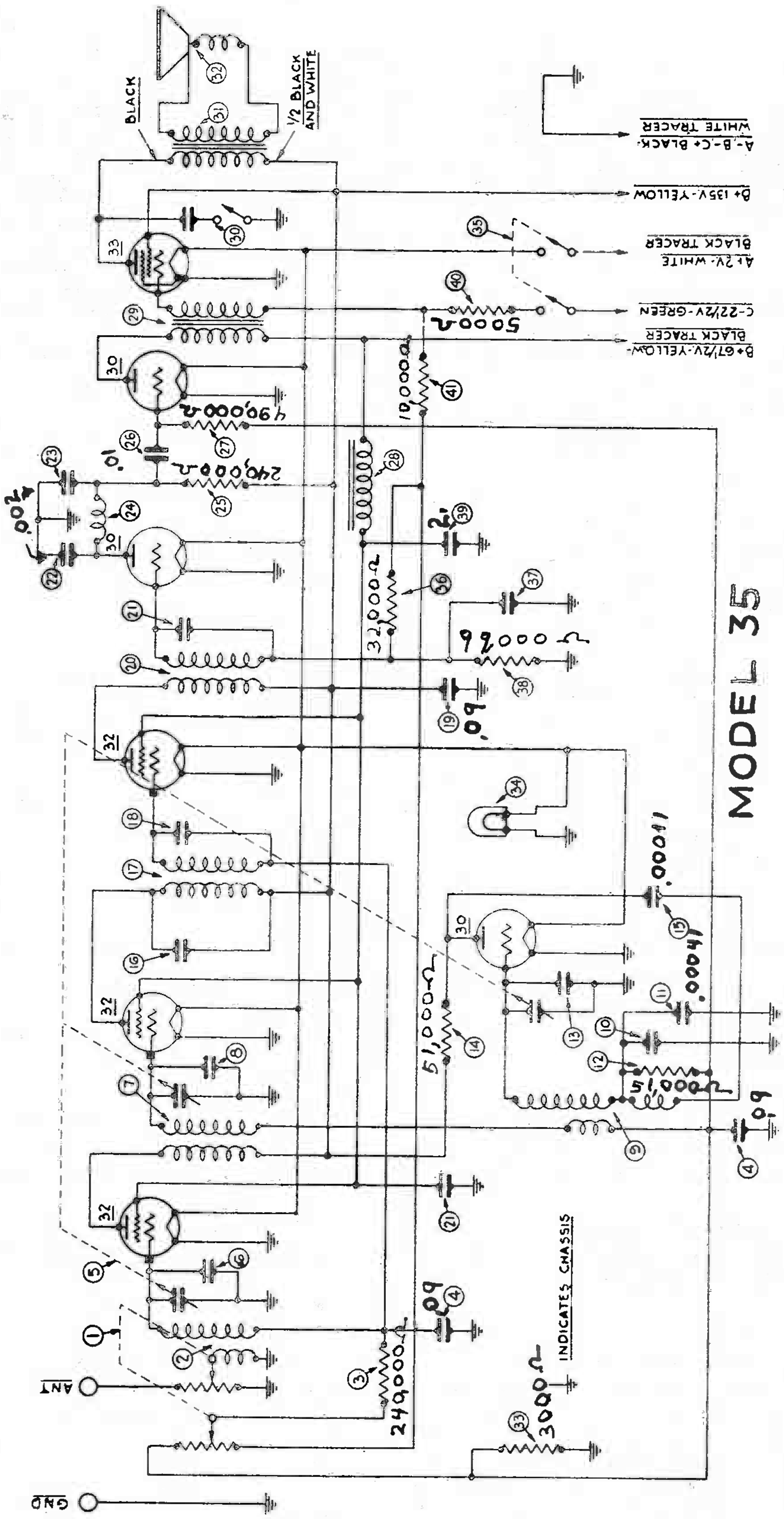
Table 2—Resistor Data

No. on Figs. 1 and 2	Color	Resistance Ohms
1	Golden Yellow	5,000
40	Auto Buff	25,000
6	Jade Green	70,000
26 27	Silver Gray	100,000
28	White	250,000
19 29 32	Battleship Gray	500,000
35	Tubular (two section)	250 / 800

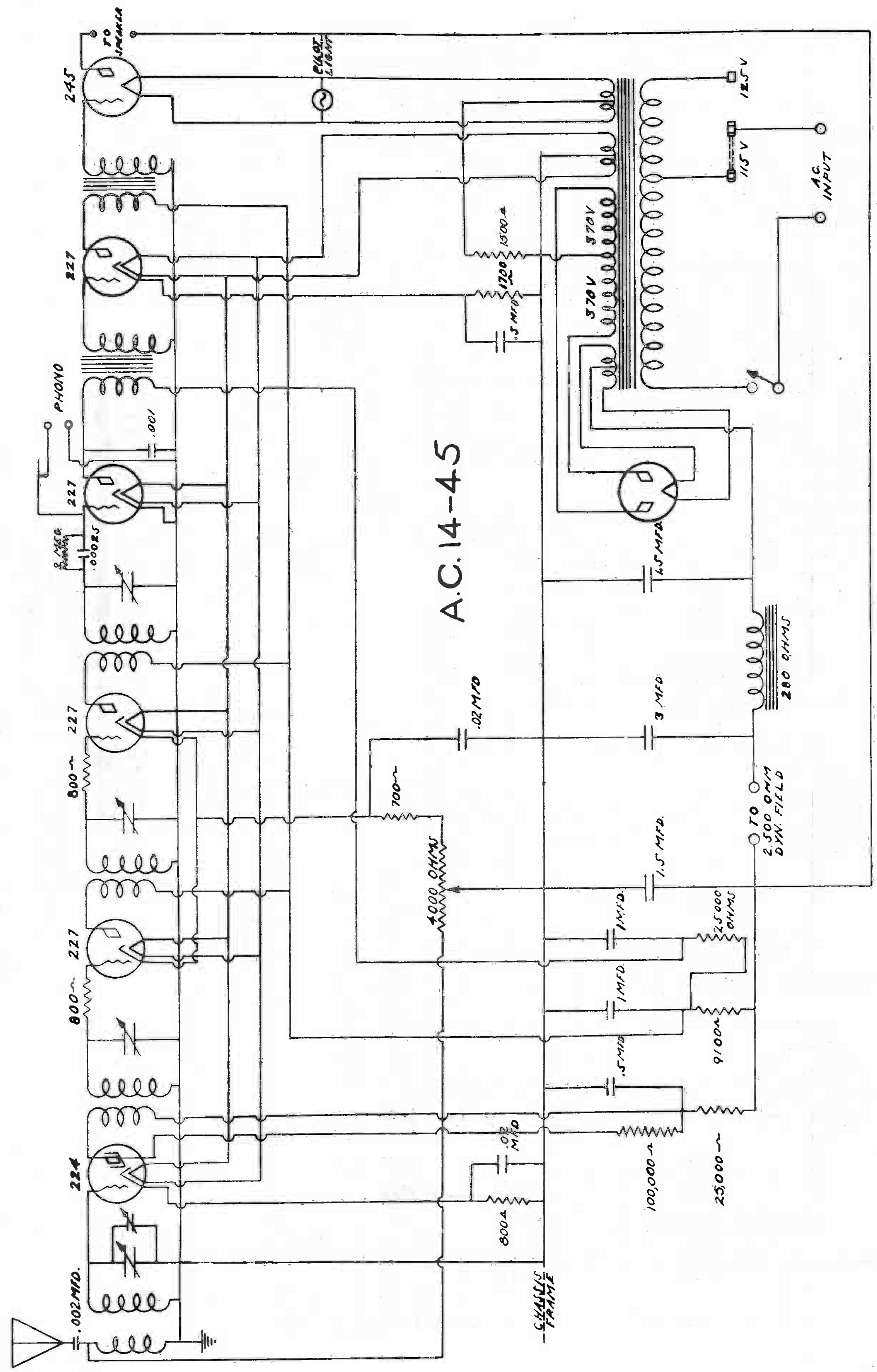
Table 3—Condenser Data

No. on Figs. 1 and 2	Capacity—MFD.
24	.00005
30 31	.000250
33	.01
3 9 15	.05
11 12 30 21	.05 with 250-ohm resistor winding
39	.25 single section
22	.25 two sections

PHILA. STORAGE BATTERY CO.



PIERCE AIRO, INC.



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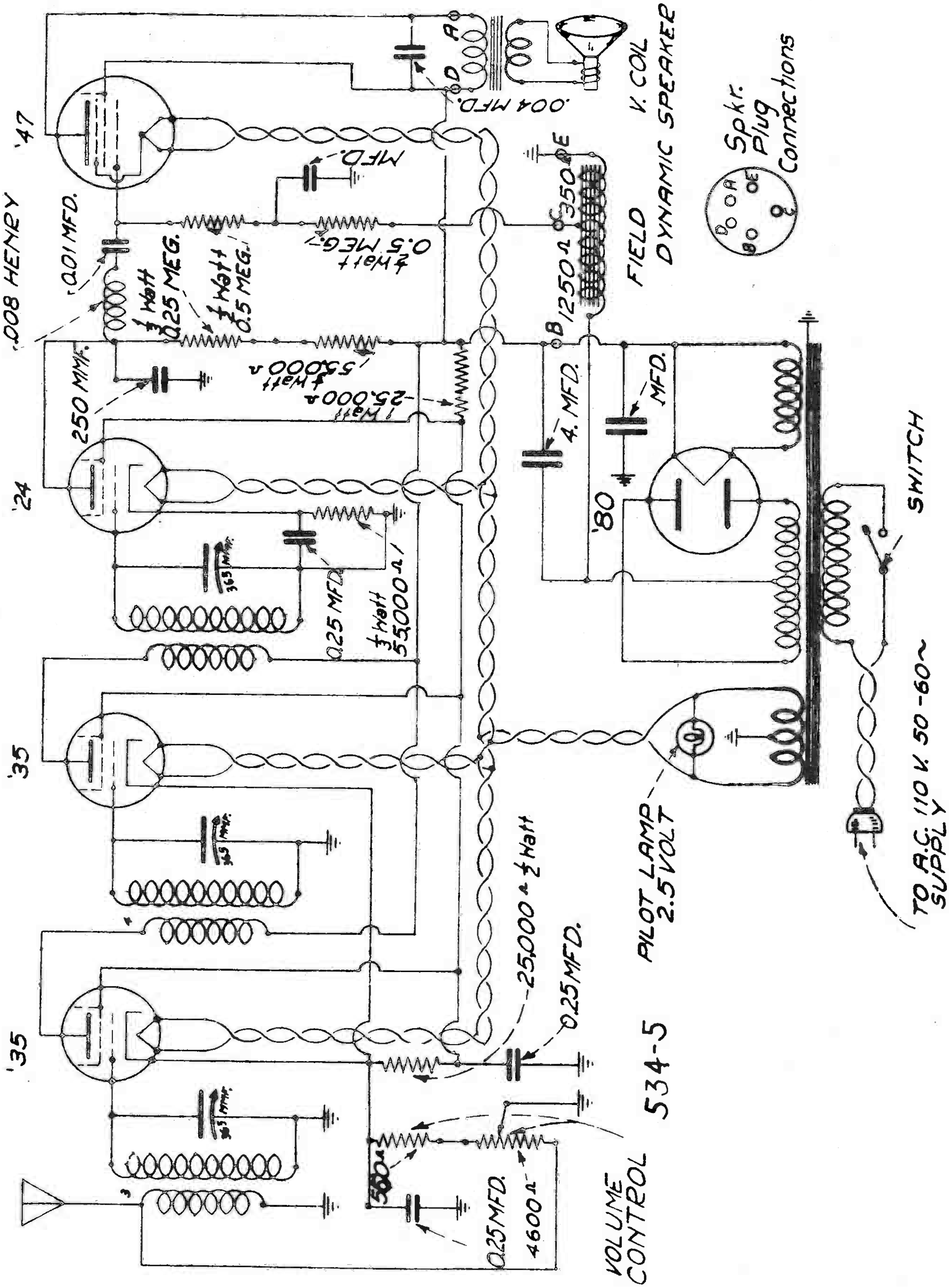

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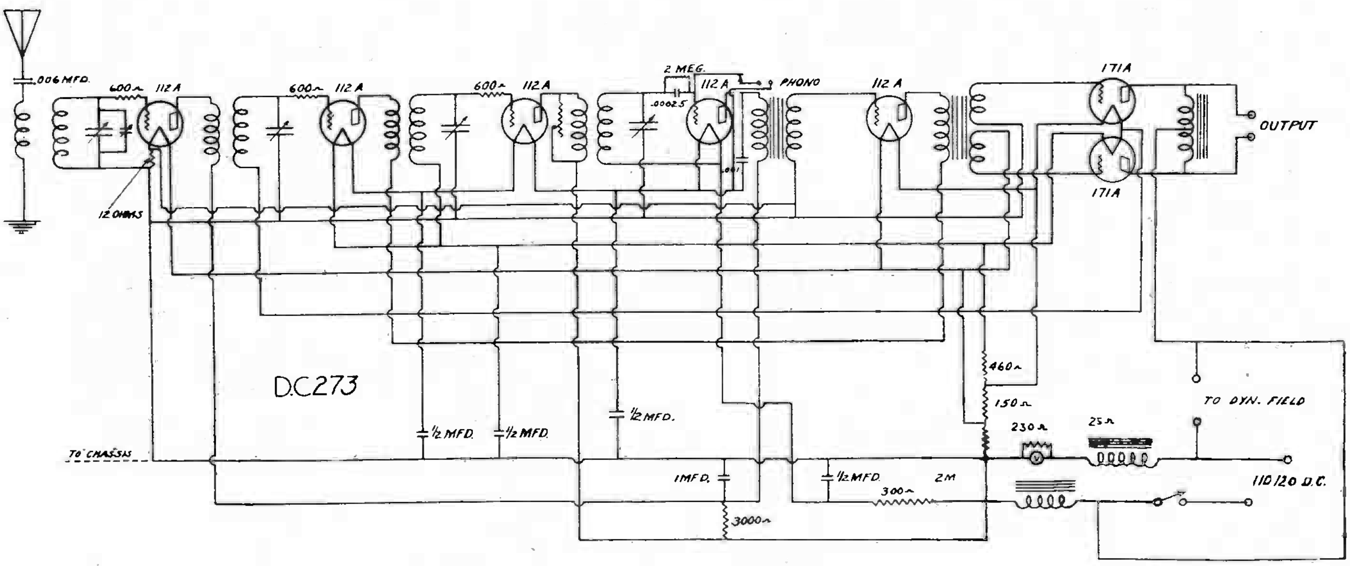

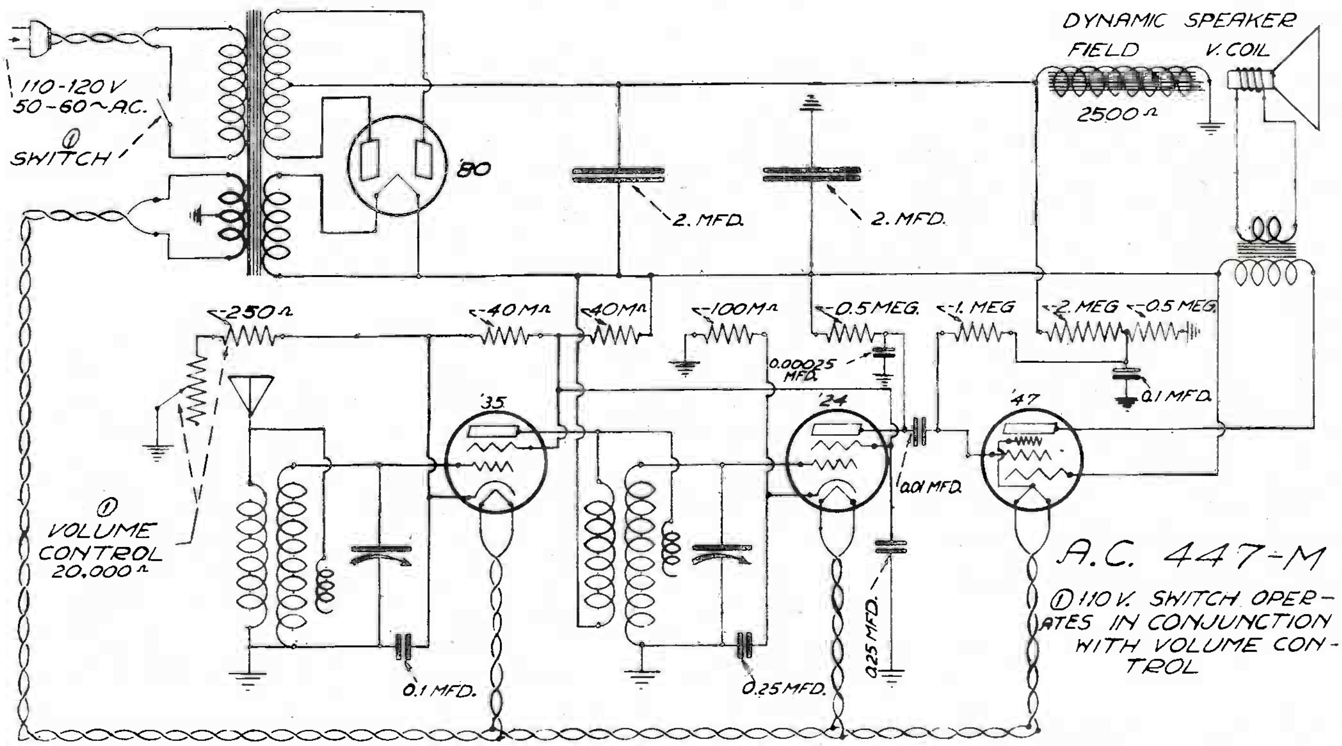

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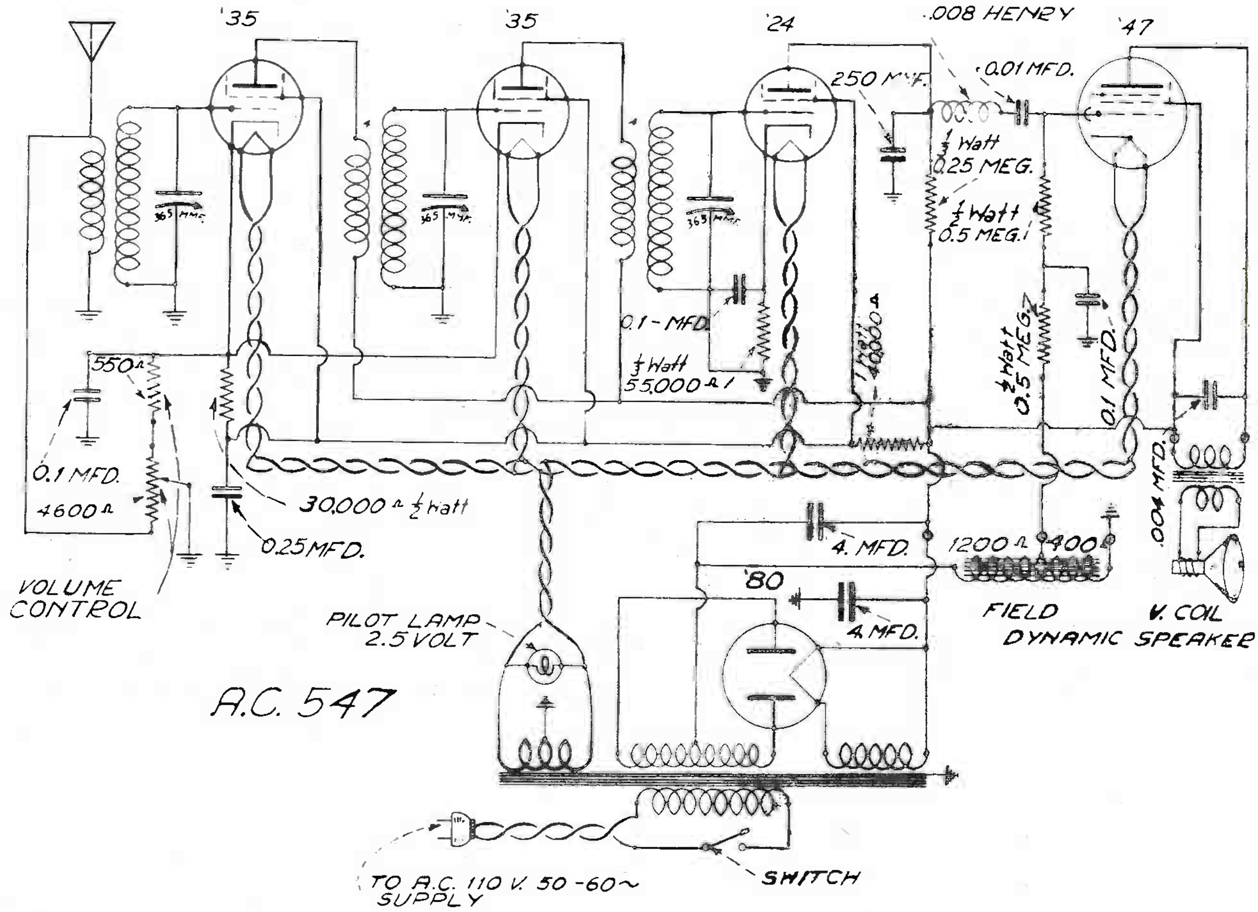

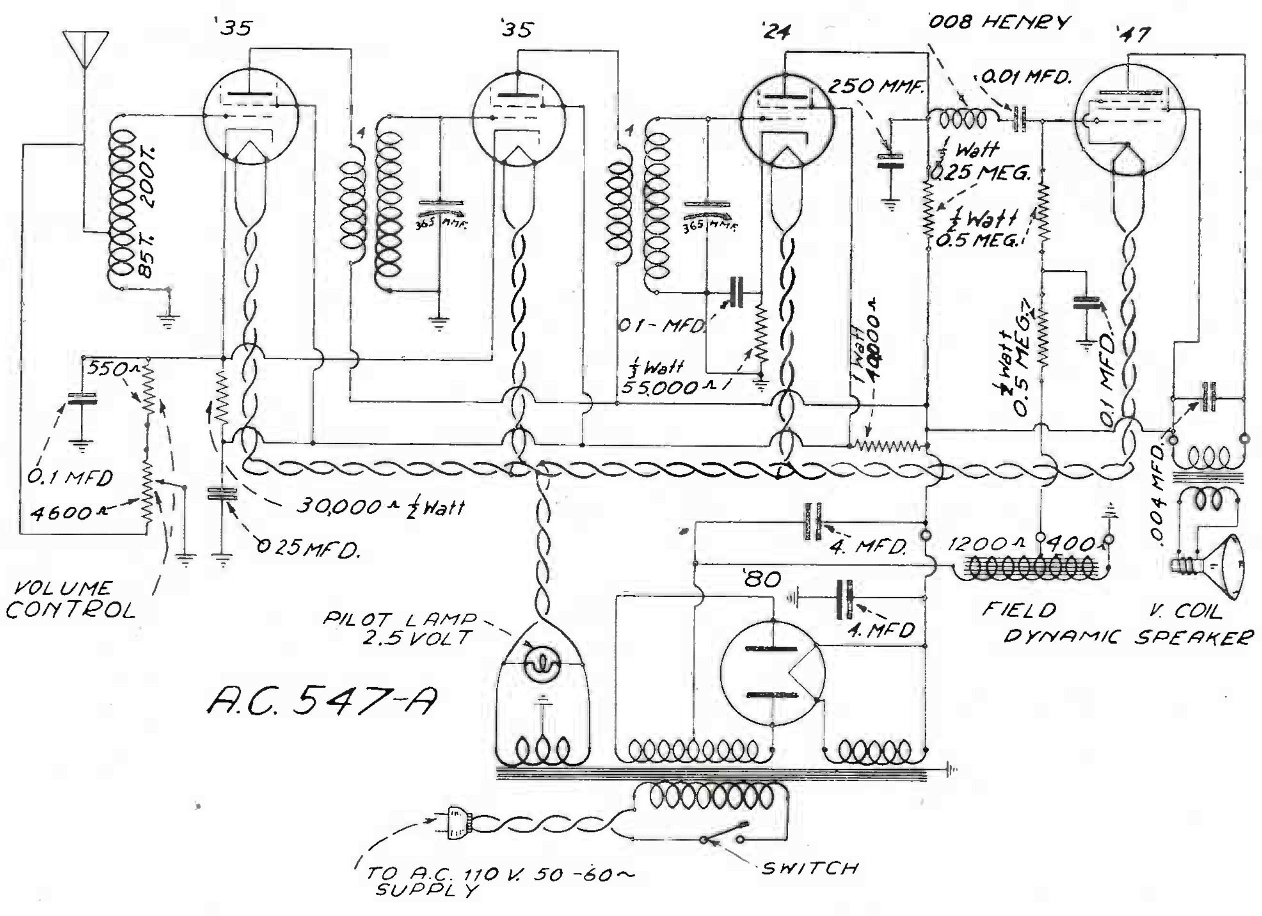

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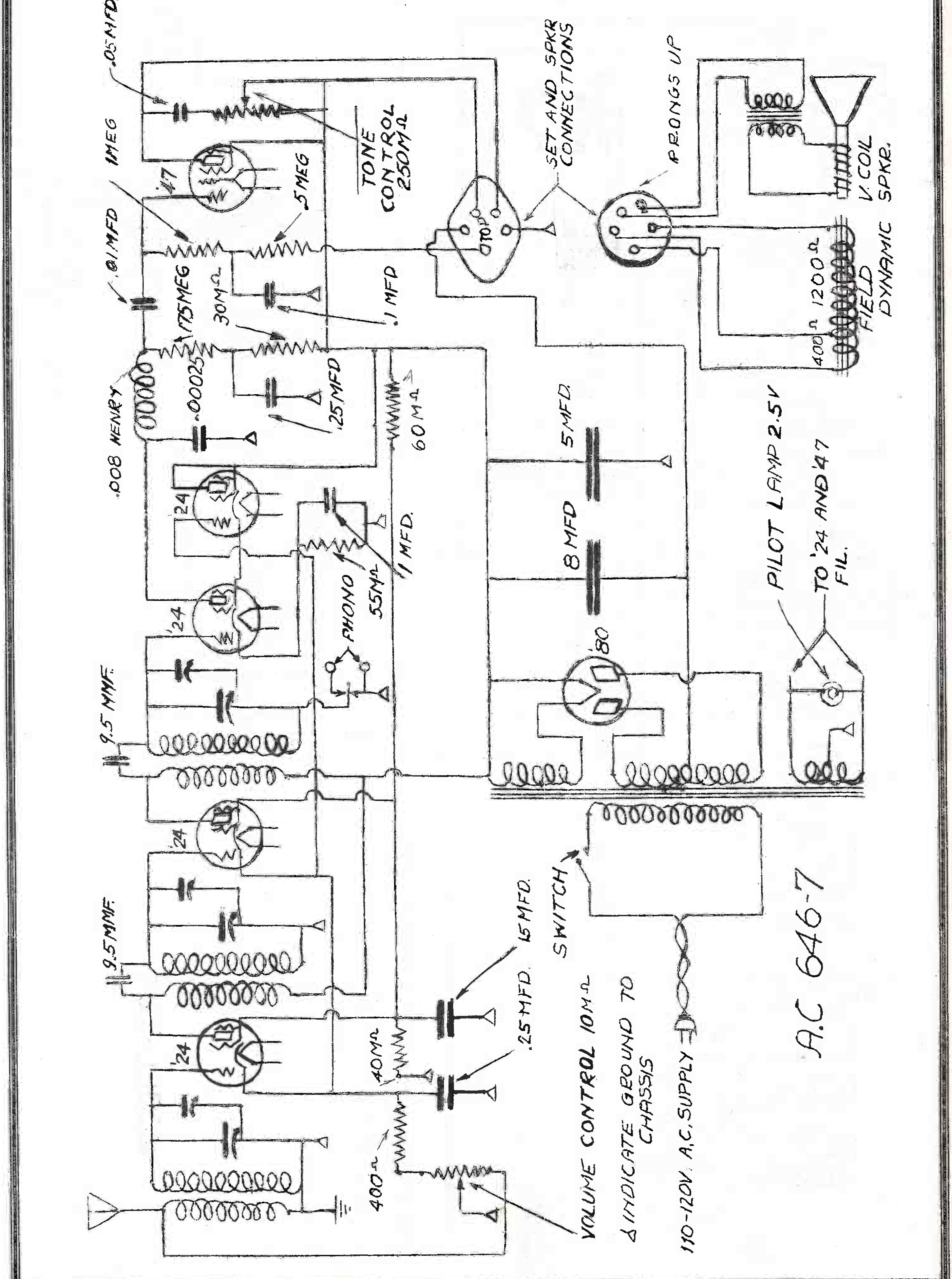

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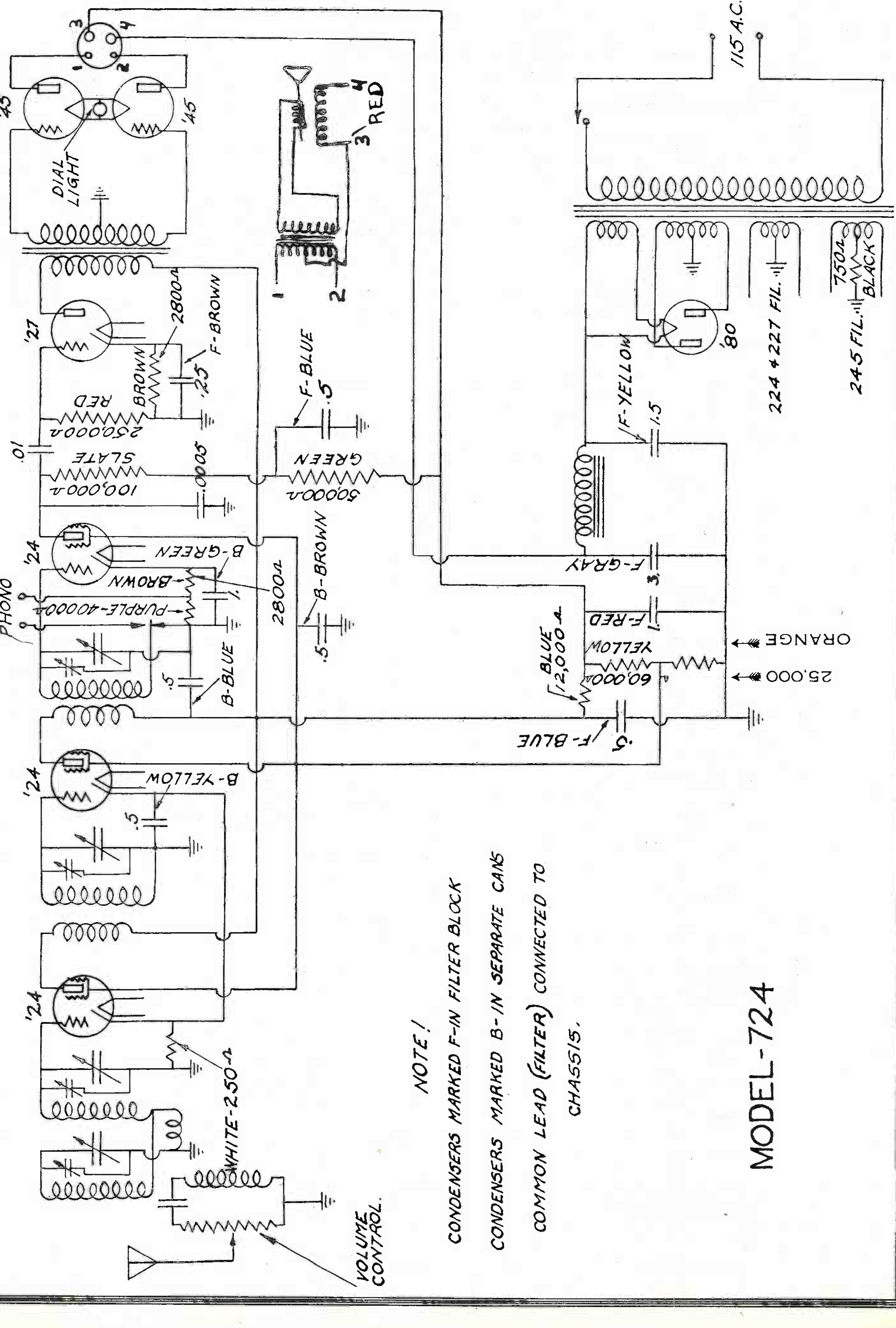


NOTE!

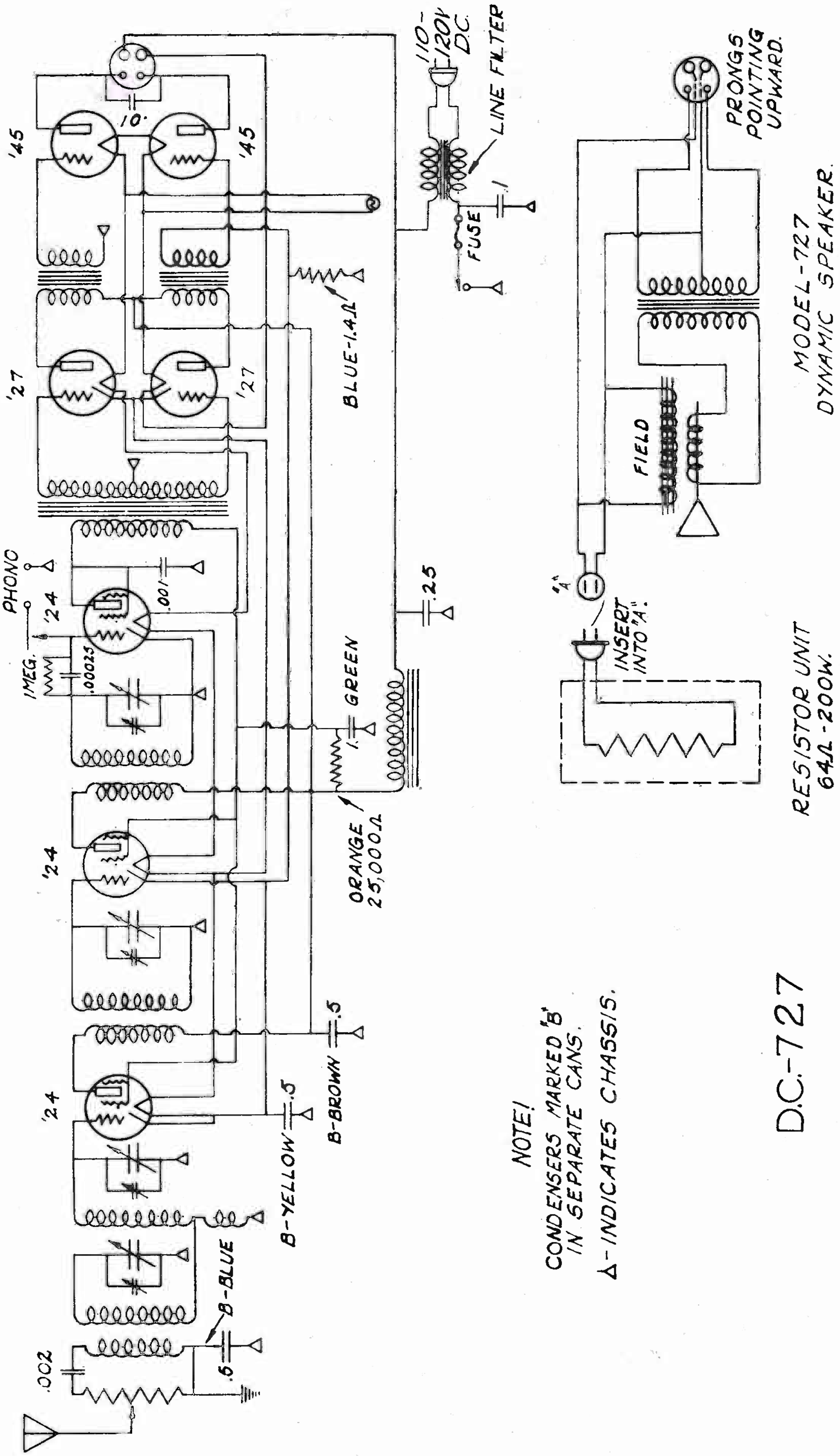
CONDENSERS MARKED F-IN FILTER BLOCK

CONDENSERS MARKED B-IN SEPARATE CANS

COMMON LEAD (FILTER) CONNECTED TO CHASSIS.

MODEL-724

PIERCE AIRO, INC.



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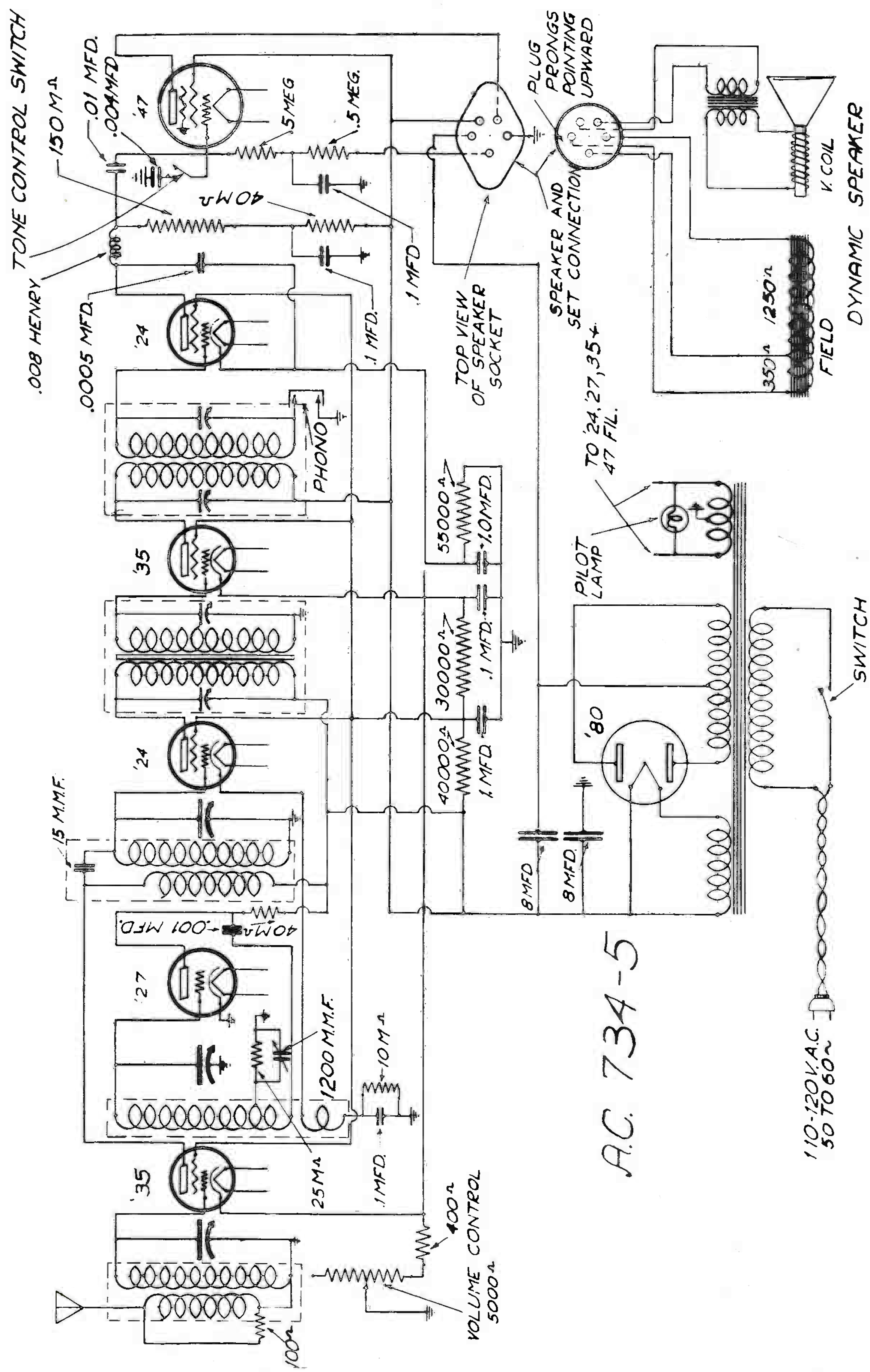

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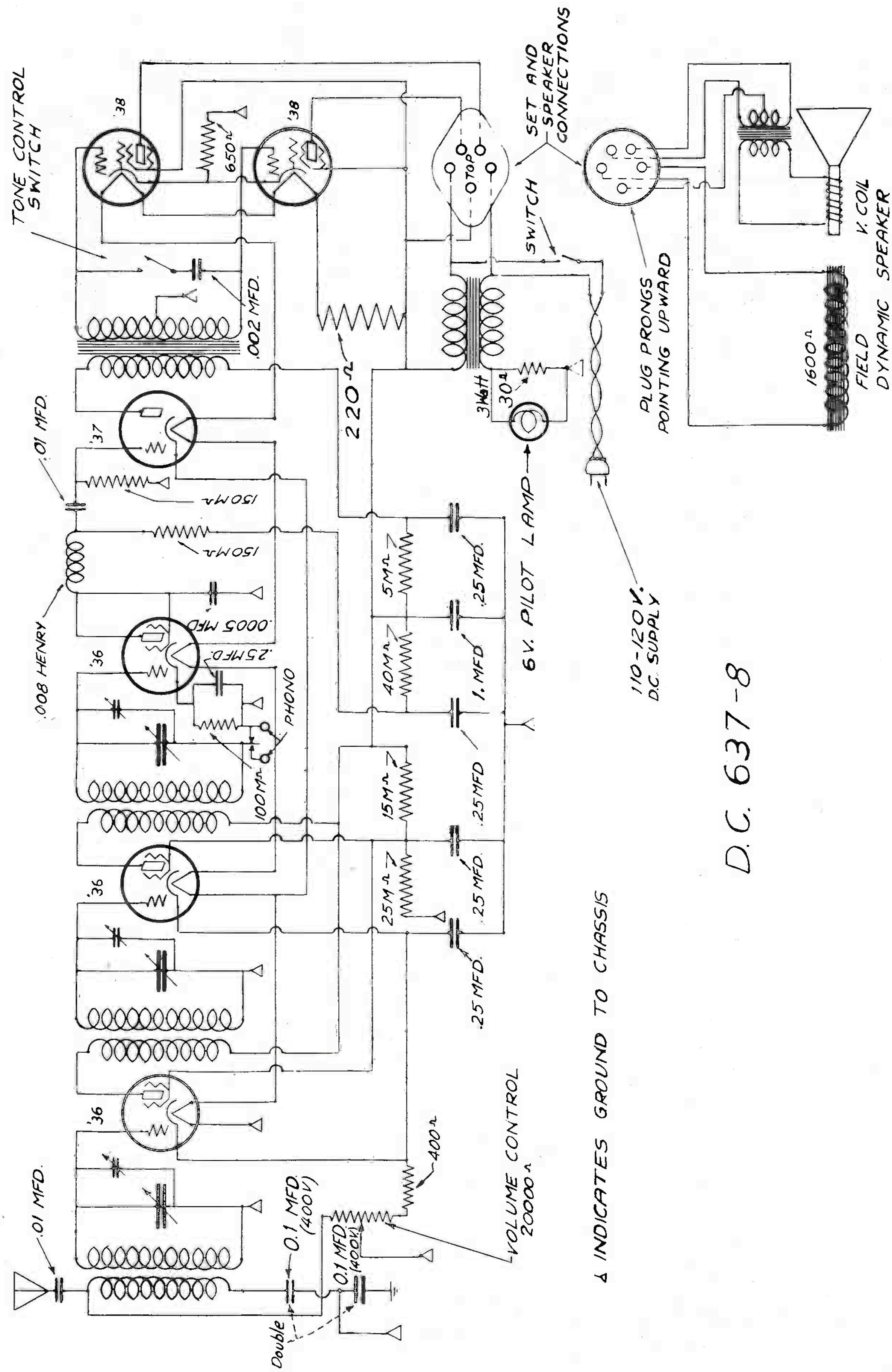

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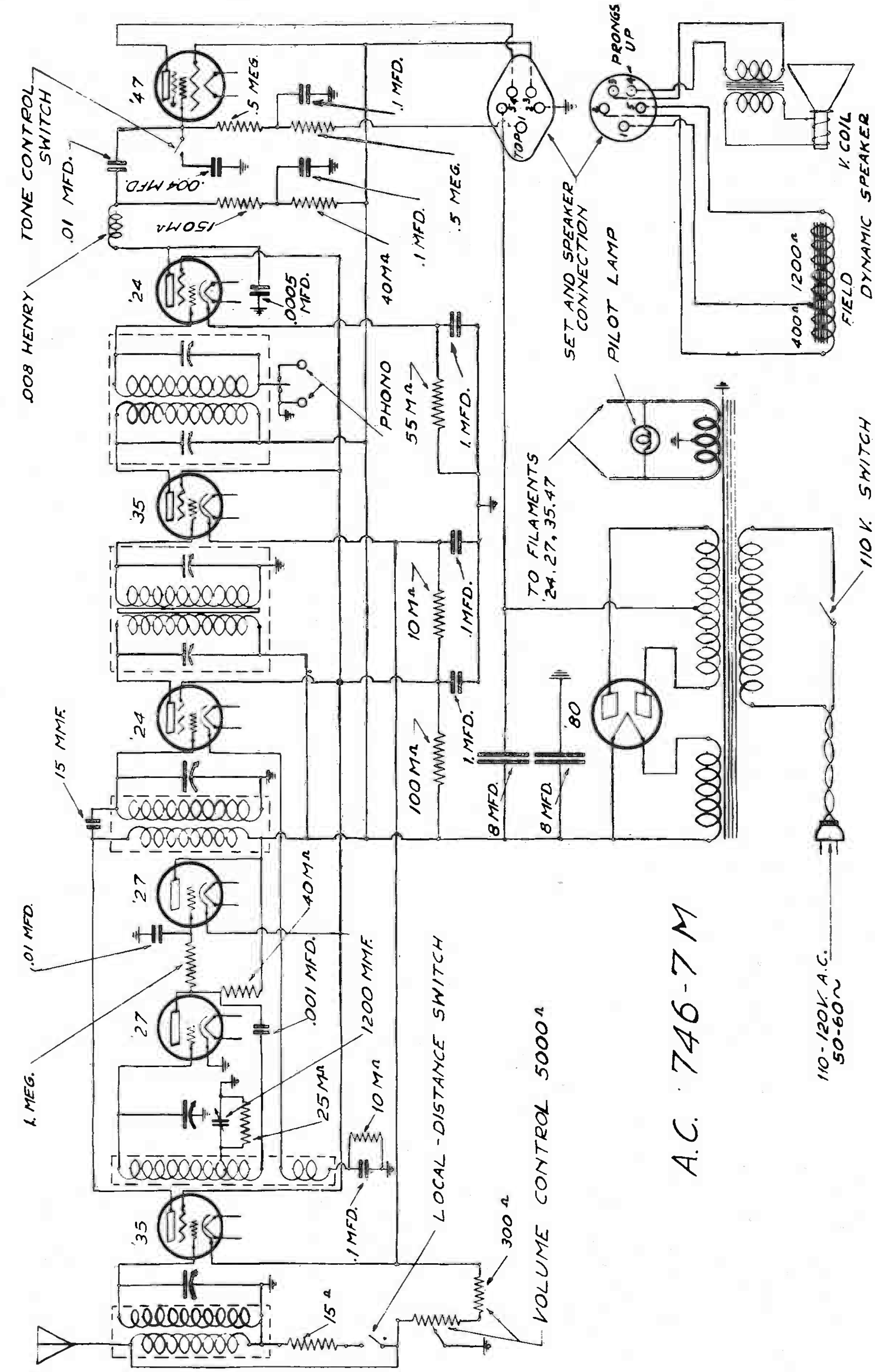
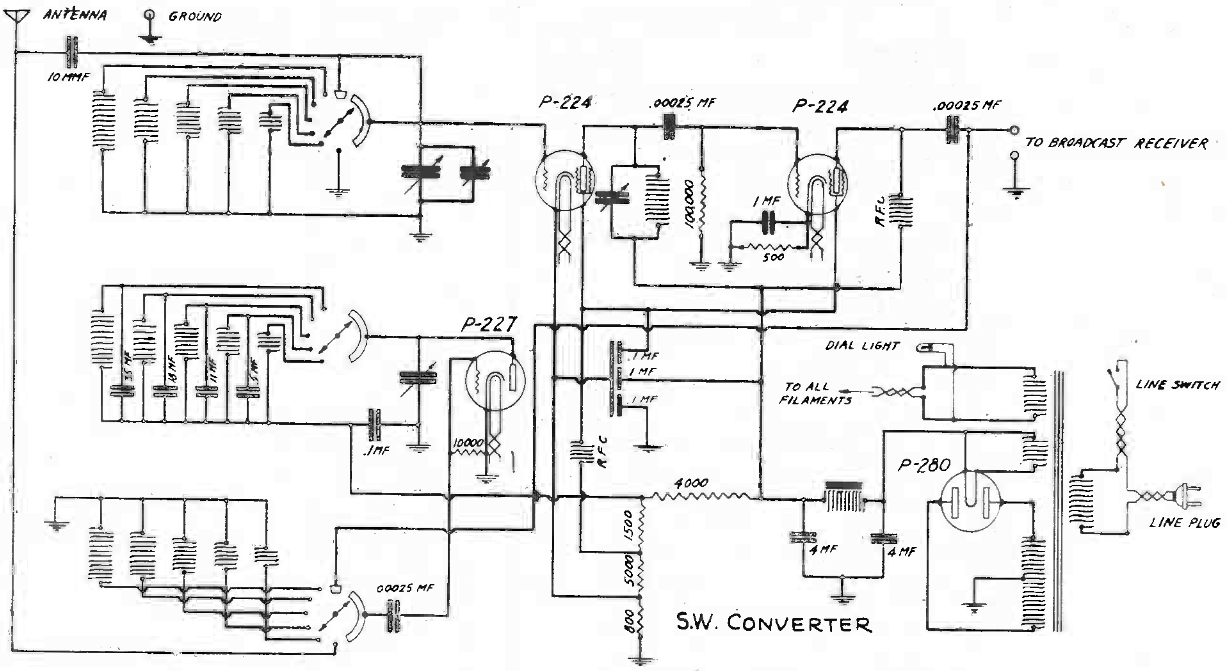
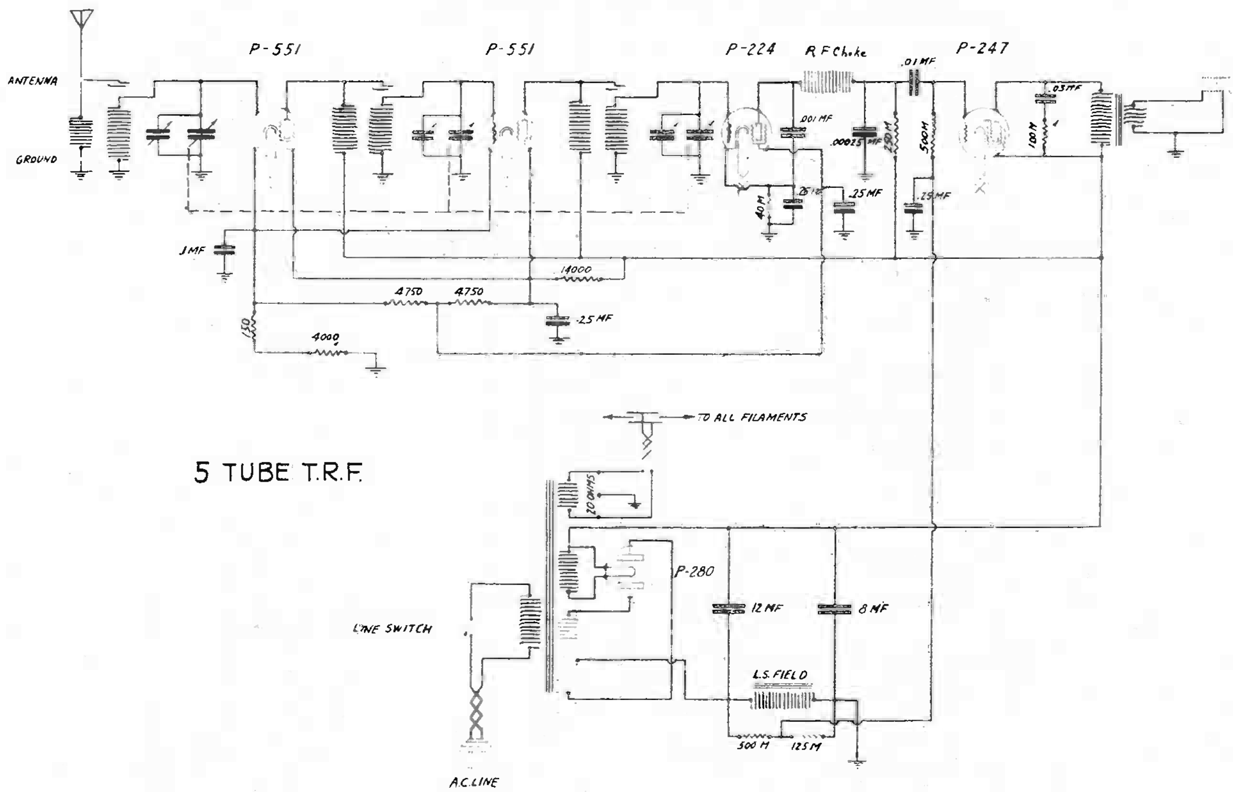


PILOT RADIO & TUBE CORP.

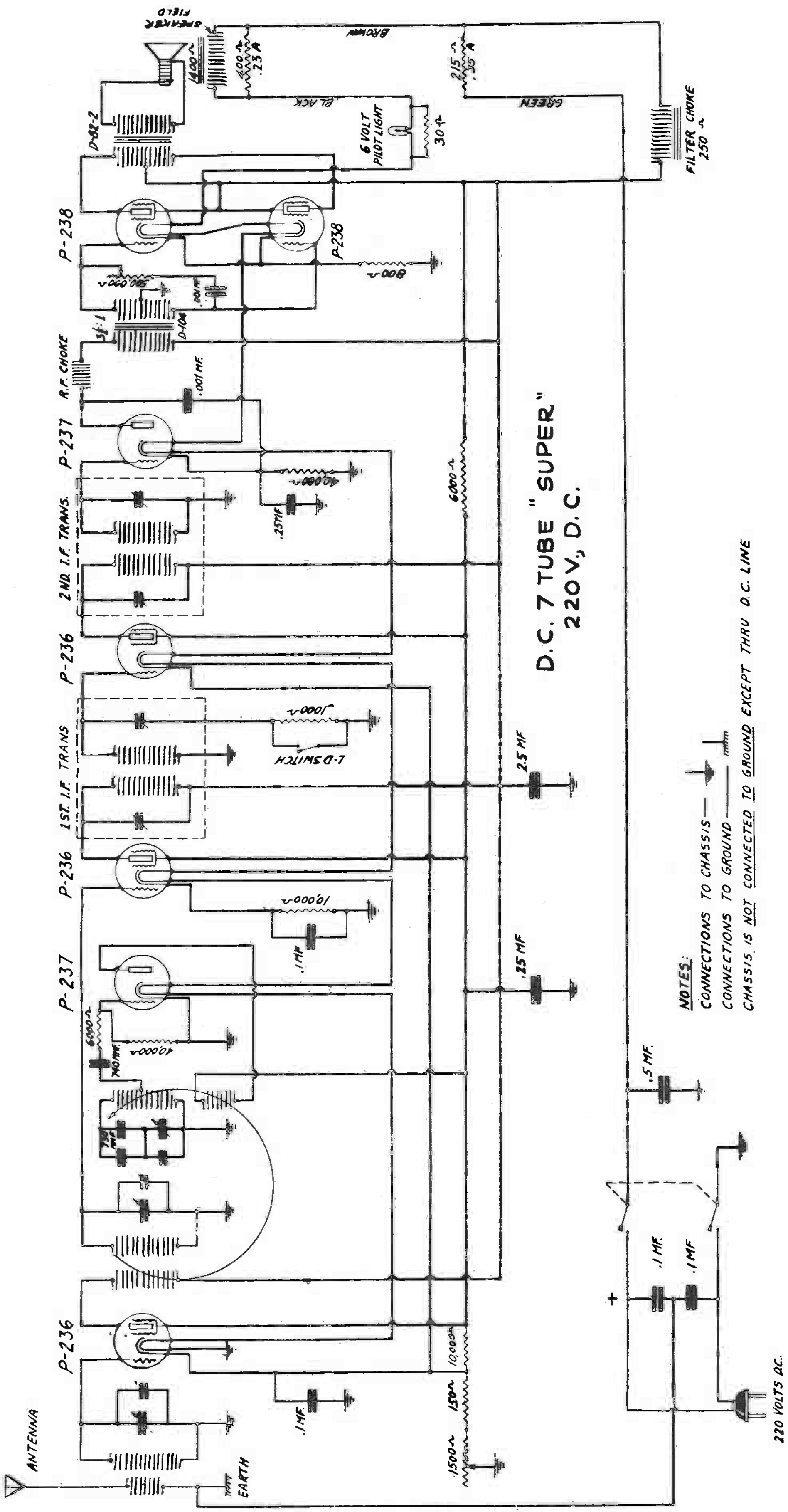


S.W. CONVERTER



5 TUBE T.R.F.

PILOT RADIO & TUBE CORP.



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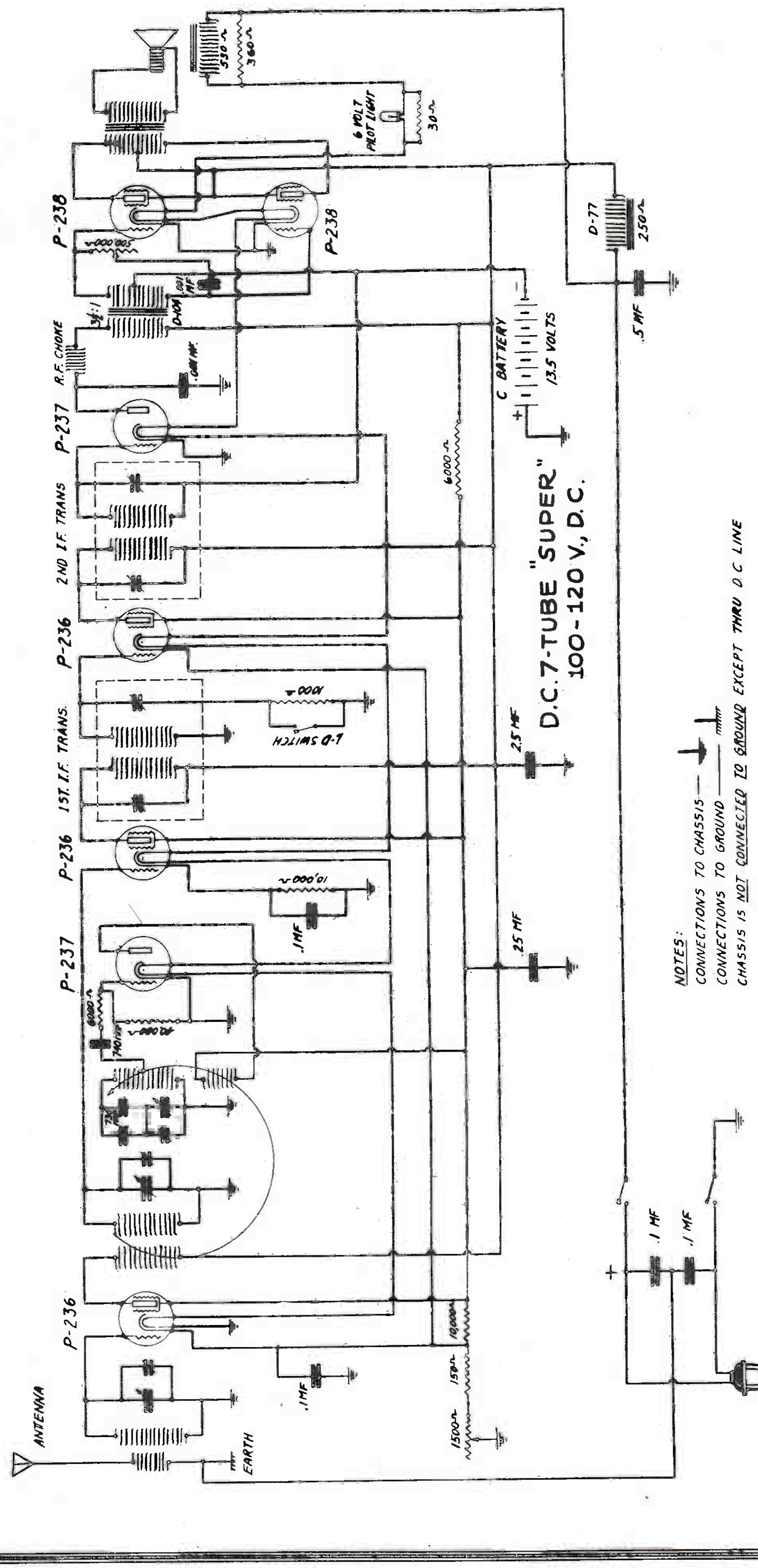
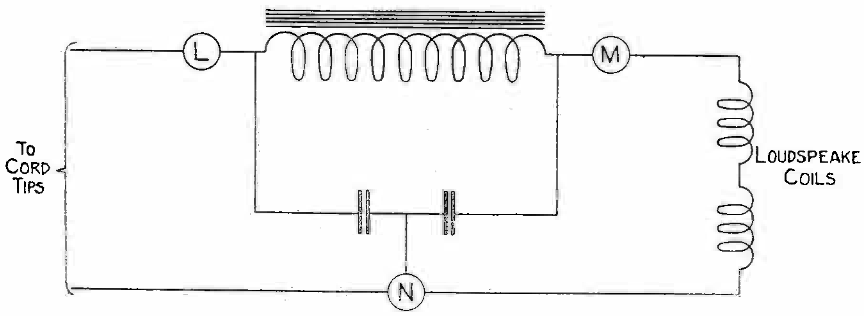


RCA VICTOR CO., INC.



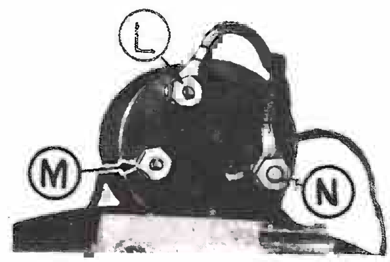
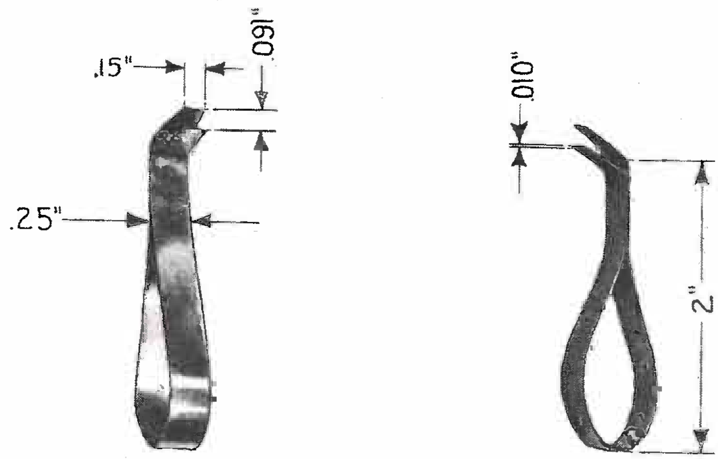


Figure 8—Schematic circuit diagram of RCA Loudspeaker Model 100A and photo of the filter unit



100-A

–General appearance and correct dimensions of armature spacing tools

FILTER UNIT CONTINUITY TEST

Disconnect Magnet Coils and Loudspeaker Cord

Test	*Correct Effect*	*Incorrect Effect Caused by*
L to M	Closed	Open filter coil
L to N	Open	Shorted filter condenser
M to N	Open	Shorted filter condenser

CONTINUITY TEST FOR MAGNET COILS AND LOUDSPEAKER CORD

Connect Magnet Coils and Loudspeaker Cord

Magnet coils may be tested as indicated below. A click test from one lead to the other while they are completely disconnected from the rest of the circuit is also a simple and effective method of testing.

Test	*Correct Effect*	*Incorrect Effect Caused by*
Jack tip to L or N	Closed	Open cord
Jack sleeve to L or N	Closed	Open cord
M to N	Closed	Open magnet coils or coil leads

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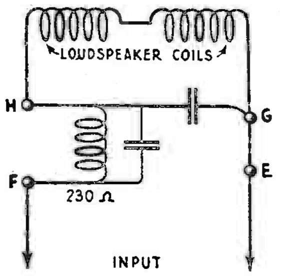
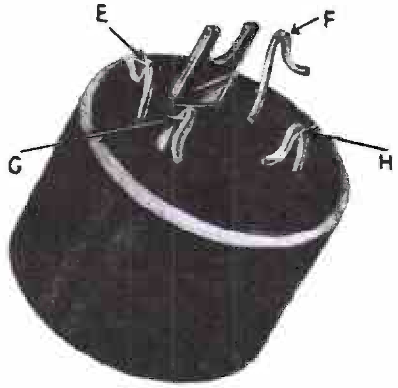


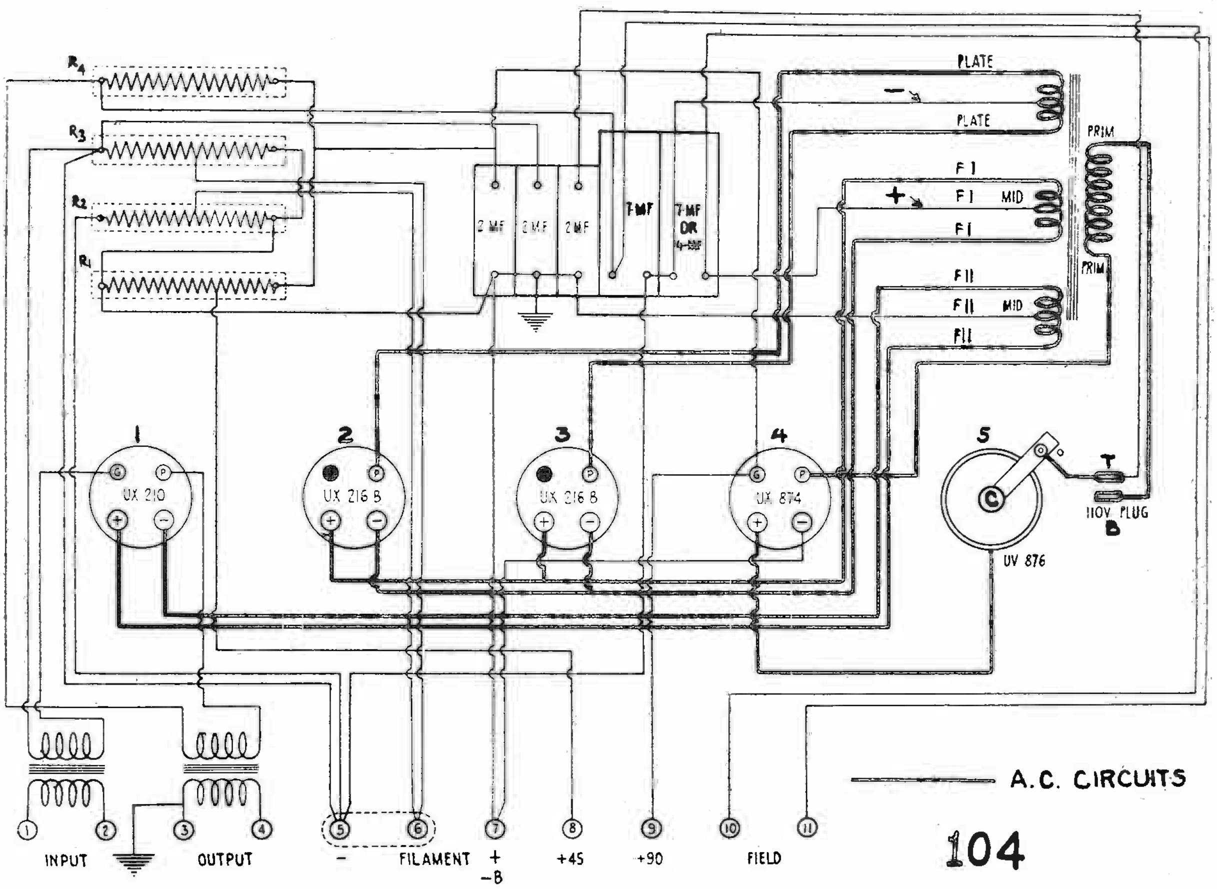


—Schematic circuit of Loudspeaker 100B coils and filter and photo of filter unit

100-B
103

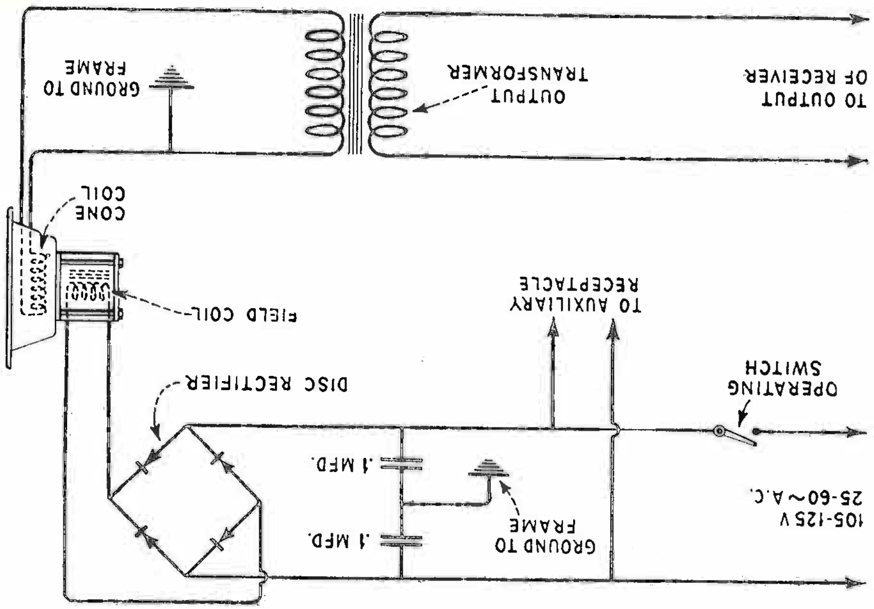
FILTER UNIT CONTINUITY TEST

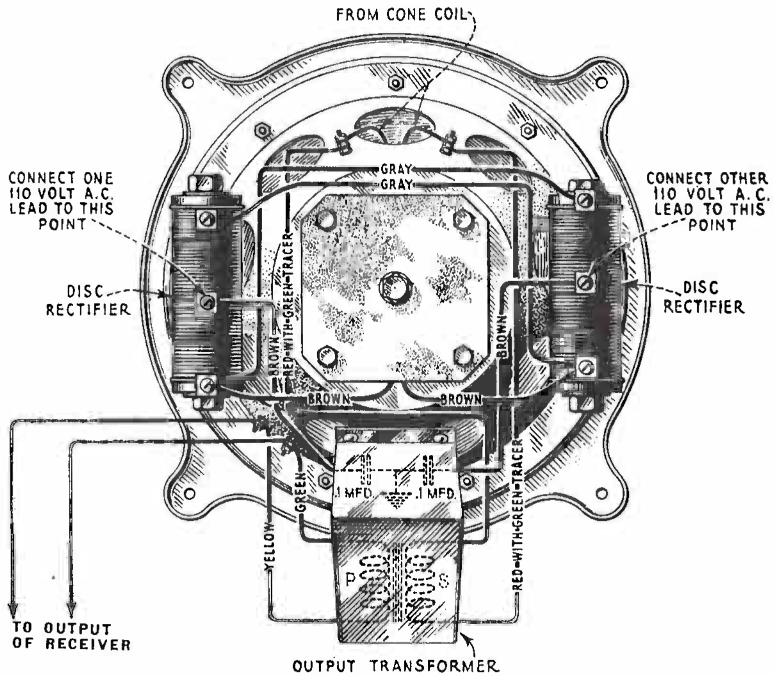
Test	*Correct Effect*	*Incorrect Effect Caused By*
G to *H*	Open	Shorted Condenser
F to *H*	Closed	Open Coil



104

RCA VICTOR CO., INC.





106

Indication	*Cause*
No Reproduction	No output from receiver Defective cone coil Defective output transformer Defective cord Loose or broken connections
Weak Reproduction	Weak receiver output Improperly centered cone Open field coil Defective rectifier Faulty connections
Distorted or noisy Reproduction (Rattle)	Distorted output from receiver Improperly centered cone Cone leads broken from side of cone Open or shorted line condensers Loose parts in cabinet assembly
Hum	Faulty receiver output Defective disc rectifier

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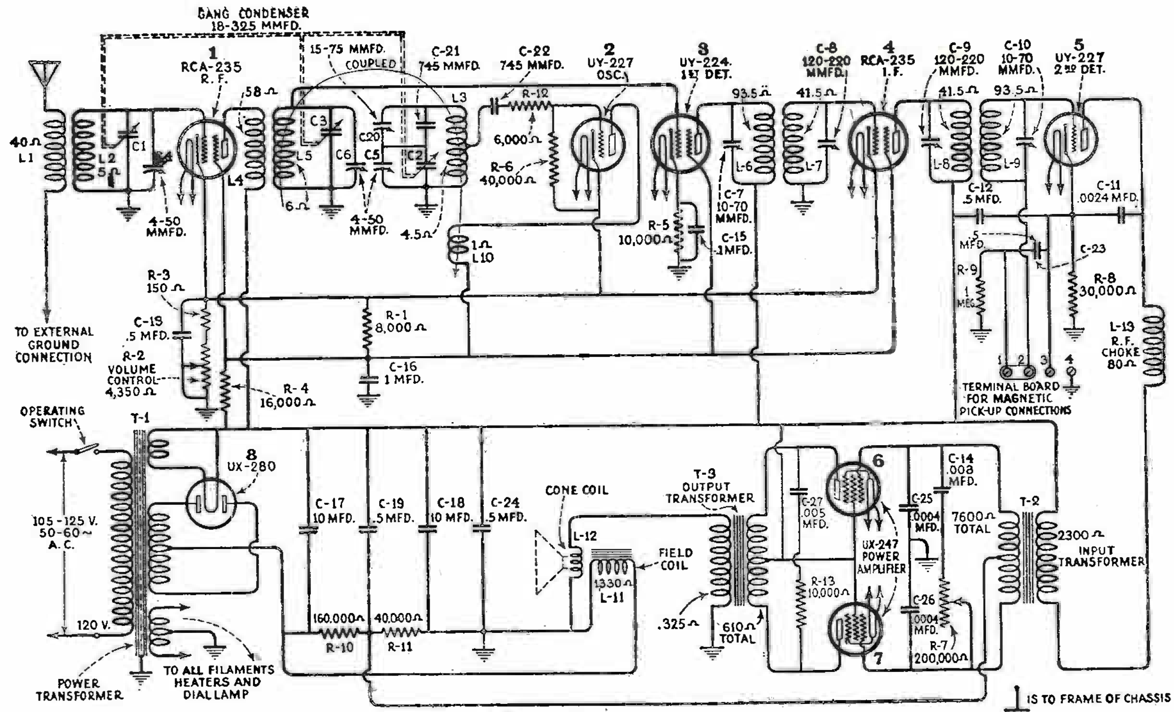
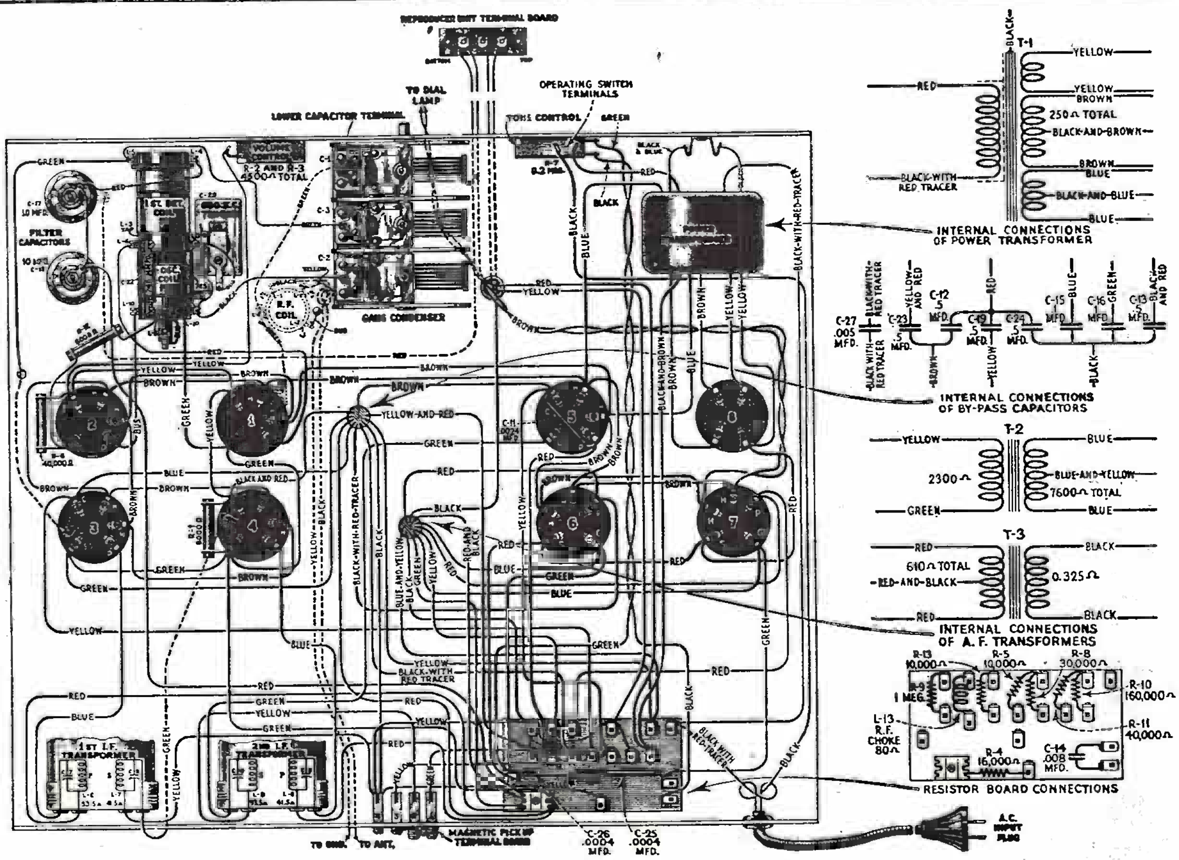
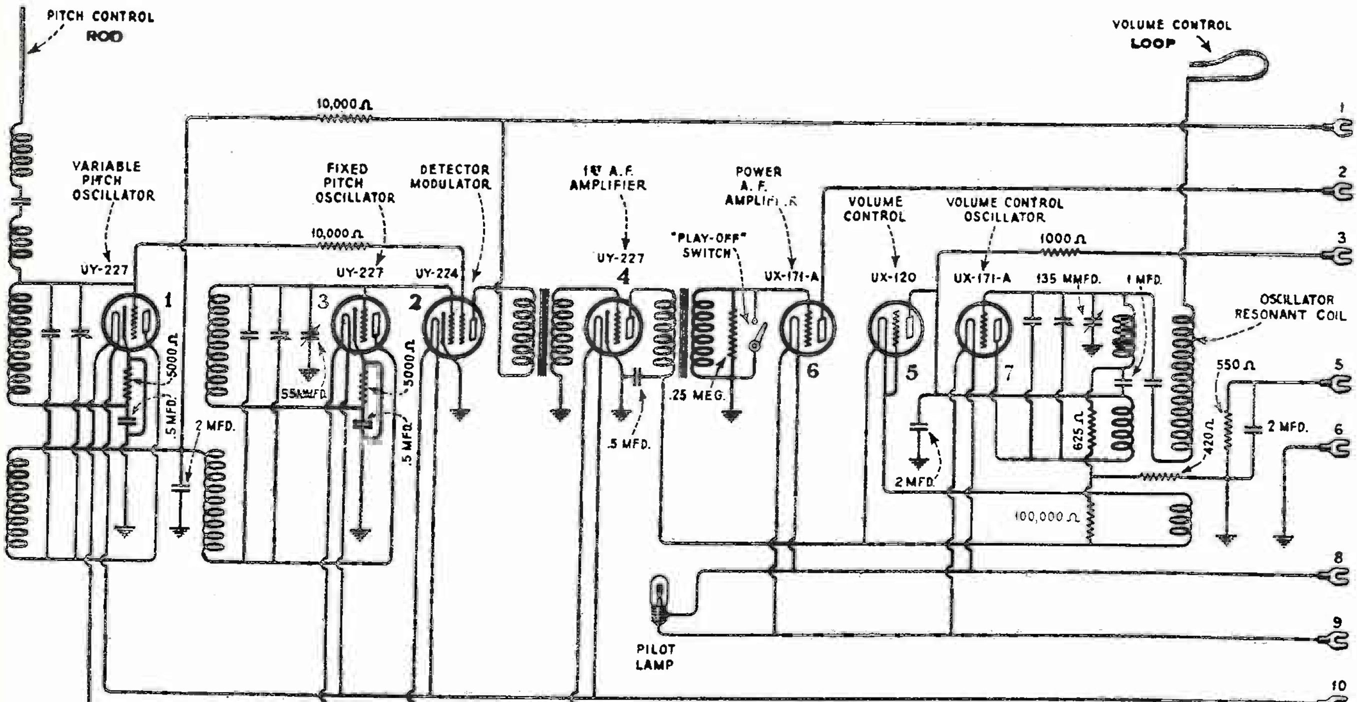


R-7A

Radiotron No.	Cathode to Heater Volts D. C.	Cathode or Filament to Control Grid Volts D. C.	Cathode to Screen Grid Volts D. C.	Cathode or Filament to Plate Volts D.C.	Plate Current M. A.	Heater or Filament Volts A. C.	Radiotron No.	Cathode to Heater Volts D. C.	Cathode or Filament to Control Grid Volts D. C.	Cathode to Screen Grid Volts D. C.	Cathode or Filament to Plate Volts D.C.	Plate Current M. A.	Heater or Filament Volts A. C.
VOLUME CONTROL AT MINIMUM							VOLUME CONTROL AT MAXIMUM						
1	38	35	50	200	.0	2.2	1	2.0	2.5	60	235	3.5	2.2
2	38	0	—	50	3.5	2.2	2	2.0	.0	—	50	4.5	2.2
3	7	6	80	235	0.5	2.2	3	4.0	4.0	55	230	0.5	2.2
4	38	35	50	200	.0	2.2	4	2.0	2.5	58	235	3.5	2.2
5	22	8	—	210	0.7	2.2	5	22	8	—	210	0.7	2.2
6	—	12	225	220	30	2.2	6	—	12	225	220	30	2.2
7	—	12	225	220	30	2.2	7	—	12	225	220	30	2.2

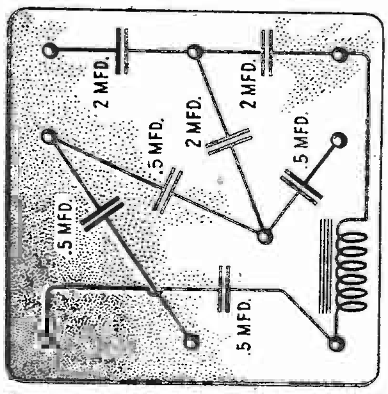


RCA VICTOR CO., INC.

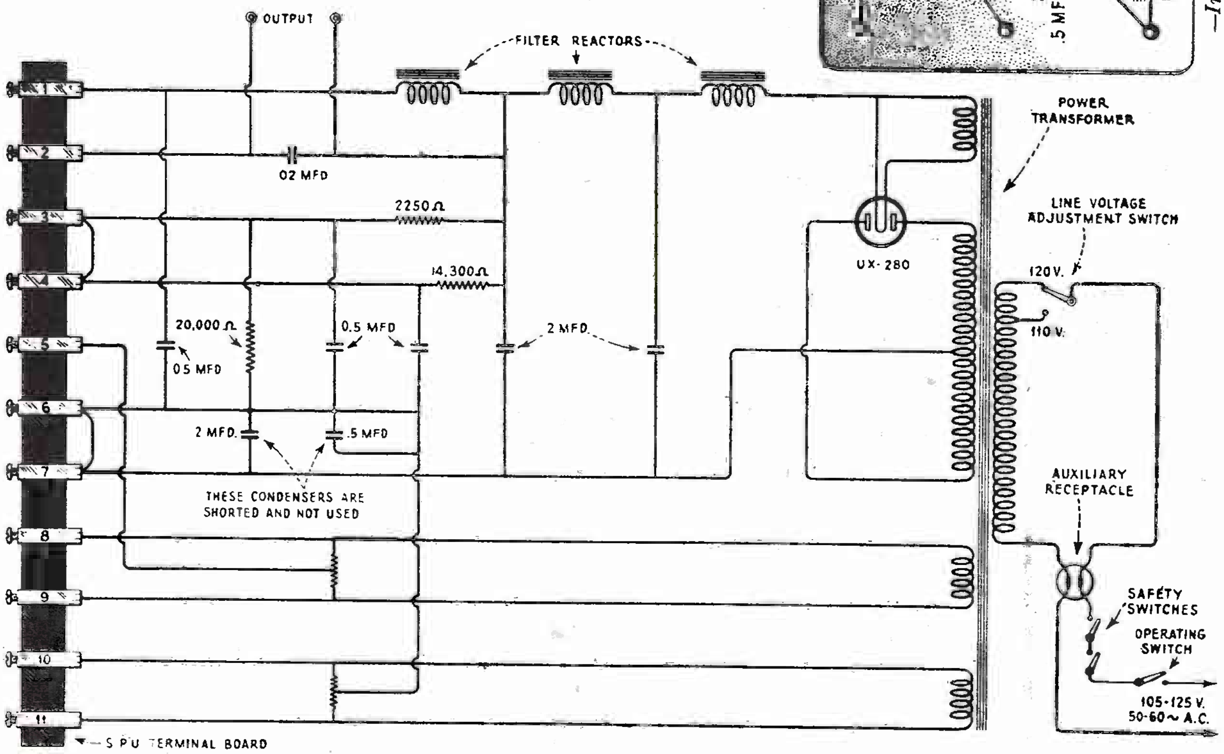


THEREMIN

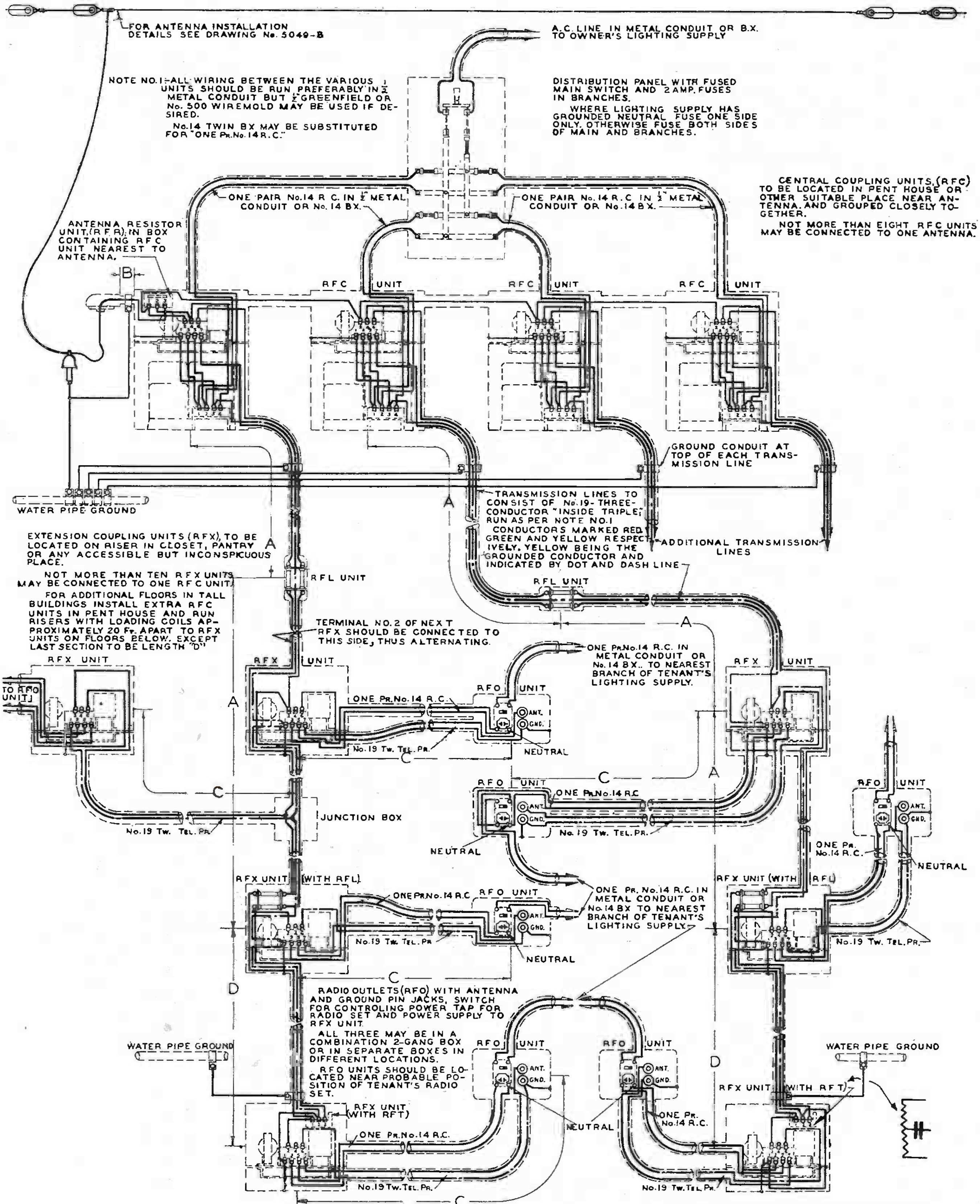
Terminals Nos.	Cable on Tubes Lighted Volts	Cable Off Volts
1 to 6 (D.C.)	190	260
2 to 6*	190	260
3 to 6	140	230
5 to 6	29.0	0
8 to 9 (A.C.) rms	2.5	2.8
10 to 11 (A.C.) rms	4.7	5.0



—*Internal connections of filter and by-pass condensers, and filter reactor*



RCA VICTOR CO., INC.

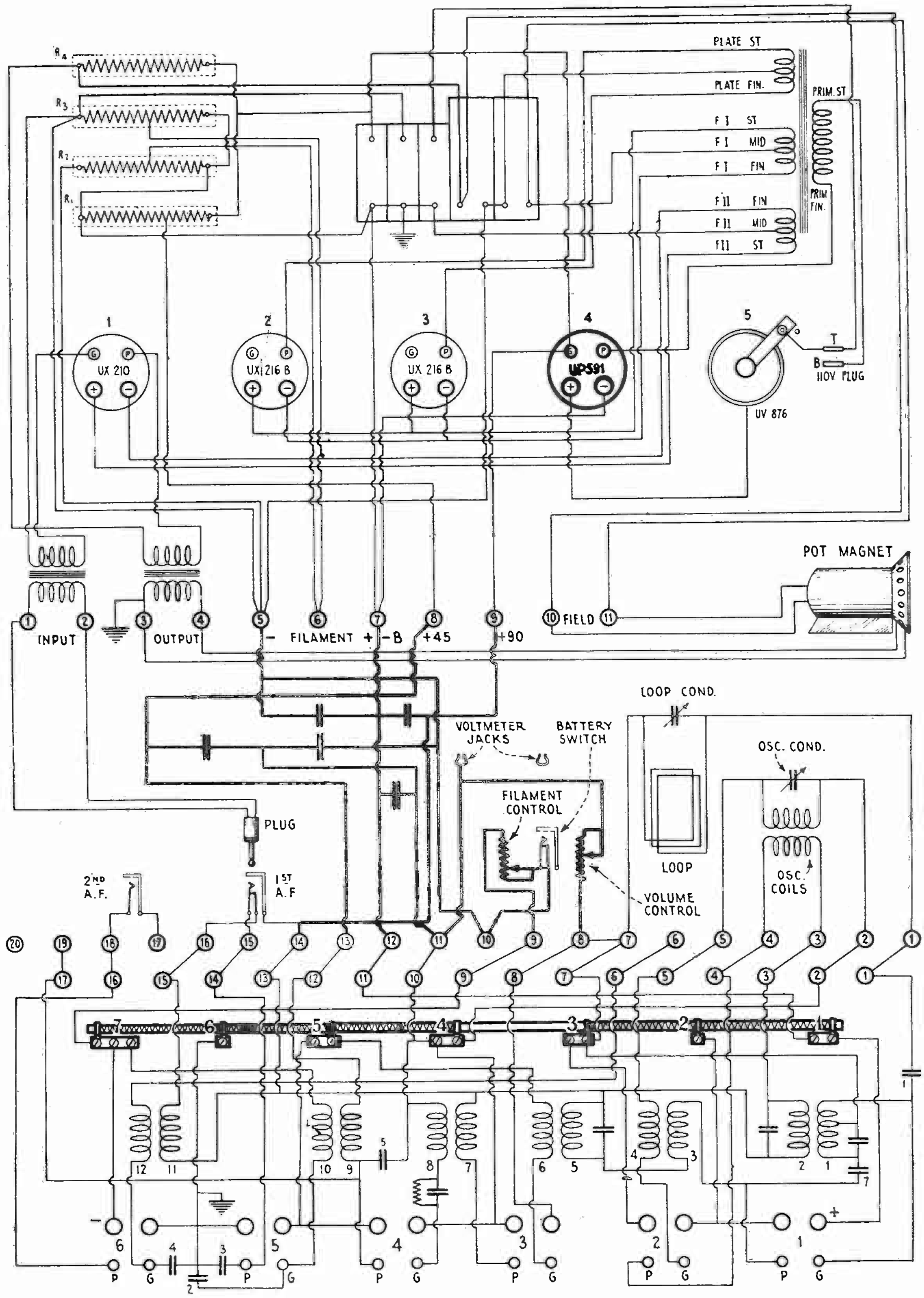


A = STANDARD SPACING FOR RFL UNITS APPROX. 20 FT.
B = AS SHORT AS POSSIBLE.
C = NOT MORE THAN 20 FT. PREFERABLY LESS
D = 5 TO 15 FT.

CENTRALIZED RADIO
WIRING DIAGRAM
R.F. DISTRIBUTION SYSTEM FOR ALTERNATING CURRENT.

RADIO-VICTOR CORPORATION OF AMERICA

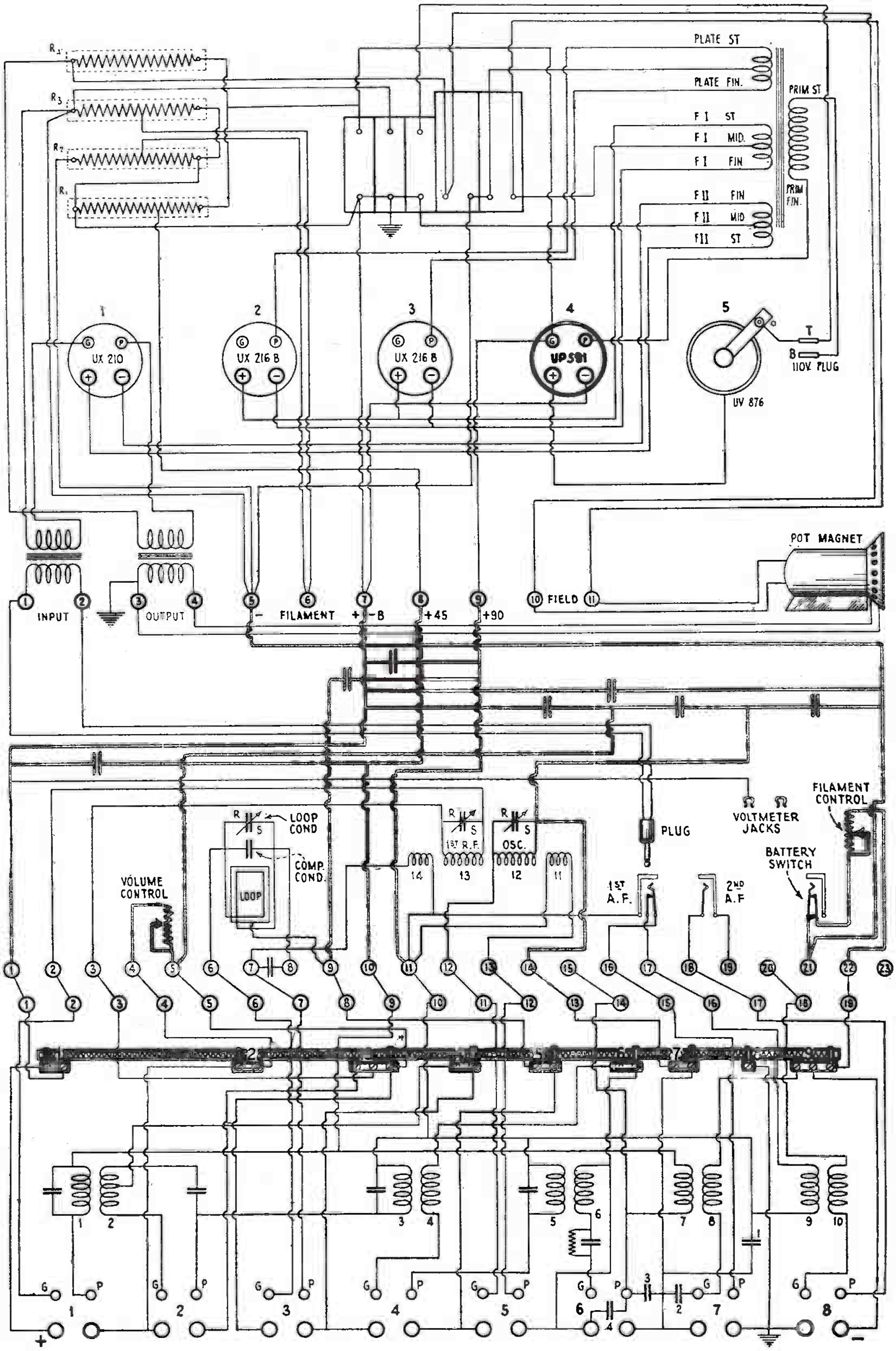
RCA VICTOR CO., INC.



A.C. PACKAGE CHANGES

25 A.C.

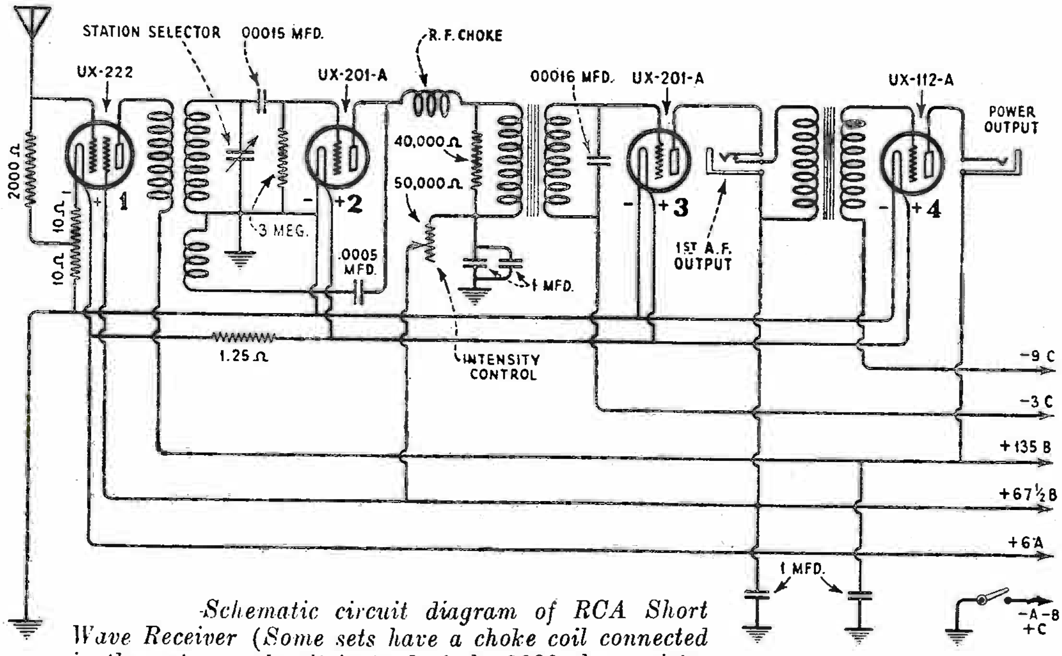
RCA VICTOR CO., INC.



A.C. PACKAGE CHANGES

28 A.C.

RCA VICTOR CO., INC.



Schematic circuit diagram of RCA Short Wave Receiver (Some sets have a choke coil connected in the antenna circuit instead of the 2000-ohm resistor shown)

AR-1145

The ratings of the different coils are as follows:

Coil No.	*Frequency Range*		*Wavelength Range Meters*
	Megacycles	*Kilocycles*	
1	20—12	20,000—12,000	15— 25
2	12—7.2	12,000— 7,200	25— 42
3	7.2—4	7,200— 4,000	42— 75
6	......	1,500— 940	200—320
7	......	940— 550	320—545

Radiotron	*Fil. Volt.*	*Grid Volt.*	*Plate Volt.*	*Plate Current*
Coupling UX-222	3.2	*Control grid 1.5 *Screen grid 67.5	130.0	Plate 3.5 mil. amp. *Screen 0.5 mil. amp.
Detector UX-201A	5.0	....	30-60 (Depending on position of intensity control)	0.65 to 1.5 mil. amp.
1st Audio Amp. UX-201A	5.0	3.0	65	1.1 mil. amp.
2d Audio Amp. (Power) UX-112A	5.0	9.0	130.0	4.0 mil. amp.

* These readings cannot be measured by ordinary methods as with the Weston Model 537 test set.

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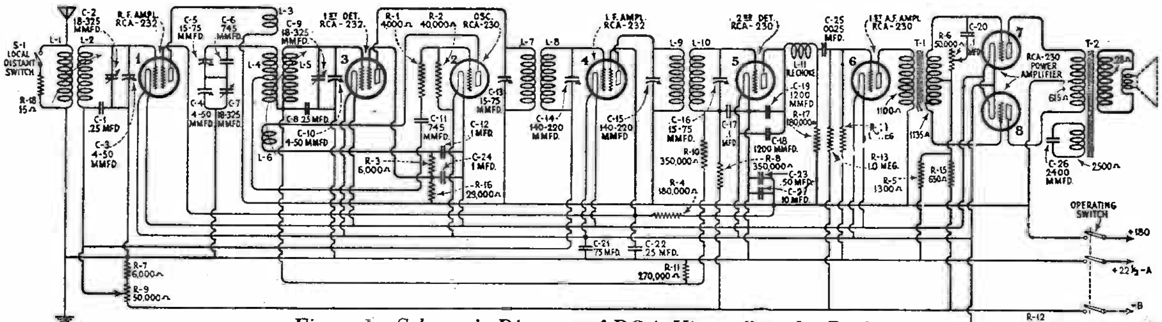


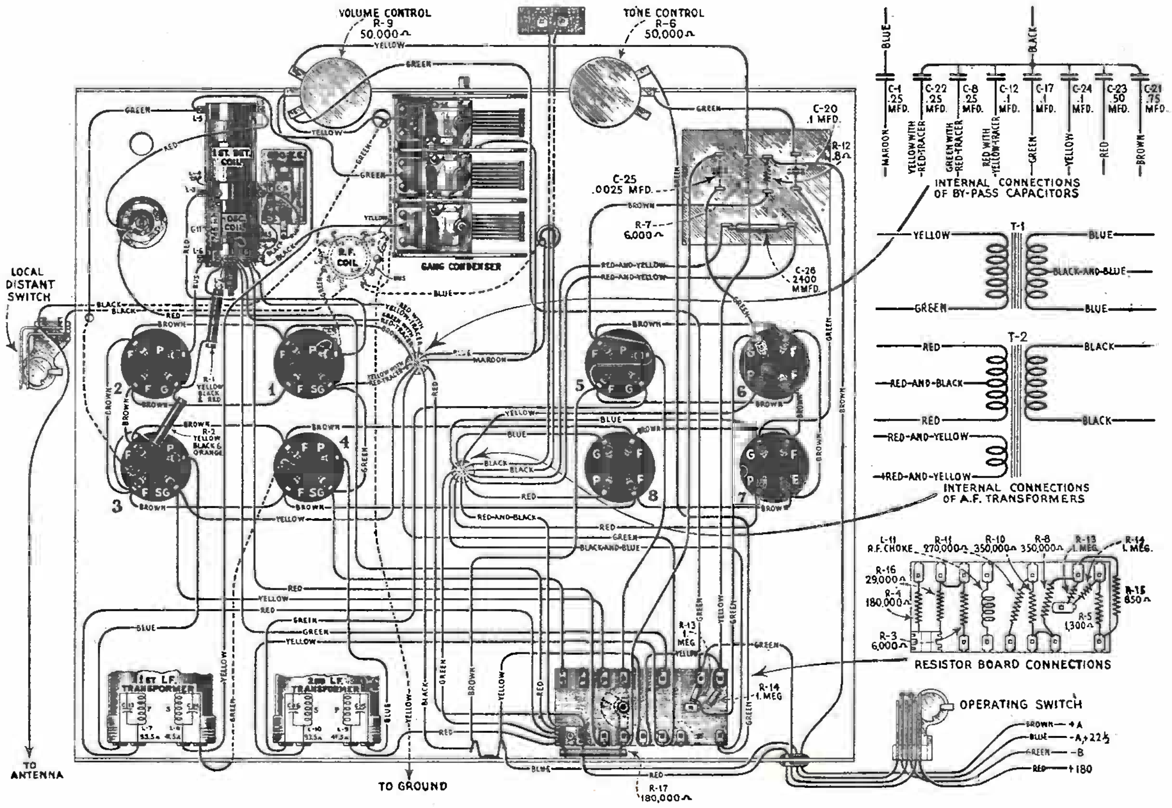
Figure 1—Schematic Diagram of RCA Victor Console, R-43

RADIOTRON SOCKET VOLTAGE

BATTERIES AT FULL VOLTAGE—NO SIGNAL BEING RECEIVED

These voltages are those obtained with one of the usual set analyzers. The values indicated, therefore, are not necessarily the voltages that actually appear at the Radiotron Sockets when the voltmeter is not connected.

Tube No.	Filament to Control Grid Volts	Filament to Screen Grid Volts	Filament to Plate Volts	Plate Current M. A.	Filament Volts
VOLUME CONTROL AT MINIMUM					
1	22	55	155	0	2.0
2	—	—	50	3.0	2.0
3	0.5	65	150	0.5	2.0
4	22	55	155	0	2.0
5	5.0	—	90	0	2.0
6	2.0	—	150	2.5	2.0
7	15.0	—	150	0.5	2.0
8	15.0		150	0.5	2.0
VOLUME CONTROL AT MAXIMUM					
1	1.5	45	150	2.5	2.0
2	—	—	50	3.0	2.0
3	0.5	60	150	0.5	2.0
4	1.5	45	150	2.5	2.0
5	5.0	—	90	0	2.0
6	2.0	—	150	2.5	2.0
7	15.0	—	150	0.5	2.0
8	15.0	—	150	0.5	2.0



RCA VICTOR CO., INC.

"MODEL R-5" RADIOLETTE

Also Graybar "Model 4 Graybarette;" Westinghouse "Model WR-14;" General Electric Model "G. E. T-12"

In this smallest RCA-Victor receiver, the following are the condenser and resistor values. Condensers C1, C2, 14- to 320-mmf. tuning condensers, shunted by 4- to 26-mmf. trimmers; C3, .00013-mf.; C4, C5, C6, 0.1-mf.; C7, .001-mf.; C8, C12, 0.25-mf.; C9, .02-mf.; C10, 320 mmf.; C11, .005-mf.; C13, 10. mf., (electrolytic); C14, C16, 0.5-mf.; C15, .05-mf.; C17, 2 mf.

Resistor R1, 20,000 ohms (volume control); R2, 600 ohms; R3, 28,000 ohms; R4, 8,000 ohms; R5, ¼-meg.; R6, 45,000 ohms; R7, ½-meg.; R8, 20,000 ohms; R9, 13,000 ohms; R10, 280,000 ohms; R11, 50,000 ohms.

Operating values are as follows. Filament potentials: V1, V2, V3, 2.2 volts. Plate currents: V1, 4 ma.; V2, 0.25-ma.; V3, 30 ma. Control-grid potentials: V1, 3 volts; V2, 7 volts; V3, 2 volts. Screen-grid potentials: V1, 85 volts; V2, 65 volts; V3, 225 volts. Plate potentials: V1, 225 volts; V2, 100 volts; V3, 215 volts. Heater-to-cathode potentials: V1, 3 volts; V2, 7 volts.

The only volume control in this receiver is by variation of potentiometer R1; the regeneration which exists in the circuit of detector V2, through feedback between the secondary and tickler coils of L2, being non-adjustable. The tickler coil is wound in two sections (high- and low-wave) to obtain even regeneration over the broadcast band. The output of the detector is resistance-capacity coupled to the single stage of A.F. amplification—pentode V3.

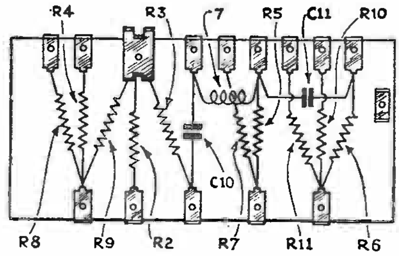
Grid bias for the pentode is obtained from a portion of the voltage drop across the field coil; due mostly to the plate current of V3, which is a considerable portion of the total drain. Consequently, increased current through this choke coil, due to a strong incoming signal, causes an increase in the grid bias; thus obtaining automatically a certain degree of compensation which prevents overload.

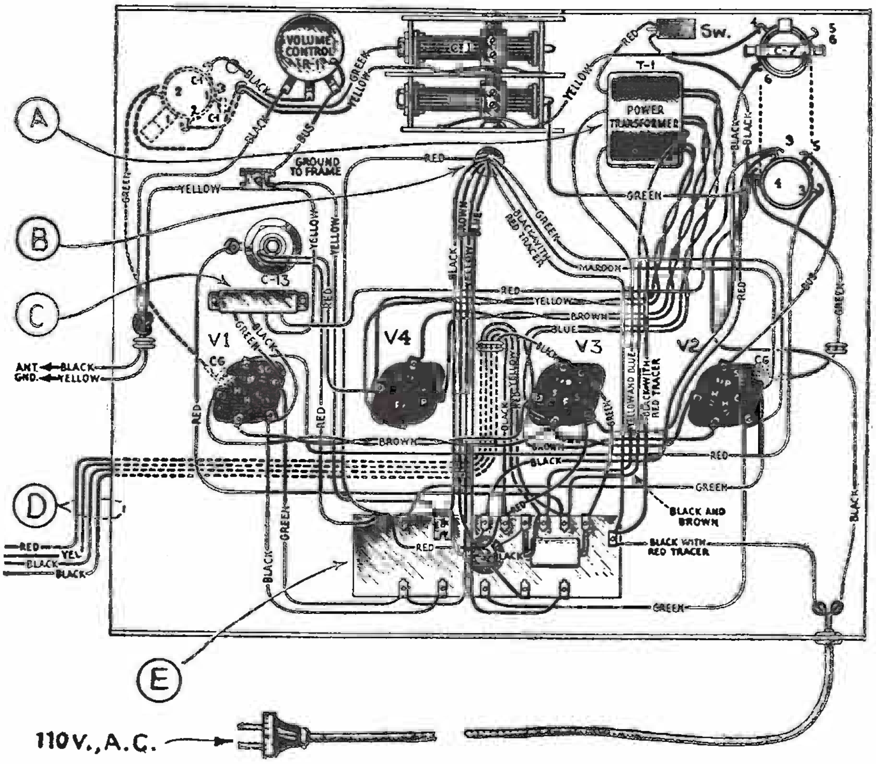
One filter condenser is of the electrolytic type, and the other is of standard paper type.

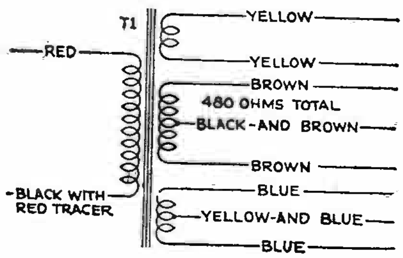
Align the R.F. circuits at 1400 kc. It is advisable to use an audio-modulated service oscillator, connected to the input of the receiver, and a thermo-galvanometer connected to the secondary of the output transformer (in place of the voice coil of the dynamic reproducer), to obtain accurate alignment of the tuned circuits.

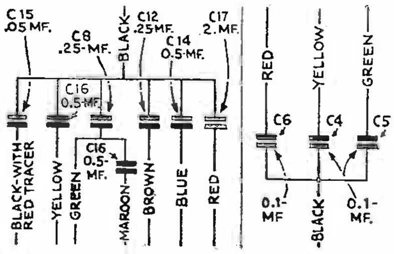
The first step, in resonating the tuner of the "Model R-5," is to turn the station selector's knob until the reading is exactly 0, and then remove the chassis from the cabinet; being careful not to disturb the setting of the dial. The gang condenser plates should be fully meshed with the stators; otherwise, the dial drum must be adjusted until they are. Having made certain of the positions of the condenser plates, replace the chassis in the cabinet.

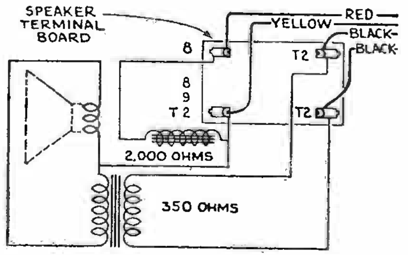
With the oscillator working at 1400 kc., and coupled to the input of the radio set, set the dial scale at 85 and put the receiver in operation. Place a soft pad on the service bench and turn the receiver on its side. It is now convenient to adjust the trimmers; a special wrench is required. A second alignment compensates for any interlocking of adjustments.

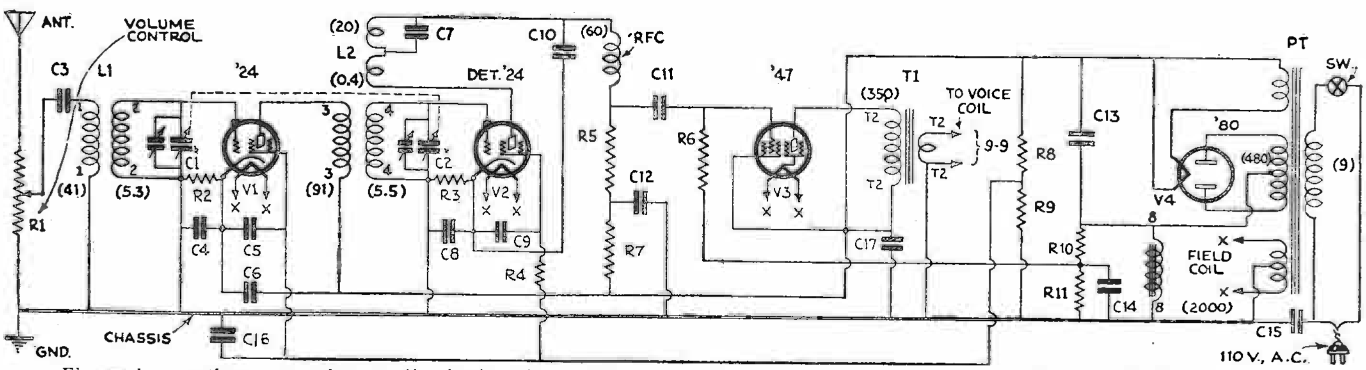






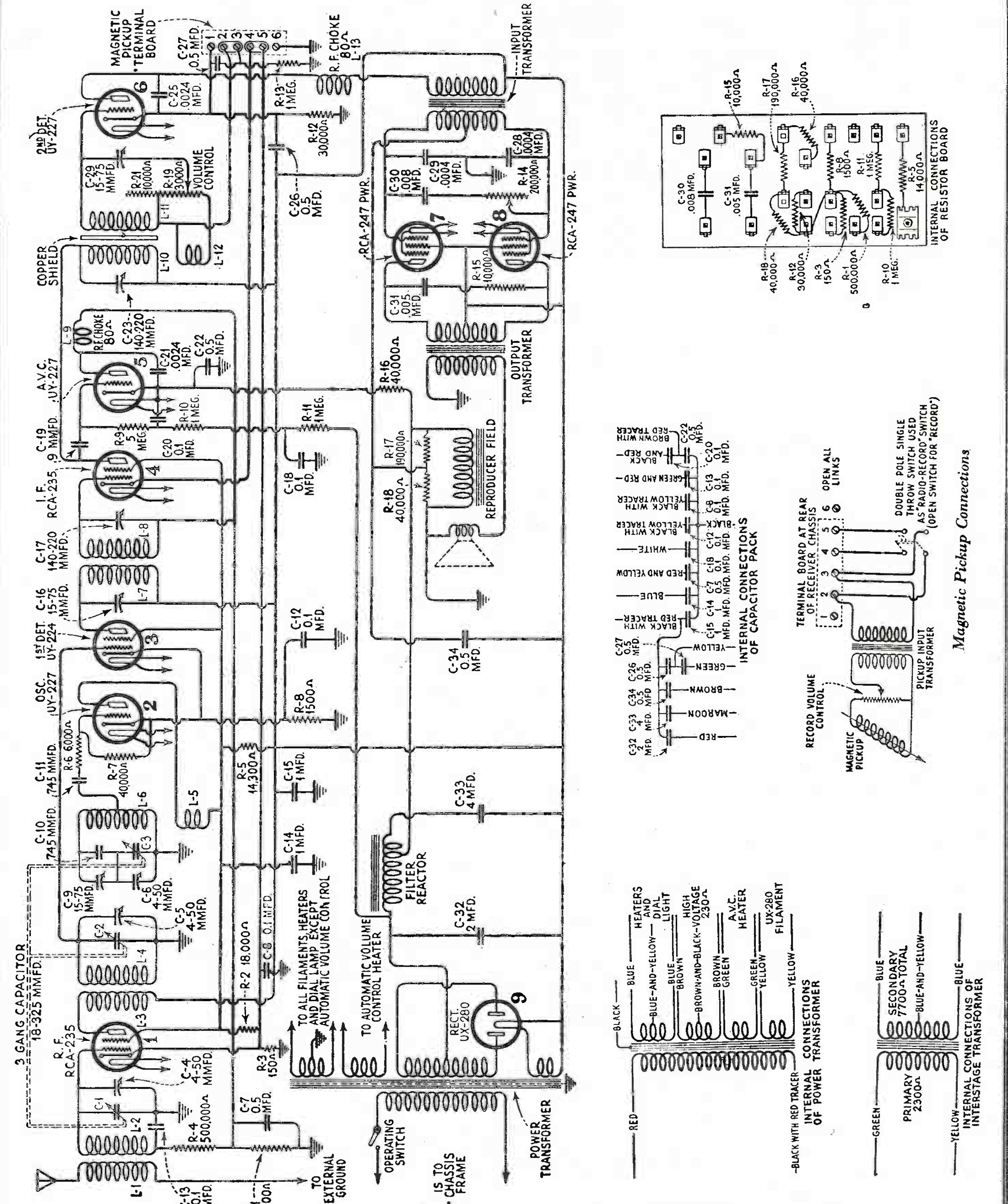






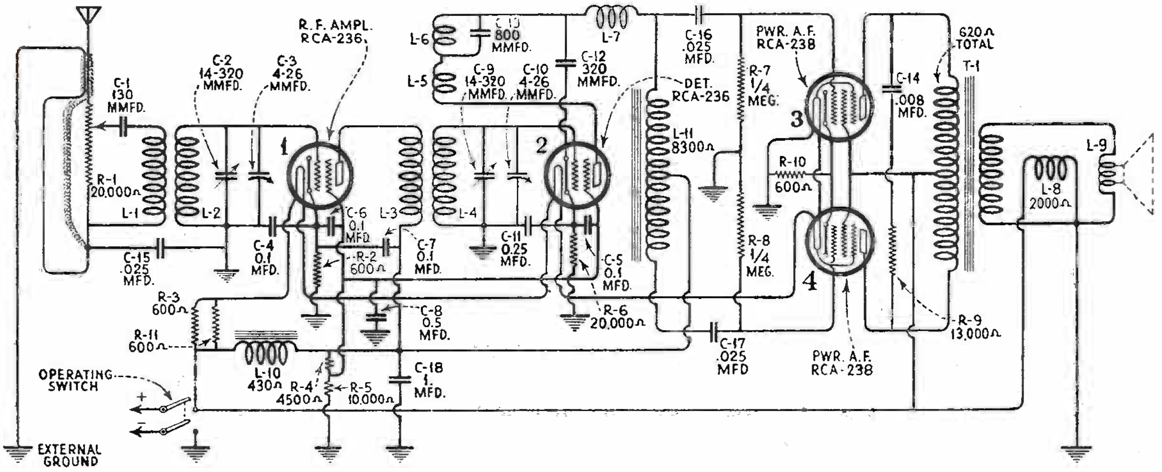
Figures in parentheses are resistances (in ohms); coil terminals correspond to the layout. Other details are shown in sketches above.

RCA VICTOR CO., INC.



R-11

RCA VICTOR CO., INC.



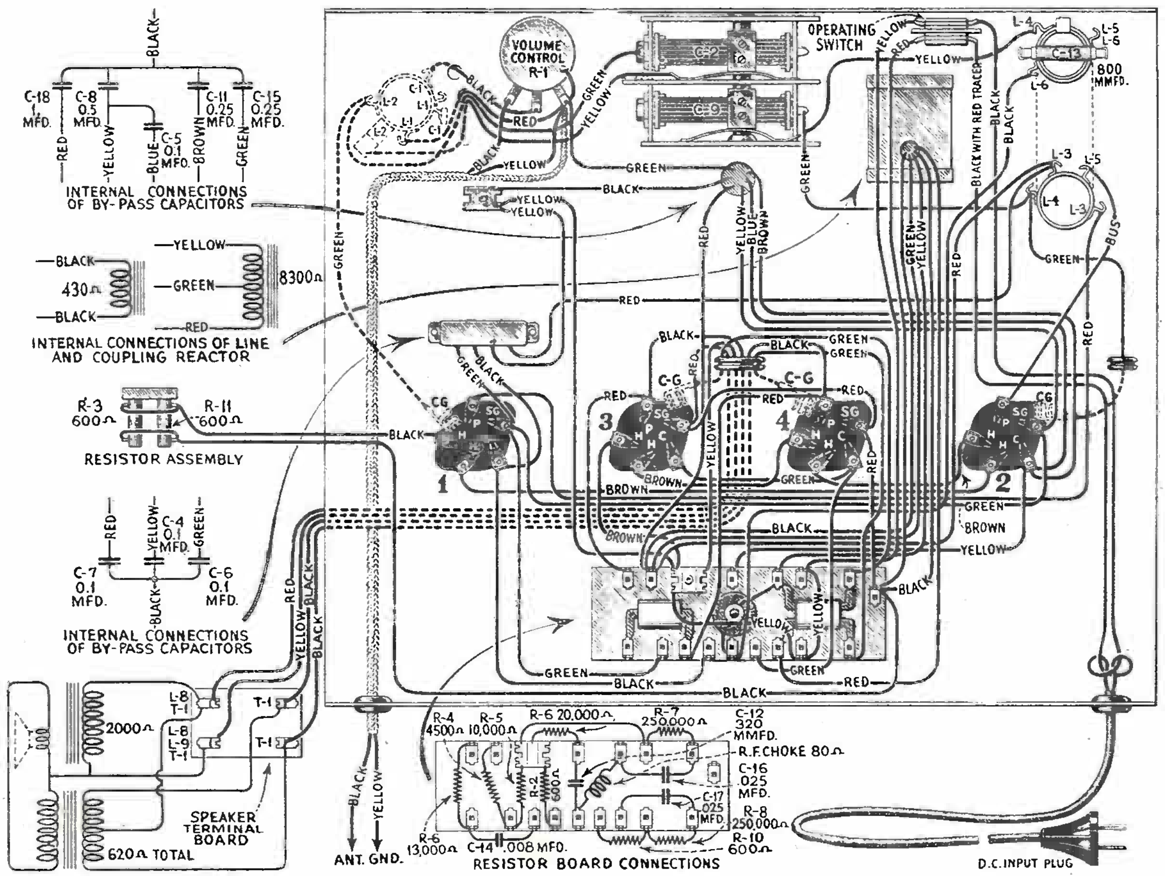
R·5 D.C.

RADIOTRON SOCKET VOLTAGE

110 VOLT D. C. LINE

These readings are obtained with the usual set analyzers and are not true readings of the voltage at which the Radiotrons operate.

Radiotron No.	Cathode to to Control Grid Volts	Cathode to Screen Grid Volts	Cathode to Plate Volts	Plate Current M. A.	Heater Volts
1	1.5	62	98	2.0	6.0
2	3.2	54	92	0.2	6.0
3	0.3	99	95	5.5	6.0
4	0.3	99	95	5.5	6.0



RCA VICTOR CO., INC.

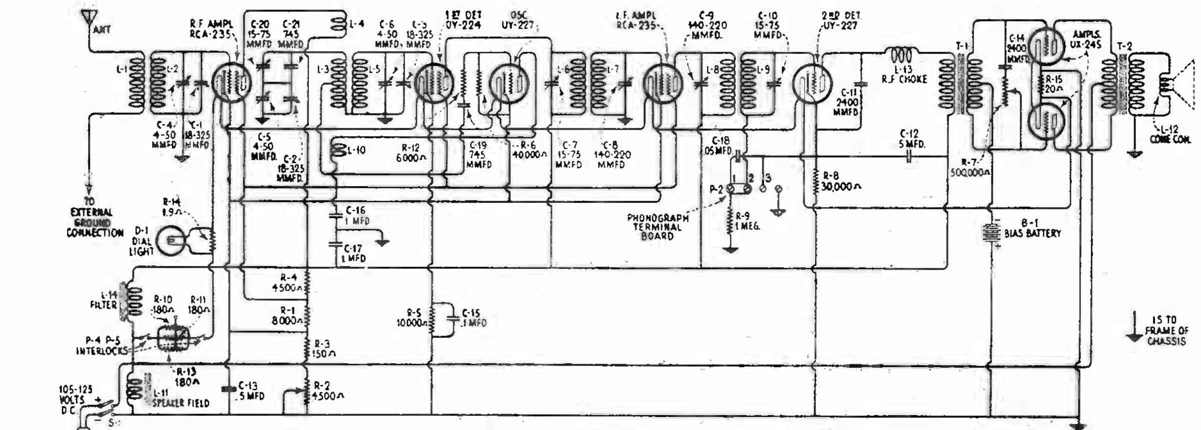


Figure 1—Schematic Circuit of RCA Victor R-7 D.C. and R-9 D.C.

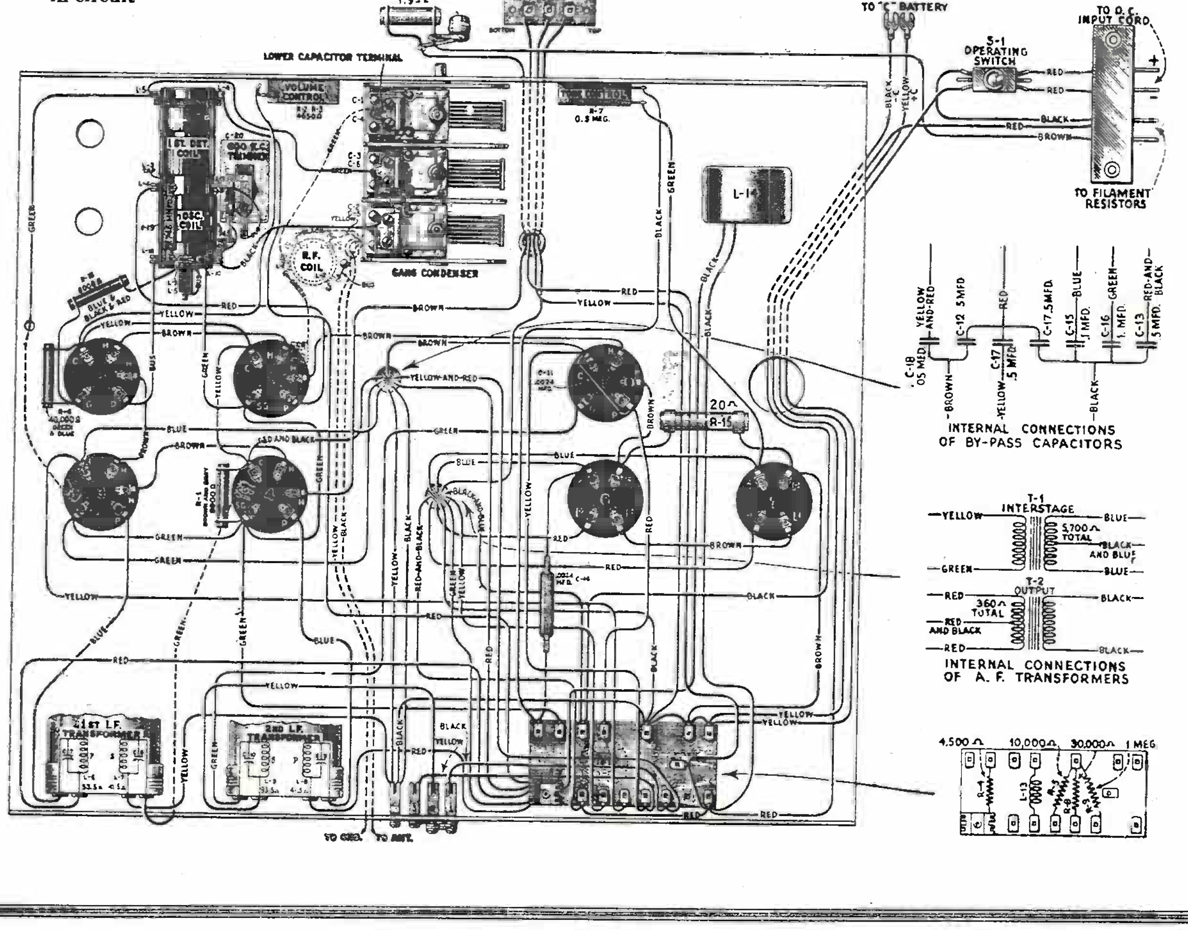
RADIOTRON SOCKET VOLTAGES—115 or 230 Volt Line

(Separate Resistance Unit Used with 230 Volt Line)

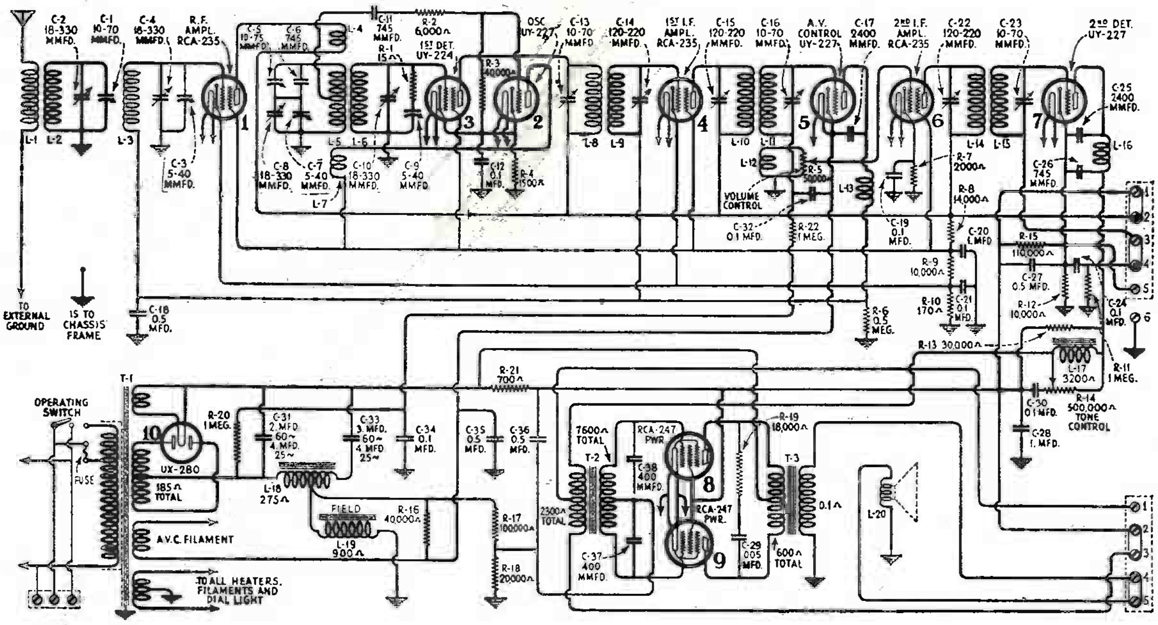
Tube No.	Cathode to Heater Volts, D.C.	Cathode or Filament to Control Grid Volts, D.C.	Cathode to Screen Grid Volts, D.C.	Cathode or Filament to Plate Volts, D.C.	Plate Current M. A.	Screen Grid Current M. A.	Heater or Filament Volts, A.C.
			VOLUME CONTROL AT MINIMUM				
1	40	30	40	75	0	0	2.3
2	20	0	—	40	2.0	—	2.3
3	6.0	3.5	65	100	.25		2.3
4	17.0	26	40	75	.0	0	2.3
5	2.0	*2.0	—	90	.23	—	2.3
6	—	25.0	—	100	4.0	—	2.3
7	—	*25.0	—	100	4.0	—	2.3
			VOLUME CONTROL AT MAXIMUM				
1	10.0	2.0	50	100	3.5	**0.5	2.3
2	6.0	.0		50	3.0	—	2.3
3	8.0	5.0	50	100	0.5	.0	2.3
4	10.0	2.0	50	100	2.5	**1.0	2.3
5	2.0	*2.0	—	90	.25	0	2.3
6	—	*25.0	—	100	4.0	—	2.3
7	—	*25.0	—	100	4.0	—	2.3

* Not true reading due to Resistance in circuit

**This may be plus or minus depending on age of tubes



RCA VICTOR CO., INC.



R-50, R-55

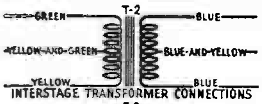
RADIOTRON SOCKET VOLTAGES

VOLTAGES ARE THE SAME AT EITHER POSITION OF THE VOLUME CONTROL

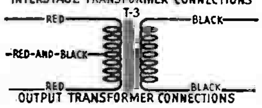
110 VOLT LINE

Radiotron No.	Heater to Cathode Volts	Cathode or Filament or Control Grid Volts	Cathode or Filament to Screen Grid Volts	Cathode or Filament to Plate Volts	Plate Current M. A.	Heater Volts
1. R.F.	2.0	*0.2	60	230	3.5	2.5
2. Osc.	5.0	0	—	50	4.0	2.5
3. 1st Det.	4.0	3.5	60	230	0.5	2.5
4. 1st I.F.	2.0	*0.2	60	230	3.5	2.5
5. A.V.C.	0	0	—	30	0.1	2.5
6. 2nd I.F.	2.0	3.5	60	230	2.5	2.5
7. 2nd Det.	20.0	*8.0	—	210	0.5	2.5
8. Pwr.	—	*10.0	250	235	25.0	2.5
9. Pwr.	—	*10.0	250	235	25.0	2.5

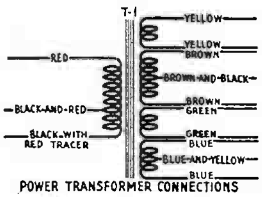
*These readings are not correct due to the resistance in the circuits



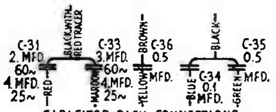
INTERSTAGE TRANSFORMER CONNECTIONS



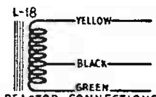
OUTPUT TRANSFORMER CONNECTIONS



POWER TRANSFORMER CONNECTIONS



CAPACITOR PACK CONNECTIONS



REACTOR CONNECTIONS

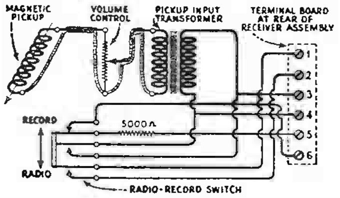
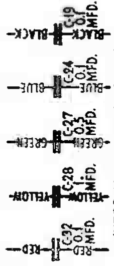
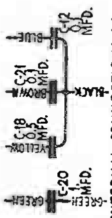


Figure 3—Magnetic Pickup connections

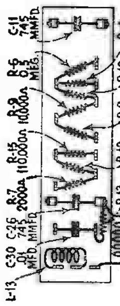
Note: Place the Radio-Record switch and input transformer in the receiver cabinet. Try connecting a wire from receiver terminal No. 6 to input transformer frame or braided shield to pickup and use connection that gives minimum hum.



INTERNAL CONNECTIONS OF BY-PASS CAPACITOR PACK

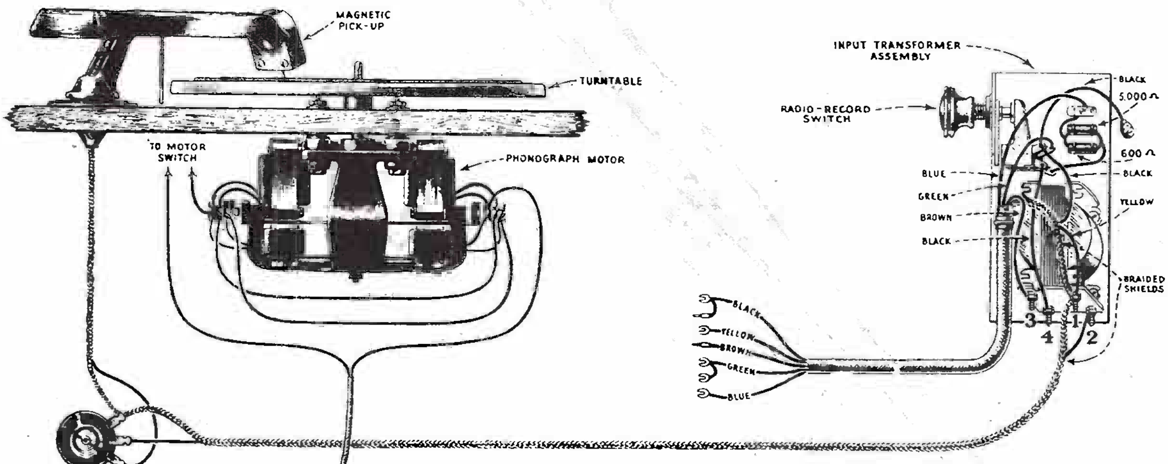


INTERNAL CONNECTIONS OF BY-PASS CAPACITOR PACK

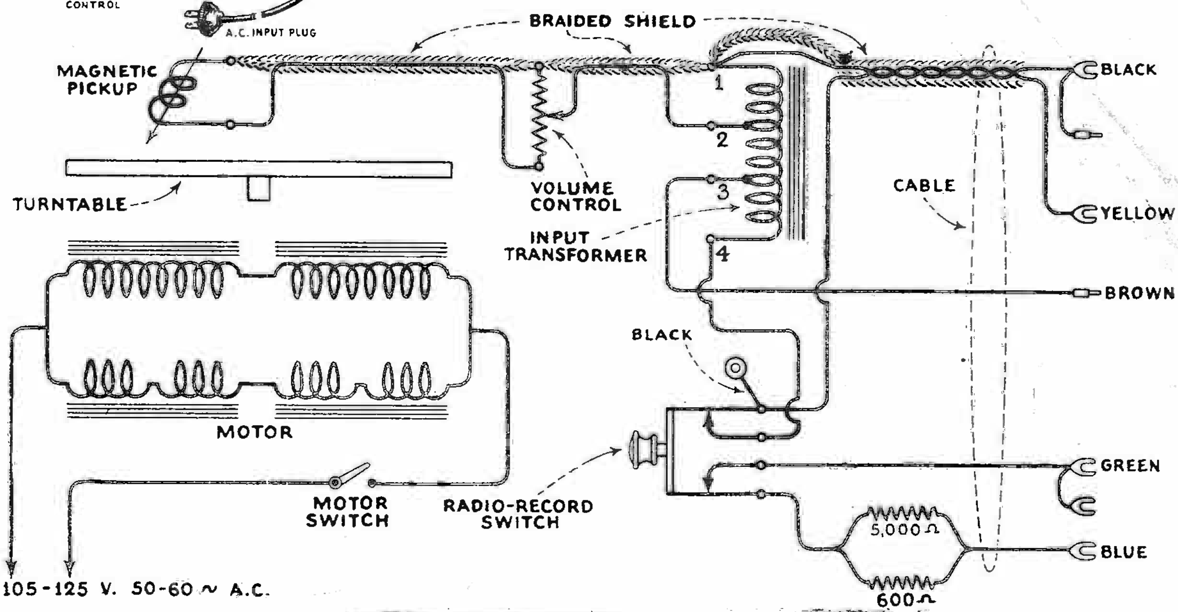


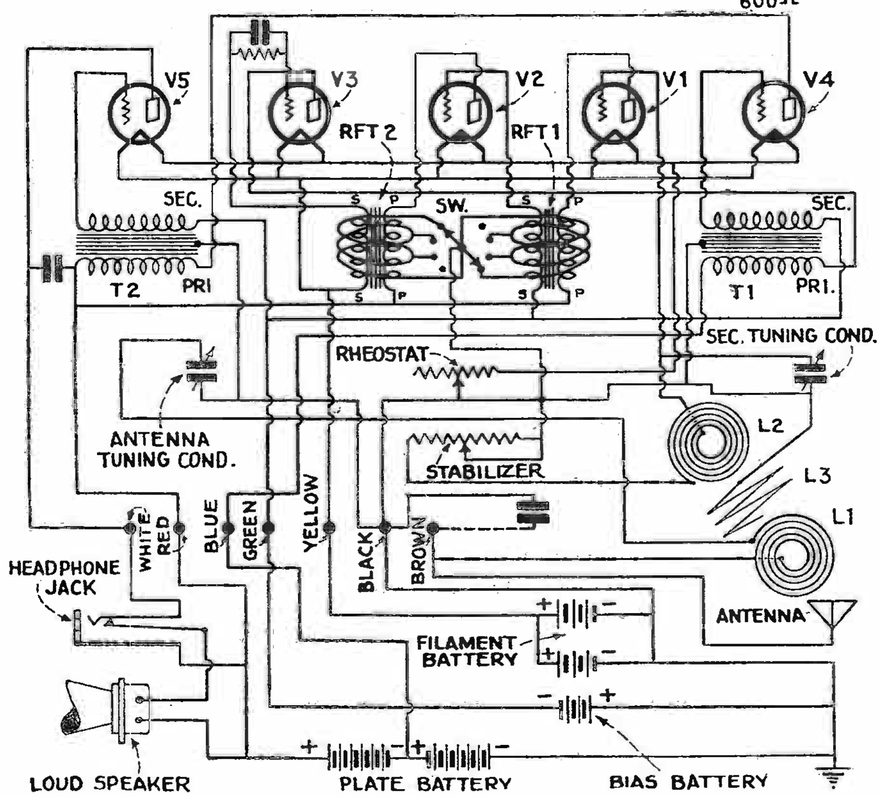
RESISTOR BOARD CONNECTIONS

RCA VICTOR CO., INC.



T-5 ELECTROLA

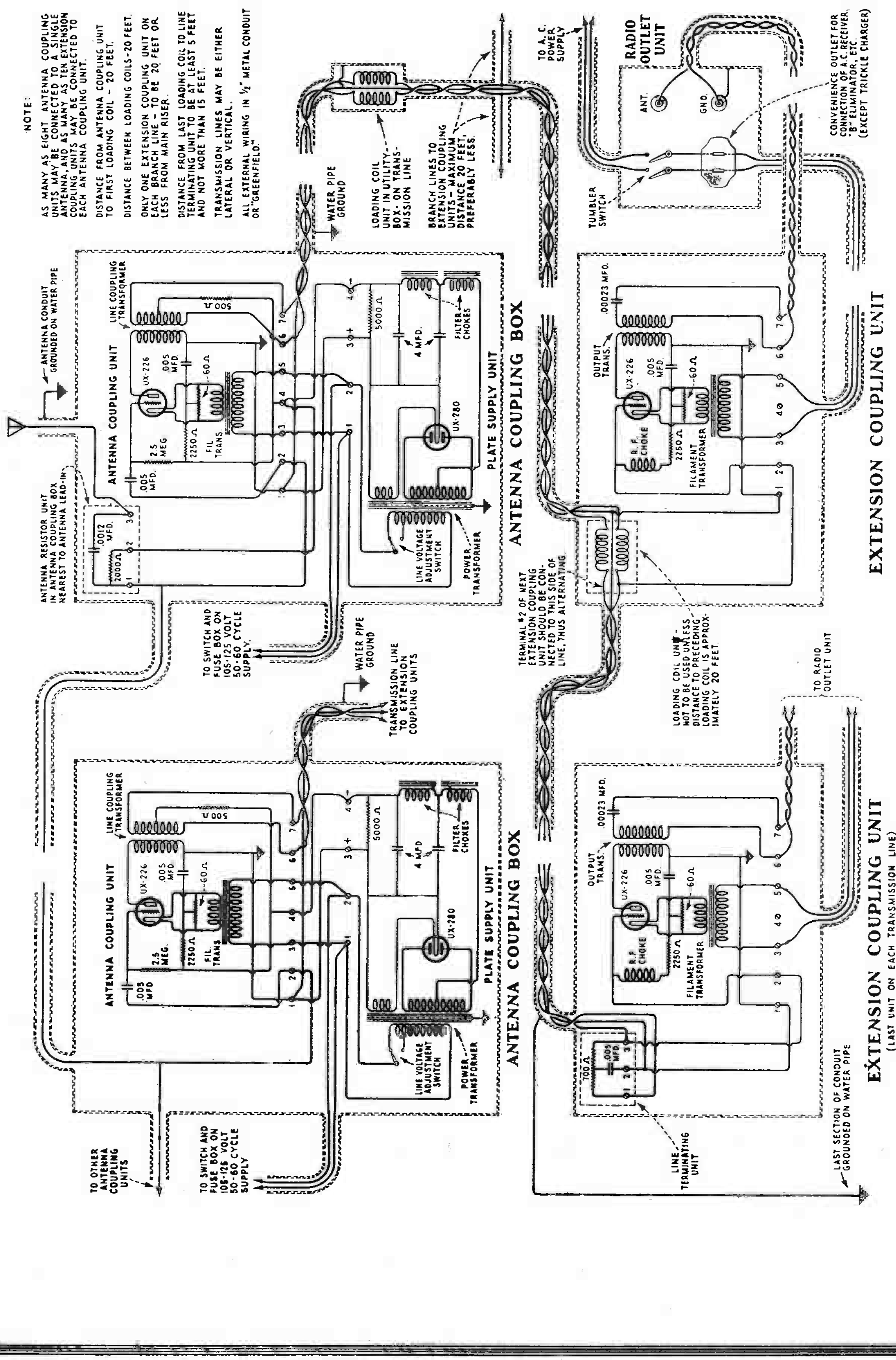




VII - B

R. C. A. VICTOR, INC.

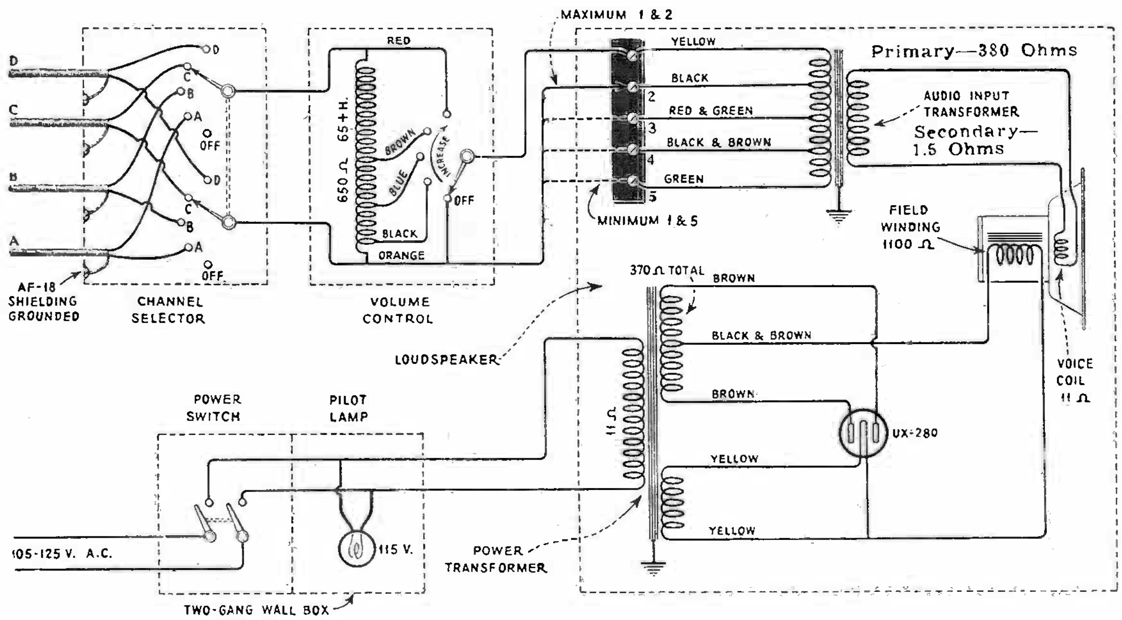
ANTENNA SYSTEM MODEL RF-5600



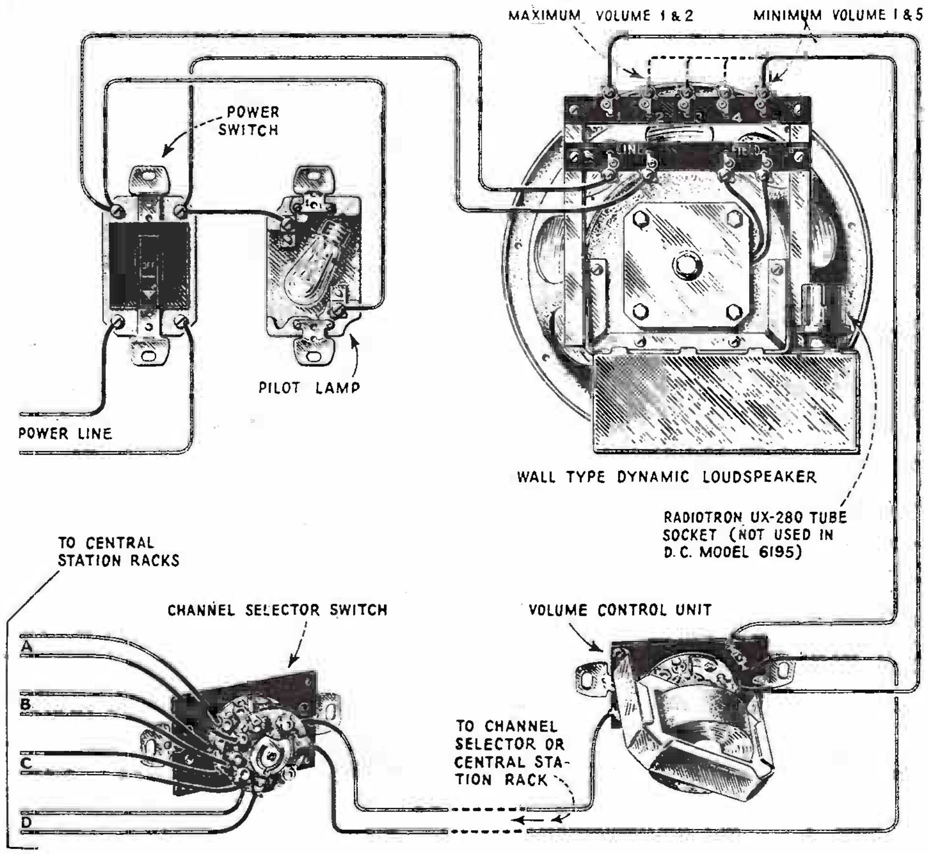
Schematic circuit diagram of the RCA antenna system for multiple receivers

R. C. A. VICTOR, INC.

WALL TYPE SPEAKER MODEL AF-6175



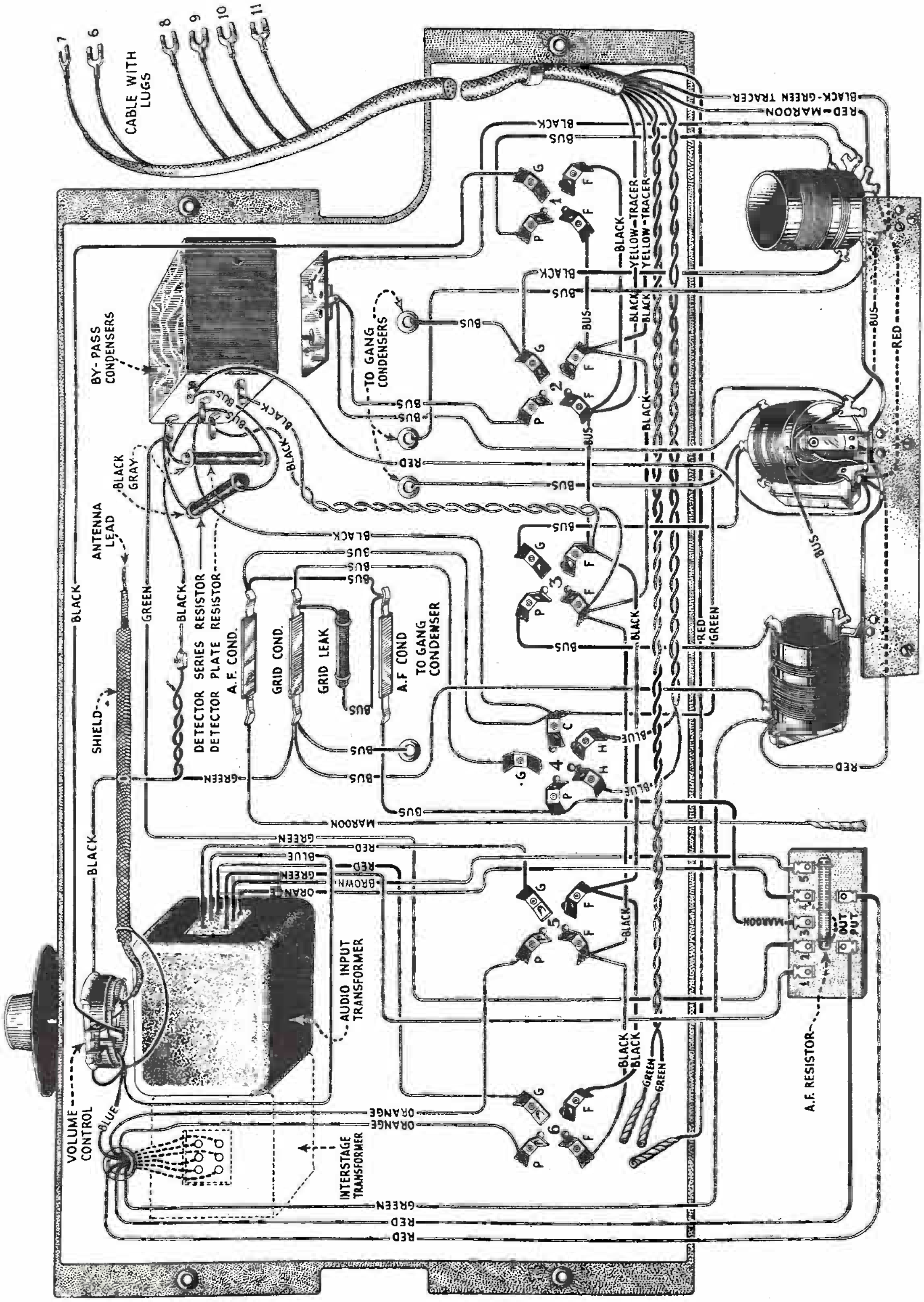
*Wall type dynamic loudspeaker and associated equipment—
D. C. resistances given*



Assembly wiring diagram showing connections to speaker, volume control, channel selector and power switch

R. C. A. VICTOR, INC.

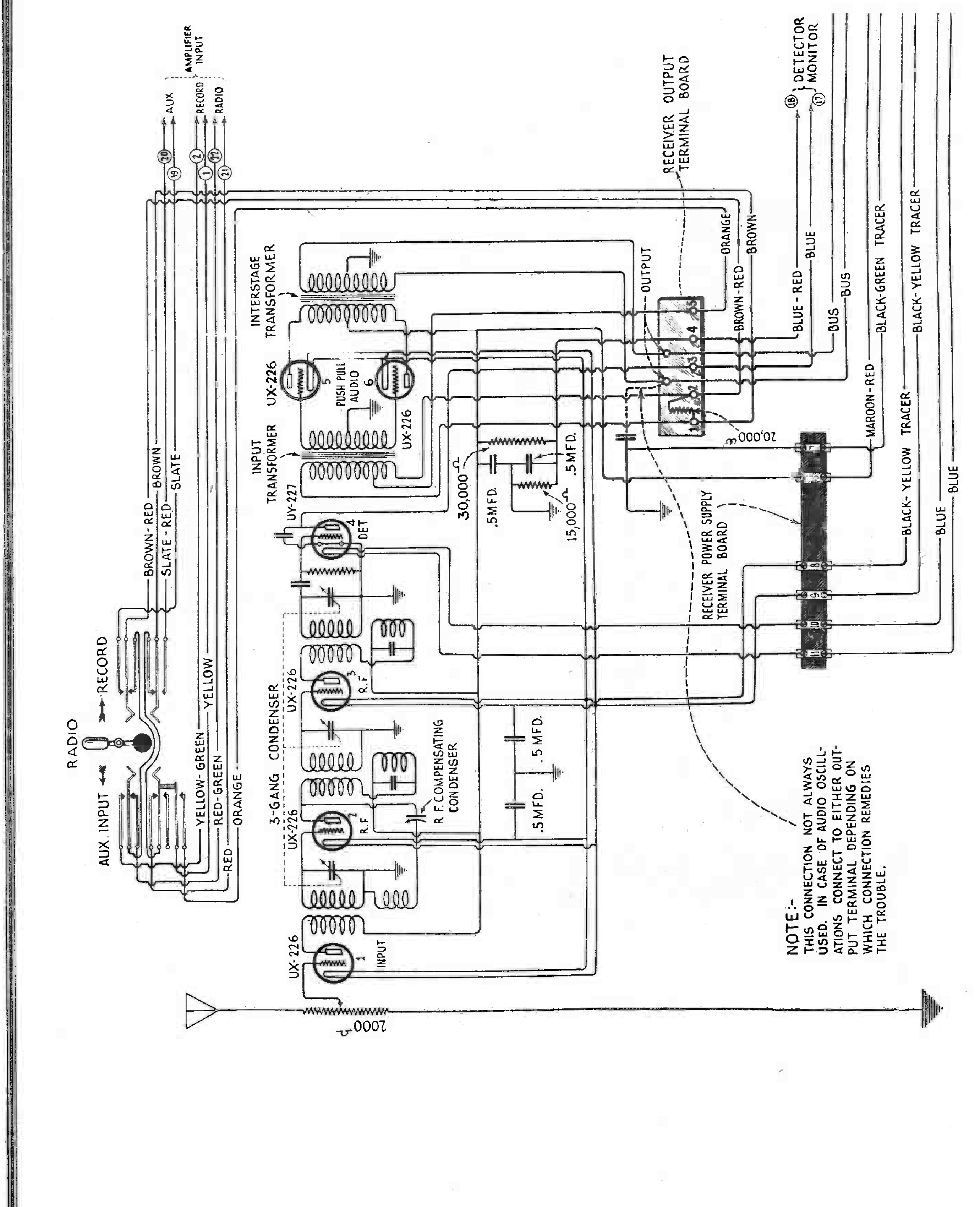
CENTRALIZED RADIO MODEL ER-1240



Wiring diagram of receiver

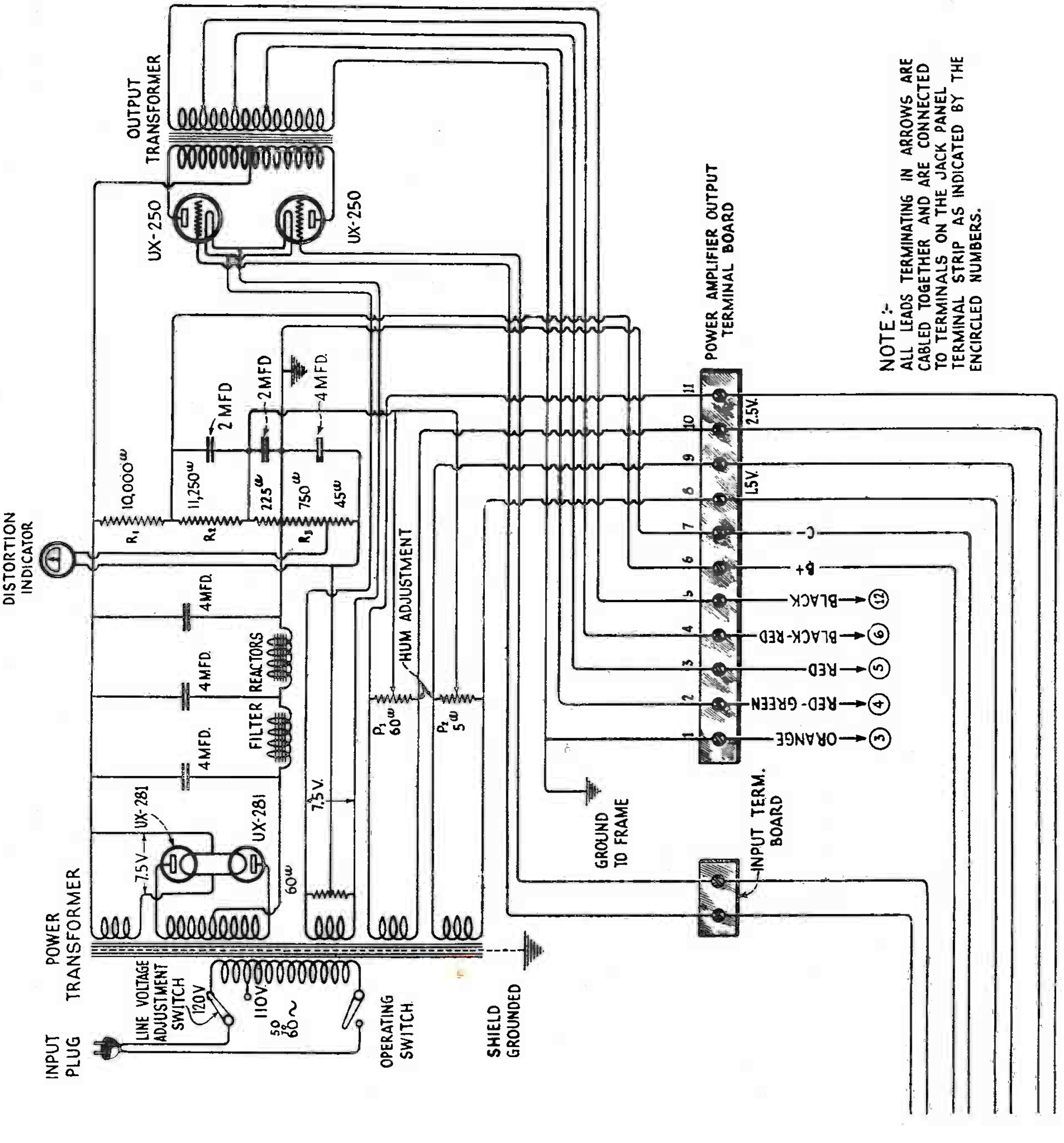
R. C. A. VICTOR, INC.

CENTRALIZED RADIO MODEL ER-1240



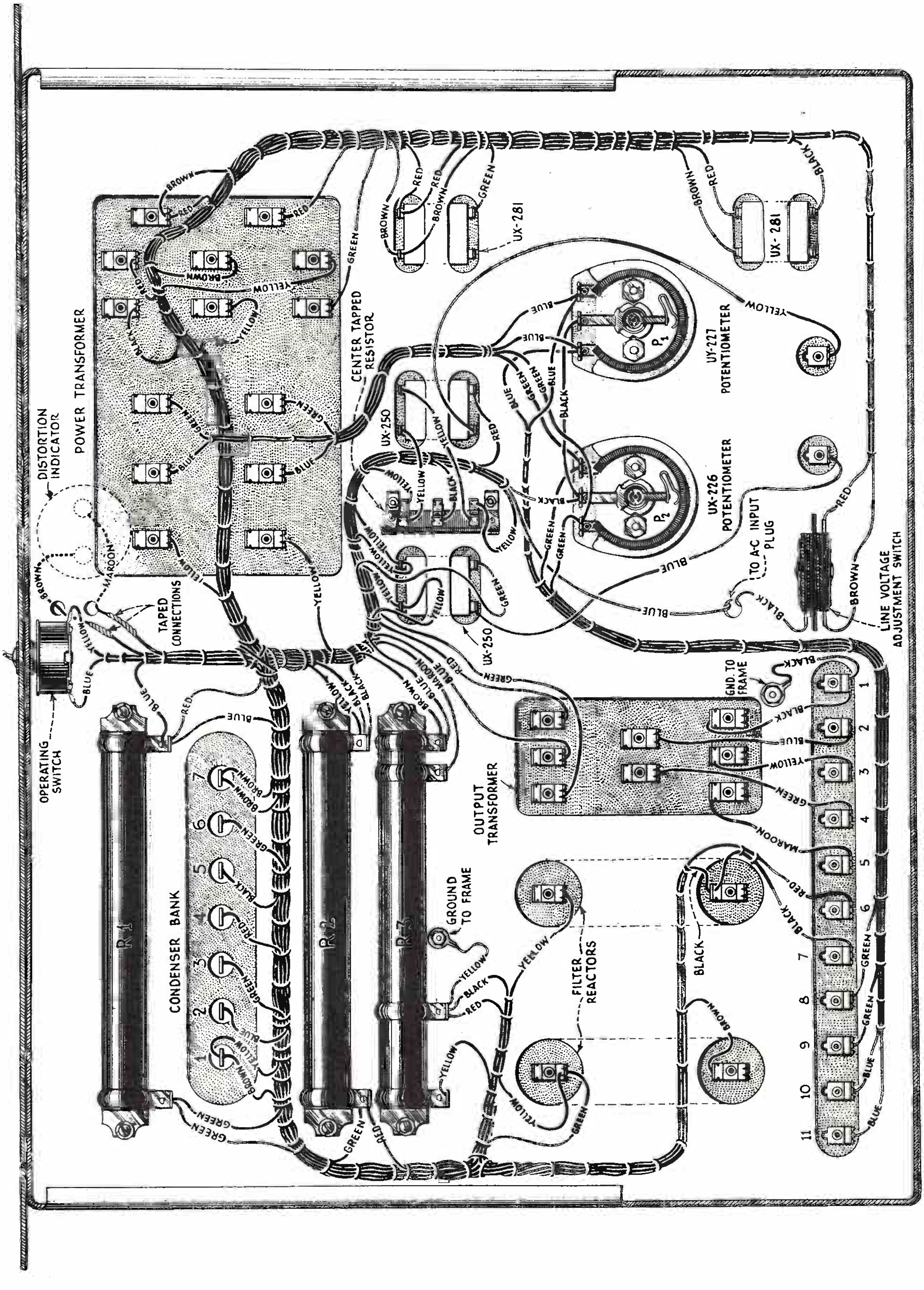
R. C. A. VICTOR, INC.

CENTRALIZED RADIO MODEL ER-1240



R. C. A. VICTOR, INC.

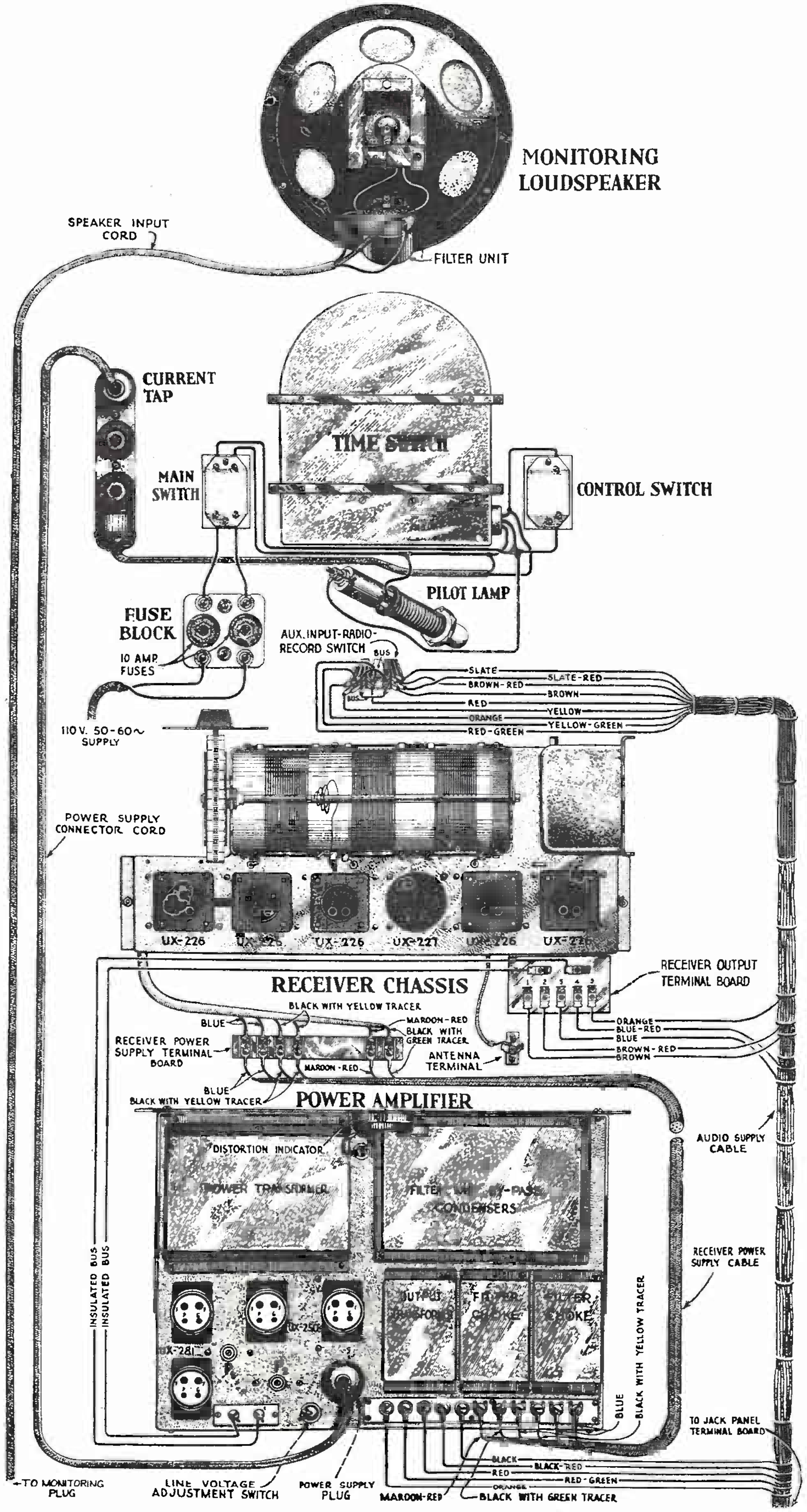
CENTRALIZED RADIO MODEL ER 1240



Wiring diagram of power amplifier

R. C. A. VICTOR, INC.

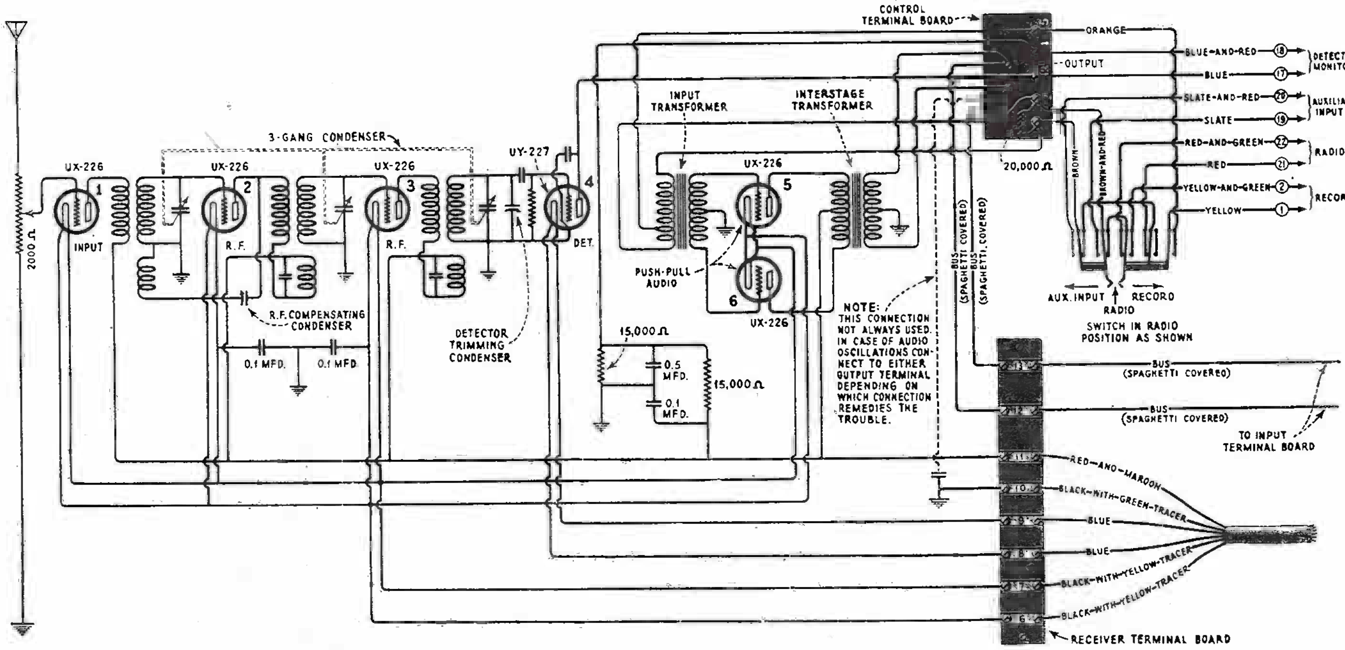
CENTRALIZED RADIO MODEL ER-1240

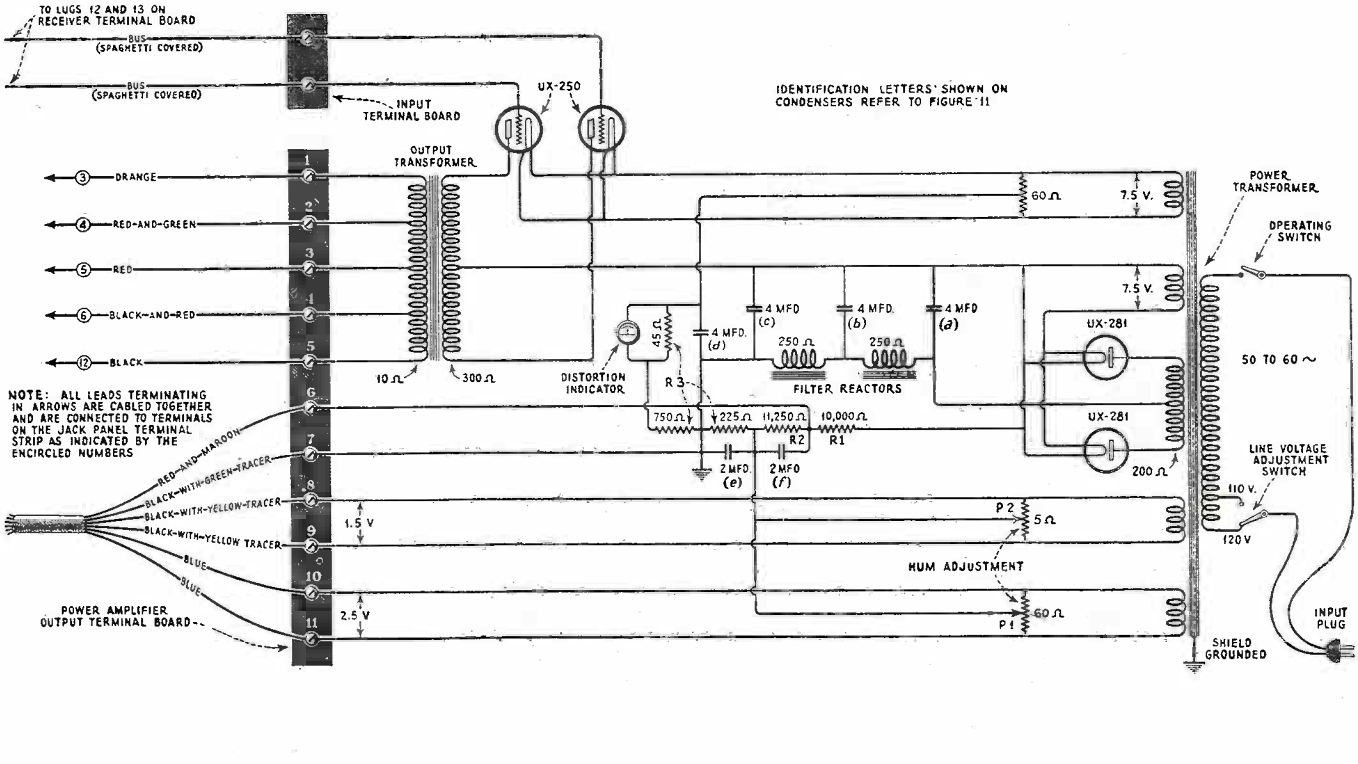


Layout showing main units with cable connections

R. C. A. VICTOR, INC.

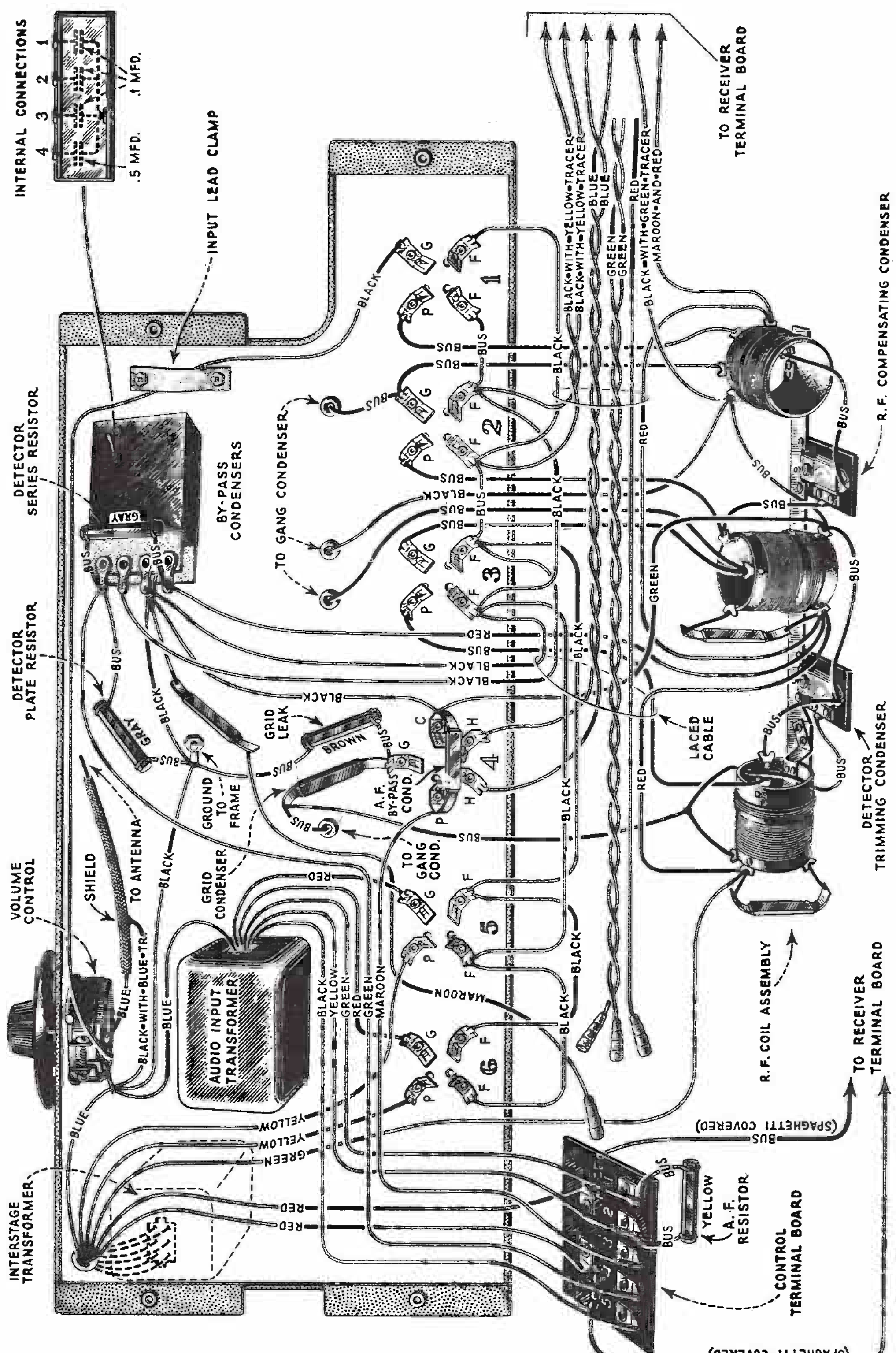
CENTRALIZED RADIO MODEL ER-1240A





R. C. A. VICTOR, INC.

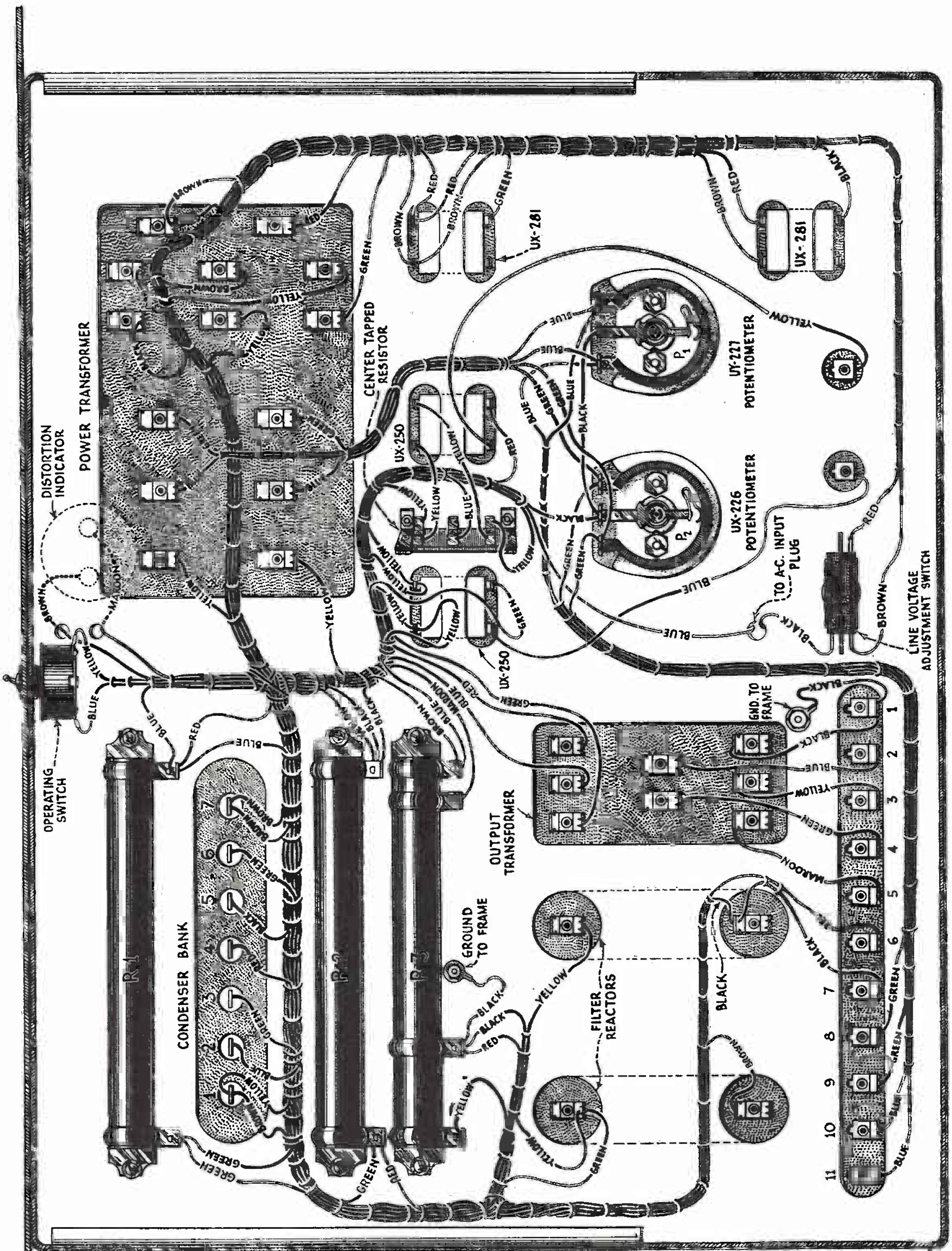
CENTRALIZED RADIO MODEL ER-1240A



Wiring diagram of receiver

R. C. A. VICTOR, INC.

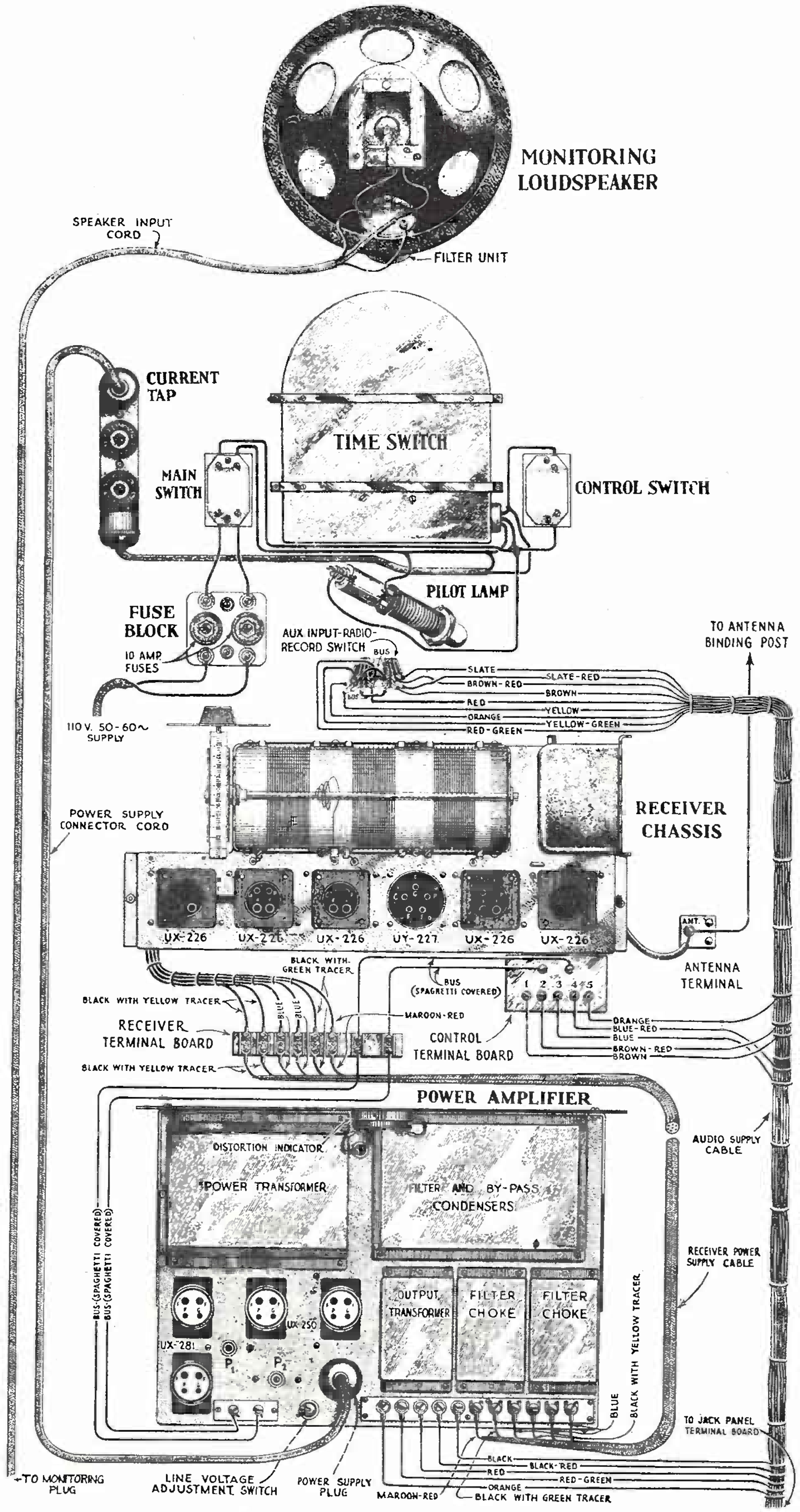
CENTRALIZED RADIO MODEL ER 1240 A



Wiring diagram of power amplifier

R. C. A. VICTOR, INC.

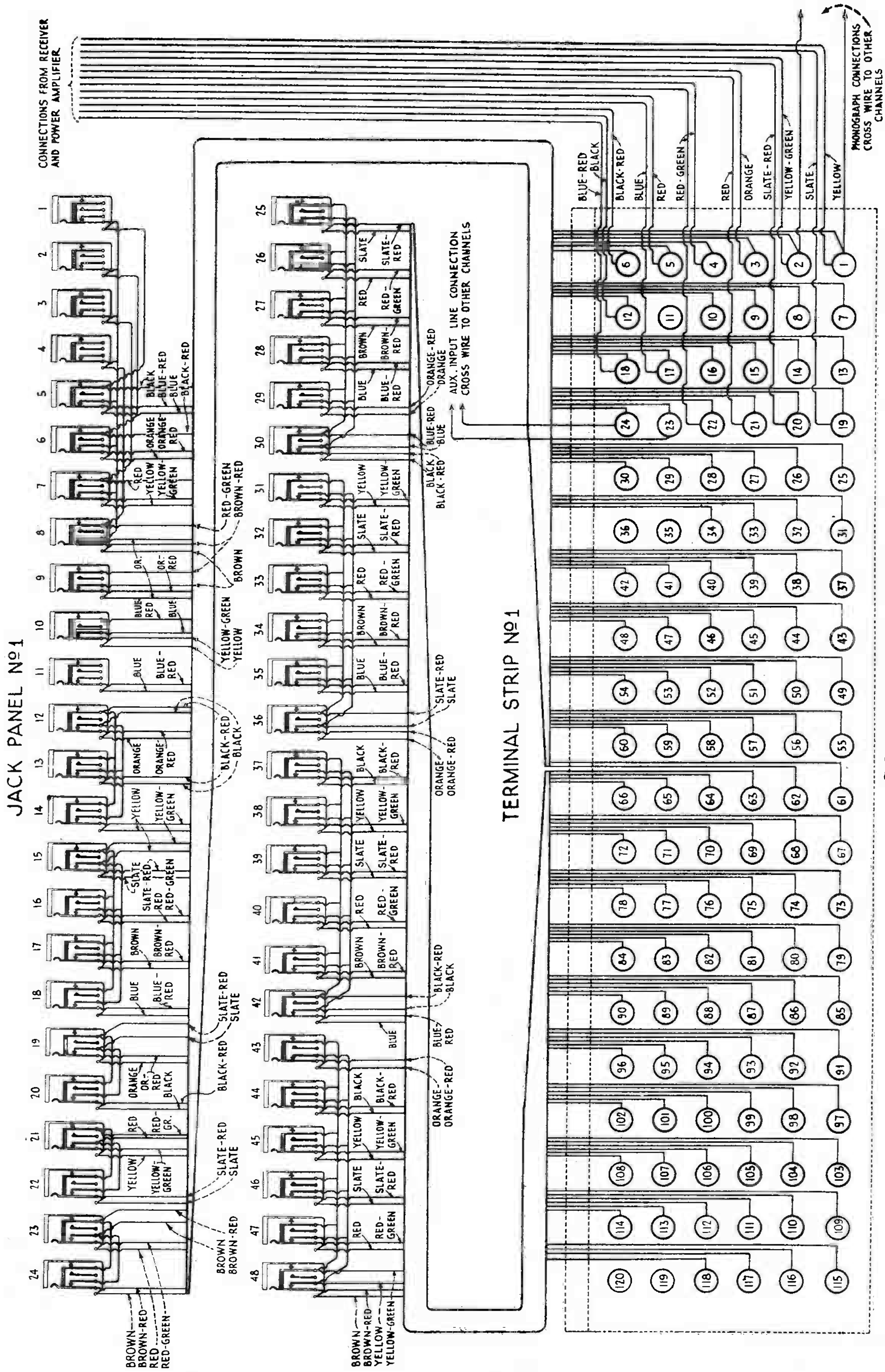
CENTRALIZED RADIO MODEL ER-1240 A



–Layout showing main units with cable connections

R. C. A. VICTOR, INC.

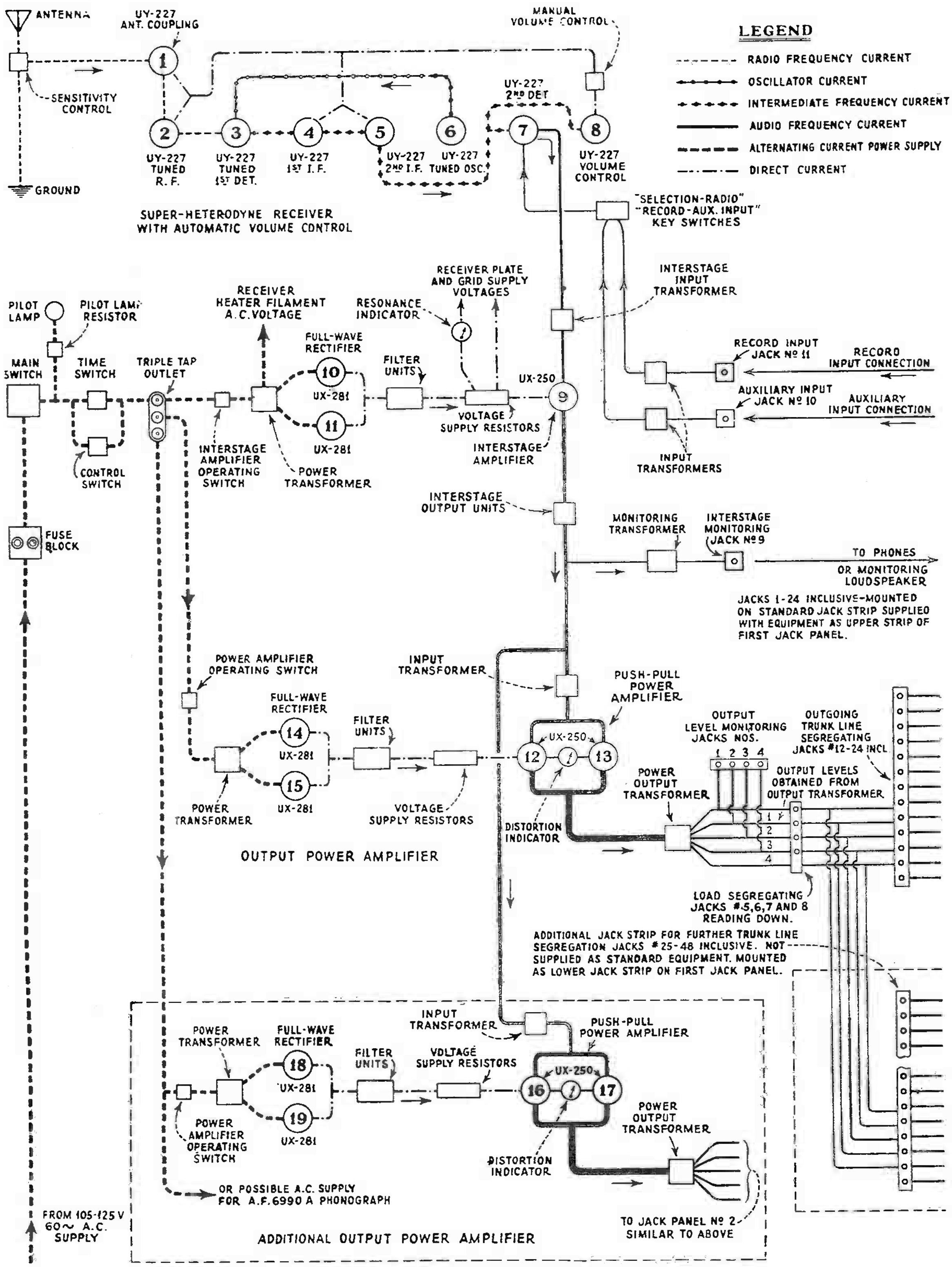
CENTRALIZED RADIO MODEL ER-1240 A



Schematic diagram of jack panel

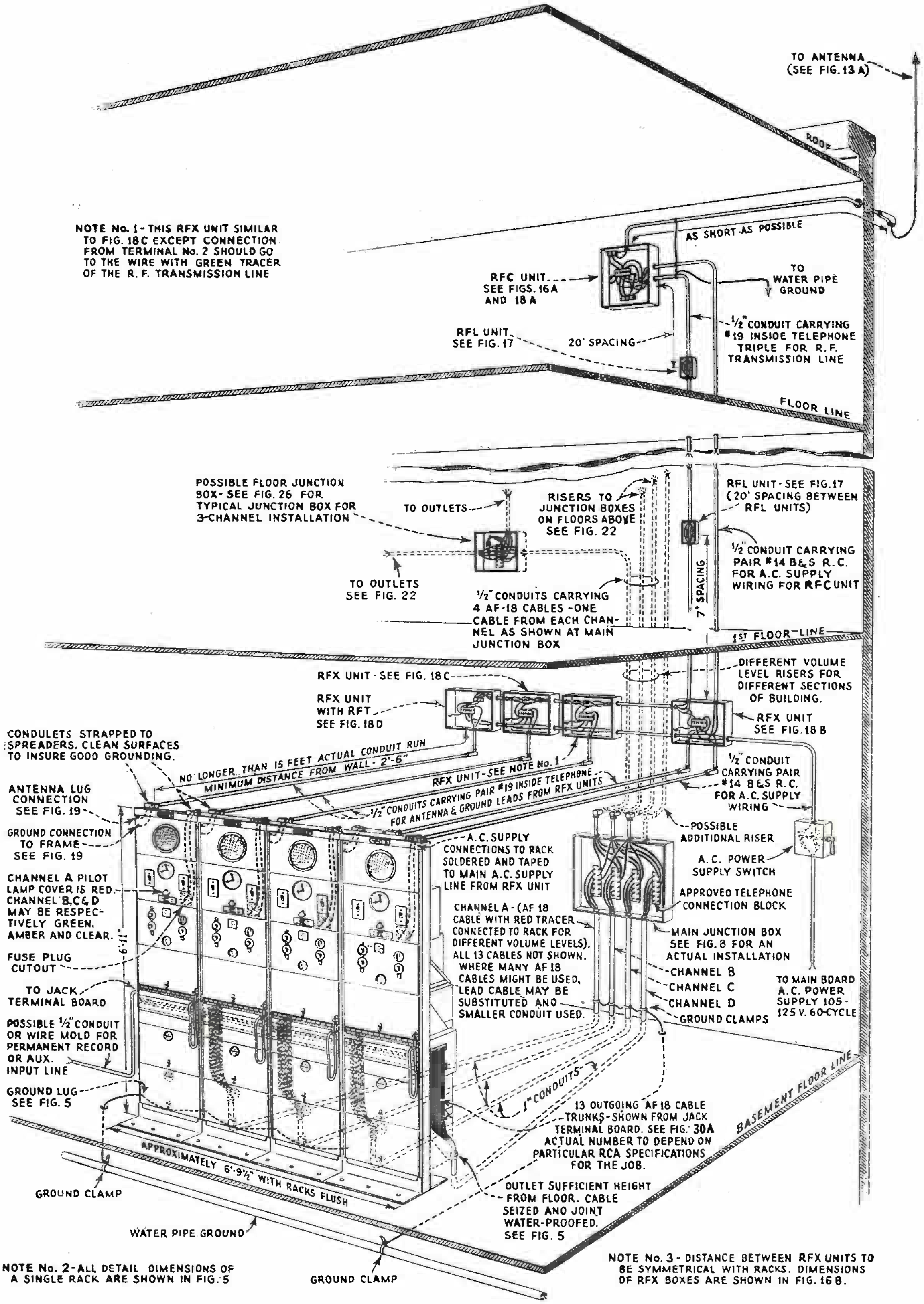
R. C. A. VICTOR, INC.

CENTRALIZED RADIO MODEL AF-6100



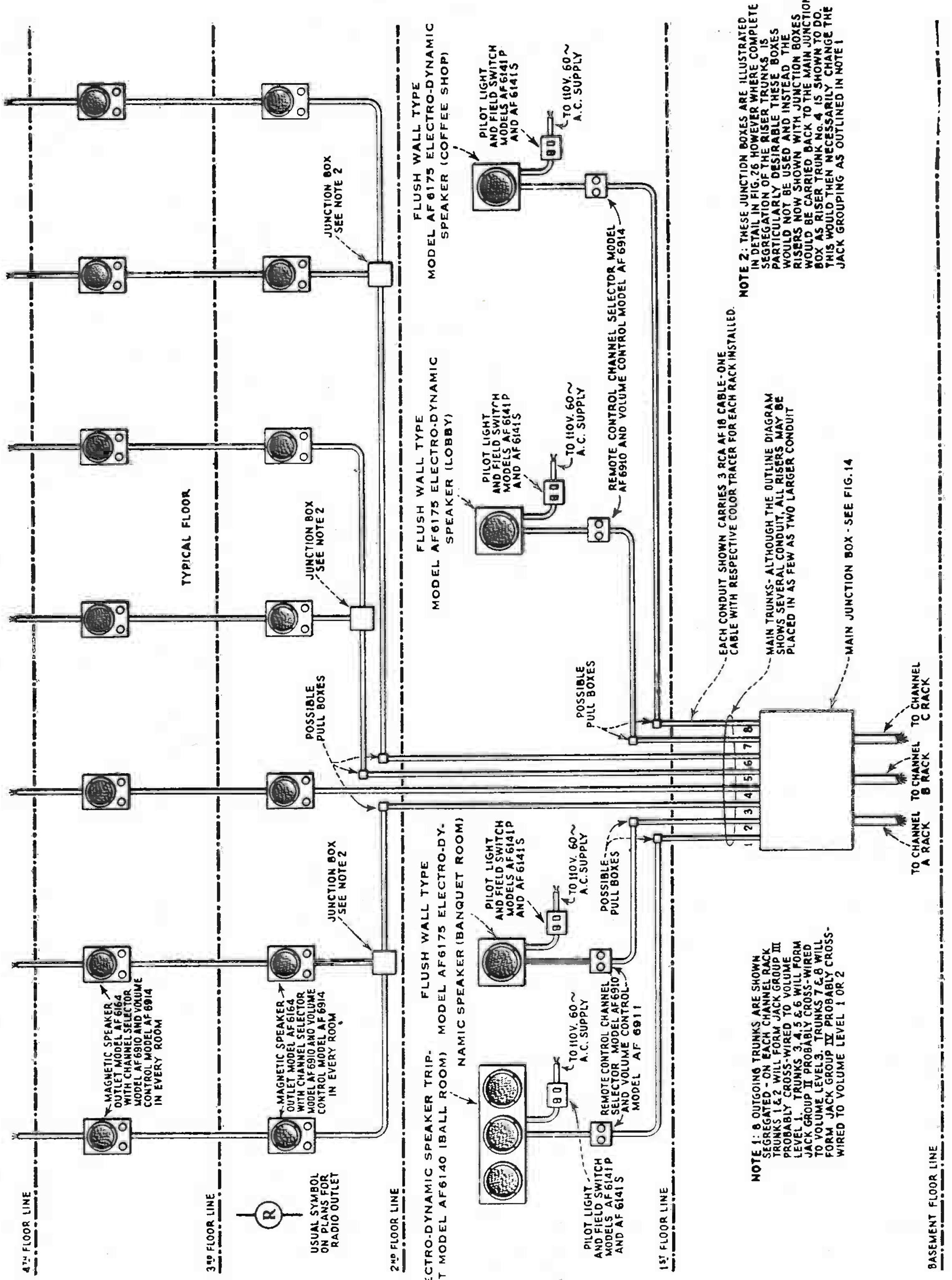
R. C. A. VICTOR, INC.

CENTRALIZED RADIO MODEL AF-6100



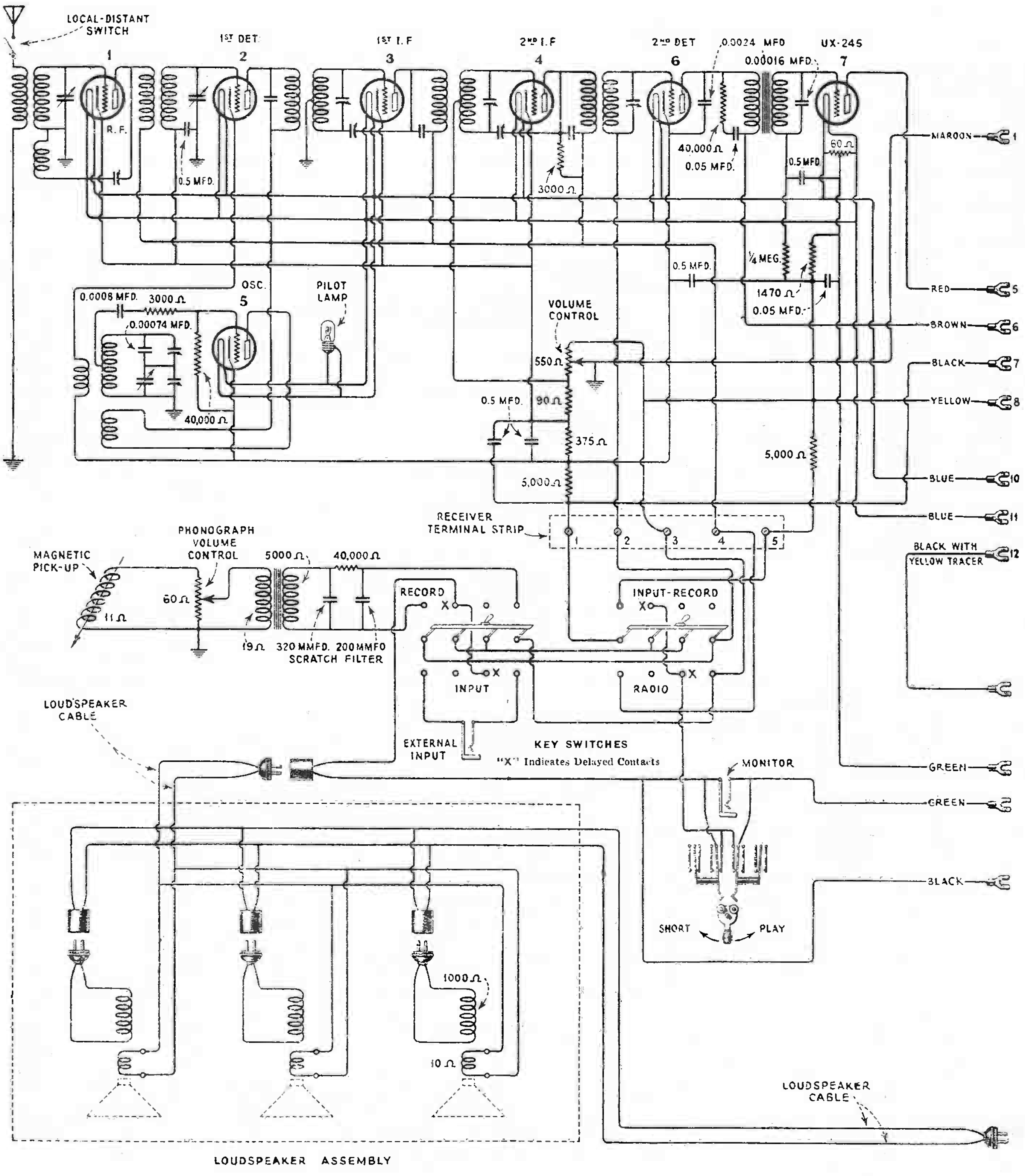
R. C. A. VICTOR, INC.

CENTRALIZED RADIO MODEL AF-6100



R. C. A. VICTOR, INC.

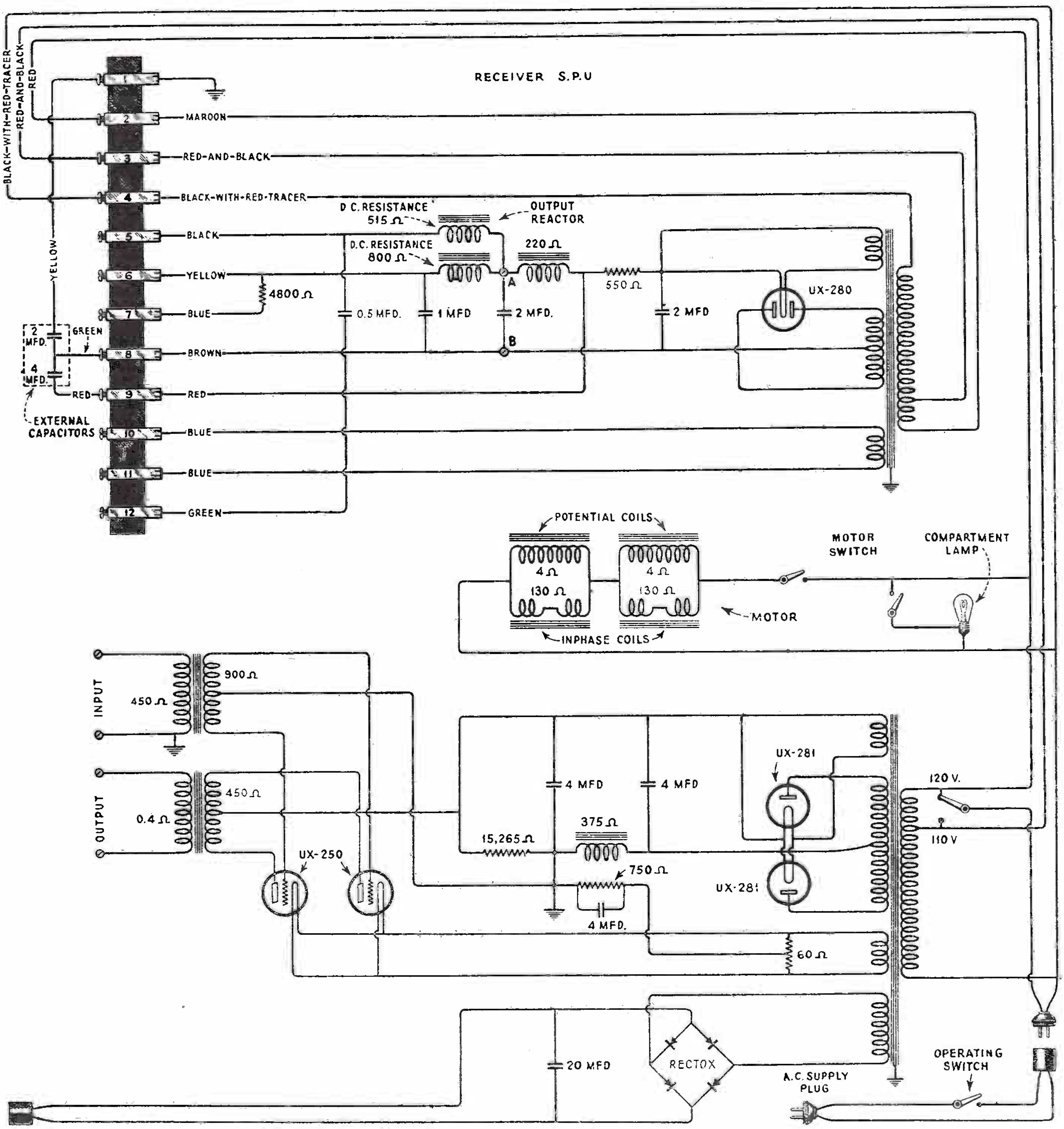
AUDITORIUM RADIOLA PHONOGRAPH



ARP

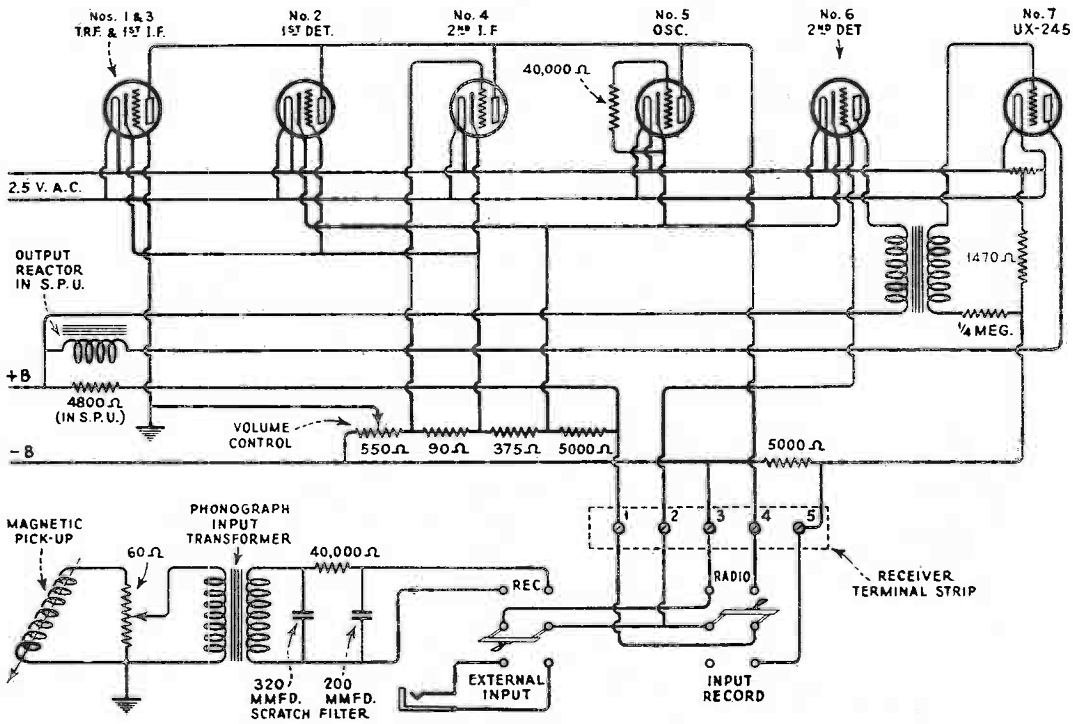
R. C. A. VICTOR, INC.

AUDITORIUM RADIOLA PHONOGRAPH



R. C. A. VICTOR, INC.

AUDITORIUM RADIOLA PHONOGRAPH



VOLTAGE READINGS AT RADIOTRON SOCKETS

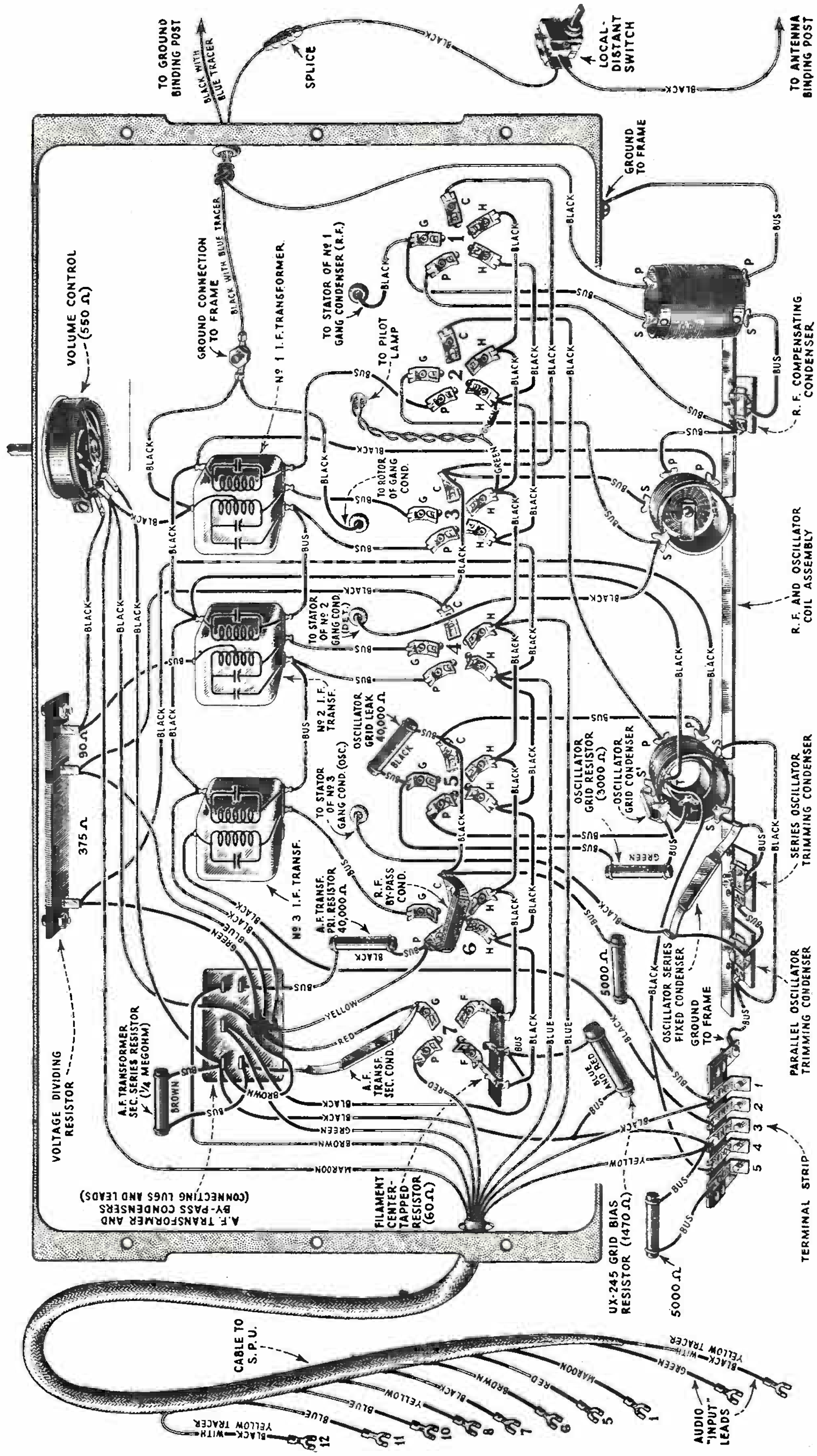
"Radio-Input-Record" Switch in Radio Position
Volume Control at Minimum

Socket No.	Cathode to Heater Volts	Cathode to Grid Volts	Cathode to Plate Volts	Plate Current Milamps	Filament or Heater Volts (rms.)
1 (RF)	−22	−20	100	0	2.3
2 (1st Det)	−13	− 8.5	90.	1.5	2.3
3 (1st IF)	−22	−20.	100.	0	2.3
4 (2nd IF)	−22	− 3.0	100.	7.0	2.3
5 (Osc)	−13	0	85.	8.2	2.3
6 (2nd Det)	−13	−29.	230.	0.5	2.3
UX-245	—	−14.*	225.	30.	2.4
UX-250's	—	−72.	420.	55.	7.2
Volume Control at Maximum					
1 (RF)	−20	− 3.0	78.	4.5	2.3
2 (1st Det)	−12	− 6.5	74.	1.3	2.3
3 (1st IF)	−20	− 3.0	78.	5.0	2.3
4 (2nd IF)	−20	− 3.0	78.	4.5	2.3
5 (Osc)	−12	0	70.	6.5	2.3
6 (2nd Det)	−12	−28.	225.	0.5	2.3
UX-245	—	−13.*	220.	29.5	2.4
UX-250's	—	−72.	420.	55.	7.2
Radio-Input-Record Switch in Record Position					
No. 6	−20	−12	218.	5.0	2.3
UX-250	—	−73	425.	55.	7.2

* The actual bias on the UX-245 Radiotron is approximately −40 volts. The low reading is caused by the one-quarter megohm resistor in series with the voltmeter.

R. C. A. VICTOR, INC.

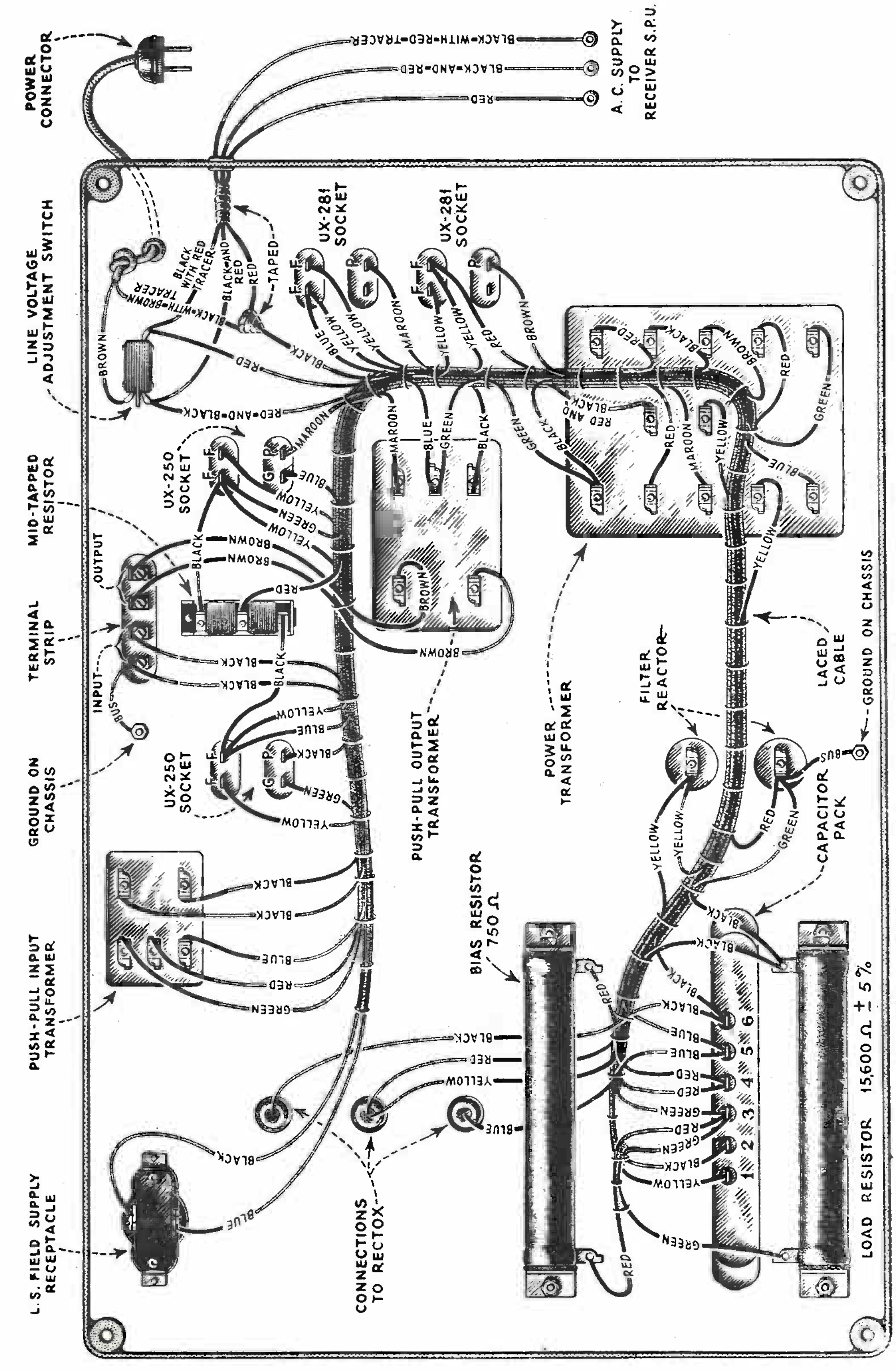
AUDITORIUM RADIOLA PHONOGRAPH



ARP

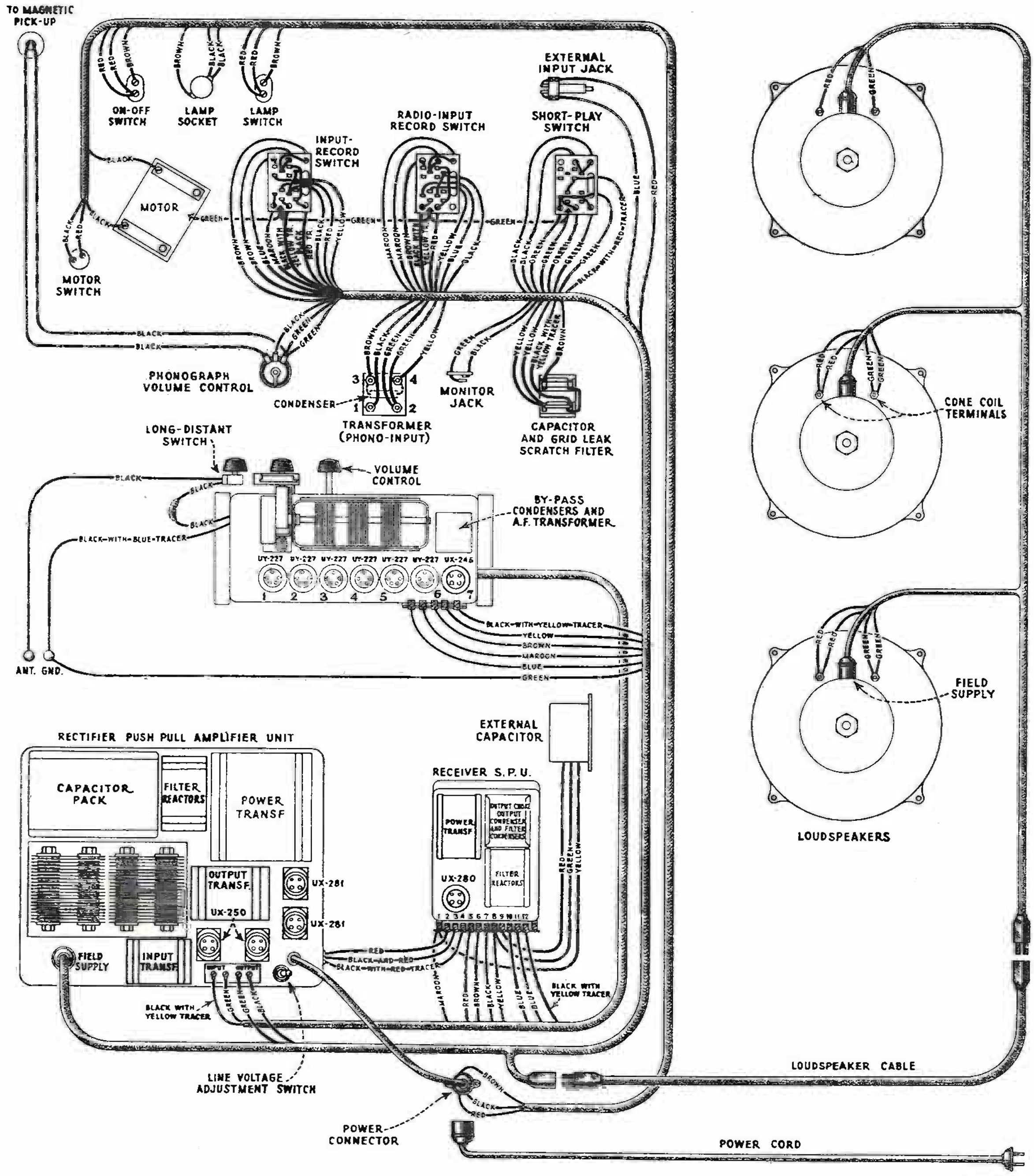
R. C. A. VICTOR, INC.

AUDITORIUM RADIOLA PHONOGRAPH

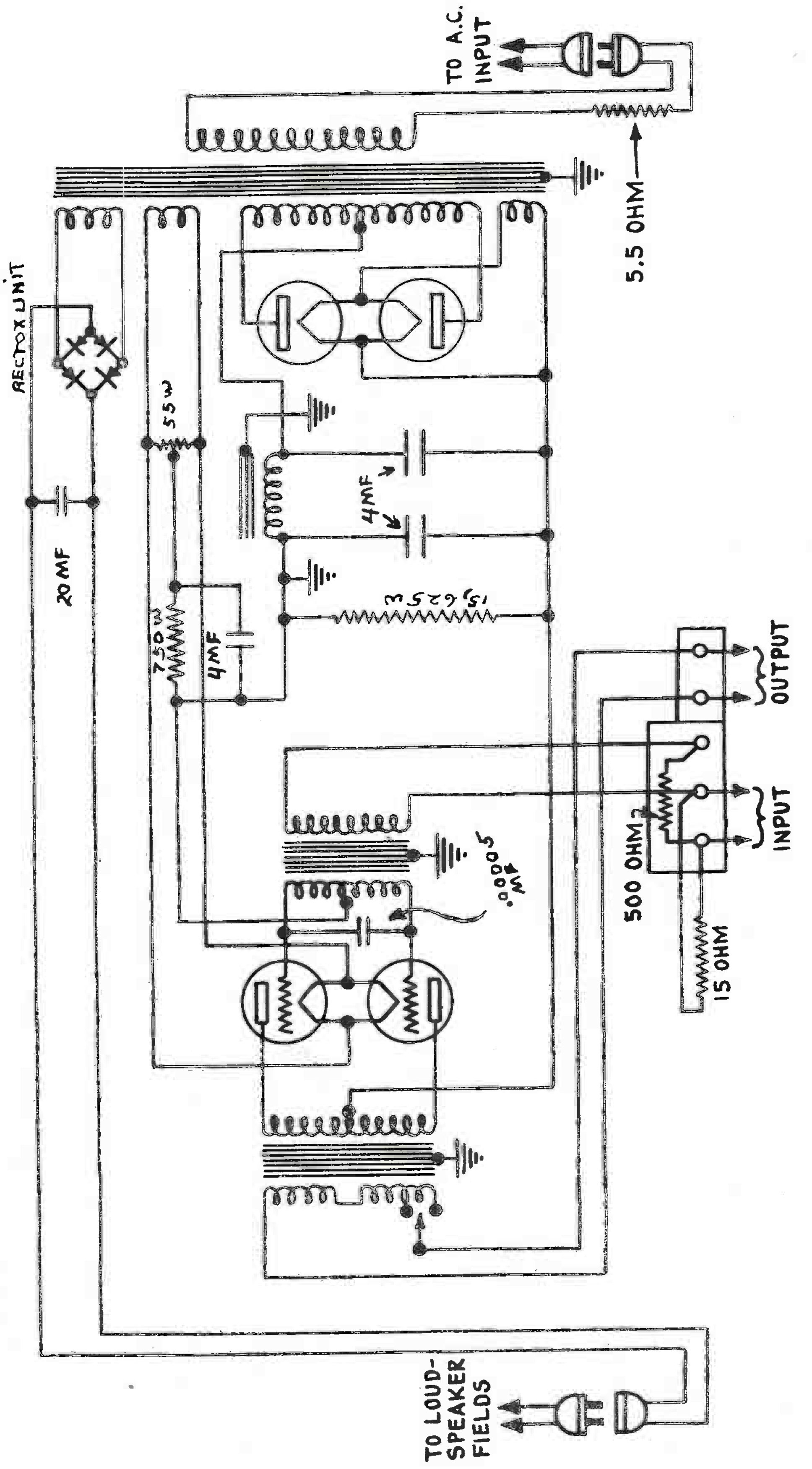


R. C. A. VICTOR, INC.

AUDITORIUM RADIOLA PHONOGRAPH

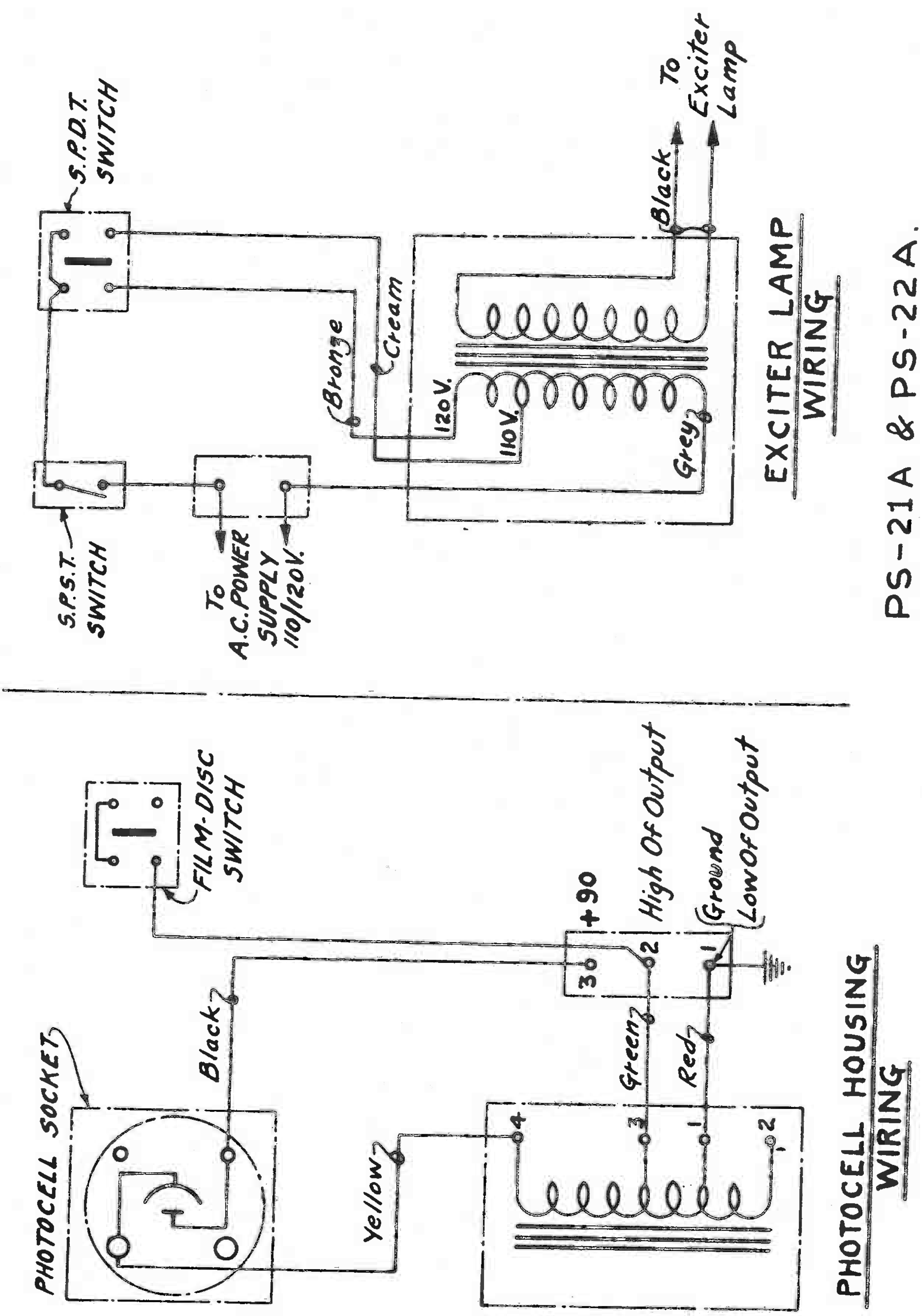


RCA.-PHOTOPHONE, INC.

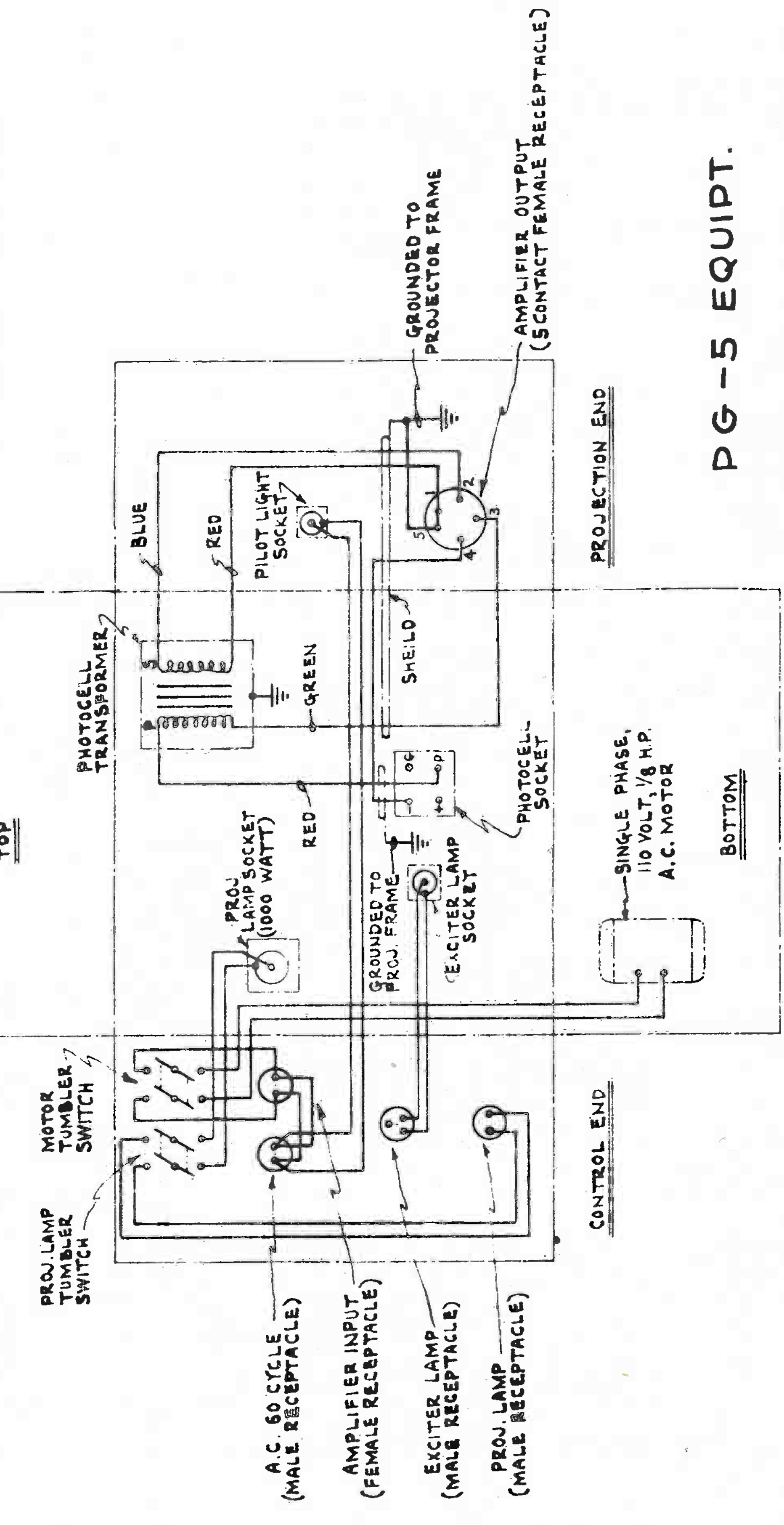


4 PK 1A2 PWR. AMP.

RCA.-PHOTOPHONE, INC.

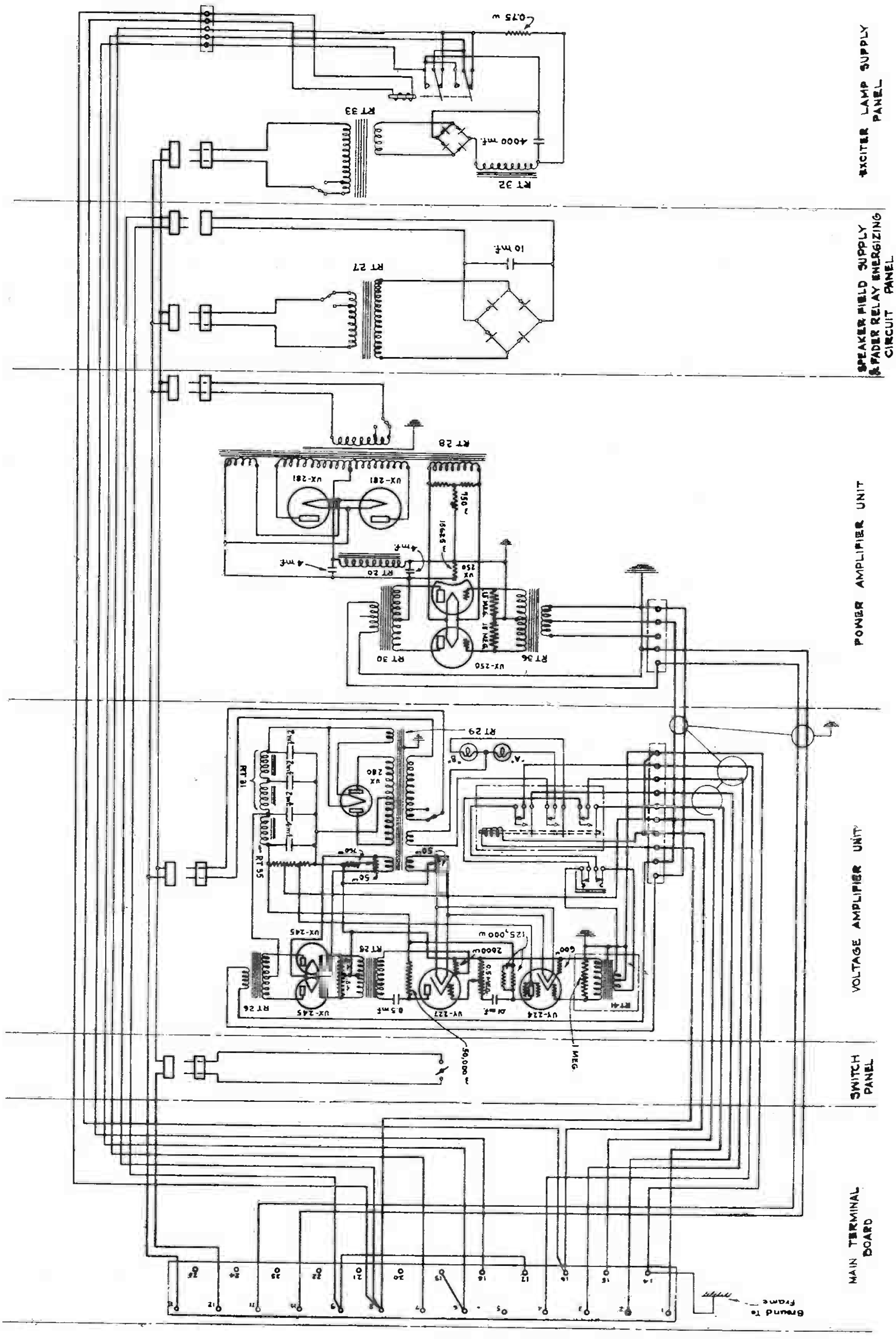


RCA.-PHOTOPHONE, INC.



DEVELOPED VIEW OF PROJECTOR

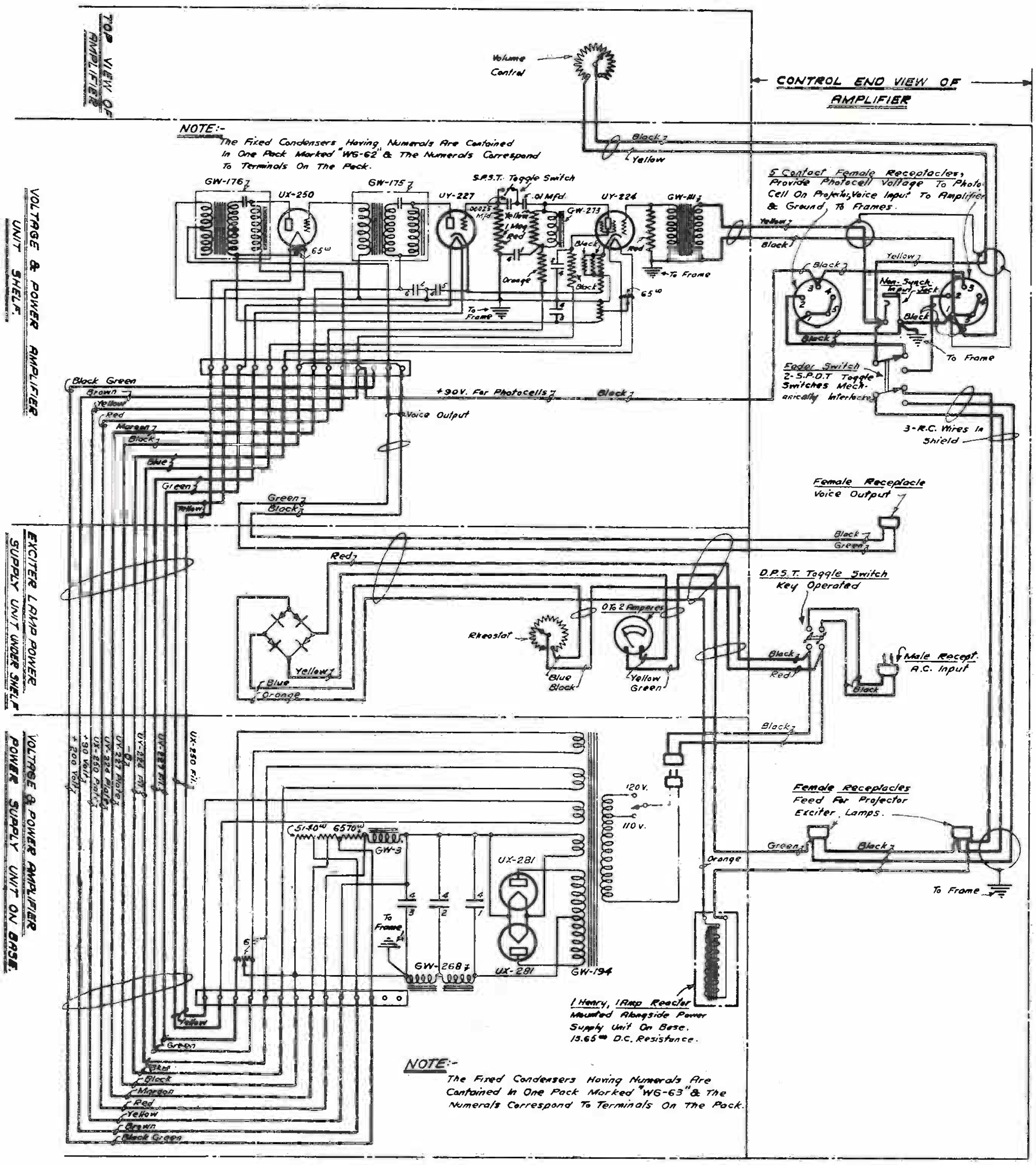
RCA.-PHOTOPHONE, INC.



NOTE- WIRES ENCLOSED BY CIRCLES INDICATE SHIELDS. SHIELDS ARE SHOWN ONLY WHERE CONNECTIONS TO OTHER SHIELDS OR RACK ARE MADE.

4 PA50A1 AMPLIFIER

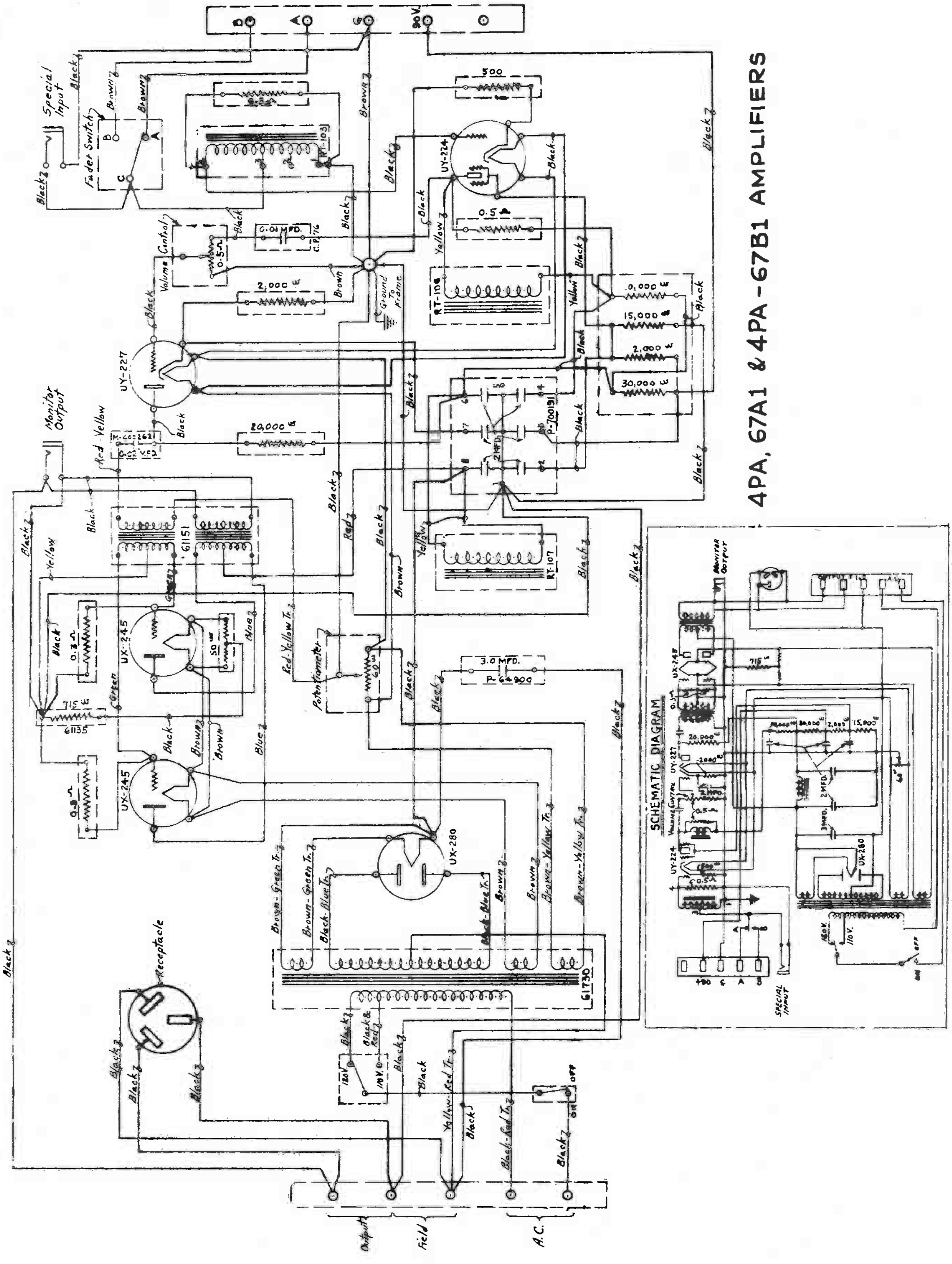
RCA.-PHOTOPHONE, INC.



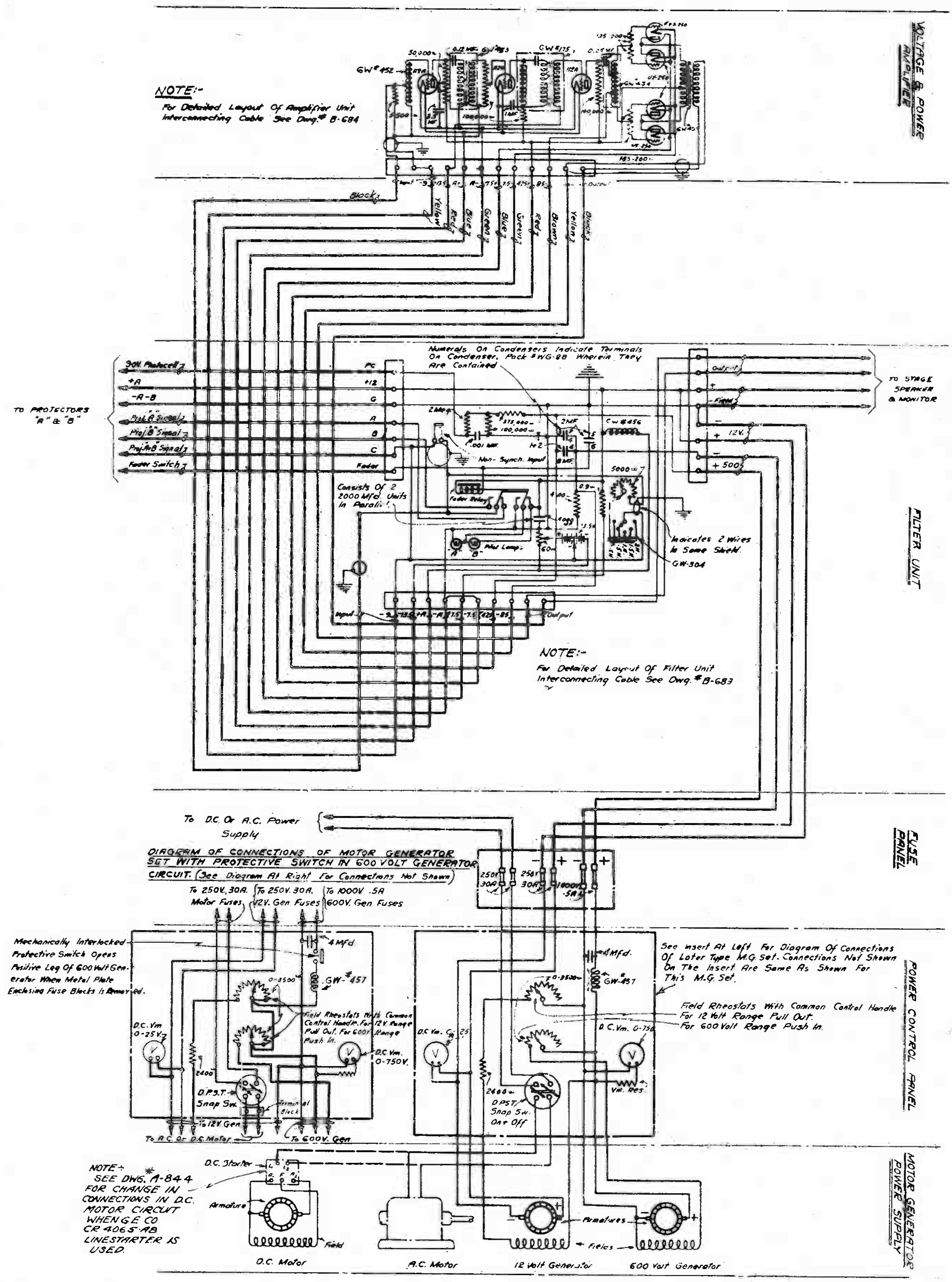
FRONT, PLAN, DEVELOPED VIEW.

RCA.-PHOTOPHONE, INC.

4PA, 67A1 & 4PA-67B1 AMPLIFIERS

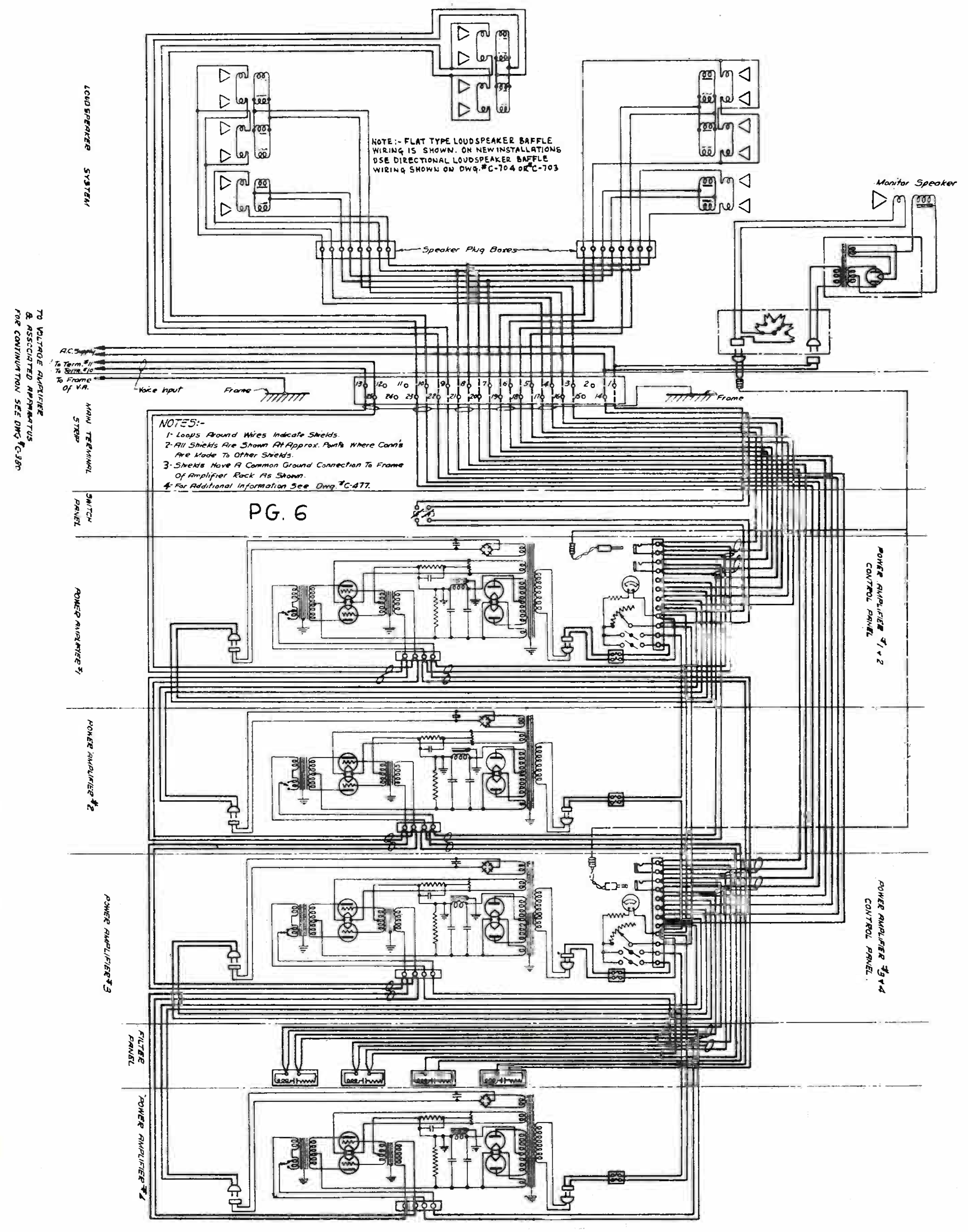


RCA.-PHOTOPHONE, INC.

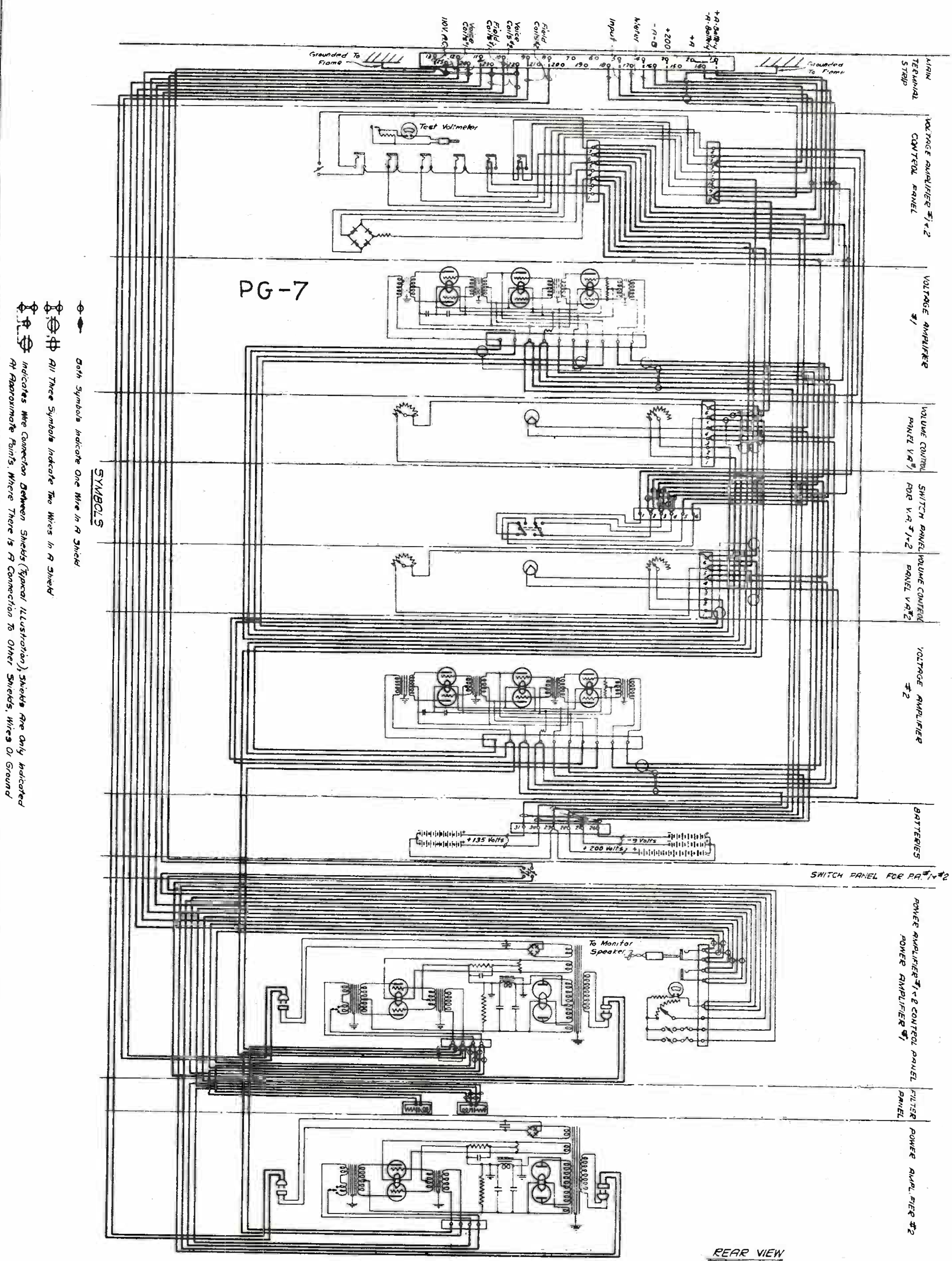


PG-13

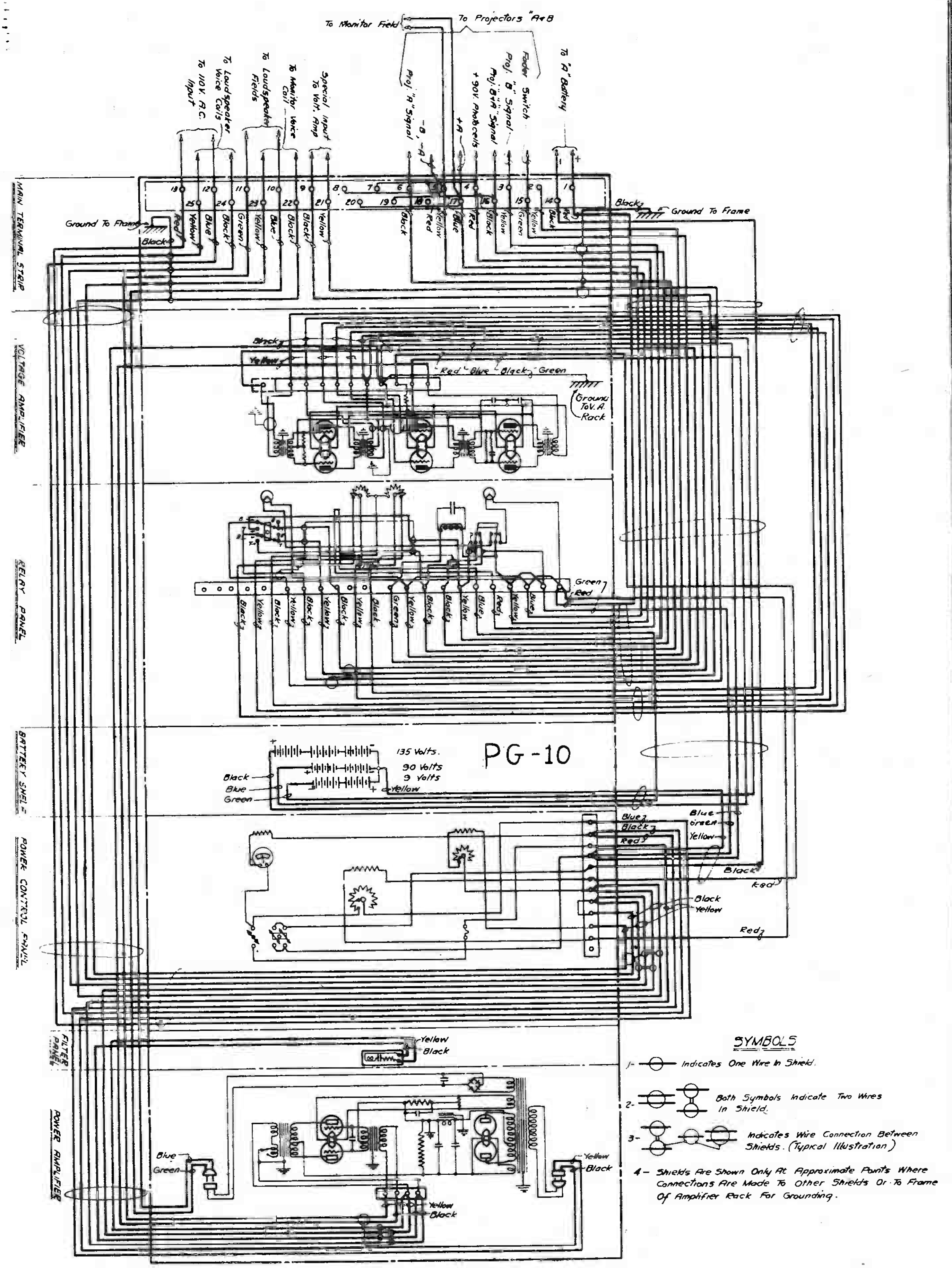
RCA.-PHOTOPHONE, INC.



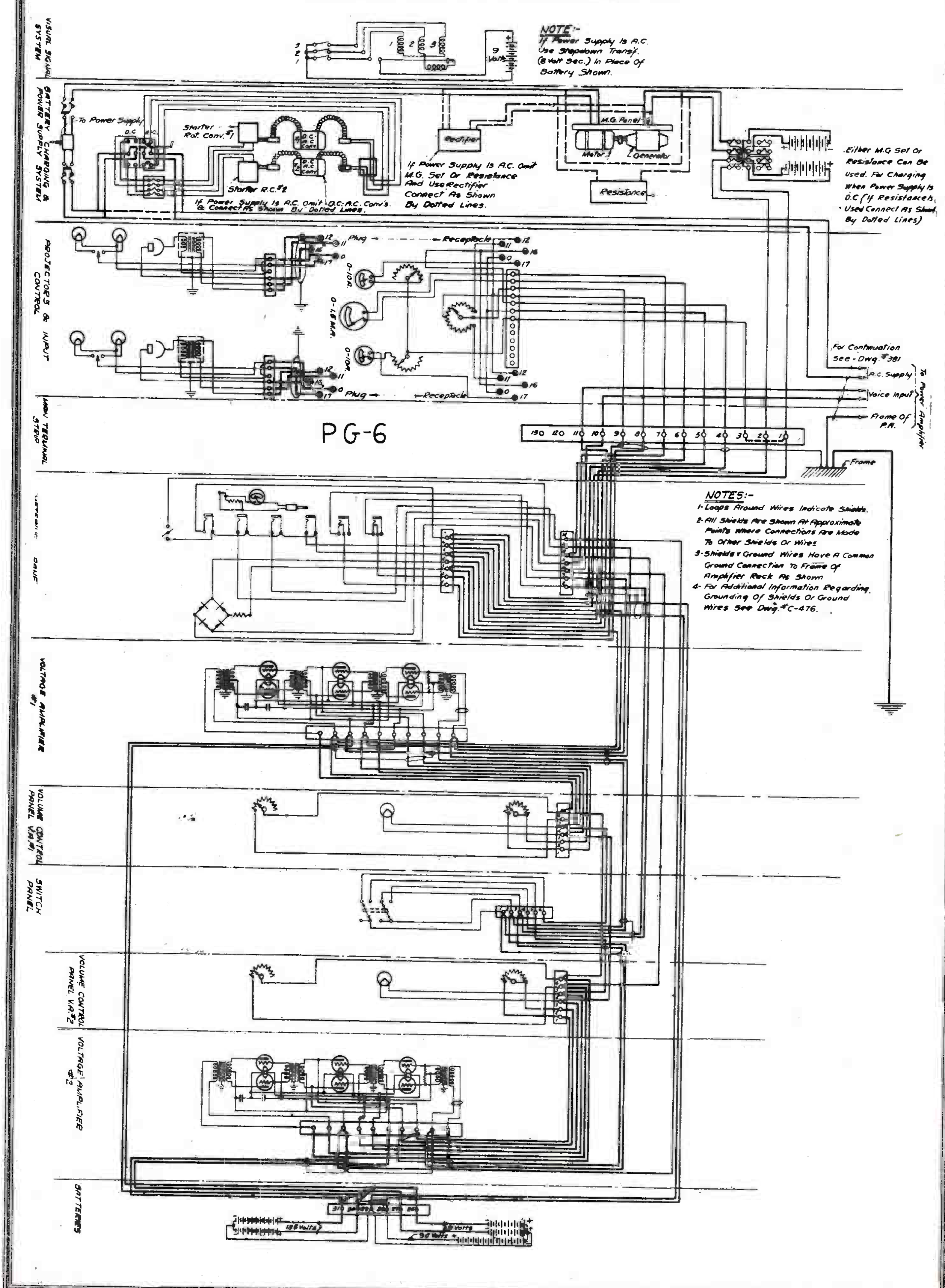
RCA.-PHOTOPHONE, INC.



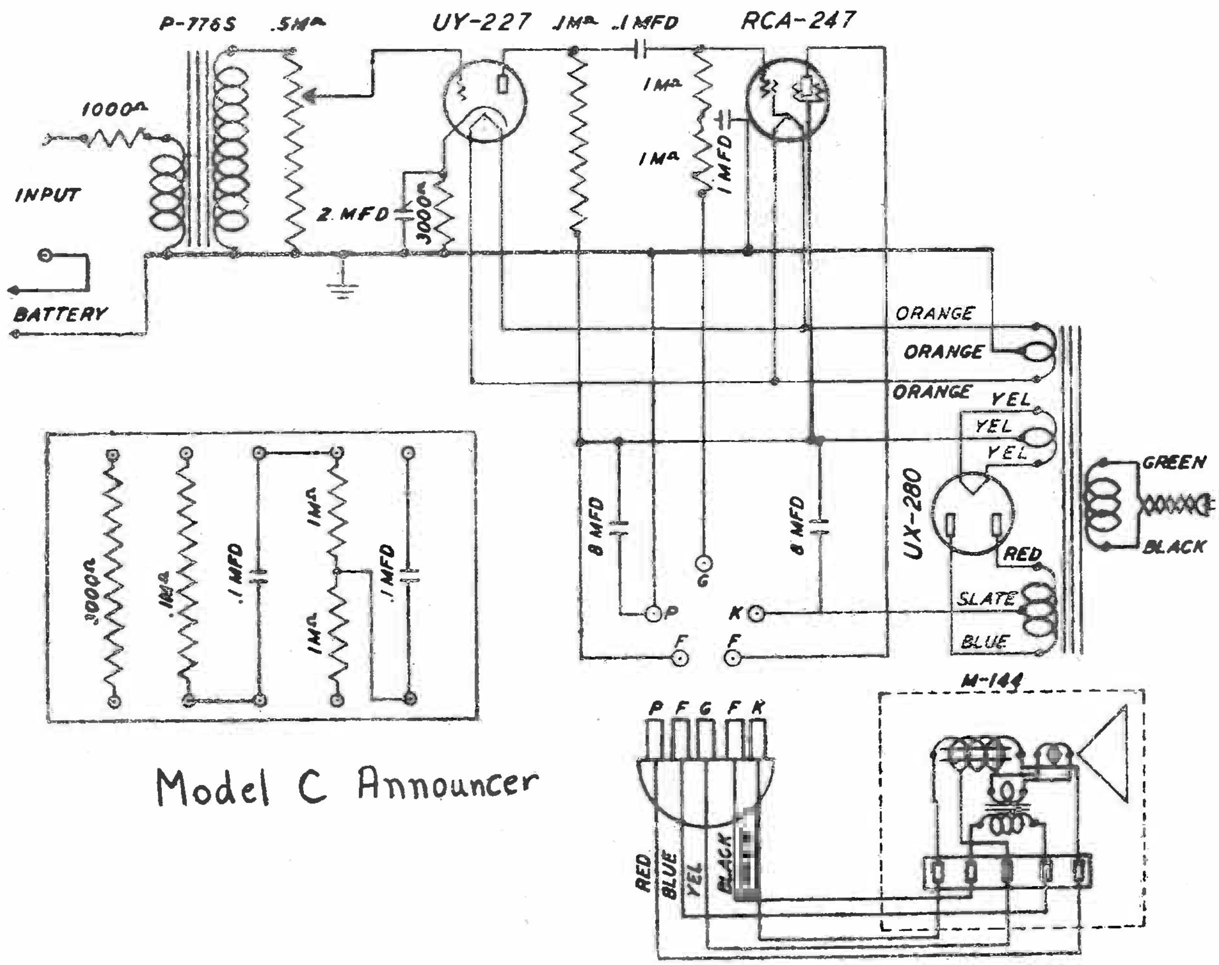
RCA.-PHOTOPHONE, INC.



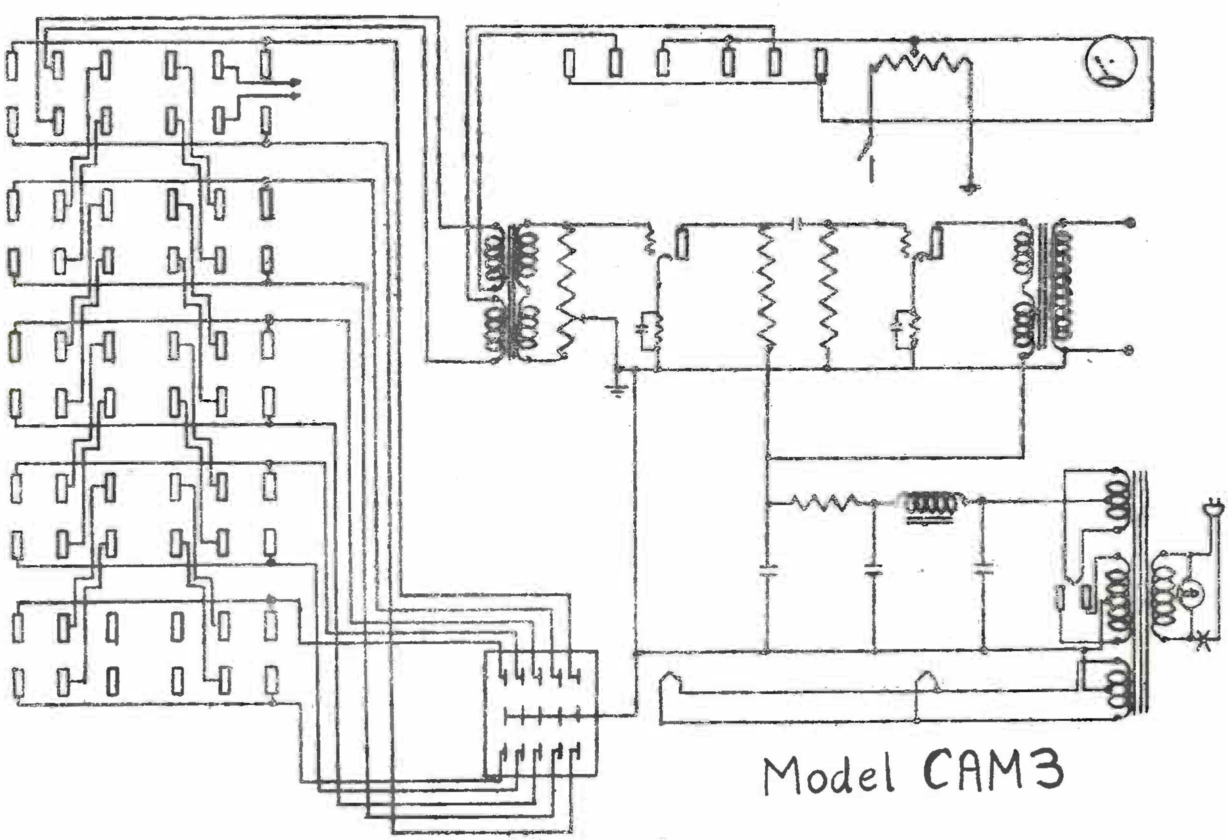
RCA.-PHOTOPHONE, INC.



RADIO RECEPTOR, INC.

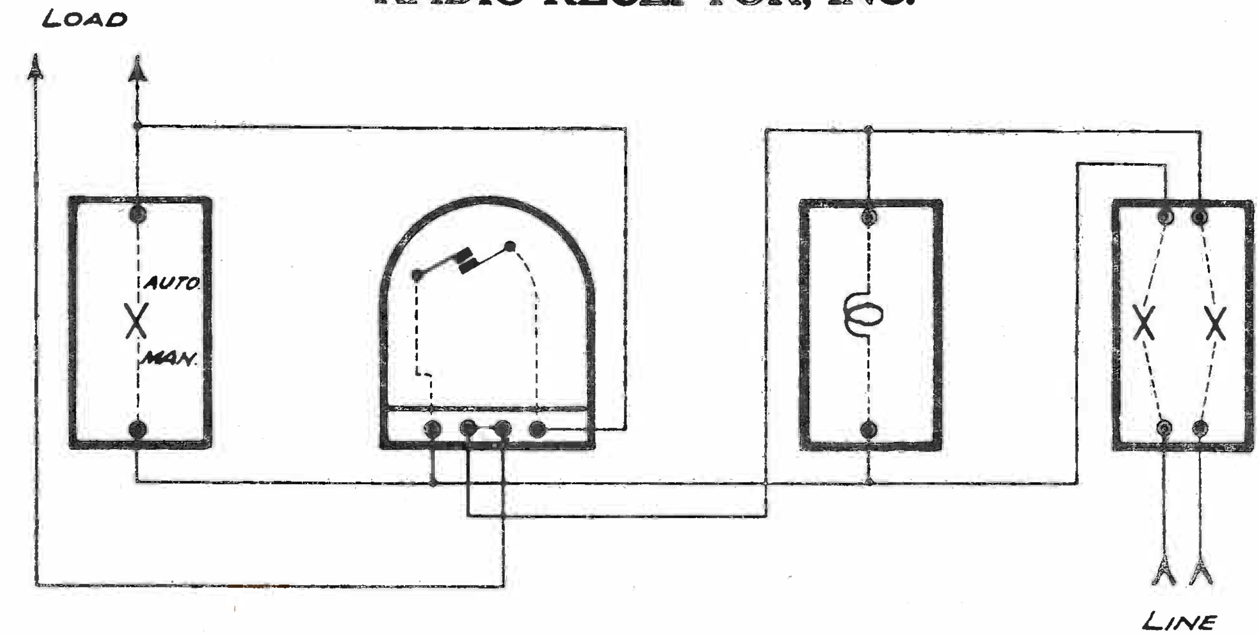


Model C Announcer



Model CAM3

RADIO RECEPTOR, INC.



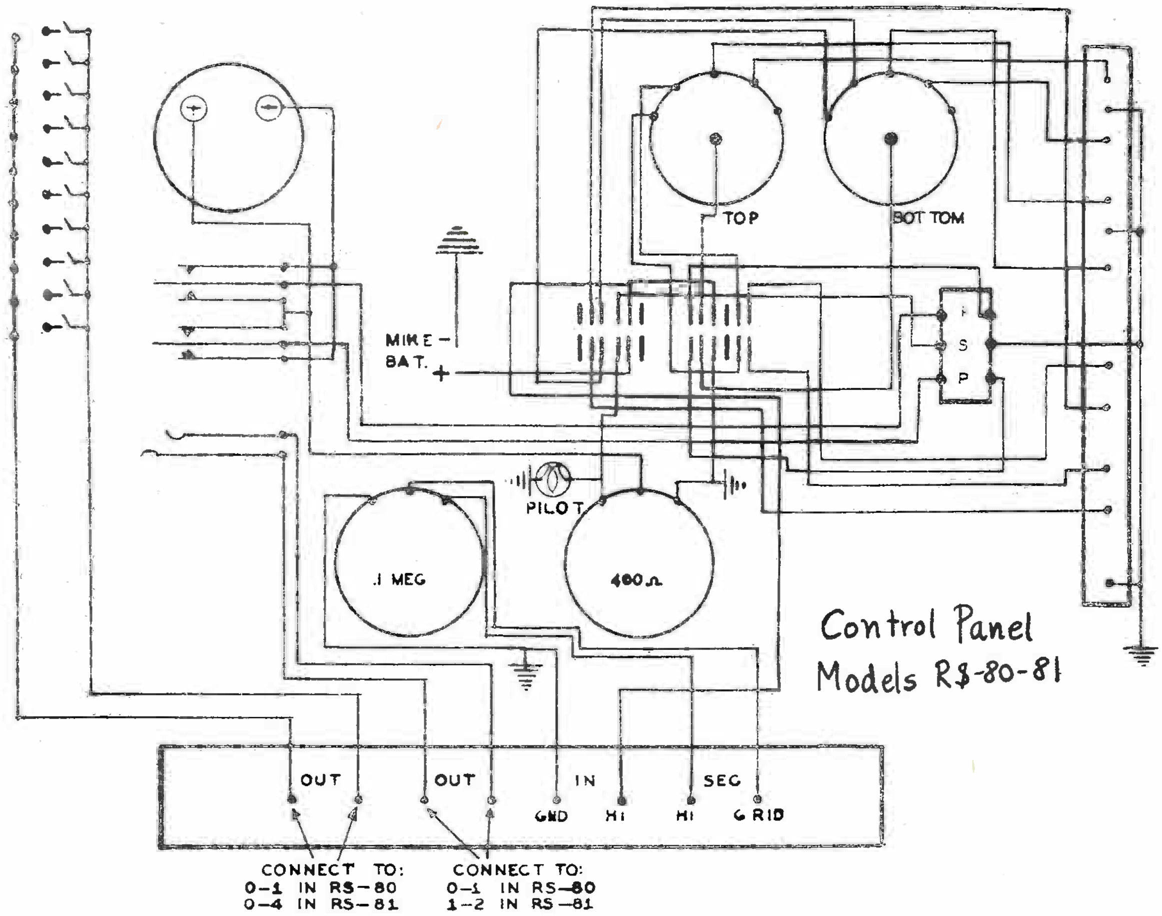
AUTOMATIC OR MANUAL OPERATION.

AUTOMATIC TIME SWITCH.

MAIN PILOT AND SWITCH.

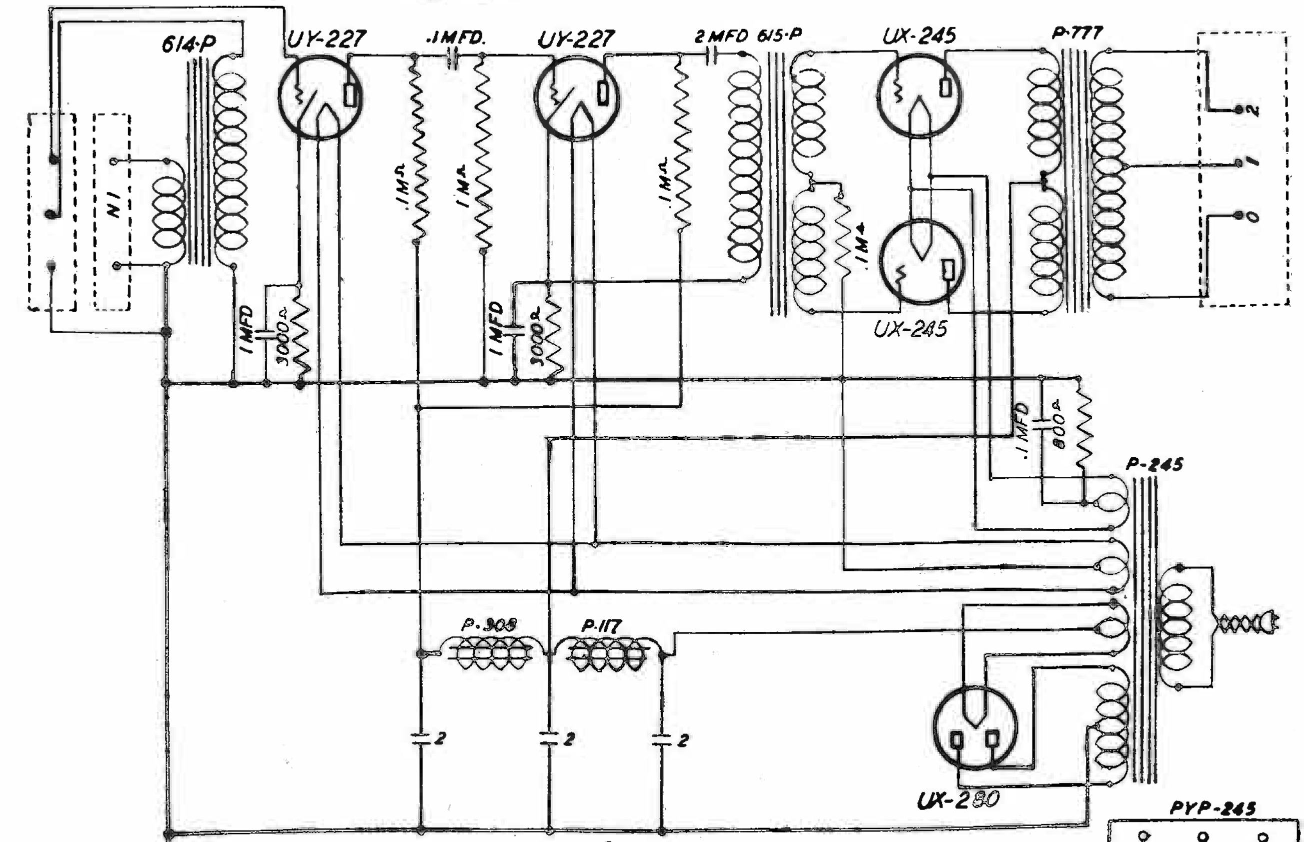
REAR VIEW.

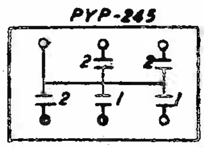
Time Clock Control Panel



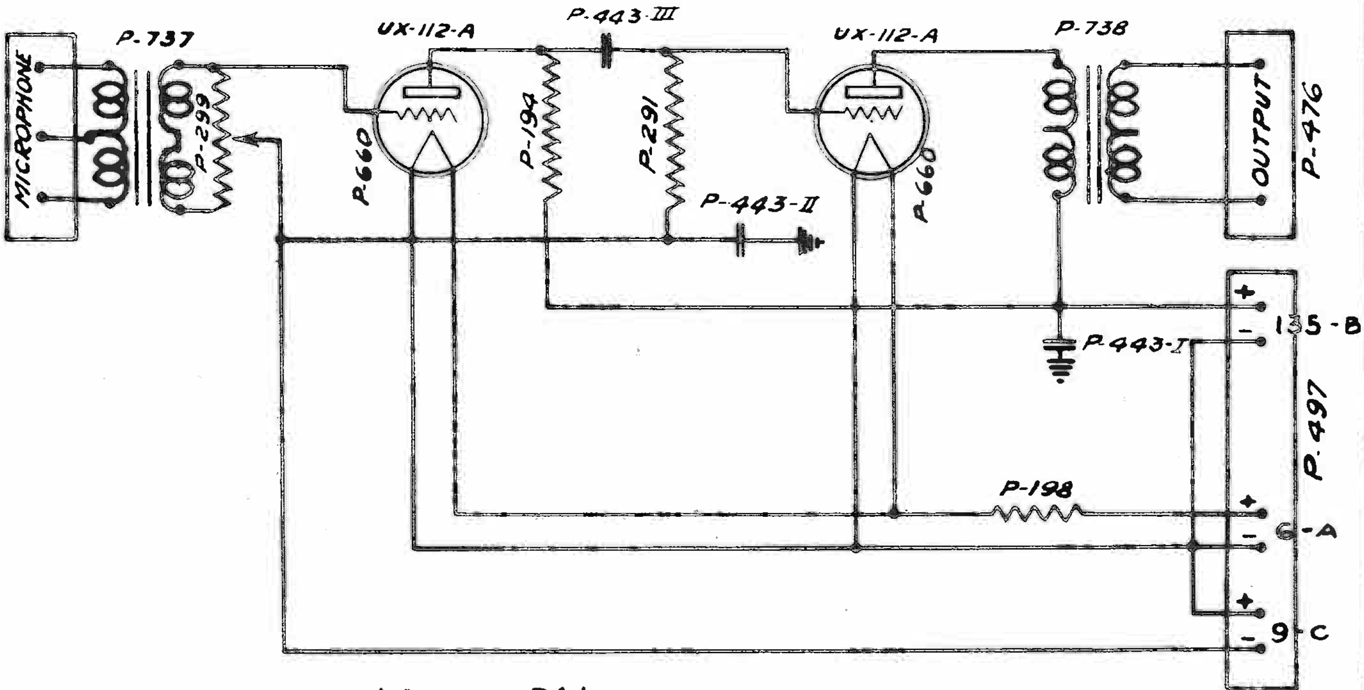
Control Panel
Models RS-80-81

RADIO RECEPTOR, INC.

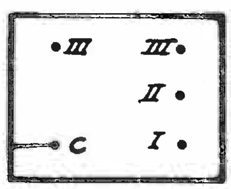




RS-80 Amplifier ~ Model PYP-245R

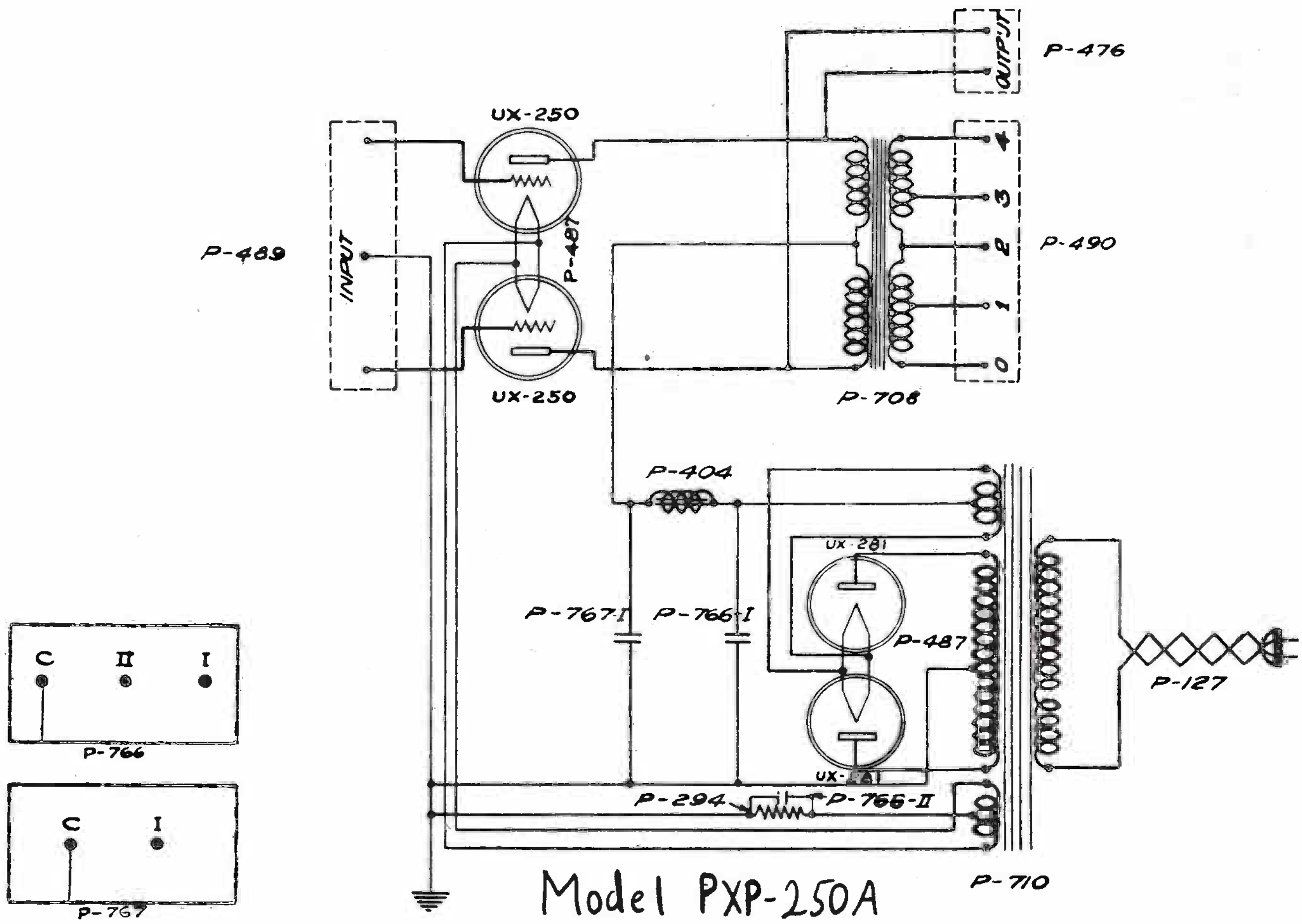


Model PMA2

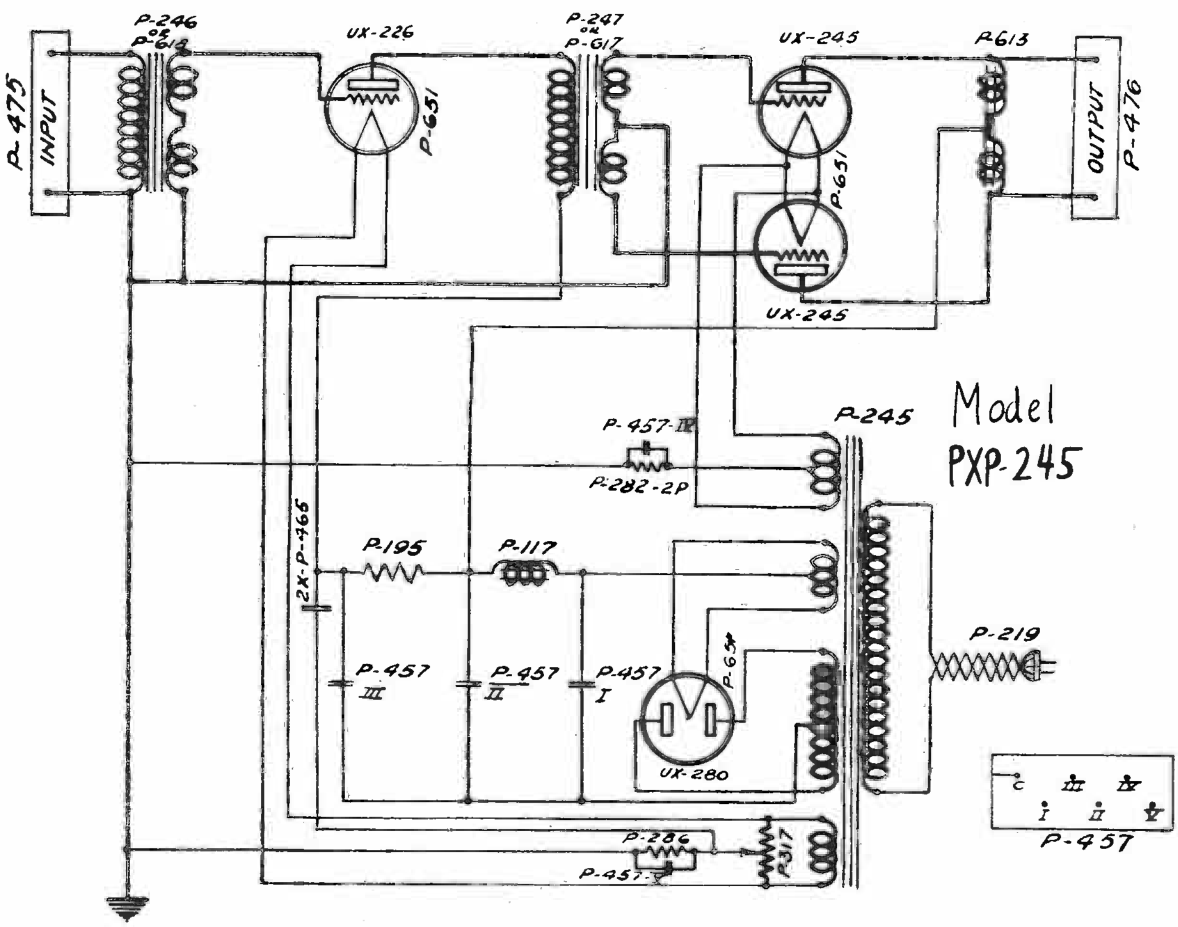


P-443

RADIO RECEPTOR, INC.

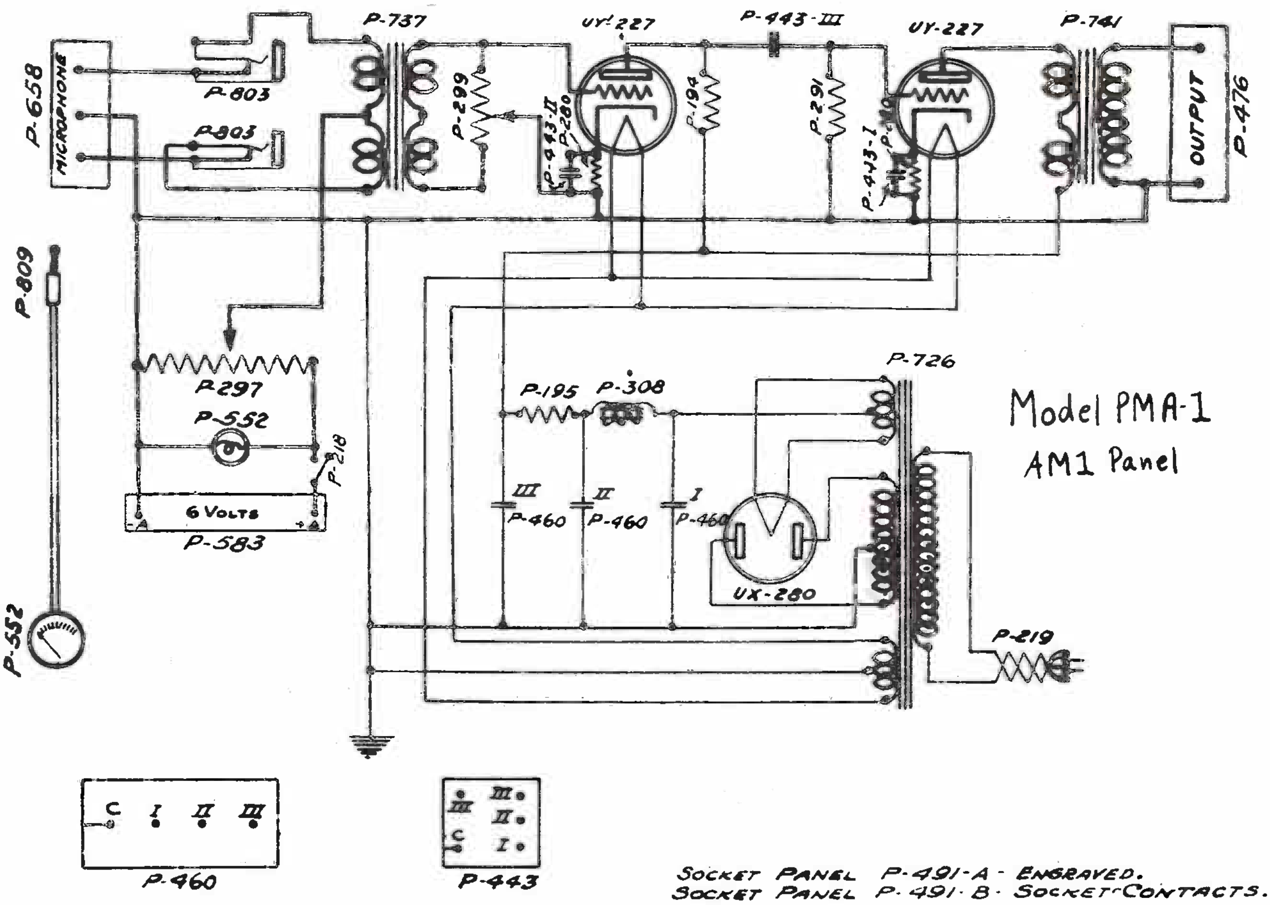


Model PXP-250A

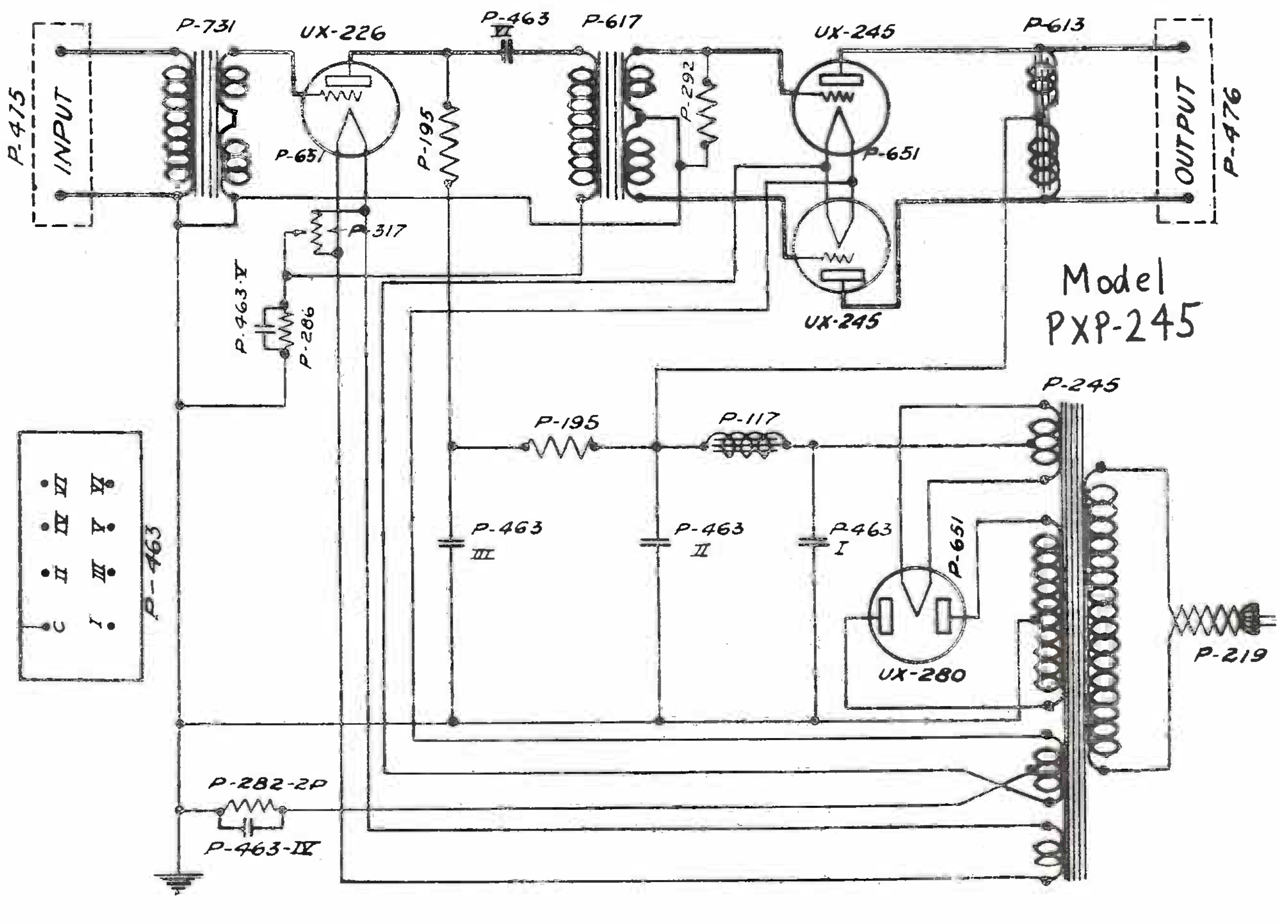


Model PXP-245

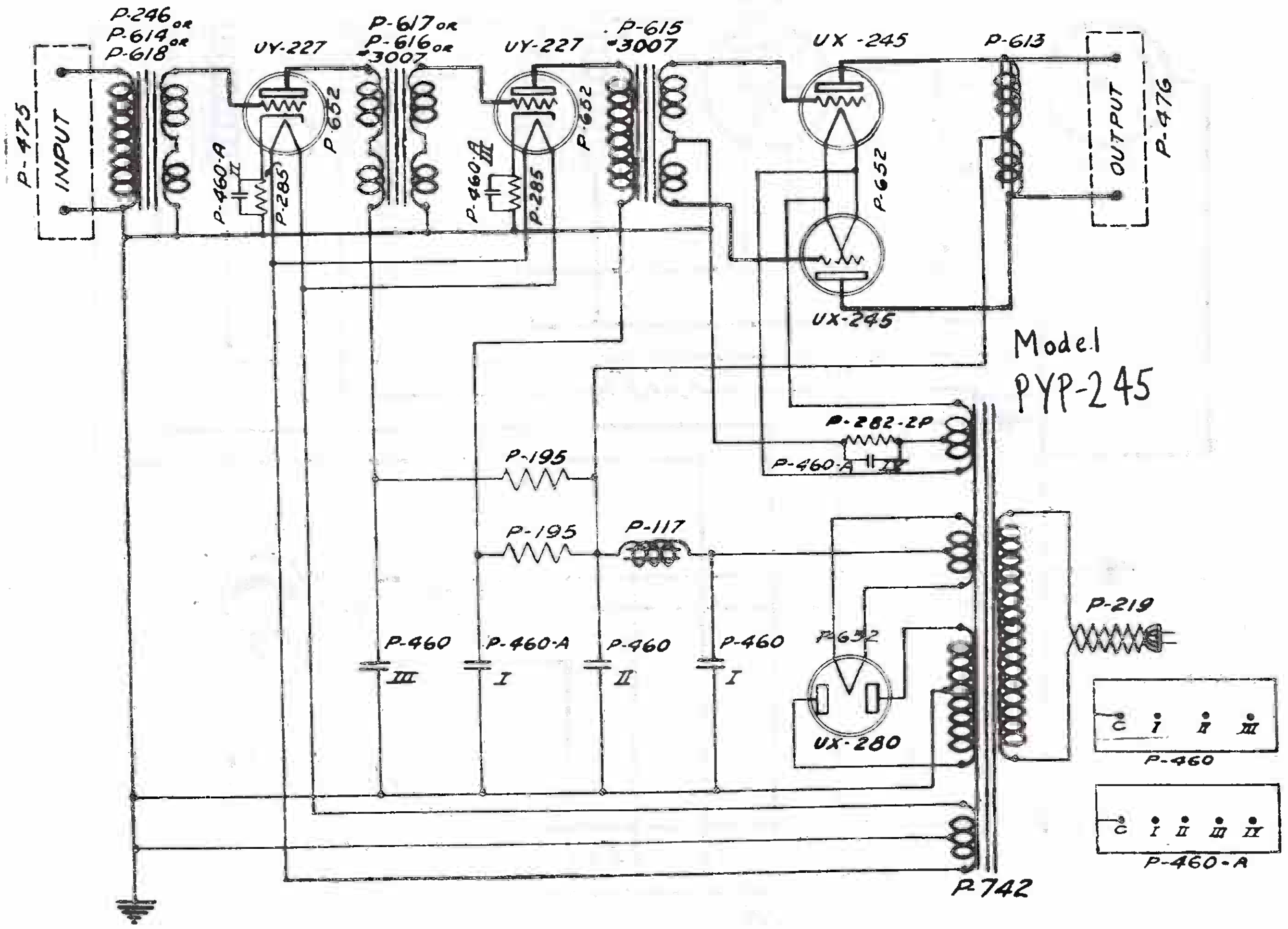
RADIO RECEPTOR, INC.

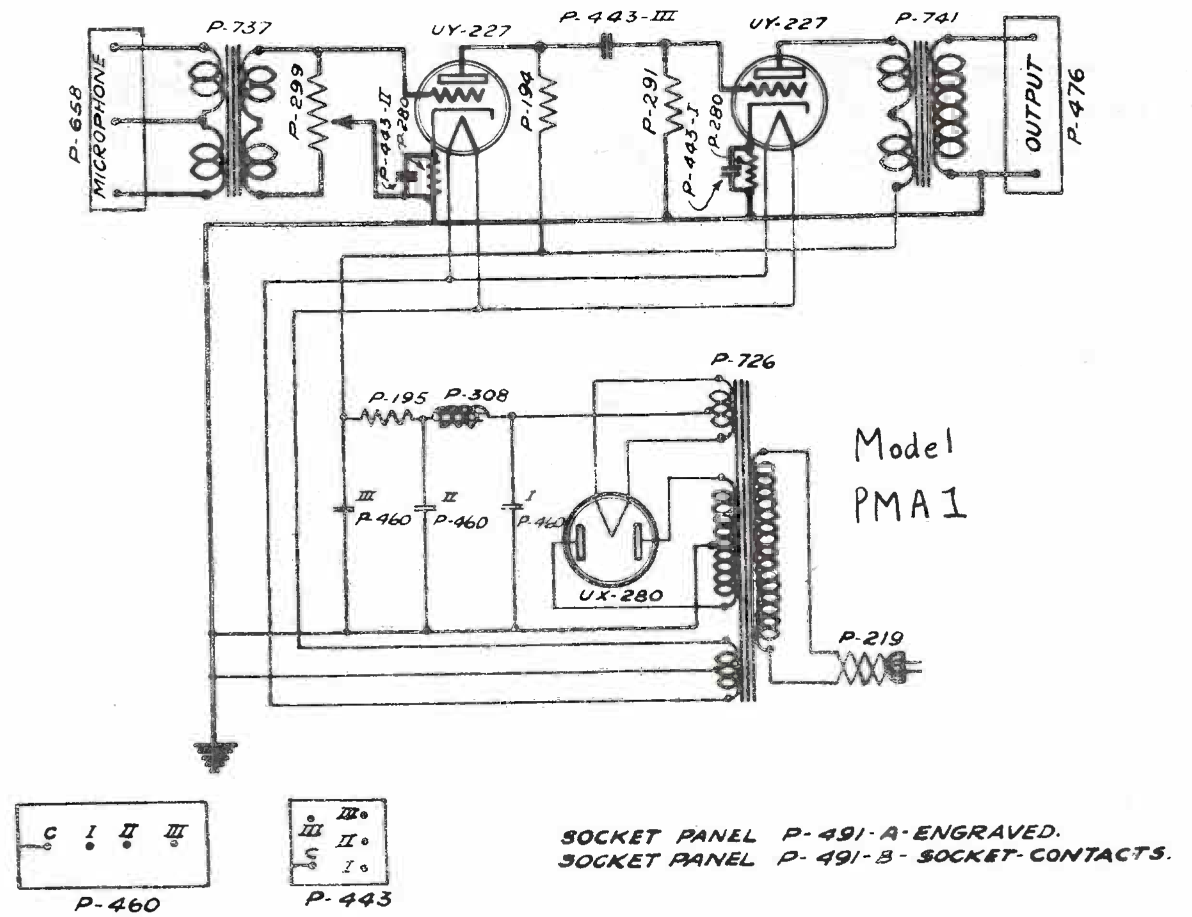


SOCKET PANEL P-491-A - ENGRAVED.
SOCKET PANEL P-491-B - SOCKET CONTACTS.



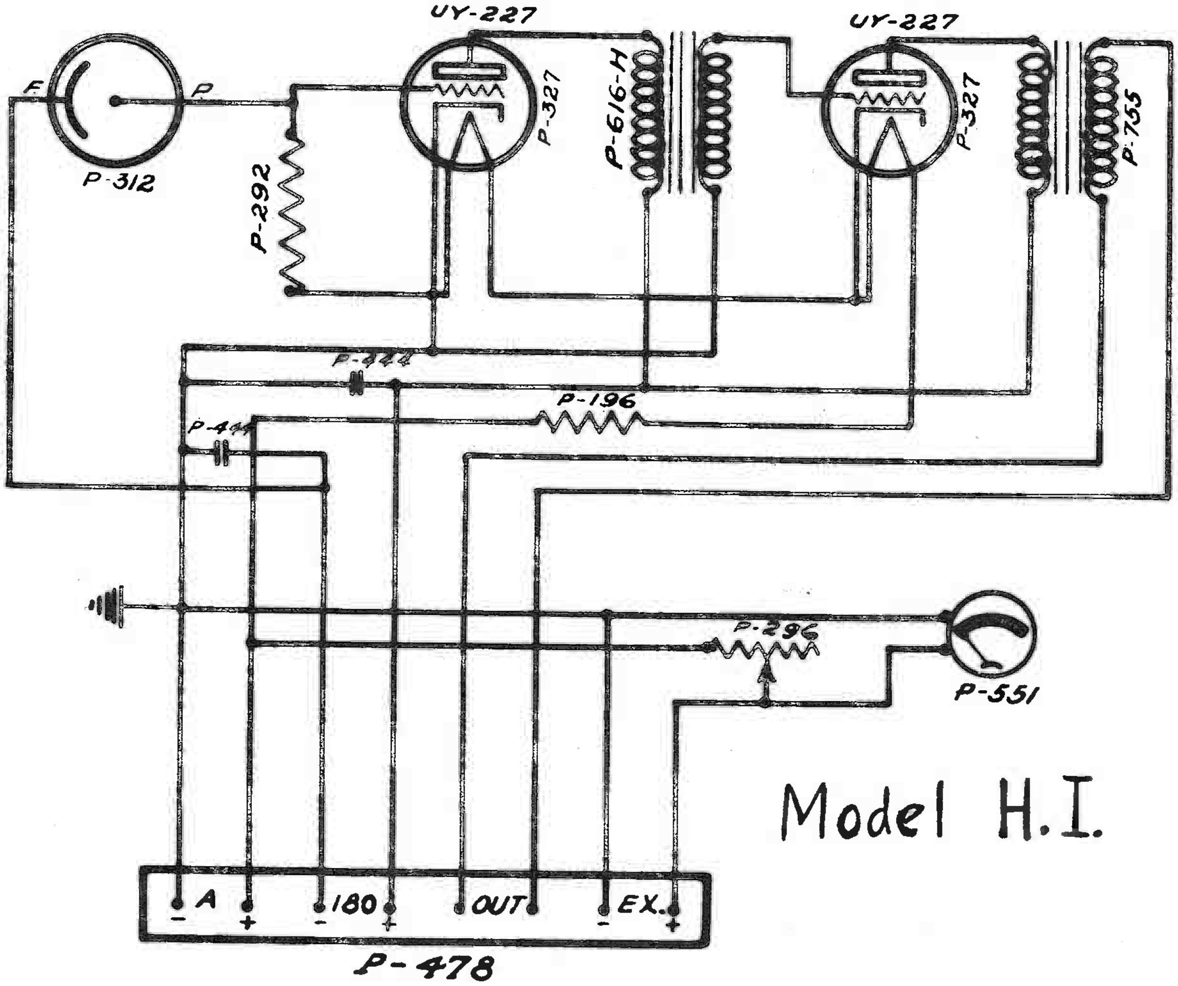
RADIO RECEPTOR, INC.



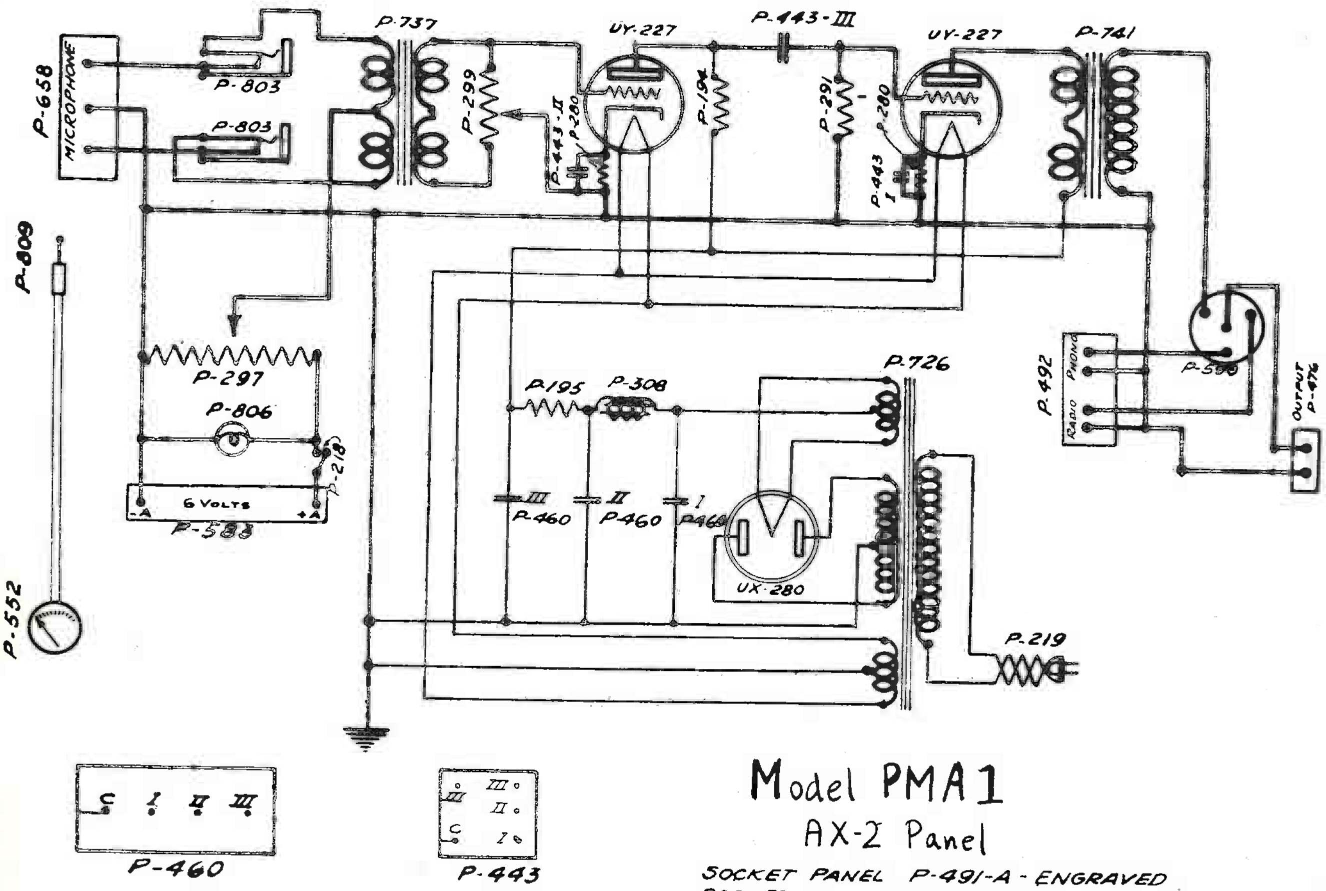


SOCKET PANEL P-491-A-ENGRAVED.
SOCKET PANEL P-491-B-SOCKET-CONTACTS.

RADIO RECEPTOR, INC.



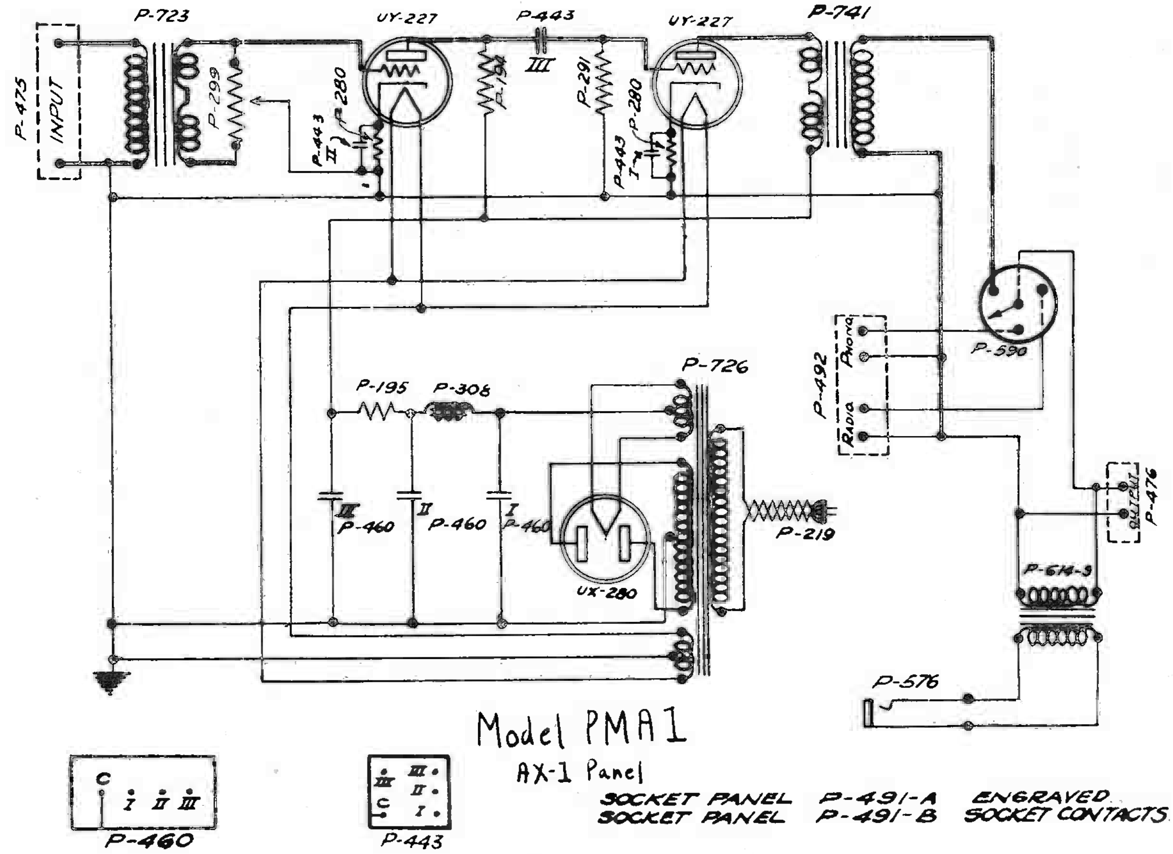
Model H.I.

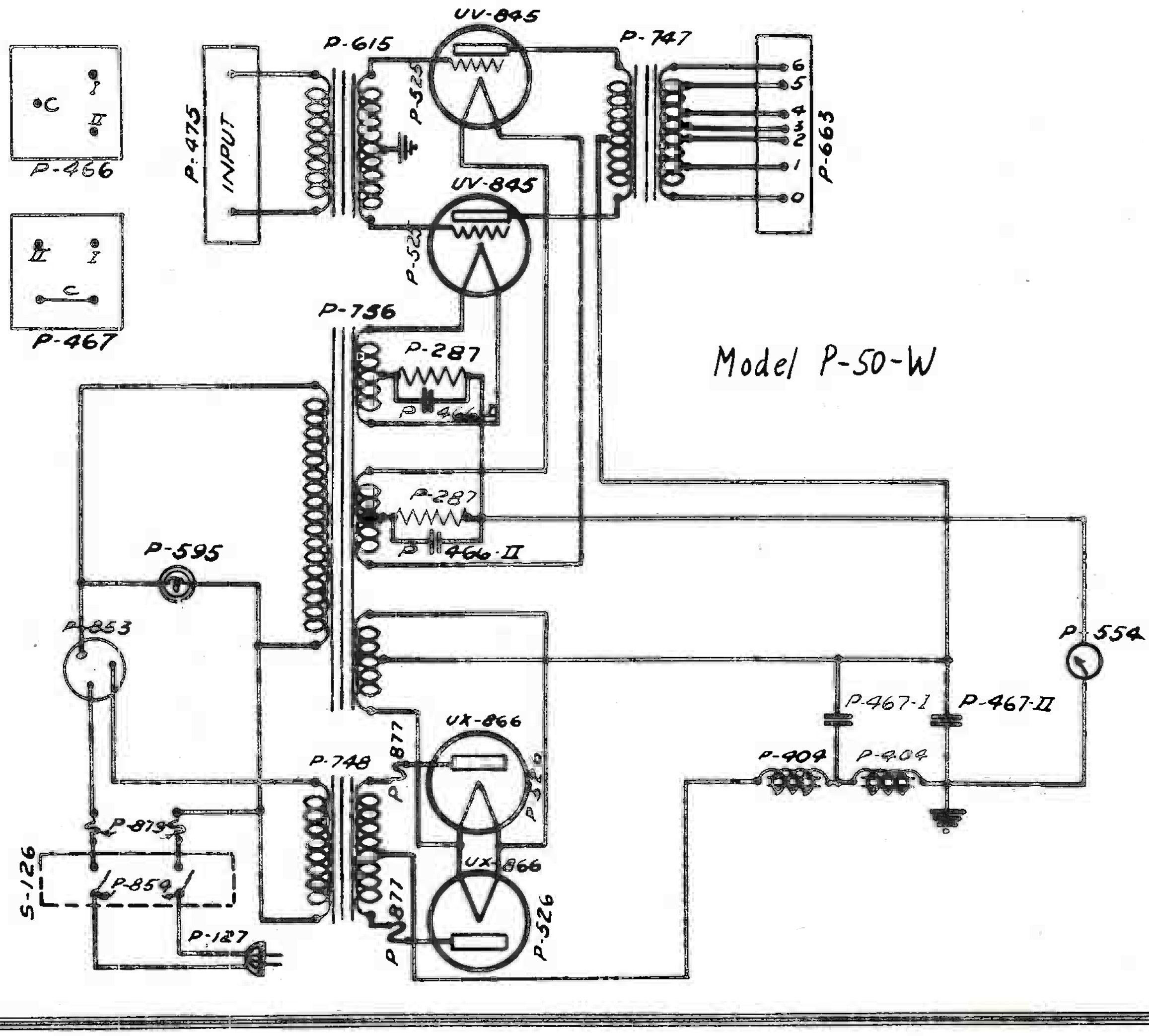


Model PMA 1
AX-2 Panel

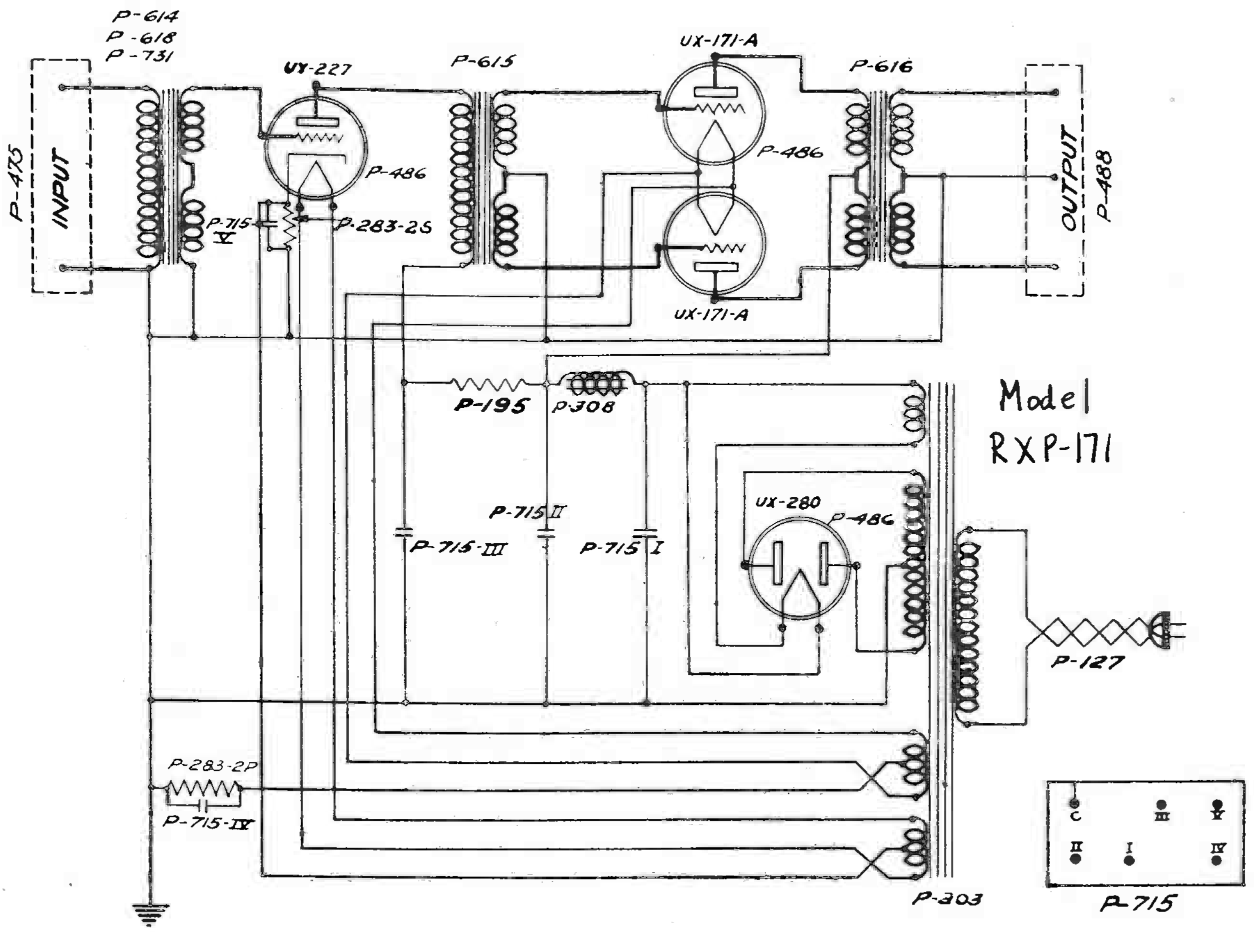
SOCKET PANEL P-491-A - ENGRAVED
SOCKET PANEL P-491-B - SOCKET CONTACTS.

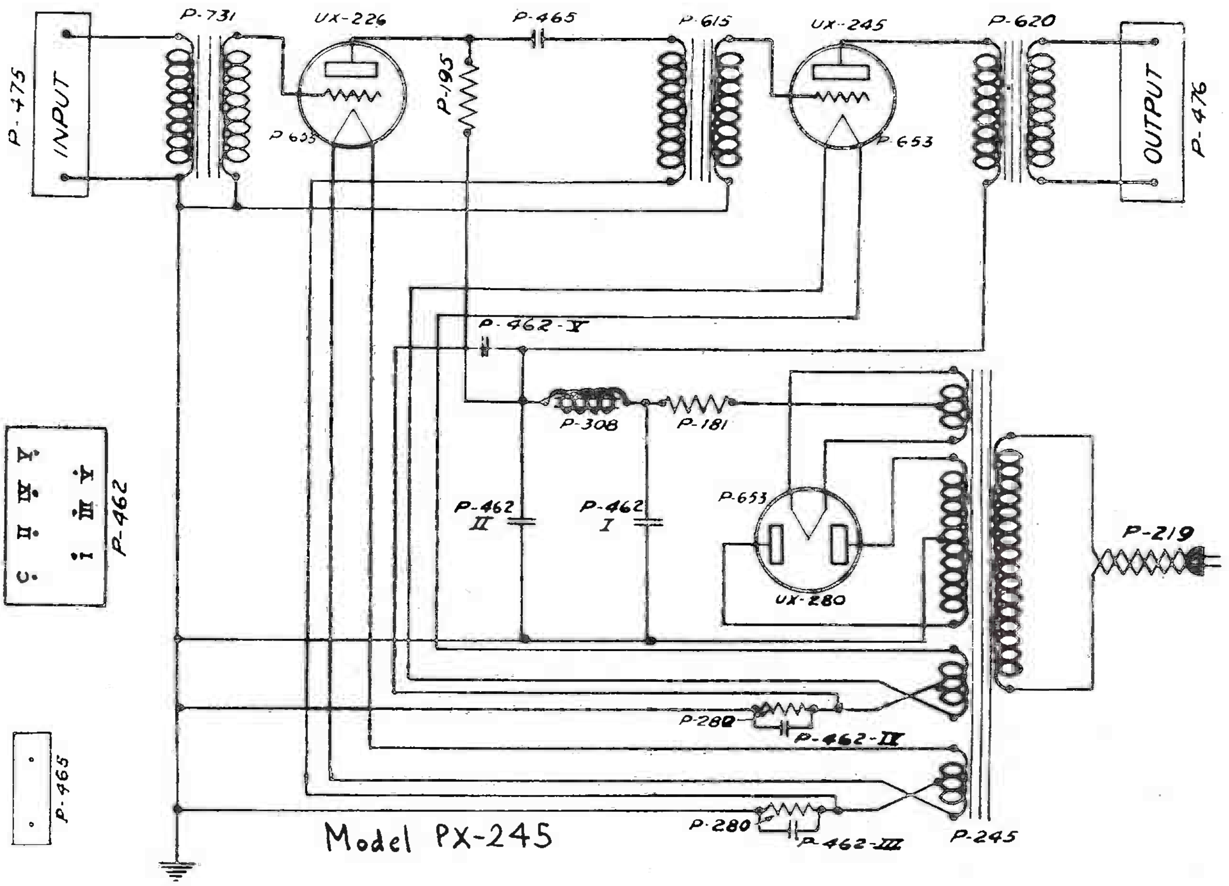
RADIO RECEPTOR, INC.



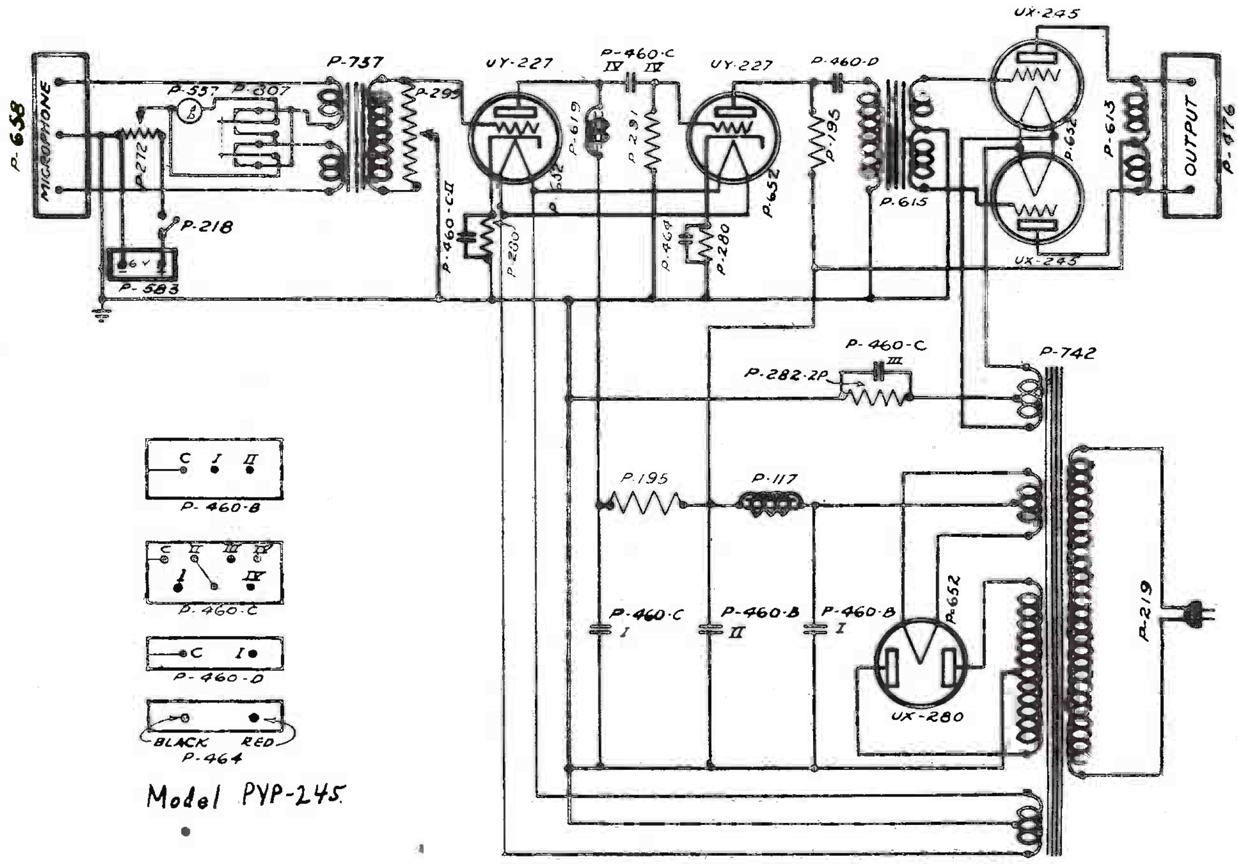


RADIO RECEPTOR, INC.

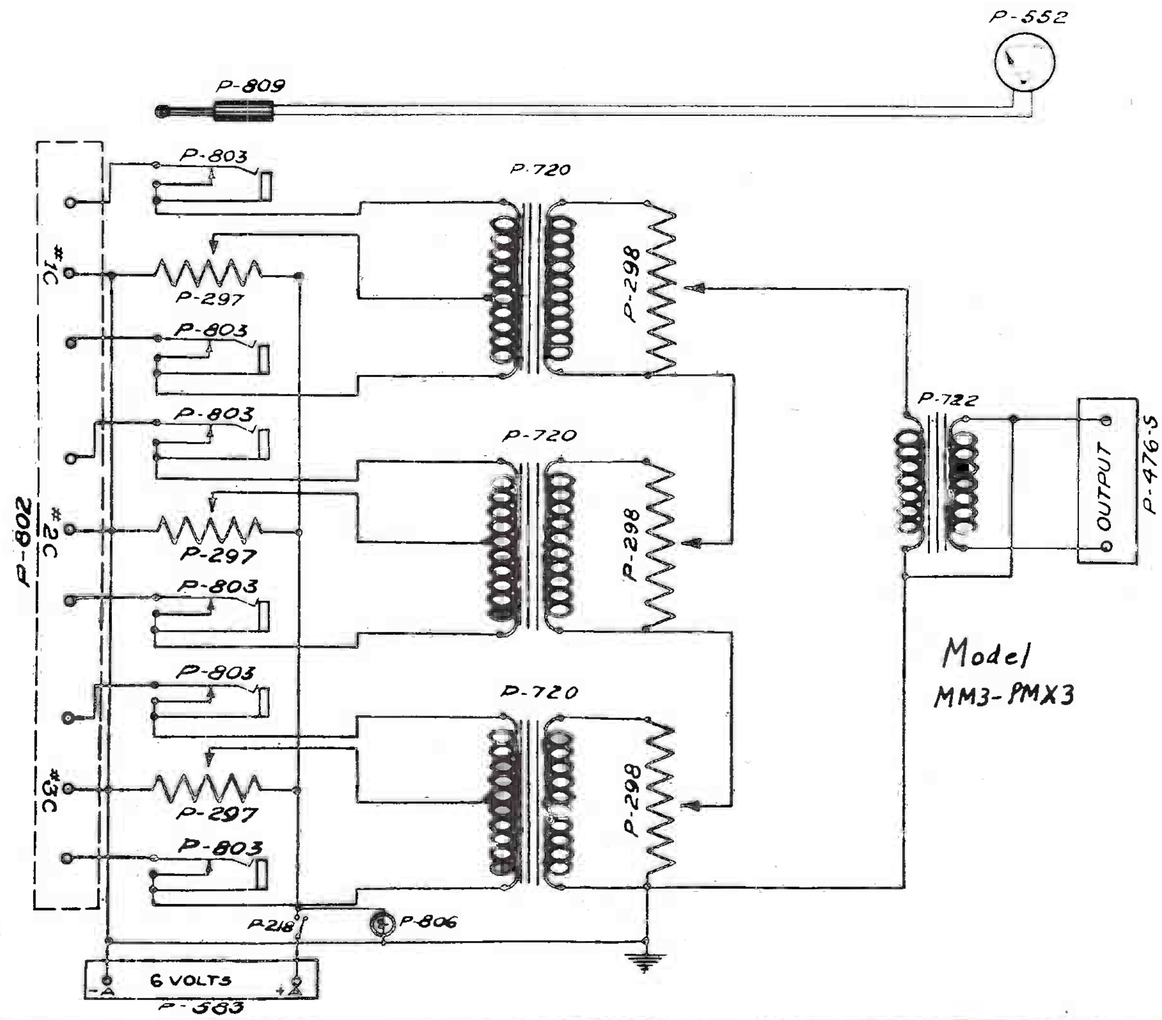




RADIO RECEPTOR, INC.

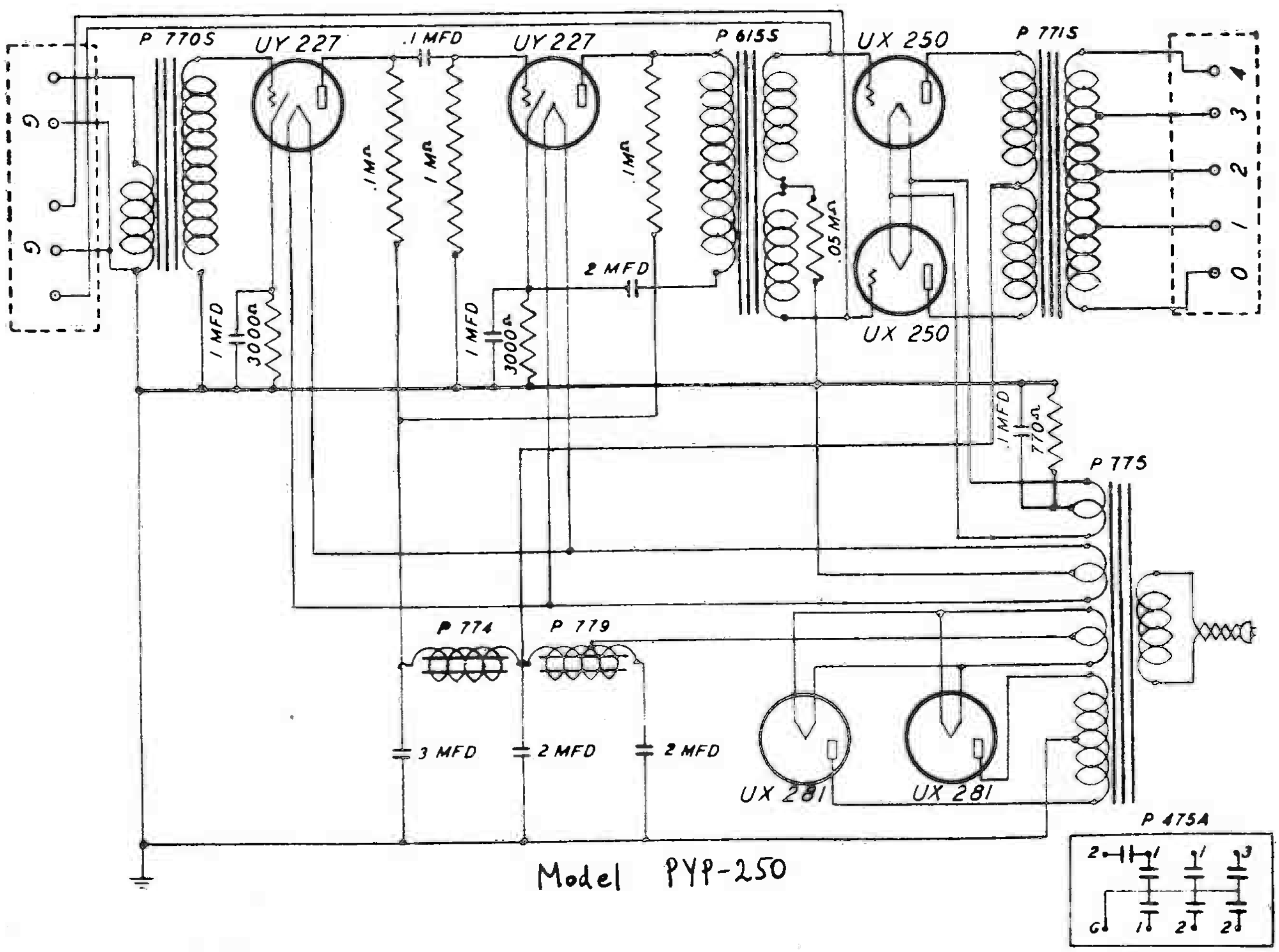


Model PYP-245

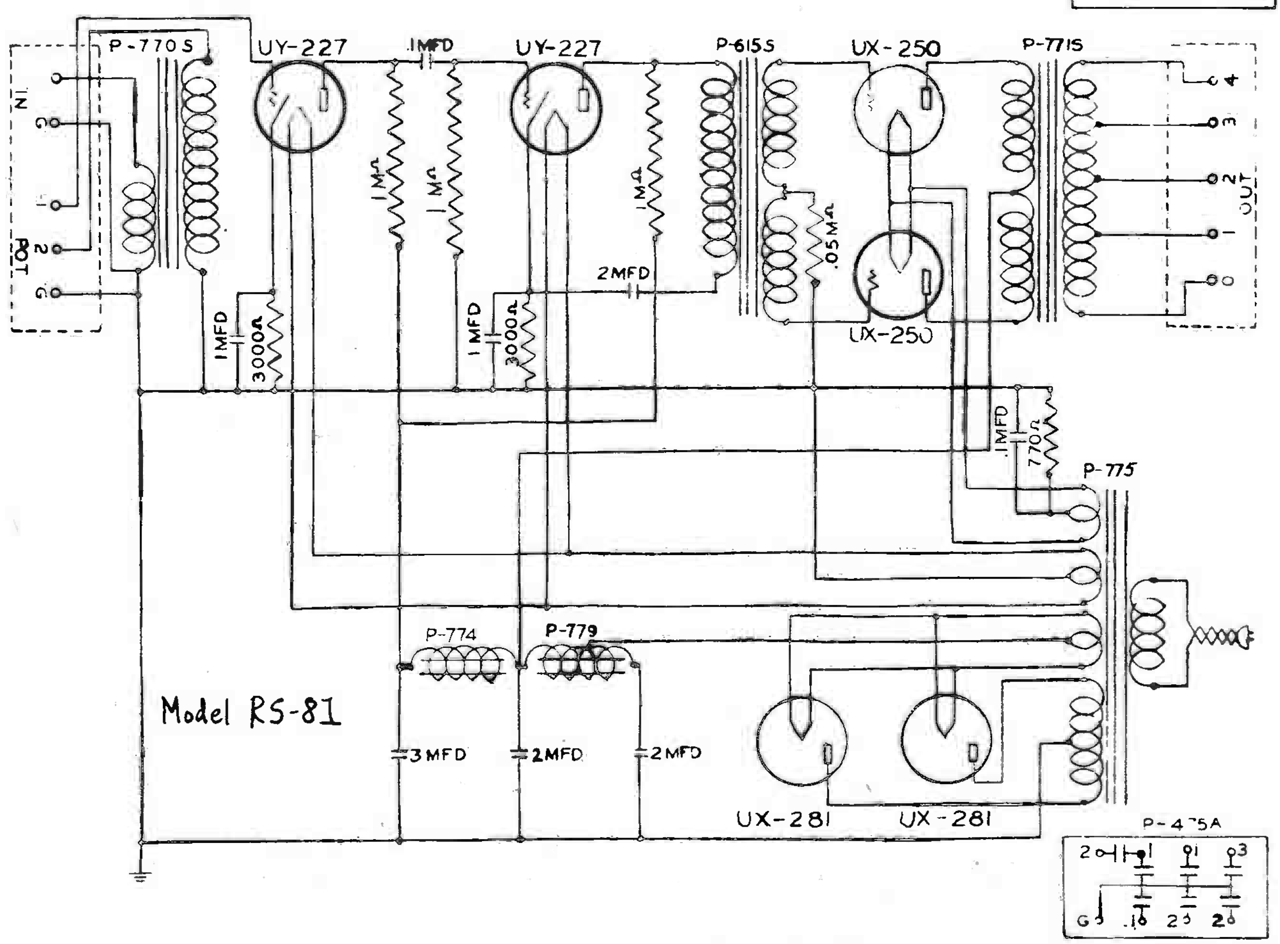


Model MM3-PMX3

RADIO RECEPTOR, INC.

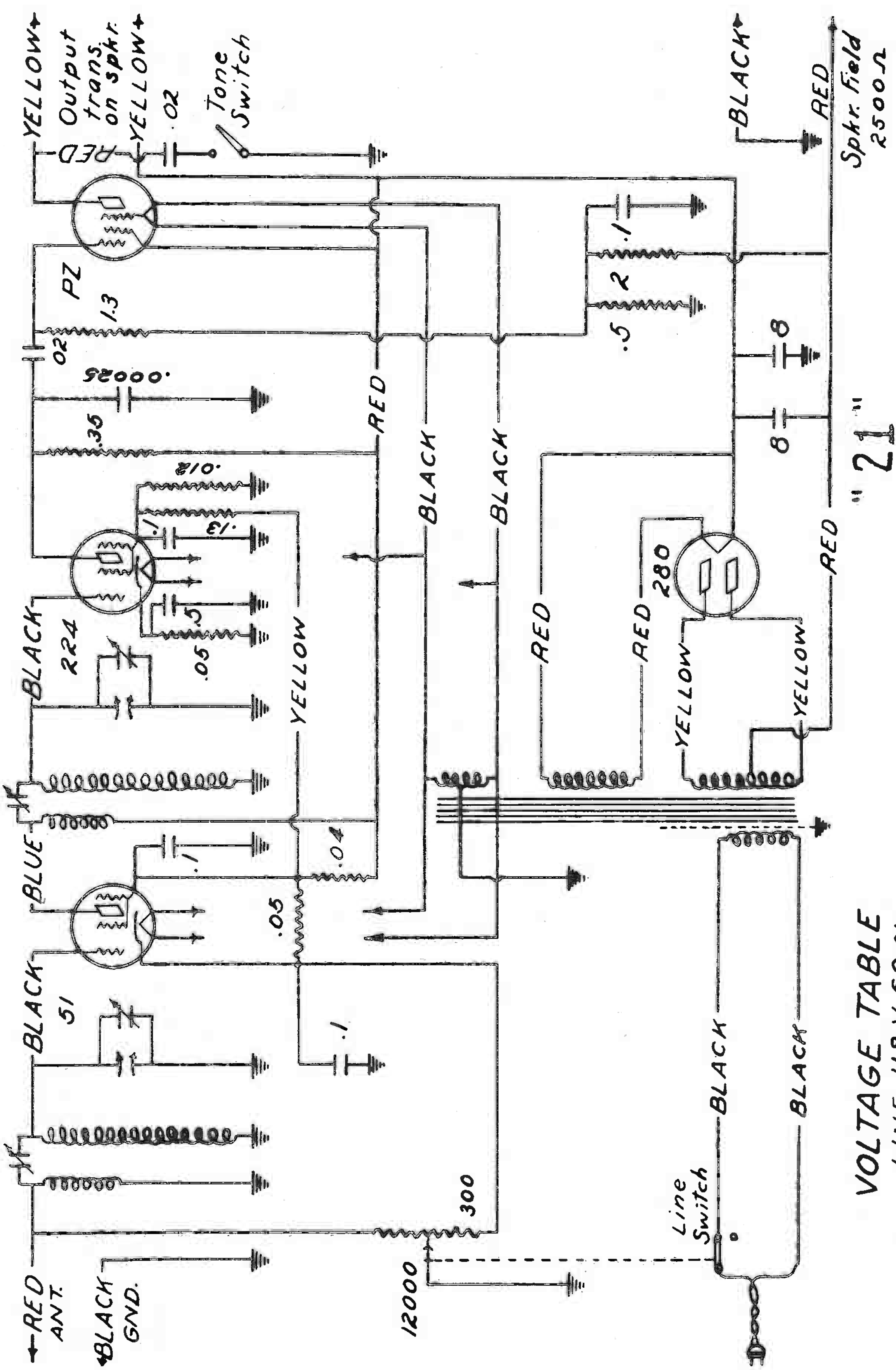


Model PYP-250



Model RS-81

REMLER CO., LTD.

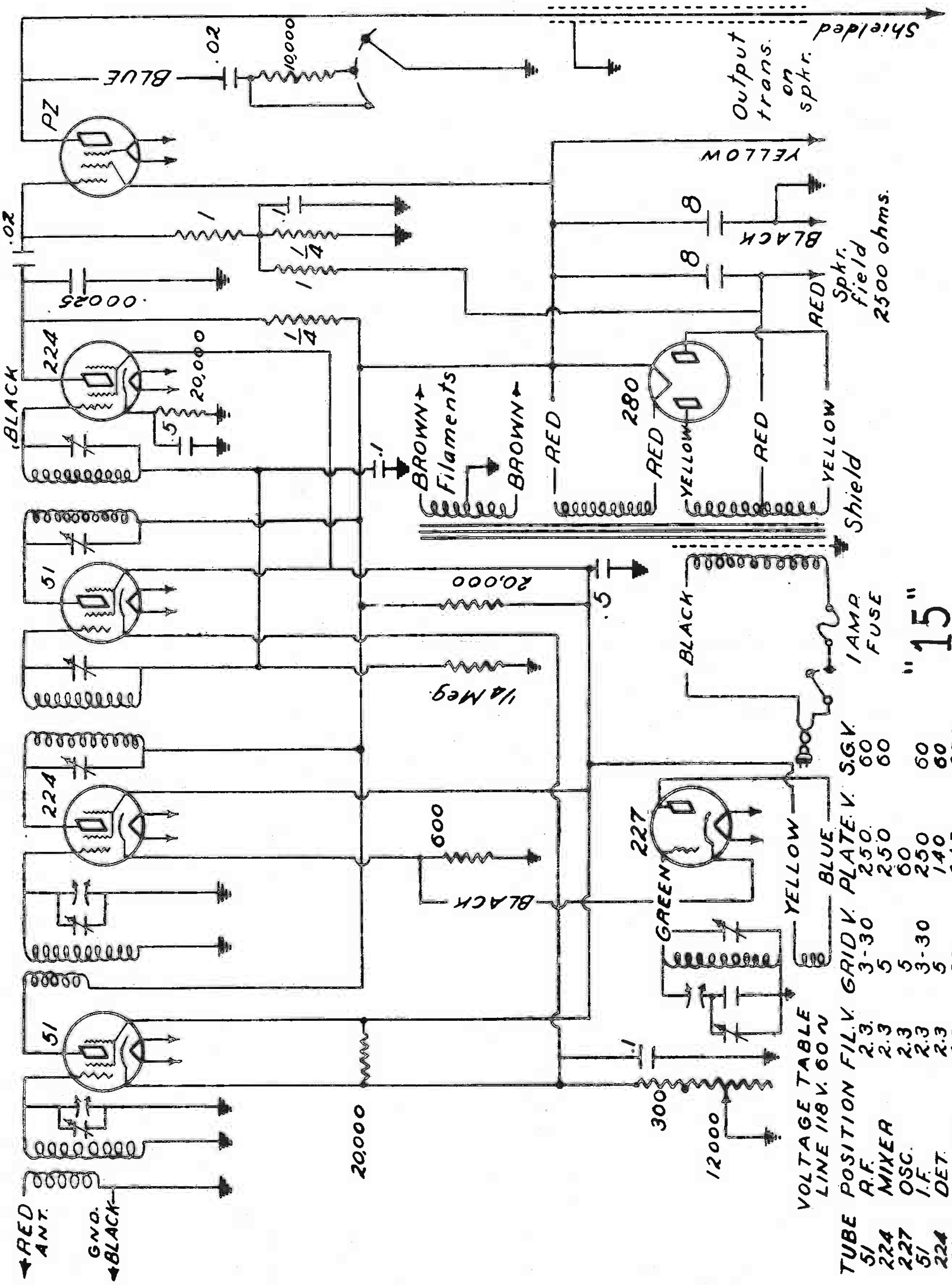


VOLTAGE TABLE

LINE 118 V. 60 ~

TUBE	POSITION	FIL. V.	GRID V.	PLATE V.	S.G.V.
51	R.F.	2.4	2.5-40	250	120
224	DET.	2.4	2.5	95	12
PZ	POWER	2.4	18	245	250
280	RECTIFIER	5		340	

REMLER CO., LTD.

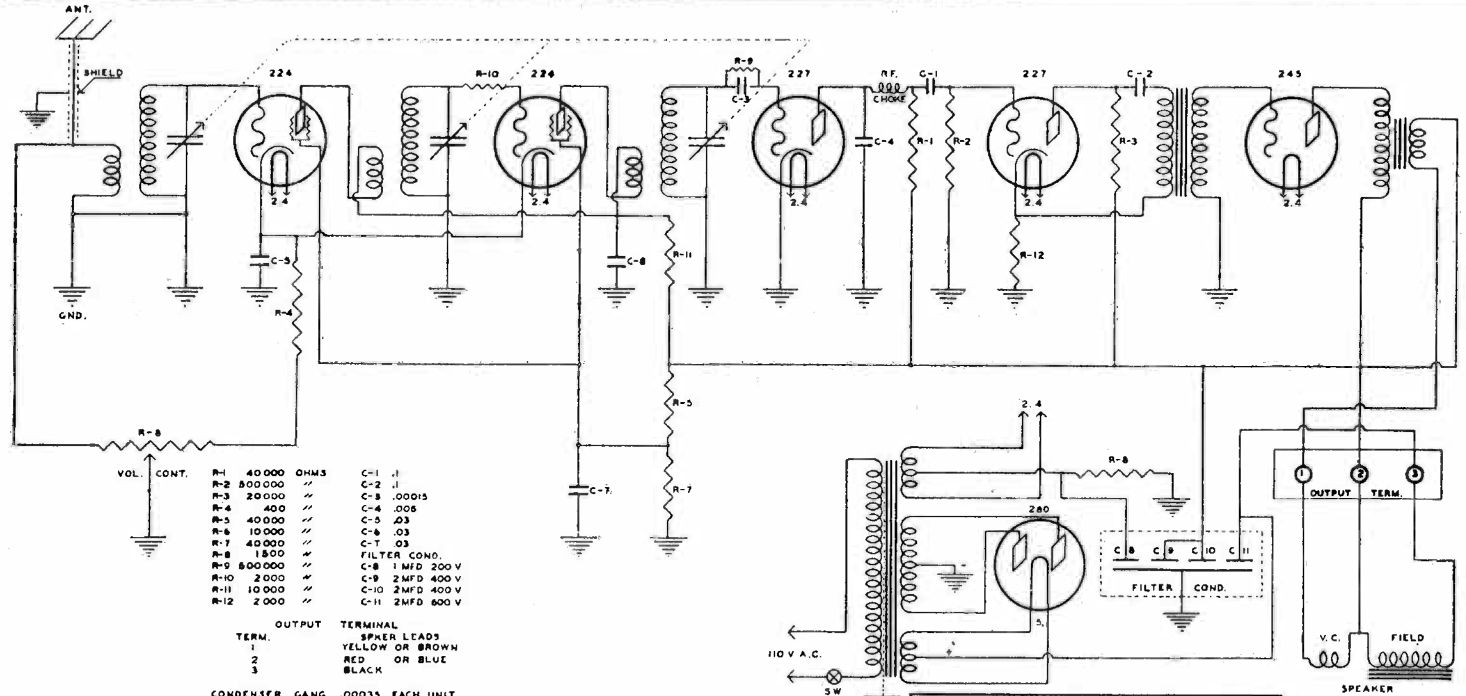


"15"

VOLTAGE TABLE
LINE 118 V. 60 N

TUBE	POSITION	FIL. V.	GRID V.	PLATE V.	S.G.V.
51	R.F.	2.3	3-30	250	60
224	MIXER	2.3	5	250	60
227	OSC.	2.3	5	60	
51	I.F.	2.3	3-30	250	60
224	DET.	2.3	5	140	60
PZ	POWER	2.3	20	245	250
280	RECTIFIER	4.5		375	

ROLA CO.



R-1	40000	OHMS	C-1	.1
R-2	800000	"	C-2	.1
R-3	20000	"	C-3	.00015
R-4	400	"	C-4	.006
R-5	40000	"	C-5	.03
R-6	10000	"	C-6	.03
R-7	40000	"	C-7	.03
R-8	1500	"	FILTER COND.	
R-9	800000	"	C-8	1 MFD 200 V
R-10	2000	"	C-9	2 MFD 400 V
R-11	10000	"	C-10	2 MFD 400 V
R-12	2000	"	C-11	2 MFD 600 V

OUTPUT TERMINAL

TERM.	SPKER LEADS
1	YELLOW OR BROWN
2	RED OR BLUE
3	BLACK

CONDENSER GANG .00035 EACH UNIT

COILS

POSITION		NO. TURNS	WIRE SIZE
ANT.	PRIM.	13	NO. 35 S.S.
	SEC.	115	" 28 E.
1 ST. R.F.	PRIM.	40	" 40 E.
	SEC.	115	" 28 E
2 ND. R.F.	PRIM.	40	" 40 E.
	SEC.	115	" 28 E.

SPEAKER

FIELD	5000 OHMS	NO. 35 E.
MOVING COIL	2 LAYER	
MODEL	ROLA	L-160

NOTE - ANT. COIL ON TUBE SIDE OF CHASSIS

80 & 90

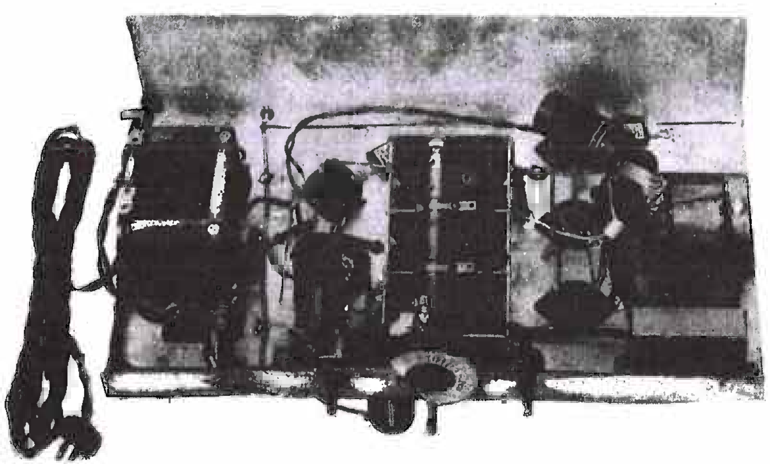
VOLTAGE READINGS

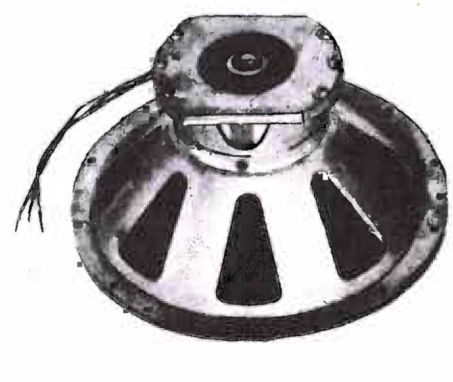
TYPE TUBE	POSITION	A VLT.	B VLT.	C VLT.	SCR. VLT.	NORMAL M. A.	CATH.
24	1-ST. R.F.	2.4	160	1.7	60	2	35
24	2-ND. R.F.	2.4	160	1.7	60	2	35
27	DET.	2.4	80			5	35
27	1-ST. A.F.	2.4	140	9.		5	35
45	2-ND. A.F.	2.4	210	35.		26	
80	RECT.	5.	430			46	

LINE VOLTAGE - 115 VOL. CONTROL - FULL ON

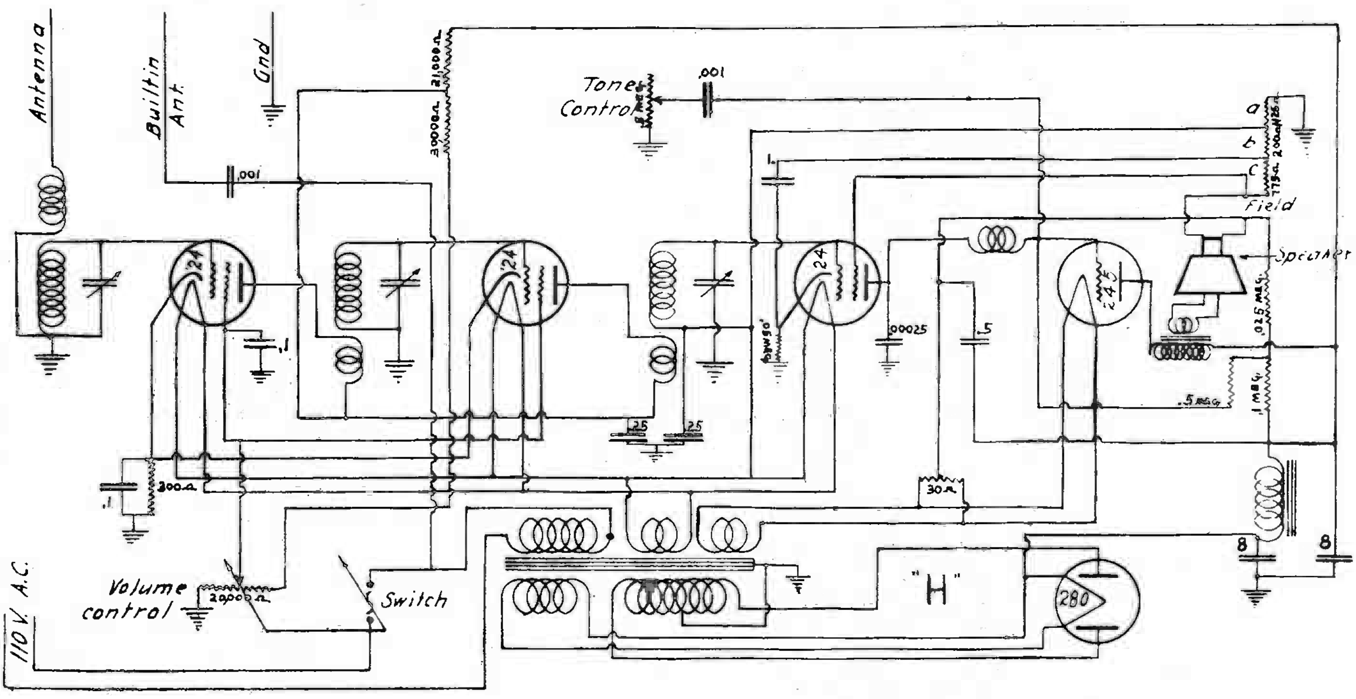
TESTER - WESTON MODEL 547

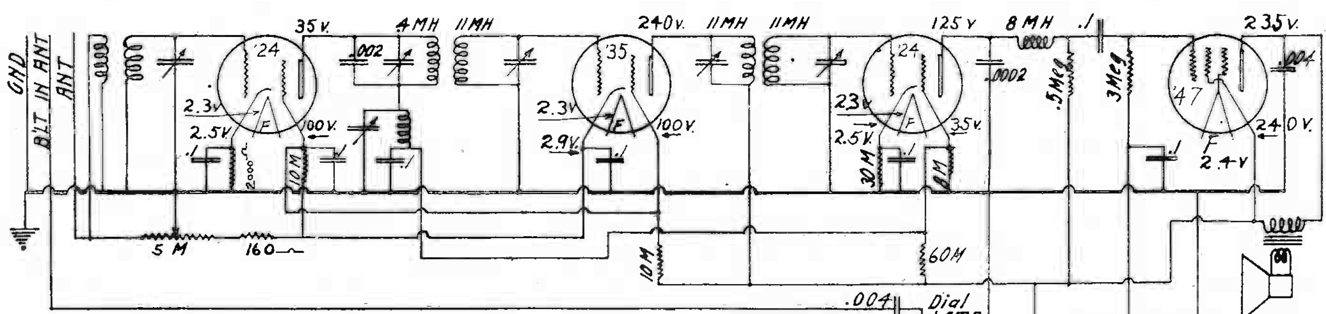
R.C.G. 1930

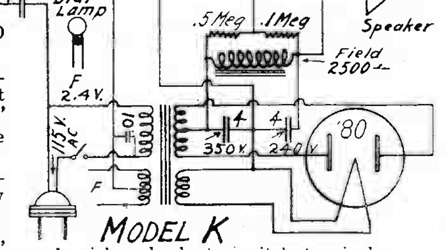




SIMPLEX RADIO CO.







MODEL K

CAUTION: DO NOT ATTEMPT TO OPERATE ON CURRENT OTHER THAN THAT NOTED ON INSTRUMENT.

INSTALLATION: Thirty feet of aerial is enough for efficient operation. More may be used if desired. If no aerial available connect "ANT" to "B'LT-IN-ANT" and operate with or without ground. When power noises are evident they may be decreased by grounding the "B'LT-IN-ANT."

OPERATION: The left hand knob is volume control, the right hand knob is switch, and the middle knob is tuning control.

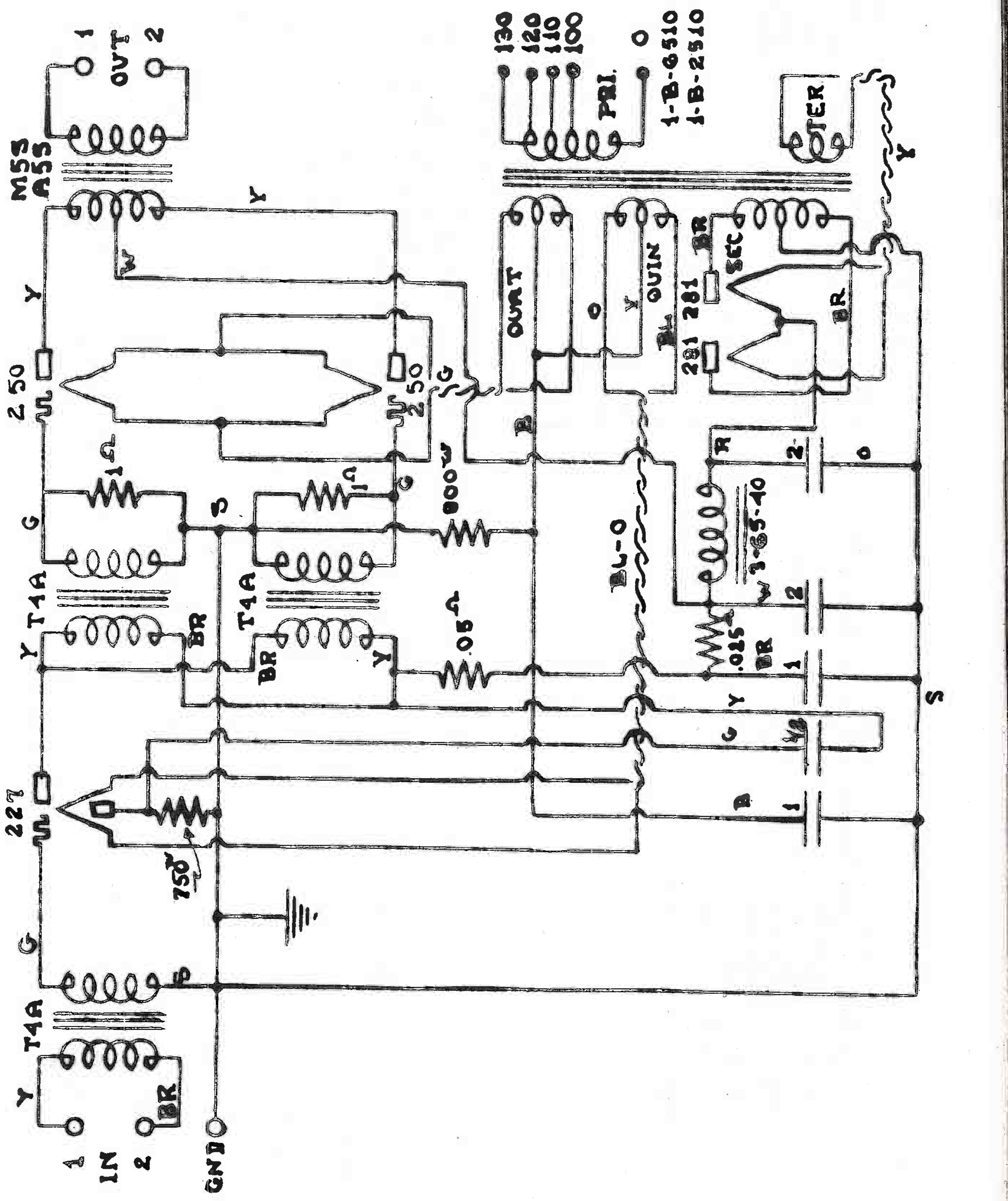
BALANCING: In case a tube change necessitates rebalancing the set dial should be set to a station of known frequency between 1200 and 1500 kilocycles and the balancing plates carefully adjusted to a point of maximum volume.

PHONOGRAPH: Use a single pole switch mounted as near as possible to second detector socket, connect in series with lead from ground end of grid coil of second detector tube. Solder phonograph pickup leads to switch terminals.

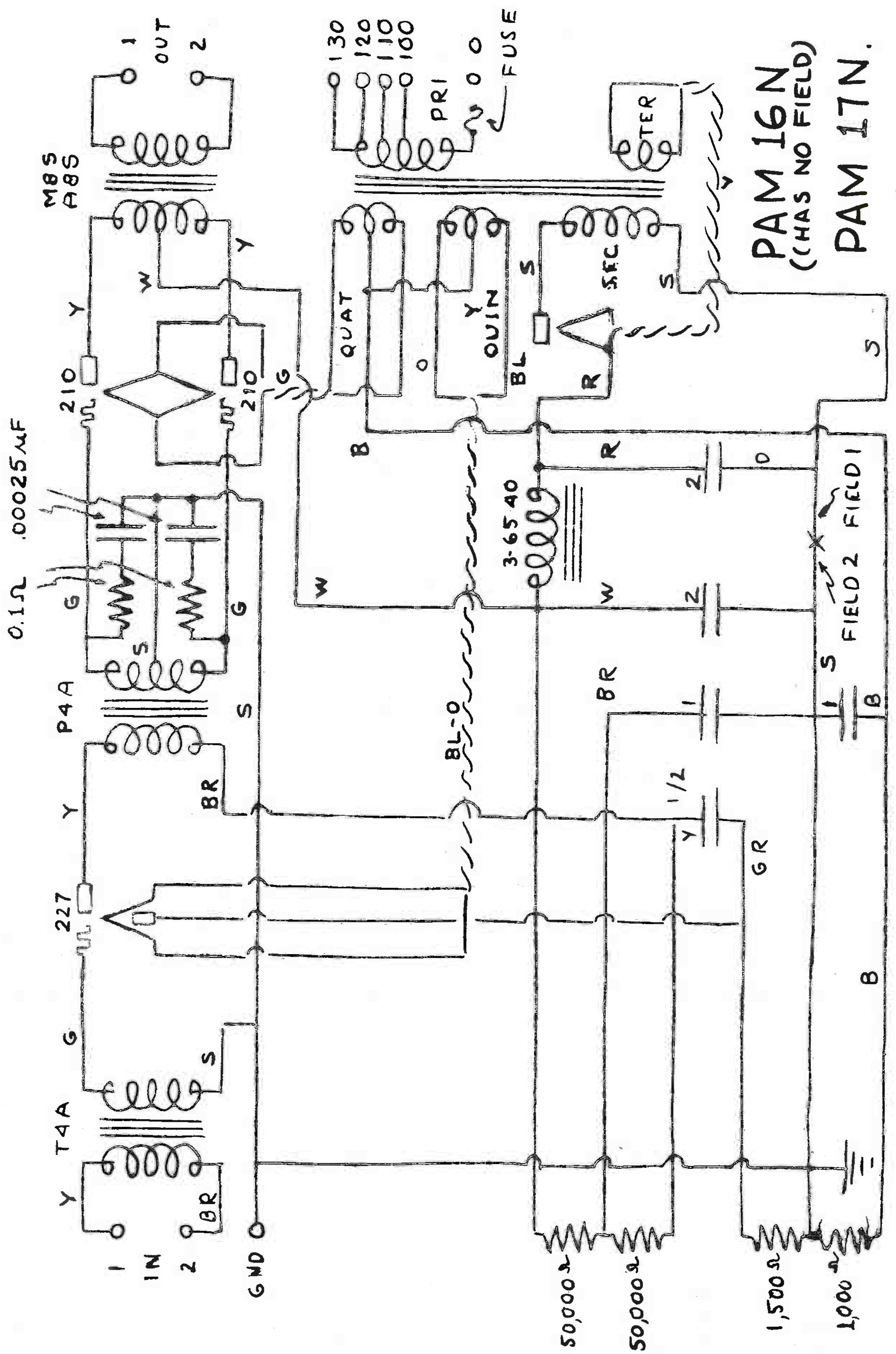
GUARANTEE: This instrument is guaranteed for ninety days, within which period any part showing electrical or mechanical defect will be replaced without charge when returned prepaid to the factory, but if the complete instrument is returned a nominal charge will be made for such labor as may be necessary to install the defective part.

SAMSON ELECTRIC CO.

PAM-9

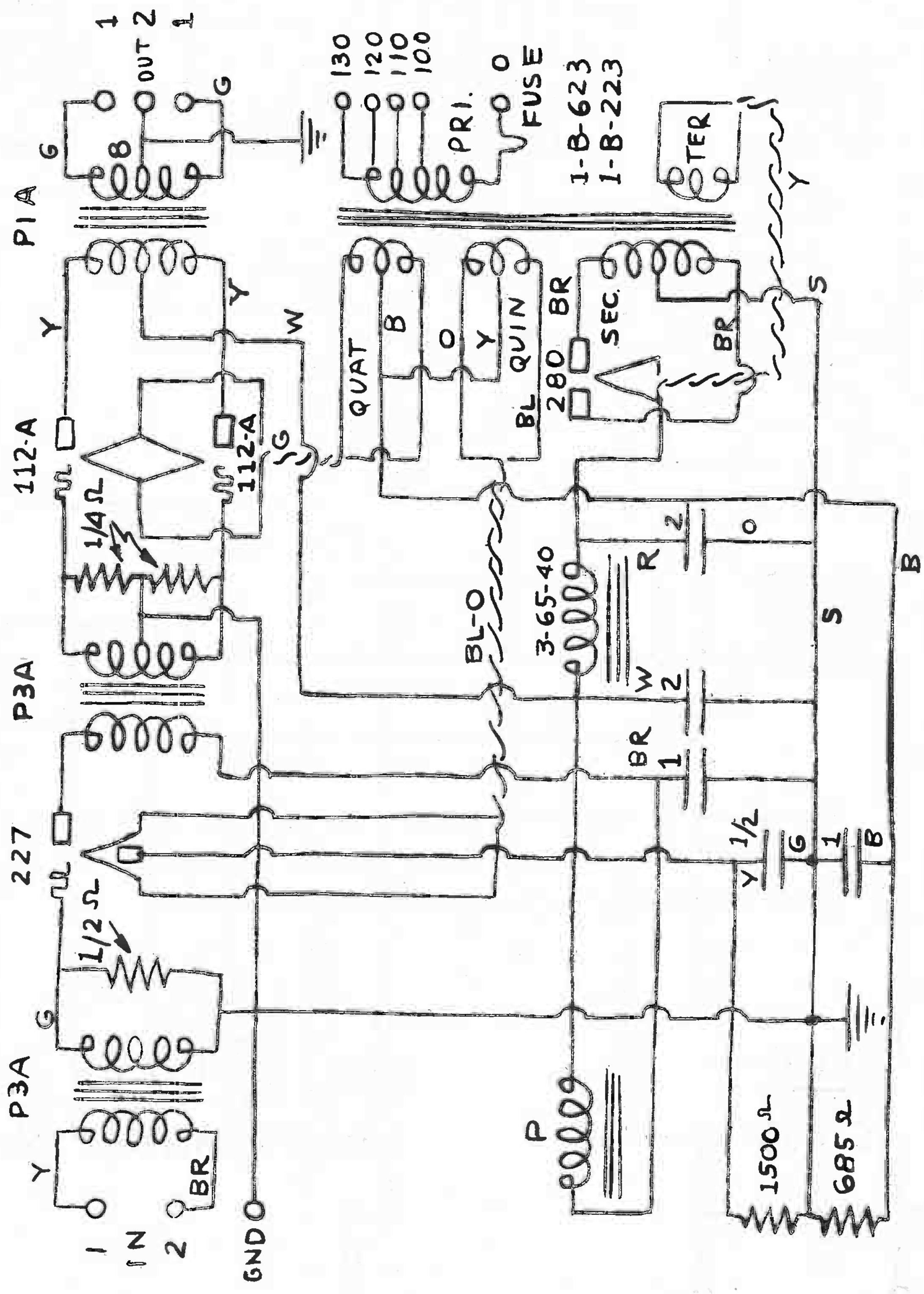


SAMSON ELECTRIC CO.



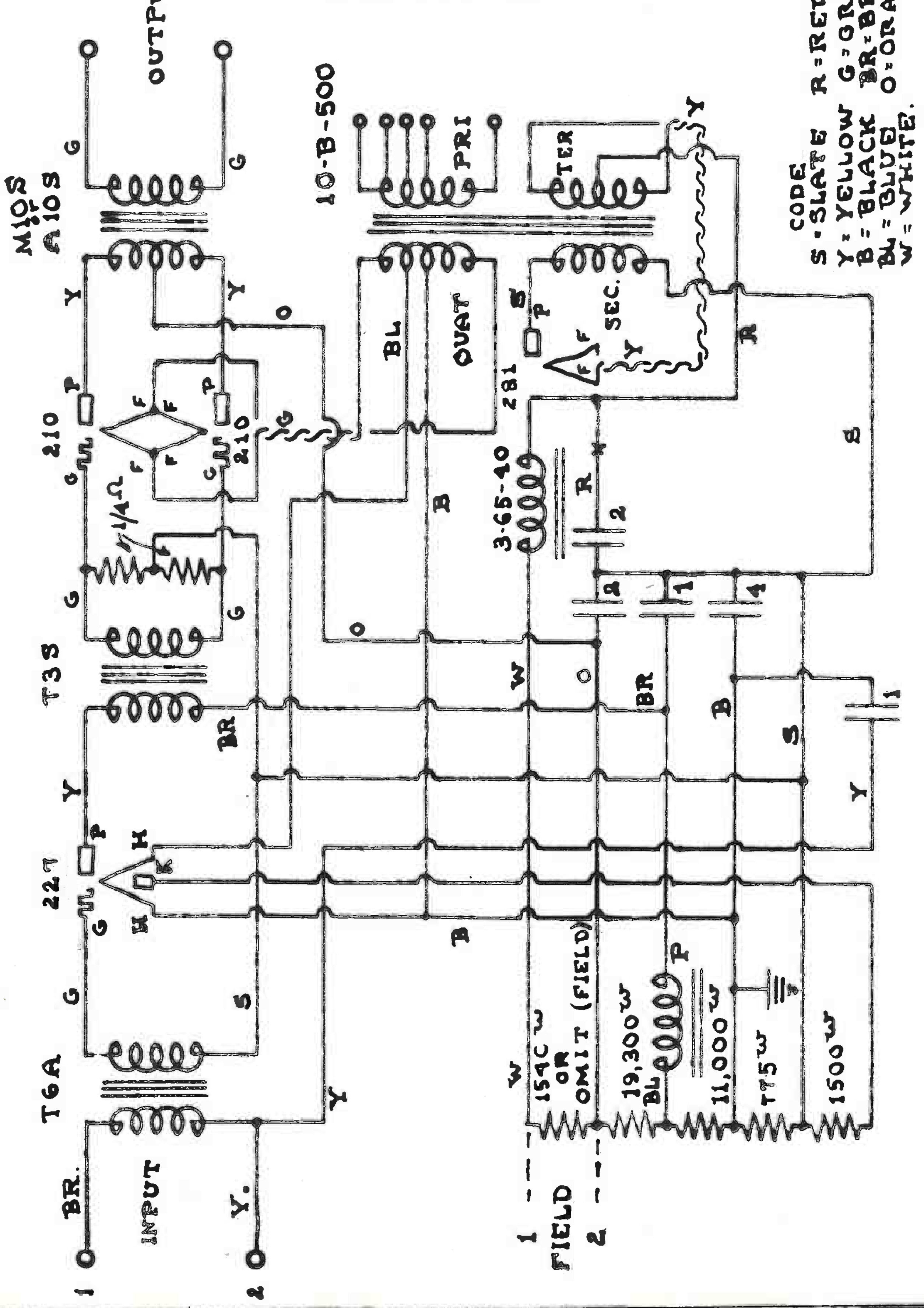
SAMSON ELECTRIC CO.

PAM - 5



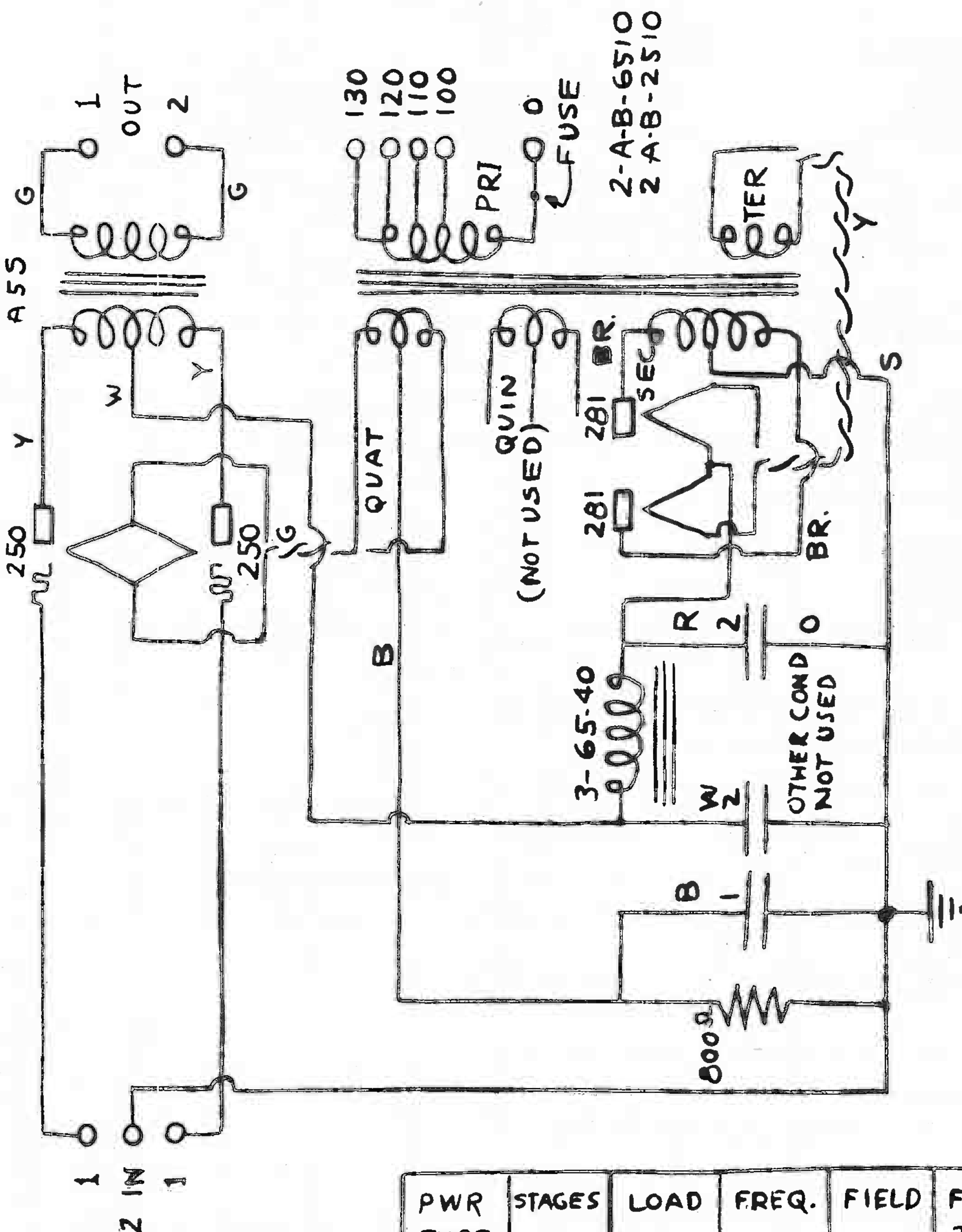
SAMSON ELECTRIC CO.

PAM-16 (HAS NO FIELD)
PAM-17



SAMSON ELECTRIC CO.

PAM-25

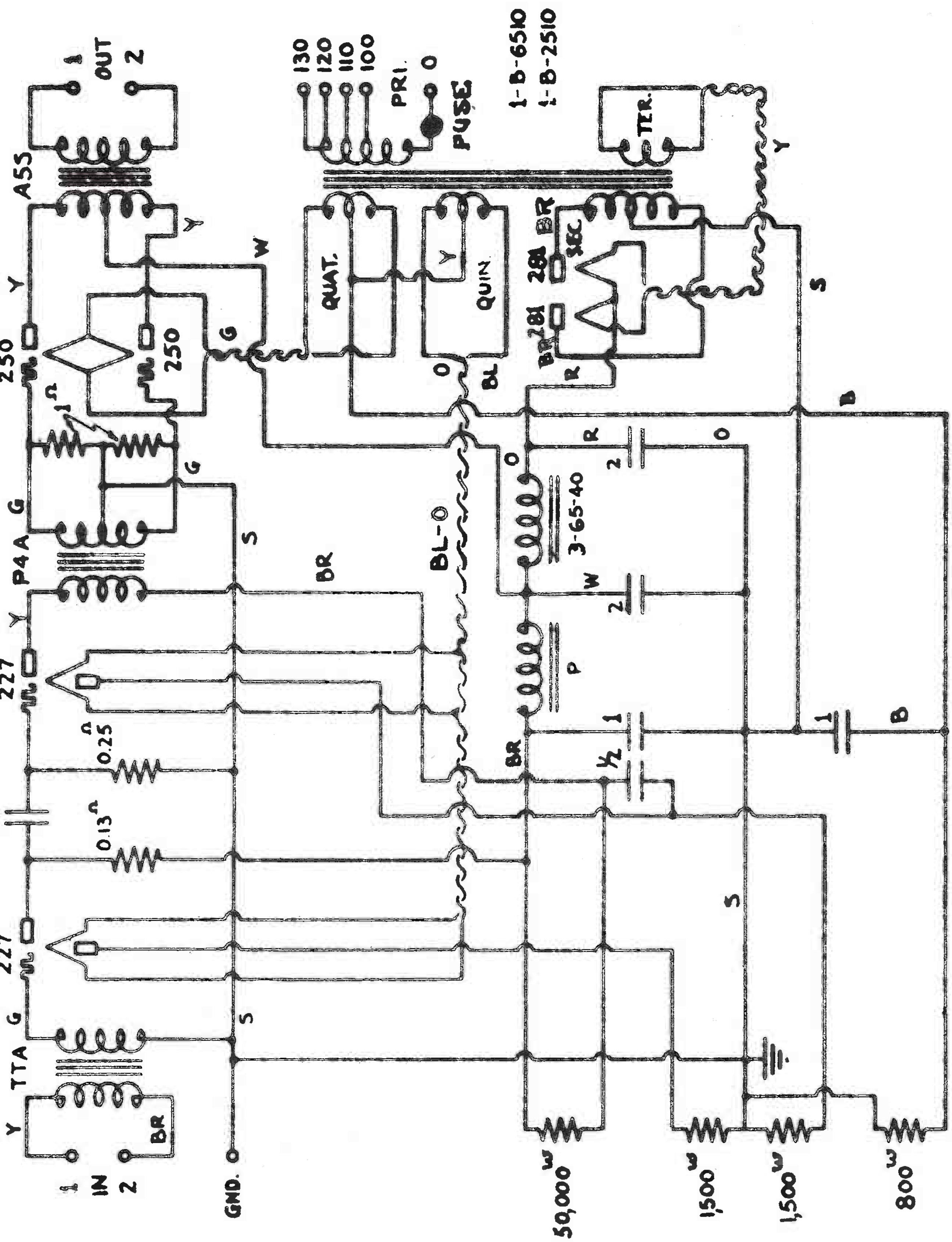


PWR TUBE *	STAGES	LOAD	FREQ.	FIELD	FIRST TUBE
50	1	♣	6 2	0	0

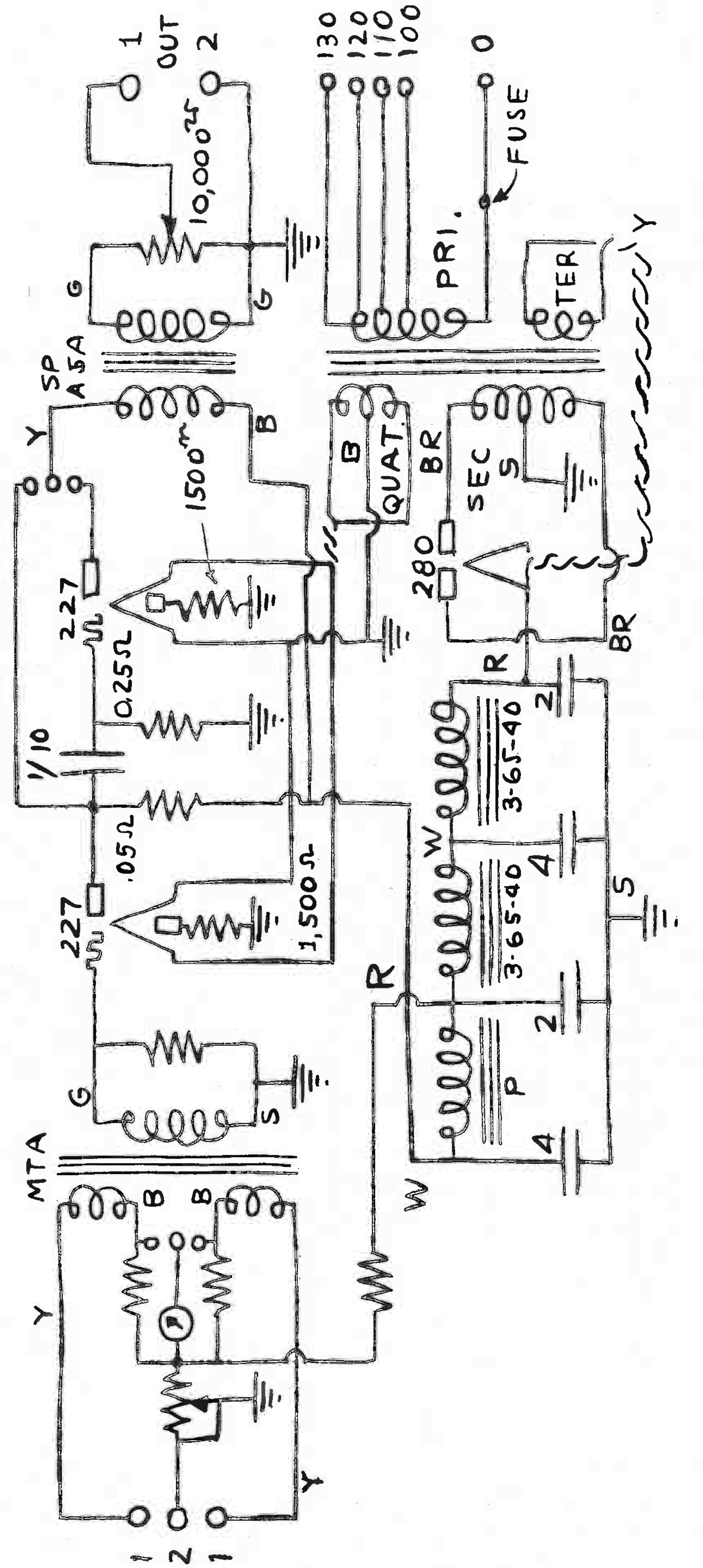
*PUSH-PULL UNLESS OTHERWISE STATED

SAMSON ELECTRIC CO.

PAM-19

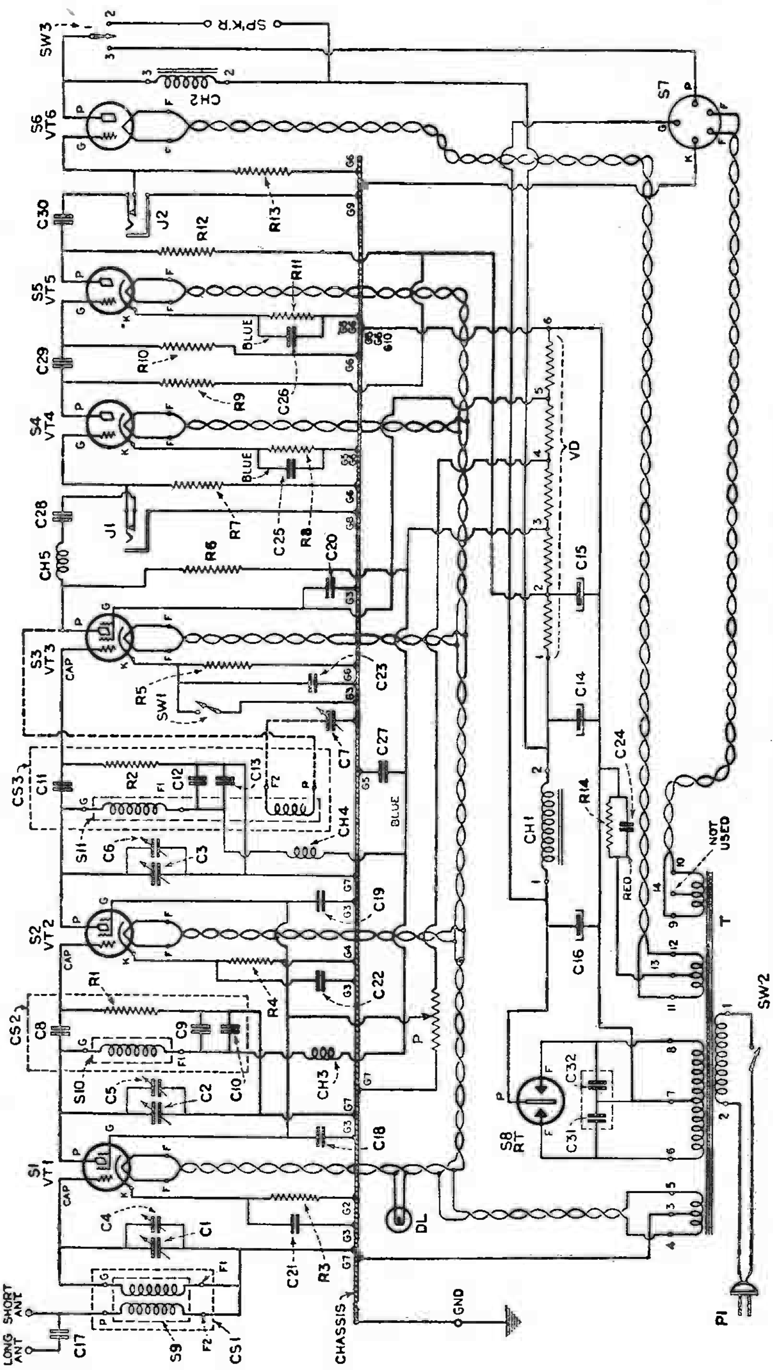


SAMSON ELECTRIC CO.



MIKI AMPLIFIER

SHORT WAVE AND TELEVISION LABORATORY

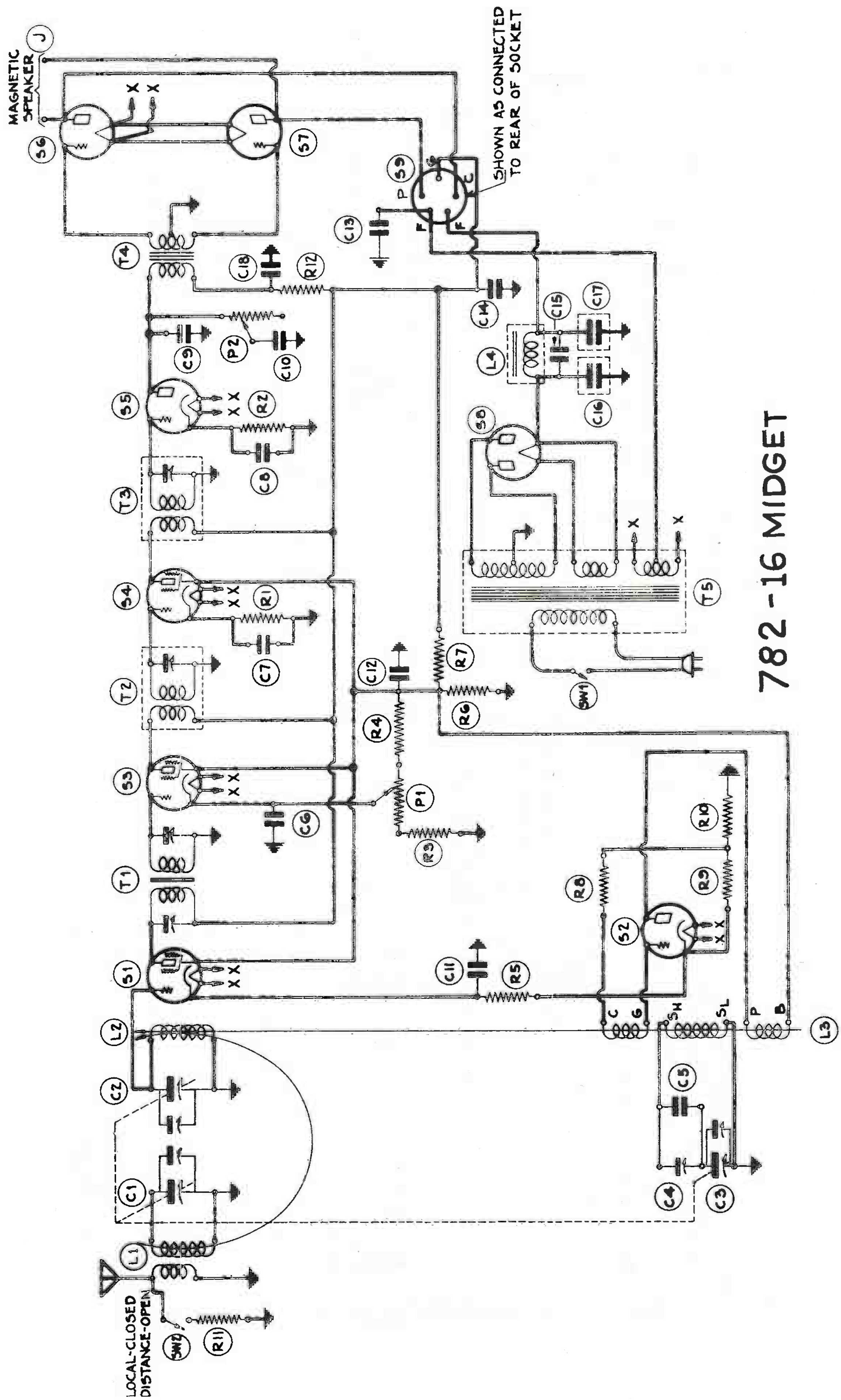


SCHEMATIC DIAGRAM OF BAIRD UNIVERSAL SHORTWAVE RECEIVER

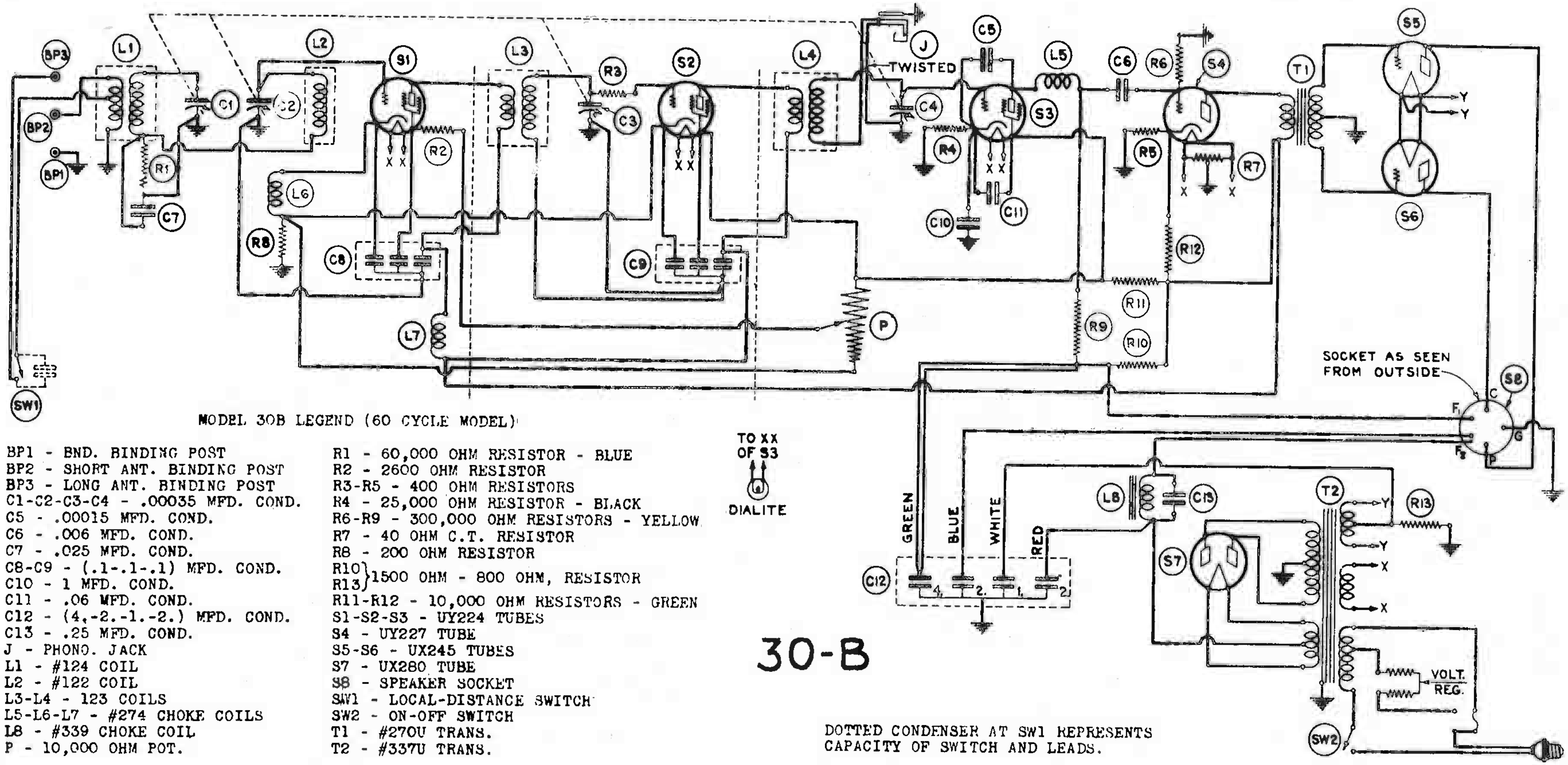
Parts Required for Baird Receiver

Stock No.	*Quan.*	*Part and Type*	*No. on Diagram*
51	1	Chassis, all mounted, with	
		8 sockets riveted	*S1, S2, S3, S4, S5, S6, S7, S8*
		3 coil shields	*CS1, CS2, CS3*
		3 tube shields	*TS1, TS2, TS3*
		2 condensers	*C10, C13*
		and 1 3-post binding strip	*Gnd., Short Ant., Long Ant.*
52	3	Coil Sockets	*S9, S10, S11*
53	2	Pig-tail Resistors	*R1, R2*
54	3	.0001 Mfd. Condensers	*C8, C11, C17*
55	3	Screen Grid Clips	
56	2	.02Mfd. Moulded Condensers	*C9, C12*
57	2	Jacks	*J1, J2*
58	1	Block Condenser	*C18, C19, C20, C21, C22, C23*
59	1	Block Condenser	*C24, C25, C26, C27*
60	3	R. F. Chokes	*CH3, CH4, CH5*
61	1	3-Gang Baird Variable Condenser	*C1, C2, C3, C5, C6*
62	3	Electrolytic Condensers	*C14, C15, C16*
63	1	Baird Power Transformer	*T*
64	1	Baird Power Choke	*CH1, CH2*
65	1	Baird Gang Resistor	*R5, R6, R7, R8, R9, R10, R11, R12, R13, R14*
66	1	3-Condenser Strip	*C28, C29, C30*
67	4	Knobs	
68	1	Toggle Switch—2 pole	*SW1*
69	1	Speaker Terminal	*Speaker*
70	1	Combination Potentiometer and Switch	*P, SW2*
71	1	No. 9 Baird Midget Condenser	*C4*
72	1	No. 15 Baird Midget Condenser	*C7*
73	1	Buffer Condenser	*C31, C32*
74	1	Voltage Divider	*VD*
75	1	Baird Dial and Escutcheon	
76	1	Baird Front Panel	
77	2	Grid Resistors	*R3, R4*
78		40′ Wire	
79		3-Pole Switch	*SW3*
80	1	Dial Bracket and Lamp	*DL*
81		AC Cord and Plug	*P1*
500		Hardware Assembly	
	15	Octocoils 15-520 meters Wave-	

SILVER-MARSHALL INC.



SILVER-MARSHALL INC.



30-B

MODEL 30B LEGEND (60 CYCLE MODEL)

BP1 - BND. BINDING POST
BP2 - SHORT ANT. BINDING POST
BP3 - LONG ANT. BINDING POST
C1-C2-C3-C4 - .00035 MFD. COND.
C5 - .00015 MFD. COND.
C6 - .006 MFD. COND.
C7 - .025 MFD. COND.
C8-C9 - (.1-.1-.1) MFD. COND.
C10 - 1 MFD. COND.
C11 - .06 MFD. COND.
C12 - (4.-2.-1.-2.) MFD. COND.
C13 - .25 MFD. COND.
J - PHONO. JACK
L1 - #124 COIL
L2 - #122 COIL
L3-L4 - 123 COILS
L5-L6-L7 - #274 CHOKE COILS
L8 - #339 CHOKE COIL
P - 10,000 OHM POT.

R1 - 60,000 OHM RESISTOR - BLUE
R2 - 2600 OHM RESISTOR
R3-R5 - 400 OHM RESISTORS
R4 - 25,000 OHM RESISTOR - BLACK
R6-R9 - 300,000 OHM RESISTORS - YELLOW
R7 - 40 OHM C.T. RESISTOR
R8 - 200 OHM RESISTOR
R10, R13 } 1500 OHM - 800 OHM, RESISTOR
R11-R12 - 10,000 OHM RESISTORS - GREEN
S1-S2-S3 - UY224 TUBES
S4 - UY227 TUBE
S5-S6 - UX245 TUBES
S7 - UX280 TUBE
S8 - SPEAKER SOCKET
SW1 - LOCAL-DISTANCE SWITCH
SW2 - ON-OFF SWITCH
T1 - #270U TRANS.
T2 - #337U TRANS.

LEGEND FOR 25 CYCLE MODEL
SAME AS 60 CYCLE MODEL EXCEPT

C11 - .04 MFD. COND.
C13 - 2. MFD. COND.
T2 - #337-25U TRANS.

ADD 1. MFD. CONDENSER
ACROSS TERMINALS OF R12

DOTTED CONDENSER AT SW1 REPRESENTS CAPACITY OF SWITCH AND LEADS.

NOTE - WHEN USING PHONOGRAPH JACK CONNECT LOW SIDE OF PHONOGRAPH VOLUME CONTROL TO SLEEVE OF PLUG.

SILVER-MARSHALL INC.

782 AC MIDGET SUPERHETERODYNE

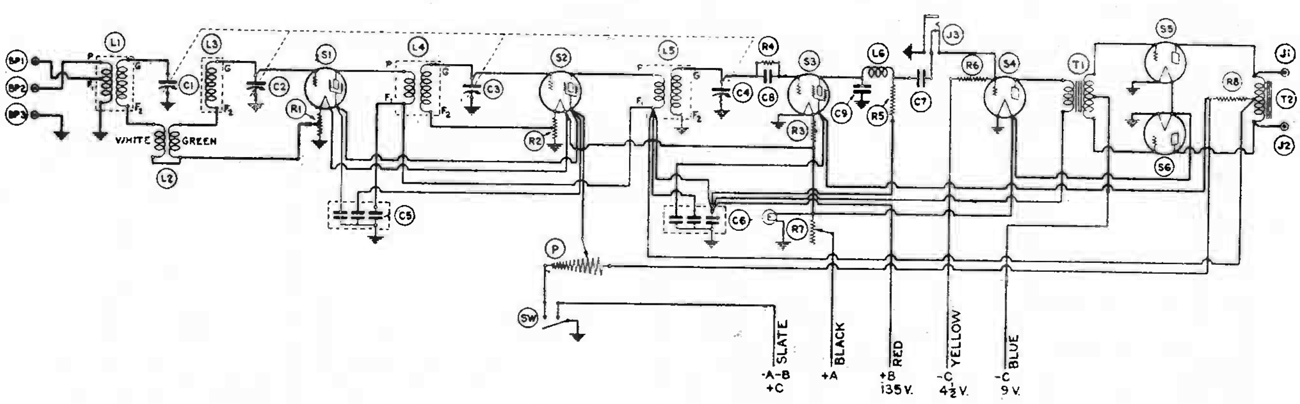
VOLUME CONTROL MAXIMUM

Tube Number	Type of Tube	Shield Volts	"A" Volts	"B" Volts	"C" Volts	Cathode Volts	Normal Plate MA
1st Det.	224	68	2.16	200		6	3.2
Oscillator	227		2.14	68		5	5
1st I.F.	224	68	2.18	200		1.6	5.7
2nd I.F.	224	68	2.19	200		2.3	5.6
2nd Det.	227		2.20	200		20	0.8
Audio	245		2.25	245	47		29
Audio	245		2.25	243	46		28

(280 Filament to ground, 400 volts)
(280 Filament, 5.1 volts AC)

C5 - 750 Mmfd.
C6 - 0.1 Mfd.
C7 - 0.1 Mfd.
C8 - 1.0 Mfd. 150 V.
C9 - .001 Mfd. Mica
C10 - .025 Mfd.
C11 - 0.1 Mfd.
C12 - 1.0 Mfd. 150 V.
C13 - 0.1 Mfd.
C14 - 1.0 Mfd. 300 V.
C15 - .25 Mfd.
C16 - 8.0 Mfd. Electrolytic
C17 - 8.0 Mfd. Electrolytic

R1 - 750 Ohms Wire wound
R2 - 25,000 ohms 1 Watt
R3 - 200 ohms Wire wound
R4 - 25,000 ohms 1 Watt
R5 - 10000 ohms 1 Watt
R6 - 10,000 ohms 1 Watt
R7 - 10,000 ohms 3 Watt
R8 - 400 ohms Wire wound
R9 - 100 ohms
R10 - 1000 ohms
(R9, R10) Wire wound, tapped at 100 ohms

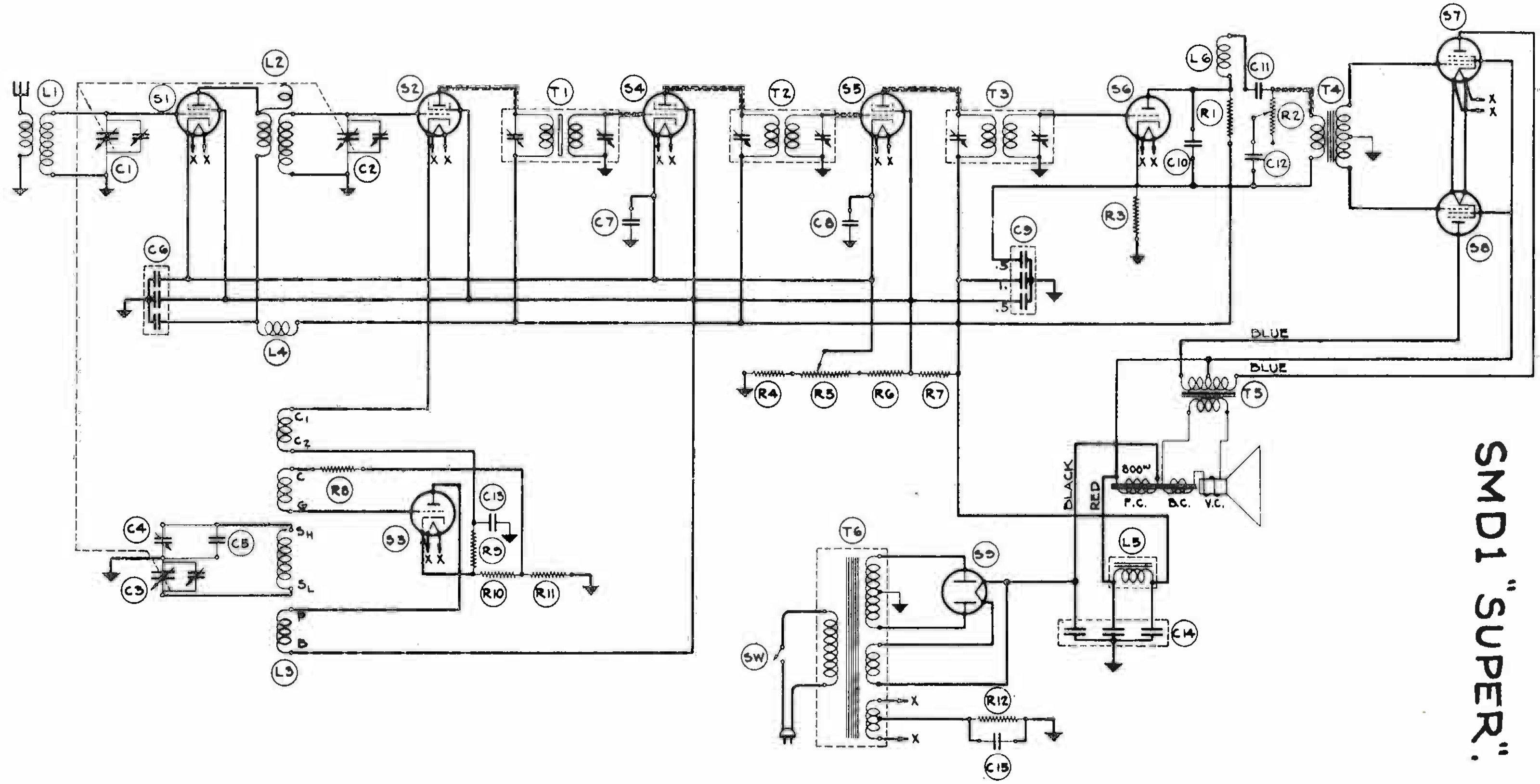


722 D.C.

C5, C6	2—Potter 30B condenser blocks
C7	1—Polymet .006 large moulded condenser
C8	1—Polymet .00015 condenser
C9	1—Polymet .0005 condenser
P	1—Yaxley 10-MJP 10,000 ohm potentiometer
J1, J2	2—Yaxley 422 Insulated tip-jacks
J3	1—Carter 2A closed circuit jack
R1, R2, R3	3—Yaxley 815C 15-ohm center-tapped resistor
R4, R6	2—Durham 2-megohm 1-watt resistors (red)
R5	1—Durham 60,000 ohm 1-watt resistor (blue)
R7	1—Carter Sub-base rheostat
R8	1—Durham 20,000 ohm 1-watt resistor (orange)

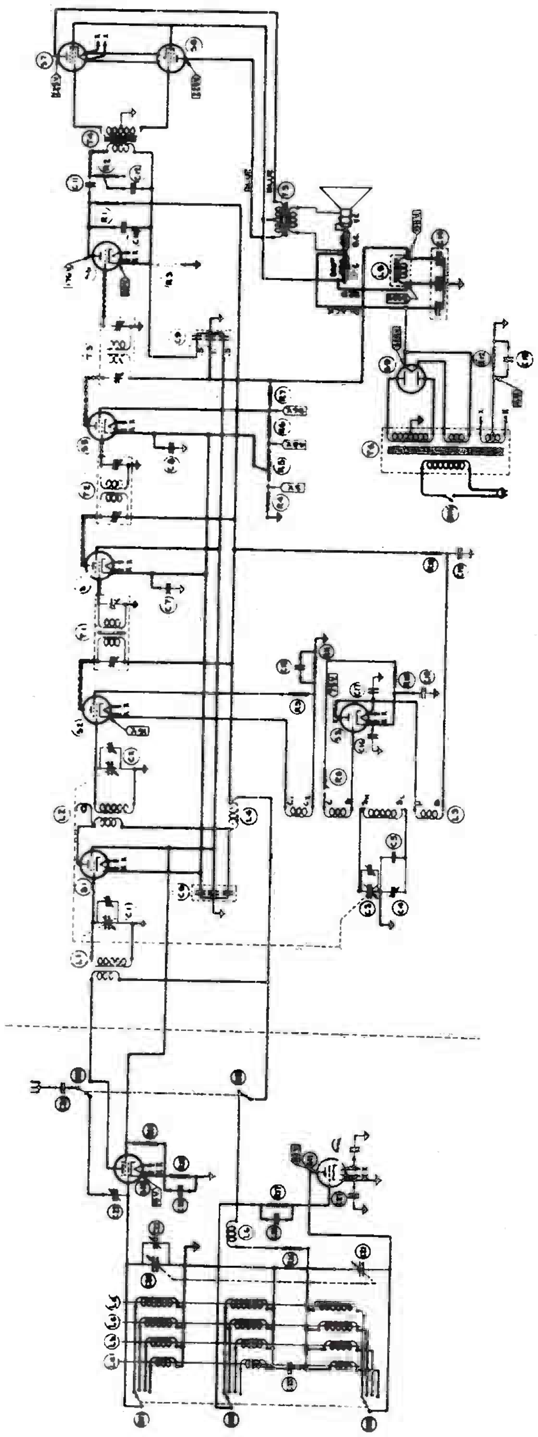
SILVER-MARSHALL INC.

SMD1 "SUPER".



R1 - 30,000 ohms 1 watt	C5 - 750 Mmfd. ± 10% (Mica)
R2 - 1/2 megohm tapered variable resistor	C6 - Triple .1 Mfd. Cond.
R3 - 60,000 ohms 1 watt	C7 - .1 Mfd.
R4 - 200 ohms wire wound	C8 - .1 Mfd.
R5 - 4500 ohms volume control (tapered)	C9 - .5, .5, 1. Mfd. Con.
R6 - 13,000 ohms 1 watt	C10 - .001 Mfd. (Mica)
R7 - 15,000 ohms 2 watt	C11 - 0.15 Mfd.
R8 - 400 ohms wire wound	C12 - .025 Mfd.
R9 - 10,000 ohms 1 watt	C13 - .1 Mfd.
R10 - 100 ohms) -1100 ohm tapped resistor	C14 - Three 4 mfd. units (dry electrolytic)
R11 - 1000 ohms)	C15 - .1 Mfd.
R12 - 220 ohms 2 watt	

SILVER-MARSHALL INC.



726 S.W.

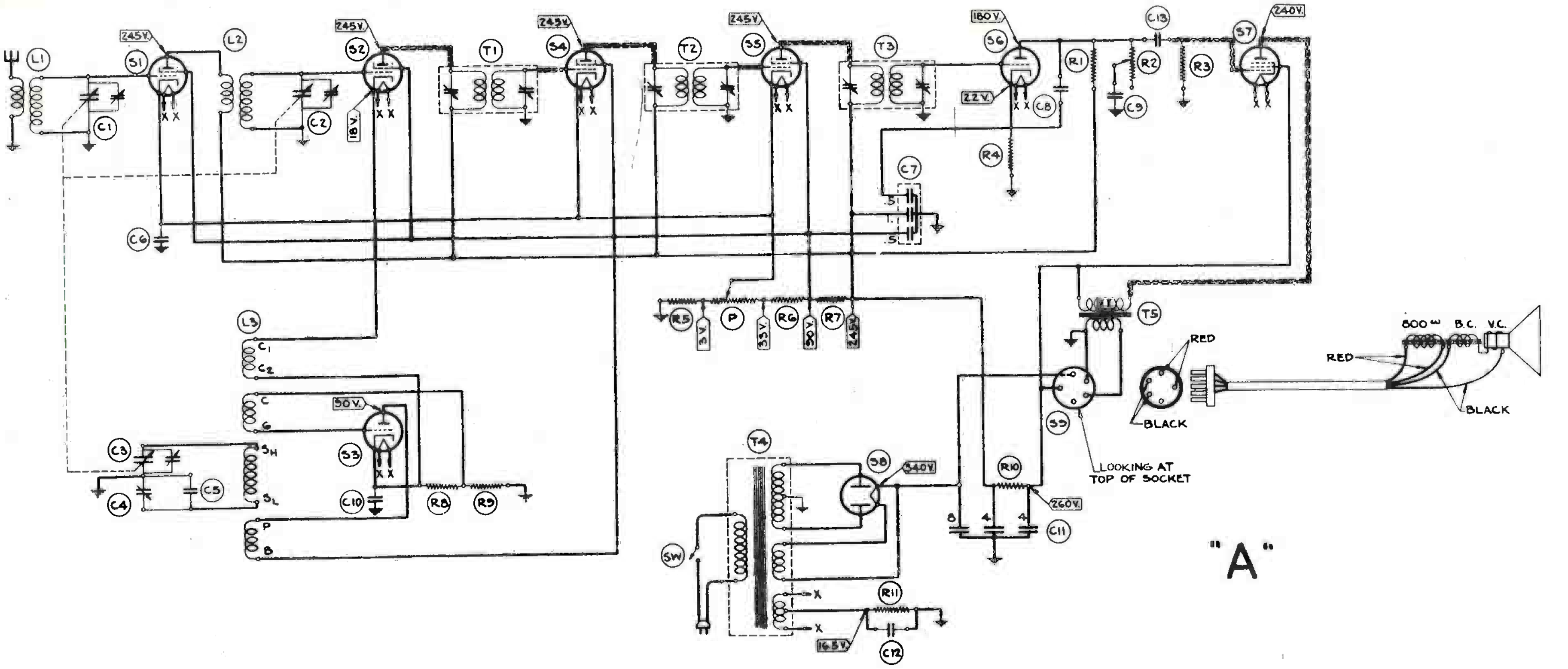
C1-C2-C3 - 407 Mmfd. Max. (3-gang variable)
C4 - Variable 250-600 Mmfd.
C5 - 750 Mmfd. ± 10% (Mica)
C6 - Triple 0.1 Mfd.
C7 - .1 Mfd.
C8 - .1 Mfd.
C9 - .5, .5, 1.0 Mfd.
C10 - .001 Mfd. (Mica)
C11 - 0.15 Mfd.
C12 - .025 Mfd.
C13 - .1 Mfd.
C14 - Three 4 Mfd. units (dry Electrolytic) Potter
C15 - .1 Mfd.
C16 - .006 Mfd.
C17 - .006 Mfd.
C18 - .1 Mfd.
C19 - .1 Mfd.
C20-C21 - 140 Mmfd. (2-gang variable)
C22 - 80 Mmfd. (variable)
C23 - Compensating Cond.
C24 - .006 Mfd.
C25 - .006 Mfd.
C26 - .001 Mfd. (Mica)
C27 - .006 Mfd.
C28 - .006 Mfd.

R1 - 30,000 ohms 1 watt
R2 - 1/2 megohm tapered variable resistor
R3 - 60,000 ohms 1 watt
R4 - 100 ohms wire wound
R5 - 4,500 ohms volume control (tapered)
R6 - 13,500 ohms 1 watt
R7 - 15,000 ohms 2 watt
R8 - 400 ohms wire wound
R9 - 60,000 ohms 1 watt
R10- 100 ohms wire wound
R11- 10,000 ohms 1 watt
R12- 220 ohms 2 watt
R13- 10,000 ohms 2 watt
R14- 60,000 ohms 1 watt
R15- 6,500 ohms 1 watt
R16- 10,000 ohms 2 watt
R17- 10,000 ohms 1 watt

VOLTAGES WITH VOLUME CONTROL AT MAXIMUM

Tube Number		Type of Tube	"A" Volts	"B" Volts	Screen Volts	"C" Volts	Normal Plate Current Mills
S.W. Det	(S10)	'24	2.2	216	96	18	.08
S.W. Osc.	(S11)	'27	2.25	80	....	0	8.
R.F.	(S1)	'51	2.25	216	96	3	6.
1st Det	(S2)	'24	2.35	216	96	16	.1
Osc.	(S3)	'27	2.35	75	....	1.1	10.
1st I.F.	(S4)	'51	2.3	216	96	3	6.
2nd I.F.	(S5)	'51	2.35	216	96	3	6.
2nd Det.	(S6)	'27	2.35	178	....	20	.1
Audio (right)	(S7)	'47	2.4	224	240	16	32.
Audio (left)	(S8)	'47	2.4	220	240	16	32.
Rectifier	(S9)	'80	5.1	.....	....	.....	.....

SILVER-MARSHALL INC.

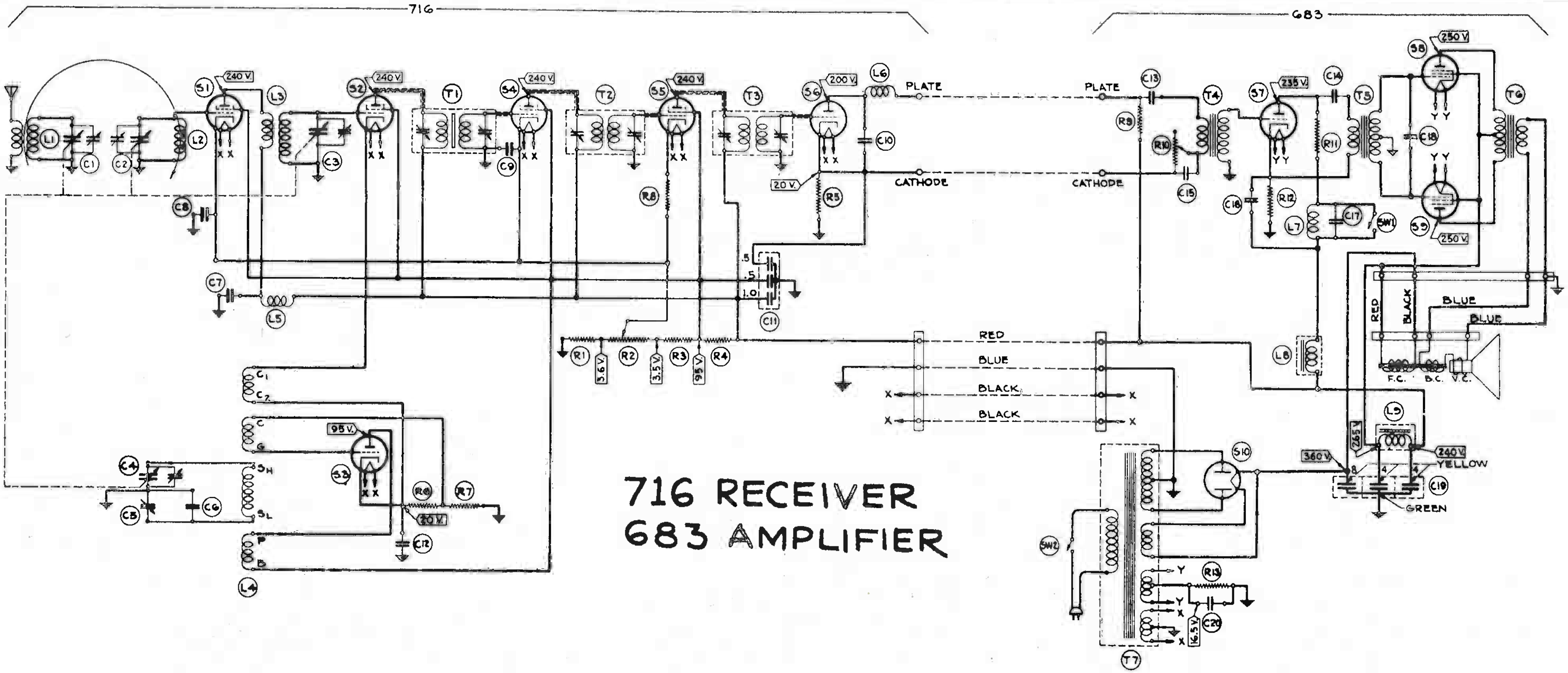


P - 4500 ohm Potentiometer (comb. with switch)

C6 -	1.0 Mfd. Cond. - 250 V. Rating		
C7 -	1.0 Mfd. 300 V., 0.5 - 0.5 Mfd. 200 V.		
C8 -	.001 Mfd. Cond. (Mica)		
C9 -	.025 Mfd. Paper Cond. -	400 V.	Rating
C10 -	0.1 Mfd. Cond.	200 V.	"
C11 -	One 8 Mfd. Cond.	450 V.	"
	Two 4 Mfd. Cond.	450 V.	"
C12 -	0.1 Mfd. Cond.	200 V.	"
C13 -	.02 Mfd. Cond.	500 V.	"

R1 -	60,000 ohm Resistor -		1 watt, Carbon
R2 -	1/2 megohm Variable Resistor		
R3 -	100,000 ohm Resistor		1 watt, Carbon
R4 -	60,000 ohm	"	1 watt, Carbon
R5 -	120 ohm	"	wire wound
R6 -	10,000 ohm	"	1 watt, Carbon
R7 -	10,000 ohm	"	3 watt, Carbon
R8 -	100 ohm	"	} wire wound, tapped unit
R9 -	1700 ohm	"	}
R10 -	425 ohm	"	1 watt, Carbon
R11 -	425 ohm	"	1 watt, Carbon

SILVER-MARSHALL INC.



716 RECEIVER
683 AMPLIFIER

R1 - 100 Ohm Resistor - wire wound
R2 - 4500 Ohm Volume Control
R3 - 13,000 Ohm Resistor - 1 Watt, Carbon
R4 - 10,000 Ohm Resistor - 2 Watt, Carbon
R5 - 60,000 Ohm Resistor - 1 Watt, Carbon
R6 - 100 Ohms) Wire wound tapped resistor
R7 - 1700 Ohms)
R8 - 750 Ohms Wire wound resistor
R9 - 30,000 Ohm Resistor - 1 Watt, Carbon
R10 - 1 Megohm riable Resistor
R11 - 1000 Ohm Resistor - 1 Watt, Carbon
R12 - 2,600 Ohm Resistor - 1 Watt, Carbon
R13 - 220 Ohm Resistor - 2 Watt, Carbon

C7 - .1 Mfd. Cond. 200V.
C8 - .1 Mfd. Cond. 200V.
C9 - .1 Mfd. Cond. 200V.
C10 - .001 Mfd. Cond. Mica
C11 - .5,.5,1.0 Mfd. Cond.(.5-200V.) (1.0-300V)
C12 - .1 Mfd. Cond. 200V.
C13 - .02 Mfd. Cond. 500V.
C14 - .04 Mfd. Cond.
C15 - .001 Mfd. Cond. Mica
C16 - 2 Mfd. Cond.
C17 - .01 Mfd. Cond.
C18 - .00075 Mfd. Cond.
C19 - 2 4mfd. Cond.
1 8Mfd. Cond.
C20 - .1 Mfd. Cond. 200V.

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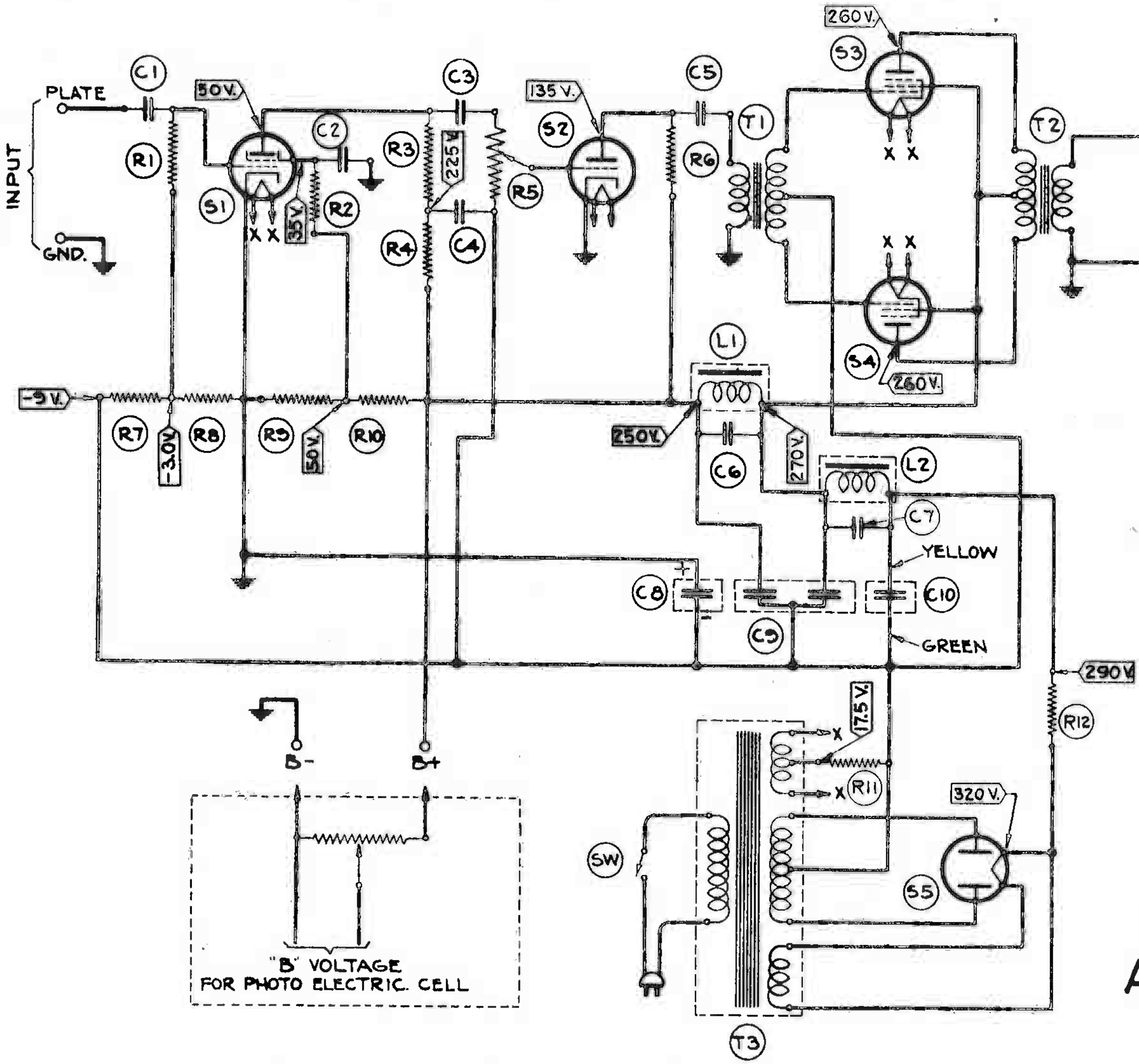


LEGEND

C1 – .05 MFD. SRAGUE (400 V.)
C2 – 1.0 MFD. (150 V.)
C3 – .01 MFD. (MICA)
C4 – 1.0 MFD. (200 V.)
C5 – .25 MFD. SPRAGUE (750 V.)
C6 – .1 MFD. " "
C7 – .25 MFD. " "
C8 – 10 MFD. ELECTROLYTIC (25 V.) DRY
C9 – 2 MFD. (PAPER) (400 V.)
2 MFD. (PAPER) (400 V.)
C10 – 4 MFD. ELECTROLYTIC (450 V.) DRY

L1 – 10145 CHOKE
L2 – 332-U CHOKE

R1 –	2 MEGOHMS	1 WATT
R2 –	60,000 OHMS	1 WATT
R3 –	½ MEGOHM	1 WATT
R4 –	30,000 OHMS	1 WATT
R5 –	1 MEGOHM TAPERED VARIABLE RESISTOR	
R6 –	30,000 OHMS	1 WATT
R7 –	250 OHMS	5 WATT
R8 –	125 OHMS	
R9 –	2300 OHMS	
R10 –	11,300 OHMS	
R11 –	220 OHMS	2 WATT
R12 –	300 OHMS	5 WATT

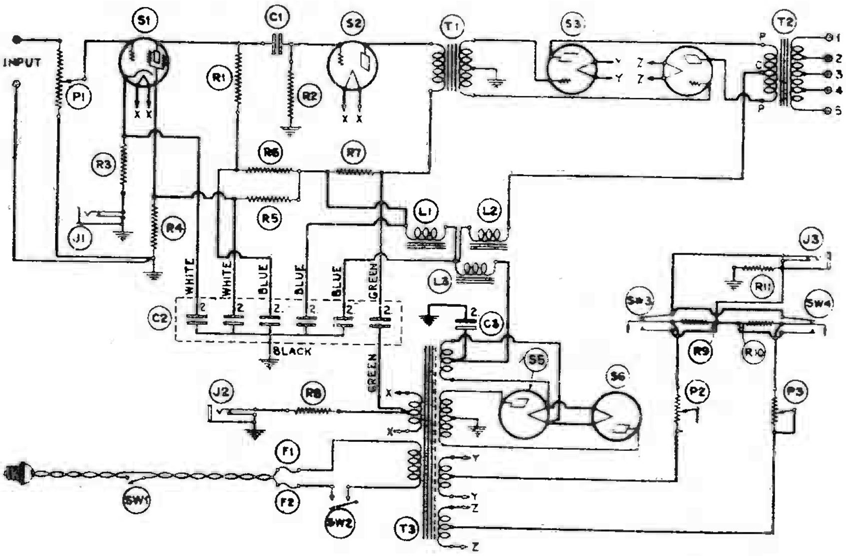
S1 – '24
S2 – '27
S3 – '47
S4 – '47
S5 – '80

SW – ON-OFF SWITCH

T1 – 10176 INPUT TRANS.
T2 – 10143 OUTPUT TRANS.
T3 – 360-U POWER TRANS.

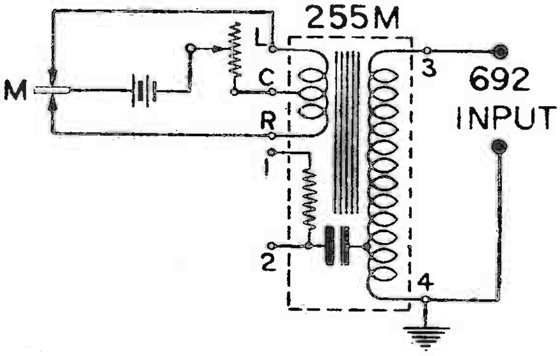
SM 684 AMPLIFIER

SILVER-MARSHALL INC.



Schematic diagram of the 692.

692



Showing use of 255 series input transformers. For radio input connect (1) to B+ 90-135 of tuner, (2) to plate of det. or one side pickup. The 255, 255P, 255R and 256 are similarly connected neglecting microphone winding. Where switching arrangement for pickup, radio and microphone is wanted, see schematic of 690 amplifier input.

REPLACEMENT PARTS LIST

C1 No. 7047—Condenser
C2 No. 7202—Condenser Bank
C3 No. 7201—Condenser
F1, F2 No. 3501—3 Amp. Fuses
J1, J2, J3 No. 3731—2A Jacks
L1 No. 338U—Choke
L2 No. 339U—Choke
L3 No. 10065—Choke
P1 No. 4491—Potentiometer
P2, P3 No. 4490—Potentiometer
R1 No. 4772—Resistor
R2 No. 4700—Resistor
R3 No. 4730—Resistor
R4 No. 4771—Resistor
R5 No. 4685—Resistor
R6 No. 4698—Resistor
R7 No. 4726—Resistor
R8 No. 4689—Resistor
R9, R10 No. 4723—Resistor
R11 No. 4776—Resistor
SW1 No. 3389—Switch Assembly
SW2 No. 5195—Momentary Contact Switch
SW3, SW4 No. 7100—Push Button Contacts
T1 No. 10075B—Transformer
T2 No. 234—Transformer
T3 No. 10081—Transformer
1 Input plug
1 Output plug

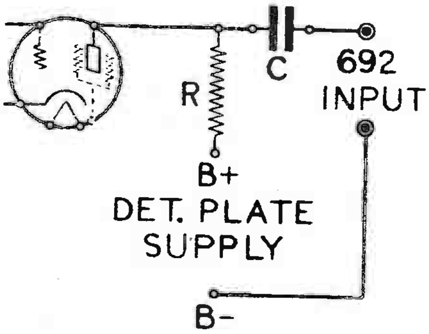
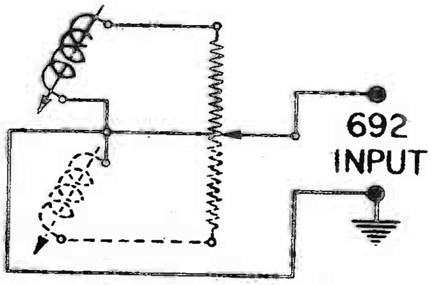


Diagram showing circuit for resistance coupling radio tuner to 692 amplifier where tuner is placed close to amplifier. Where tuner is to be operated at some distance from amplifier see Figure 6. Resistance R should be about 100,000 ohms (.1meg-ohm) and C about .01 mfd. Either a '27 or '24 detector may be used, though the former is preferable.

Showing use of one or two pickups with 692. Where two pickups are used and a smooth change-over is wanted ("fader effect") use center tapped (preferably double tapered) potentiometer and connect slider and center tap to 692 input, as shown at right. The resistance per side depends on pickup, but 25,000 ohms is generally used for high impedance pickups and about 3000-5000 ohms for 500 ohm pickup.



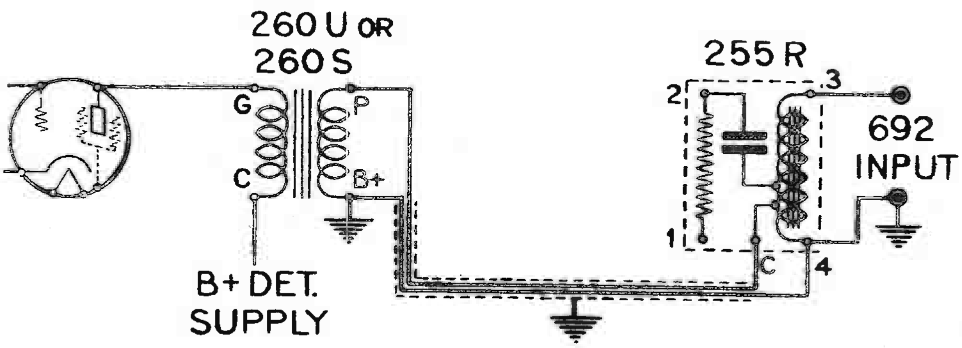


Diagram showing coupling of radio input to 692 where radio is to be operated at some distance from amplifier. The 260U or S transformer, connected "step down", couples tube to a line giving fairly low impedance for running to "distant" amplifier. 255R couples this line to 692 as shown. If switching arrangement is desired for radio and record pickup, the switch should be connected between 255R and amplifier input so that pickup is coupled direct. The line between 260U and 255R should be about No. 18 wire with heavy insulation and shielded.

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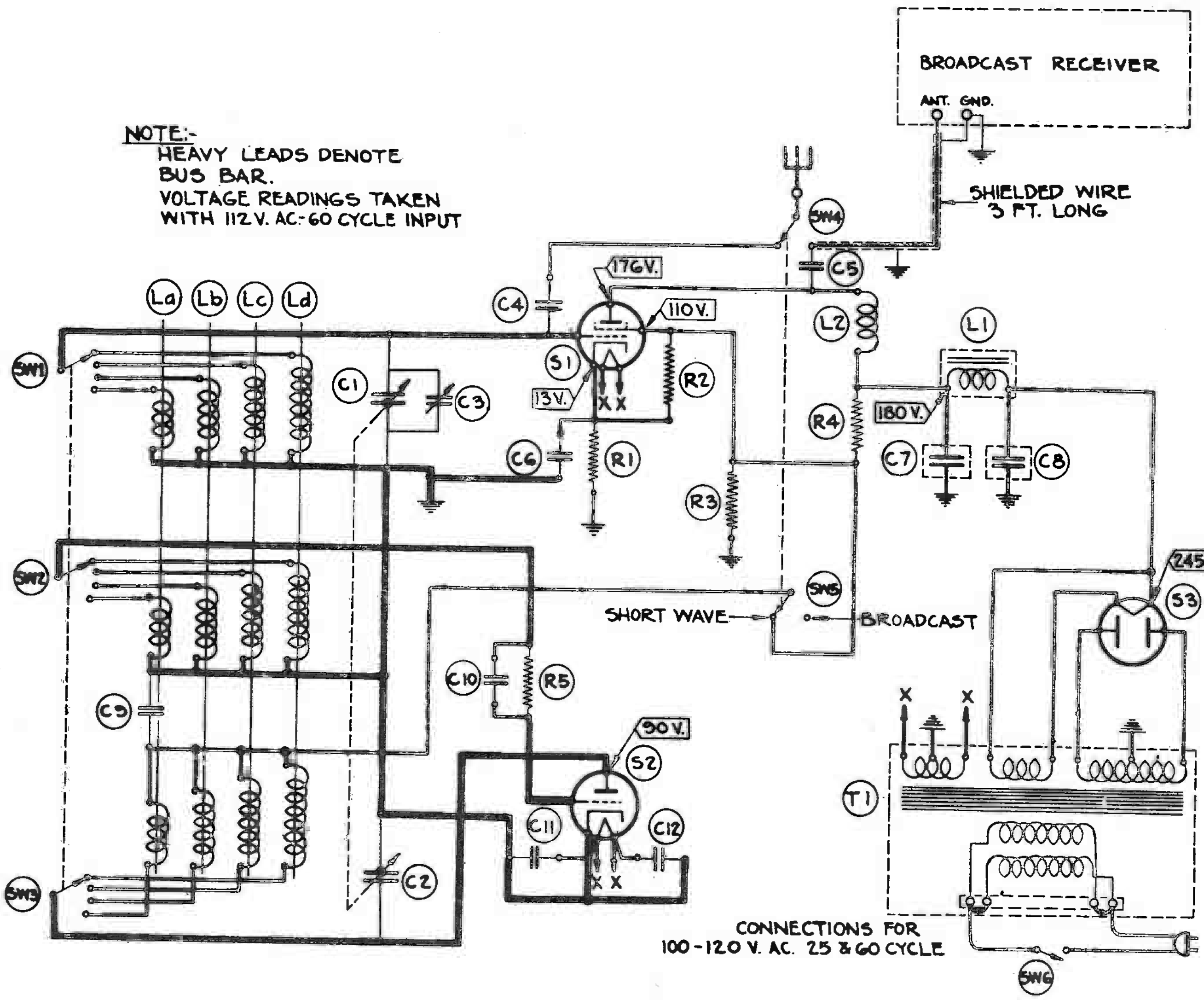
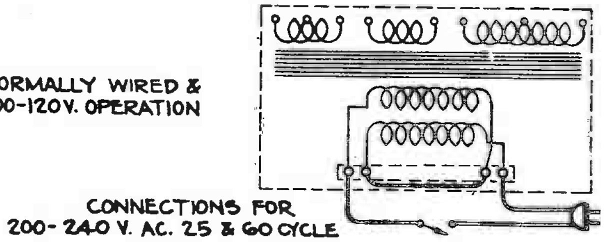




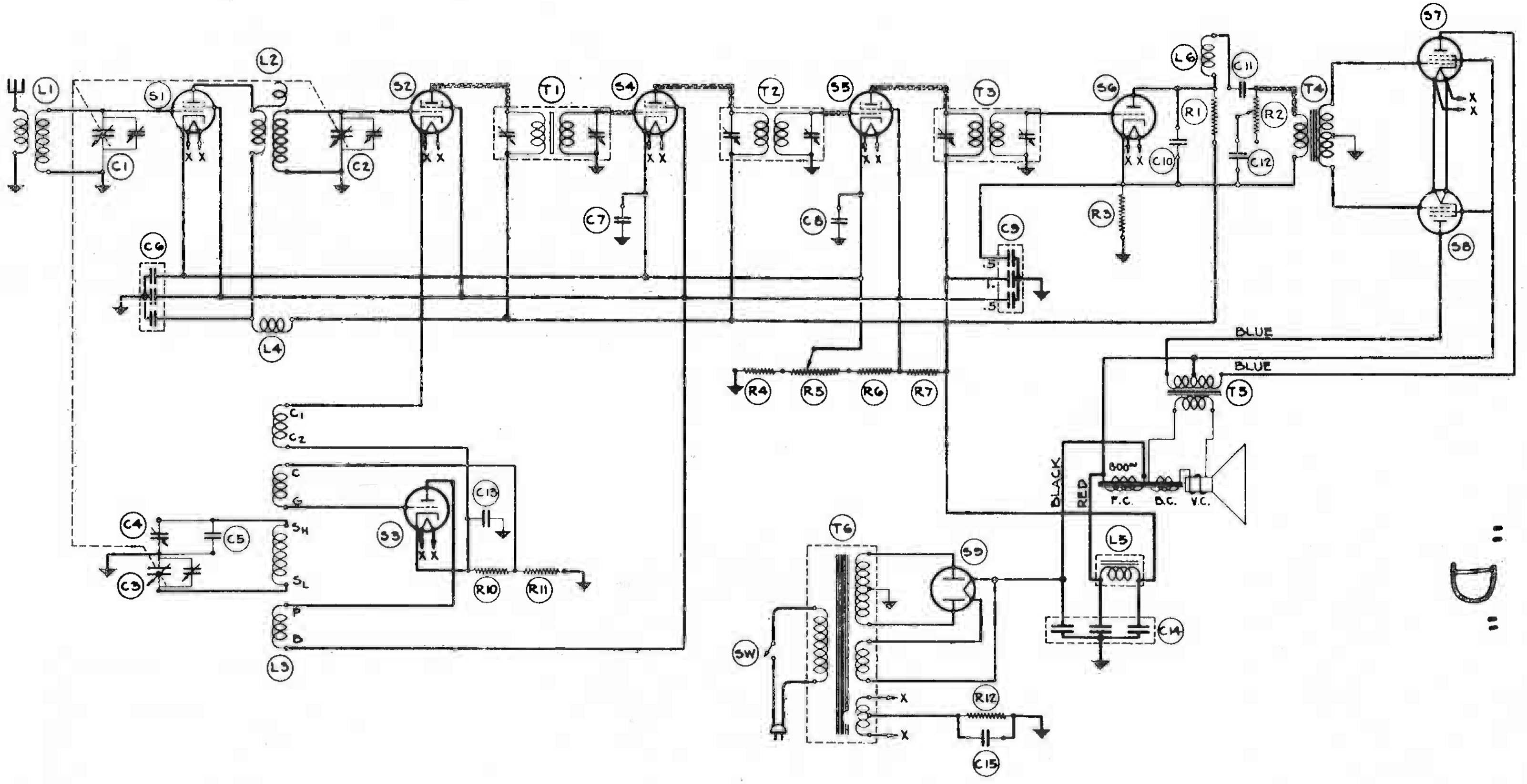
739 Parts List

	Quantity	Description
	1	S-M 739 Chassis & Shield Assembly...
C1, C2	1	S-M 318 Two-gang midget condenser...
C4	1	S-M 3335 Compensating condenser.....
La to Ld	1	S-M 133 Short wave coil assembly....
	1	S-M 13454 Escutcheon................
	1	S-M 13449 wave length name plate....
	1	S-M 13450 switch name plate.........
SW4, SW5	1	S-M SW-Broadcast switch.............
C3	1	S-M 345 Condenser...................
	1	S-M 819 Knob........................
	2	S-M 820 " @ .30.....................
	1	S-M 818 Hookup wire.................
C6,C11,C12	3	Polymet .006 condenser @ .60........
C5,C10	2	Polymet .0001 " @ .30........
C9	1	Sprague .1 mfd. condenser...........
R5	1	Durham 10,000 ohm resistor..........
R2	1	Durham 60,000 ohm resistor..........
R1	1	Durham 6500 ohm resistor............
R3	1	Durham 6000 ohm resistor 2 watt.....
R4	1	Durham 3500 ohm resistor, 2 watt....
	1	Antenna binding post................
SW6	1	5174 H & H on-off switch............
	1	10' cord & plug.....................
	1	Set of hardware.....................

739
S.W. ADAPTER

SILVER-MARSHALL INC.

"D"



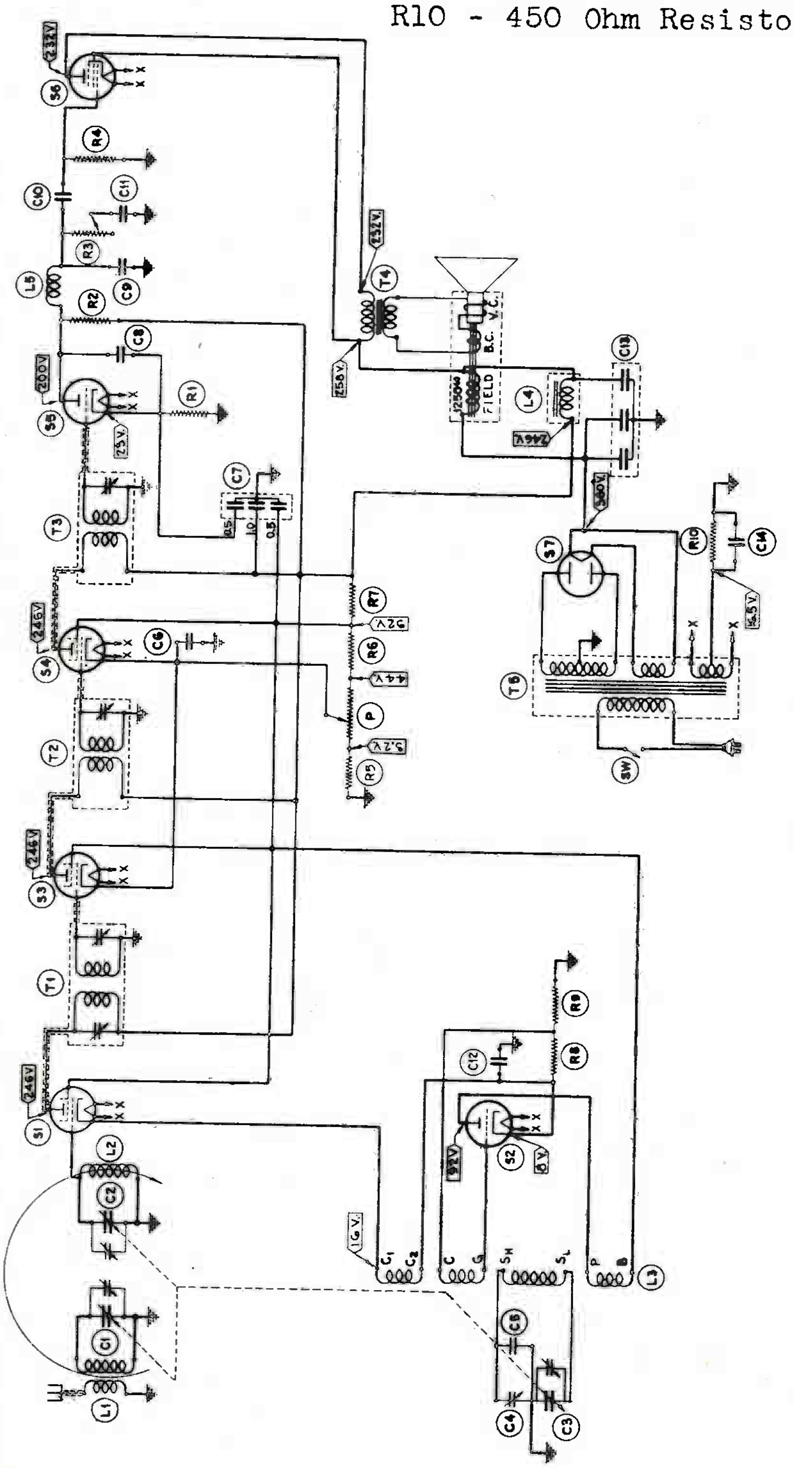
C1-C2-C3	-	365 Mmfd. Max.
C4	-	Variable
C5	-	500 Mmfd. ± 10% Mica
C6	-	Triple .1 Mfd. Cond.
C7	-	.1 Mfd.
C8	-	.1 Mfd.
C9	-	.5, .5, 1. Mfd. Cond.
C10	-	.001 Mfd. (Mica)
C11	-	0.15 Mfd.
C12	-	.025 Mfd.
C13	-	.1 Mfd.
C14	-	Three 4 mfd. units (dry electrolytic)
C15	-	.1 Mfd.

R1	-	30,000 ohms	1 watt
R2	-	1/2 megohm tapered variable resistor	
R3	-	60,000 ohms	1 watt
R4	-	200 ohms	wire wound
R5	-	4500 ohms volume control (tapered)	
R6	-	13,000 ohms	1 watt
R7	-	15,000 ohms	2 watts
R8	-	400 ohms	wire wound
R9	-	10,000 ohms	1 watt
R10	-	100 ohms)	1100 ohm tapped resistor
R11	-	1000 ohms (	
R12	-	220 ohms	2 watt

SILVER-MARSHALL INC.

P - 4500 Ohm Potentiometer

R1 - 60,000 Ohm Resistor - 1 Watt, Carbon
R2 - 30,000 Ohm " - 1 Watt, "
R3 - 1/2 Megohm Variable Resistor
R4 - 250,000 Ohm Resistor - 1 Watt, Carbon
R5 - 100 Ohm Resistor - Wire wound
R6 - 6000 Ohm Resistor - 1 Watt, Carbon
R7 - 10,000 Ohm " - 2 Watt, Carbon
R8 - 100 Ohm Resistor)
R9 - 1700 Ohm Resistor) - Wire wound, tapped unit
R10 - 450 Ohm Resistor - 2 Watt, Carbon



"F"

C1-C2-C3 - Variable cond. 407 Mmfd. Max.
C4 - Osc. Trimmer Cond. 600 Mmfd. max.
C5 - 750 Mmfd. Cond. - Mica
C6 - .1 Mfd. Cond. - 200 Volts
C7 - 1. Mfd. 300 Volts, .5-.5 Mfd. - 200 Volts
C8-C9 - .001 Mfd. Mica Cond.
C10-C11 - .025 Paper Cond. - 200 Volts
C13 - Electrolytic Filter Cond. - Three 4 mfd. units - 450 v
C14 - .1 Mfd. Cond. - 200 Volts

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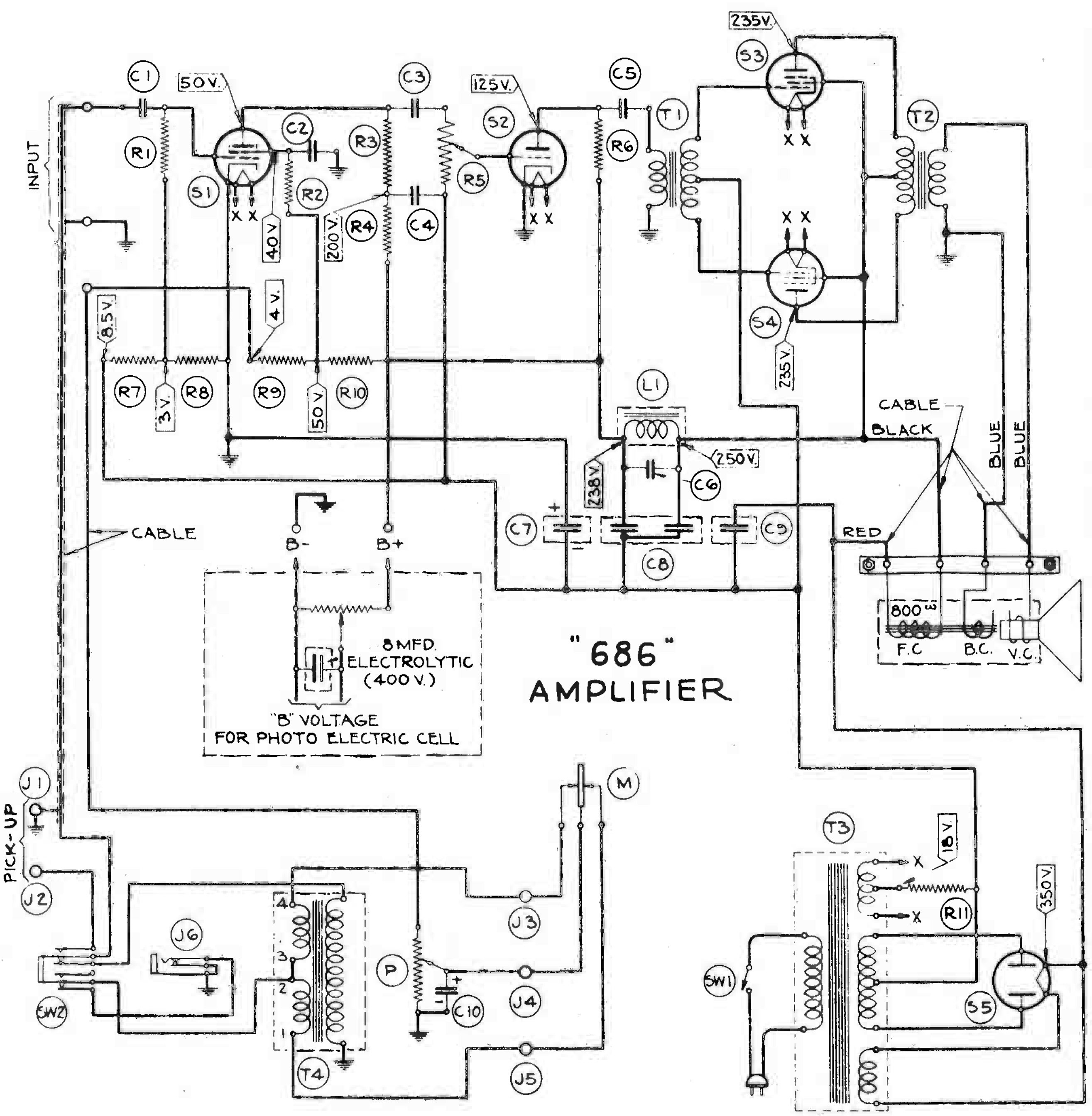


LEGEND

C1 – .05 MFD. SPRAGUE (400 V.)
C2 – 1.0 MFD. (150 V.)
C3 – .01 MFD. (MICA)
C4 – 1.0 MFD. (200 V.)
C5 – 0.25 MFD. SPRAGUE (750 V.)
C6 – 0.1 MFD. SPRAGUE (750 V.)
C7 – 10 MFD. DRY ELECTROLYTIC (25 V)
C8 – 2 MFD. PAPER (400 V.)
2 MFD. PAPER (400 V.)
C9 – 8 MFD. DRY ELECTROLYTIC (450 V.)
C10 – 10 MFD. DRY ELECTROLYTIC (25 V.)

L1 – 10145 CHOKE

J1-J4 – TIP JACK (BLACK) TYPE #420
J2-J3-J5 – TIP JACK (RED) TYPE #420
J6 – MIDGET JACK
M – UNIVERSAL MICROPHONE

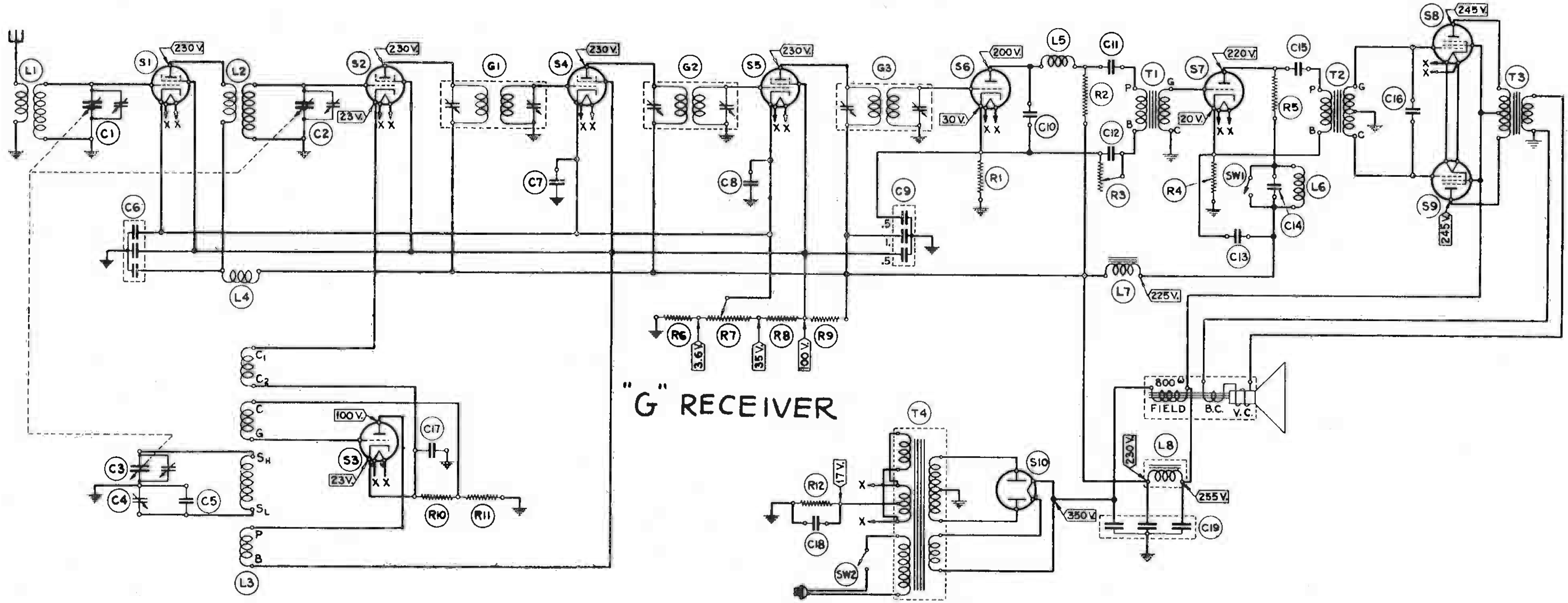
P – 200 OHM POTENTIOMETER

R1 – 2 MEGOHMS 1 WATT
R2 – 60,000 OHMS 1 WATT
R3 – ½ MEGOHM 1 WATT
R4 – 30,000 OHMS 1 WATT
R5 – 1 MEGOHM TAPERED VARIABLE RESISTOR
R6 – 30,000 OHMS 1 WATT
R7 – 250 OHMS } 5 WATT
R8 – 125 OHMS } 5 WATT
R9 – 2300 OHMS } 5 WATT
R10 – 11300 OHMS } 5 WATT
R11 – 220 OHMS 2 WATT

S1 – '24
S2 – '27
S3-S4 – '47
S5 – '80
SW1 – ON-OFF A.C. SWITCH
SW2 – SWITCH (MICROPHONE TO PICK-UP)

T1 – 10176 INPUT TRANS.
T2 – 10143 OUTPUT TRANS.
T3 – 360-U POWER TRANS.
T4 – 10154-M MICROPHONE-PHONO TRANS.

SILVER-MARSHALL INC.



"G" RECEIVER

C1-C2-C3 - 365 Mfd. Condenser
C4 - Variable 250-600 Mmfd.)
C5 - 500 Mmfd. Cond. (Mica))
C6 - Triple .1 Mfd. Cond.
C7-C8 - .1 Mfd. Cond. 200 V Rating
C9 - .5 - .5 - 1. Mfd. Cond.
C10 - .001 Mfd. Cond. Mica
C11 - .02 Mfd. Cond.
C12 - .001 Mfd. Cond. Mica
C13 - 4 Mfd. Cond. - 450V Rating
C14 - .01 Mfd. Cond.
C15 - .06 Mfd. Cond.
C16 - .00075 Mfd. Cond. Mica
C17-C18 - .1 Mfd. Cond. - 200V Rating
C19 - Three 4 Mfd. Units 450V Rating

R1 - 60,000 ohm resistor		1 watt
R2 - 30,000 ohm "		1 watt
R3 - 1 Megohm variable resistor		
R4 - 2600 ohm resistor		1 watt
R5 - 1000 ohm resistor		1 watt
R6 - 300 ohm resistor		wire wound
R7 - 4500 ohm potentiometer with on-off switch		
R8 - 13,500 ohm resistor		1 watt
R9 - 10,000 ohm resistor		2 watt
R10 - 100 ohm resistor)	wire wound	
R11 - 1700 ohm resistor)		
R12 - 210 ohm resistor		2 watt - carbon

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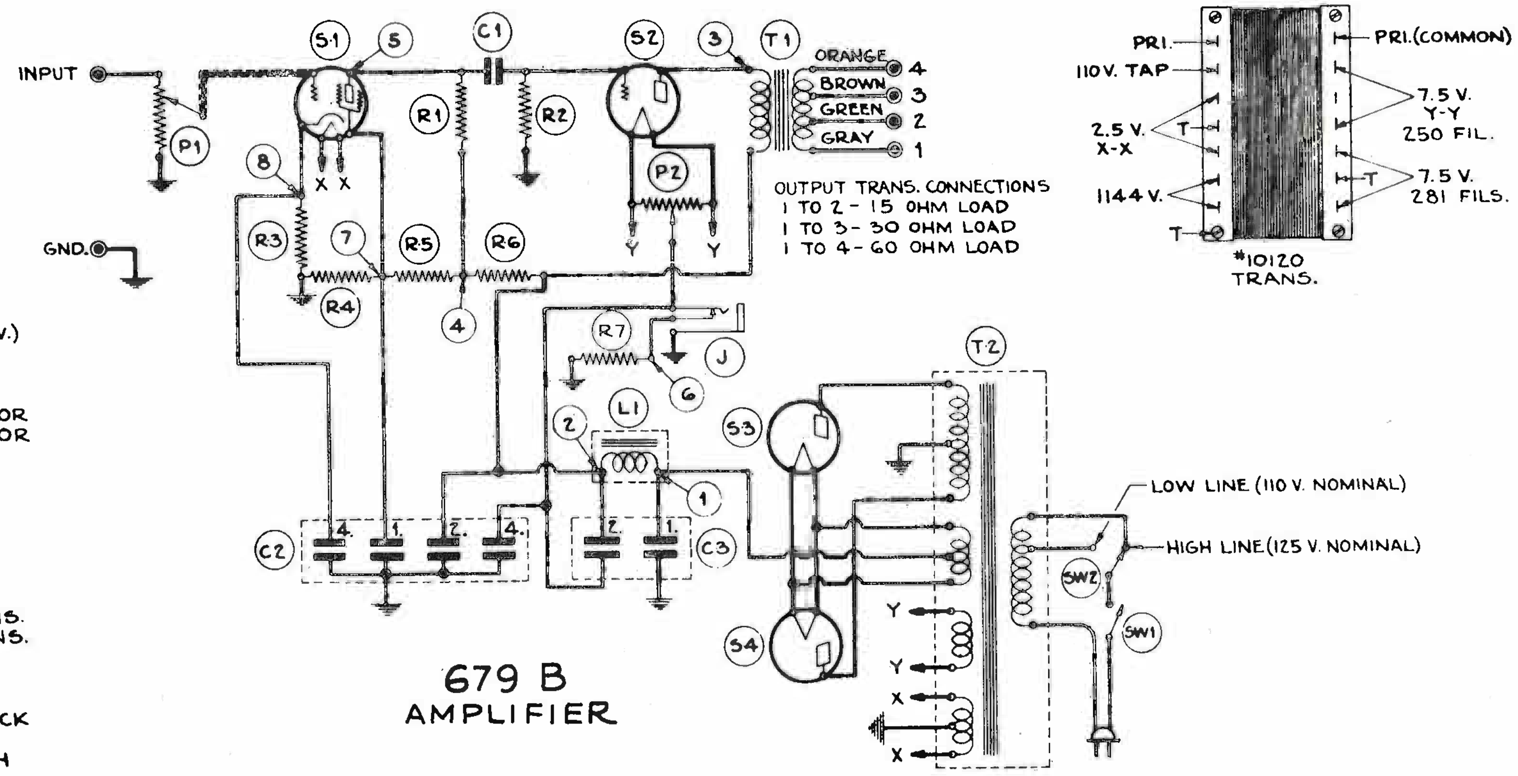


679 B AMPLIFIER

LEGEND

C1 - .025 MFD. COND. (750 V.)
C2 - *7149 COND. BANK
C3 - *7148 COND. BANK

R1 - 1.0 MEGOHM RESISTOR
R2 - 0.5 MEGOHM RESISTOR
R3 - 2600 OHM "
R4 - 10.0 MEGOHM "
R5 - 0.3 MEGOHM "
R6 - 20.0 MEGOHM "
R7 - 1500 OHM "

L1 - *10119 CHOKE

T1 - *10121 OUTPUT TRANS.
T2 - *10120 POWER TRANS.

P1 - 100,000 OHM POT.
P2 - 20 OHM POT.
J. - SPEAKER FIELD JACK
SW1 - ON-OFF SWITCH
SW2 - HIGH-LOW SWITCH
S1 - '24
S2 - '50
S3 - '81
S4 - '81

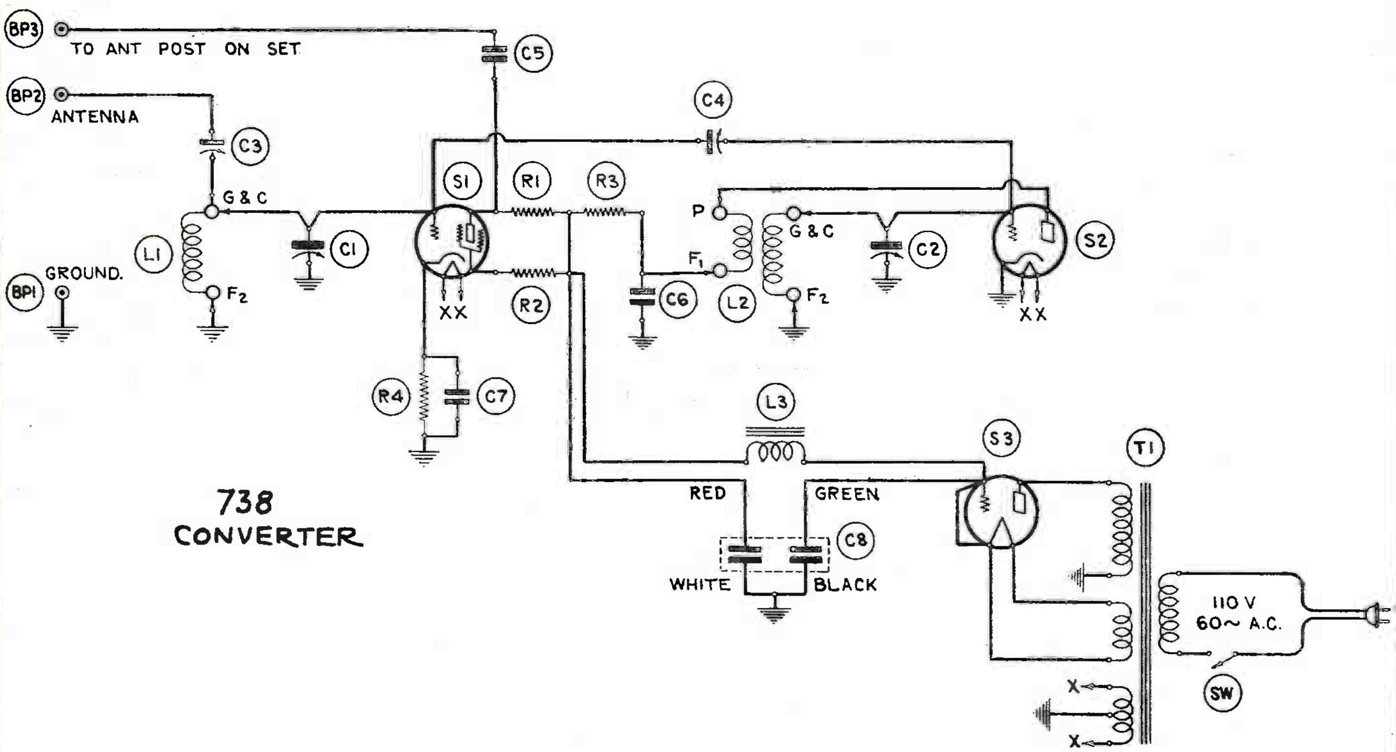
REPRESENTATIVE VOLTAGES

FROM 1	TO GROUND	— 548 V.	TAKEN WITH 600 V. SCALE 1000 OHMS PER VOLT METER
" 2	" "	— 504 V.	
" 3	" "	— 496 V.	
" 4	" "	— 450 V.	
" 5	" "	— 115 V.	
" 6	" "	— 76 V.	
" 7	" "	— 13 V.	
" 8	" "	— 2 V.	

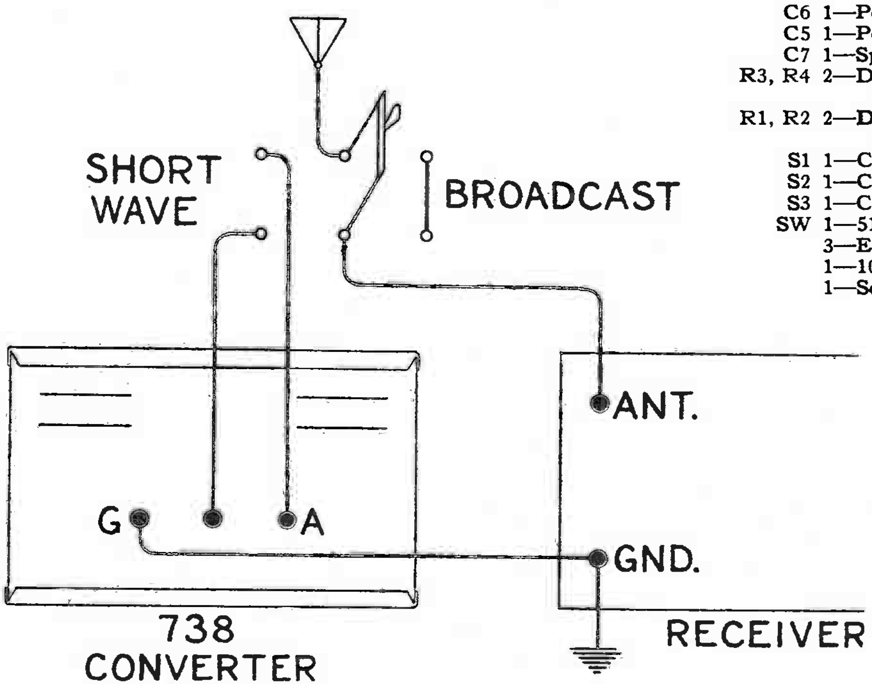
IMPORTANT NOTICE

THIS AMPLIFIER MUST BE EQUIPPED WITH 250 TYPE TUBE SHOWING NOT MORE THAN 5 MICRO AMPERES GAS CURRENT. THIS MAY BE CHECKED BY PLACING A MILLIAMMETER IN THE PLATE CIRCUIT AND ASCERTAINING THAT PLATE CURRENT READING DOES NOT CHANGE MORE THAN 5 M.A. WHEN R2 IS SHORTED

SILVER-MARSHALL INC.



Designation	Qnty.	Description
	1	S-M 738 Chassis & Shield Assembly...
C3, C4	1	S-M 344 Dual Trimmer Condenser....
C2	1	S-M 314 .00015 Variable Condenser....
C1	1	S-M 317 Variable Condenser..........
C8	1	S-M 672-8 mfd. Condenser Bank......
L1, L2	2	S-M 131L Coils @ 1.25..............
	2	S-M 131M Coils @ 1.25..............
	2	S-M 131N Coils @ 1.25..............
	2	S-M 131O Coils @ 1.25..............
L3	1	S-M 338U Choke.....................
T1	1	S-M 285 Power Transformer..........
	2	S-M 512 Sockets @ .60..............
	1	National E Dial....................
C6	1	Polymet .005 Fixed Condenser........
C5	1	Polymet .0001 Condenser............
C7	1	Sprague .1 Mfd. Condenser..........
R3, R4	2	Durham 10,000 Ohm 1-watt Resistors @ .75..........................
R1, R2	2	Durham 300,000 Ohm 1-watt Resistors @ .50..........................
S1	1	C-R 224 Tube Socket................
S2	1	C-R 227 Tube Socket................
S3	1	C-R 226 Tube Socket................
SW	1	5174 H & H Rotary On-off Switch.....
	3	Eby Binding Posts @ .15............
	1	10' Cord and Plug..................
	1	Set of Hardware....................



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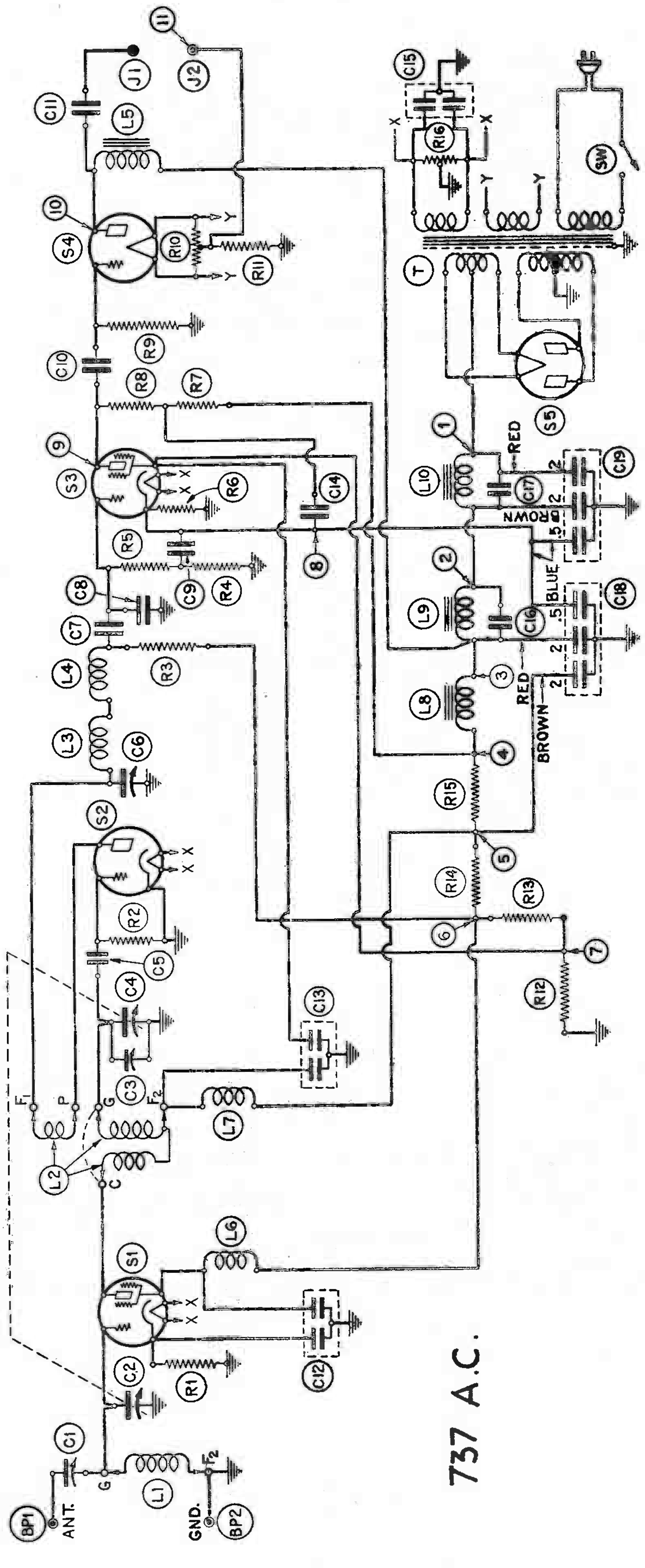


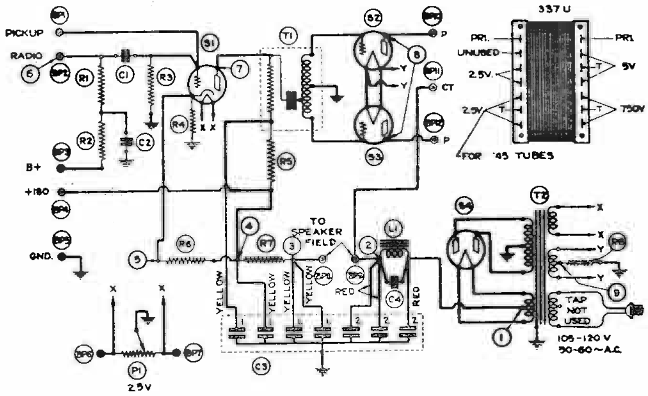
737 A.C.

	1—S-M 738 Chassis, Partitions and Cabinet.
C2, C3	1—S-M 315 Dual .00014 Condenser.....
	2—S-M 638 Shields @ 1.50........
T	1—S-M 336U Transformer....
S1, S2, L1, L2	4—S-M 512 Sockets @ .60.
C1, C4	2—S-M 342B Condensers
C3	1—S-M 343 Condenser...
L5	1—S-M 251S Choke........
L10	1—S-M 333S Single Choke.
L4, L6, L7	3—S-M 277 Chokes @
L3	1—S-M 275 Choke...
L8	1—S-M 338U Choke..
L9	1—S-M 339U Choke...
	2—S-M 816 Large Knobs
	1—S-M 817 Small Knob...
	2—S-M 818 Hookup Wire
	1—National B Vernier Dial.
C18, C19	2—Potter 4636 Condensers @
C12 C13, C15	3—Potter Dual 1/10 condensers
C17	1—Potter 1 Mfd. Condenser.....
C14, C16	2—Potter ¼ Mfd. Condenser Cased
S3	1—C-R 224 Socket...............
S4	1—C-R 245 Socket...............
S5	1—C-R 280 Socket...............
R2	1—Durham 2 Megohm Resistor...
R14	1—Durham 10,000 ohm Resistor...
R3, R8	2—Durham .15 Megohm Resistors
R7	1—Durham 60,000 ohm Resistor...
R4, R5, R9	3—Durham 1 Megohm Resistors @
R1	1—Carter RU400 Resistor.........
R10, R16	2—Carter 40 ohm Center Tap Resistor
C5, C8	2—Polymet .00015 Condensers @
C7, C10	2—Polymet .006 Condensers @
C17	1—Sprague .1 Mfd. Condenser..
C9	1—Sprague ¼ Mfd. Condenser.
SW	1—H & H Toggle Switch #991.
BP1	1—Eby Antenna Binding Post..
BP2	1—Eby Ground Binding Post..
R11	1—Ohmite 1500 ohm Resistor.
R15	1—Ohmite 3500 ohm Resistor.
R6, R12, R13	3—Yaxley 3500 ohm Resistors

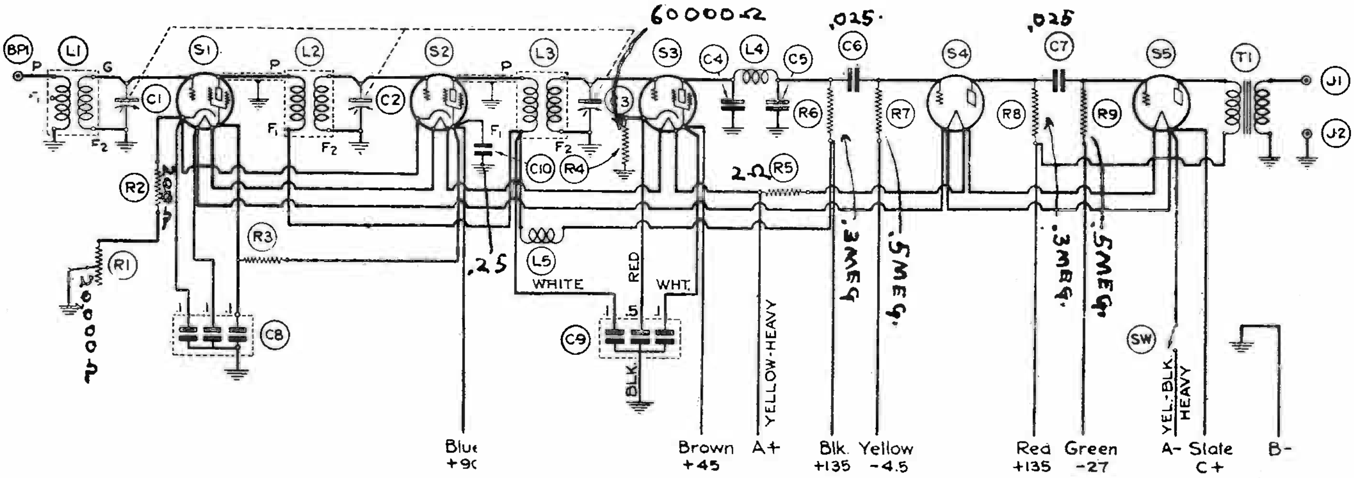
SILVER-MARSHALL INC.

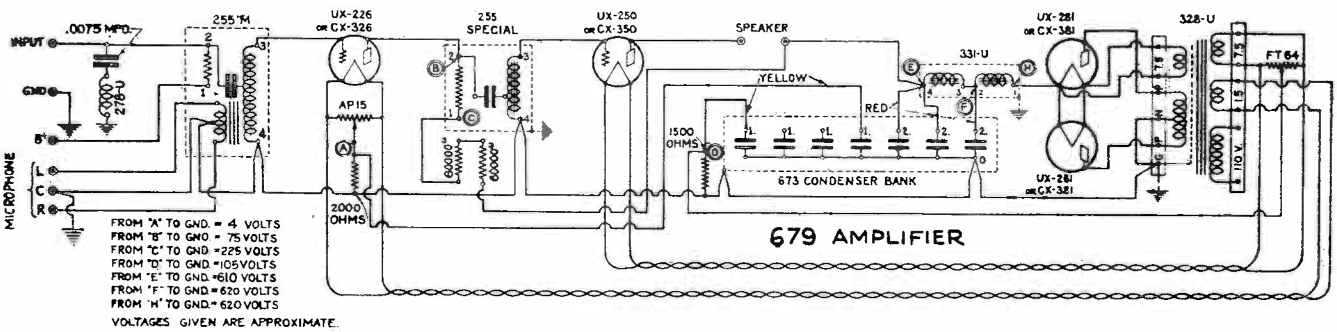
COMPONENT PARTS FOR
677B AMPLIFIER

Designation	
C1	.1 mfd. Sprague Condenser
C2 & C4	.25 " " "
C3	#673 Condenser Bank
R1 & R2	60,000-ohm Durham Resistor
R3	2-megohm Durham Resistor
R4	400-ohm Carter Resistor
R5 & R6	10,000-ohm Durham Resistor
R7 & R8	1500-800-ohmite Resistor
L1	#339 Choke
P1	Carter AP-15 Hum Balance
S1	C-R 227 tube socket
S2 & S3	C-R 245 " "
S4	C-R 280 " "
T1	#257 Audio transformer
T2	#337 Power "
	1 636 tube shield
	1 677 Panel, chassis and case

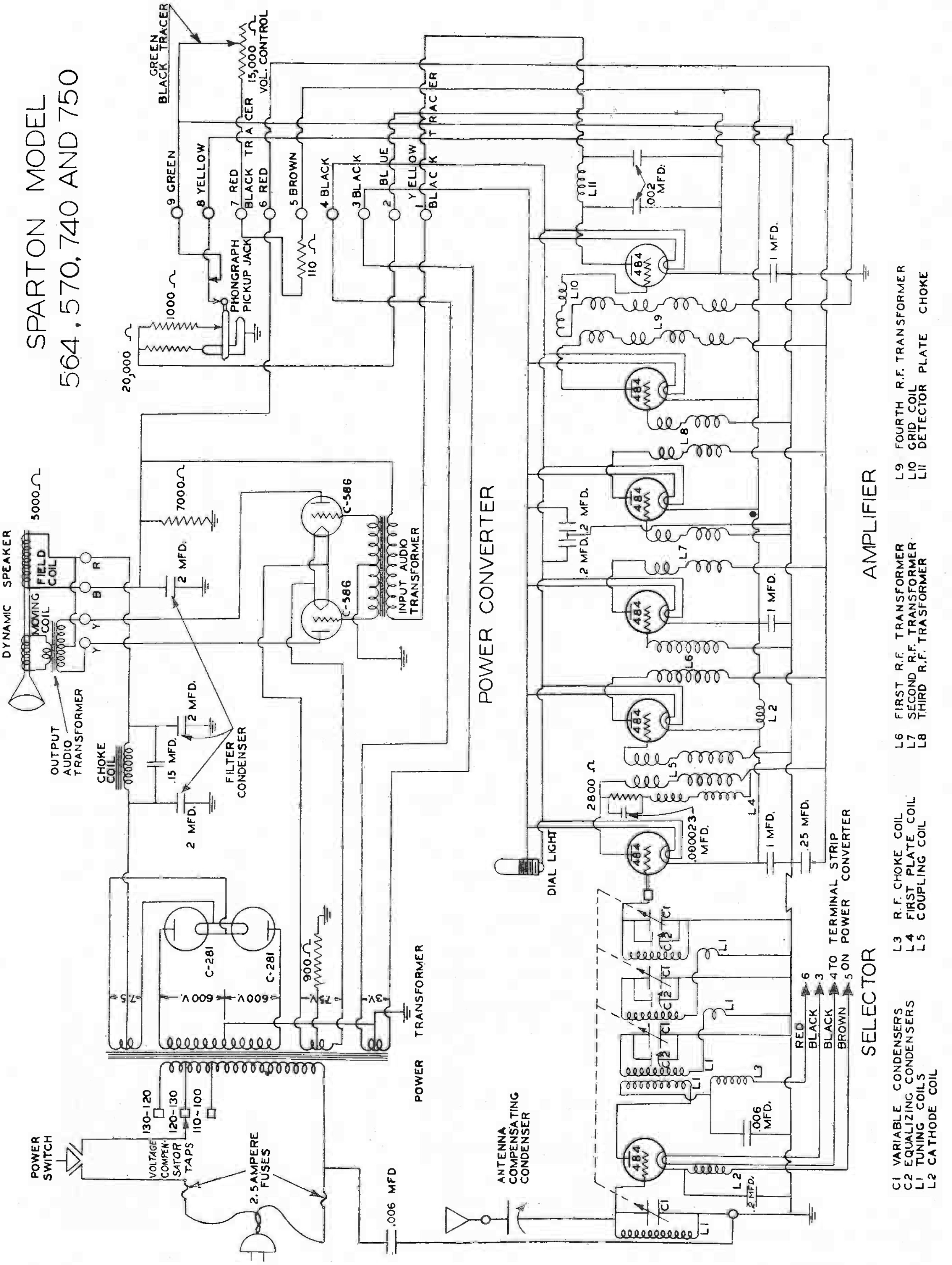


677 B



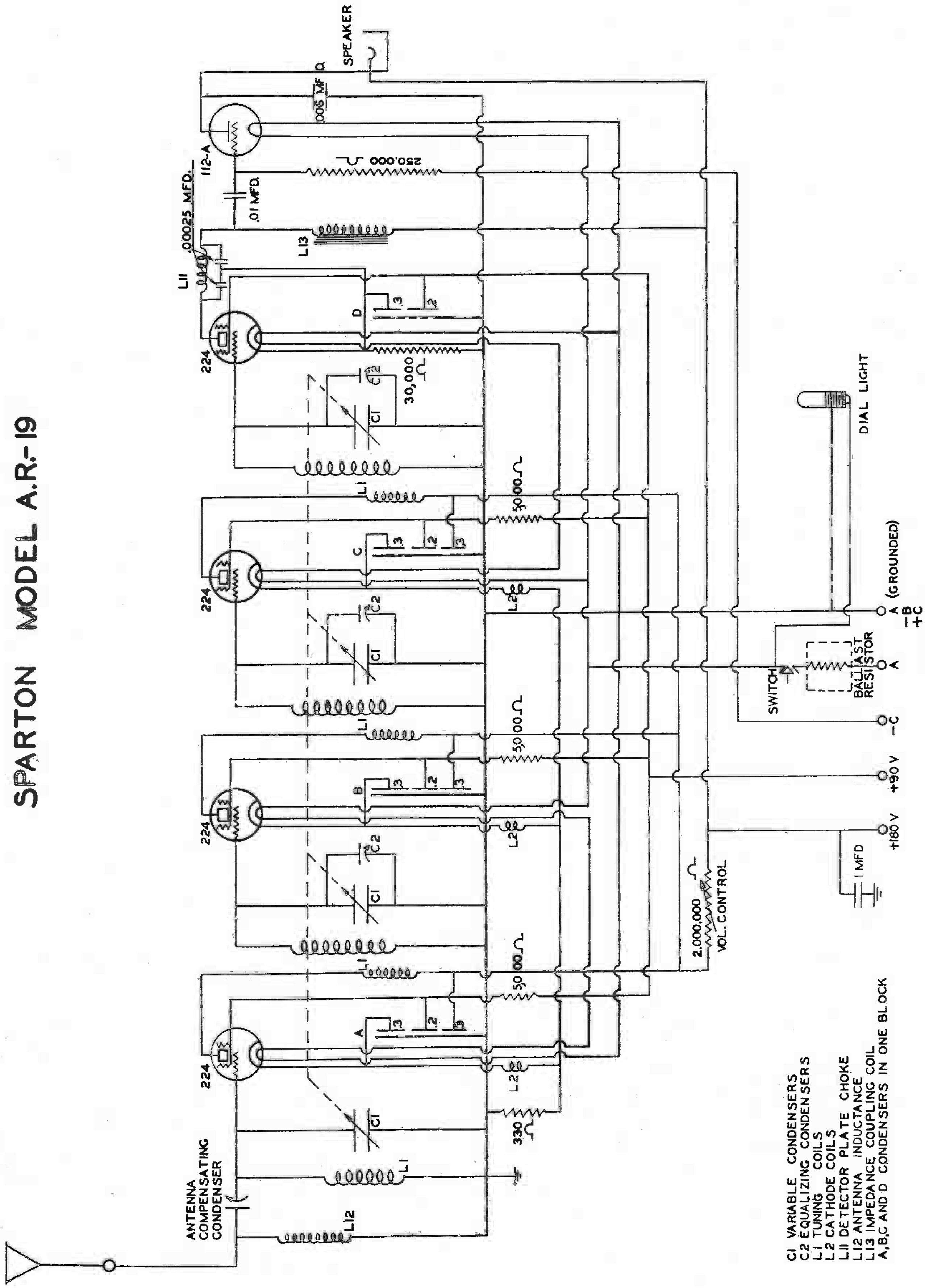


SPARKS-WITHINGTON CO.



SPARKS-WITHINGTON CO.

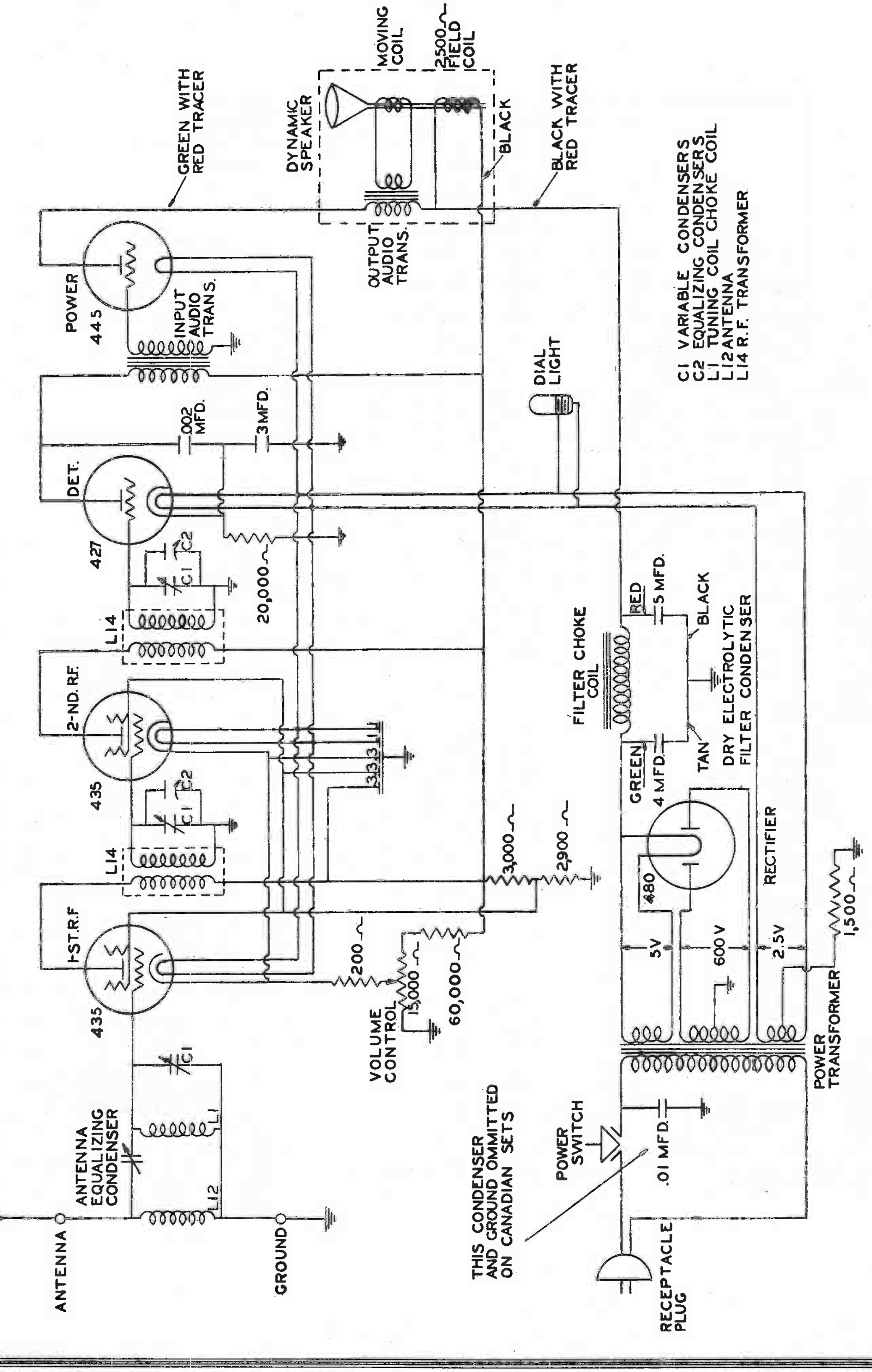
SPARTON MODEL A.R.-19



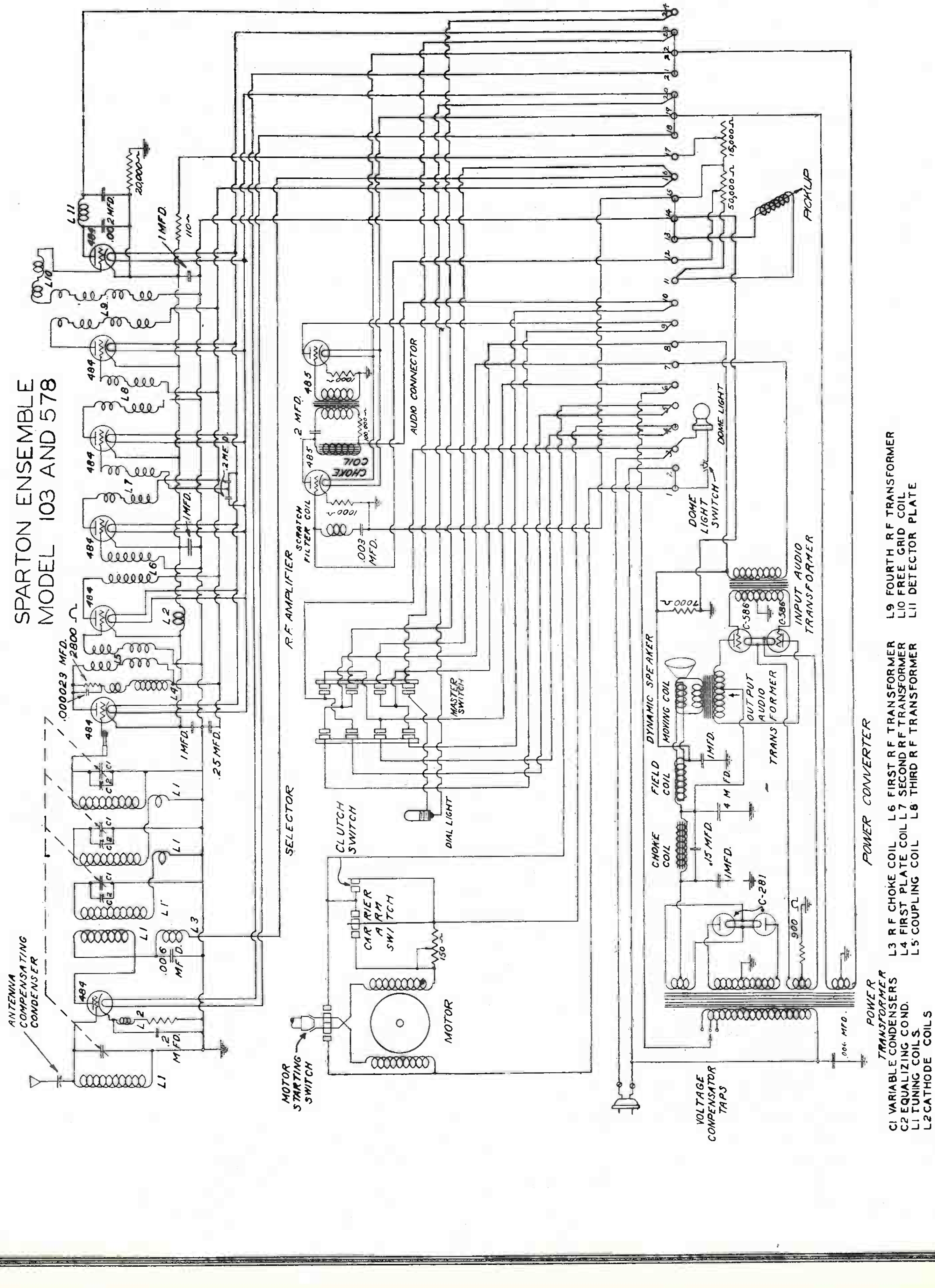
C1 VARIABLE CONDENSERS
C2 EQUALIZING CONDENSERS
L1 TUNING COILS
L2 CATHODE COILS
L11 DETECTOR PLATE CHOKE
L12 ANTENNA INDUCTANCE
L13 IMPEDANCE COUPLING COIL
A,B,C AND D CONDENSERS IN ONE BLOCK

SPARKS-WITHINGTON CO.

SPARTON MODEL 5 AND 9 SCHEMATIC DIAGRAM



SPARKS-WITHINGTON CO.



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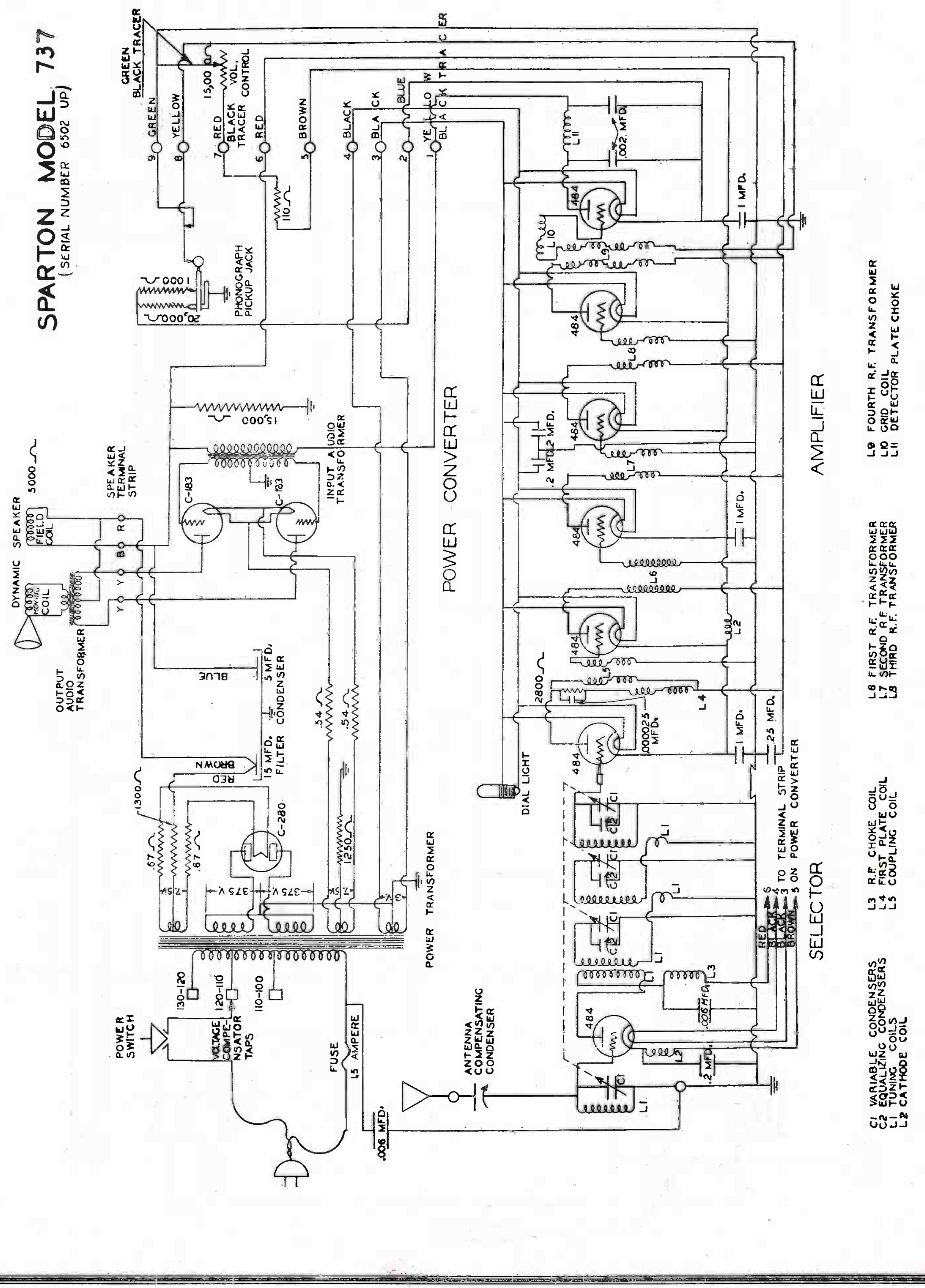
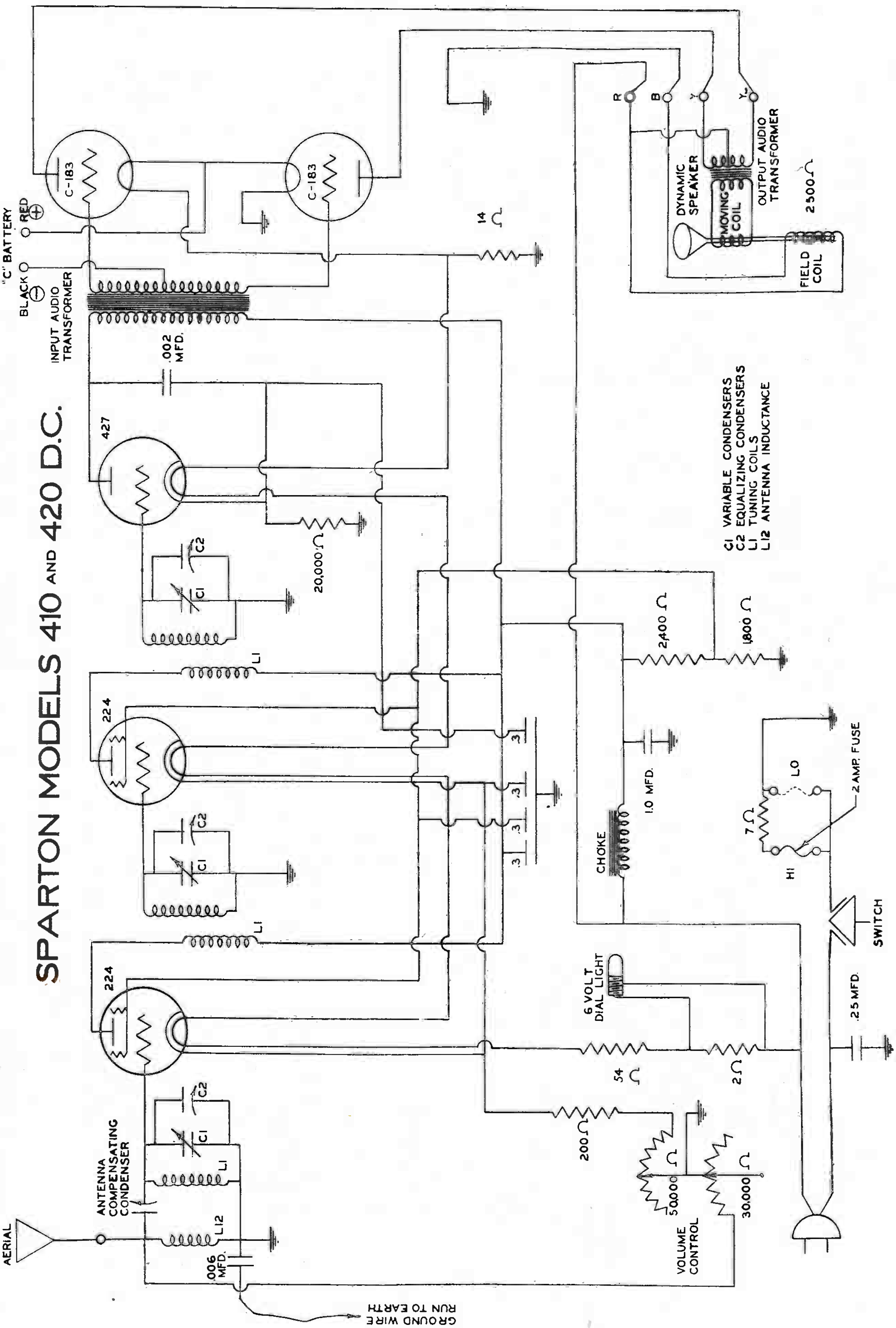


SPARKS-WITHINGTON CO.

SPARTON MODELS 410 AND 420 D.C.



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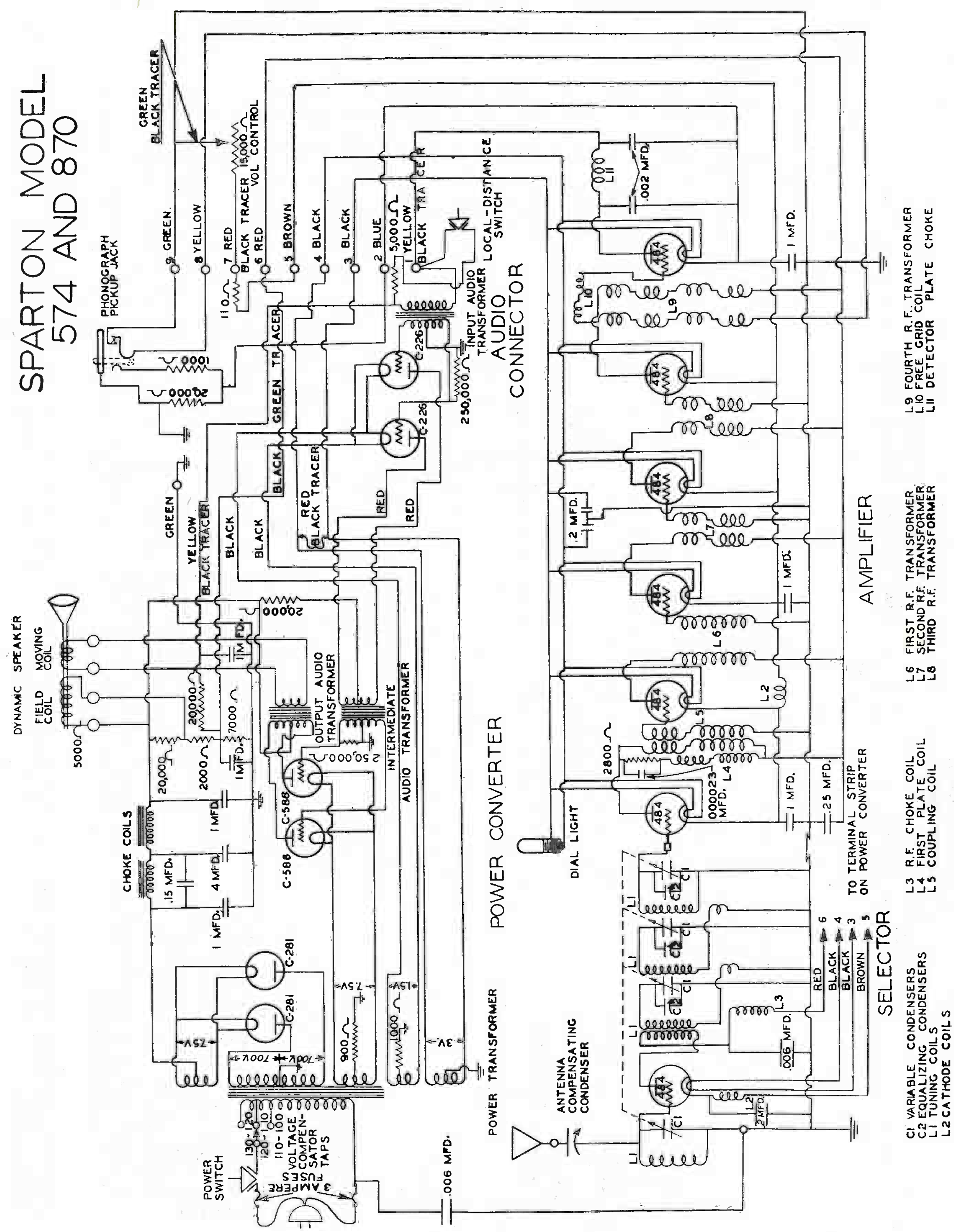

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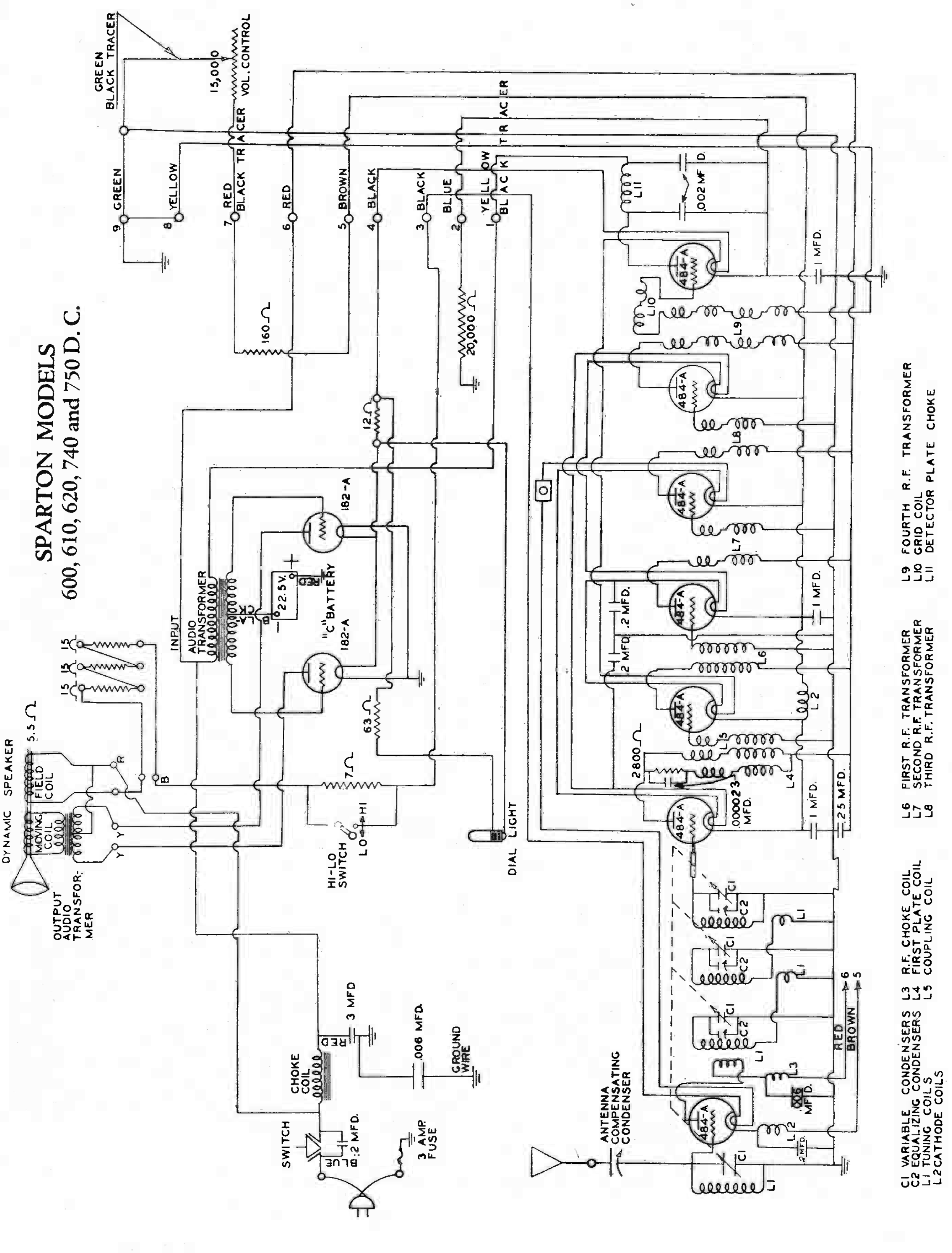
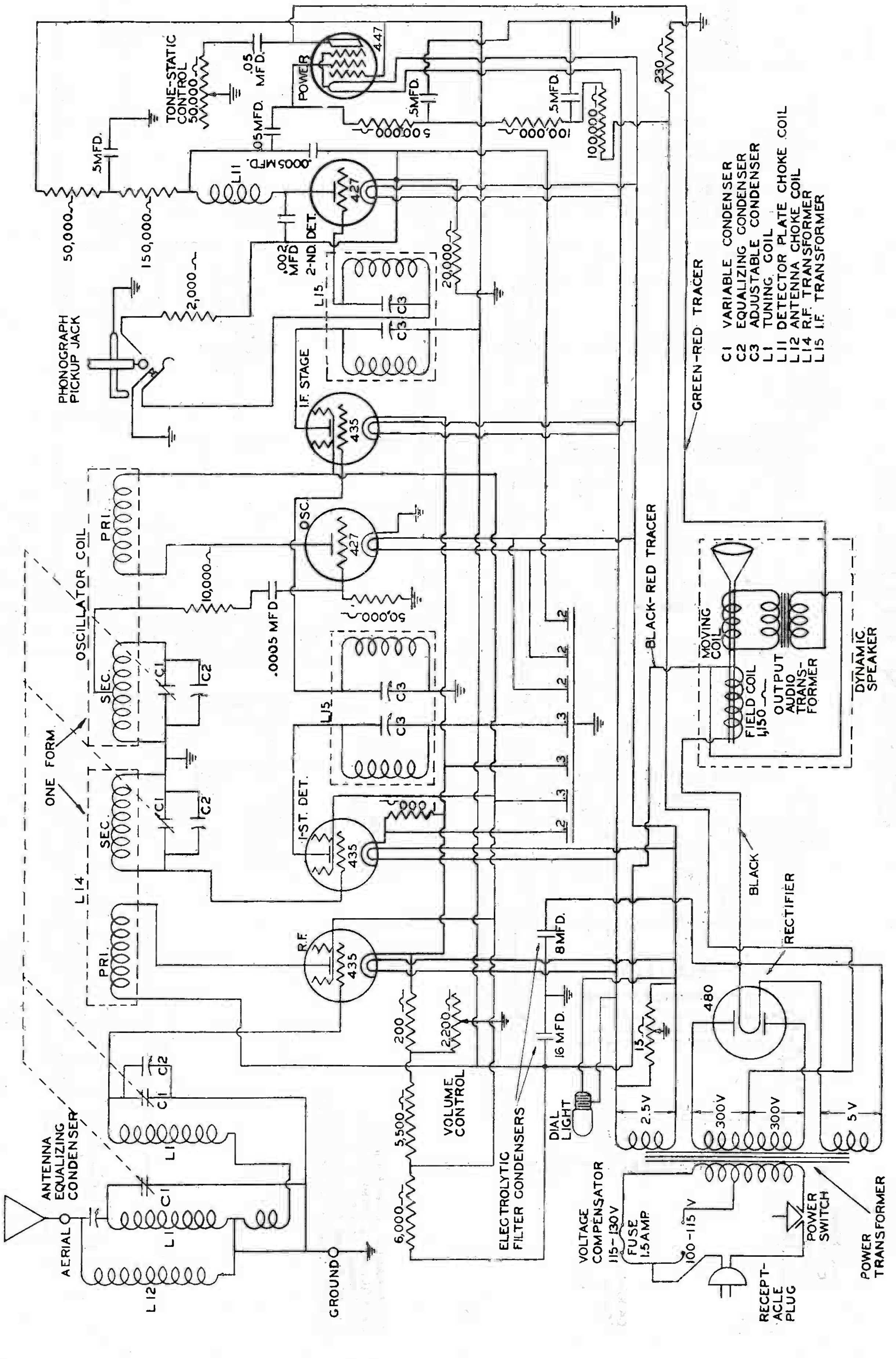


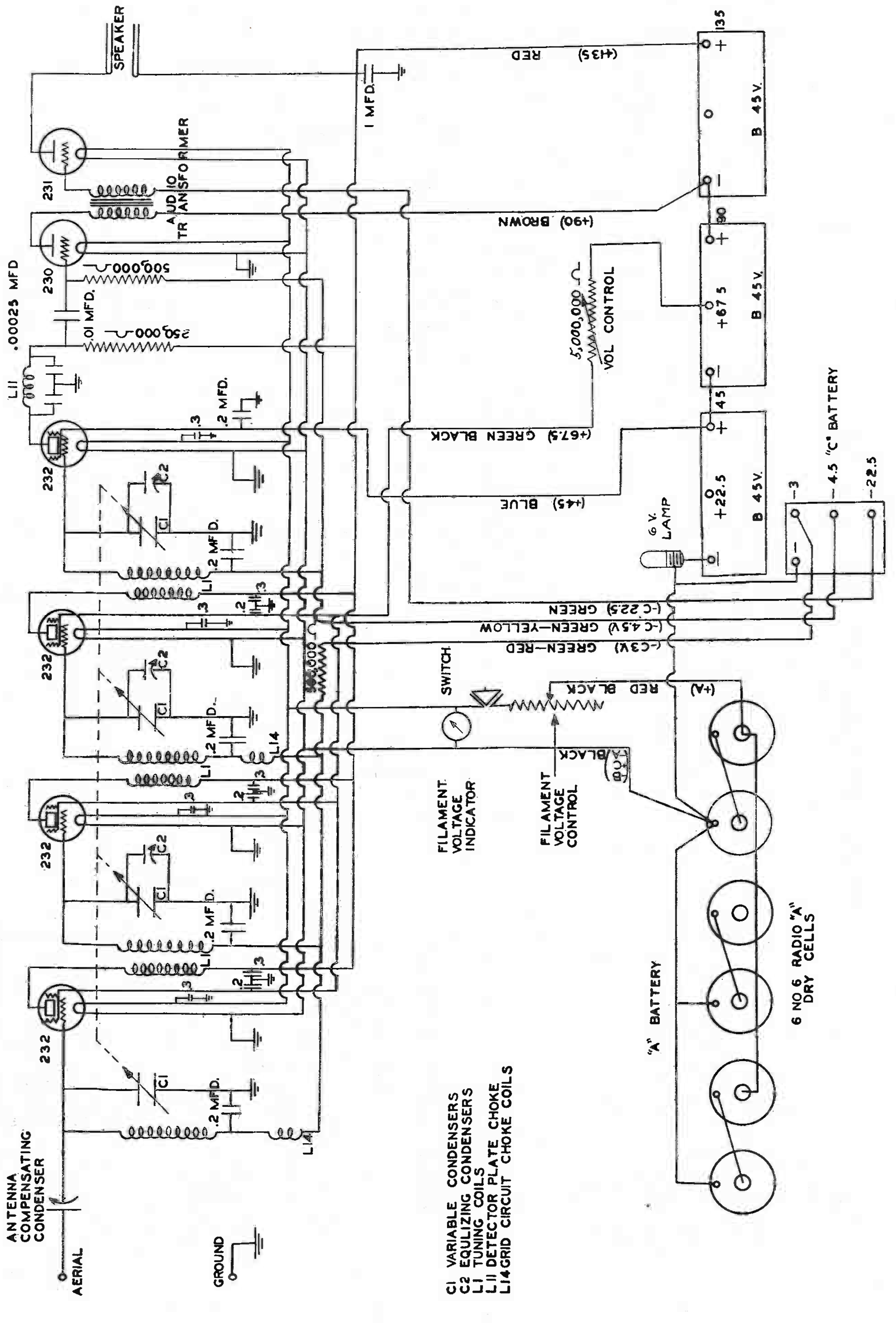
SPARKS-WITHINGTON CO.

Sparton Model 10—Schematic Diagram

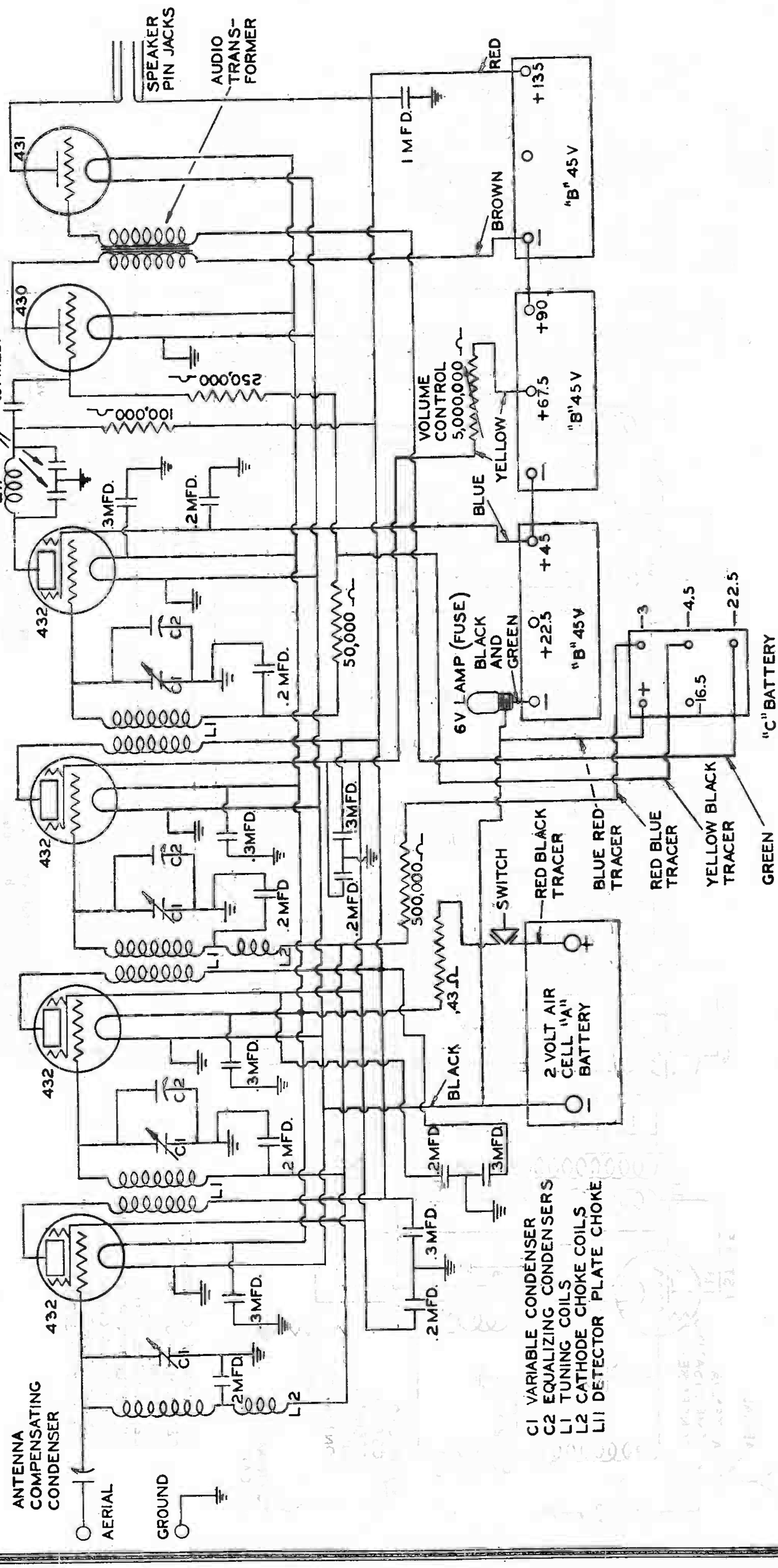


SPARKS-WITHINGTON CO.

SPARTON MODEL 31



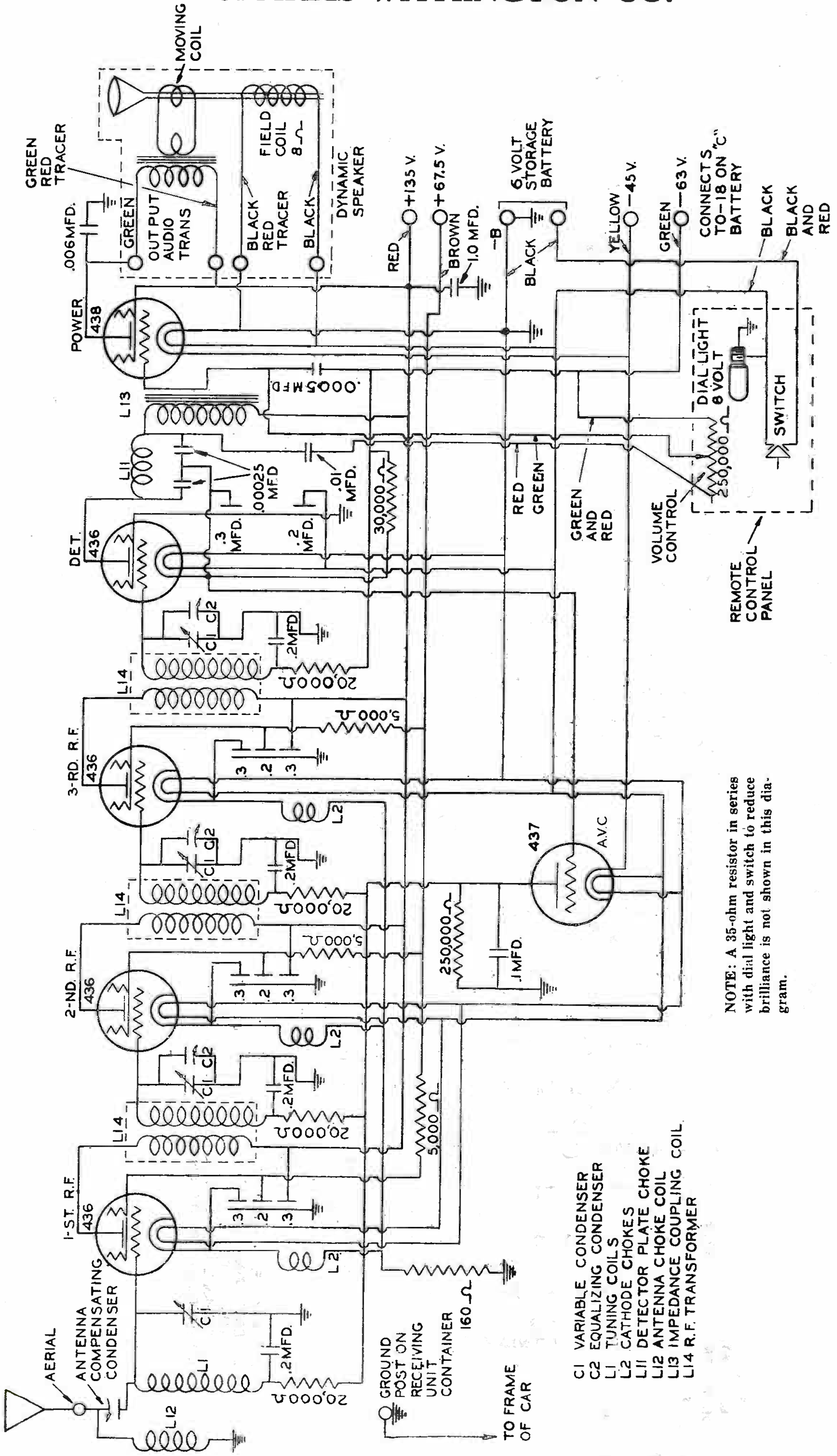
SPARKS-WITHINGTON CO.



Sparton Model 51 and 52 Schematic Diagram

SPARKS-WITHINGTON CO.

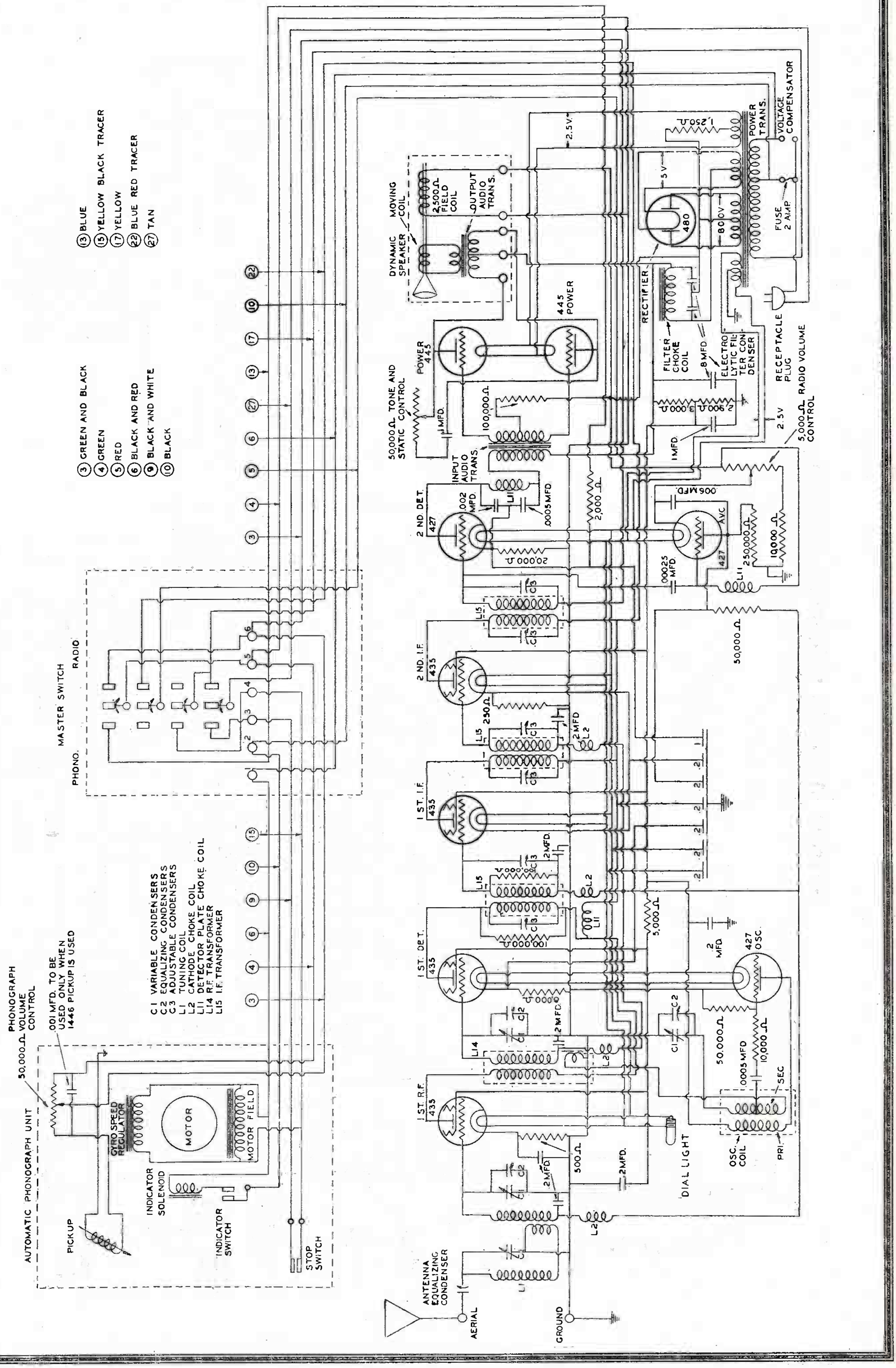
SPARTON MODEL 40 SCHEMATIC DIAGRAM



C1 VARIABLE CONDENSER
C2 EQUALIZING CONDENSER
L1 TUNING COILS
L2 CATHODE CHOKES
L11 DETECTOR PLATE CHOKE
L12 ANTENNA CHOKE COIL
L13 IMPEDANCE COUPLING COIL
L14 R.F. TRANSFORMER

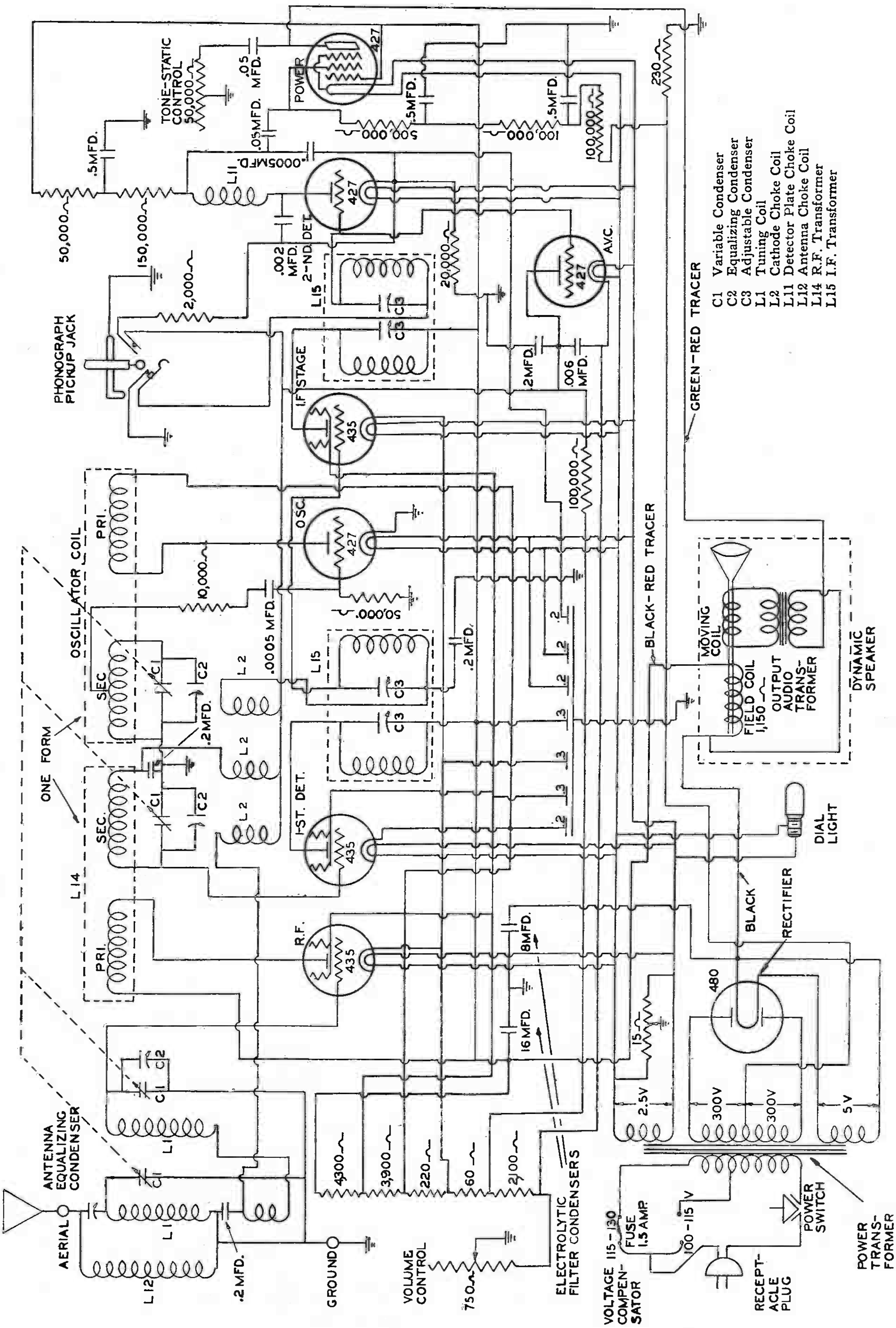
NOTE: A 35-ohm resistor in series with dial light and switch to reduce brilliance is not shown in this diagram.

SPARKS-WITHINGTON CO.



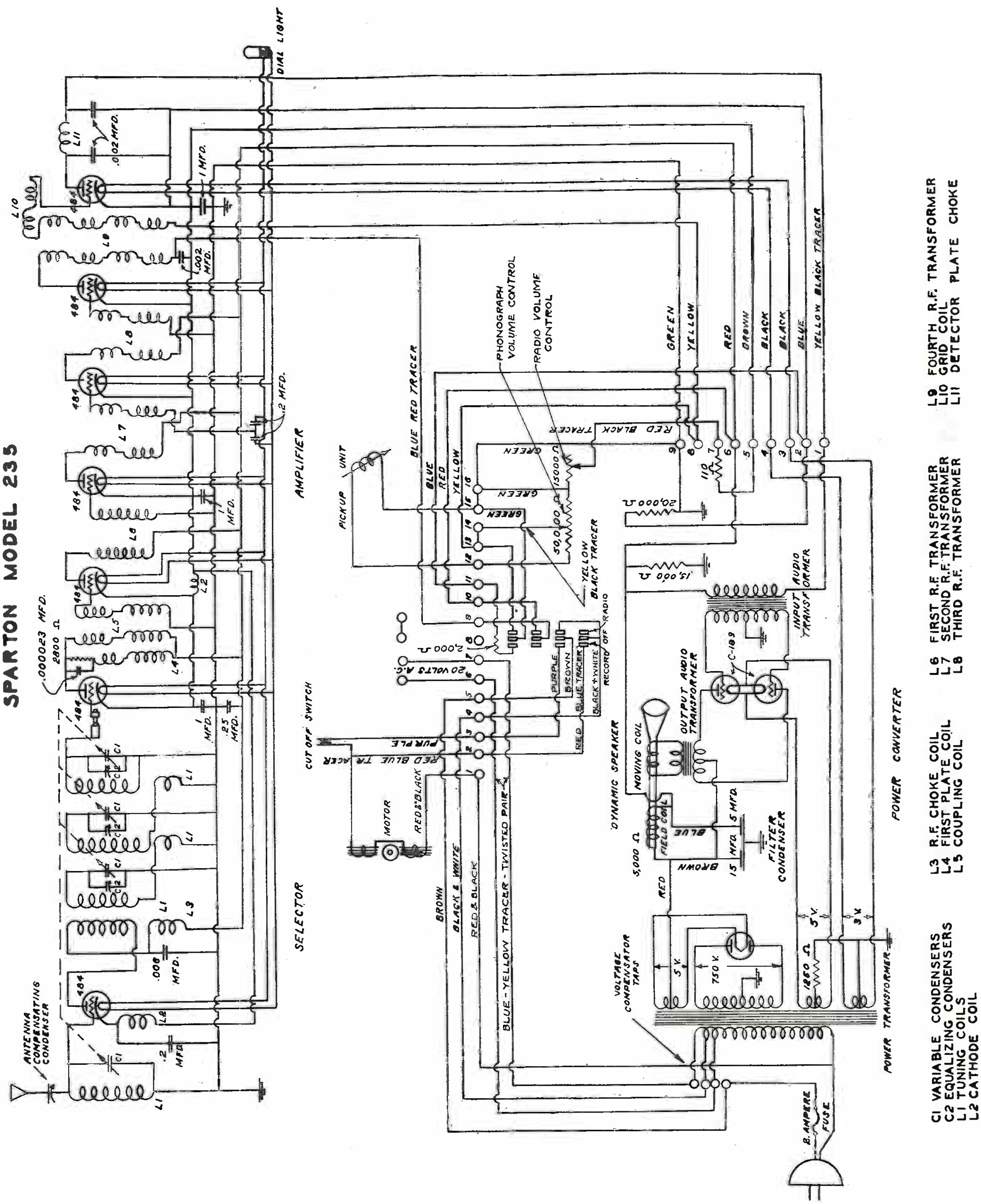
SPARTON MODEL 30 SCHEMATIC DIAGRAM

SPARKS-WITHINGTON CO.



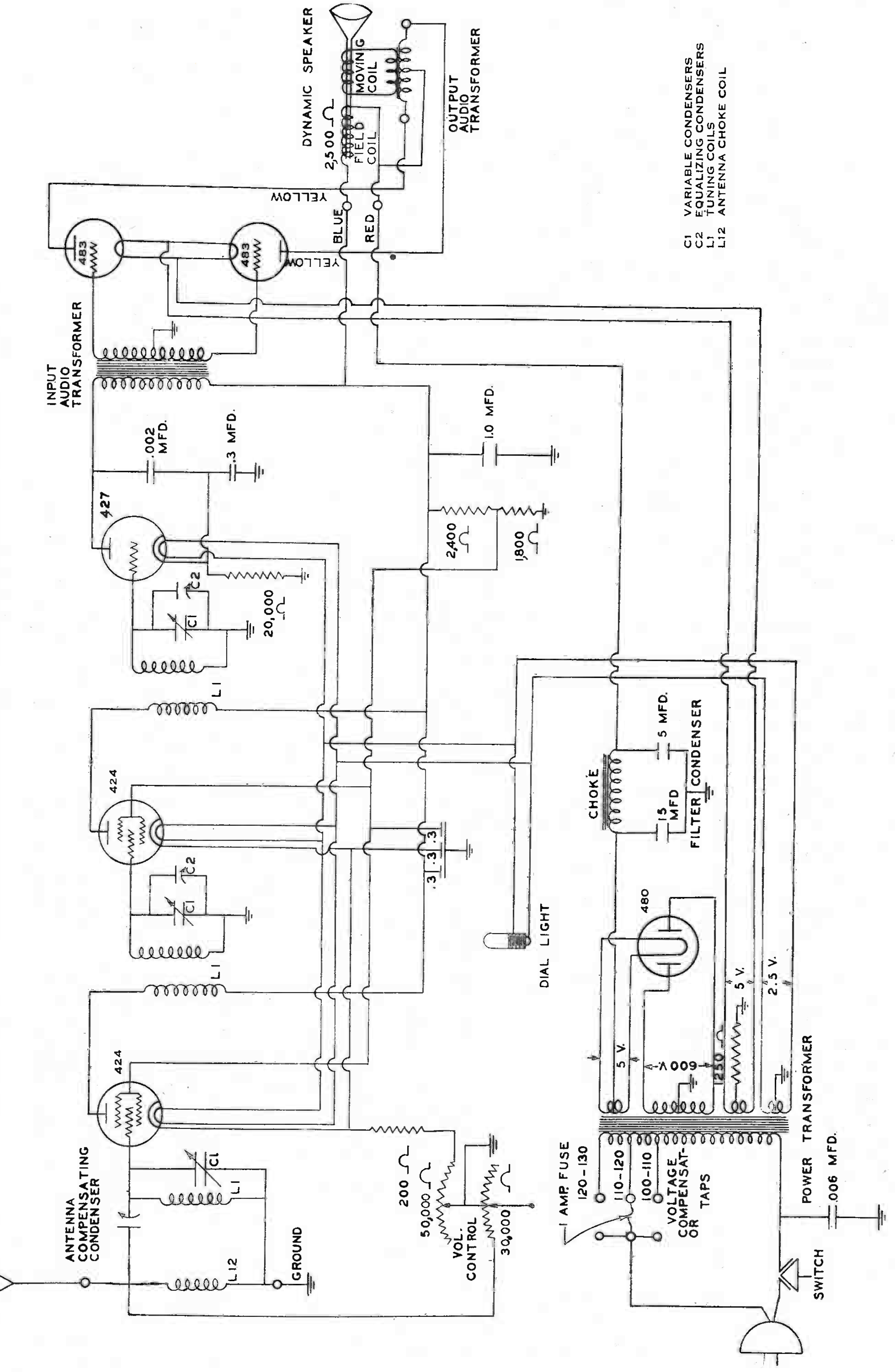
Sparton Model 15 Schematic Diagram

SPARKS-WITHINGTON CO.

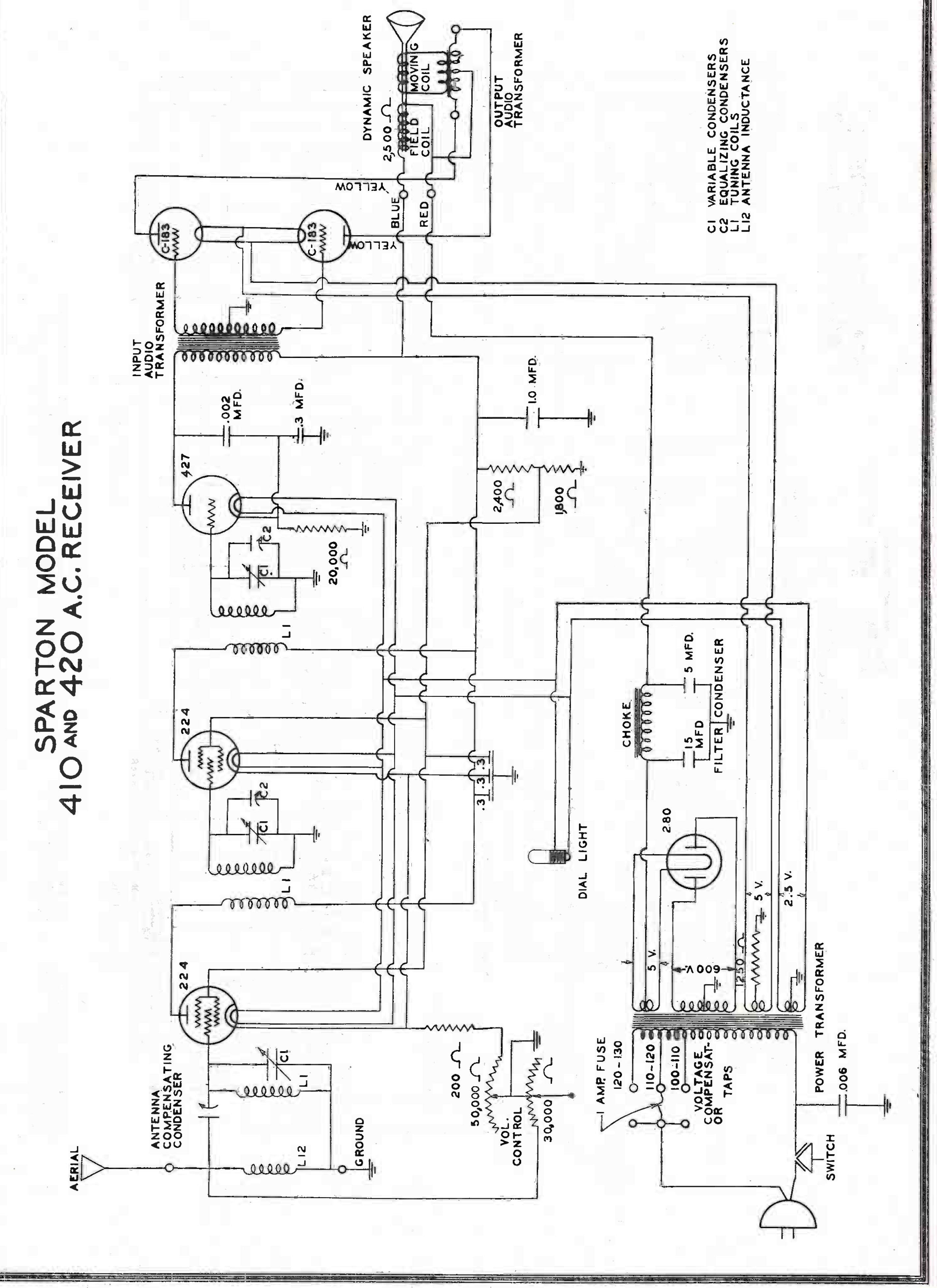


SPARKS-WITHINGTON CO.

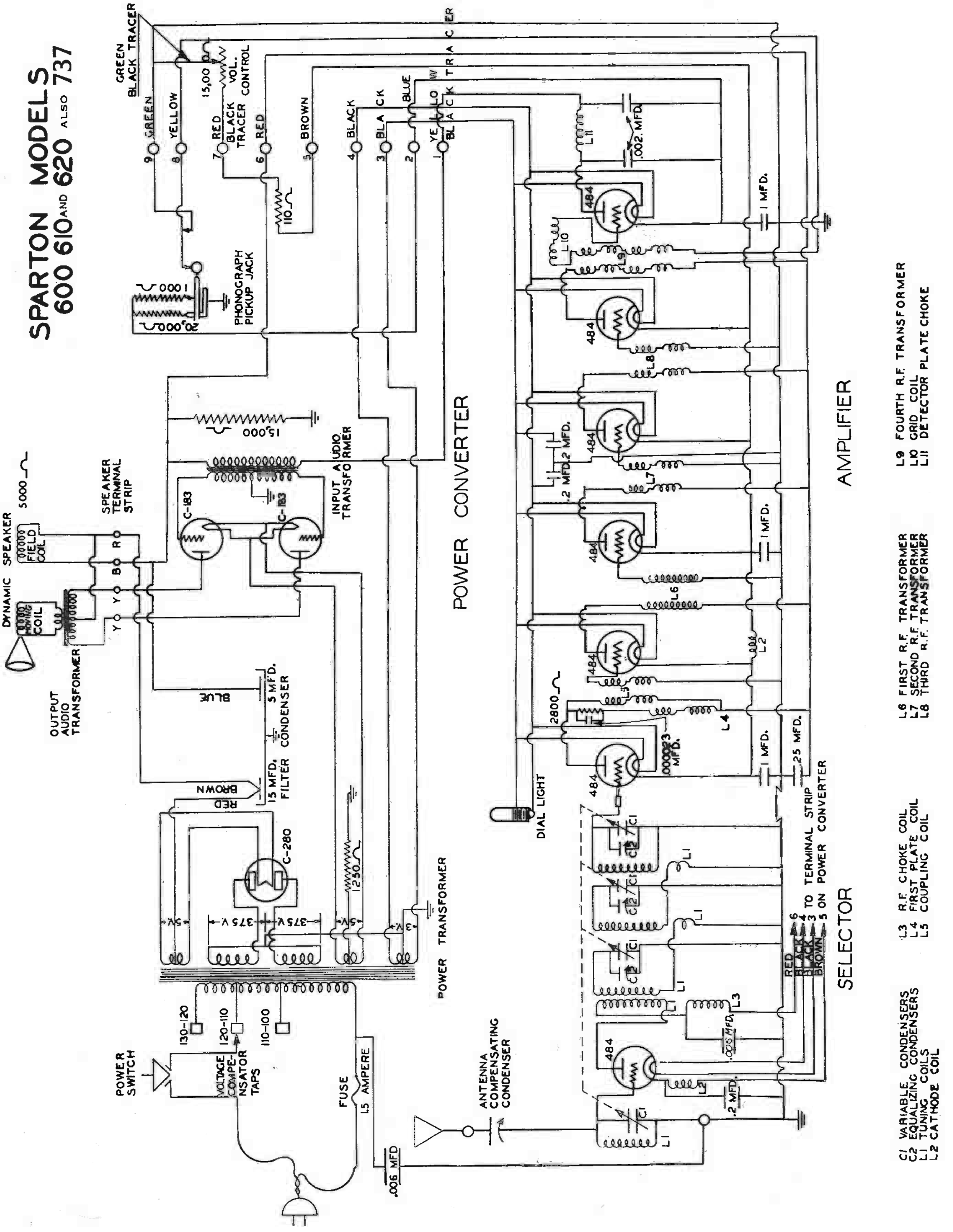
Sparton Model 9-A—Schematic Diagram



SPARKS-WITHINGTON CO.

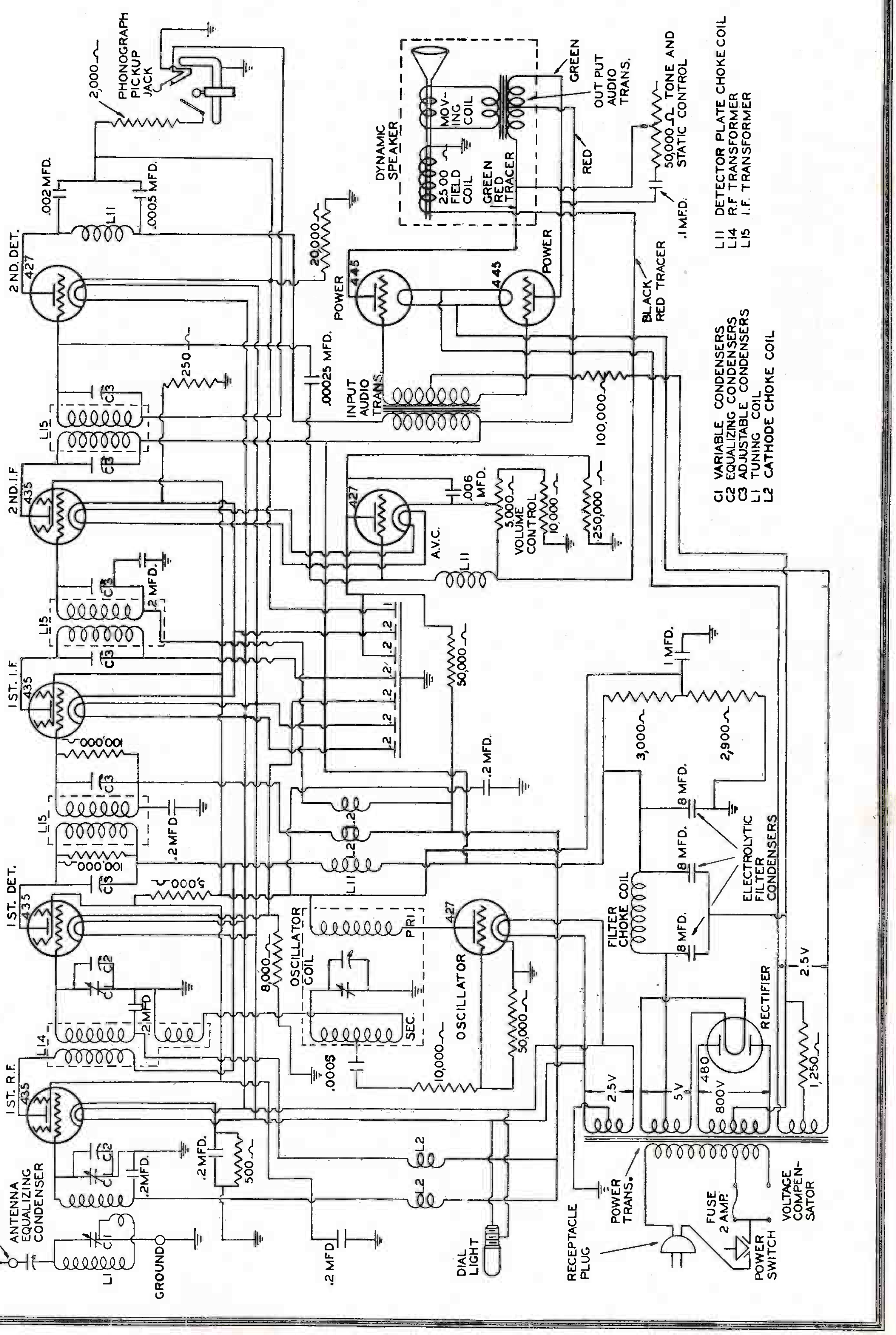


SPARKS-WITHINGTON CO.

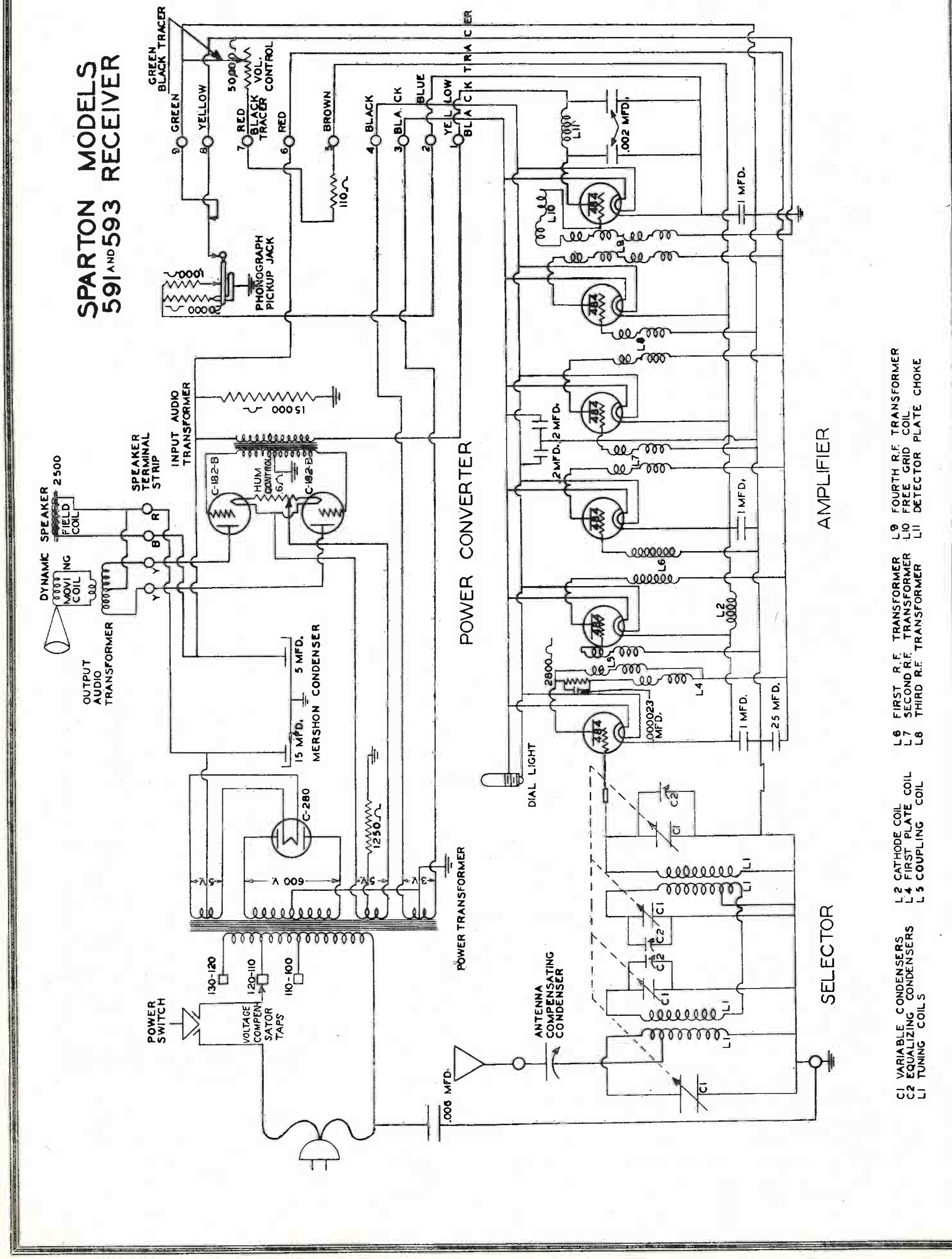


SPARKS-WITHINGTON CO.

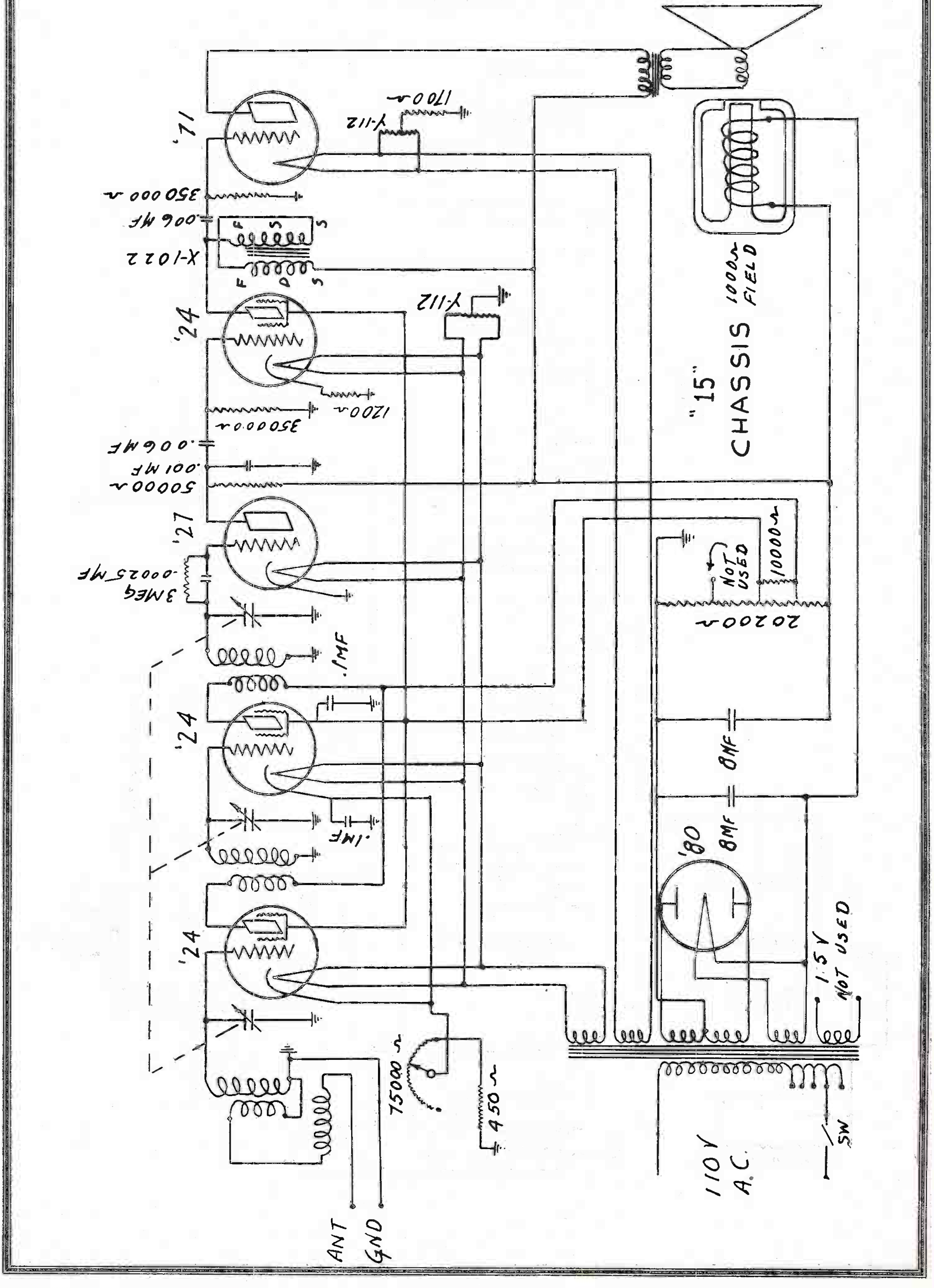
SPARTON MODEL 25 AND 26 SCHEMATIC DIAGRAM



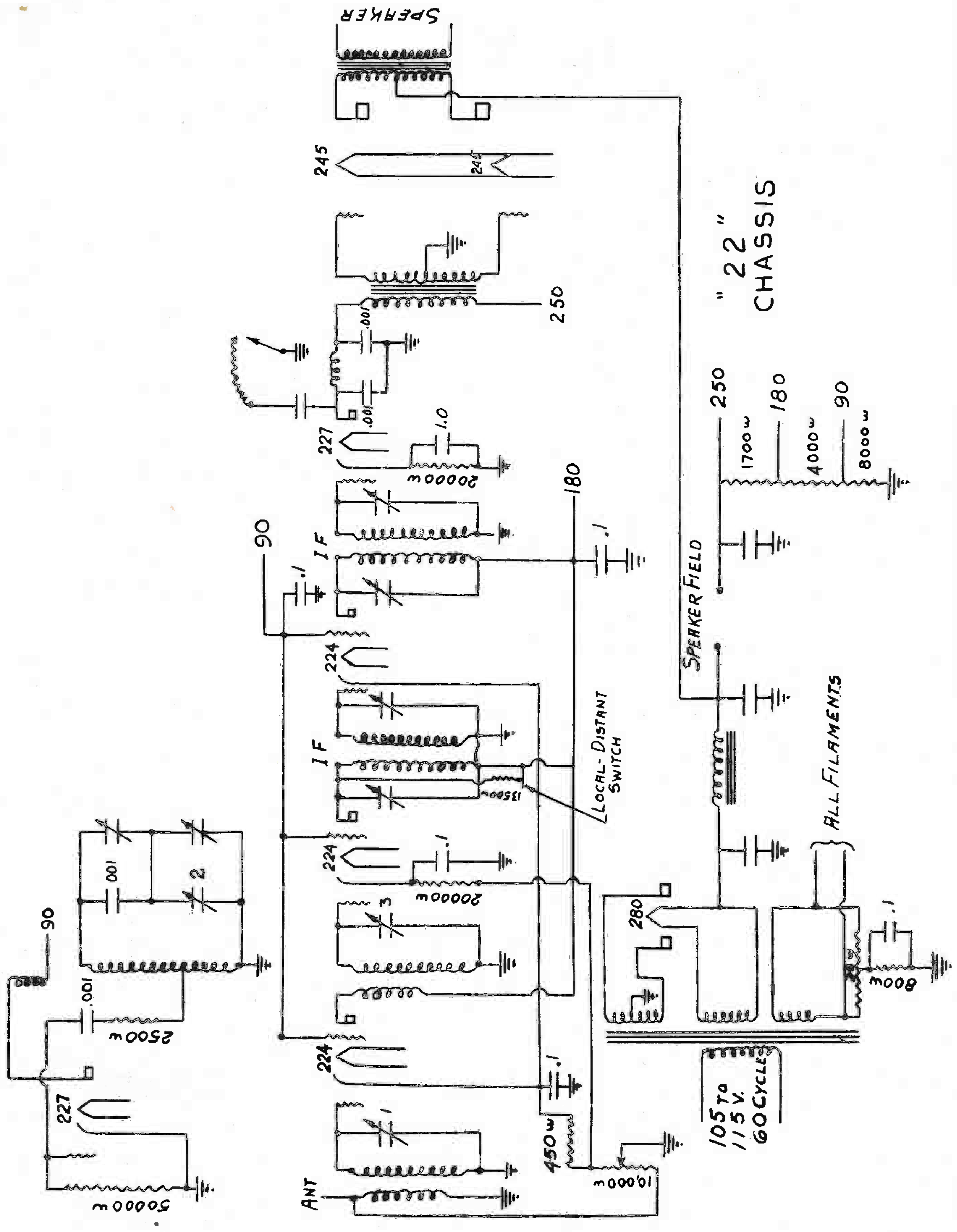
SPARKS-WITHINGTON CO.



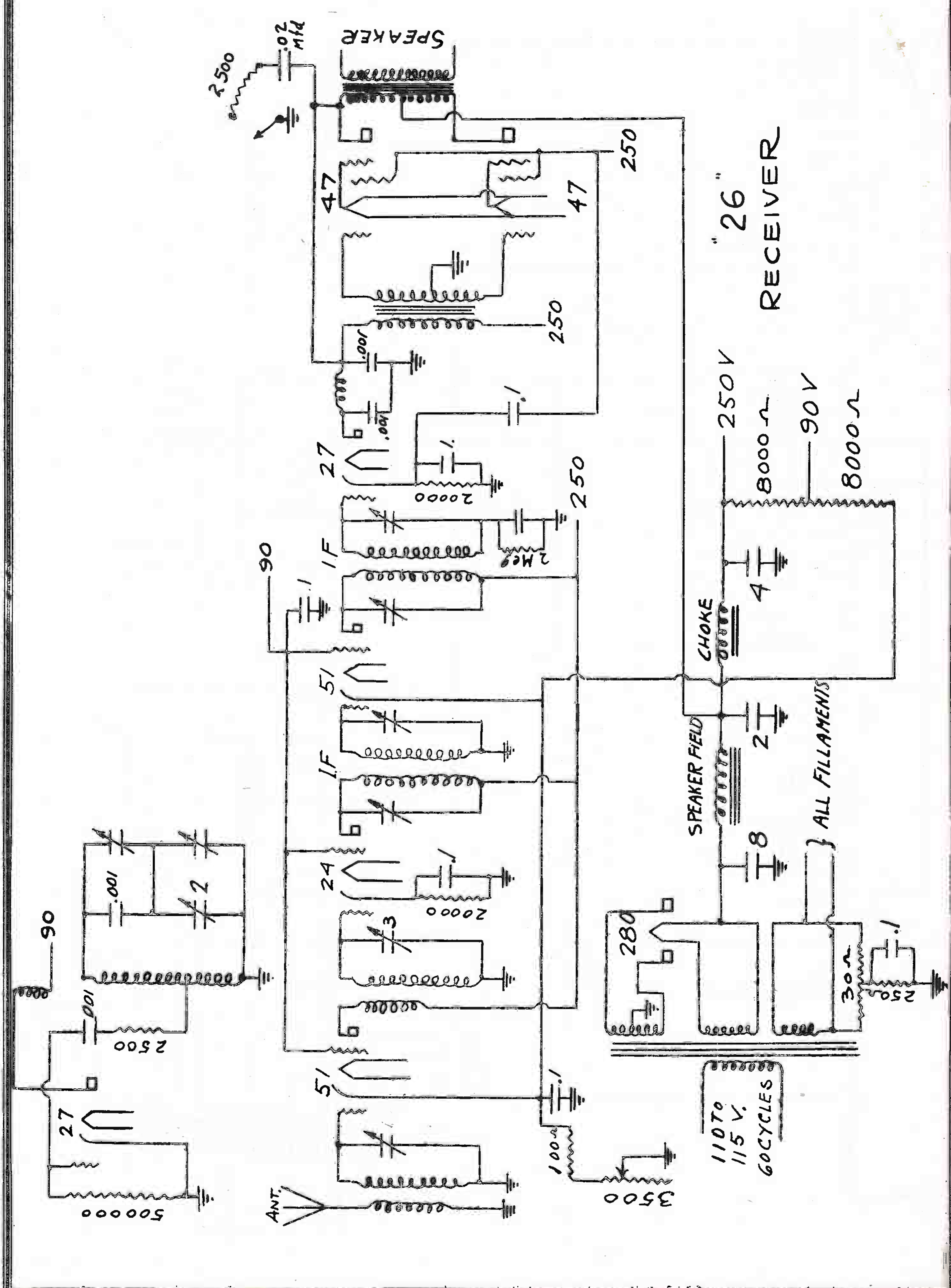
STEINITE RADIO CO.



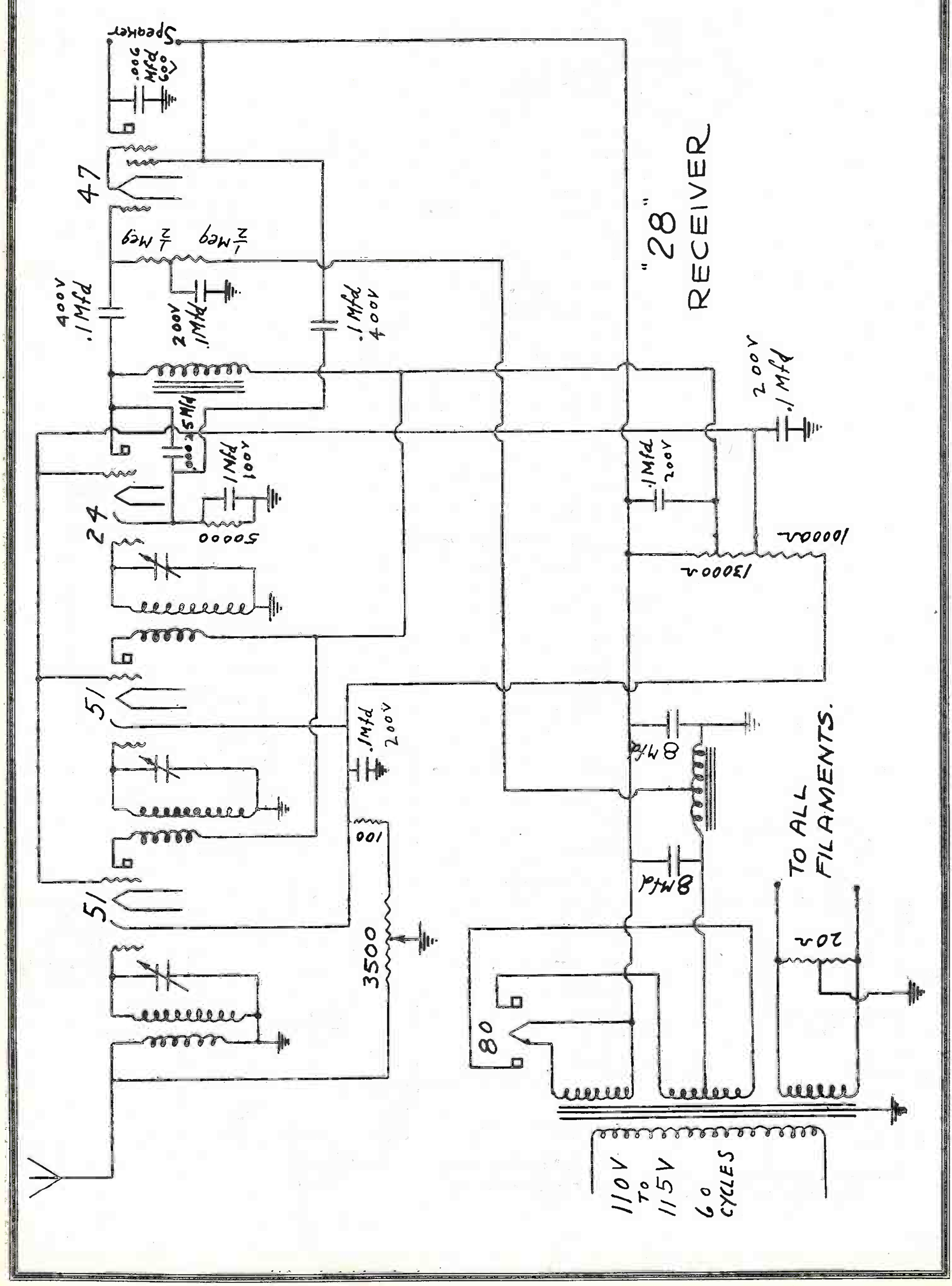
STEINITE RADIO CO.



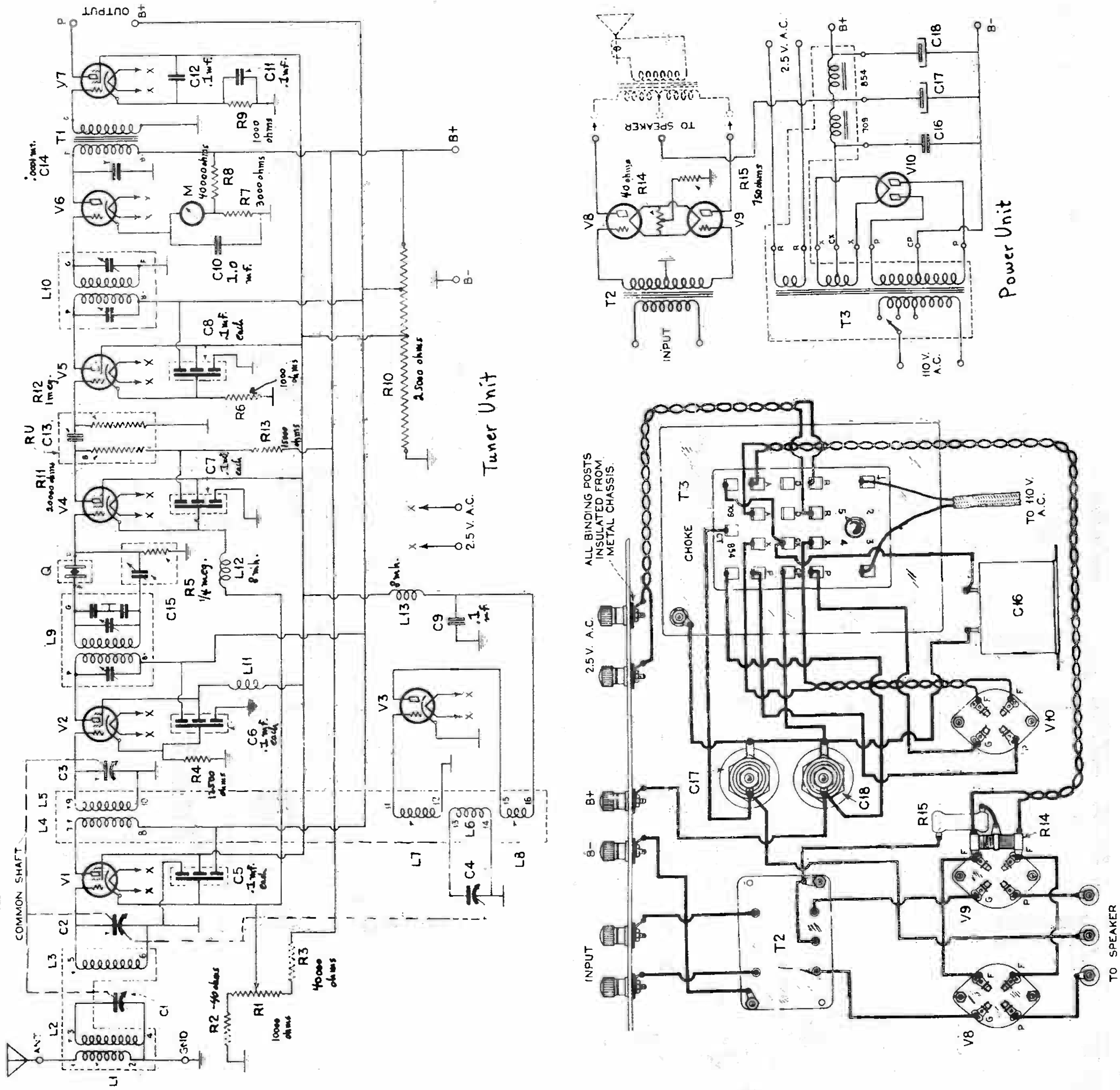
STEINITE RADIO CO.



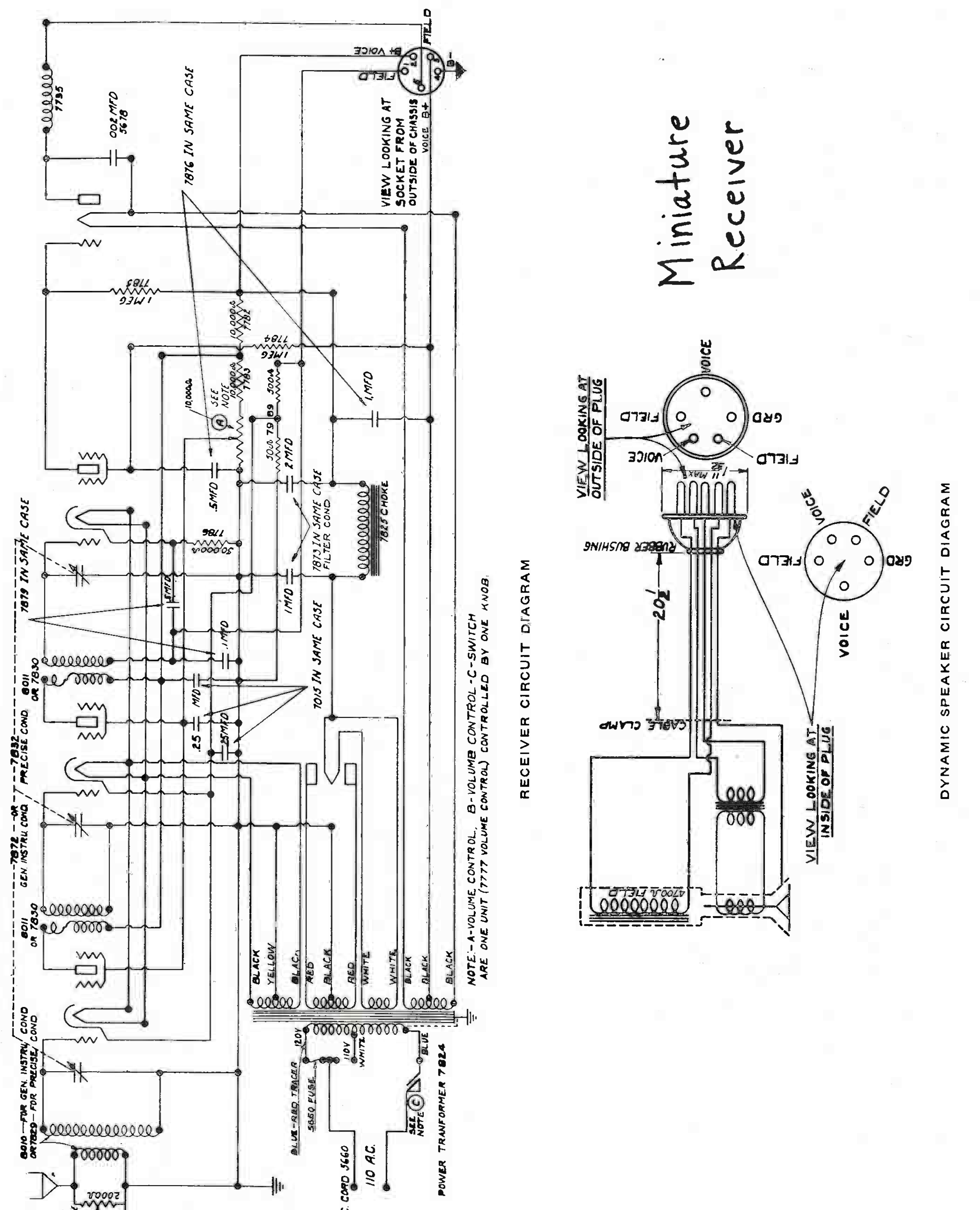
STEINITE RADIO CO.



STENODE CORP. OF AMERICA.



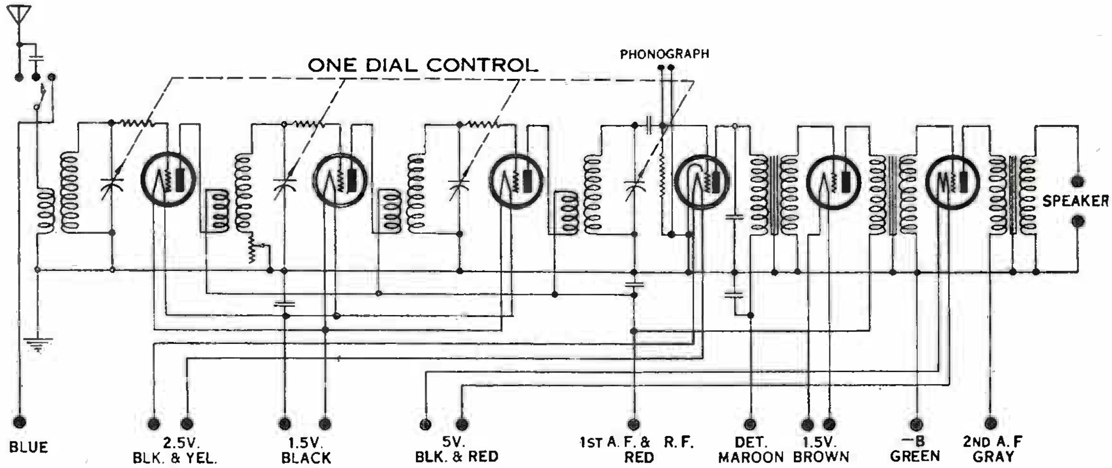
STERLING MFG. CO.



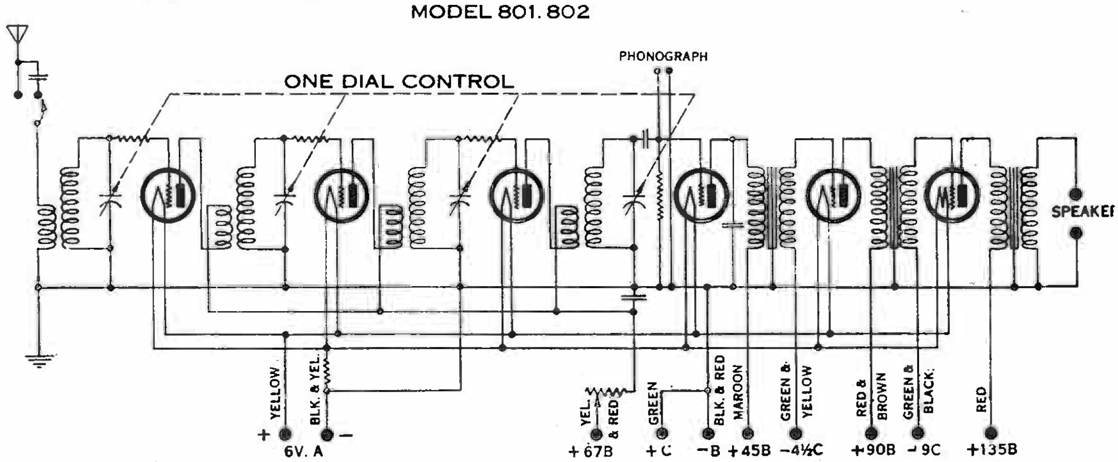
RECEIVER CIRCUIT DIAGRAM

DYNAMIC SPEAKER CIRCUIT DIAGRAM

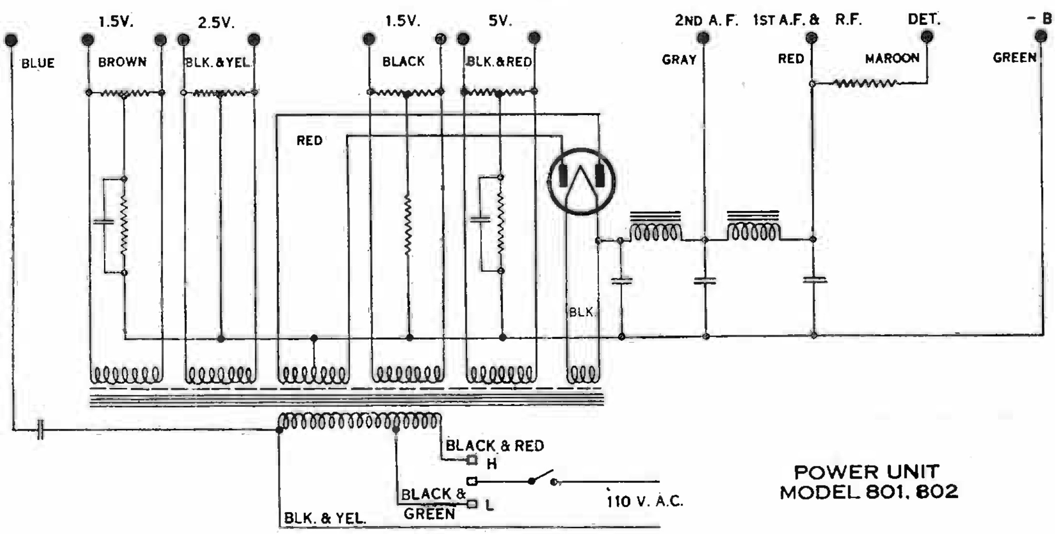
STEWART-WARNER CORP.



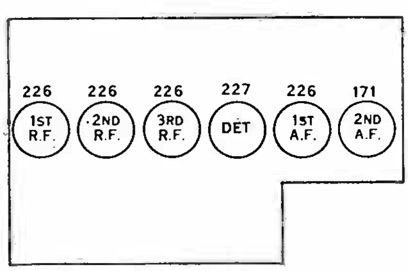
MODEL 801. 802



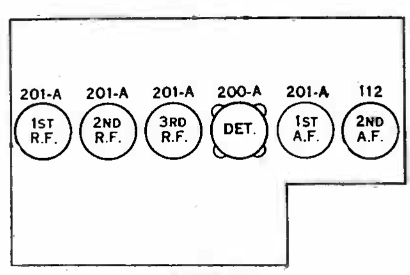
MODEL 806



POWER UNIT
MODEL 801. 802



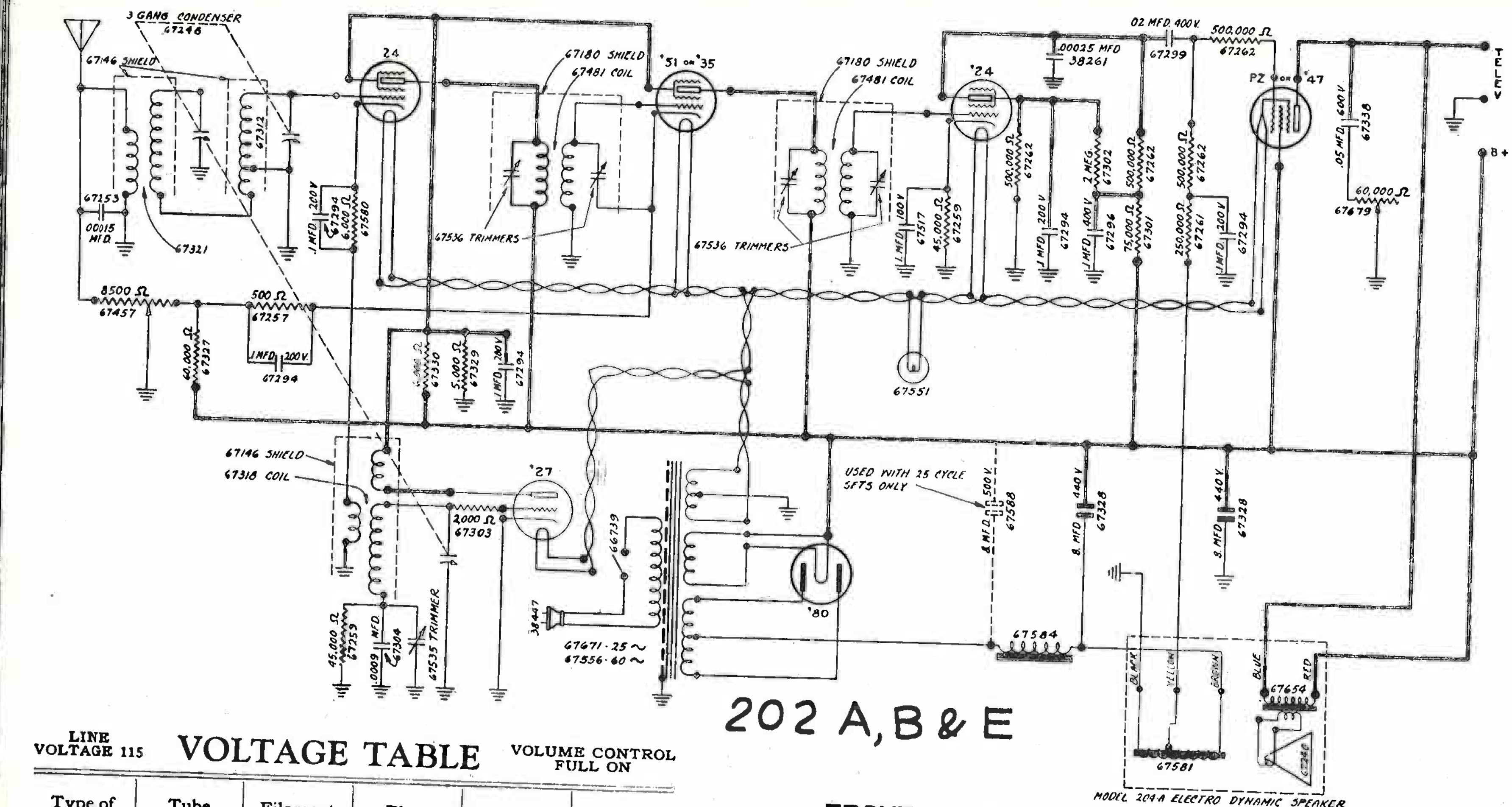
MODEL 801. 802



MODEL 806

LOCATION OF VARIOUS TUBES

STEWART-WARNER CORP.



202 A, B & E

LINE VOLTAGE 115

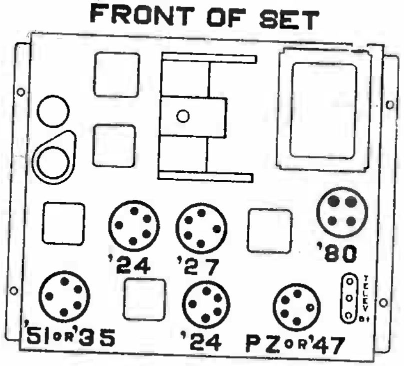
VOLTAGE TABLE

VOLUME CONTROL FULL ON

Type of Tube	Tube Circuit	Filament Voltage	Plate Voltage	Screen Grid Voltage	Bias Voltage
'24	1st Det.	2.4	245	90	6.7
'27	Osc.	2.4	90		0
'51	I. F.	2.4	245	90	3
'24	2nd Det.	2.4	100	20	3
P. Z. or '47	Output	2.4	220	245	15*
'80	Rect.	4.8			

* This reading obtained between ground and yellow speaker lead. Direct reading from grid to ground or reading taken with a set tester will show low voltage because of high resistance in grid circuit.

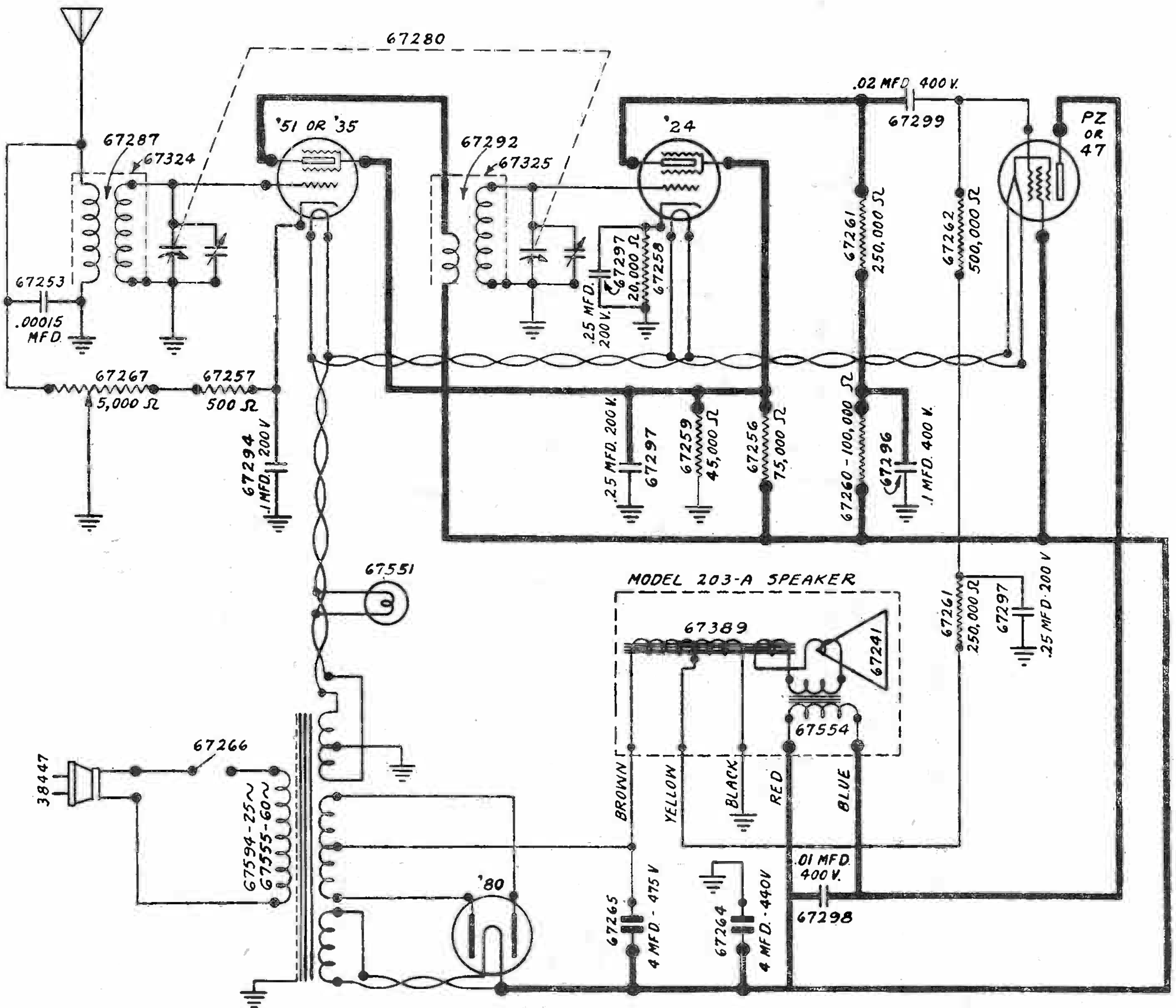
FRONT OF SET



TUBE LOCATIONS

INTERMEDIATE FREQUENCY TRANSFORMERS TUNED TO 177.5 K. C.

STEWART-WARNER CORP.



Circuit Diagram R-101 A & B

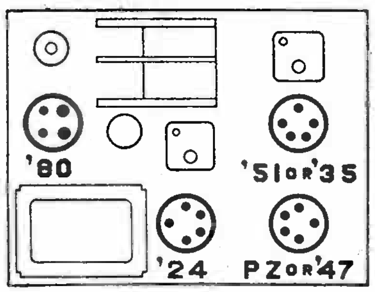
VOLTAGE TABLE

Type of Tube	Tube Circuit	Filament Voltage	Plate Voltage	Screen Grid Voltage	Bias Voltage
'51	R.F.	2.4	243	68	2.75
'24	Det.	2.4	80	68	6
PZ or '47	Output	2.4	228	243	16 *
'80	Rect.	4.8			

* This reading obtained between ground and yellow speaker lead. Direct reading from grid to ground or reading taken with a set tester will show low voltage because of high resistance in grid circuit.

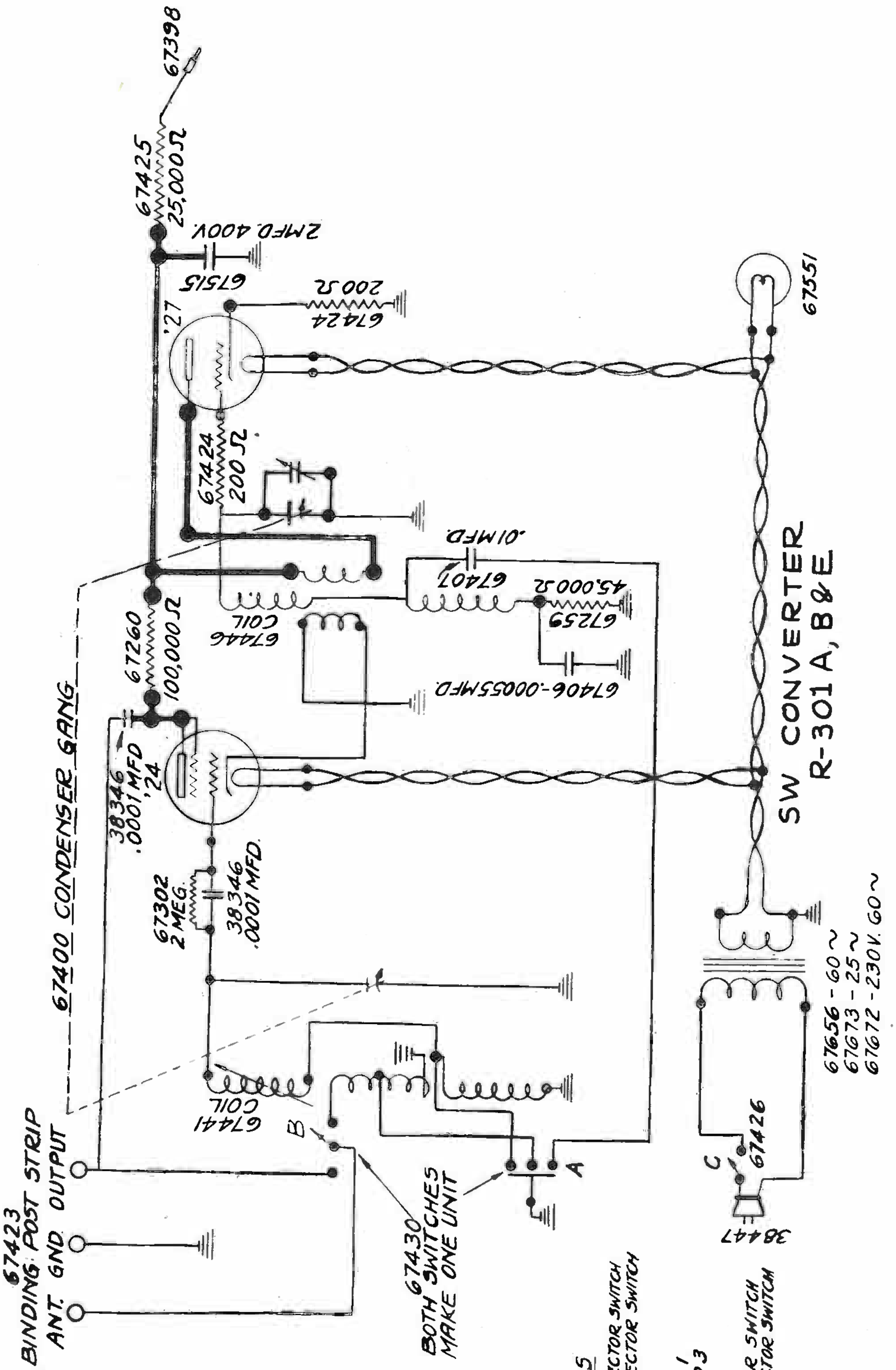
All D.C. voltages are taken between socket terminals and ground with high resistance voltmeters having resistances of 1000 ohms per volt.
Line Voltage—115.
Volume Control full on.

FRONT OF SET



TUBE LOCATIONS

STEWART-WARNER CORP.



SWITCH POSITIONS

A – "OFF" IN POSITION 1 AND 2 OF SELECTOR SWITCH
"ON" IN POSITION 3 OF SELECTOR SWITCH

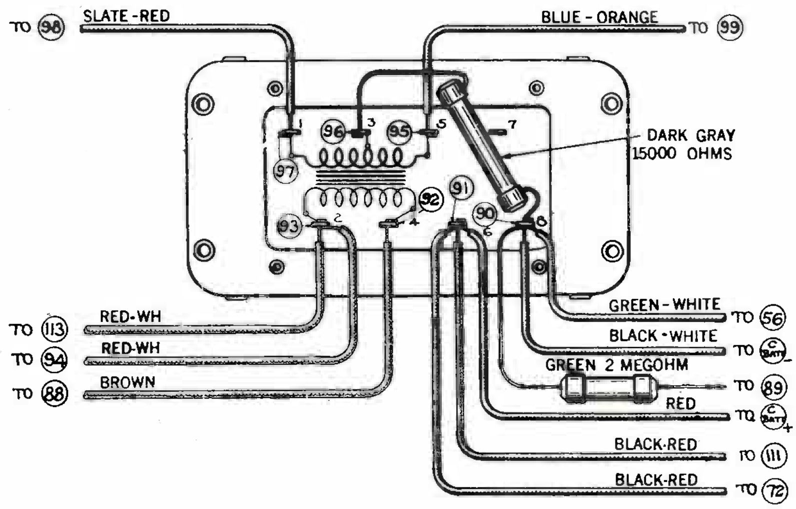
B – TO OUTPUT POST IN POSITION 1
TO COIL IN POSITIONS 2 AND 3

C – "OFF" IN POSITION 1 OF SELECTOR SWITCH
"ON" IN POSITION 2 AND 3 OF SELECTOR SWITCH

STROMBERG-CARLSON MFG. CO.

Model 645

"Art Console"



Detail of P-19203 Input Transformer Assembly.

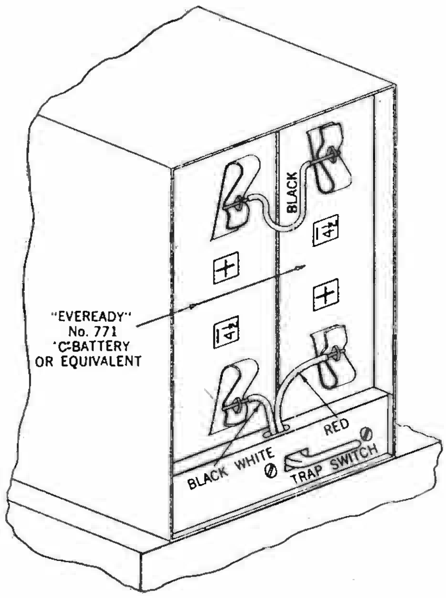
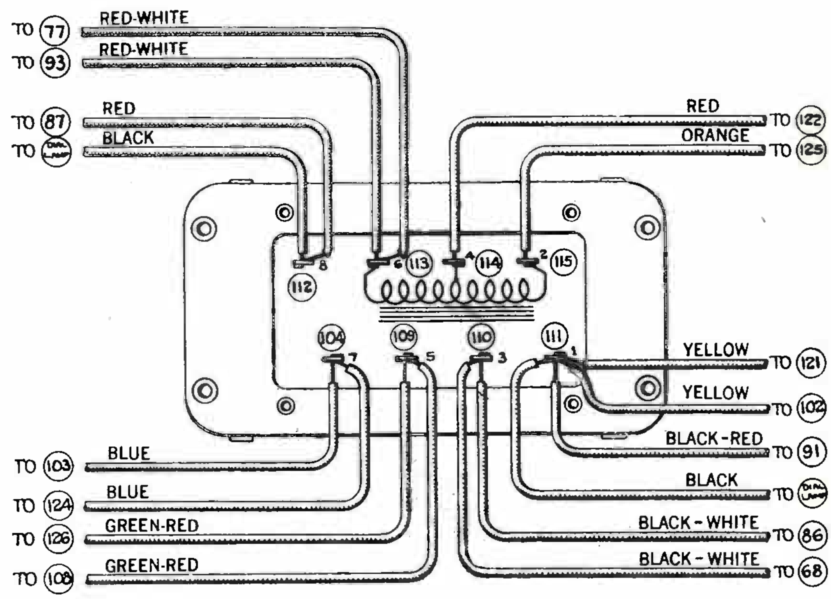
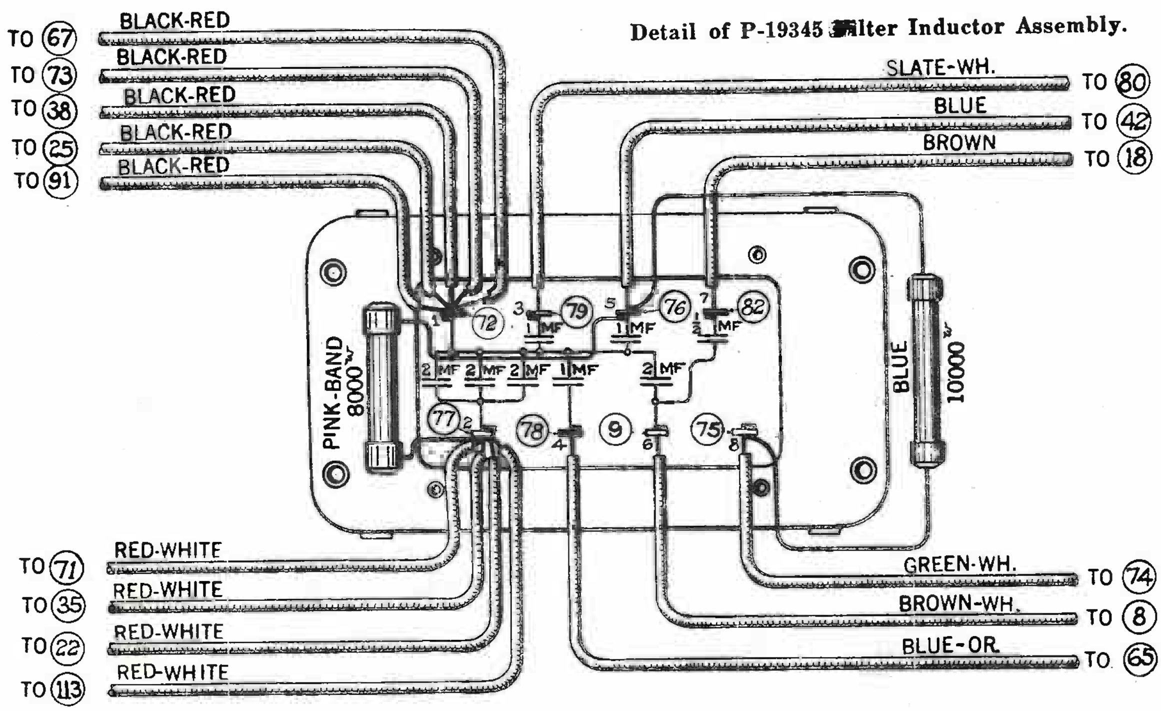


Diagram of "C" Battery Container with Cover Removed Showing Connections.

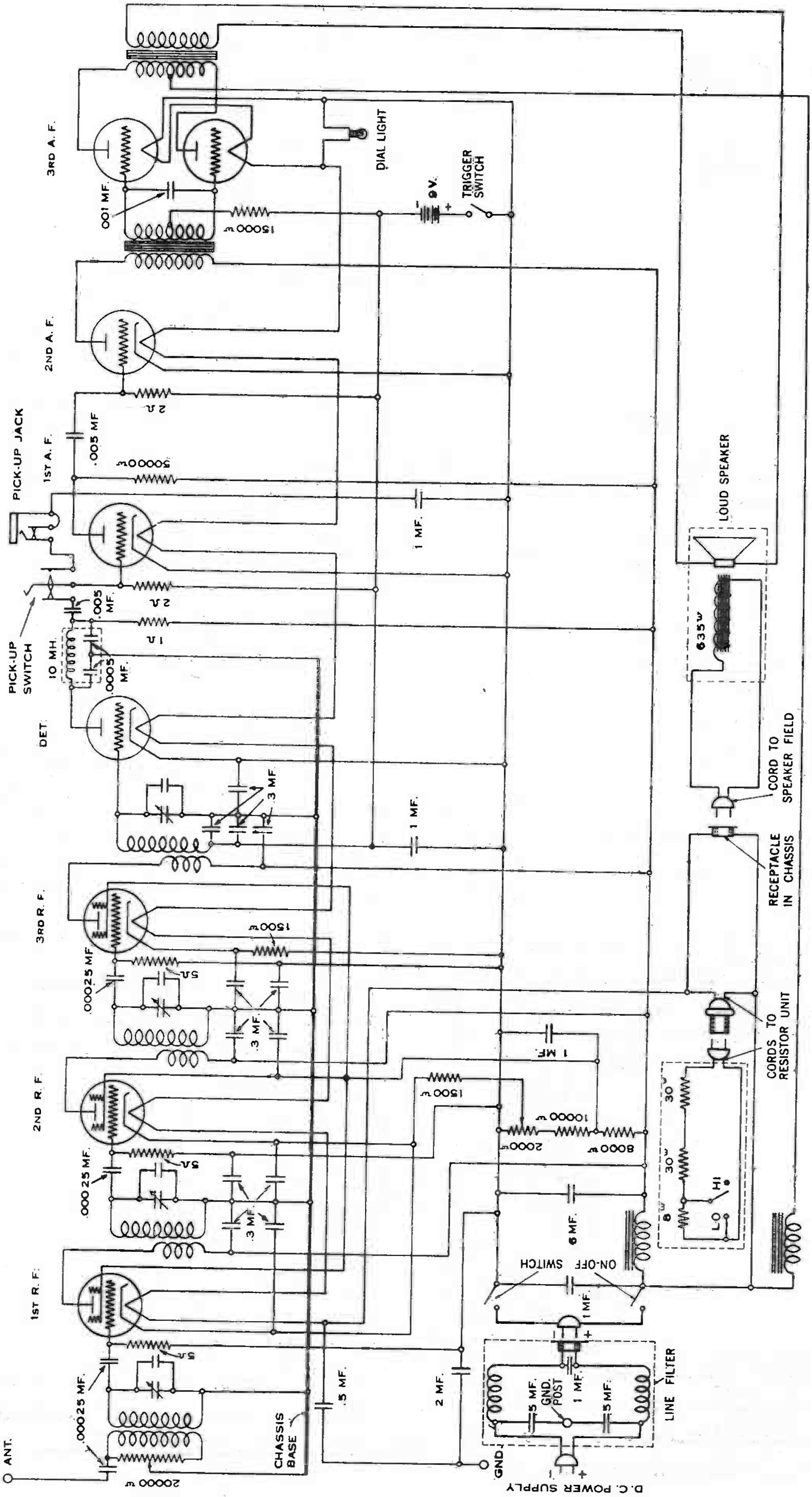


Detail of P-19345 Filter Inductor Assembly.



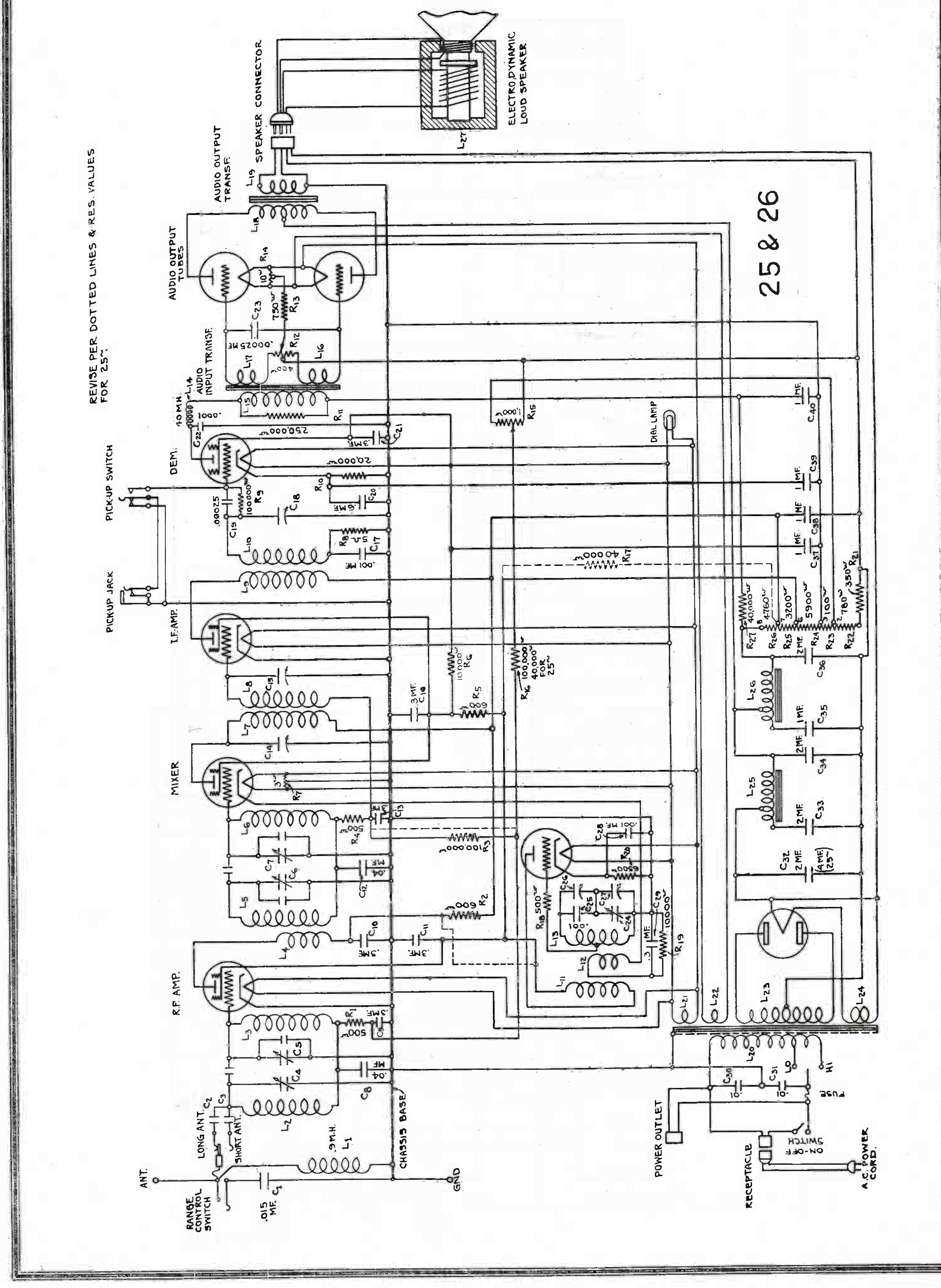
Detail of P-19252 Capacitor Assembly.

STROMBERG-CARLSON MFG. CO.

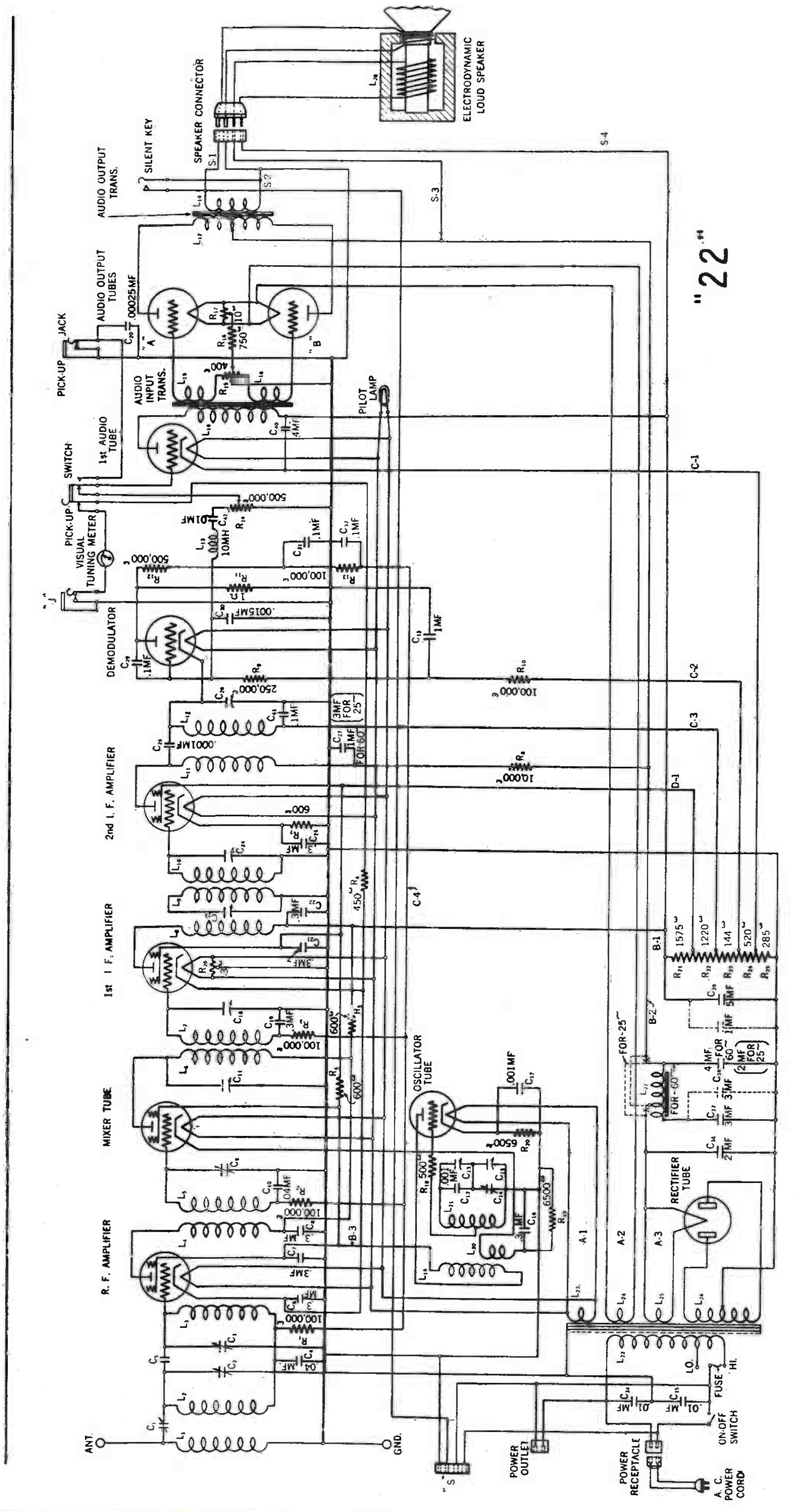


Complete Schematic Circuit of Chassis of No. 645 Art Console.

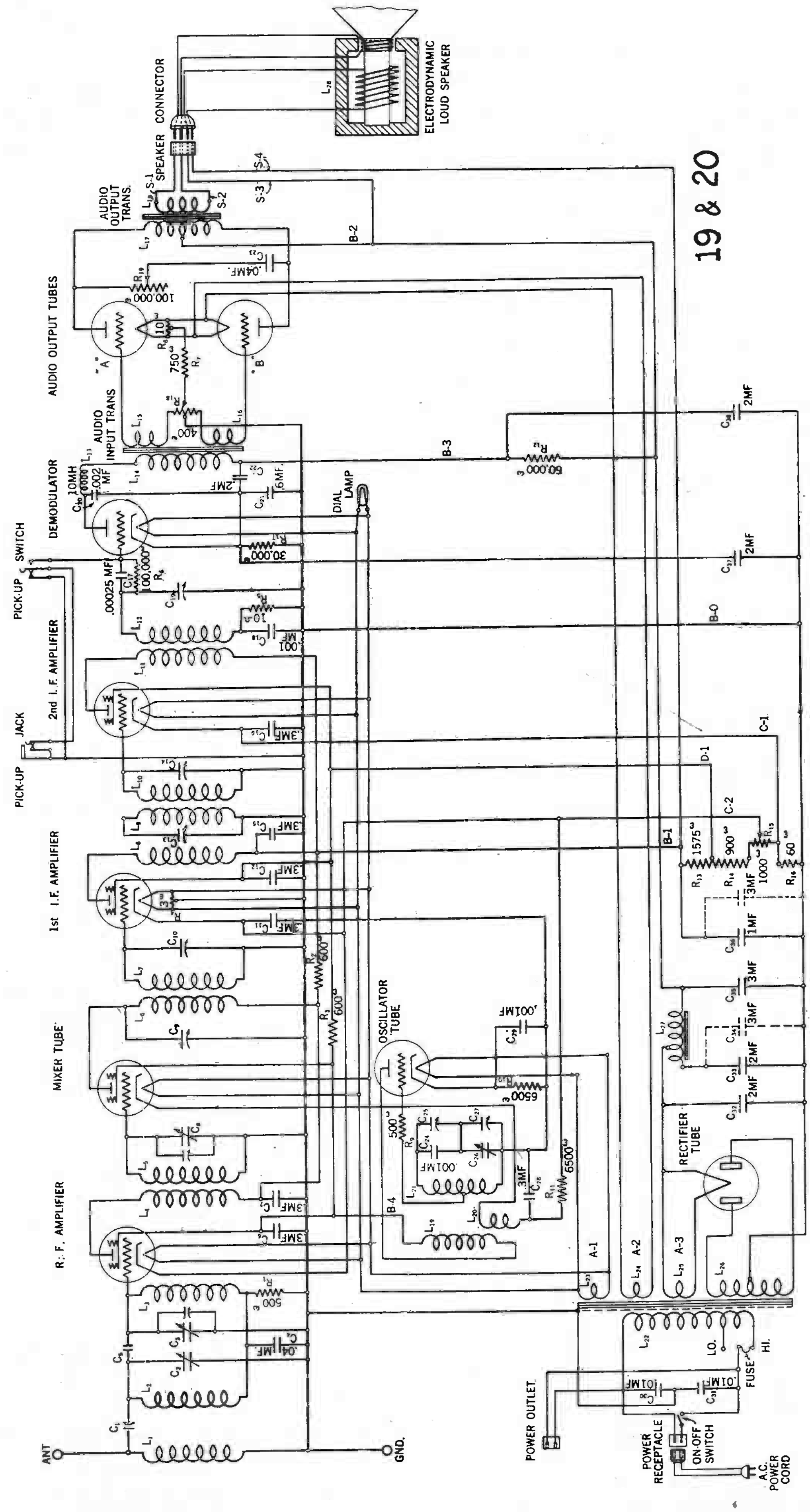
STROMBERG-CARLSON MFG. CO.



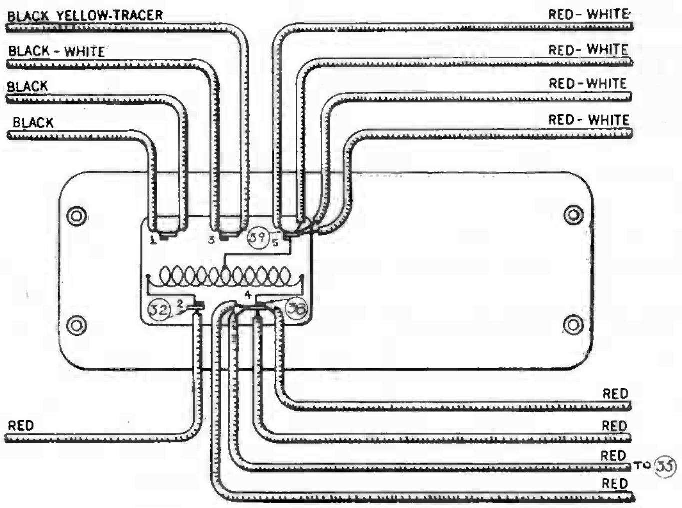
STROMBERG-CARLSON MFG. CO.



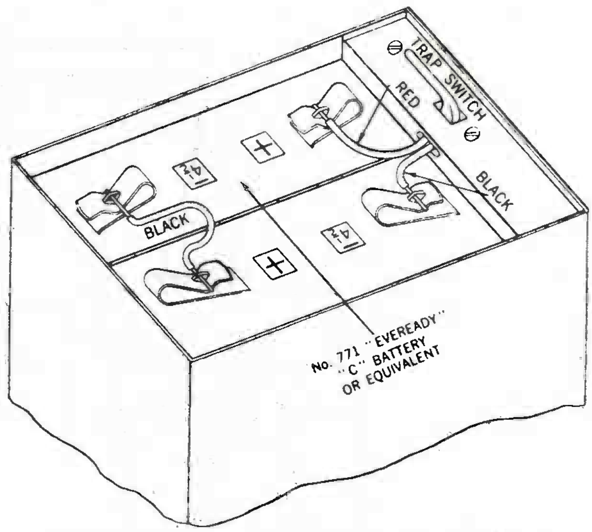
STROMBERG-CARLSON MFG. CO.



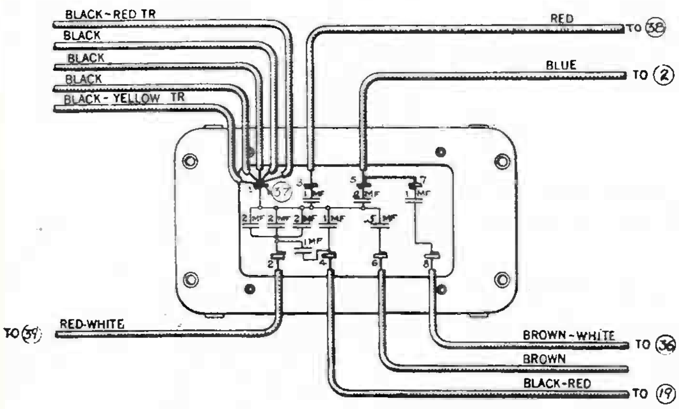
STROMBERG-CARLSON MFG. CO.



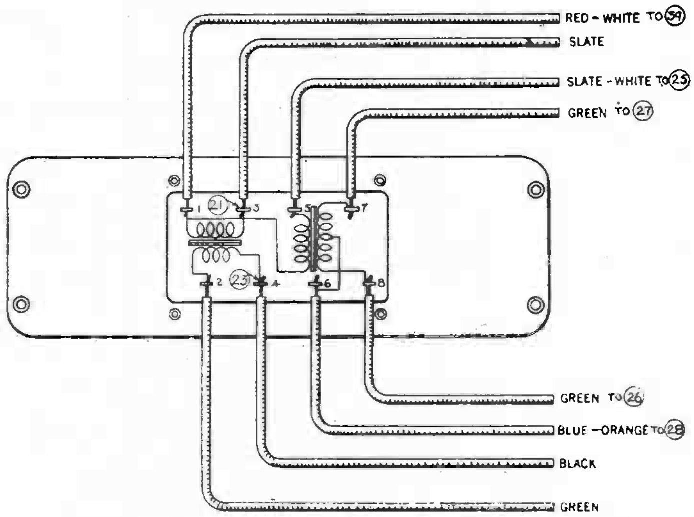
Connection Detail of P-21054 Filter Inductor Assembly showing colors of wires and correct connection to Terminals.



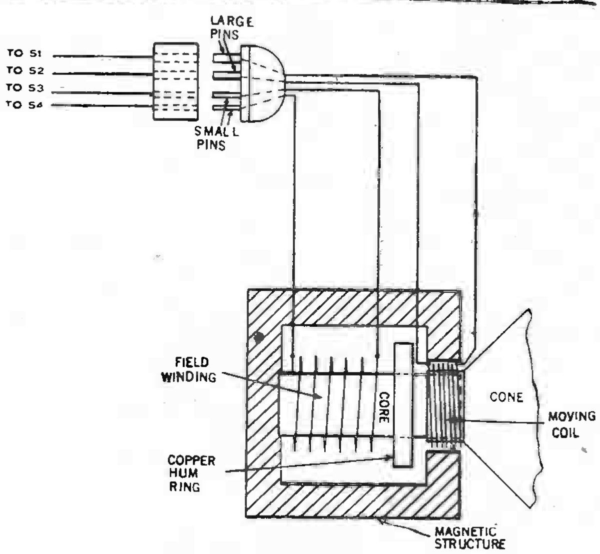
"C" Batteries Mounted in Container on Chassis. Note Trap Switch and Wiring.



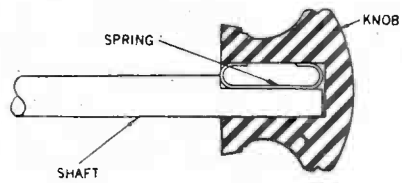
Connection Detail of P-19775 Capacitor Assembly.



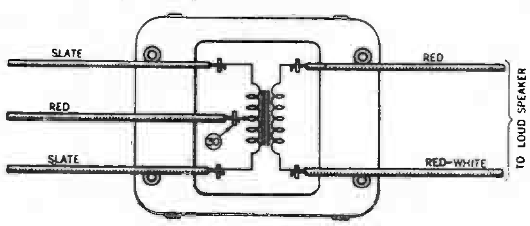
all for Model 16 Receiver



Schematic Circuit of Electrodynamic Loud Speaker and Connector



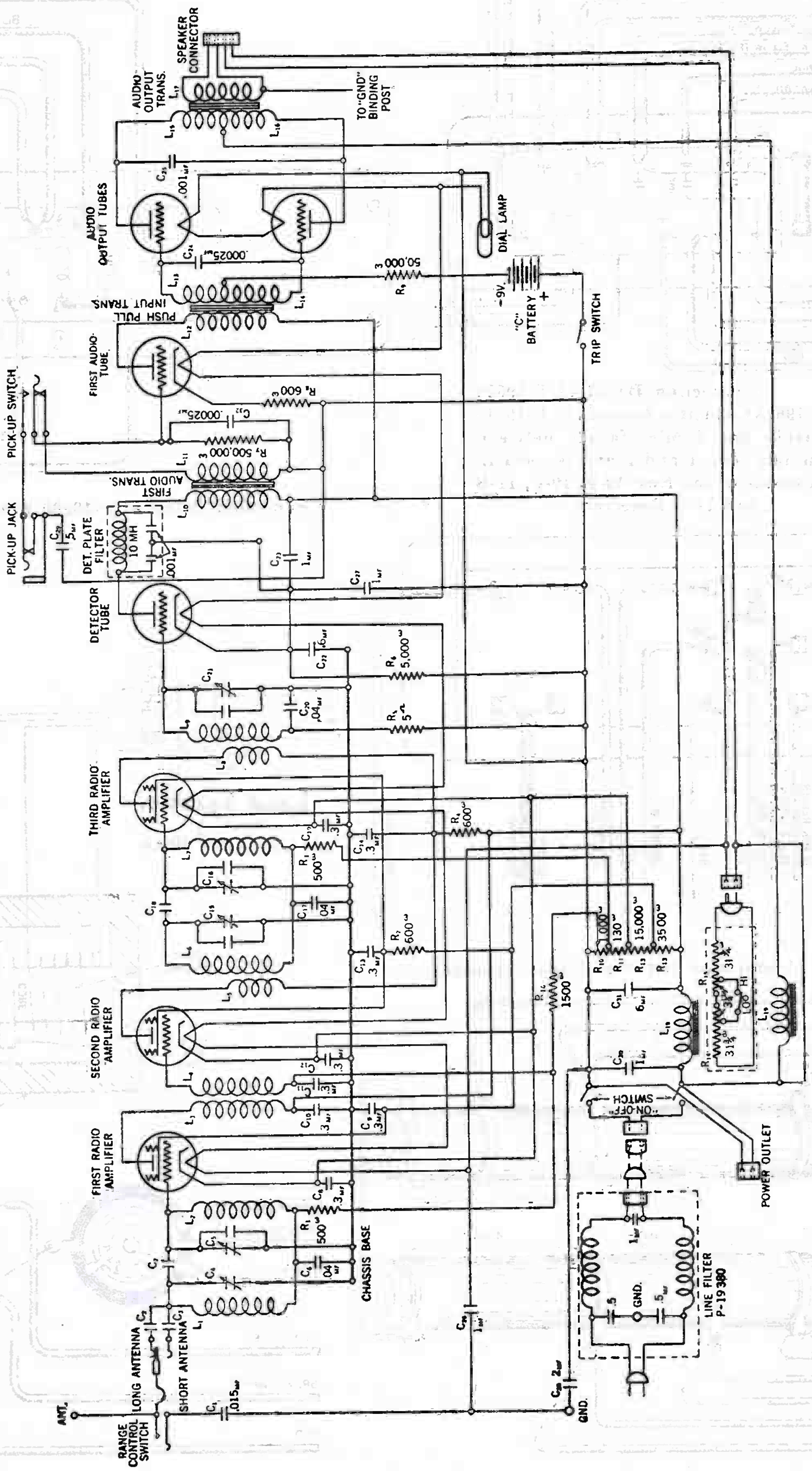
Cross Section of Control Knob and Shaft showing arrangement of spring holding Knob in place. If this spring becomes bent so that the Knob is loose it should be reformed by bending in middle, or replaced with a new spring.



Connection Detail of P-19505 Audio Output Transformer.

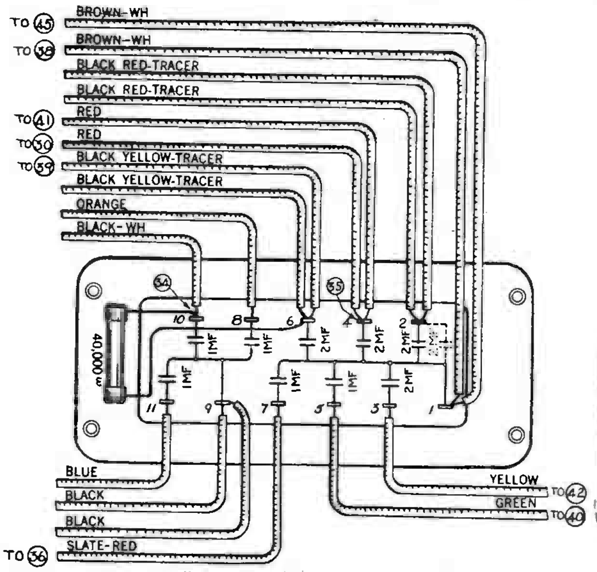
STROMBERG-CARLSON MFG. CO.

Schematic Circuit of Chassis for No. 16 Receiver

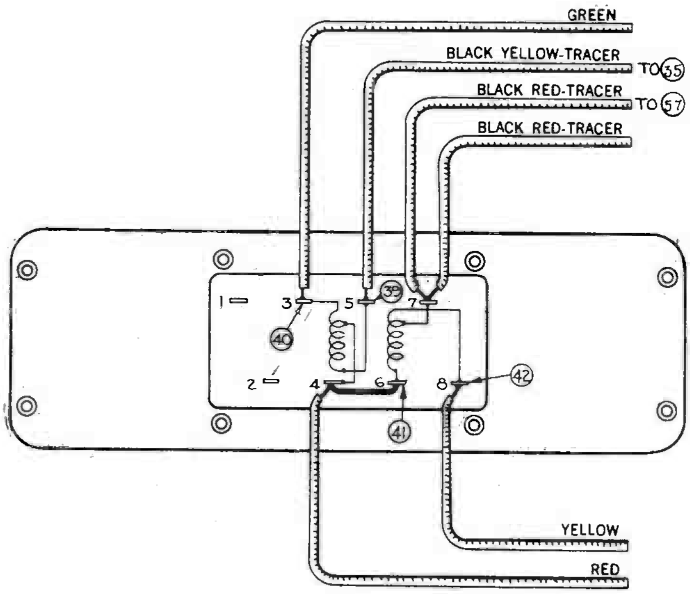


STROMBERG-CARLSON MFG. CO.

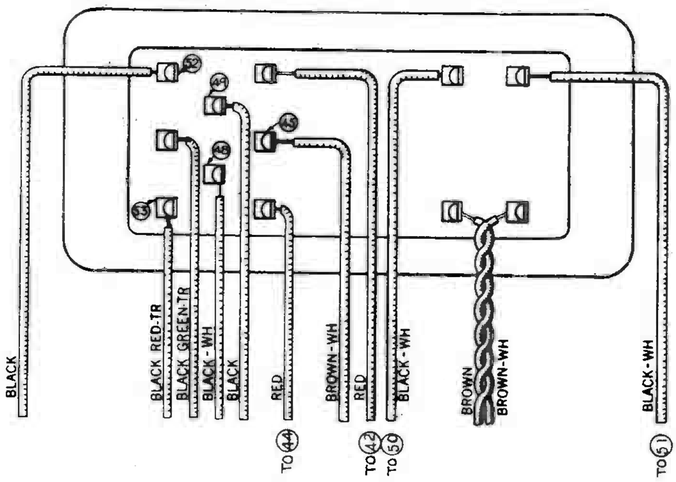
Models 10 and 11



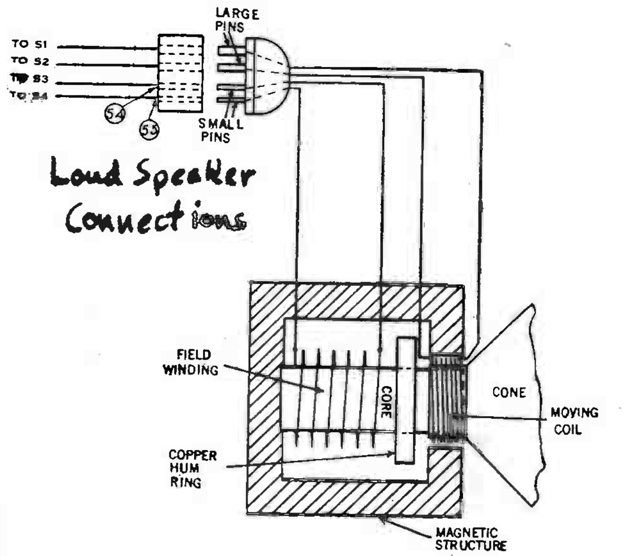
Connection Detail of P-19604 or P-19618 Capacitor Assembly. P-19618 Assembly has 4 Microfarads between Terminals Nos. 1 and 2 and is used in the Chassis of the Nos. 10-B, 10-C, 11-B and 11-C Receivers.



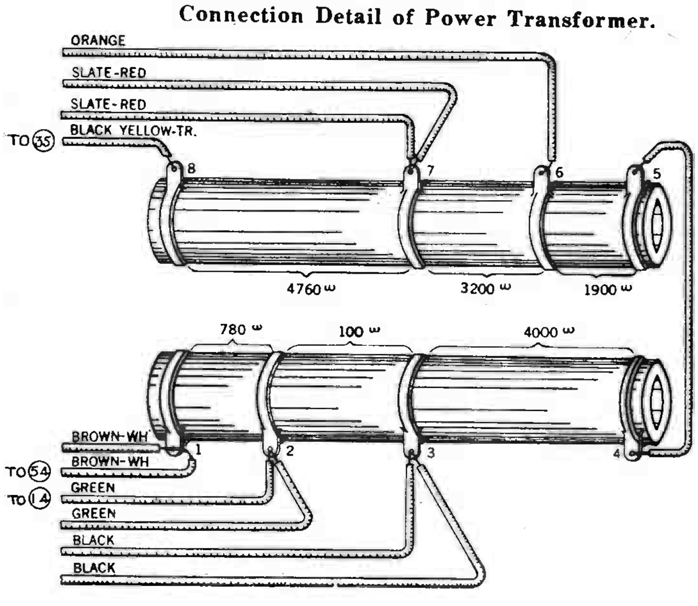
Connection Detail of P-18200 Filter Inductor Assembly



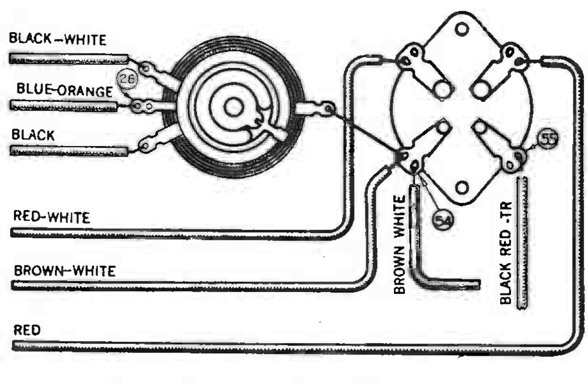
Connection Detail of Power Transformer.



Loud Speaker Connections

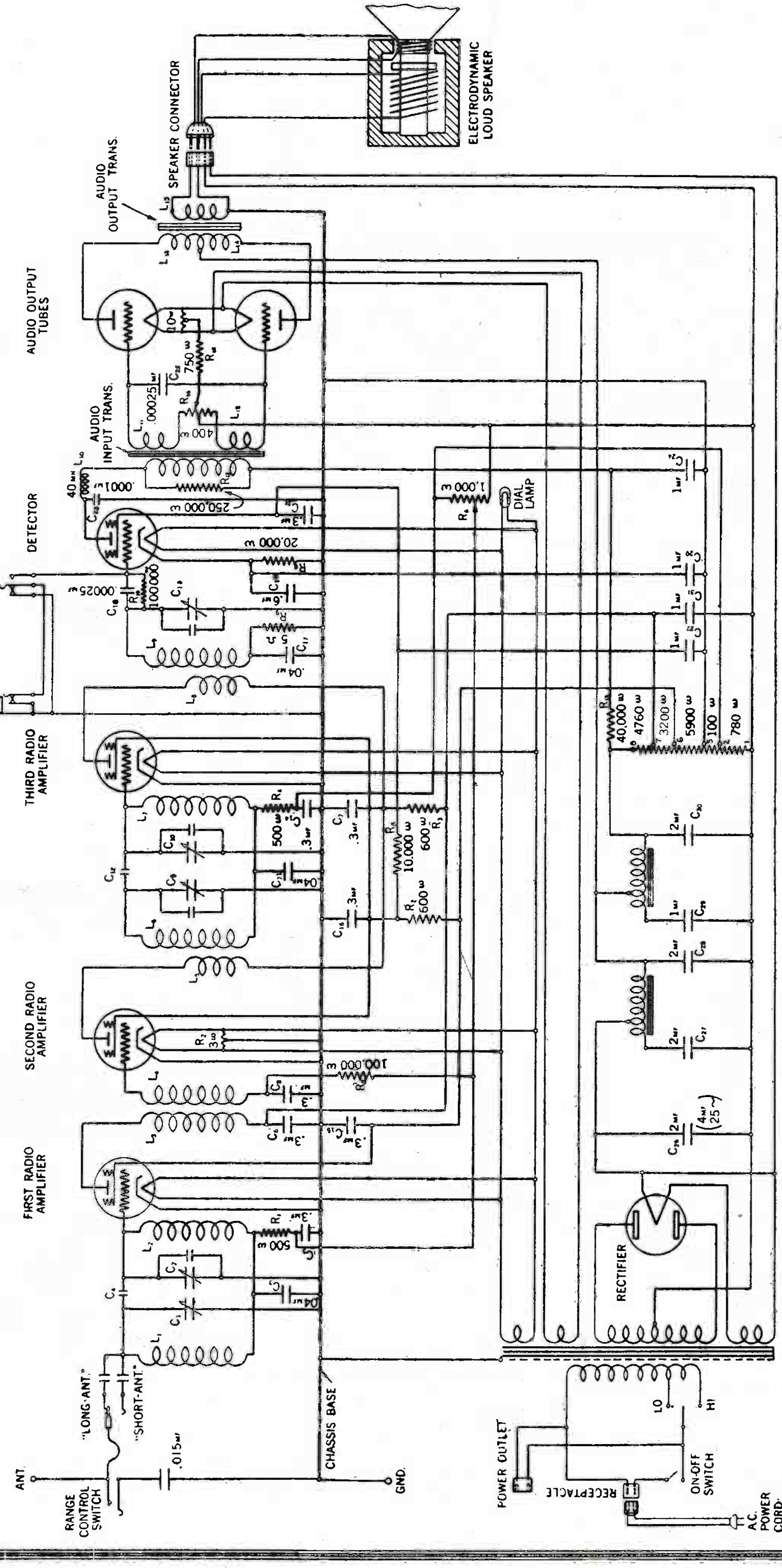


Connection Detail of Voltage Divider Resistors. The upper one is P-19557 and the lower one is P-19559.



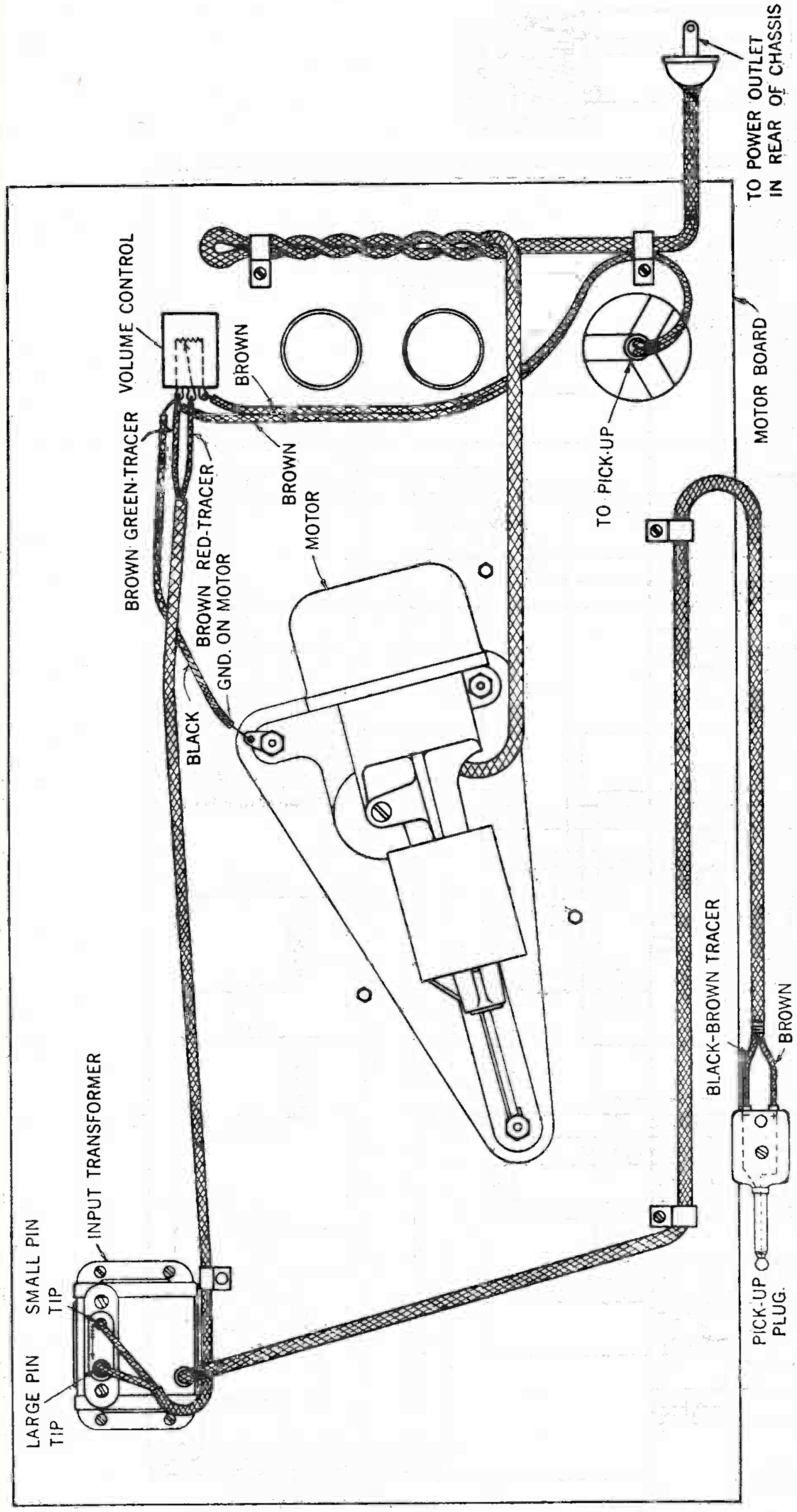
Connection Detail of Hum Balancer and Speaker Connector Socket.

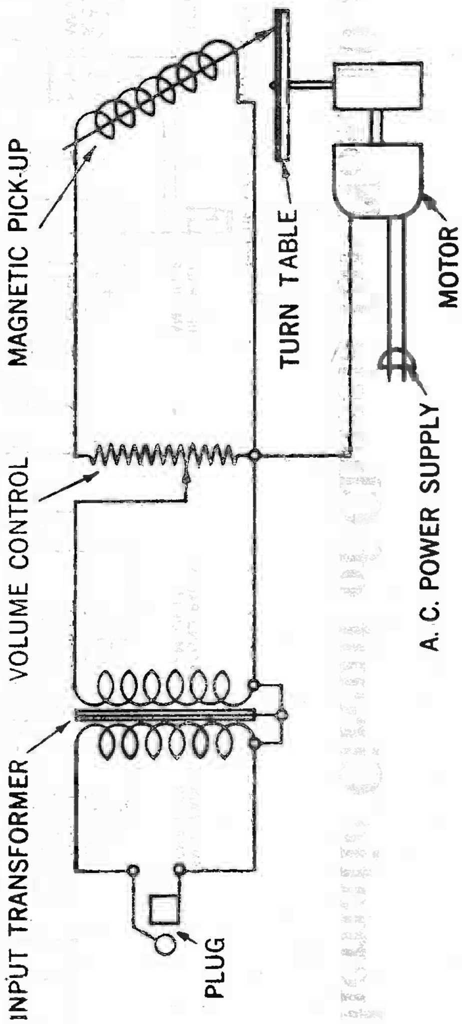
STROMBERG-CARLSON MFG. CO.



Schematic Circuit of Chassis for Nos. 10 and 11 Receivers

STROMBERG-CARLSON MFG. CO.



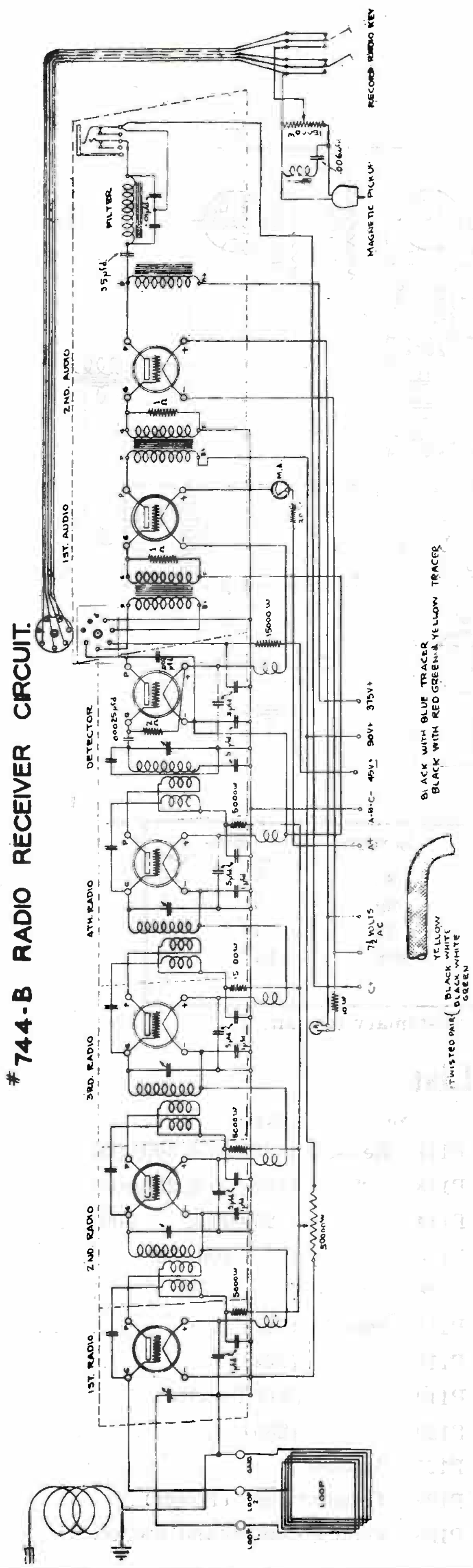


LEFT—Schematic Circuit of No. 1 Phonograph Panel Assembly

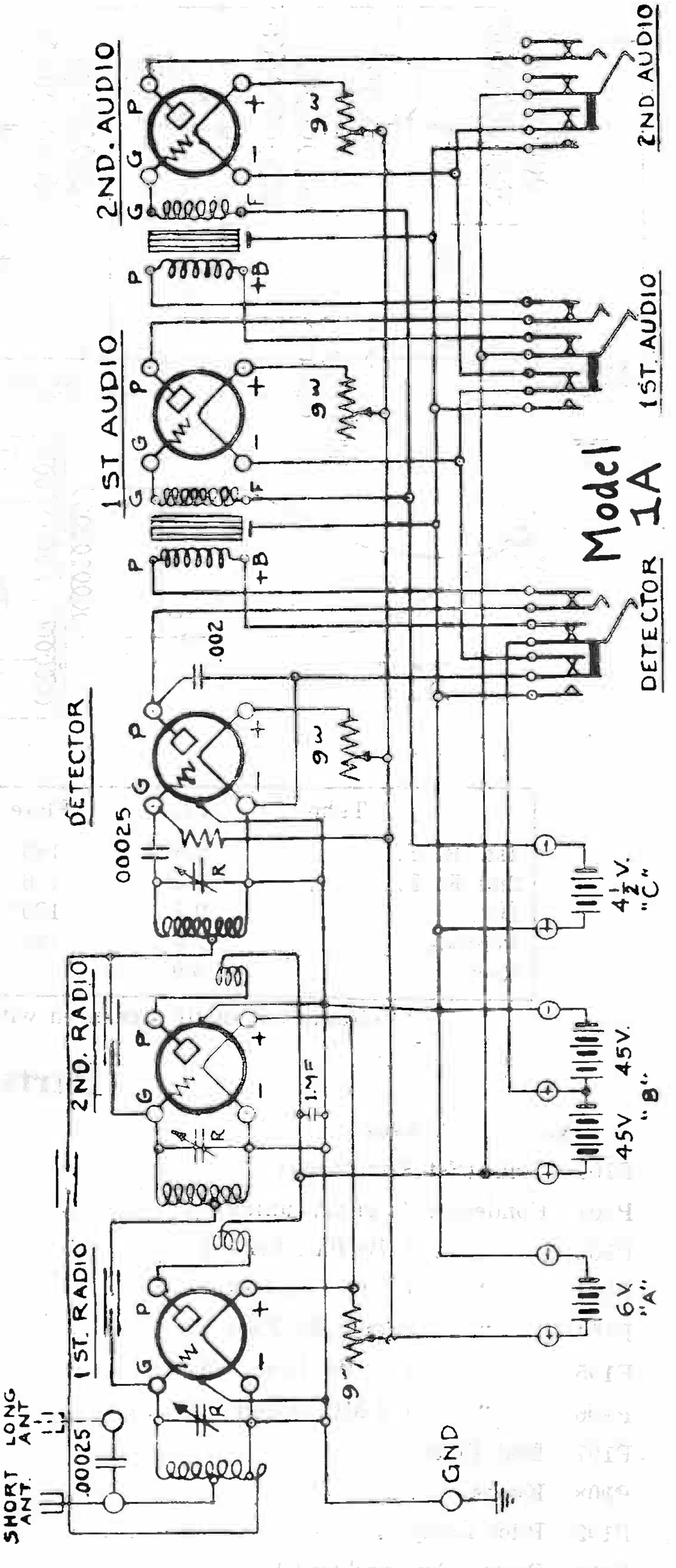
BELOW—Wiring Diagram of No. 1 Phonograph Panel Assembly

(used in model 11 Receiver)

STROMBERG-CARLSON MFG. CO.

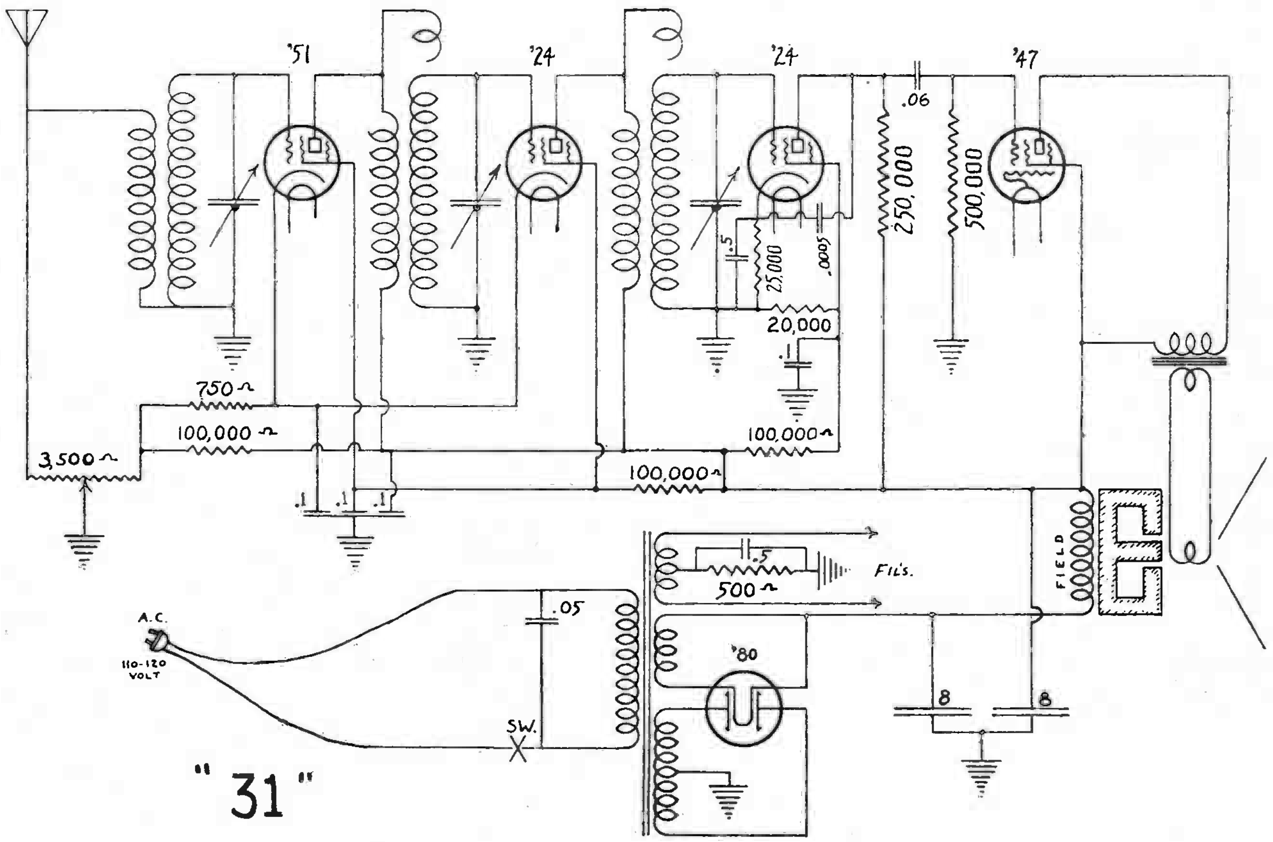


#744-B RADIO RECEIVER CIRCUIT.



Model 1A

STUDEBAKER LABORATORIES



"31"

Tube	Fil.	Plate	Screen	Bias "On"	Bias "Off"
1st. R. F.	2.5	185	88	5	16
2nd R. F.	2.5	176	89	5	16
Det.	2.5	120*	32	4*	4
Pentode	2.5	192	208	16	16
Rect.	5.0	......	......	----	----

*Voltages not easily measured with Customary test kit.

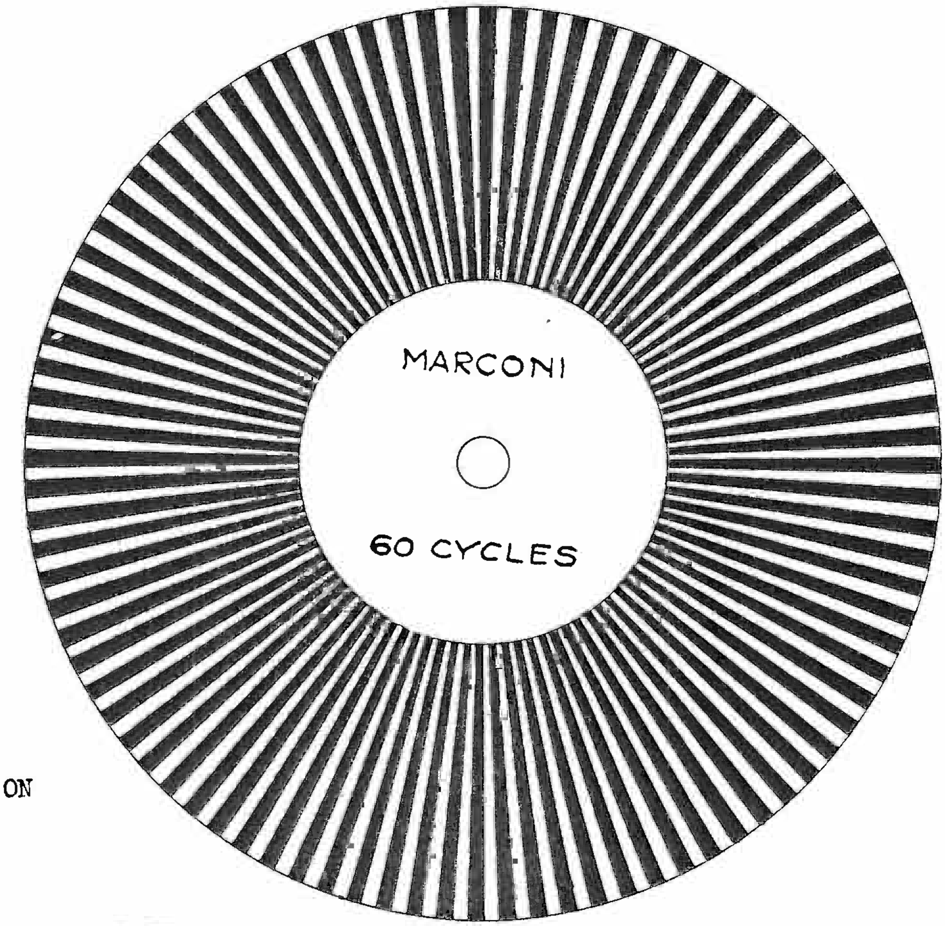
Parts List

No	Name
P100	Coils (Set 3 matched)
P101	Condenser (3 gang, tuning)
P102	" (By Pass bank)
P103	" (.06 Coupling)
P104	" (.0005 By Pass)
P105	" (.05 Line)
P106	" (8 Mfd. Filter)
P107	Dial Plate
P108	Knobs
P109	Pilot Lamp
P110	Posts (Ant. and Grd.)
P111	Resistor (100,000 & 50,000)

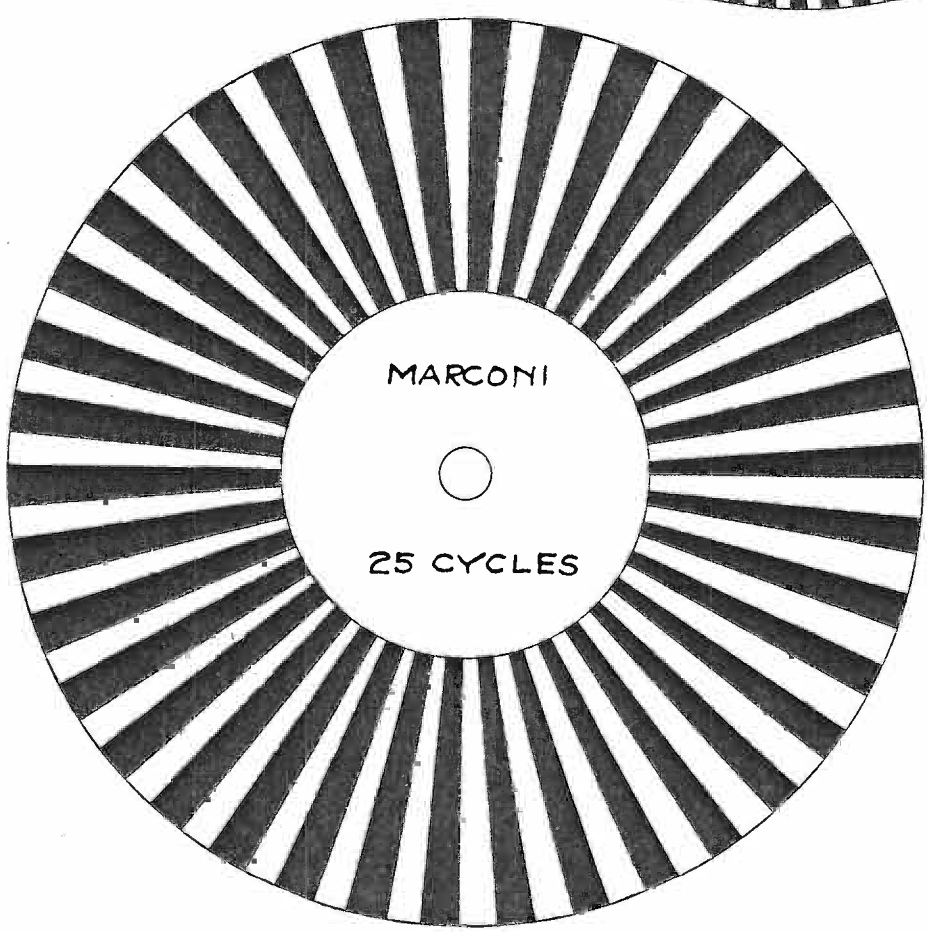
No	Name
P112	Resistor (20,000 & 500,000)
P113	" (100,000 & 250,000)
P114	" (25,000 & 500)
P115	" (100,000)
P116	" (750)
P117	Socket (551)
P118	" (224)
P119	" (247 Pent)
P120	" (280)
P121	Speaker
P122	Transformer (Power)
P123	Volume Control and Switch

SPEED INDICATOR

HOLD AN ELECTRIC LIGHT OVER THE REVOLVING DISC AND ADJUST THE SPEED REGULATOR OF THE PHONOGRAPH UNTILL THE LINES STAND STILL.

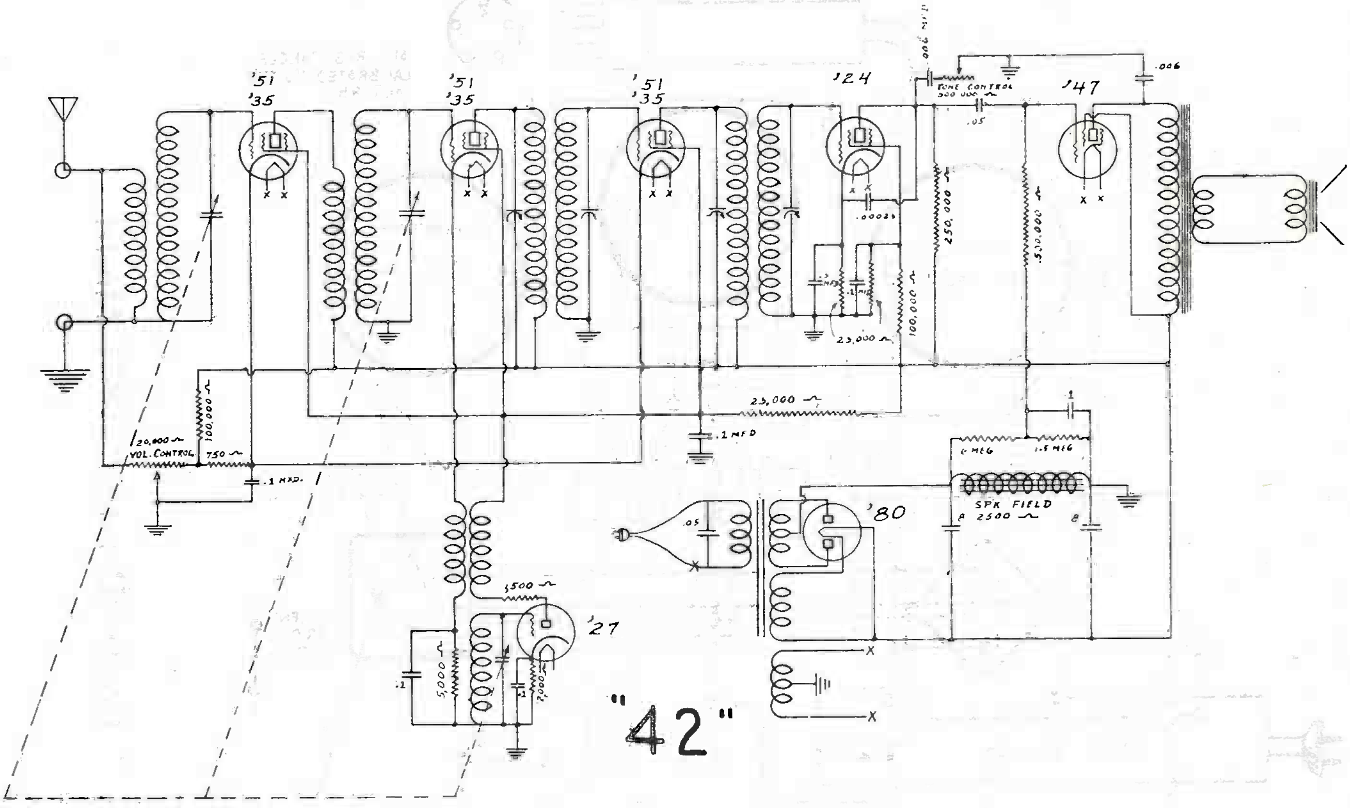


CUT OUT AND PASTE ON STIFF CARDBOARD.



USE THE 60 CYCLE DISC WITH A 60 CYCLE CURRENT AND THE 25 CYCLE DISC WITH 25 CYCLE CURRENT.

STUDEBAKER LABORATORIES



"42"

Tube	Type	Fil. Ac.	Plate	Screen	Bias.
Radio frequency	551	2.45	235	75	6 to 45
1st Detector	551	2.50	235	75	10
Int. Frequency	551	2.45	235	75	6 to 45
2nd Detector	224	2.45	75	40	4
Power Output	247	2.40	225	235	16*
Oscillator	227	2.5	75	....	10

*Effective voltage.

Parts List

S400 Coils—Set matched with Shields

S401 Condenser—Tuning.
S402 " 1 Mfd. 200 volt.
S403 " 1 Mfd. 400 volt.
S404 " .5 Mfd.
S405 " .05 Mfd.
S406 " .006 Mfd.
S407 " .00025 Mfd.
S408 " 8.0 Mfd. filter.
S409 " Insulating washers for 8.0 Mfd.

S410 Cord—A. C. Cord and Plug.

S411 Dial—Dial assembly with scale.

S412 Pilot Lamp—Lamp only.

S413 Resistors—Variable, tone control 500,000.
S414 " Variable, volume control 20,000
S415 " 6 Meg. graphite
S416 Resistors—1.5 Meg. graphite
S417 " 500,000 Ohm. "
S418 " 250,000 " "
S419 " 100,000 " "
S420 " 25,000 " " (1½ watt)
S421 " 5,000 " "
S422 " 2,000 " "
S423 " 1,500 " "

S424 Shields—Tube shield tops
S425 " Tube shield complete

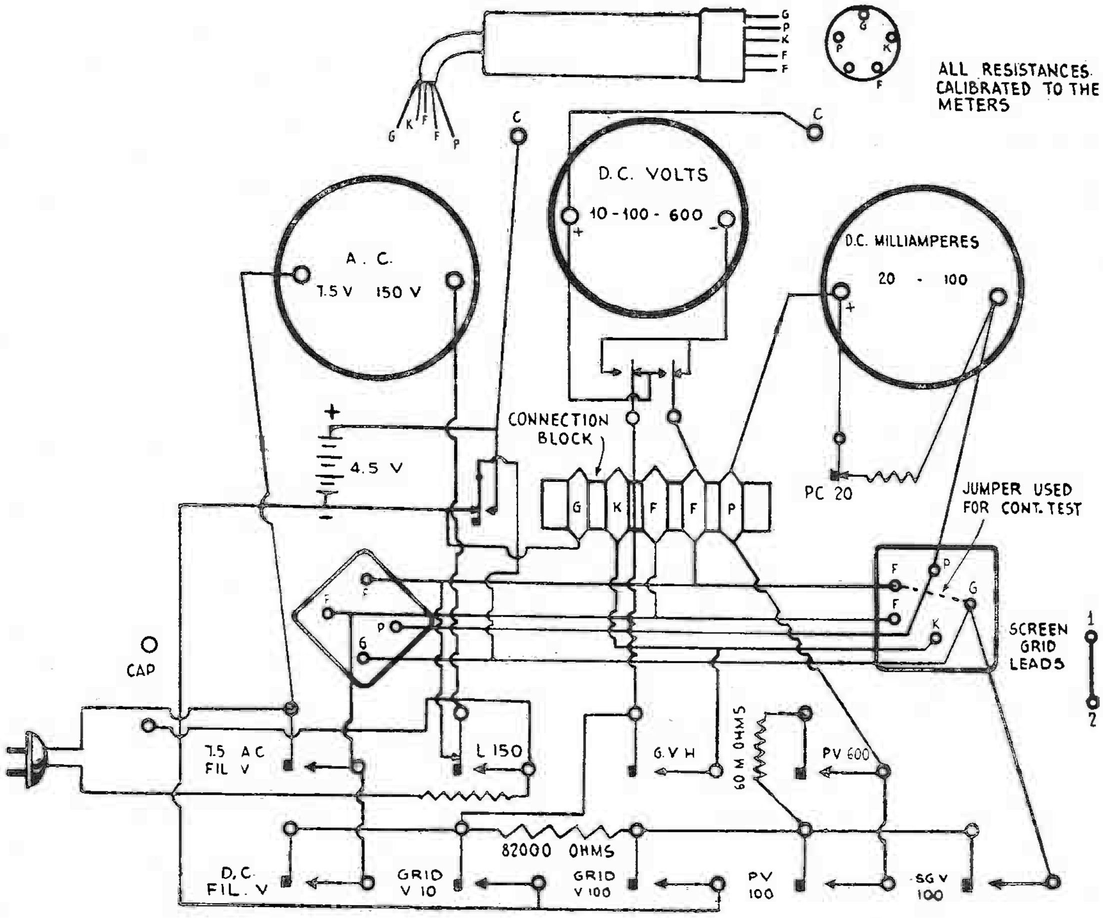
S426 Sockets—Type 551
S427 " Type 224
S428 " Type 247
S429 " Type 227
S430 " Type 280

S431 Speaker—Pentode speaker

S432 Transformers—Power transformer
S433 " Intermediate frequency transformer

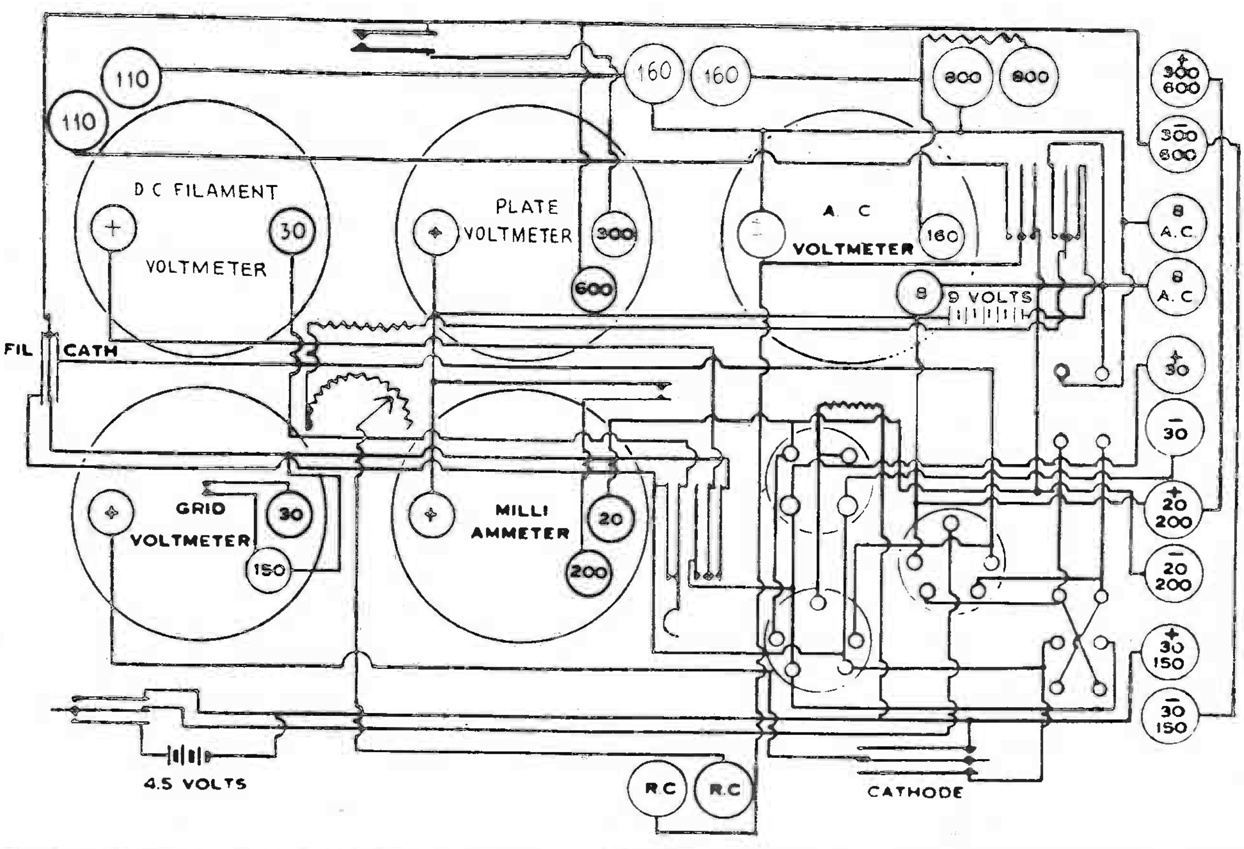
TEST EQUIPMENT SECTION

BEEDE ELECTRICAL INSTRUMENT CO.



Beede "Preston" 1931 Model

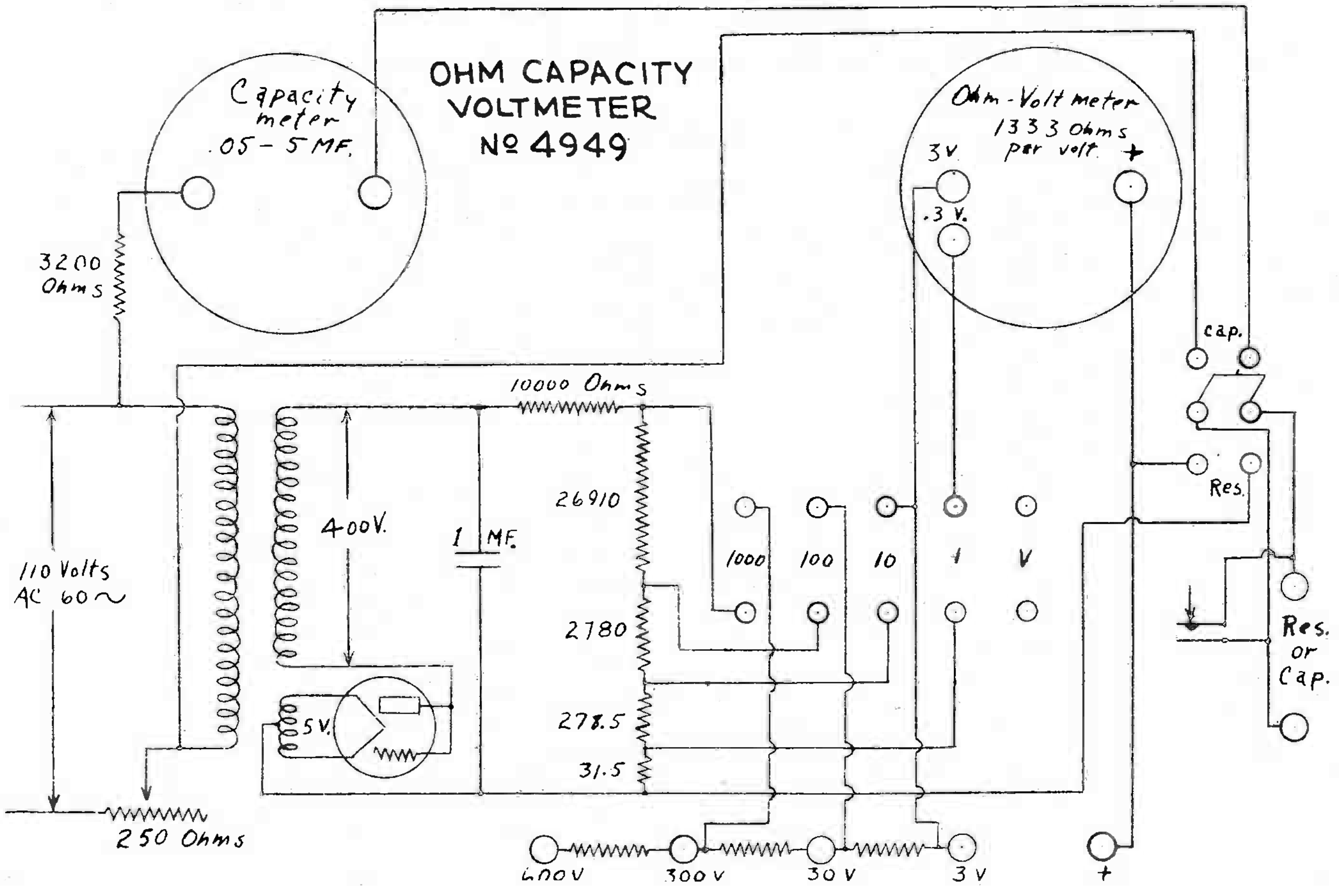
HICKOK ELECTRICAL INSTRUMENT CO.



Hickok "Model SG-4700"

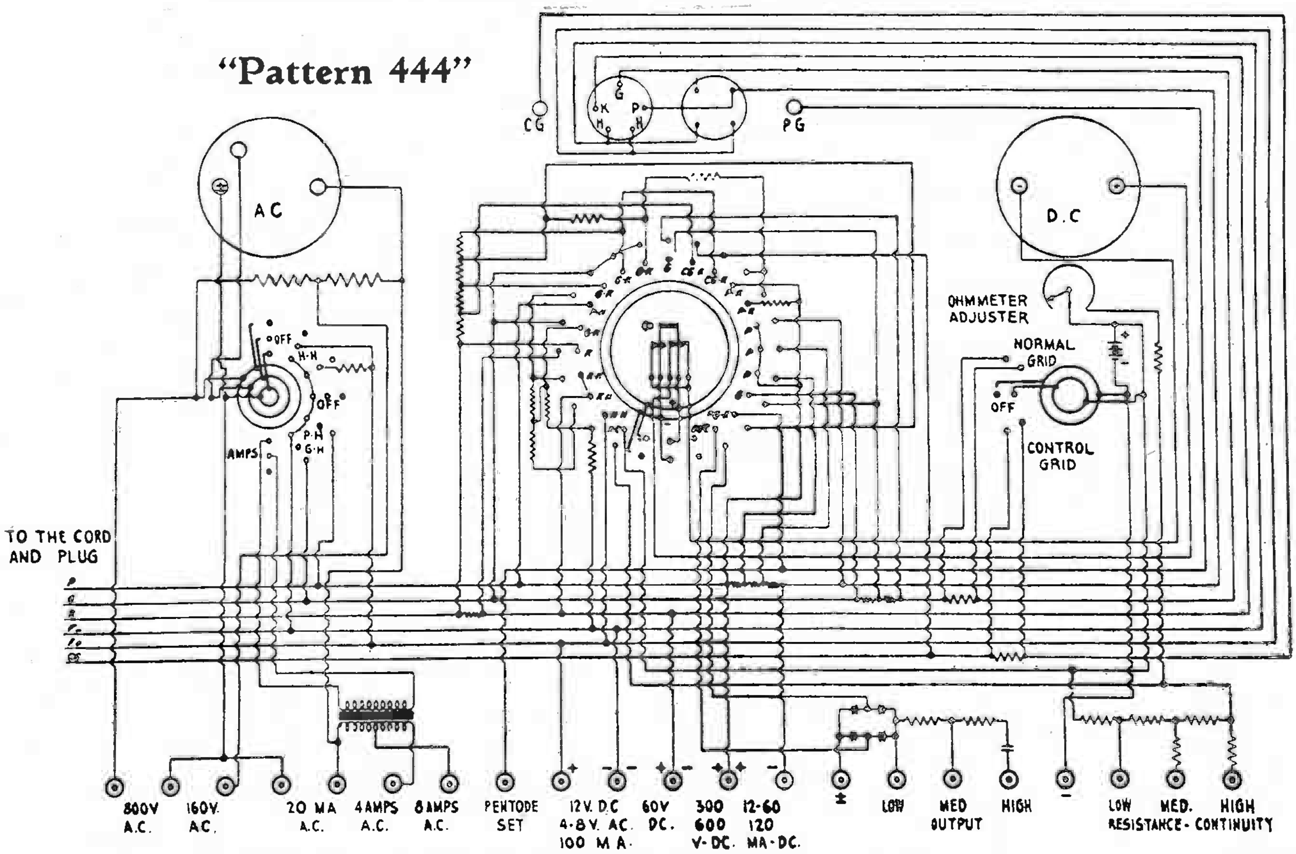
TEST EQUIPMENT SECTION

HICKOK ELECTRICAL INSTRUMENT CO.

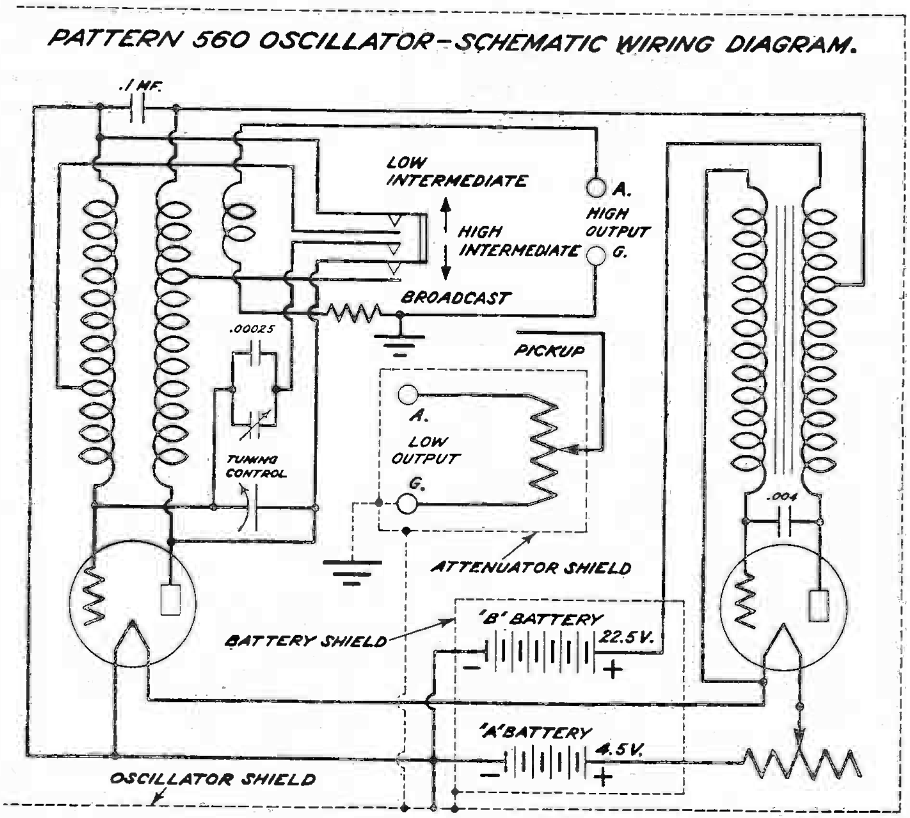


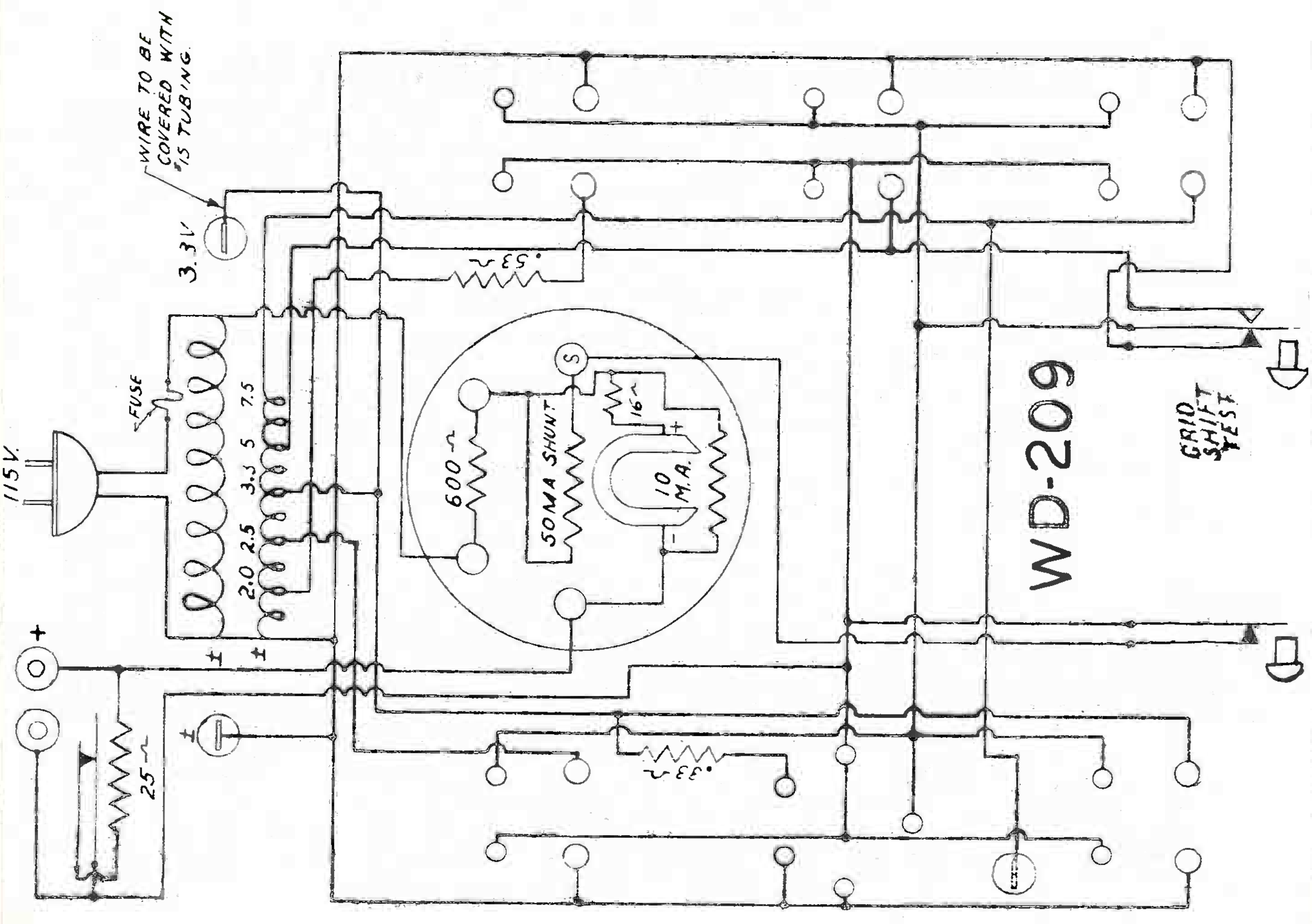
JEWELL ELECTRICAL INSTRUMENT CO.

"Pattern 444"

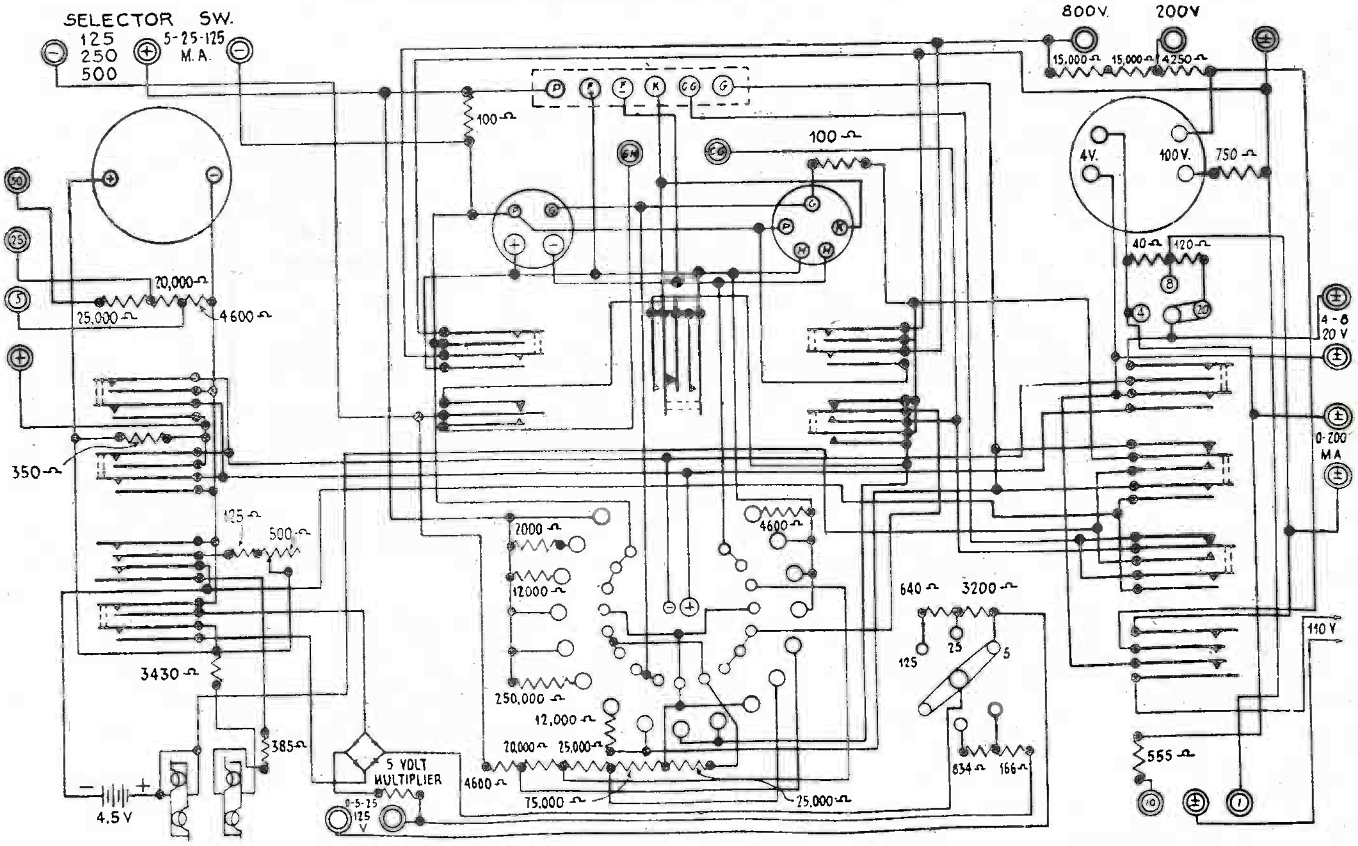


TEST EQUIPMENT SECTION
JEWELL ELECTRICAL INSTRUMENT CO.

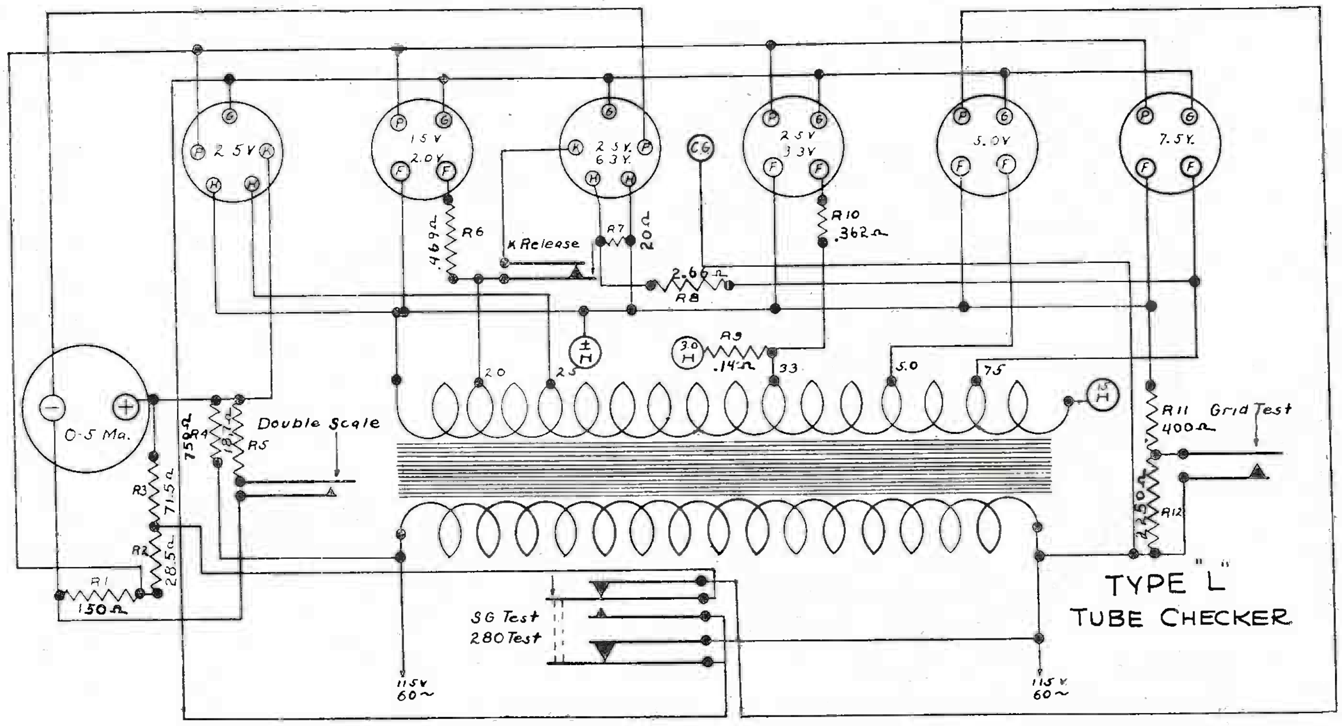




TEST EQUIPMENT SECTION
RADIO PRODUCTS CO., INC.

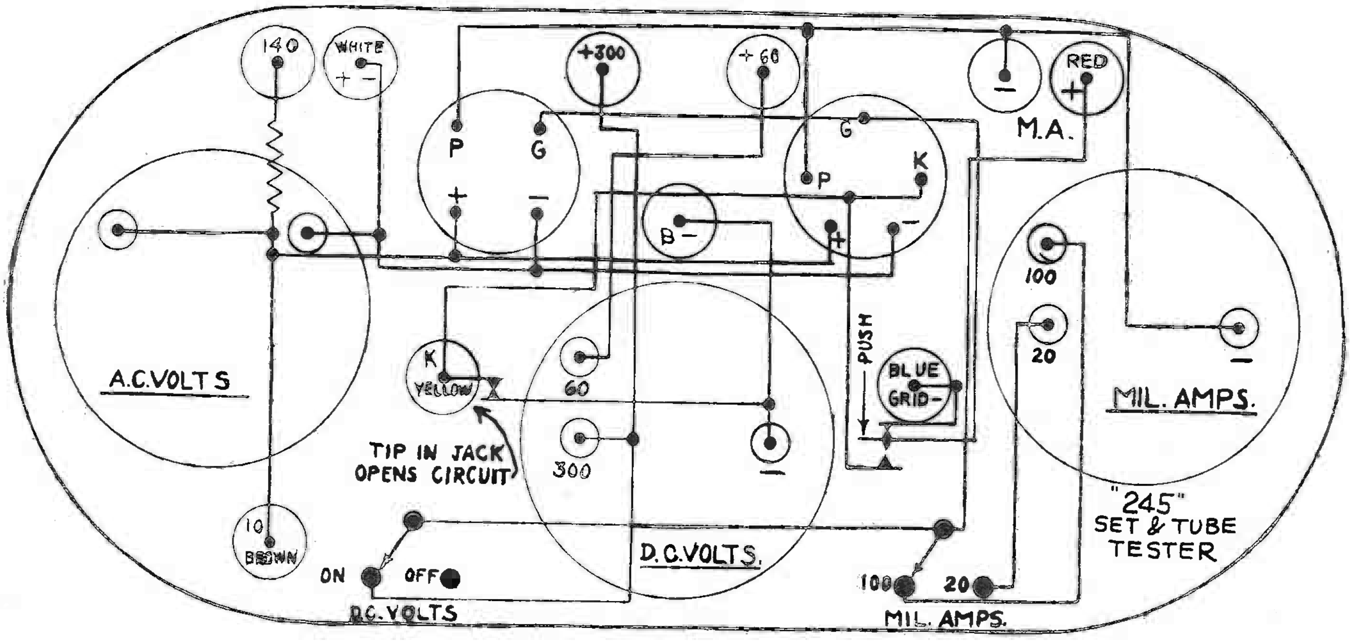


"TYPE 880"

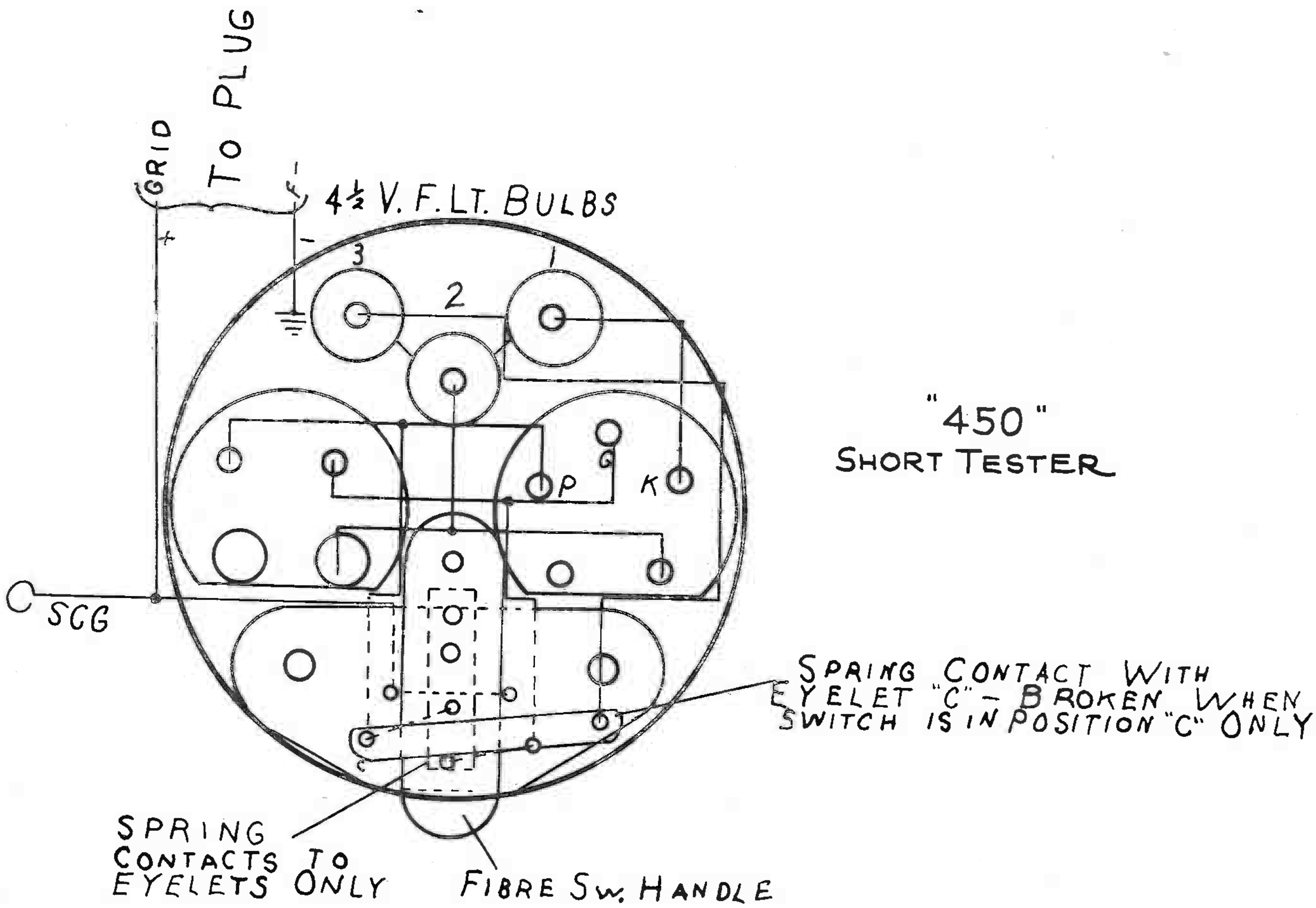


TYPE "L"
TUBE CHECKER

TEST EQUIPMENT SECTION
READRITE METER WORKS

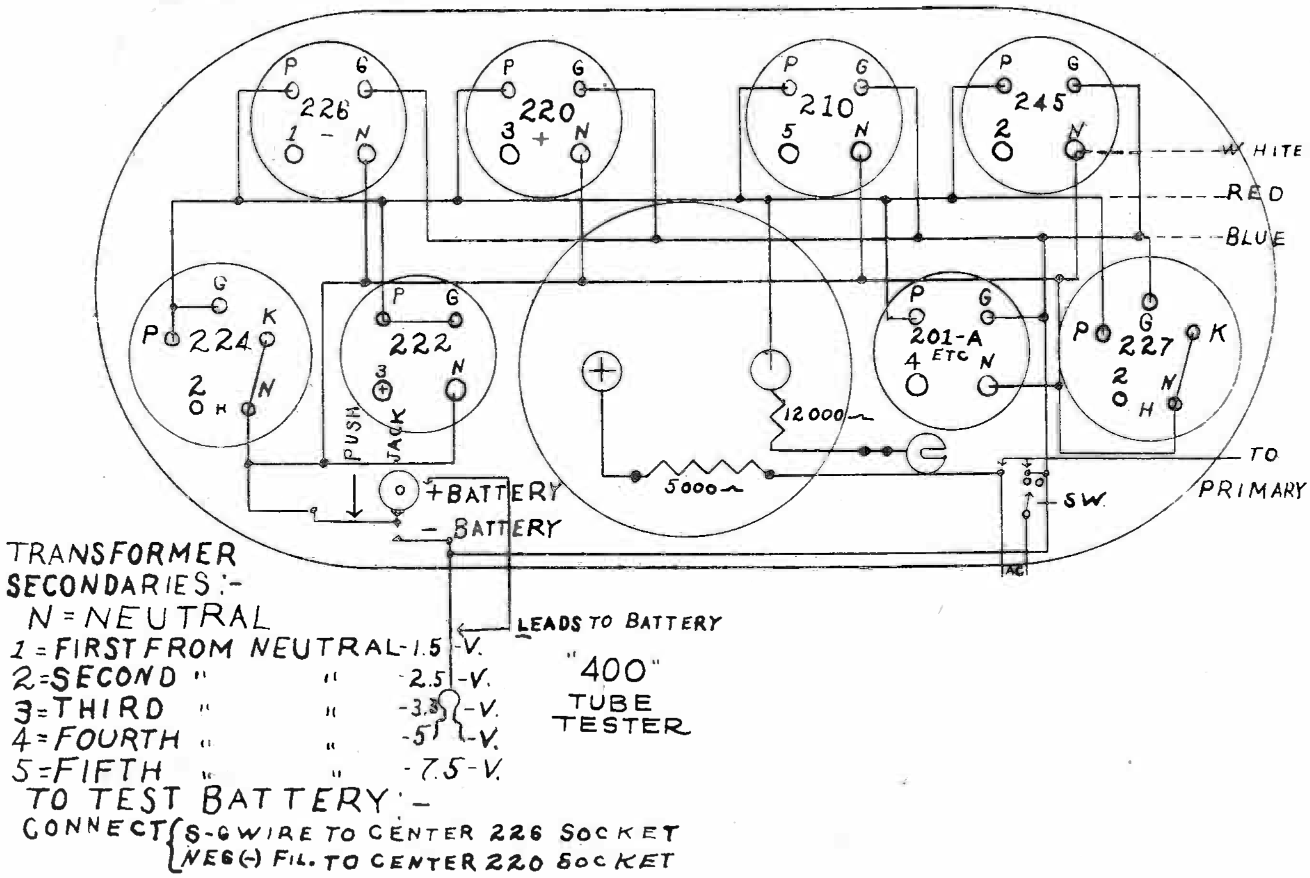


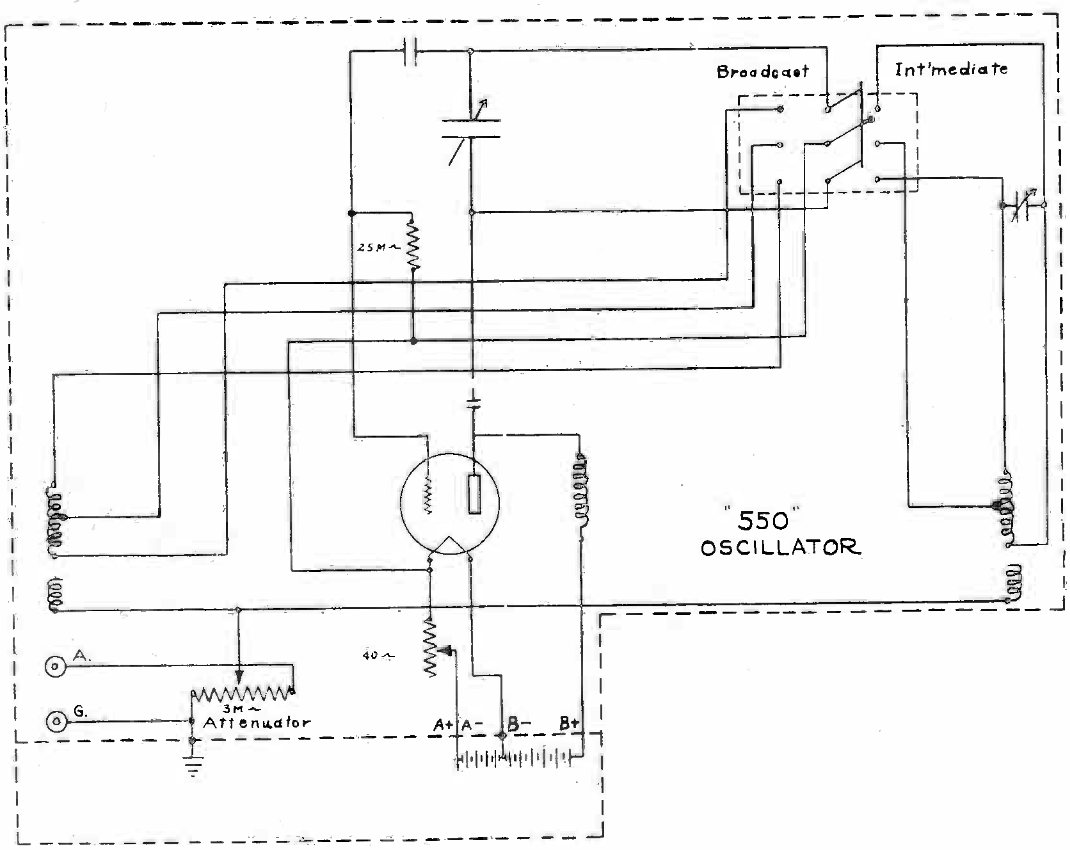
"245" SET & TUBE TESTER



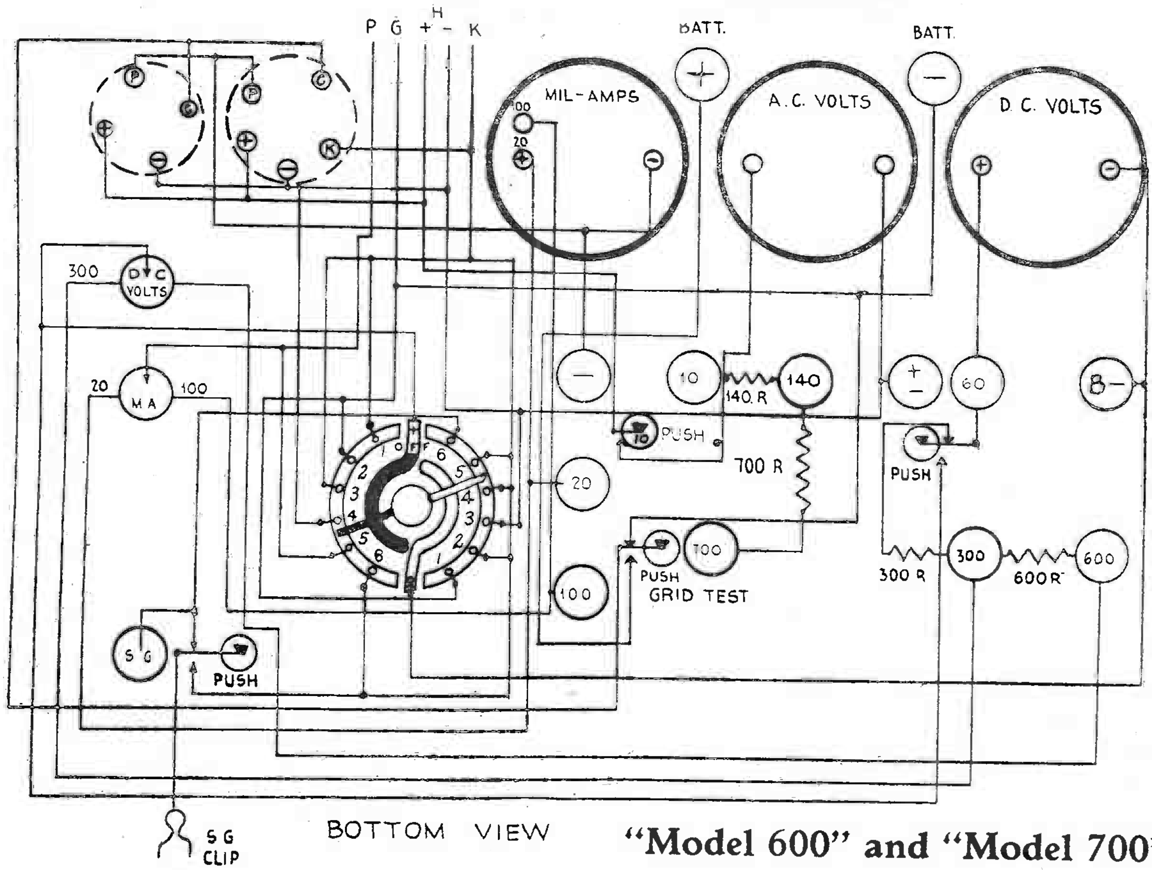
"450" SHORT TESTER

TEST EQUIPMENT SECTION
READRITE METER WORKS



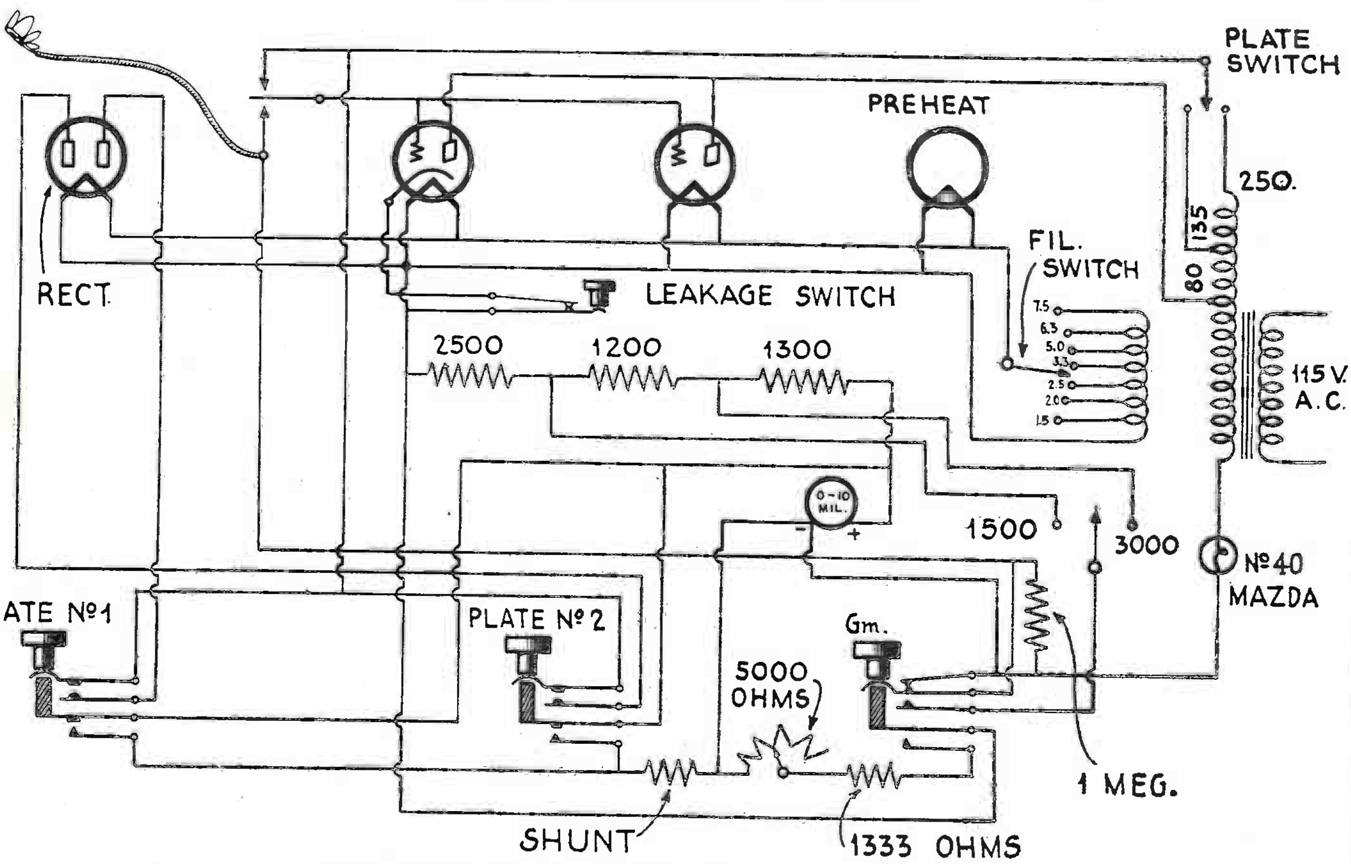


TEST EQUIPMENT SECTION
READRITE METER WORKS



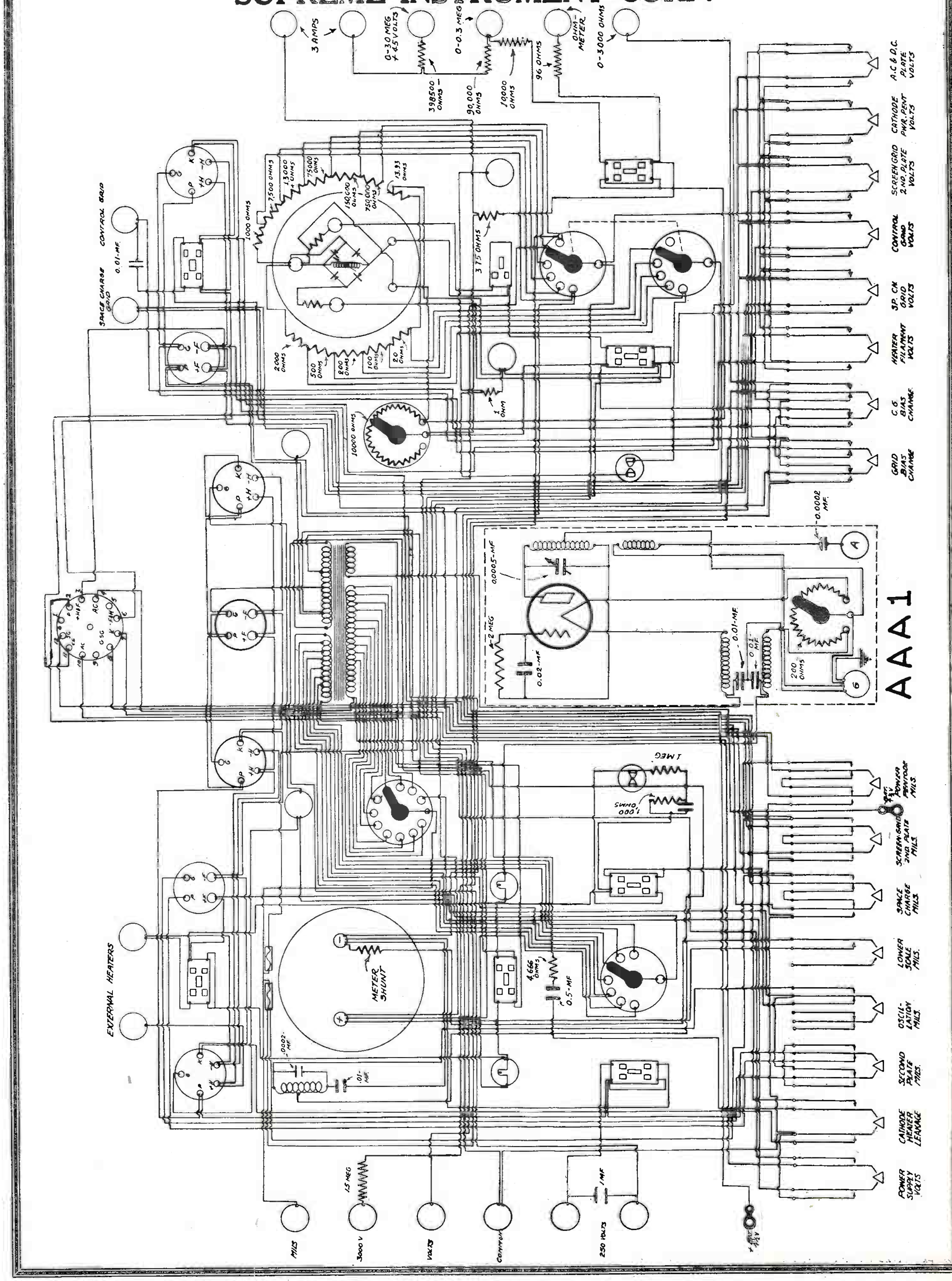
"Model 600" and "Model 700"

STERLING MFG. CO.

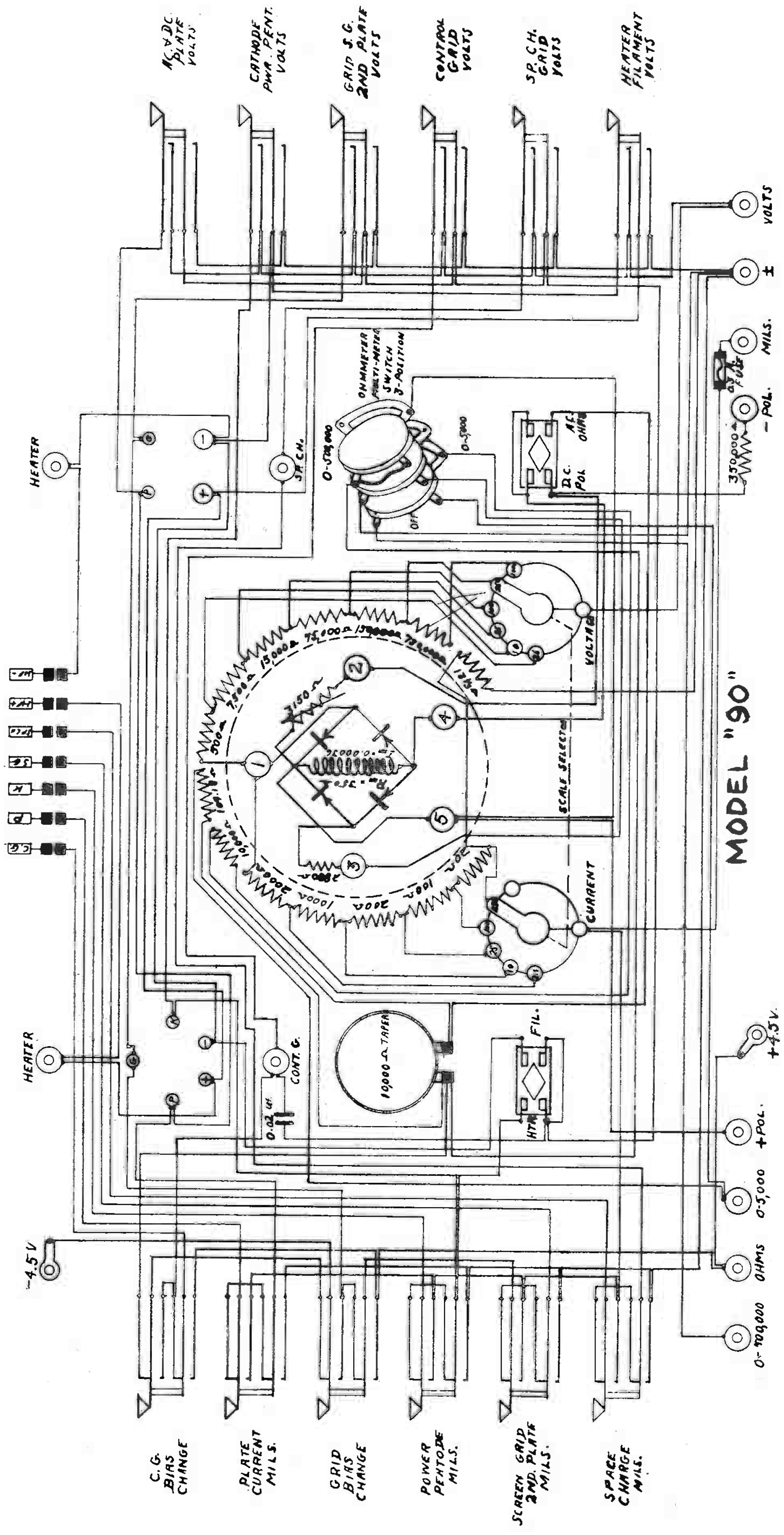


"R-517" Mutual Conductance Meter

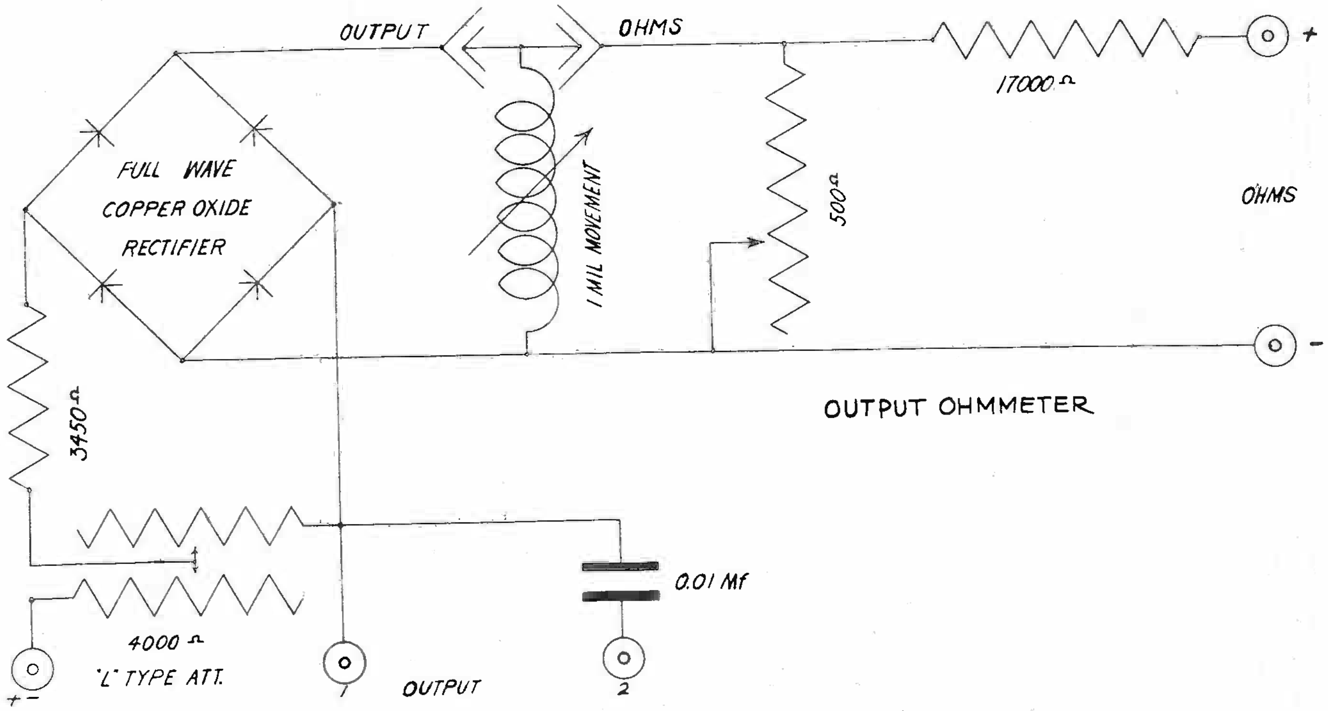
TEST EQUIPMENT SECTION
SUPREME INSTRUMENT CORP.



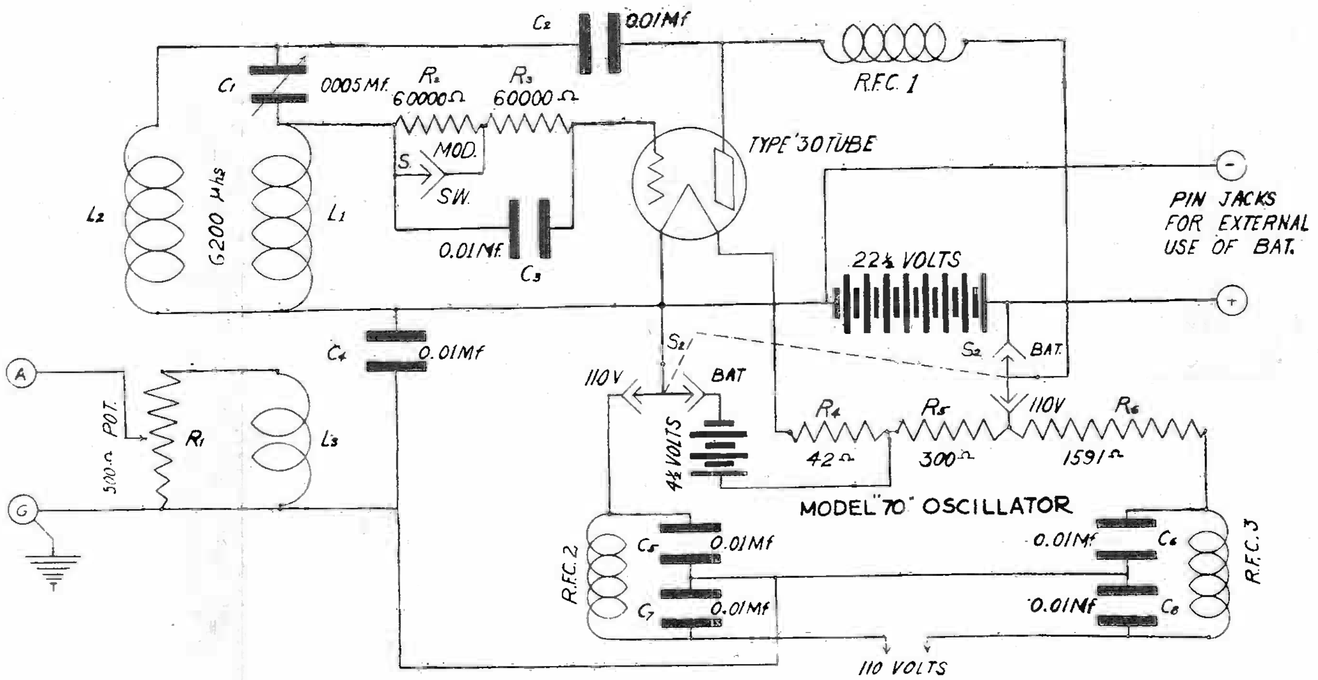
TEST EQUIPMENT SECTION
SUPREME INSTRUMENT CORP.



TEST EQUIPMENT SECTION
SUPREME INSTRUMENT CORP.

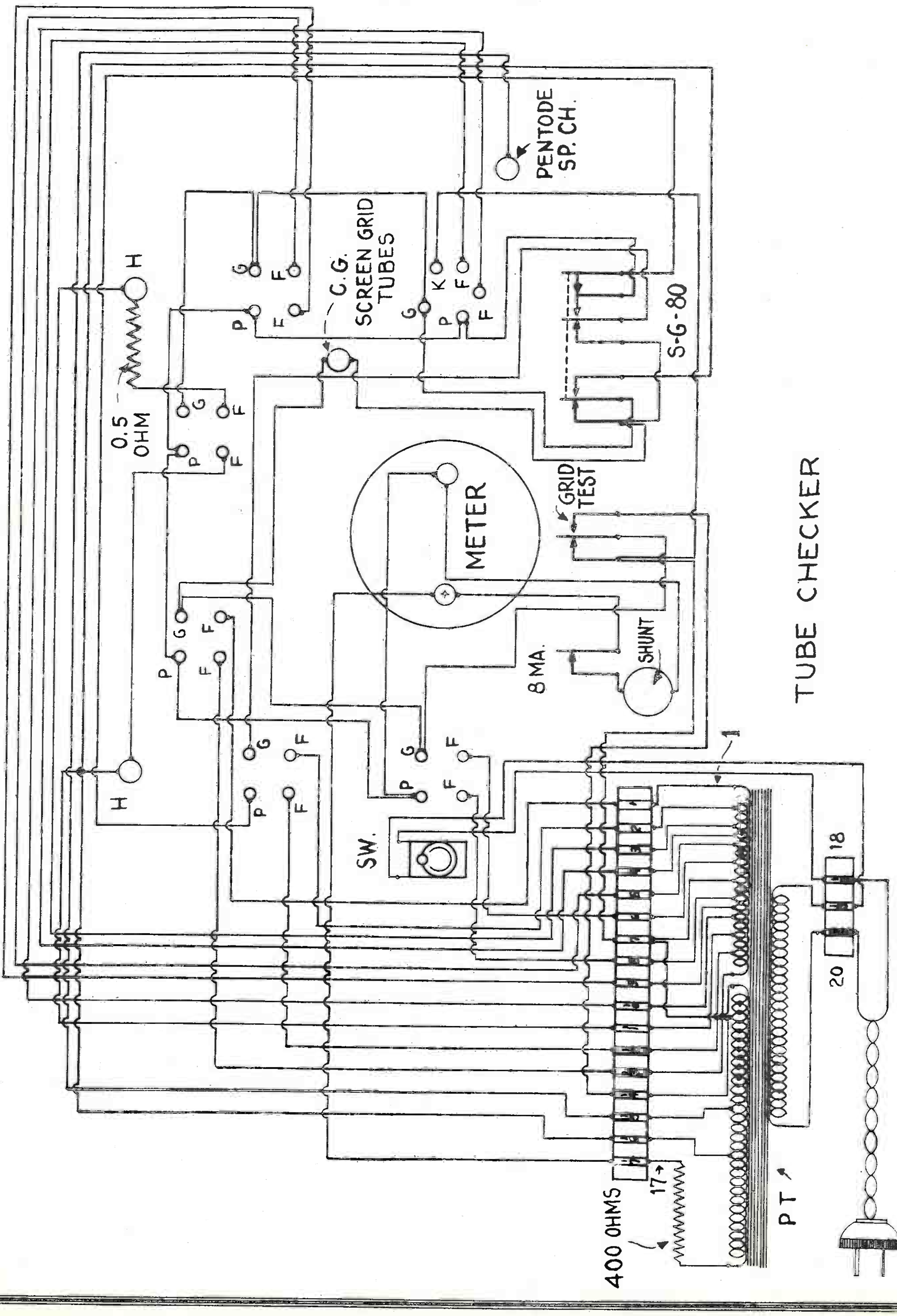


OUTPUT OHMMETER

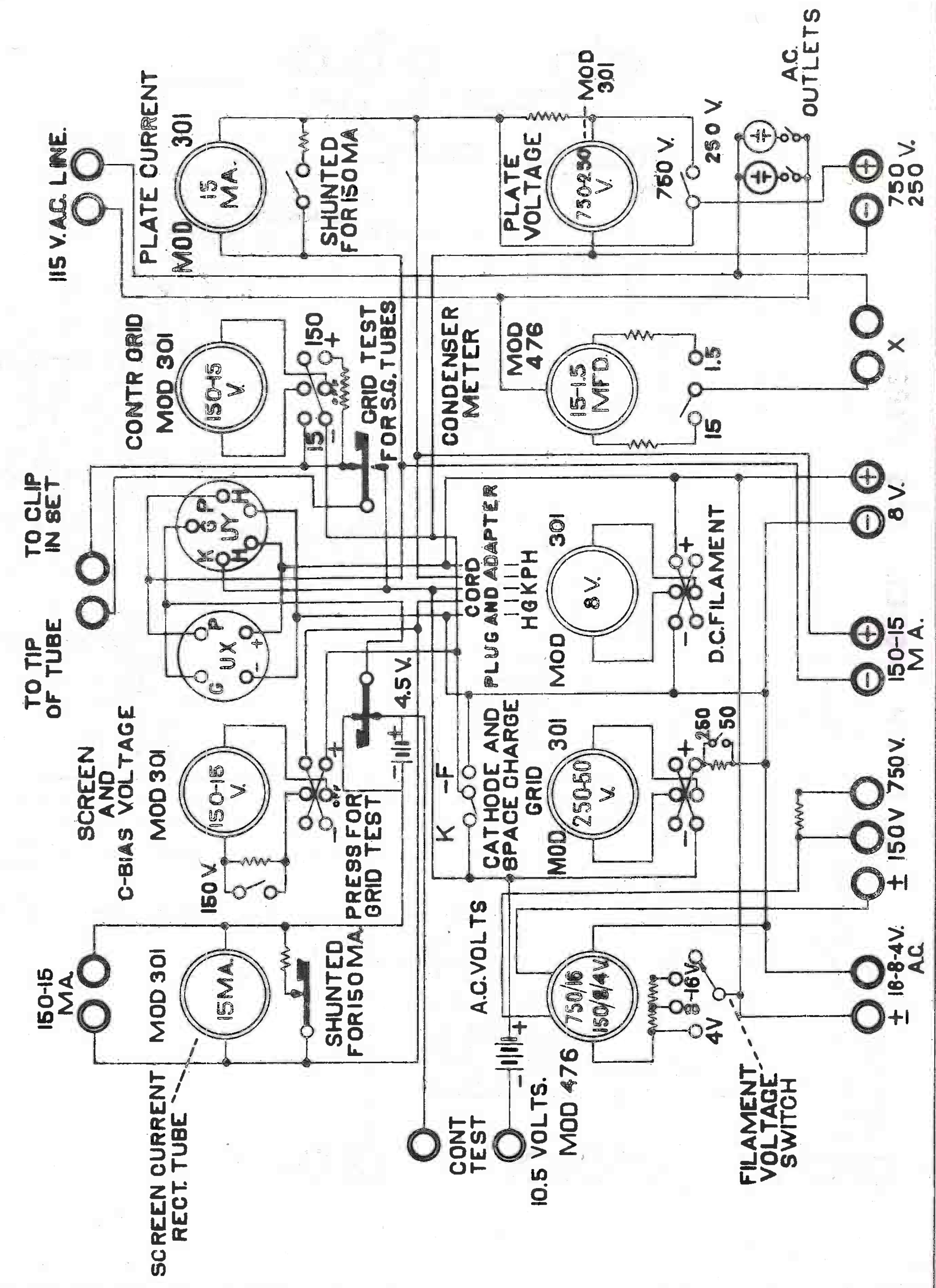


MODEL "70" OSCILLATOR

TEST EQUIPMENT SECTION
SUPREME INSTRUMENT CORP.



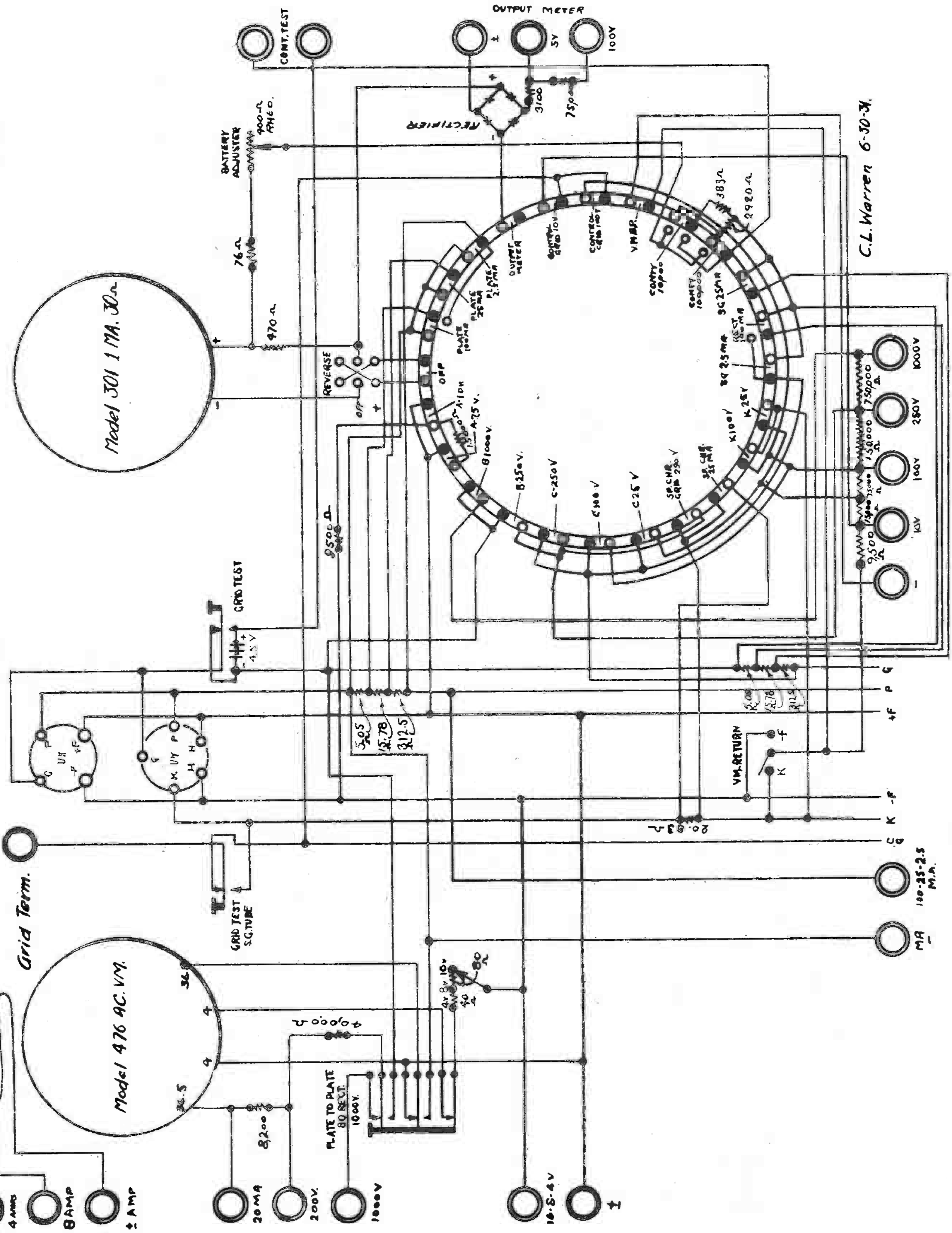
TEST EQUIPMENT SECTION
WESTON ELECTRICAL INSTRUMENT CORP.



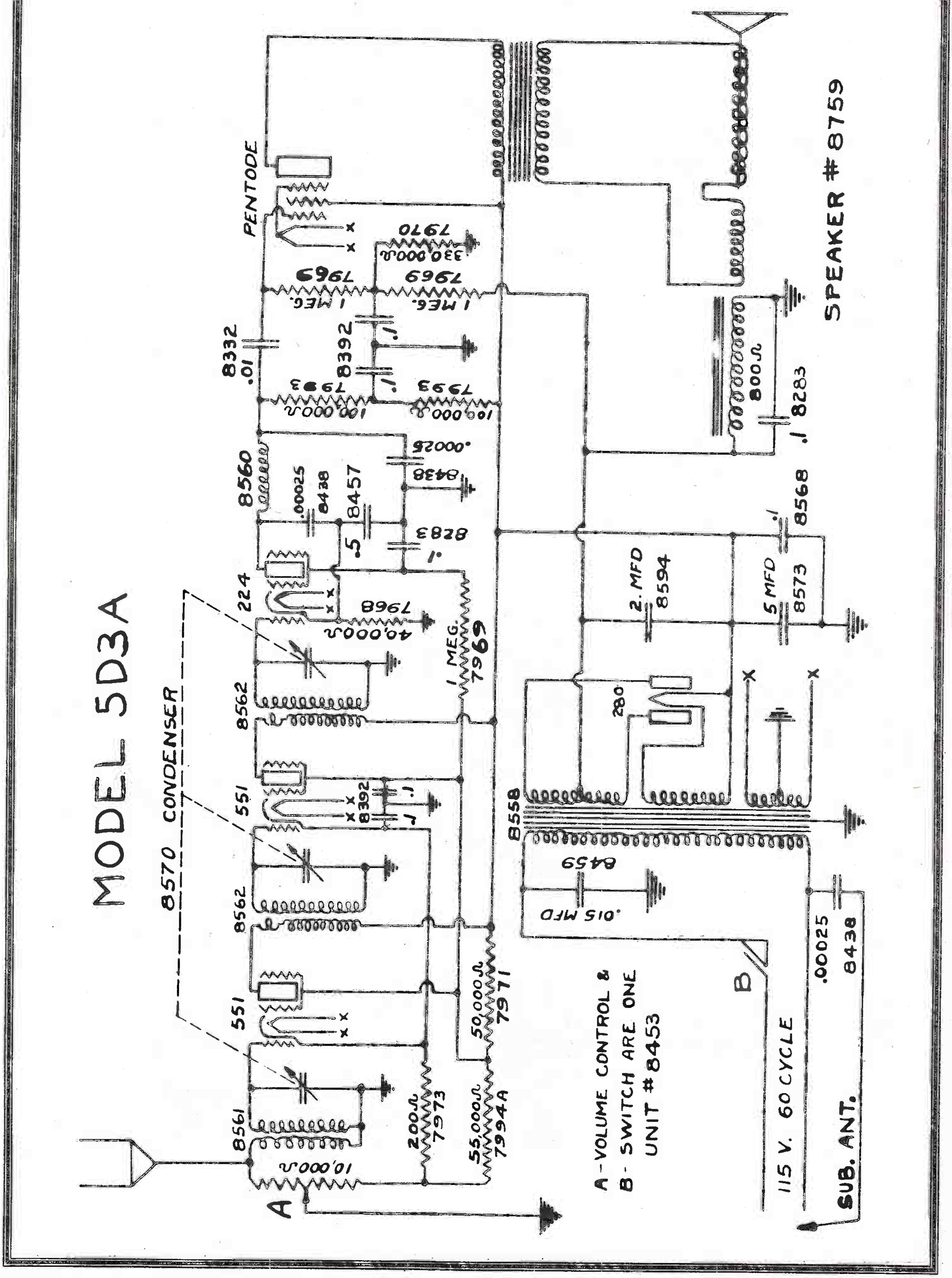
WIRING DIAGRAM OF RADIO TEST PANEL

TEST EQUIPMENT SECTION
WESTON ELECTRICAL INSTRUMENT CORP.

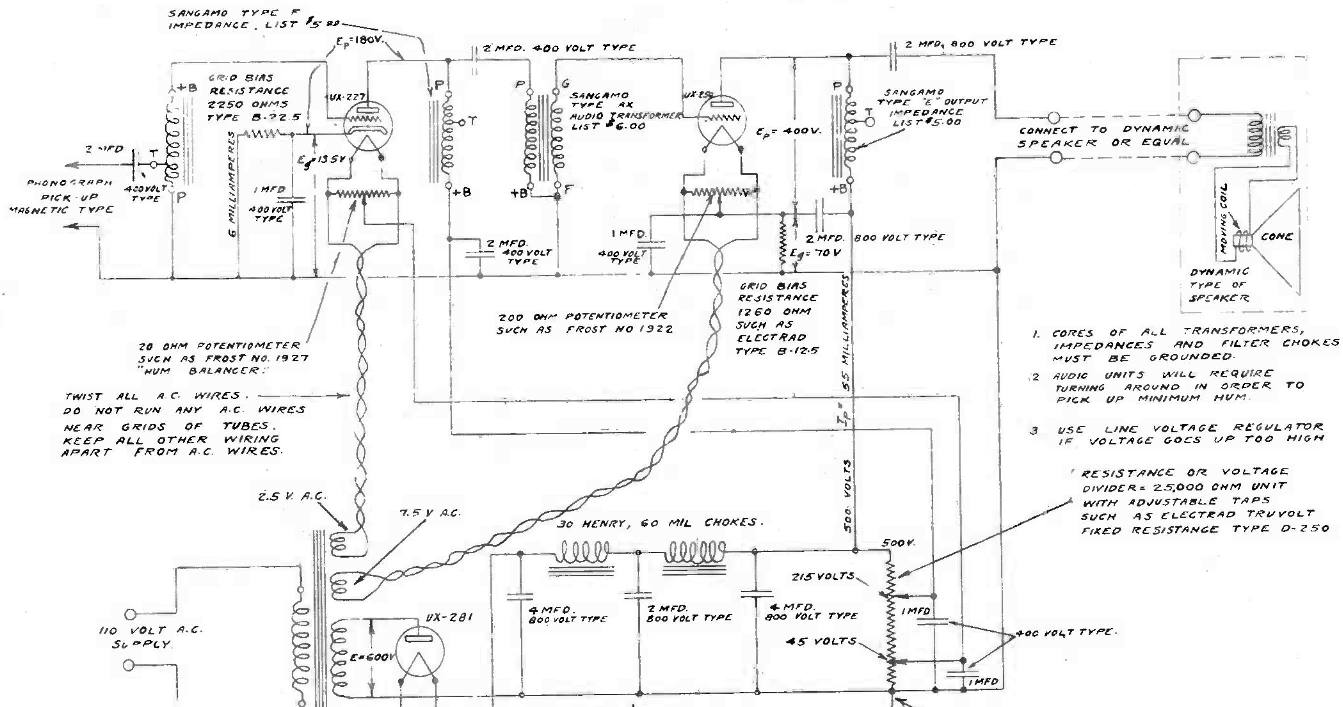
WESTON MODEL 566 TYPE 3



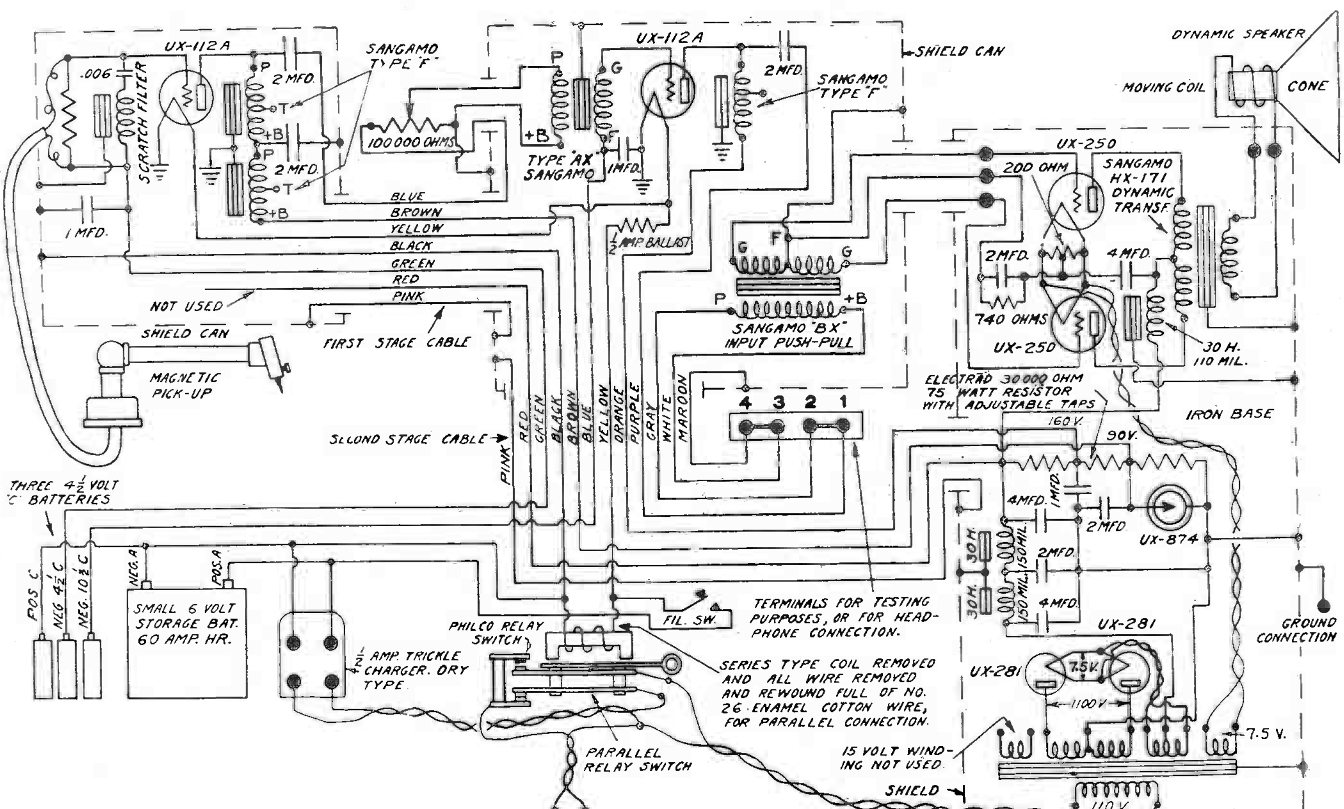
STERLING MFG. CO.



SANGAMO ELECTRIC CO.

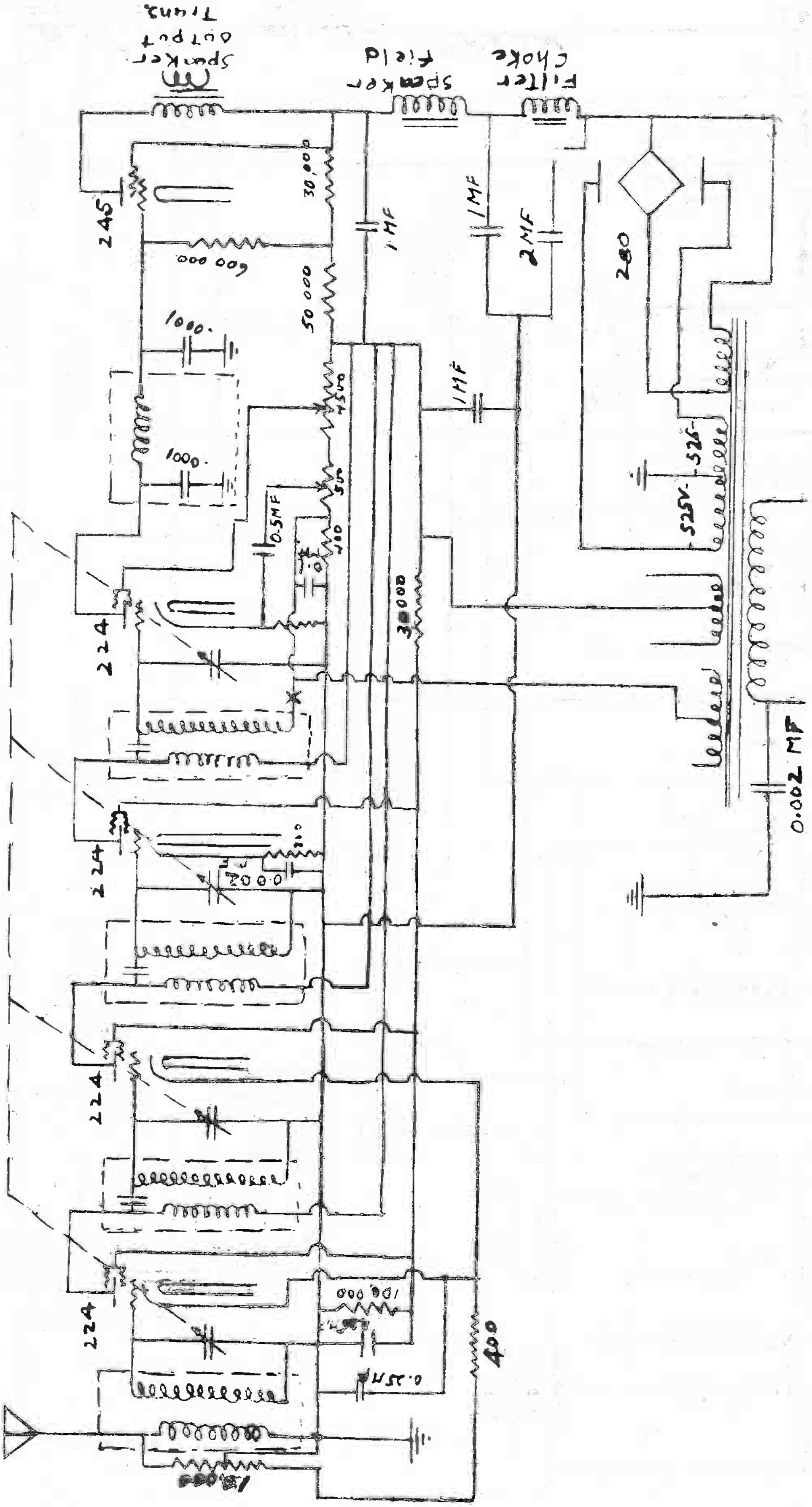


Single '50 Amplifier



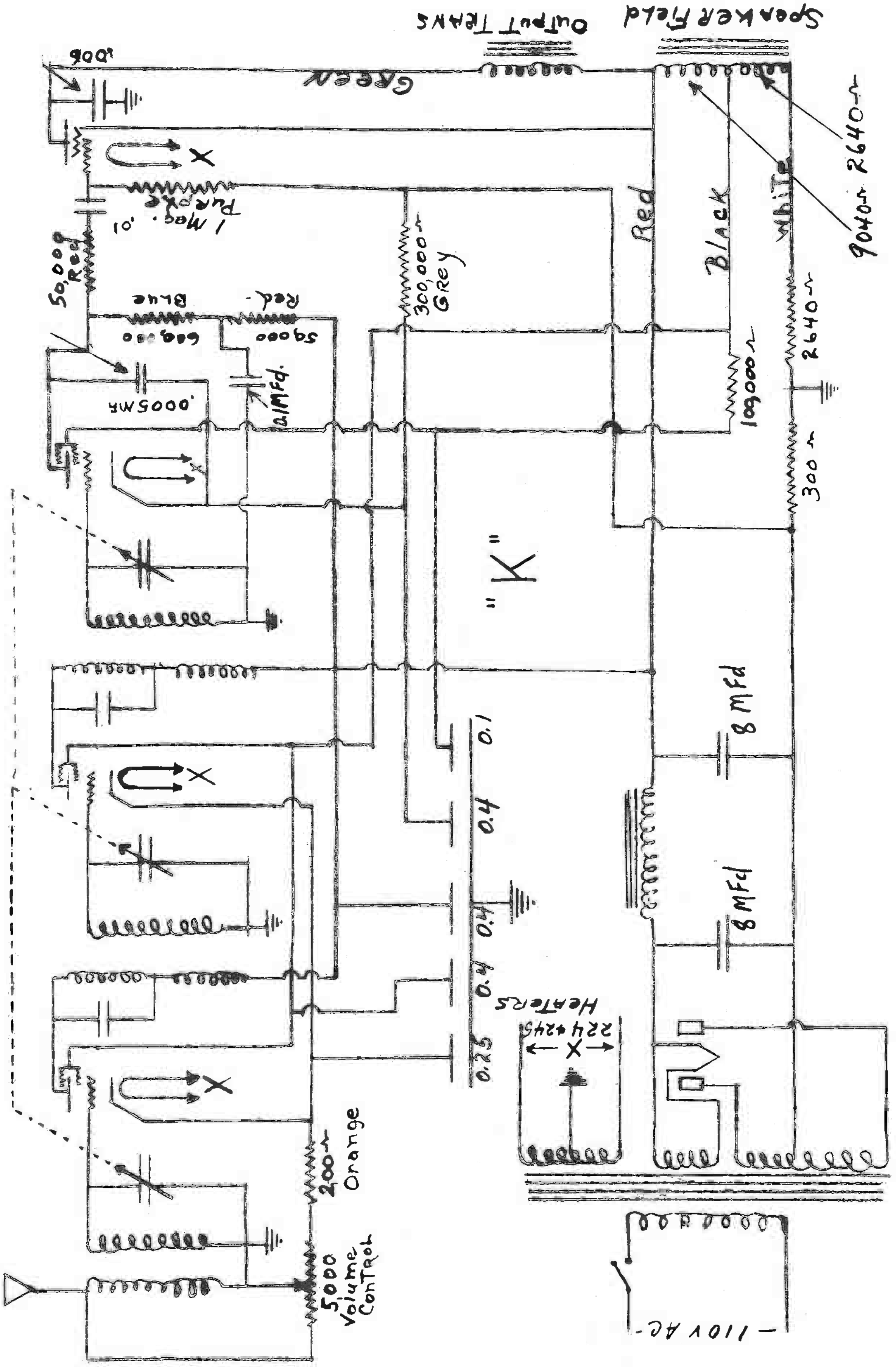
'50- 3 Stage Amp.

TRAV-LER MFG. CO.

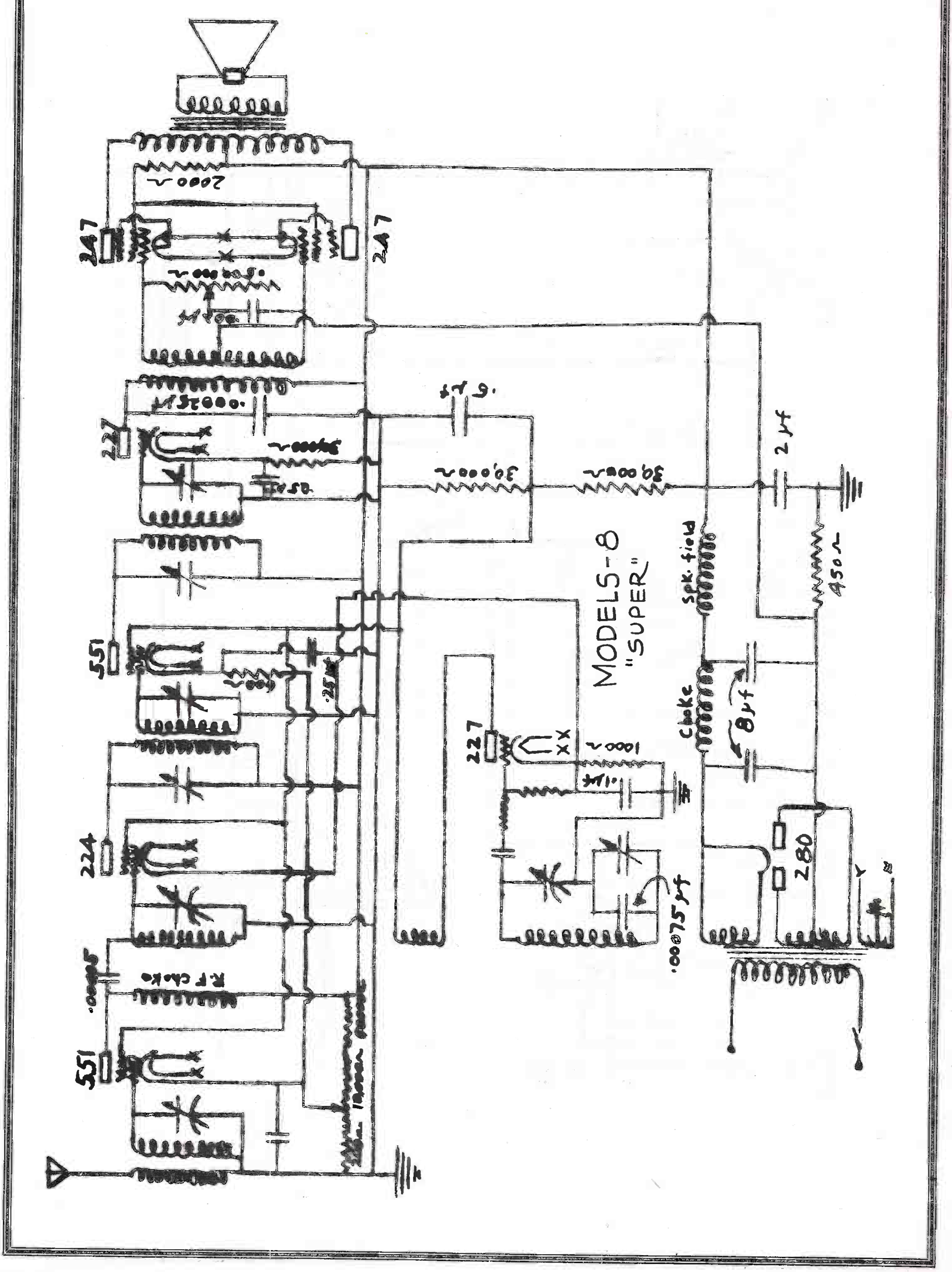


A.C. S.G. "DX"

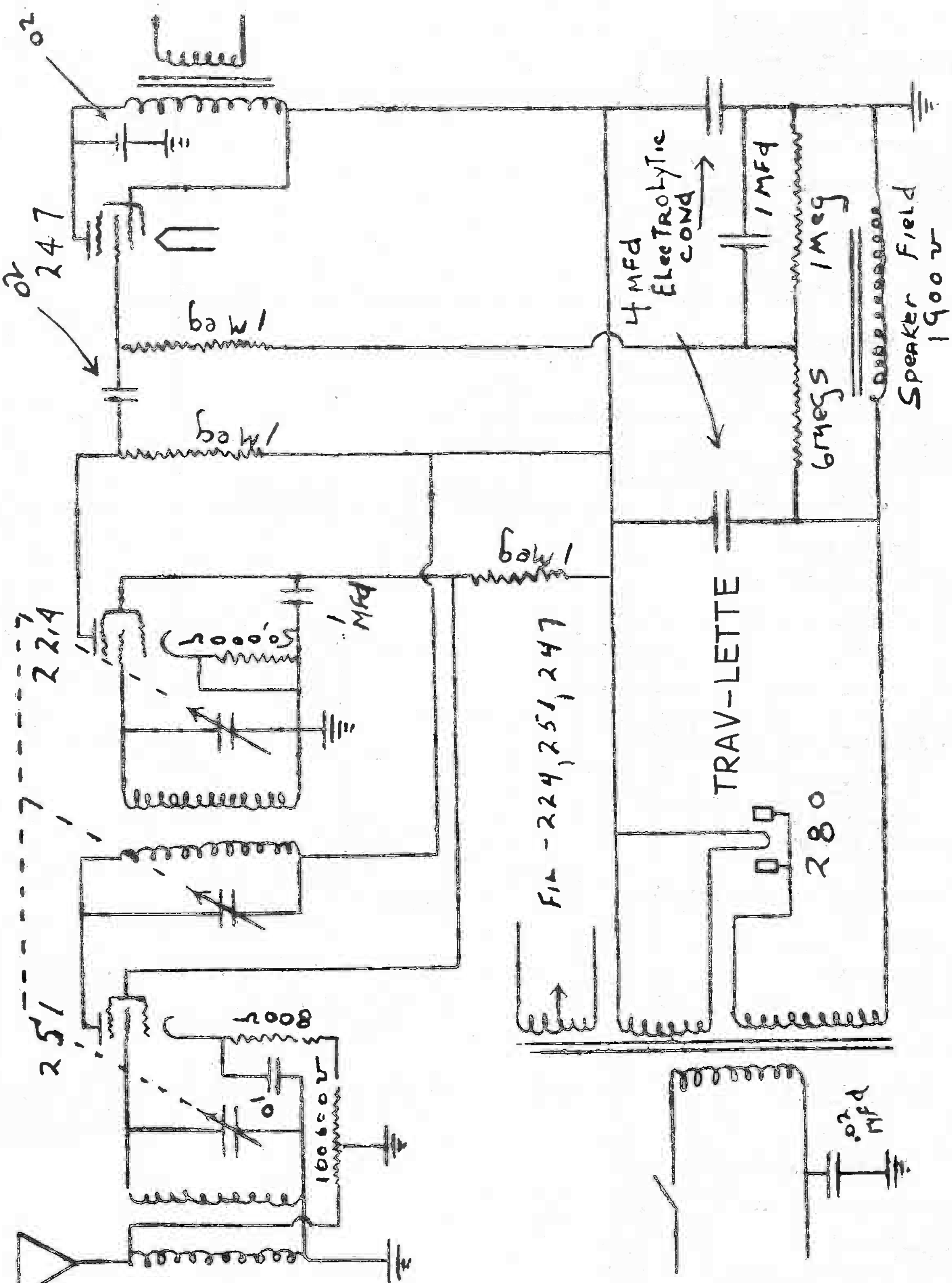
TRAV-LER MFG. CO.



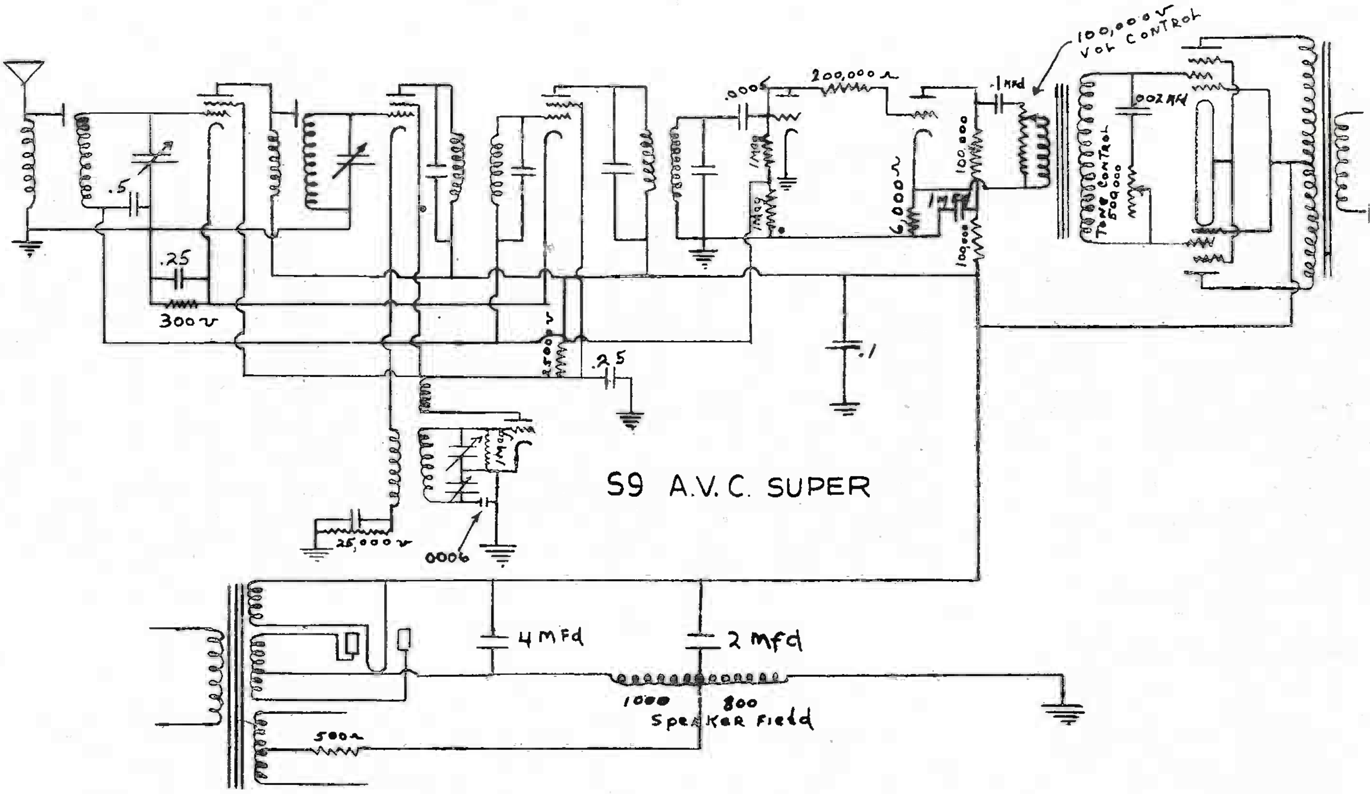
TRAV-LER MFG. CO.



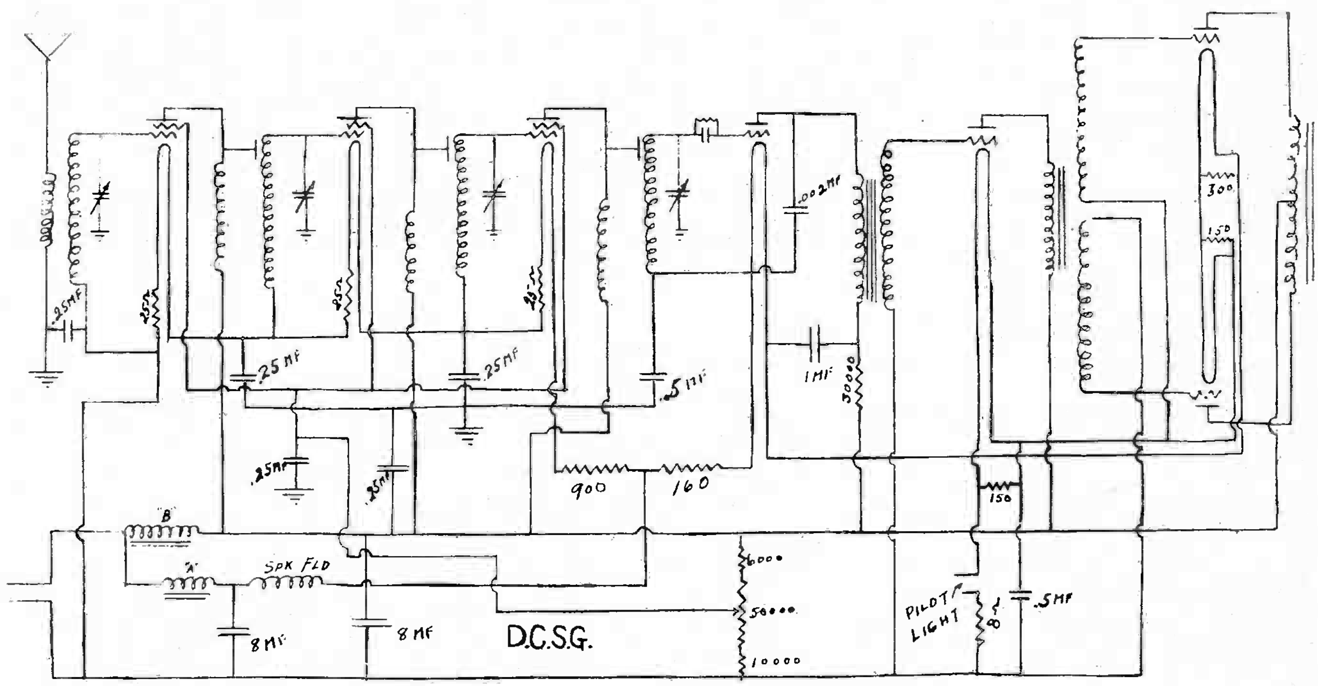
TRAV-LER MFG. CO.



TRAV-LER MFG. CO.



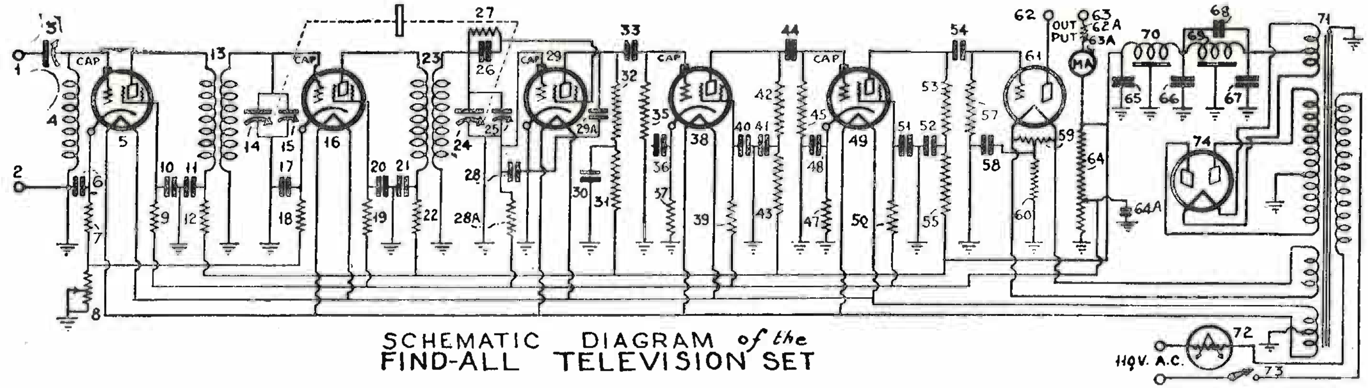
S9 A.V.C. SUPER



D.C.S.G.

TELEVISION RECEIVER SECTION

ALLIED ENGINEERING INSTITUTE



SCHEMATIC DIAGRAM of the FIND-ALL TELEVISION SET

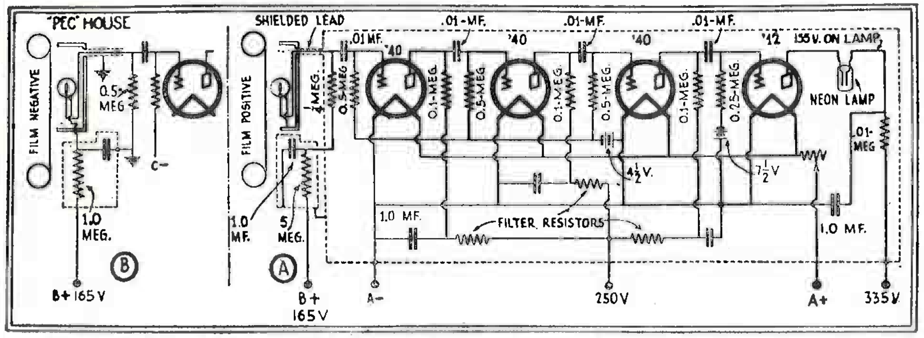
Complete List of Parts Required for the Find-All Television Receiver

1—.000365-mfd. Cardwell "Midway" Variable Condenser, type 407-C (3).
1—.0002-mfd. (each section) Dual Cardwell "Midway" Variable Condenser, type "C", (14, 24).
2—De-Jur-Amsco Single Varitors, 140-mf. maximum, type X-71 (15, 25).
1—Electrad Volume Control, type RI-202 (8).
1—Electrad Truvolt Fixed Resistor, type B-15 (60).
1—Electrad Truvolt Fixed Resistor, type B-30 (62A).
4—1,000 ohm Electrad Truvolt Flexible Wire Grid Resistors, type 2G-1000 (7, 18, 37, 47).
1—Electrad Truvolt Fixed Resistor Voltage Divider, type C-200, with extra tap (64).
1—Electrad Truvolt Type V-20 Center Tap Resistor (Optional) (59).
1—Power Switch (73).
1—.0001-mf. Aerovox Fixed Mica Condenser, type 1460 (26).
1—0.1-mf. Aerovox Fixed Condenser, type 207 (68).
1—.001-mf. Aerovox Fixed Mica Condenser, type 1460 (optional) (29A).
3—0.25-mf. Aerovox Fixed Condensers, type 207 (33, 44, 54).
1—1-mf. Aerovox Fixed Condenser, type 261 (28).
6—2-mf. Aerovox Fixed Condensers, type 207 (36, 40, 48, 51, 52, 58).
2—0.1-mf. (each section) Triple Section, Metal Case Aerovox Condensers, type 461-31 (6, 10, 11) and (17, 20, 21).
2—8-mf. Aerovox Hi-Farad Dry Electrolytic Condensers, type G5-8 (66, 67).
1—16-mf. Aerovox Hi-Farad Dry Electrolytic Condensers, type G5-88 (65).
2—4-mf. Aerovox Fixed By-Pass Condensers, type 207 (30, 41).
8—50,000-ohm Durham Metallized Resistor Powerohms, with Pigtail Connectors, type MF-4 (9, 19, 28A) (32, 39, 42, 50, 53).
(NOTE: Resistors (34, 46, 56) are omitted in revised diagram; these are not needed.)
1—4-mf. Aerovox Fixed By-Pass Condenser, type 207 or G5-4 (64A).
3—25,000-ohm Durham Metallized Resistor Powerohms, with Pigtail Connectors, type MF-4 (31, 43, 55).
1—50,000-ohm Durham Metallized Resistor Grid Leak, with Pigtail Connector (27).
2—75,000-ohm Durham Metallized Resistor Powerohms, with Pigtail Connectors (12, 22), type MF-4.
3—250,000-ohm Durham Metallized Resistor Powerohms, type MF-4 (33, 45, 57).
1—Find-All Shielded Television Antenna R.F. Inductance Coil (4).
2—Find-All Shielded Television R.F. Transformers (13, 23).
1—Acratest 45-type Power Transformer (Television Model) (71).
1—Acratest Double Filter Choke (two 30 Henry—80 mil. Chokes in Single Case) (69, 70).
1—Roll Corwico Braidite Hook-up Wire, Solid Core.
5—Five-Prong Wafer-type Sockets (5, 16, 29, 38, 49).
3—Four-Prong Wafer-type Sockets (61, 72, 74).
1—Amperite Self-Adjusting Line Voltage Regulator, type 8A-5 (72).
4—Binding Posts (1, 2) and (62, 63).
3—Tube Shields.
5—124 Arcturus Screen-Grid Tubes (5, 16, 29, 38, 49).
1—145 Arcturus Power Output Tube (61).
1—180 Arcturus Rectifier Tube (74).
1—Weston Milliammeter, 0-50 ma. type 301 (63A).
1—Aluminum Chassis, 12 gauge, 12" x 15" x 3½" high.
2—Vernier Dials.
(NOTE—Numbers in Parentheses refer to Corresponding Numbers Used to Mark Parts on Diagrams.)

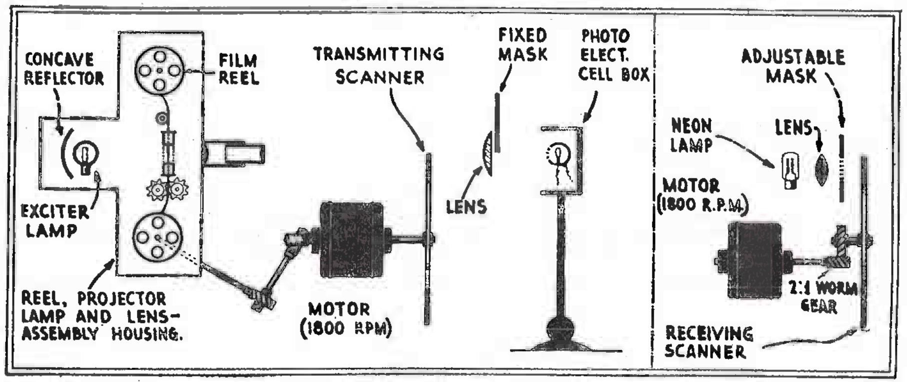
Radiovisor Parts Required

1—Jenkins Radiovisor Kit Assembly, type RK.
1—Low Internal Capacity Neon Lamp, type 601.
1—Lens Assembly, type RK-11.
1—Jenkins Self-Synchronizing Motor, type 502, with necessary amplifier Kit, type SK-30 (optional).

TELEVISION RECEIVER SECTION

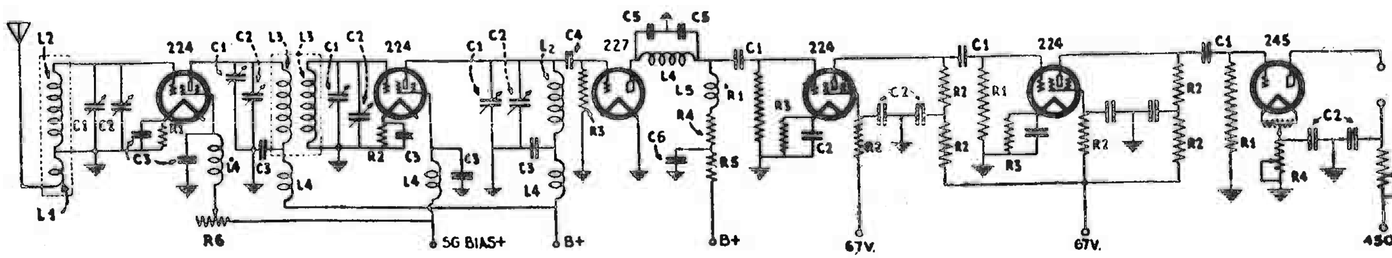


The electrical circuit of the home television projector and receiver described here; the phase-shifter is connected as shown at the left (B) for use with negative films; as at the right (A) with positives. It is the resistor and condenser shown in the grounded shield (dotted lines).



Arrangement of "movie" television projector at left; receiver at right.

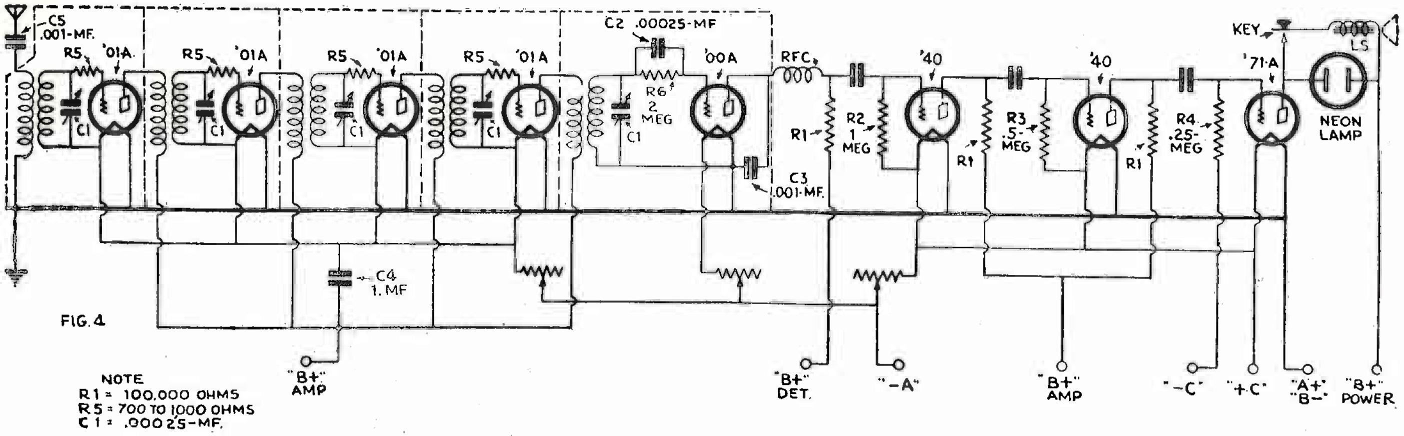
INSULINE CORPORATION OF AMERICA



Radiovision receiver with band-pass filter, and 15 to 30,000 cycle radiovision amplifier—L1, 24 turns No. 32 DCC, 1 in. diameter; L2, 48 turns No. 32 DCC, 1 in. diameter; L3, 48 turns No. 32 DCC, 1 in. diameter (ends together); L4, R. F. choke; L5, 20-100 mh. choke; C1, .00015-mf. gang condenser (shielded); C2, trimmer condensers; C3, .01 mf. radio frequency by pass condenser; C4, .0001 mf. grid condenser; C5, .001-mf. by pass condenser; C6, 1 mf.; R1, 500 ohms.; R2, 500 ohms.; R3, 2 meg.; R4, 30,000 ohms.; R5, 20,000 ohms.; R6, 0-200,000 variable resistor; C1, .2 mf.; C2, 1 mf.; R1, .25 meg.; R2, .05 meg.; R3, 1000 ohms.: R4, 2000 ohms variable; R5, 2500 ohms variable. The neon tube connects in a '45 tube plate circuit.

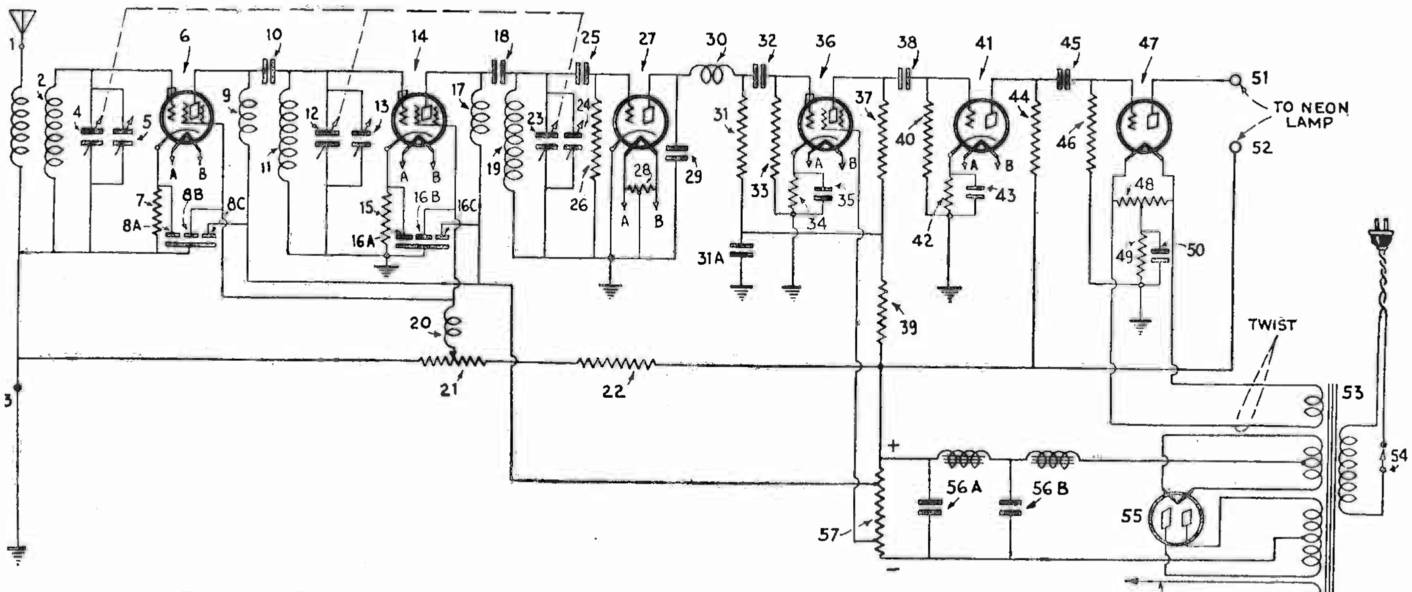
NATIONAL RADIO INSTITUTE

TELEVISION RECEIVER SECTION



Shows wiring diagrams of the Stair-Winters television tuner and amplifier, the latter utilizing three stages of resistance coupling. A key or switch cuts the loudspeaker out of circuit and the neon tube in circuit.

STAIRS - WINTERS CO.



JENKINS TELVISION CORPORATION

Complete wiring diagram of new Jenkins television receiver. The numbers correspond to those on the photo of the set shown on opposite page. List of parts appears at end of article. This receiver was designed and tested in the Jenkins television laboratory under actual "image reception" conditions of all kinds. No regeneration is used in this receiver.

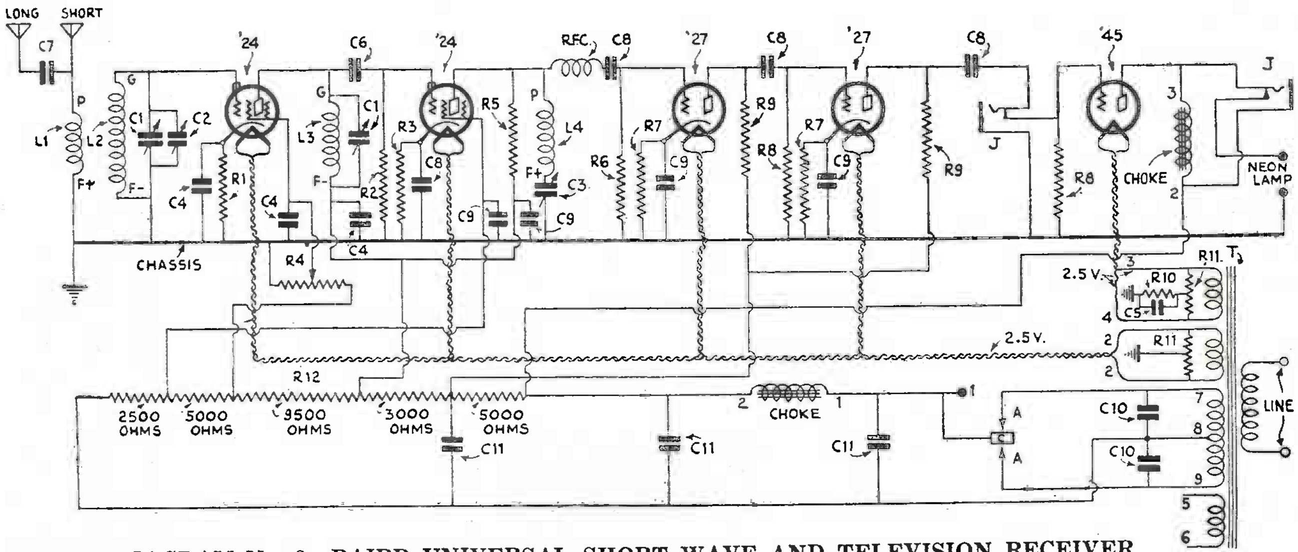
List of Jenkins Parts Required

(These Parts, without tubes, are available in Kit Form)

1—Three-gang Variable Condenser, .00025-mf. each section, sections shielded (4, 12, 23);
3—.00002-mf. Trimmer Condensers (5, 13, 24);
1—Special Shielded Jenkins Television Antenna Coupler (2);
2—Special Shielded Jenkins Television R.F. Coils (11, 19);
4—Special 300-Turn R.F. Chokes (9, 17, 20, 30);
2—By-Pass Condenser Blocks, each containing 3 -0.1-mf., 400-volt units (8A, B, C), (16A, B, C);
4—.0001-mf. Fixed Mica Condensers (10, 18, 25, 29);
1—1-mf. 600-volt By-Pass Condenser (31A);
3—¼-mf., 600-volt Blocking Condensers (32, 38, 45);
3—2-mf., 200-volt, By-Pass Condensers (35, 43, 50);
1—Filter Condenser Block containing one-4-mf., 600-volt unit (56A) and one- 2-mf., 600-volt unit (56B);
1—Power Compact (also containing two-30 henry chokes) for supplying all plate and filament voltages (53);
3—500-ohm, 1-watt Metallized Resistors (7, 15, 34);
3—100,000-ohm, 2-watt Metallized Resistors (22, 26, 31);
2—50-ohm, Center-Tapped Wire-Wound Resistors (28, 48);
3—¼-megohm, 1-watt Metallized Resistors (33, 40, 46);
1—25,000-ohm Potentiometer Volume Control (21) with Power Switch (54);
1—2000-ohm, 1-watt Resistor (42);
1—2000-ohm, 5-watt Resistor (49);
2—50,000-ohm, 2-watt Metallized Resistors (37, 44);
1—25,000-ohm, 2-watt Metallized Resistor (39);
1—41,000-ohm, 10-watt Enameled Resistor Voltage Divider (57);
5—UY-type Five-Prong Sockets (6, 14, 27, 36, 41);
2—UX-type Four-Prong Sockets (47, 55);
4—Binding Posts (1, 3, 51, 52);
3—Screen-Grid Tubes, type 424, (6, 14, 36);
2—427-Type Tubes (27, 41);
1—480-Type Full Wave Rectifier Tube (55);
1—445-Type Power Tube (47);
1—Aluminum Panel, 6¾"x12⅞"x⅛";
1—Chromium-Plated Steel Chassis (mounting holes drilled), 12⅞"x18½"x1⅝" high;
1—Dial;
Wire, etc.

(NOTE: Numbers in parentheses after each part, refer to corresponding numbers used to designate parts on diagrams.)

TELEVISION RECEIVER SECTION
SHORT WAVE AND TELEVISION LABORATORY



WIRING DIAGRAM No. 3—BAIRD UNIVERSAL SHORT WAVE AND TELEVISION RECEIVER

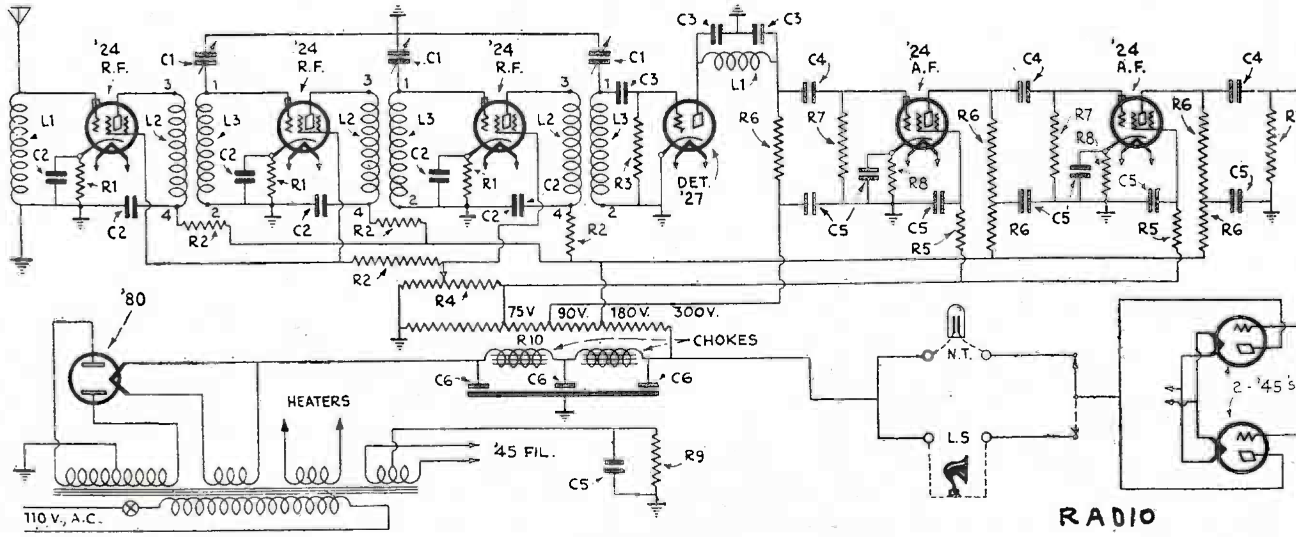
L1-L2—Octocoil, No. 7 Socket, connect as shown.
L3-L4—Octocoil, No. 8 Socket, connect as shown.
C1—*MLW No. 150 Hammarlund Variable Condenser.*
C2—*J-13 Midget Variable Condenser.*
C3—*J-23 Midget Variable Condenser.*
C4—*No. 1450 .02 mfd. Aerovox Bakelite Moulded Condenser.*
C5—*No. 261 2 mfd. Aerovox Non-Inductive By-Pass Condenser.*
C6—*No. 1450 .00015 mfd. Aerovox Bakelite Moulded Condenser.*
C7—*No. 1450 .00005 mfd. Aerovox Bakelite Moulded Condenser.*
C8—*No. 260 .25 mfd. Aerovox Condenser.*
C9—*No. 261XX 1 mfd. Aerovox Condenser.*
C10—*No. 1070 .02 mfd. Aerovox 1,000v. DC Buffer Condenser.*
C11—*3 Section Aerovox No. E5-888 Electrolytic Condenser.*
R1—*No. 992 400 ohms Pyrohm Aerovox Resistor.*
R2—*5 megohms 1-watt Resistor.*
R3—*50,000 ohms 1-watt Resistor.*
R4—*50,000 ohms Royalty Electrad Potentiometer.*
R5—*100,000 ohms 1-watt Resistor.*
R6—*.5 megohms 1-watt Resistor.*
R7—*4,000 ohms Electrad Wire Grid Resistor.*
R8—*.25 megohms 1-watt Resistor.*
R9—*50,000 ohms 1-watt Resistor.*
R10—*1,500 ohms International 2-watt Resistor.*
R11—*No. 354 Center Tapped Resistors, 20 ohms.*
R12—*Aerovox No. 996SW Special Voltage Divider, 25,000 ohms.*
J—*Frost 3-contact Jack.*
R.F.C.—*No. 100 Baird Television Choke.*
Choke—*No. 431 Double Choke.*
T—*No. 411 Power Transformer.*
C—*Cathode of B.H. Raytheon.*
A—*Anode of B.H. Raytheon.*

Connect Anodes to Filament Prongs on No. 1 Socket. Connect Cathode to Plate of this Socket.

R3 is replaced with a 201A Fixed Rheostat which acts as a short circuit when regeneration is used.

Windings 5 and 6 light power tube in synchronizing amplifier.

RADIO TECHNIC LABORATORY

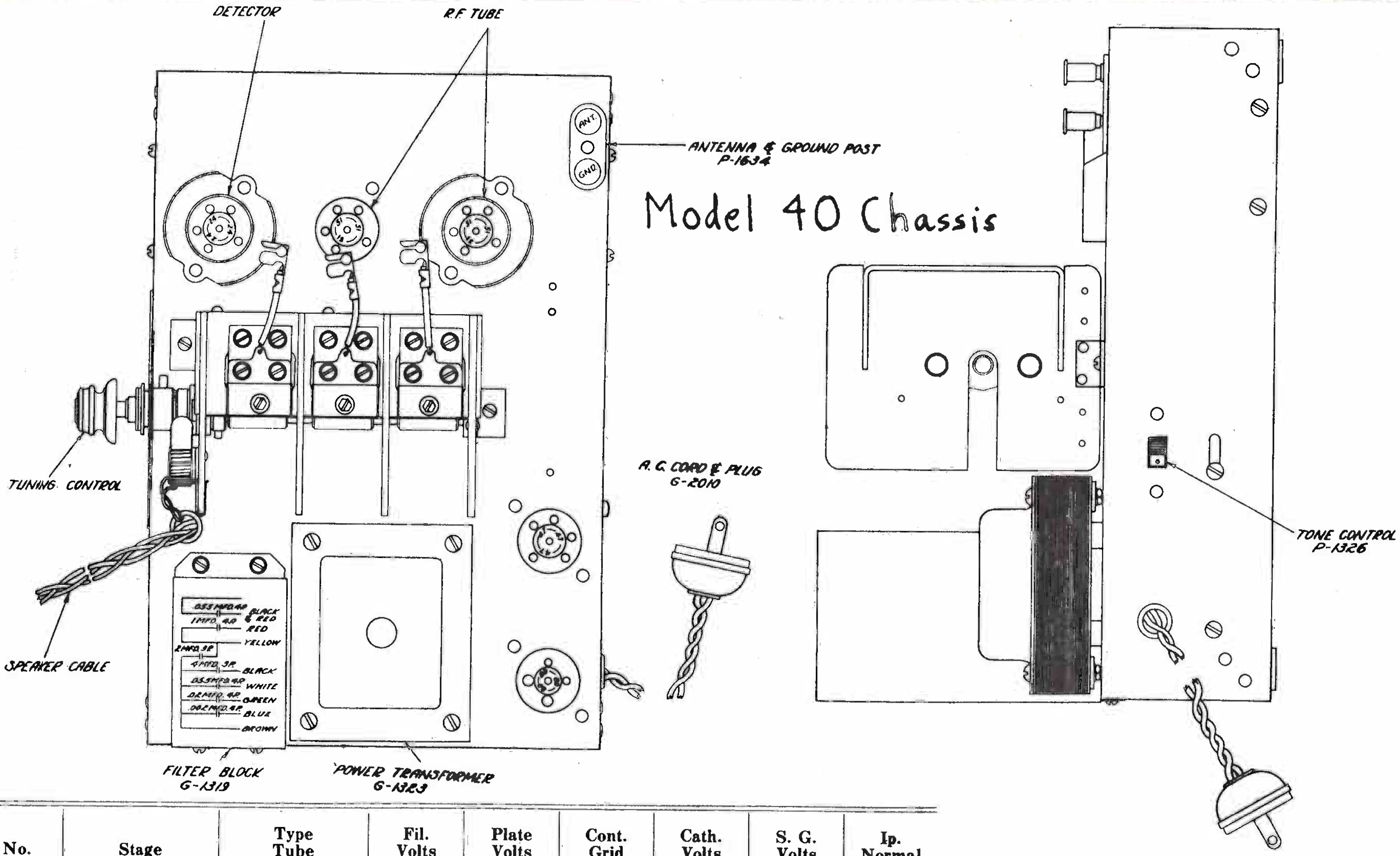


RADIO TECHNIC CORP.

List of Parts

R1	500 *ohms*	R7	250,000 *ohms*	C4	.01 *mf.*
R2	10,000 *ohms*	R8	1,000 *ohms*	C5	1. *mf.*
R3	2 *Megohms*	R9	750 *ohms*	C6	8. *mf.*
R4	50,000 *ohm potentiometer*	R10	13,500 *ohm voltage divider*	L1	*Shortwave R.F. choke (60 millihenries)*
R5	20,000 *ohms*	C1	.00014 *mf.*	L2	*Primaries of R.F. Trans.*
R6	50,000 *ohms*	C2	.1 *mf.*	L3	*Secondaries of R.F. Trans.*
		C3	.00015 *mf.*		

TRANSFORMER CORP. OF AMERICA

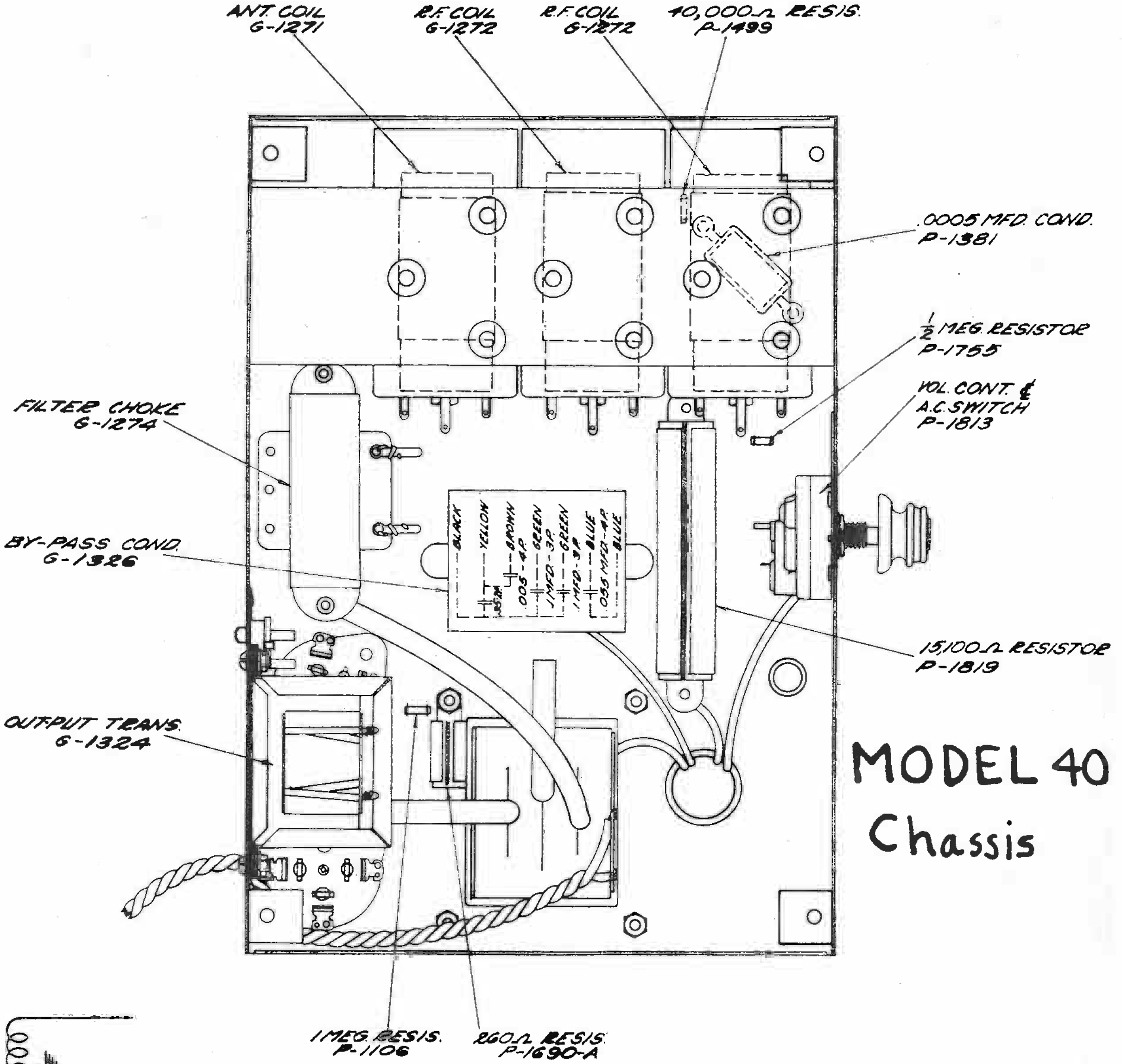


No.	Stage	Type Tube	Fil. Volts	Plate Volts	Cont. Grid Volts	Cath. Volts	S. G. Volts	Ip. Normal
1	1st R. F.	C. L. 51	2.1	225	2.1	2	75	5
2	2nd R. F.	C. L. 51	2.1	230	2.2	2	75	4.5
3	Det.	C. L. 24	2.1	160*	7	5	75	.02
4	Output	C. L. 47	2.1	215	5*	0	225	26.5
5	Rect.	C. L. 80	4.8	280				†30

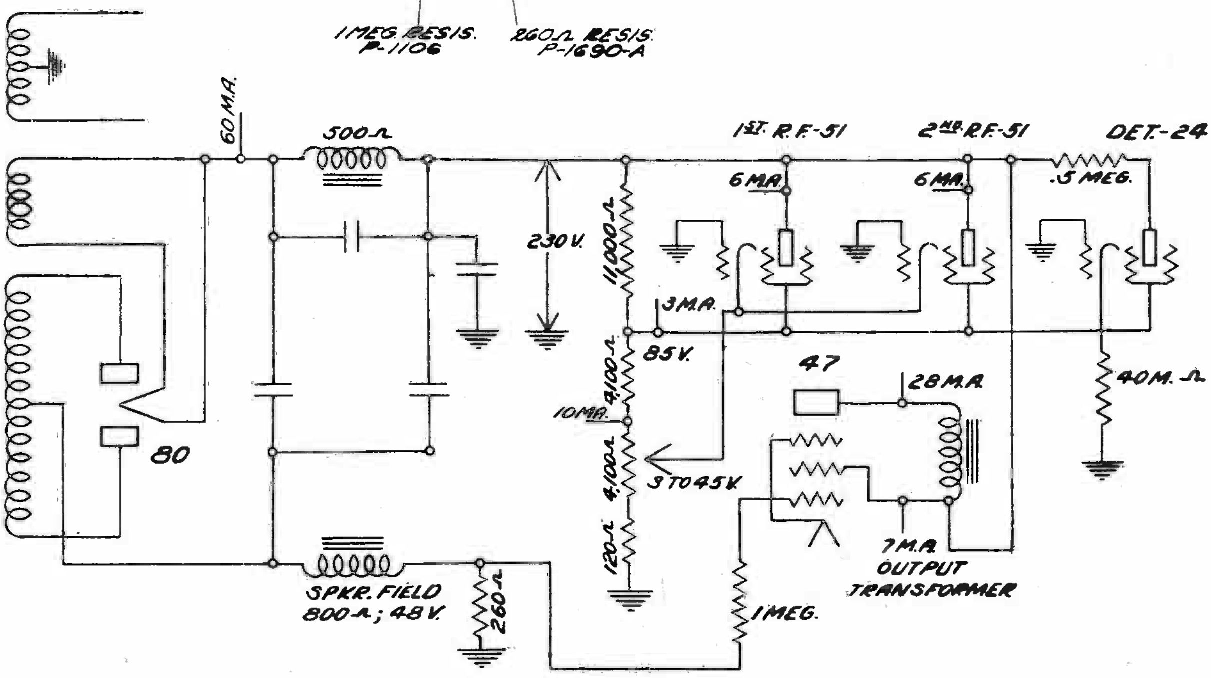
*Reading dependent upon resistance of meter.
†Reading taken for one anode only: 60 milliamperes would be about correct.
Volume control position full. Line voltage 115—60 cycle.

READINGS TAKEN WITH WESTON MODEL 565 ANALYZER
on Model 40

TRANSFORMER CORP. OF AMERICA



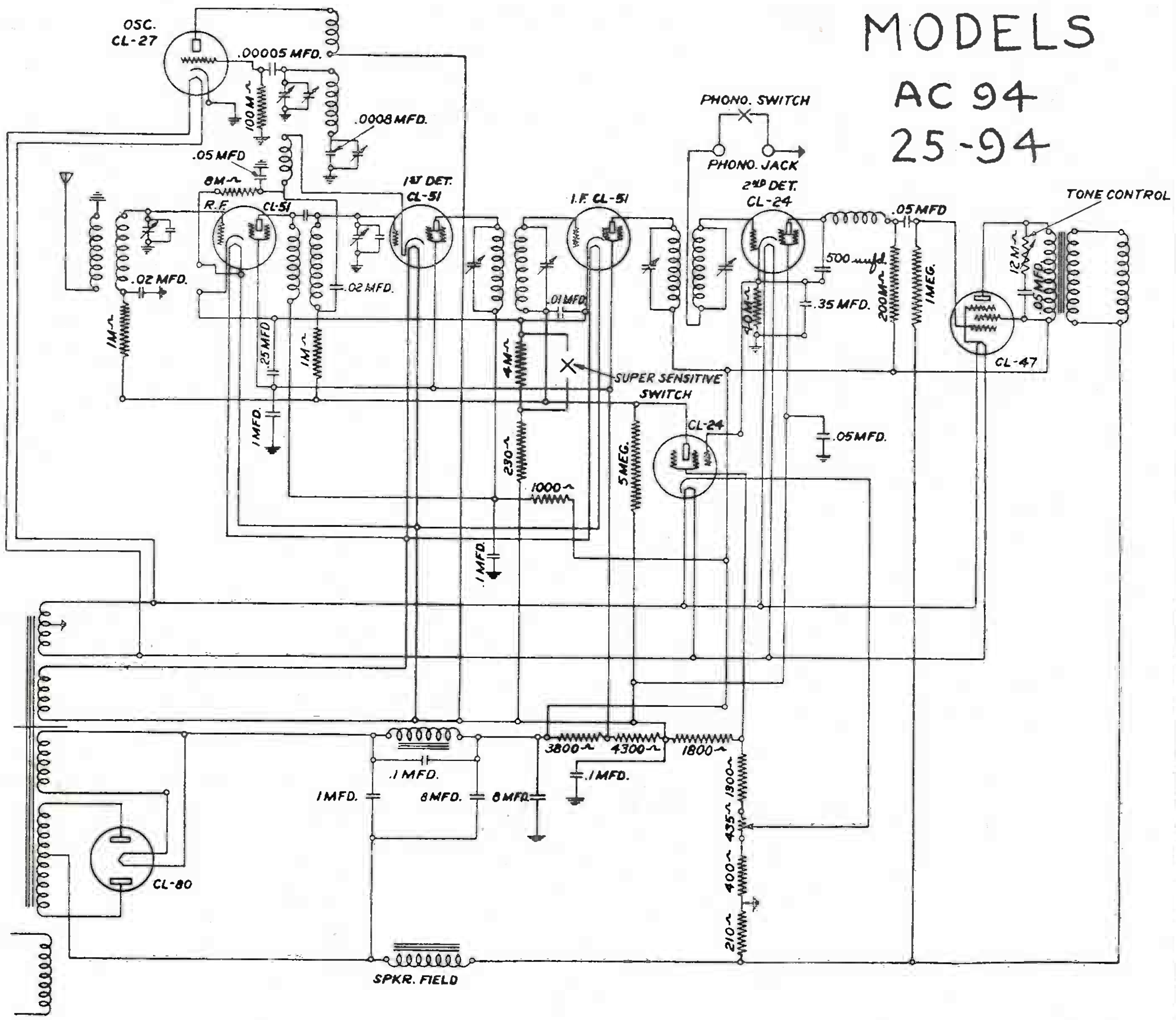
MODEL 40 Chassis



BREAKDOWN ANALYSIS FOR MODEL-40

TRANSFORMER CORP. OF AMERICA

MODELS
AC 94
25-94



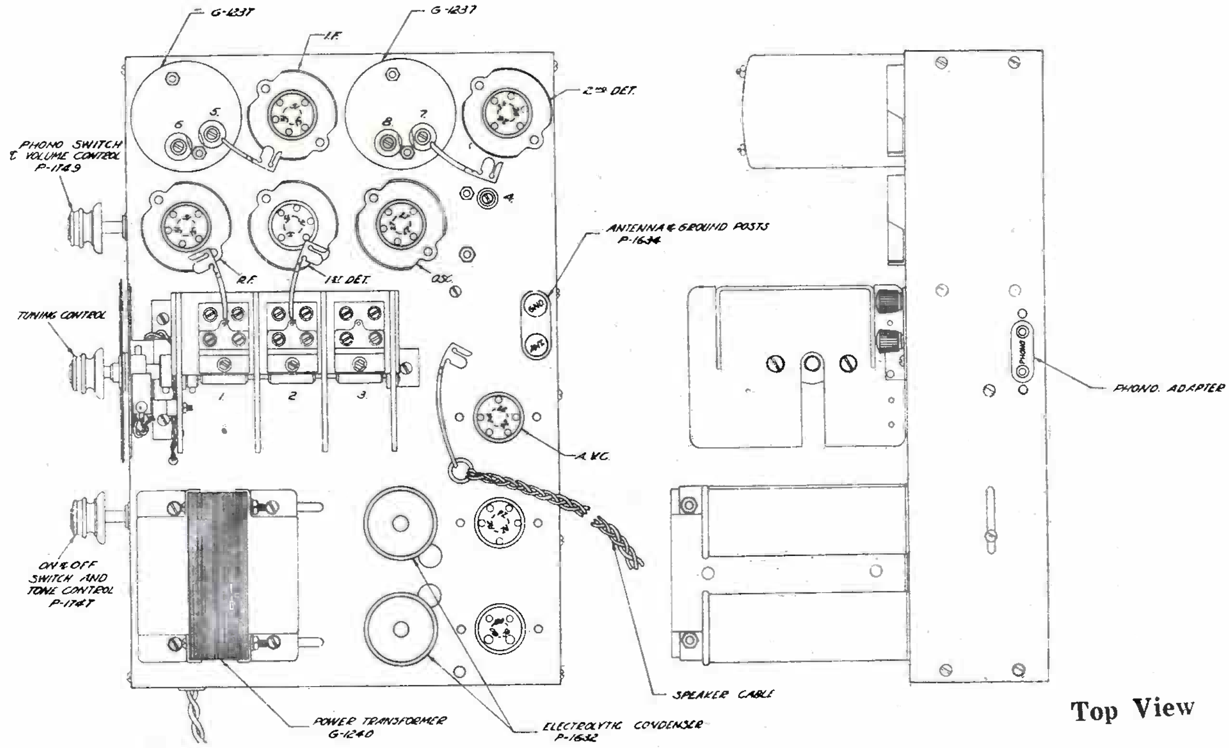
READINGS TAKEN WITH WESTON MODEL 565 ANALYSER

No.	Stage	Type Tube	A Volts	B Volts	Cont. Grid Volts	Cath. Volts	Ip' Norm.	SG Volts
1	r. f	51	2.1	178	1.5	2.5	4.5	82
2	1st det.	51	2.1	160	9.5	10.	1.2	75.
3	Osc.	27	2.05	120	0	0	10	0
4	I. F.	51	2.05	180	.6	3.	3	82.
5	2nd det.	24	2.05	220	8.	8.	.25	85.
6	A.V.C.	24	2.05	50	12.	20	0	37
7	A.F.	47	2.1	260	16.5		40	275.
8	Rect.	80	4.6	160			40	

Volume control position Full. Line Voltage 115-60 cycle.

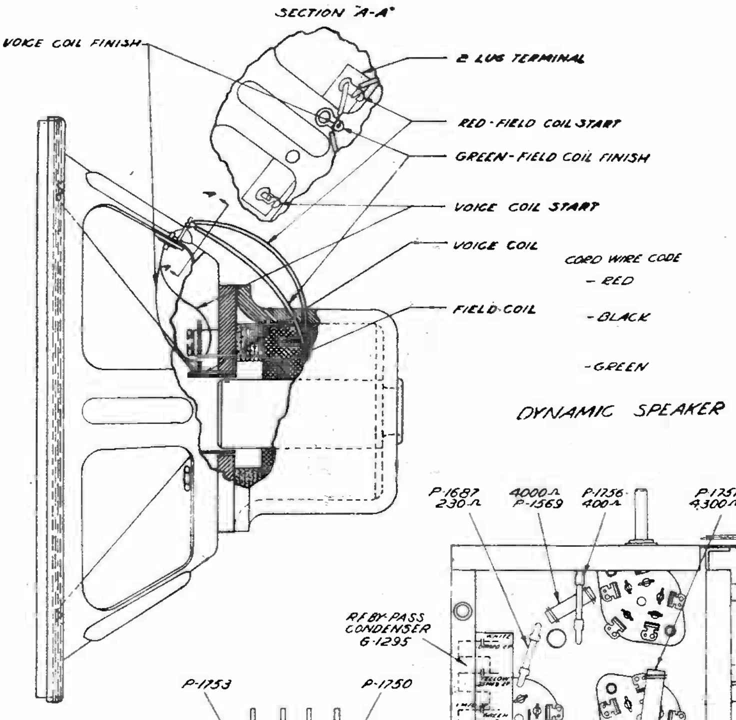
NOTE: Filaments and cathodes of R.F., I.F., and first detector are 95 volts positive with respect to ground.
NOTE: Since resistance tolerances in the sets are plus or minus 10%, and tubes may vary over 20%, your readings may disagree with the above by plus or minus 30%.

TRANSFORMER CORP. OF AMERICA

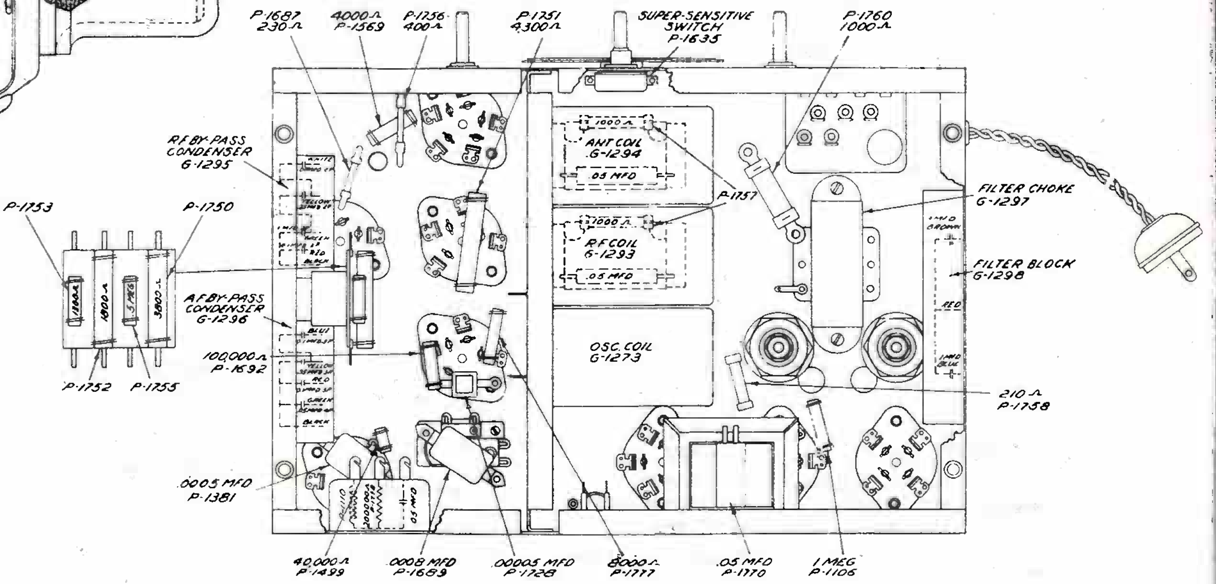


Top View

MODELS AC-94 25-94

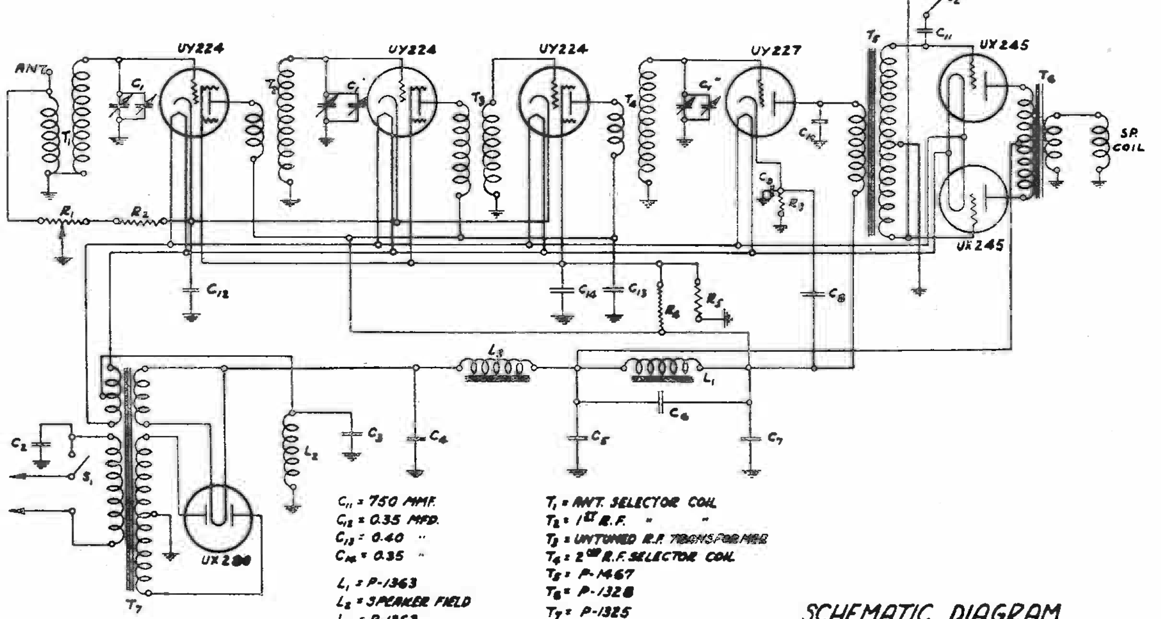


DYNAMIC SPEAKER



Bottom View

TRANSFORMER CORP. OF AMERICA



DESIGN DATA:

C_1-C_1'-C_1'' = 410 MFD. 3 GANG VARIABLE CONDENSER.

C_2 = 0.05 MFD.	C_6 = 0.035 MFD.
C_3 = 0.35 "	C_7 = 1.0 "
C_4 = 1.50 "	C_8 = 0.06 "
C_5 = 1.50 "	C_9 = 0.36 "
	C_{10} = 750 MMF.

C_{11} = 750 MMF.
C_{12} = 0.35 MFD.
C_{13} = 0.40 "
C_{14} = 0.35 "

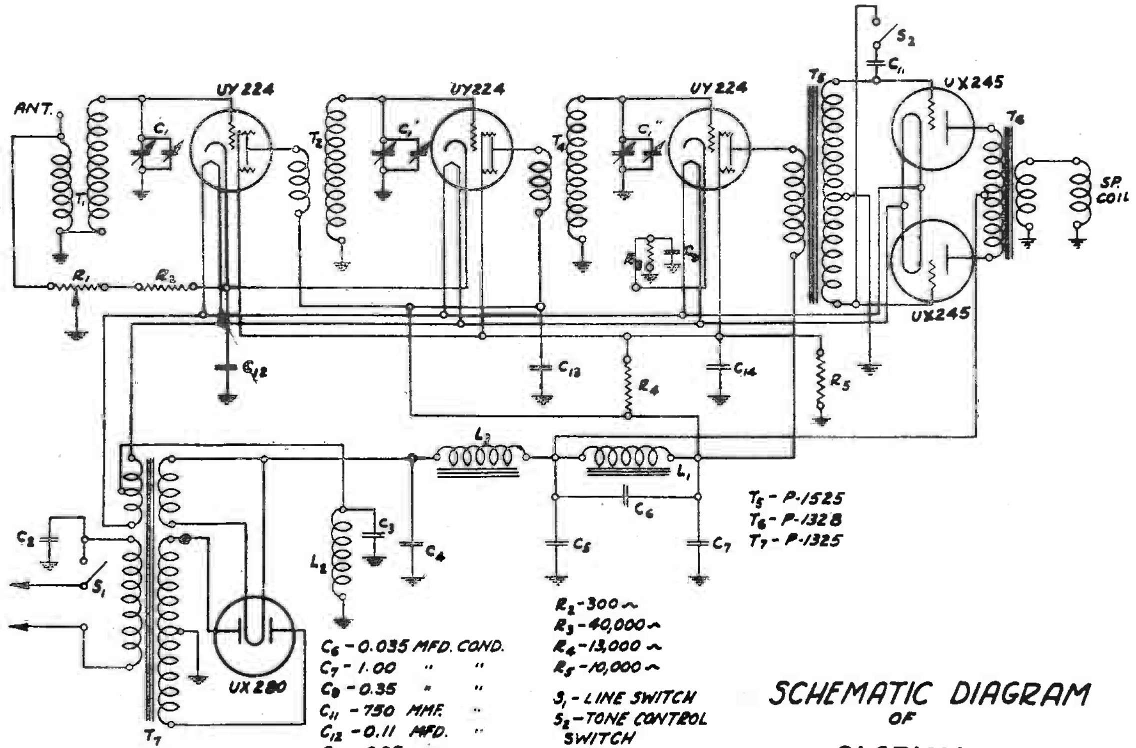
L_1 = P-1363
L_2 = SPEAKER FIELD
L_3 = P-1362

R_1 = VOL. CONT., 12,000 ~
R_2 = 200 ~
R_3 = 20,000 ~
R_4 = 13,000 ~
R_5 = 10,000 ~

S_1 = LINE SWITCH
S_2 = TONE CONT. SWITCH

T_1 = ANT. SELECTOR COIL
T_2 = 1ST R.F. " "
T_3 = UNTUNED R.F. TRANSFORMER
T_4 = 2ND R.F. SELECTOR COIL
T_5 = P-1467
T_6 = P-1328
T_7 = P-1325

SCHEMATIC DIAGRAM OF CLARION MODEL "70"



T_5 - P-1525
T_6 - P-1328
T_7 - P-1325

DESIGN DATA:

C_1, C_1', C_1'' - 410 MMF. 3 GANG VARIABLE CONDENSER.
C_2 - 0.05 MFD. COND.
C_3 - 0.35 " "
C_4 - 1.50 " "
C_5 - 1.50 " "

C_6 - 0.035 MFD. COND.
C_7 - 1.00 " "
C_8 - 0.35 " "
C_{11} - 750 MMF. "
C_{12} - 0.11 MFD. "
C_{13} - 0.25 " "
C_{14} - 0.25 " "

L_1 - P-1363
L_2 - SPEAKER FIELD
L_3 - P-1362

R_1 - VOL. CONT., 12,000 ~

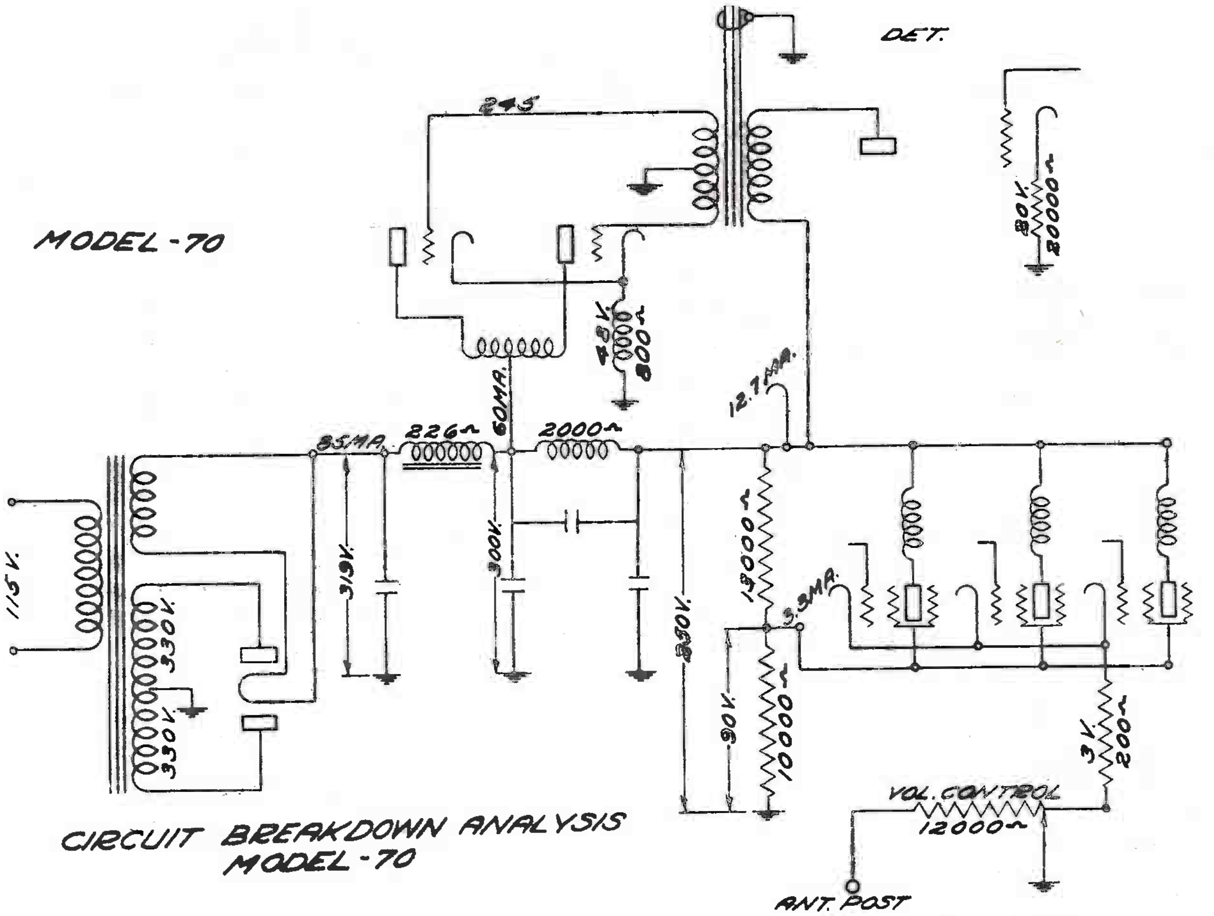
R_2 - 300 ~
R_3 - 40,000 ~
R_4 - 13,000 ~
R_5 - 10,000 ~

S_1 - LINE SWITCH
S_2 - TONE CONTROL SWITCH

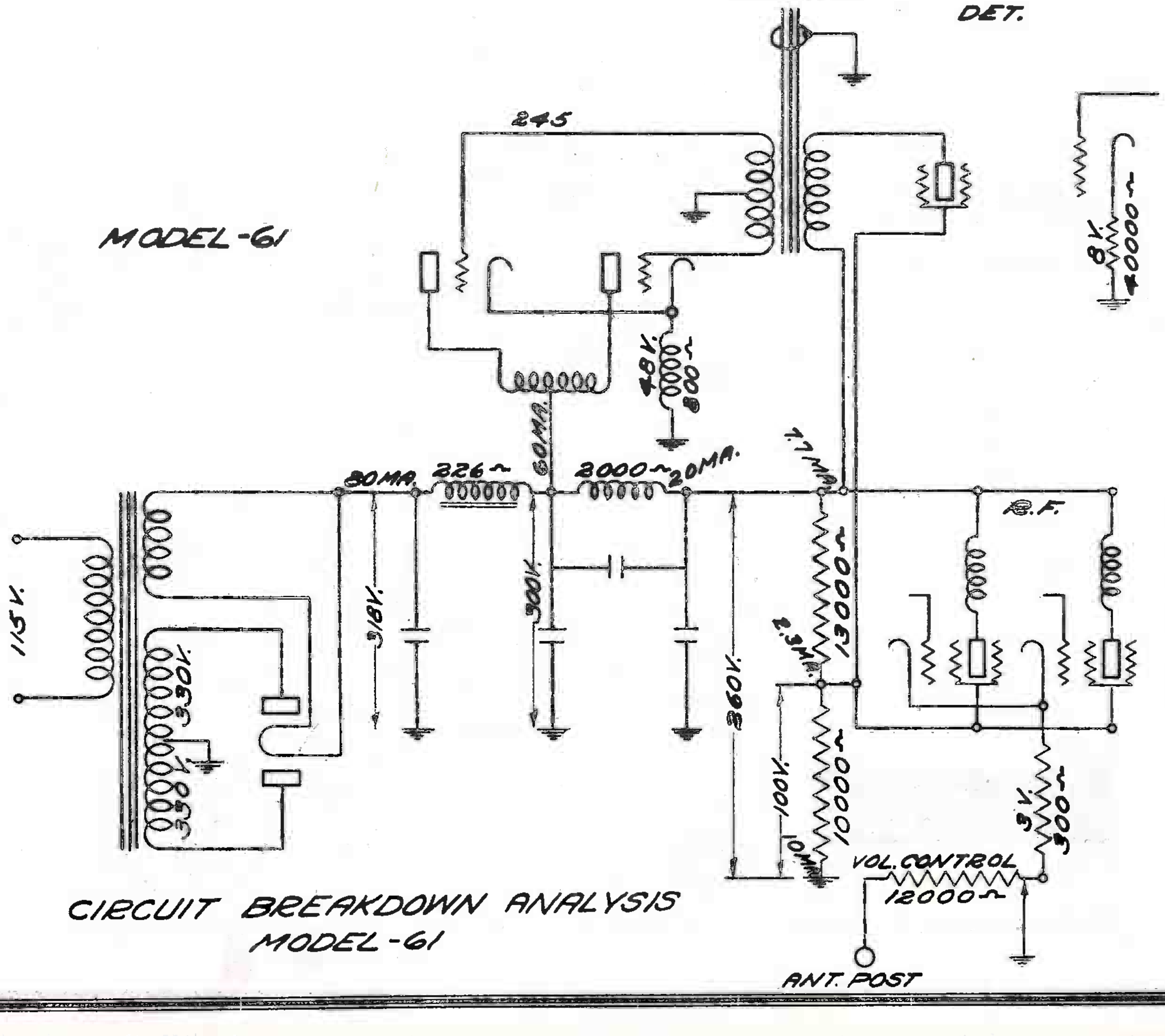
T_1 - ANT. SELECTOR COIL
T_2 - 1ST R.F. SELECTOR COIL
T_4 - 2ND R.F. " COIL

SCHEMATIC DIAGRAM OF CLARION MODEL-61

TRANSFORMER CORP. OF AMERICA

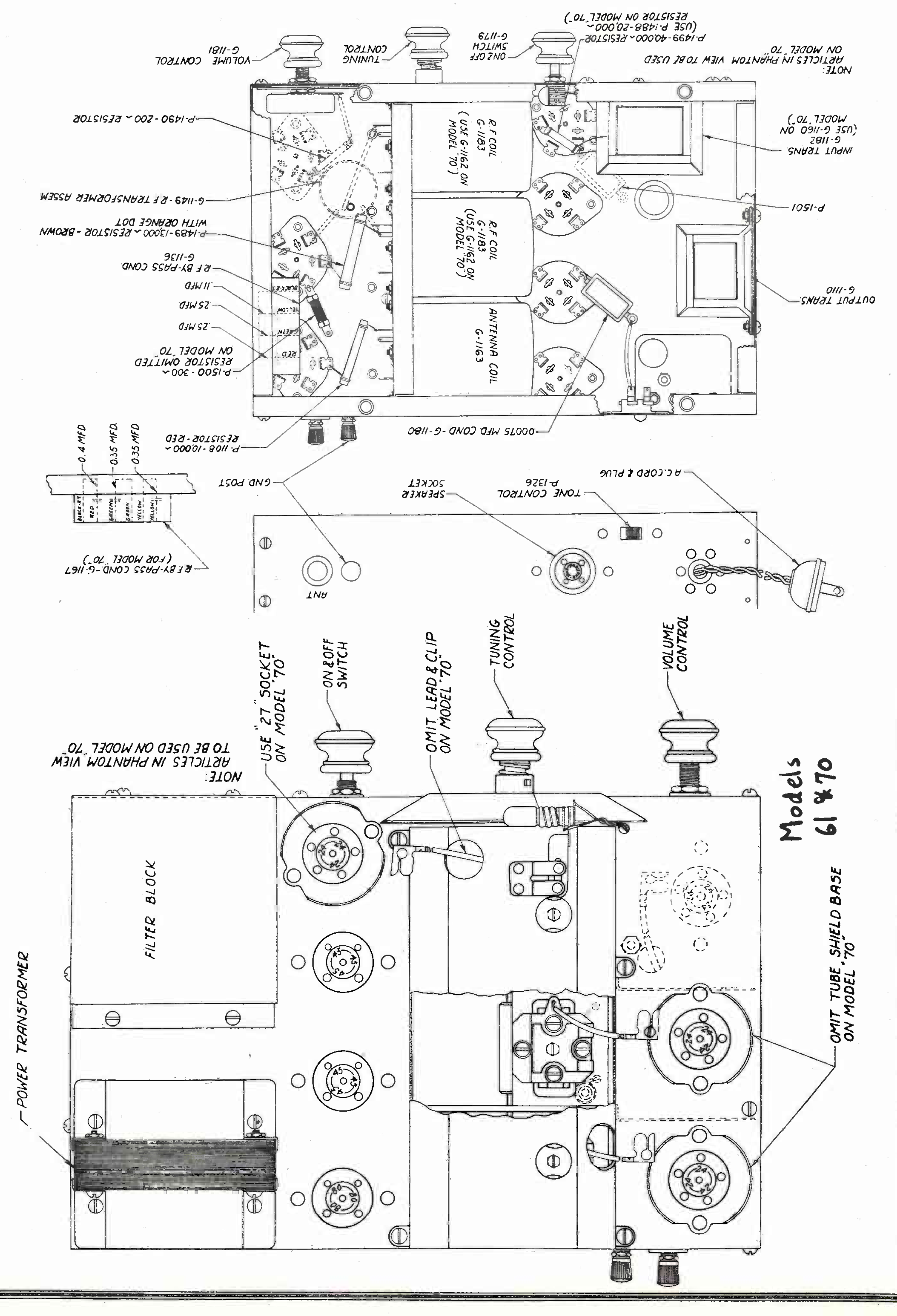


CIRCUIT BREAKDOWN ANALYSIS
MODEL-70

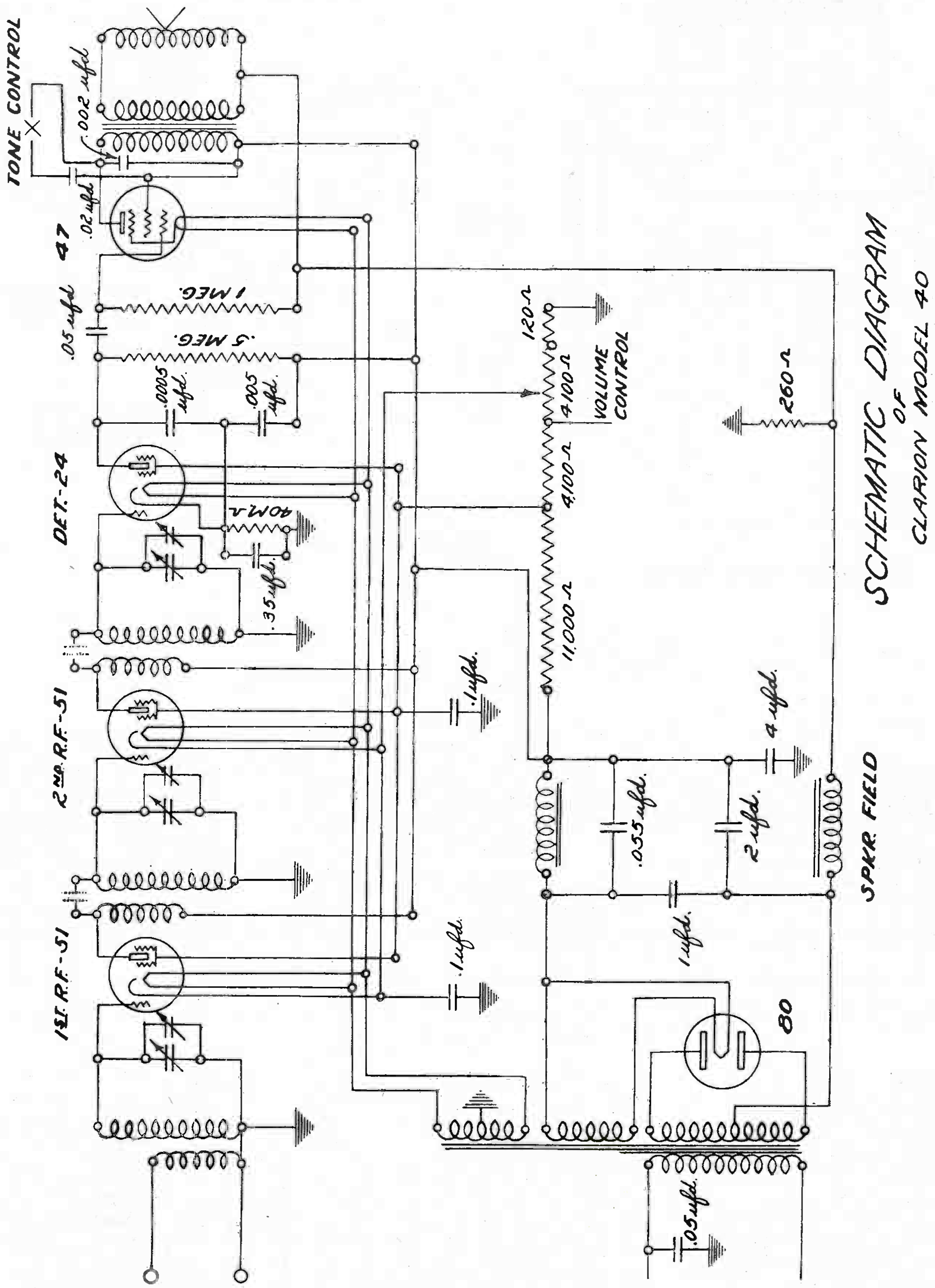


CIRCUIT BREAKDOWN ANALYSIS
MODEL-61

TRANSFORMER CORP. OF AMERICA

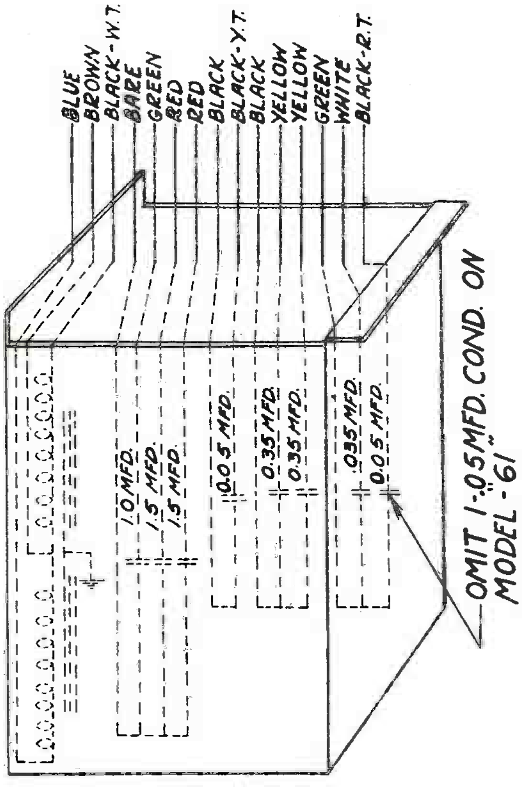


TRANSFORMER CORP. OF AMERICA

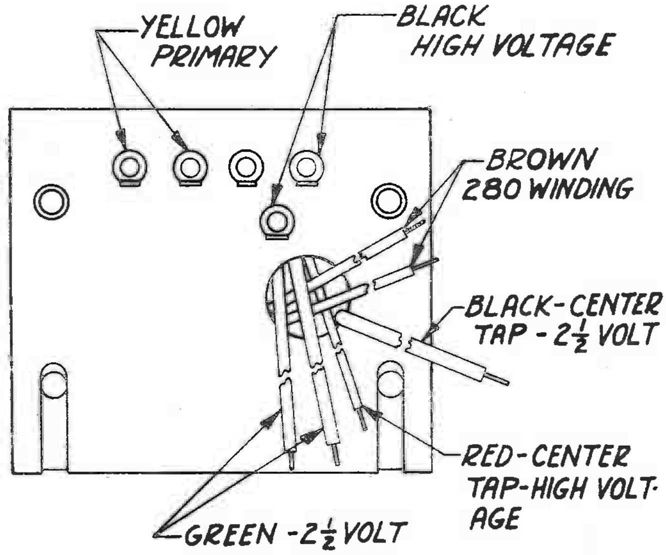


TRANSFORMER CORP. OF AMERICA

MODEL "61" & "70"

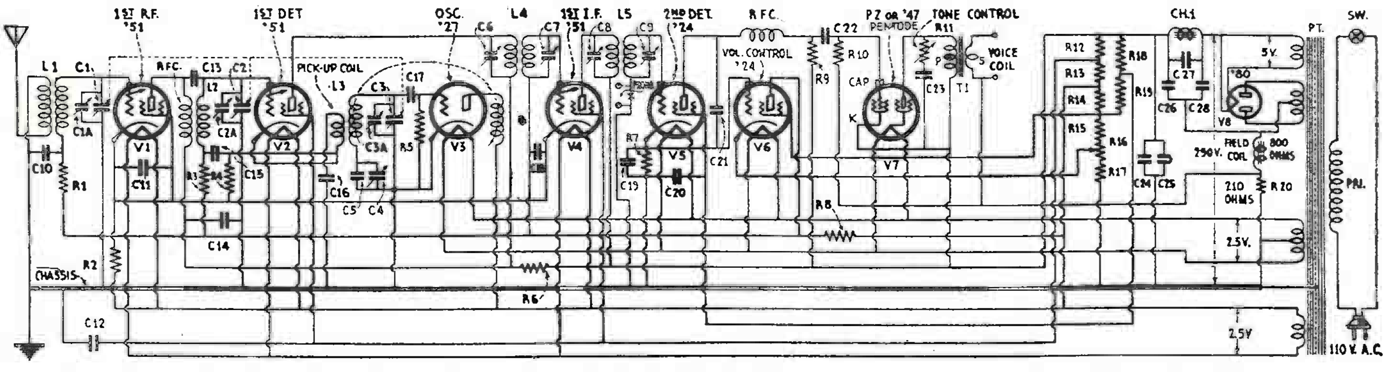


60 CYCLE FILTER BLOCK



60 CYCLE POWER TRANSFORMER

MODEL 90

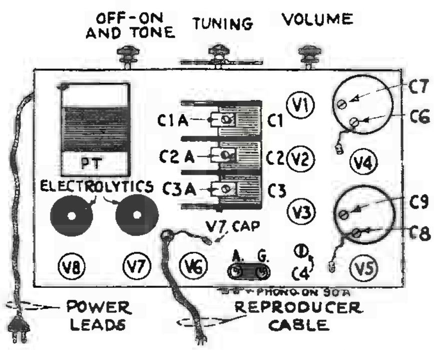


Schematic circuit of the highly-developed midget and console Clarion "Series 90" superheterodyne receivers; these utilize both variable-mu and pentode tubes, with automatic volume control. (Note: in the manufacturer's "breakdown analysis" illustration of this receiver, condensers C24 and C25 return to the juncture of R10 and R20, instead of to the chassis.)

All available constants are as follows: condensers C1, C2, C3, tuning units; C1A, C2A, C3A, shunt trimmers; C5, C21, .0008-mf.; C6, C7, C8, C9, I.F. circuit trimmers; C10, C15, C16, C18, C20, C22, C23, .05-mf.; C11, 0.25-mf.; C12, 1.0-mf.; C14, C24, C27, C28, 0.1-mf.; C17, .00005-mf.; C19, 0.35-mf.; C25, C26, 8 mf. (electrolytic).

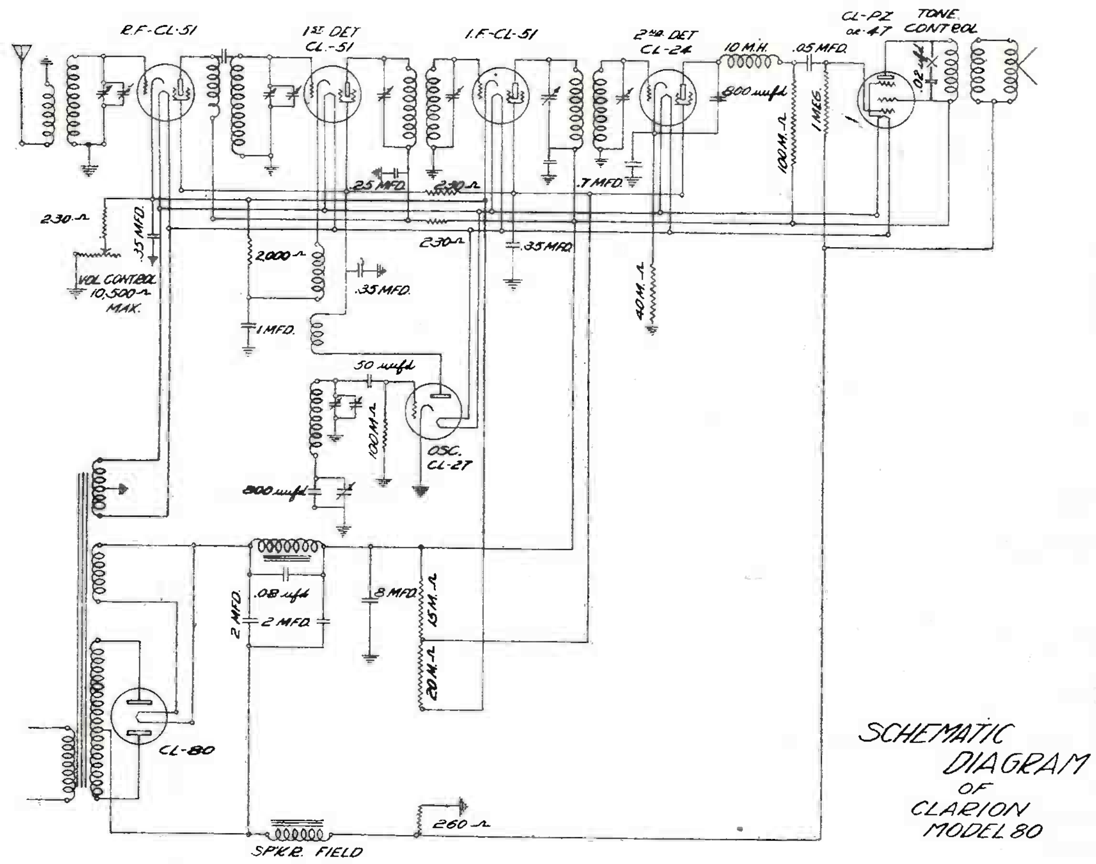
Resistors R1, R3, R6, 1,000 ohms; R2, 230 ohms; R4, 2,000 ohms; R5, R9, 100,000 ohms; R7, 40,000 ohms; R8, ½-meg.; R10, 1.0-meg.; R11, 12,000 ohms; R12, 3,800 ohms; R13, 4,300 ohms; R14, 1,800 ohms; R15, 1,300 ohms; R16, 435 ohms; R17, 400 ohms; R18, 65,000 ohms; R19, 20,000 ohms; R20, 210 ohms.

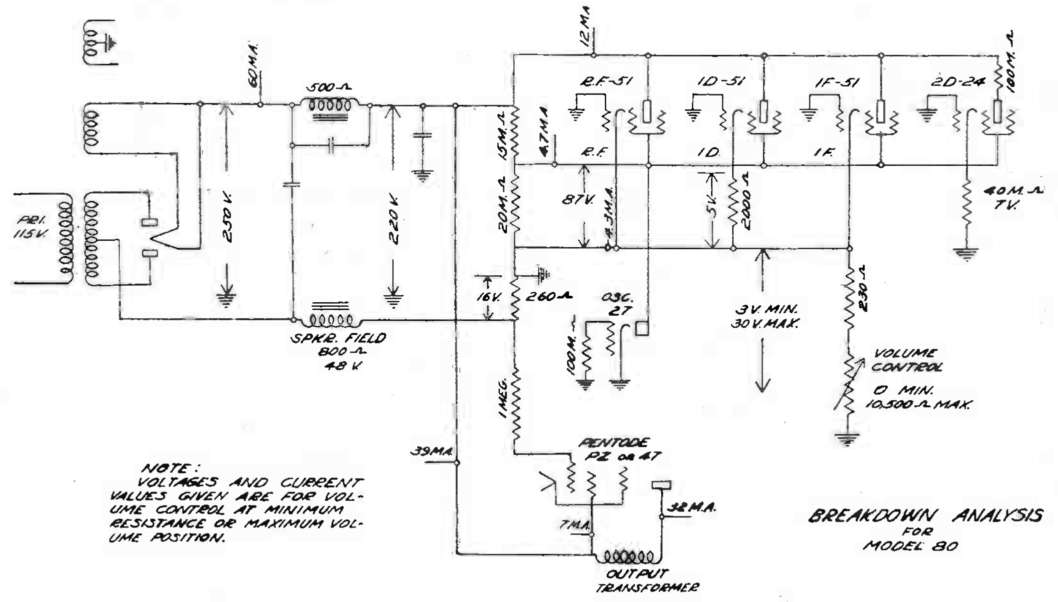
Operating voltages (with volume control in position "full" and line potential 115 volts) are as follows: Filaments V1, V2, V3, V4, V5, V6, V7, 2.2 volts; V8, 4.6 volts. Plate potentials, V1, 160 volts; V2, 168 volts; V3, 125 volts; V4, 163 volts; V5, 178 volts; V6, 25 volts; V7, 260 volts; V8, 350 volts. Control-grid potentials, V1, 0.9-volt; V2, 7.6 volts; V3, none; V4, 0.6-volt; V5, 6.8 volts; V6, 4.6 volts; V7, 16.5 volts. Cathode potentials, V1, V4, 2 volts; V2, 4.9 volts; V3, none; V5, 9 volts; V6, 4.5 volts. Plate currents (normal), V1, 2.8 ma.; V2, V4, 2. ma.; V3, 9.5 ma.; V5, 0.25-ma.; V6, none; V7, 36 ma.; V8, 72 ma. Screen-grid potentials, V1, V2, V4, 77 volts; V5, 90 volts; V6, 40 volts; V7, 260 volts.



Top view of a Clarion superheterodyne

TRANSFORMER CORP. OF AMERICA



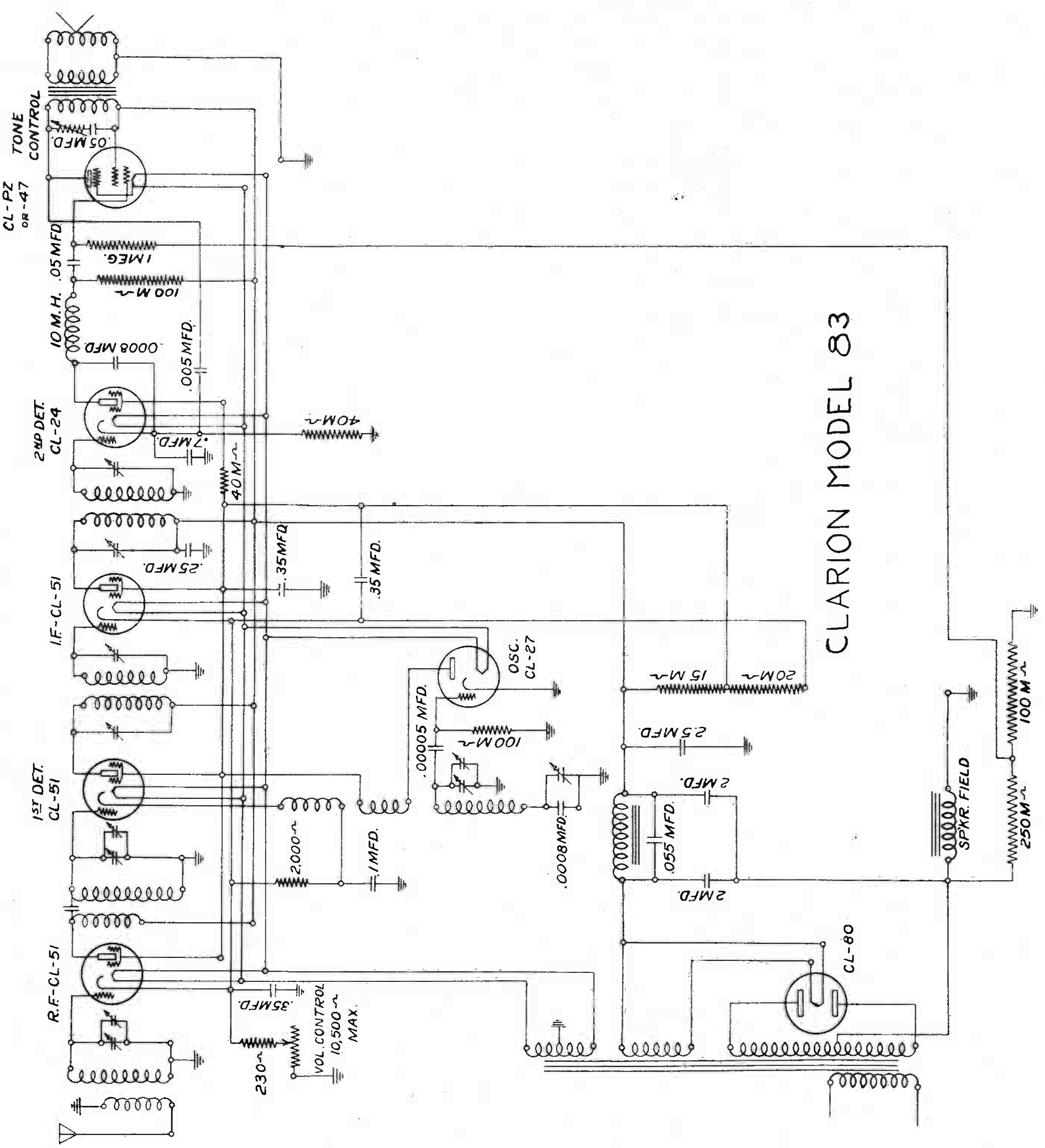


READINGS TAKEN WITH WESTON MODEL 565 ANALYSER

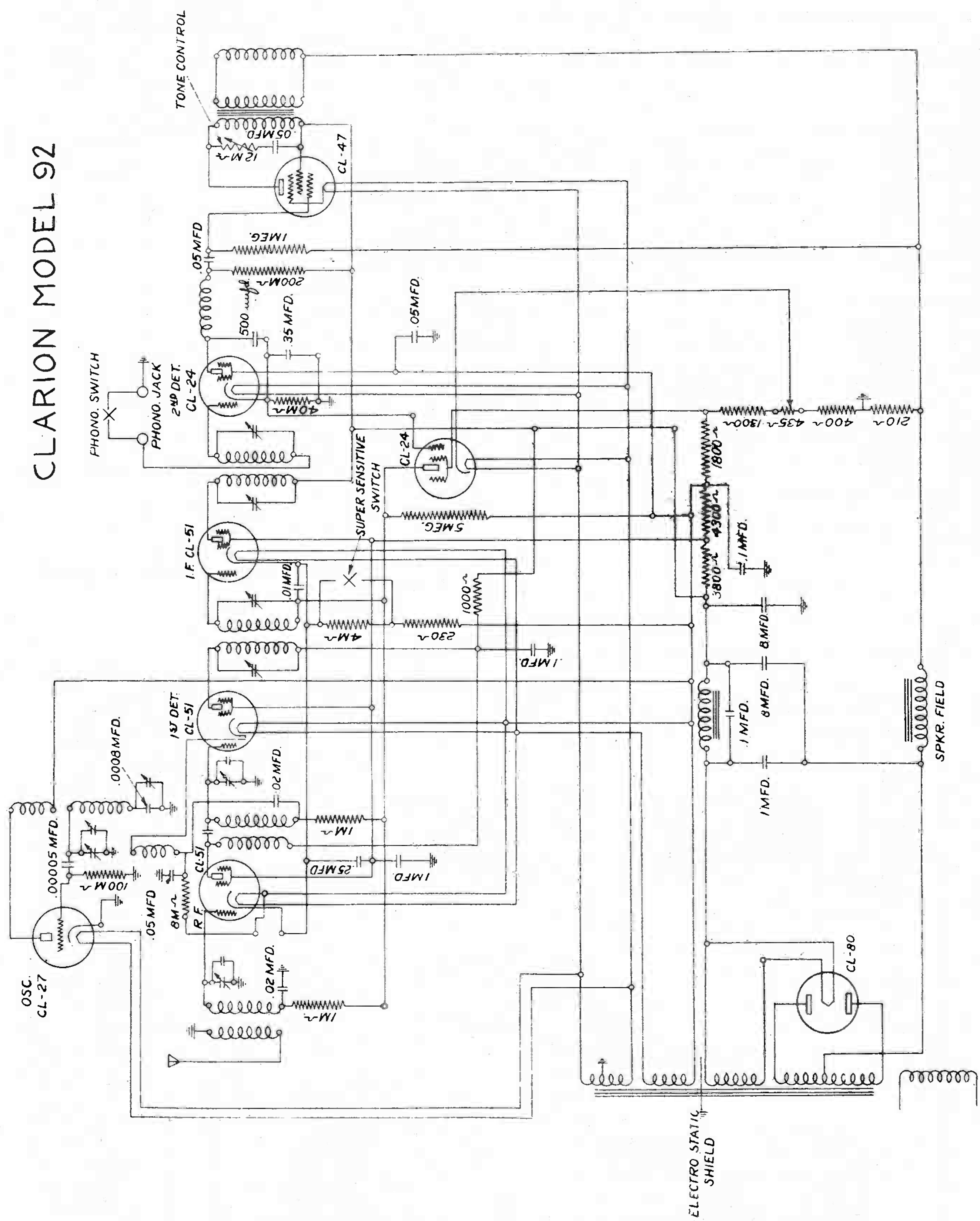
No.	Stage	Type Tube	A Volts	B Volts	Cont. Grid Volts	Cath. Volts	Ip' Norm.	SG Volts
1	r. f.	CL-51	2.2	233	3.	3.	5.	66
2	1st Det.	CL-51	2.2	233	7.	7.	2.3	73
3	Osc.	CL-27	2.2	80	0	0	4.	0
4	I.F.	CL-51	2.2	233	3	3	5.	77
5	2nd det.	CL-24	2.2	162	6.2	7.2	.5	73
6	Output	CL-PZ	2.2	228	15.	0	27.	233
7	Rect.	CL-80	4.8	300	0	0	50.	0

Volume control position **Full** Line Voltage **115**

TRANSFORMER CORP. OF AMERICA

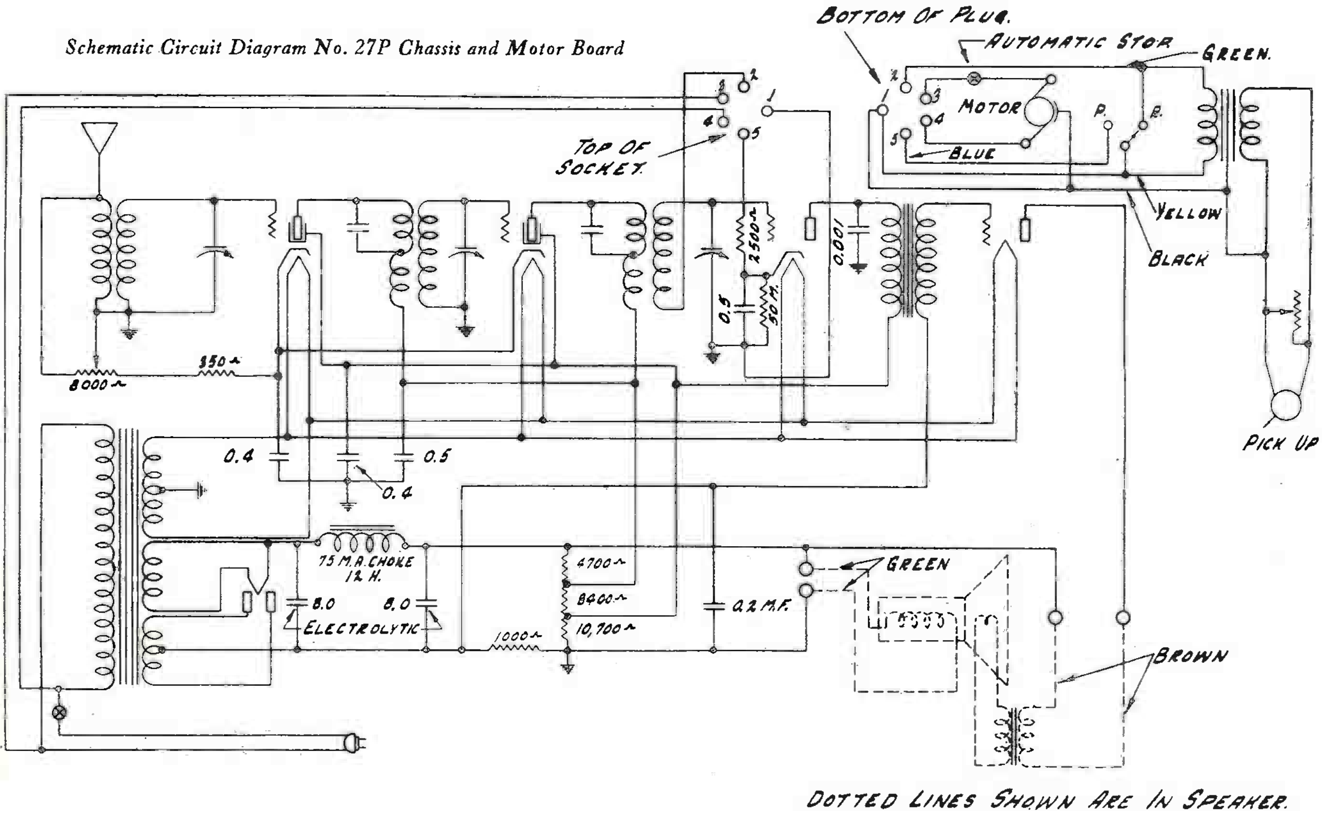


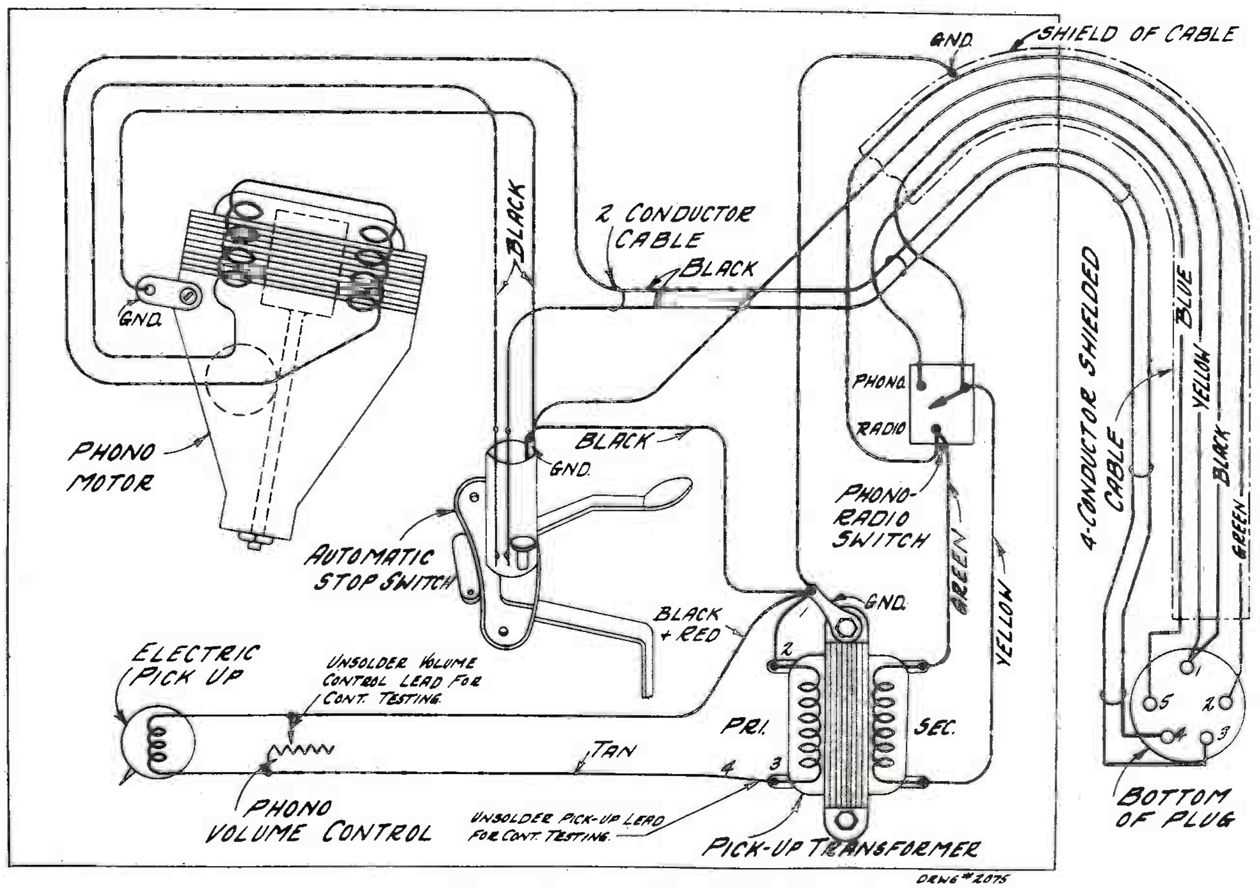
TRANSFORMER CORP. OF AMERICA



U. S. RADIO AND TELEVISION CORP.

Schematic Circuit Diagram No. 27P Chassis and Motor Board

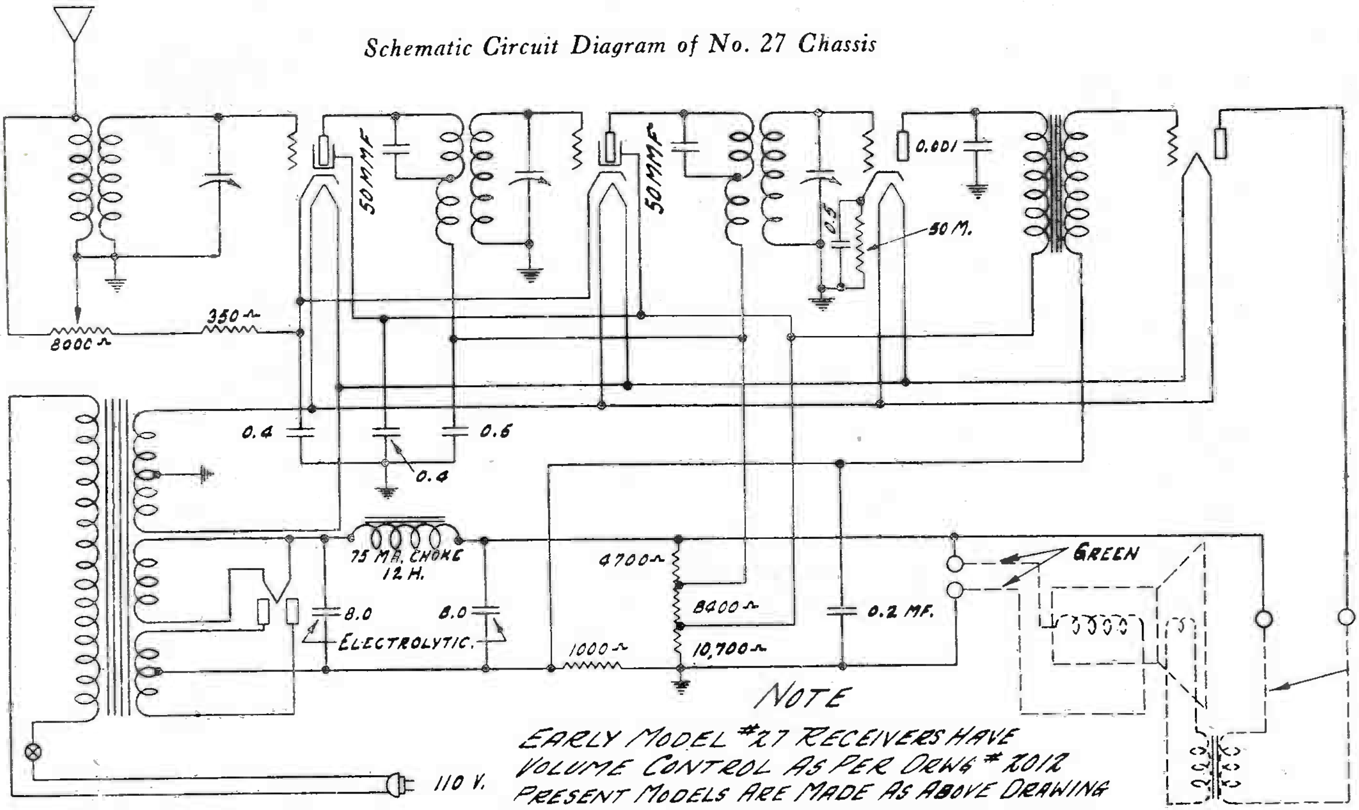


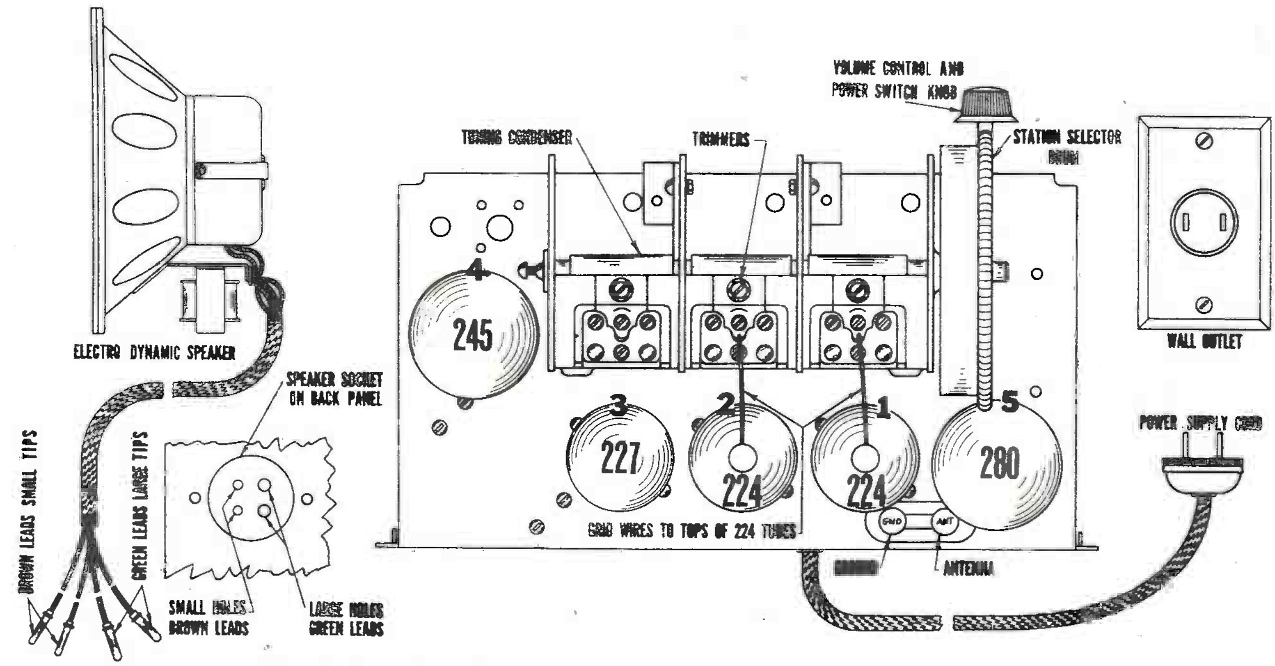


Wiring Diagram, Model 27P Motor Board

U. S. RADIO AND TELEVISION CORP.

Schematic Circuit Diagram of No. 27 Chassis



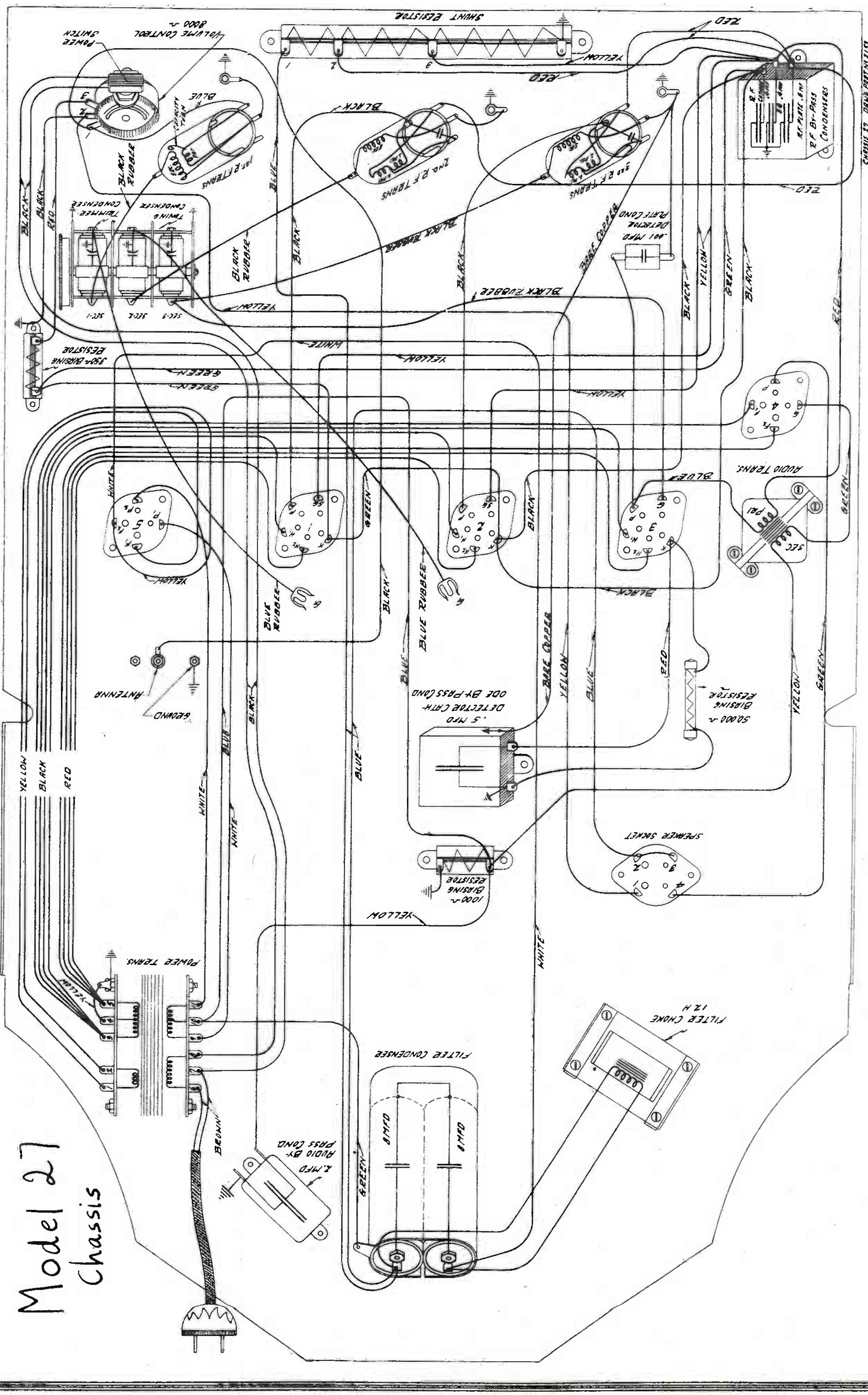


Top View of No. 27 Chassis Showing Tube Sequence and Speaker Connections

VOLTAGES AT SOCKETS — VOLUME CONTROL AT MAXIMUM — LINE VOLTAGE, 115 — PLUG IN SOCKET OF RECEIVER — TUBE IN TEST SET

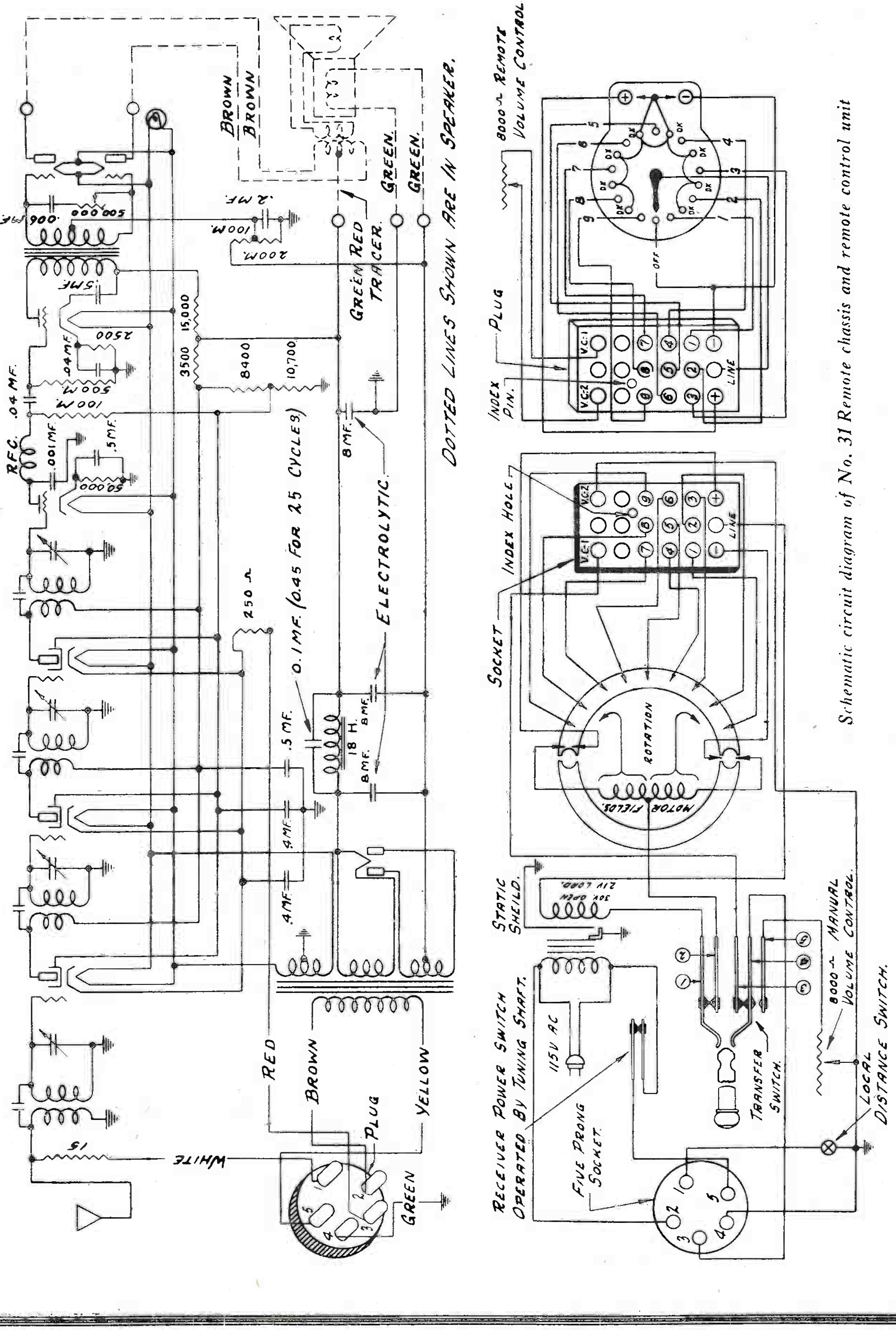
Type of Tube	Position of Tube	Function	"A" Volts	"B" Volts	Control Grid "C" Volts	Screen Volts	Screen Current MA	Cathode Volts	Plate MA	Grid Test MA
224	1	1st Radio	2.25	160	2.5	80	.6	2.5	3.	5.1
224	2	2nd Radio	2.25	160	2.5	80	.6	2.5	3.	5.1
227	3	Detector	2.25	70	8.5			8.5	.1	.2
245	4	Audio	2.35	238	44.				19.	22.
280	5	Rectifier	4.8						26.5 per Plate	

U. S. RADIO AND TELEVISION CORP.



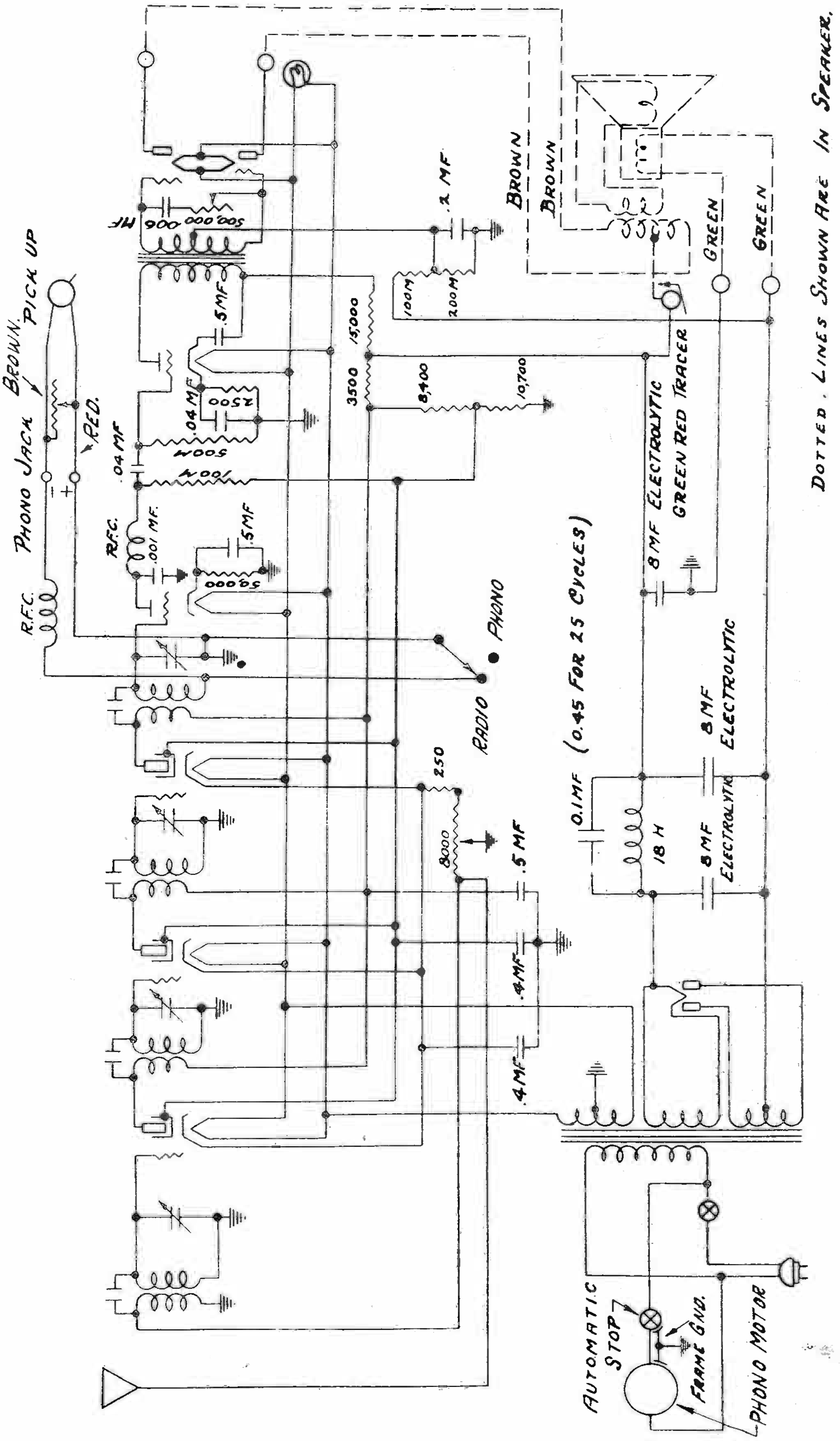
Model 27
Chassis

U. S. RADIO AND TELEVISION CORP.



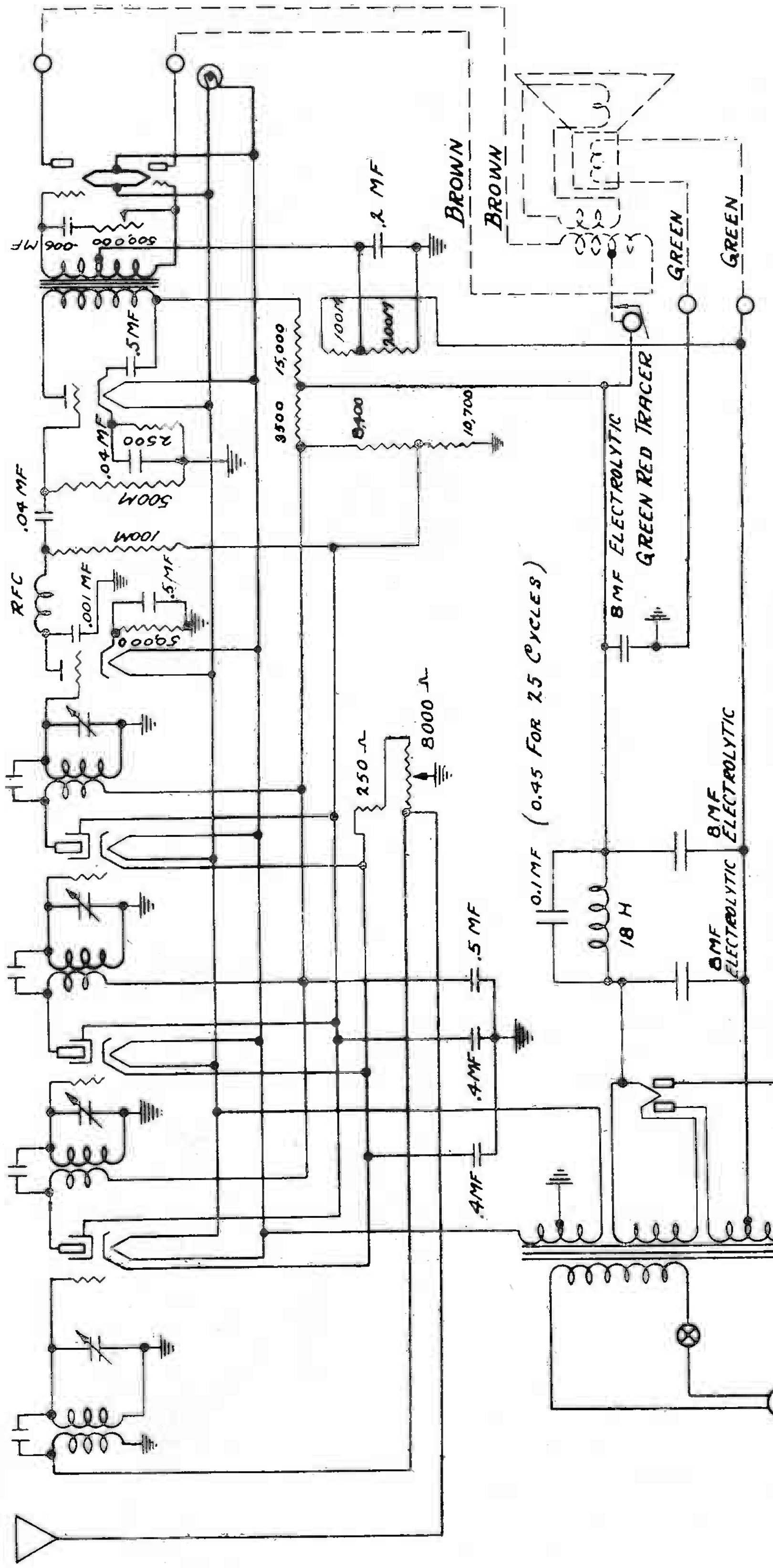
Schematic circuit diagram of No. 31 Remote chassis and remote control unit

U. S. RADIO AND TELEVISION CORP.



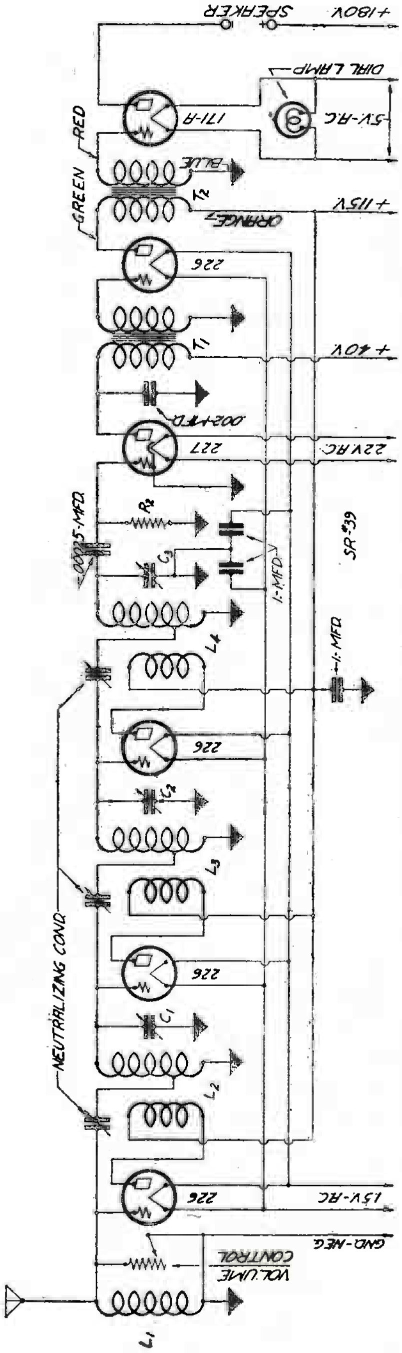
Schematic circuit diagram of No. 31 Phono chassis

U. S. RADIO AND TELEVISION CORP.



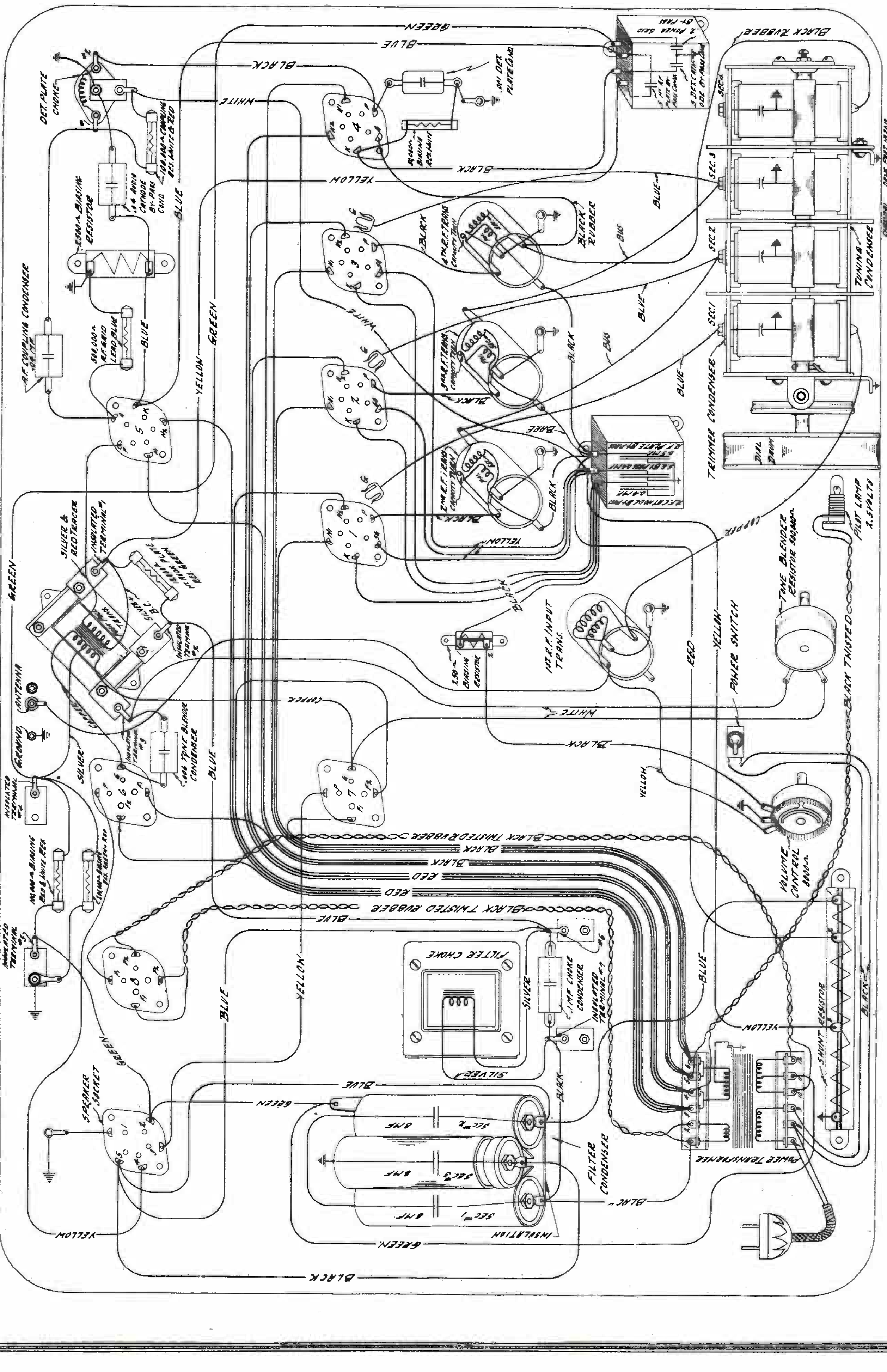
DOTTED LINES SHOWN ARE IN SPEAKER.

Schematic circuit diagram of No. 31 chassis



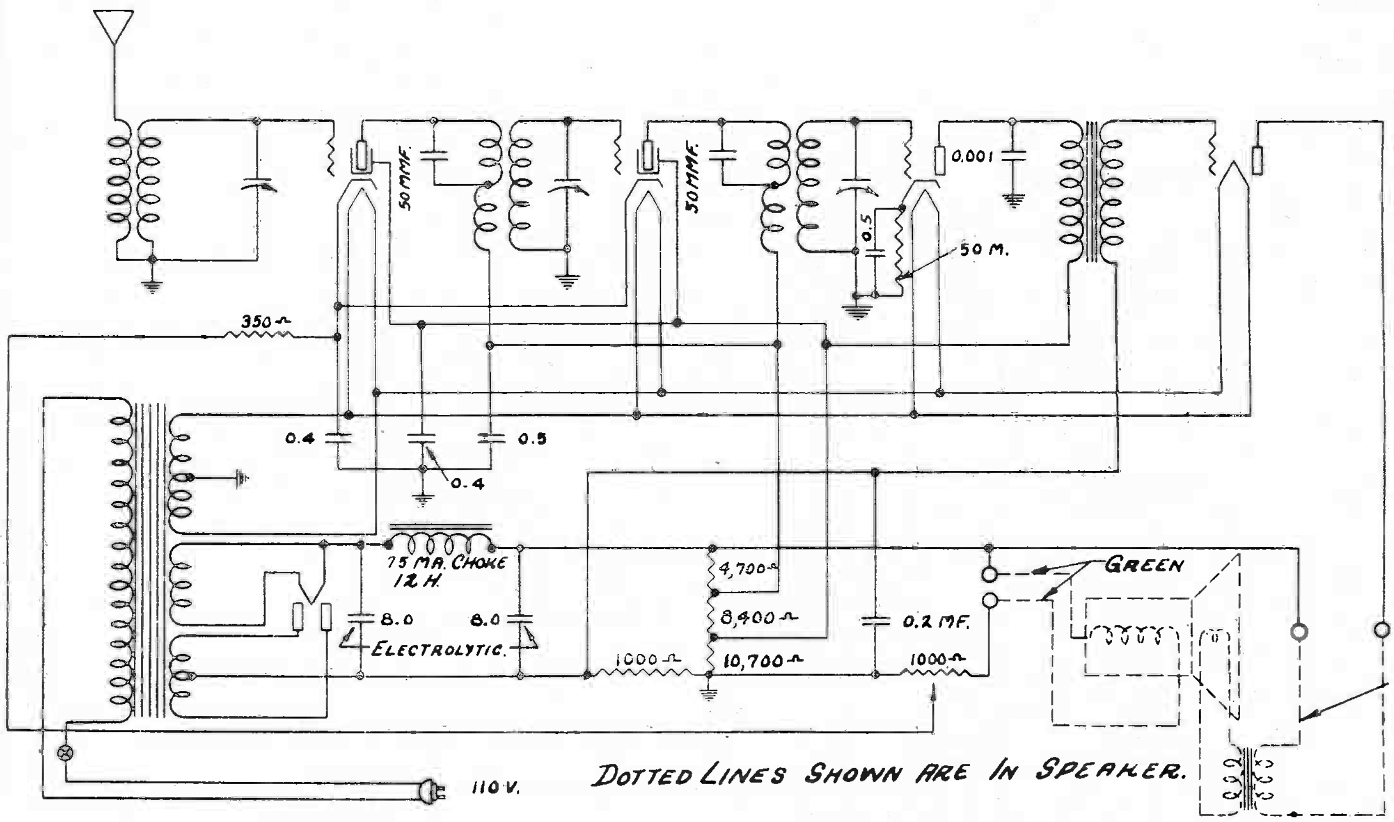
In this illustration may be seen the schematic diagram of the U. S. Radio and Television model 37 chassis

U. S. RADIO AND TELEVISION CORP.



Wiring diagram No. 31 chassis complete assembly

U. S. RADIO AND TELEVISION CORP.



Model 27

NOTE
EARLY MODEL Nº27 RECEIVERS HAVE VOLUME CONTROL AS PER ABOVE DRAWING. FOR PRESENT MODELS SEE DRWG# 2012A

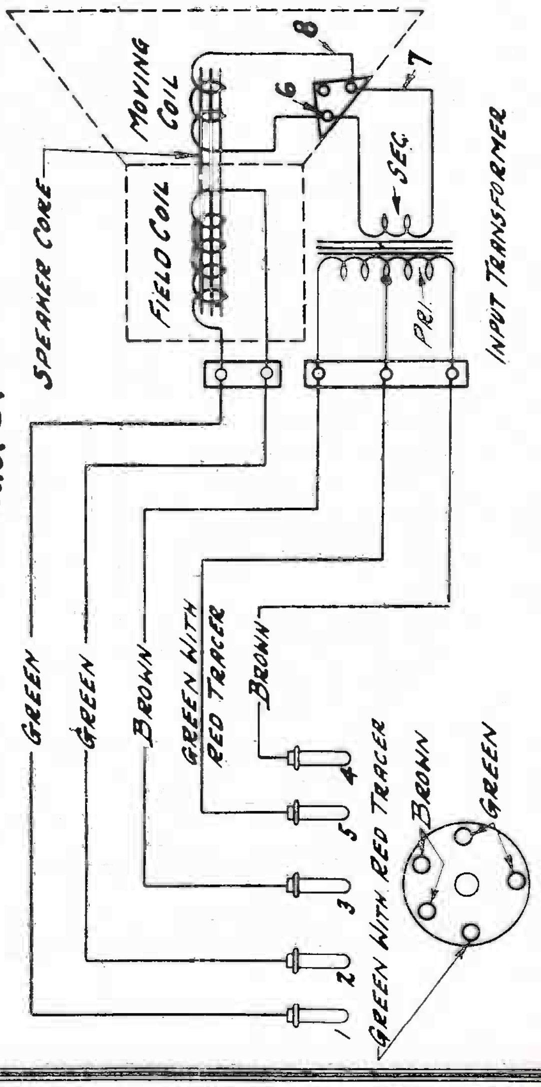
VOLTAGES AT SOCKETS — VOLUME CONTROL AT MAXIMUM — LINE VOLTAGE, 115 — PLUG IN SOCKET OF RECEIVER — TUBE IN TEST SET

Model 31

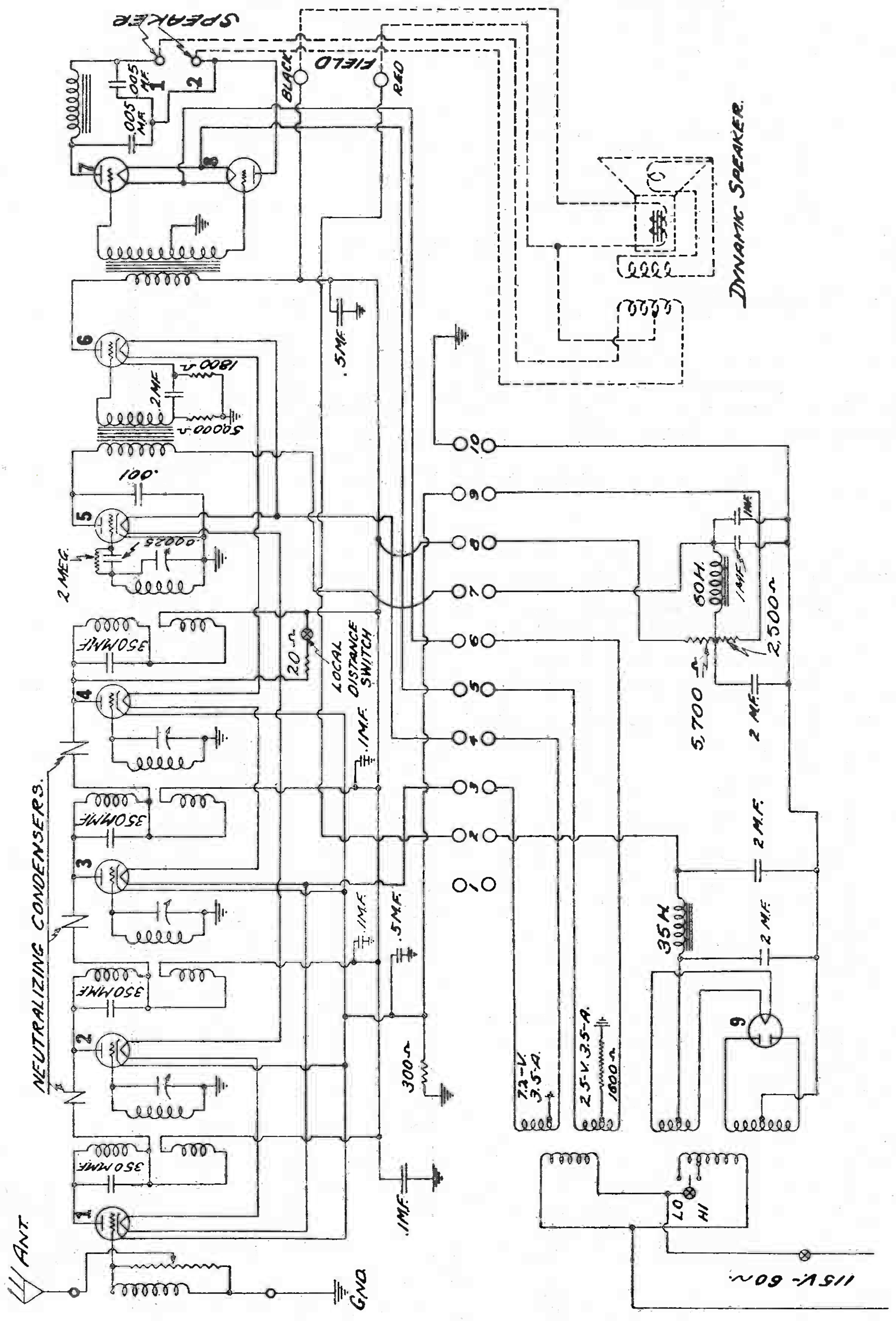
Type of Tube	Position of Tube	Function	"A" Volts	"B" Volts	Control Grid "C" Volts	Screen Volts	Screen Current M.A.	Cathode Volts	Plate M.A.	Grid Test M.A.
224	1	1st Radio	2.25	178	3.0	86	.45	3.0	3.4	5.8
224	2	2nd Radio	2.25	178	3.0	86	.45	3.0	3.4	5.8
224	3	3rd Radio	2.25	178	3.0	86	.45	3.0	3.4	5.8
227	4	Detector	2.25	60	9			9	.25	.3
227	5	1st Audio	2.25	160	12			12	4.5	5.5
245	6	2nd Audio	2.35	246	40				25	30
245	7	2nd Audio	2.35	246	40				25	30
280	8	Rectifier	4.9						37 Per Plate	

ELECTRODYNAMIC SPEAKER

Model 31

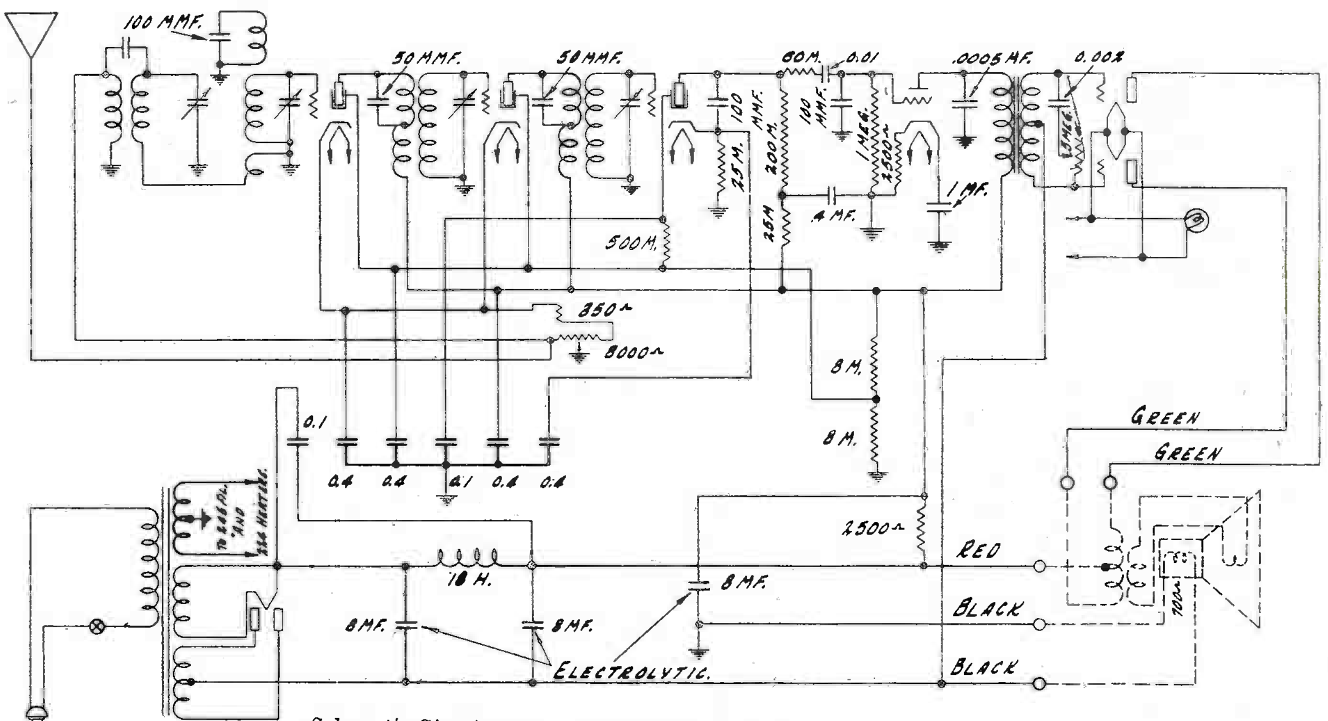


U. S. RADIO AND TELEVISION CORP.



Schematic circuit diagram of No. 90 chassis

U. S. RADIO AND TELEVISION CORP.

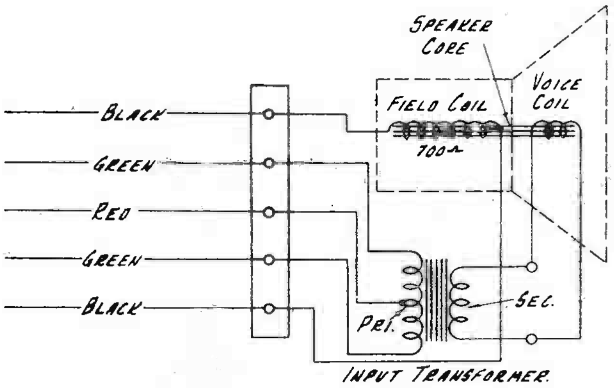


Schematic Circuit Diagram of No. 32 Chassis

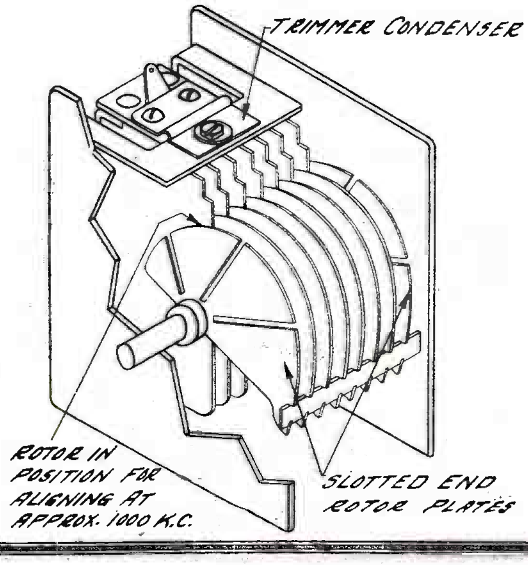
DOTTED LINES SHOWN ARE IN SPEAKER.

No. 32 CHASSIS—VOLTAGES AT SOCKETS—VOLUME CONTROL AT MAXIMUM LINE VOLTAGE, 115—PLUG IN SOCKET OF RECEIVER—TUBE IN TEXT SET

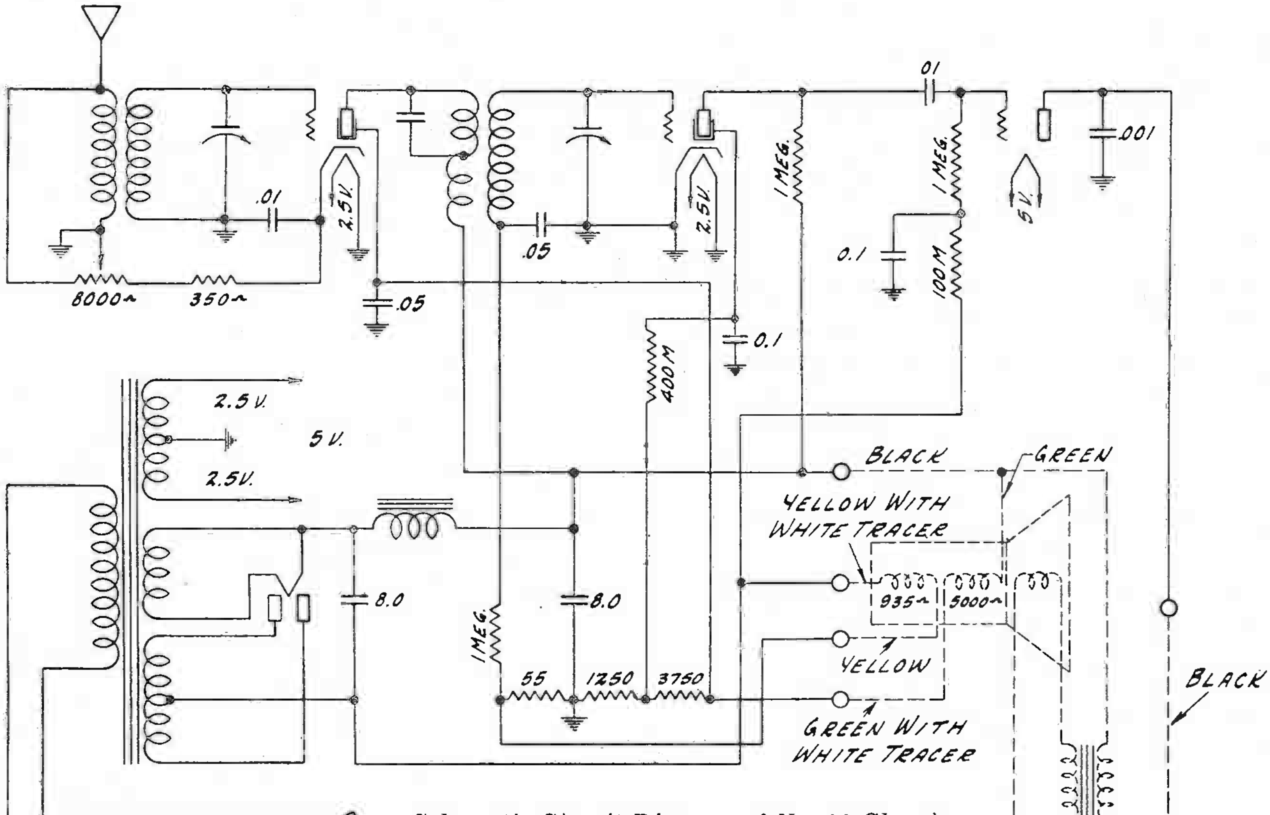
Type of Tube	Position of Tube	Function	"A" Volts	"B" Volts	Control Grid "C" Volts	Screen Volts	Screen Current MA	Cathode Volts	Plate MA	Grid Test MA
224	1	1st Radio	2.3	198	3.	88	.9	3.	3.5	6.
224	2	2nd Radio	2.3	198	3.	88	.9	3.	3.5	6.
224	3	Detector	2.3	150	6.	45	.1	6.	.25	.4
227	4	1st Audio	2.3	180	12.5			12.5	5.	6.1
245	5	2nd Audio	2.4	255	55.				26.	31.
245	6	2nd Audio	2.4	255	55.				26.	31.
280	7	Rectifier	5.						36. Per Plate	



Electrodynamic Speaker and Connections



U. S. RADIO AND TELEVISION CORP.



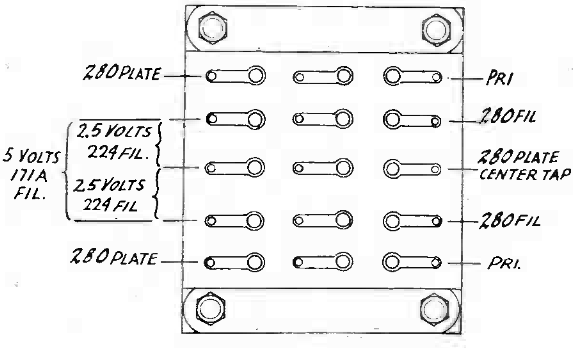
Schematic Circuit Diagram of No. 20 Chassis

DOTTED LINES SHOWN ARE IN SPEAKER.

No. 20 CHASSIS—VOLTAGES AT SOCKETS—VOLUME CONTROL AT MAXIMUM LINE VOLTAGE, 115—PLUG IN SOCKET OF RECEIVER—TUBE IN TEST SET

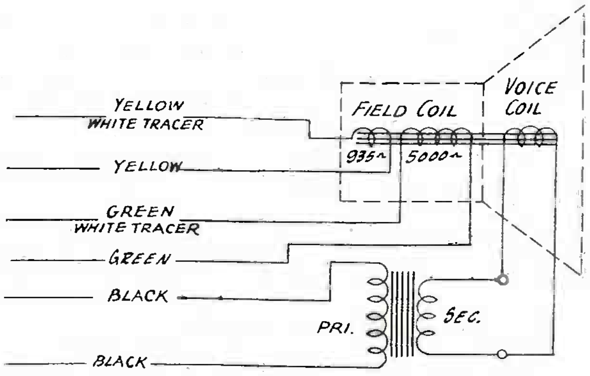
Type of Tube	*Position of Tube*	*Function*	*"A" Volts*	*"B" Volts*	*Control Grid "C" Volts*	*Screen Volts*	*Screen Current MA*	*Cathode Volts*	*Plate MA*	*Grid Test MA*
224	1	1st Radio	2.5	196	2.2	85	1.4	2.2	5.	7.1
224	2	Detector	2.5	95 (1)	2.3 (2)	17 (3)	.015		.1	.2
171A	3	1st Audio	5.1	191	43. (4)				18.	20.
280	4	Rectifier	5.1						23. Per Plate	

(1) (3) Computed value. Reading with voltmeter will be lower.
(2) This voltage read across 55 ohm section of shunt resistor.
(4) This voltage read across 935 ohm section of speaker field and 55 ohm section of shunt resistor.



CENTER ROW OF LUGS USED AS WIRING TERMINALS ONLY

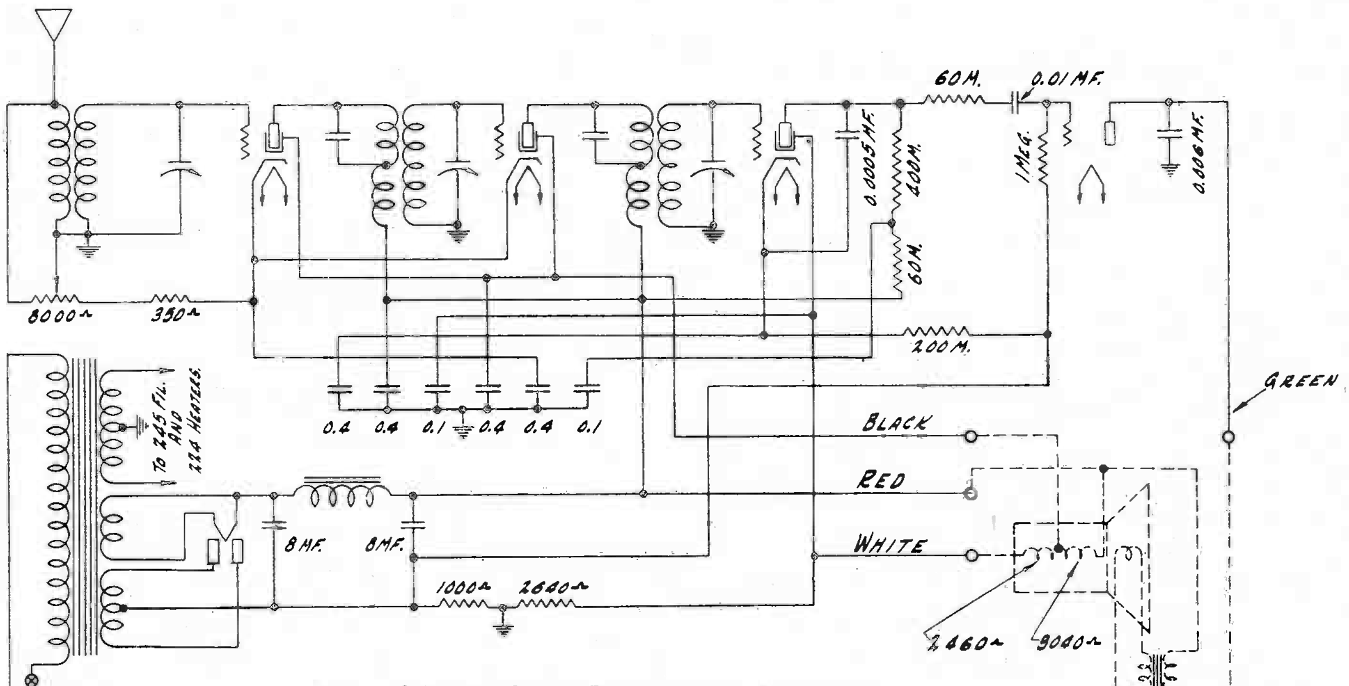
Power Transformer Terminals



INPUT TRANSFORMER

Electrodynamic Speaker and Connections

U. S. RADIO AND TELEVISION CORP.

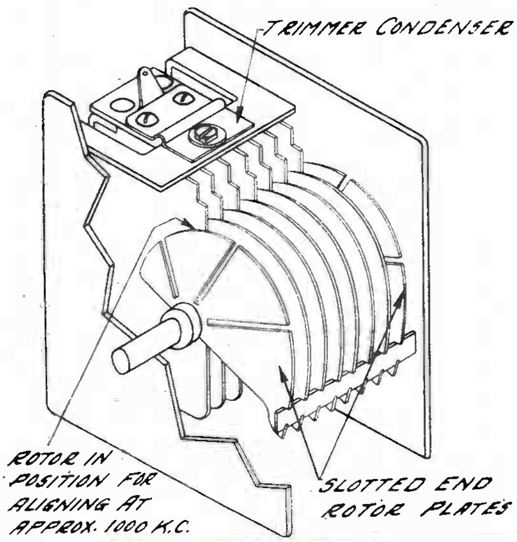


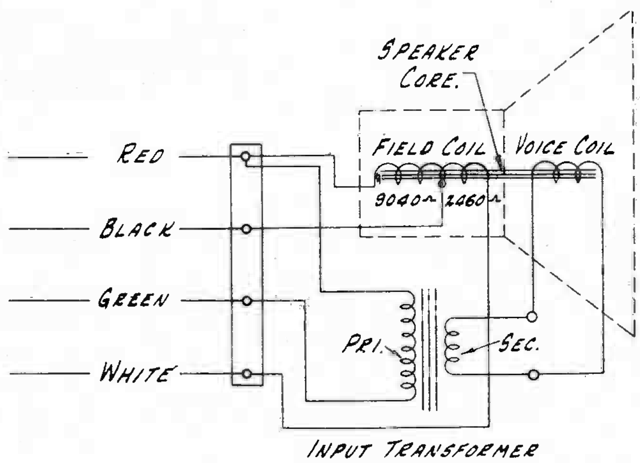
Schematic Circuit Diagram of No. 26 Chassis

DOTTED LINES SHOWN ARE IN SPEAKER

No. 26 CHASSIS—VOLTAGES AT SOCKETS—VOLUME CONTROL AT MAXIMUM LINE VOLTAGE. 115—PLUG IN SOCKET OF RECEIVER—TUBE IN TEST SET

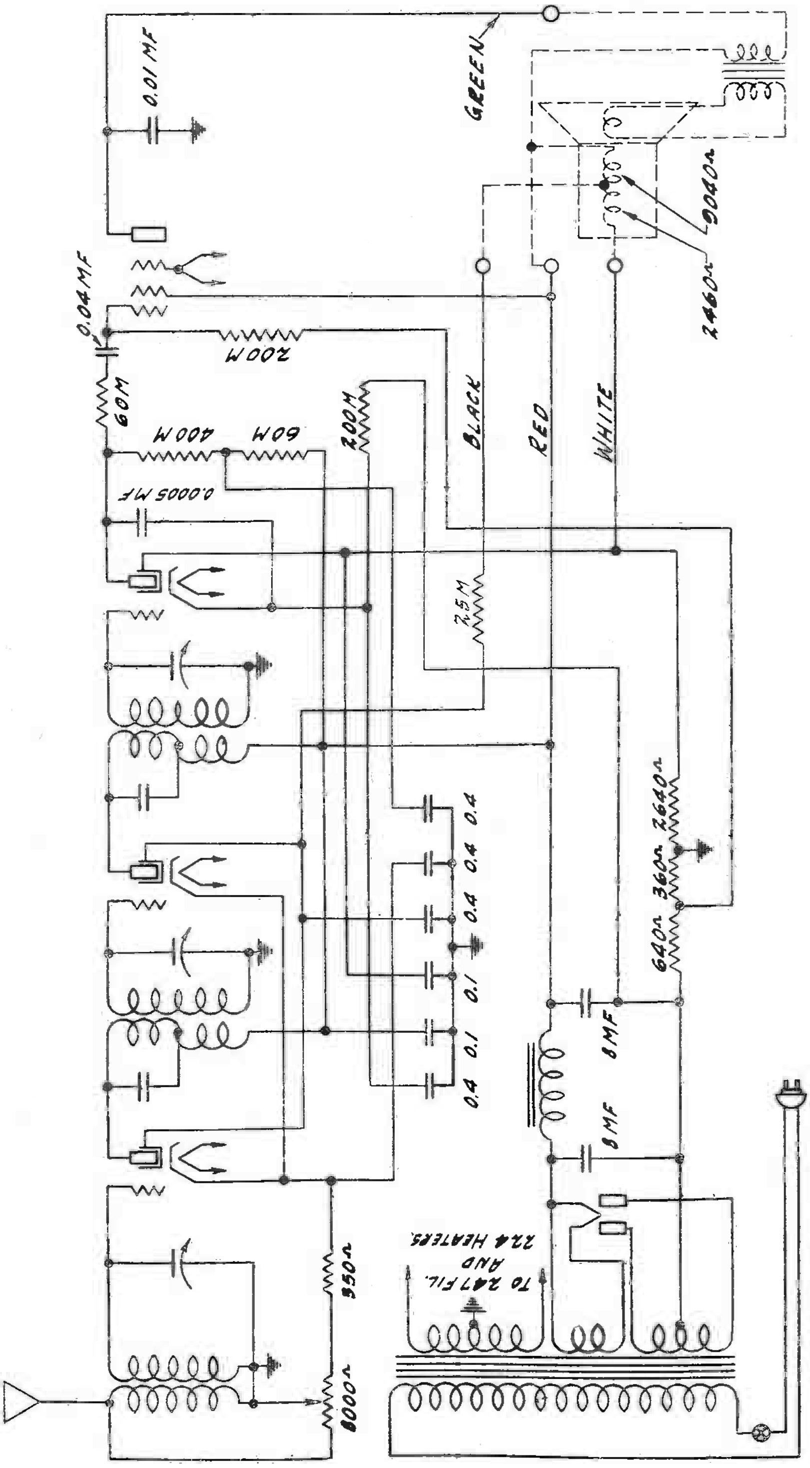
Type of Tube	*Position of Tube*	*Function*	*"A" Volts*	*"B" Volts*	*Control Grid "C" Volts*	*Screen Volts*	*Screen Current MA*	*Cathode Volts*	*Plate MA*	*Grid Test MA*
224	1	1st Radio	2.2	245	2.5	80	.6	2.5	2.9	5.1
224	2	2nd Radio	2.2	245	2.5	80	.6	2.5	2.9	5.1
224	3	Detector	2.2	130	3.	40	.1	3.	.25	.4
245	4	Audio	2.35	245	50.				28.	31.
280	5	Rectifier	4.6						25. Per Plate	





Electrodynamic Speaker and Connections

U. S. RADIO AND TELEVISION CORP.



Model
26P

No. 26P CHASSIS—VOLTAGES AT SOCKETS
VOLUME CONTROL AT MAXIMUM—LINE VOLTAGE, 115

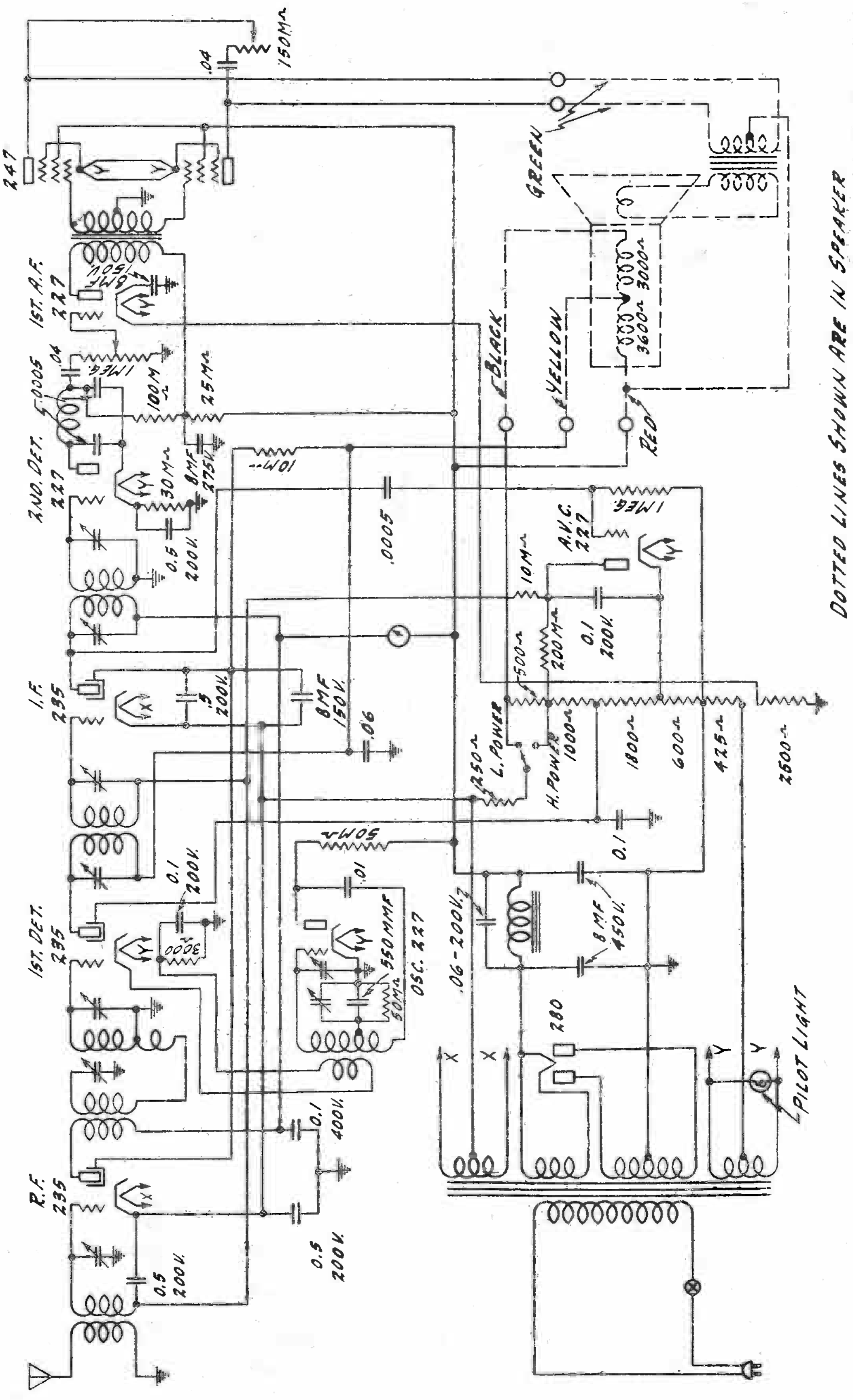
Type of Tube	*Position of Tube*	*Function*	*"A" Volts*	*"B" Volts*	*Control Grid "C" Volts*	*Screen Volts*	*Screen Current MA*	*Cathode Volts*	*Plate MA*	*Grid Test MA*
224	1	1st Radio	2.2	250	2.	55 (1)	.6	2.	2.1	3.5
224	2	2nd Radio	2.2	250	2.	55 (1)	.6	2.	2.1	3.5
224	3	Detector	2.2	130	2.8	40 (1)	.1	2.8	.25	.4
247	4	Audio	2.3	238	18. (2)	250	5.5		27.	31.
280	5	Rectifier	4.65						28. Per Plate	

(1) Reading with 250,000 ohm meter. Reading will be less with lower resistance meter.
(2) This voltage read across 360 ohm section of shunt resistor.

Making Pentode Current and Voltage Readings

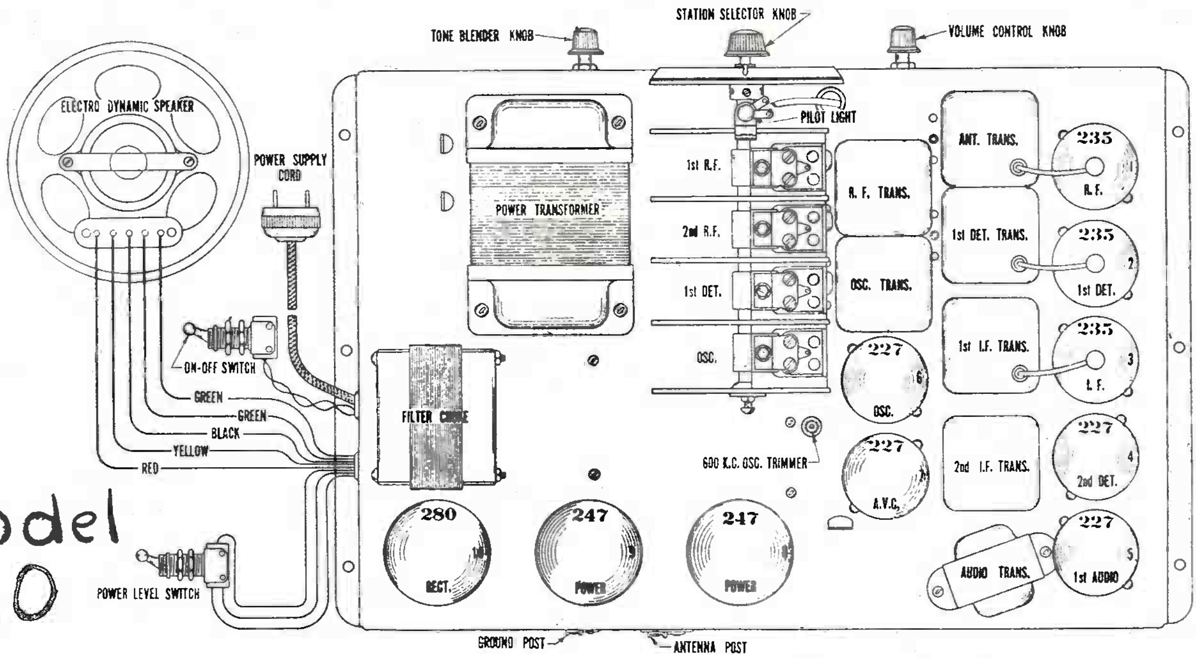
Reading	Terminals	Meter
A Volts	Across filament terminals	0-4 A.C. Voltmeter
B Volts	Plate terminal to subpanel	0-300 D.C. Voltmeter
C Volts	Across 360 ohm resistor	0-50 D.C. Voltmeter
Screen Volts	Screen grid terminal to subpanel	0-300 D.C. Voltmeter
Screen M.A.	Insert milliameter in screen grid line	0-25 D.C. Milliameter
Plate M.A.	Insert milliameter in plate line	0-50 D.C. Milliameter

U. S. RADIO AND TELEVISION CORP.



Schematic Circuit Diagram of No. 10 Super-heterodyne Chassis

U. S. RADIO AND TELEVISION CORP.



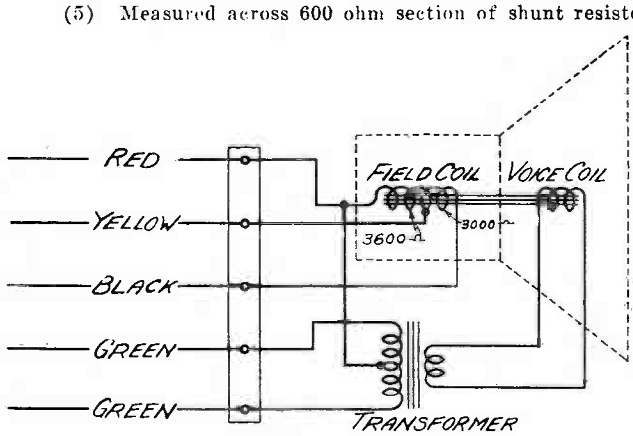
Model 10

Top View of Chassis Showing Tube Location and Speaker Connections

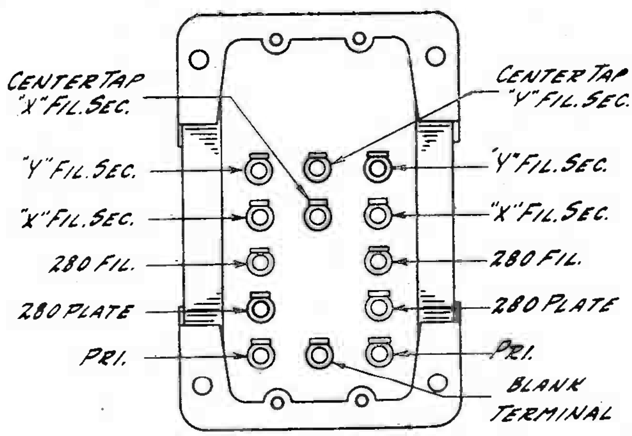
No. 10 CHASSIS—VOLTAGES AT SOCKETS—LINE VOLTAGE 115
VOLUME CONTROL AT MAXIMUM—POWER LEVEL SWITCH HIGH POWER

Type of Tube	*Position of Tube*	*Function*	*"A" Volts*	*"B" Volts*	*Control Grid "C" Volts*	*Screen Volts*	*Screen Current MA*	*Cathode Volts*	*Plate MA*	*Grid Test MA*
235	1	R.F.	2.3	175	2.3 (1)	65	.7	0.	4.0	6.0
235	2	1st Det.	2.3	185	7.0	69	.4	14.	2.0	2.6
235	3	I.F.	2.3	175	2.3 (1)	65	.7	0.	4.0	6.0
227	4	2nd Det.	2.3	115	12.			7.5	.4	.5
227	5	1st Audio	2.3	145	11. (2)			10.	4.6	5.4
227	6	Osc.	2.3	83	15–35 (3)			21.	4.2	4.4
227	7	A.V.C.	2.3	89 (4)	20. (5)			1.5	0.	0.
247	8	Power	2.35	255	18.5	265	4.5		21.	28.
247	9	Power	2.35	255	18.5	265	4.5		21.	28.
280	10	Rect.	4.9						45. Per Plate	

(1) Measured across 250 ohm series resistor.
(2) Measured across 2500 ohm series resistor.
(3) Bias voltage varies from 15 to 35 between 1500 and 550 K.C. settings of tuning condenser.
(4) Measured across 1000 and 1800 ohm sections of shunt resistor.
(5) Measured across 600 ohm section of shunt resistor.

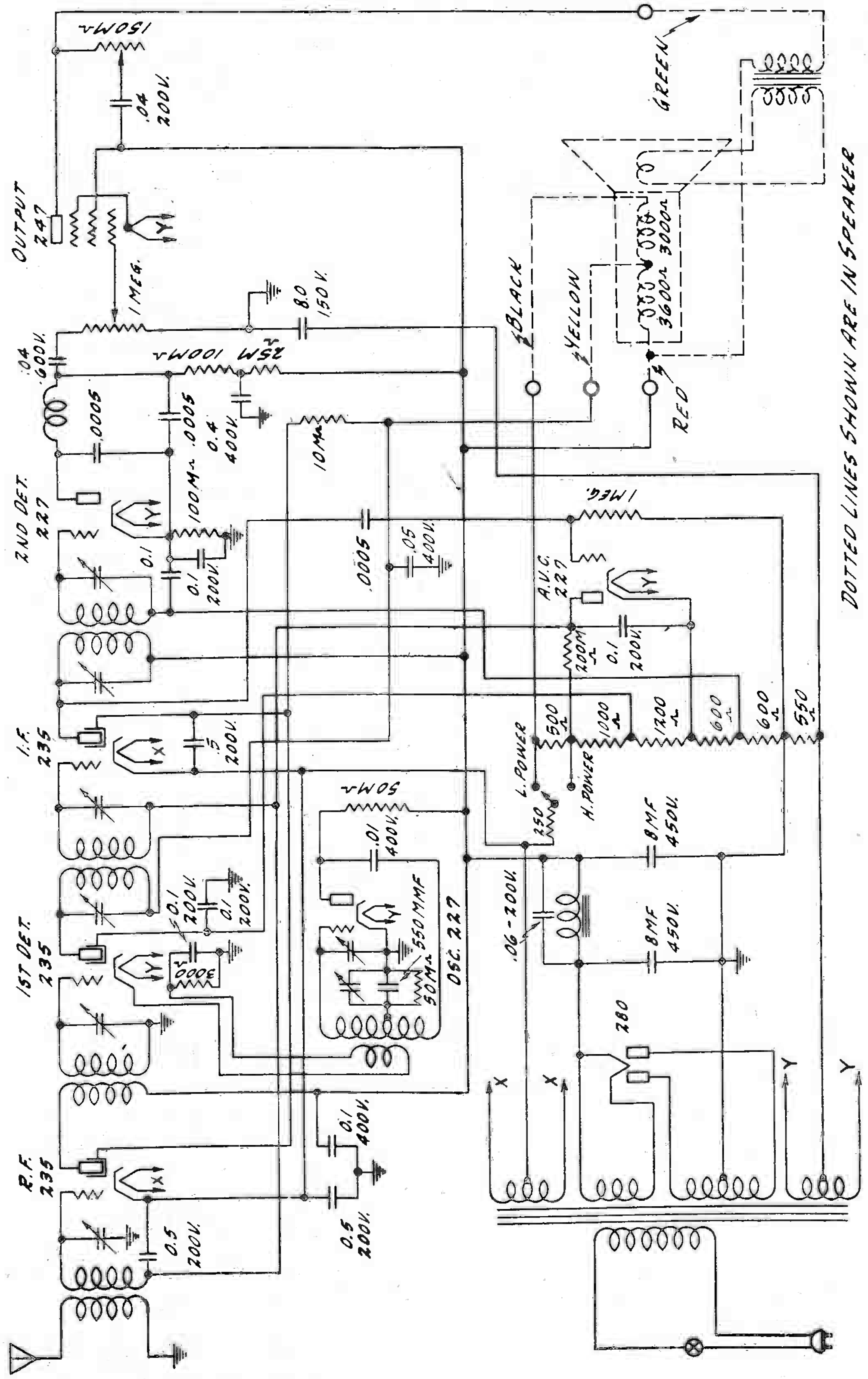


Electrodynamic Speaker and Connections



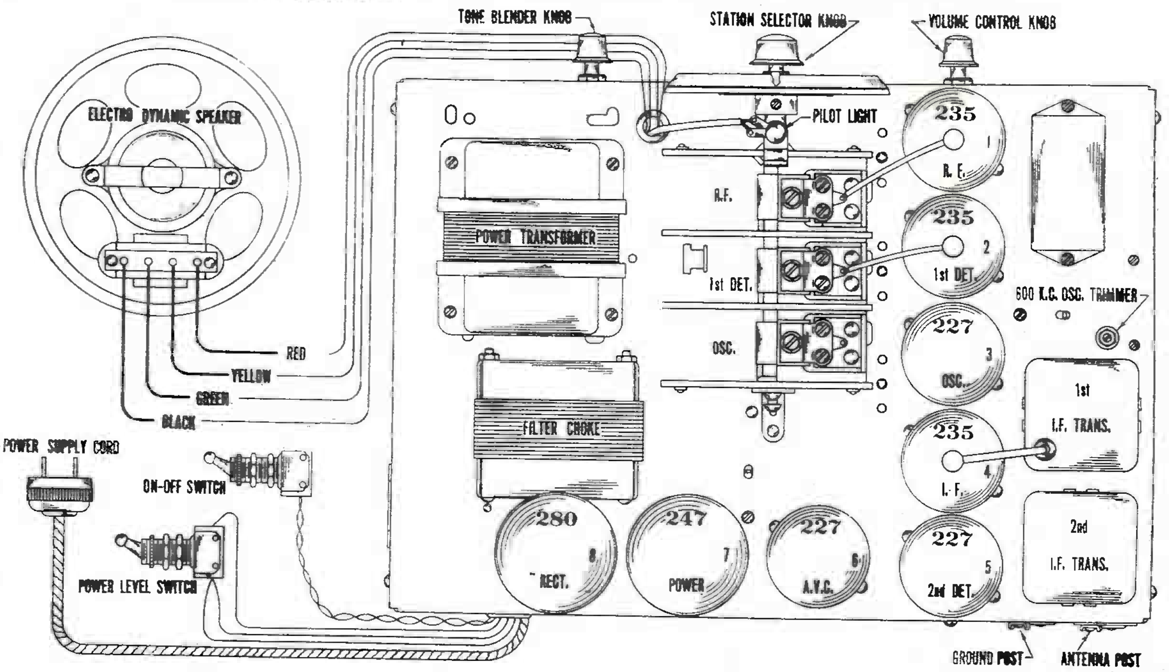
Power Transformer Terminals

U. S. RADIO AND TELEVISION CORP.



Schematic Circuit Diagram of No. 8 Super-heterodyne Chassis

U. S. RADIO AND TELEVISION CORP.



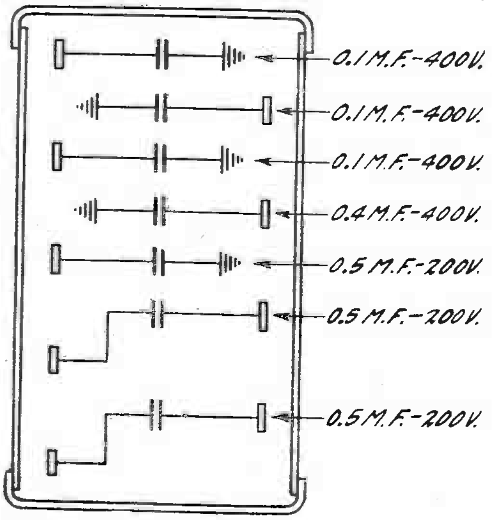
Top View of Chassis Showing Tube Location and Speaker Connections

No. 8 CHASSIS—VOLTAGES AT SOCKETS—LINE VOLTAGE 115
VOLUME CONTROL AT MAXIMUM—POWER LEVEL SWITCH HIGH POWER

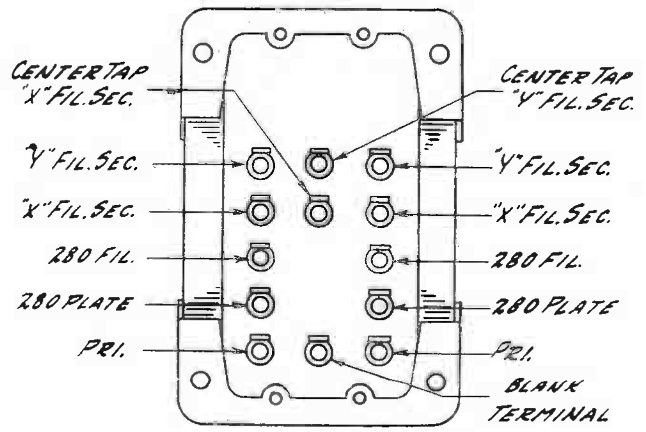
Type of Tube	Function	"A" Volts	"B" Volts	Control Grid "C" Volts	Screen Volts	Screen Current MA	Cathode Volts	Plate MA	Grid Test MA
235	R.F.	2.3	190	2.3(1)	68	1.0	0.	3.8	6.5
235	1st Det.	2.3	190	6.5	70	.35	14.	2.0	4.9
227	Osc.	2.3	80	15–50(2)			20.	4.7	4.8
235	I.F.	2.3	190	2.3(1)	68	.6	0.	3.6	6.0
227	2nd Det.	2.3	150	20.			20.	.4	.4
227	A.V.C.	2.3	65(3)	40. (4)			20.	0.	0.
247	Power	2.35	260	20. (5)	280	7.		32.	36.
280	Rectifier	5.						41. Per Plate	

(1) Measured across 250 ohm series resistor.
(2) Bias voltage varies from 15 to 50 between 1500 and 550 K.C. settings of tuning condenser.
(3) Measured across 1000 and 1200 ohm sections of shunt resistor.
(4) Measured across two 600 ohm sections of shunt resistor.
(5) Measured across 550 ohm series resistor.

Model 8

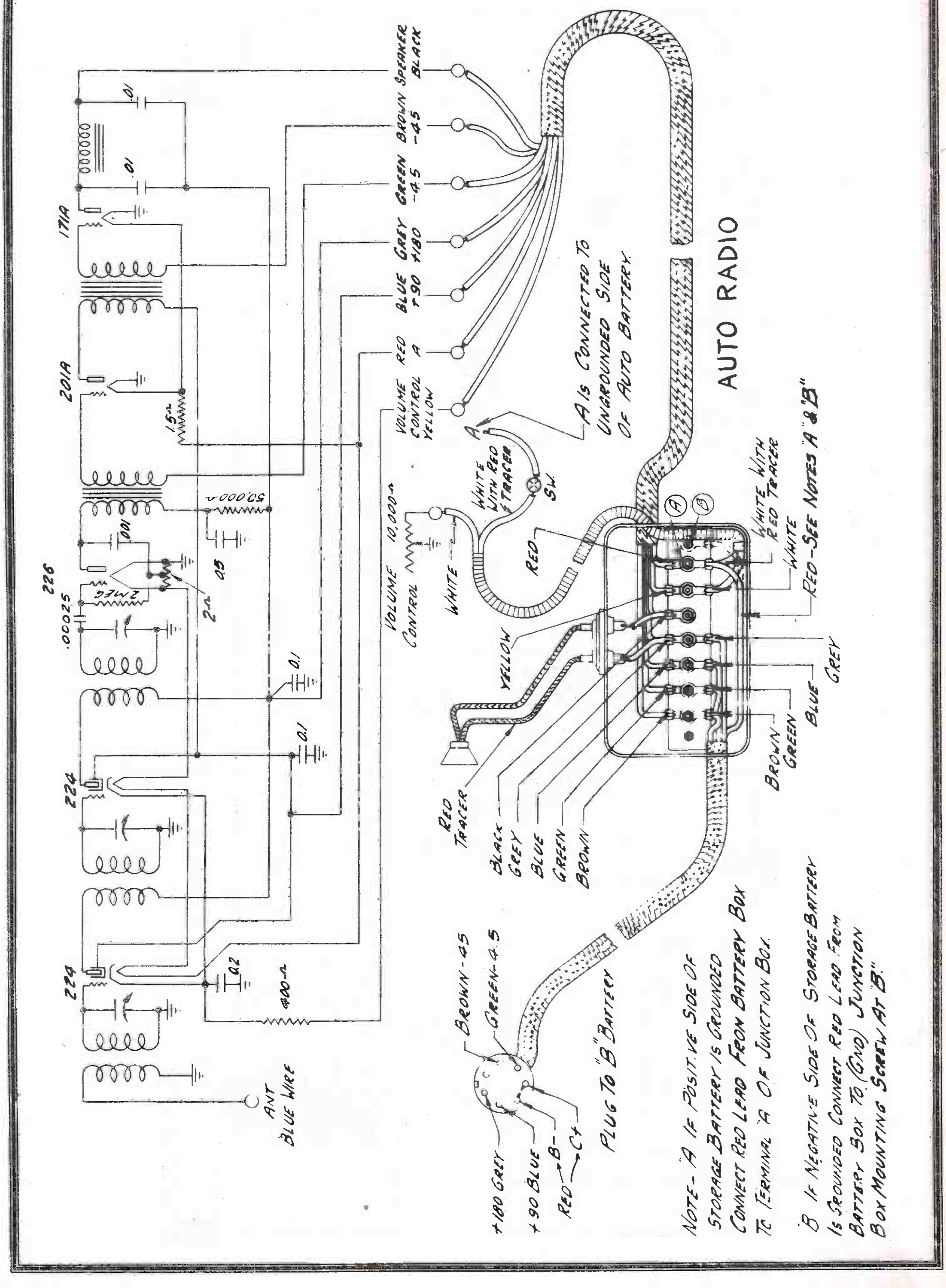


7 Section Condenser Internal Wiring

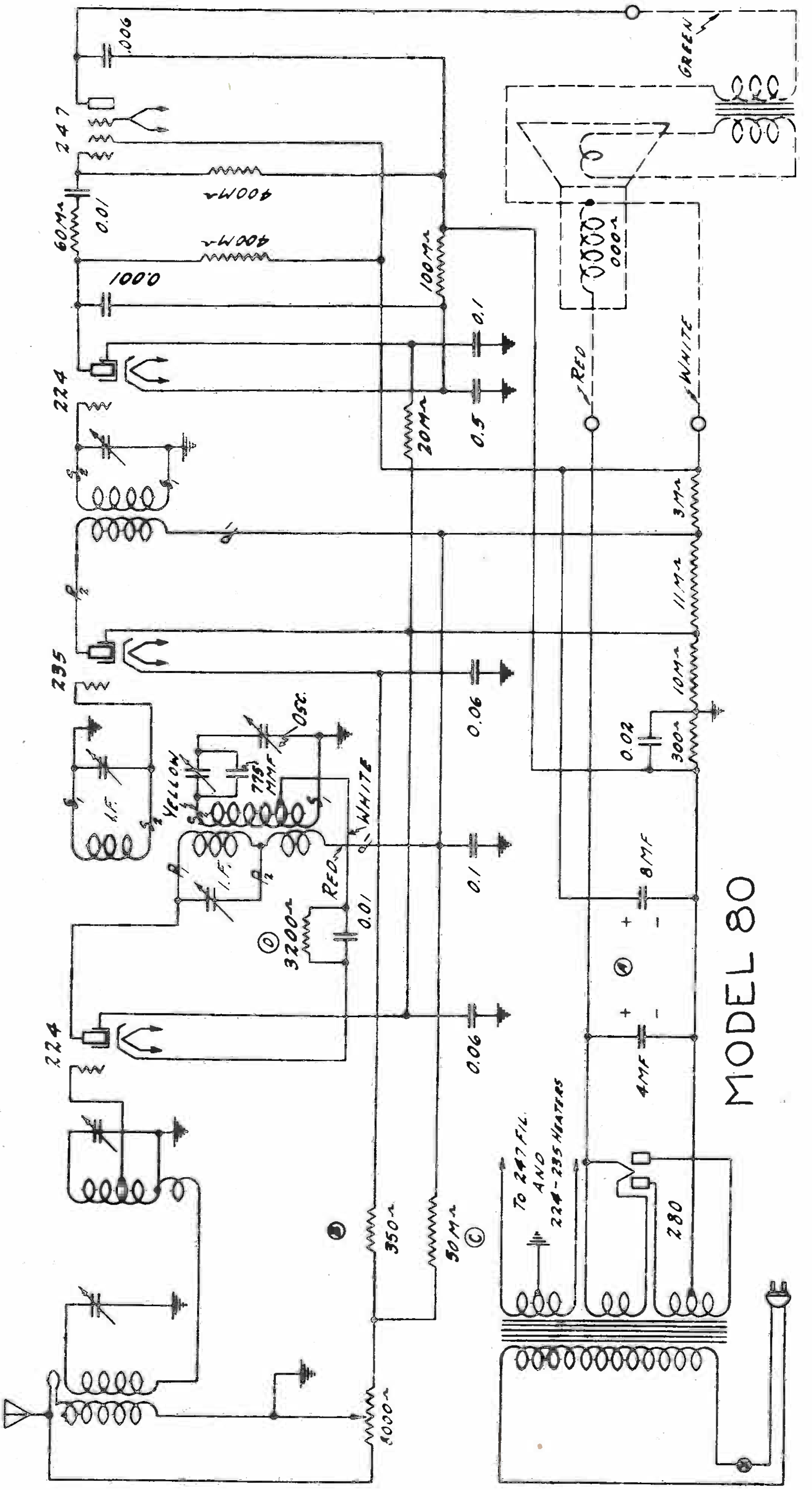


Power Transformer Terminals

U. S. RADIO AND TELEVISION CORP.



U. S. RADIO AND TELEVISION CORP.



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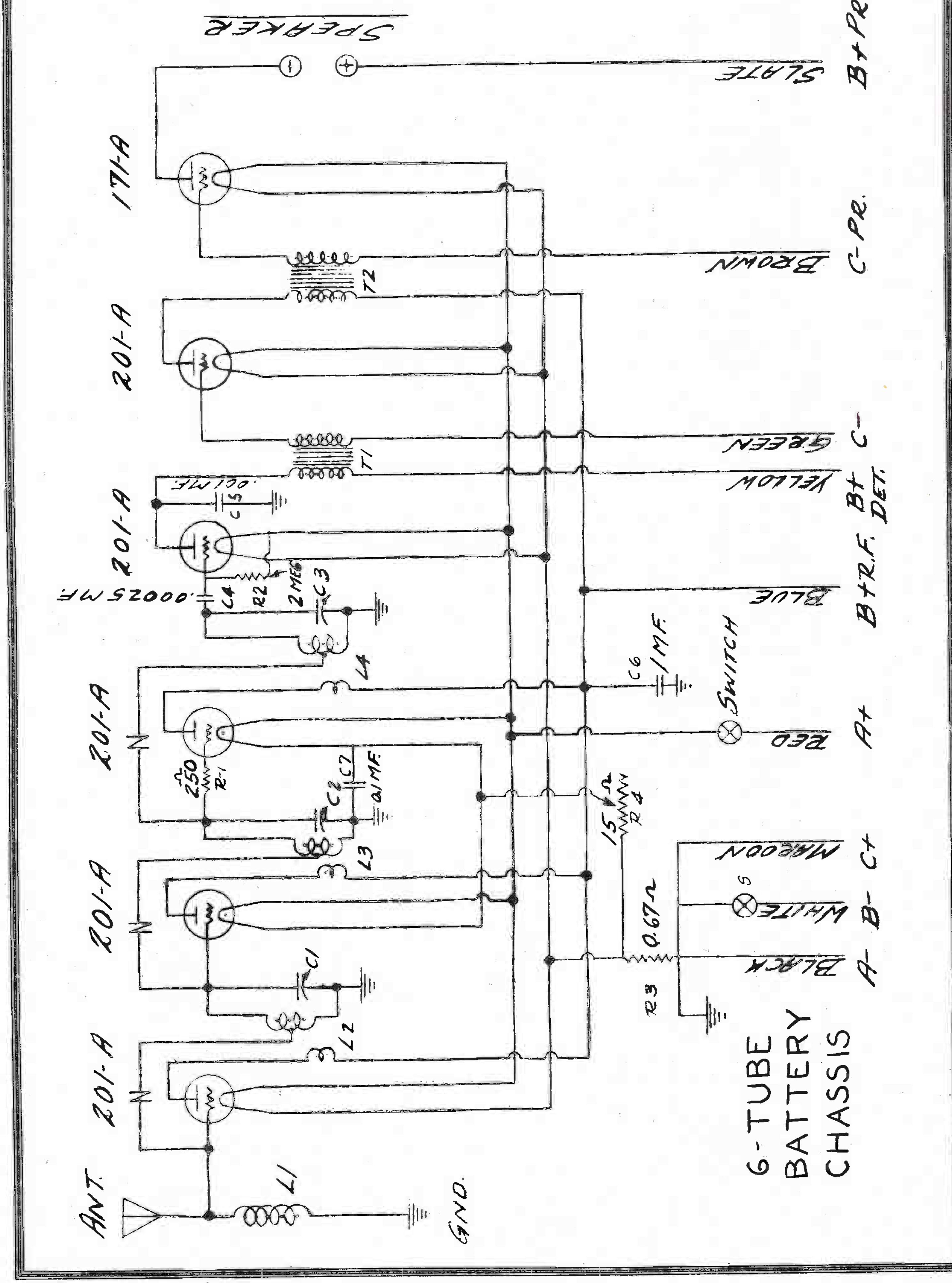

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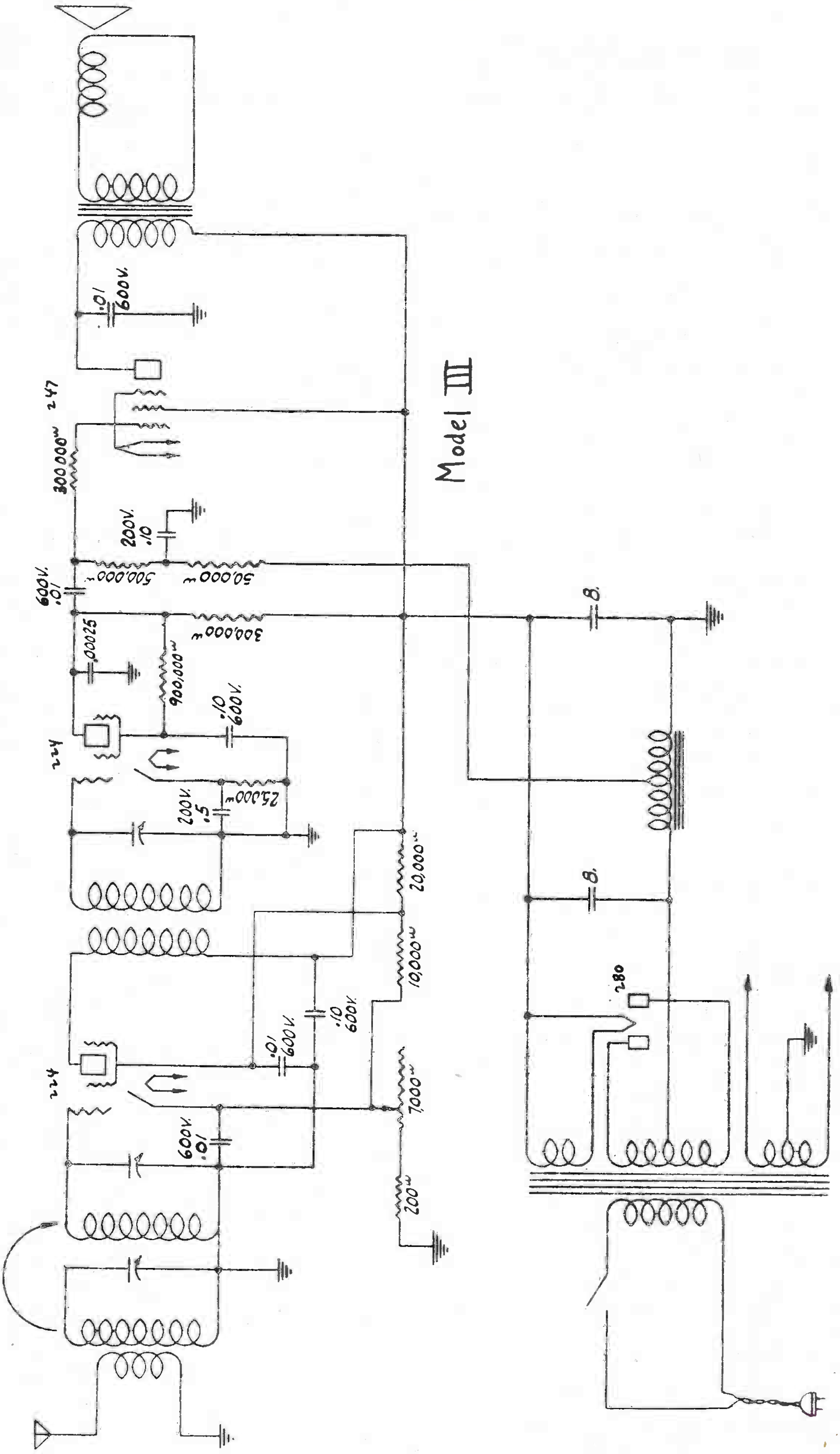
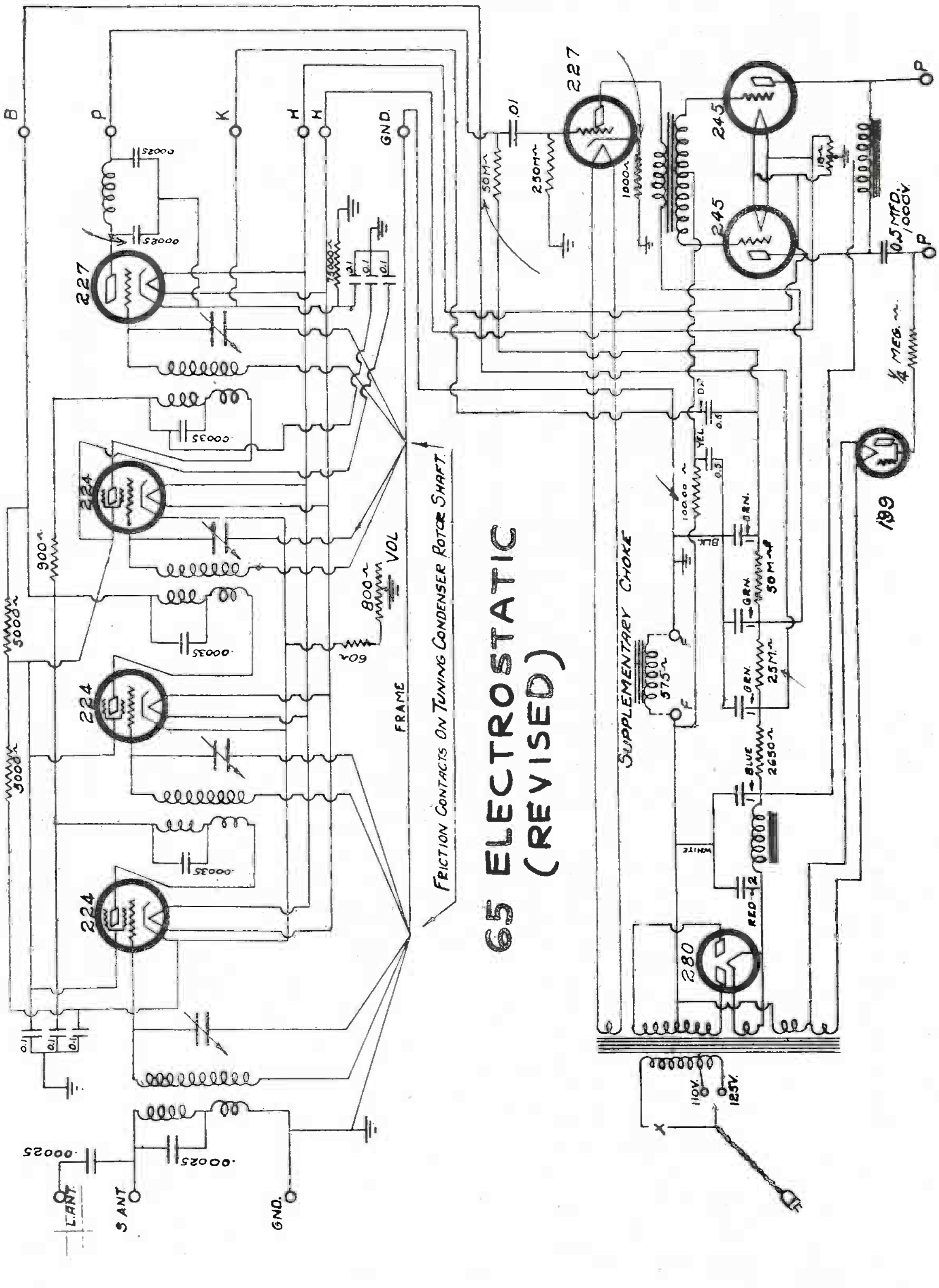
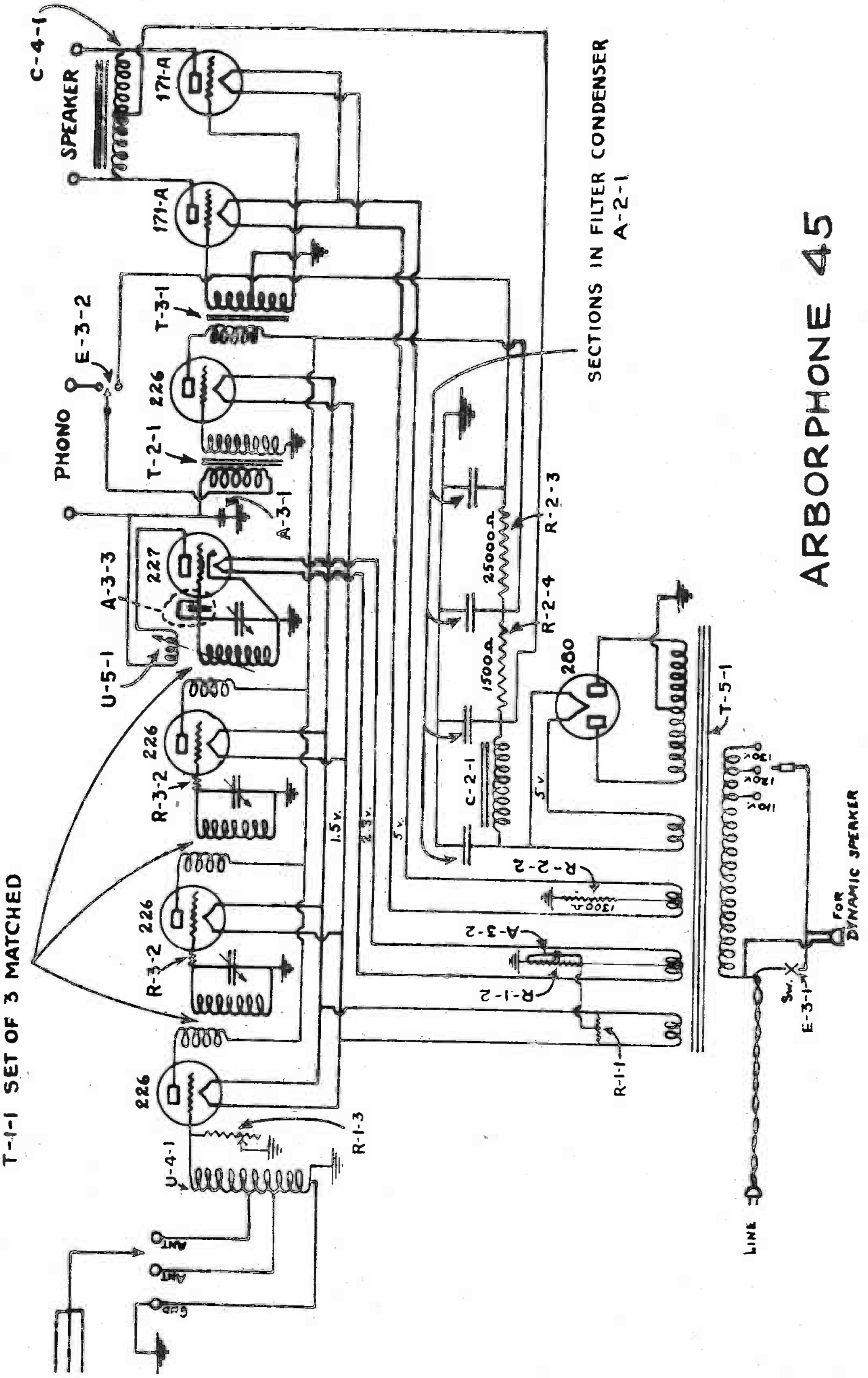


UNITED REPRODUCERS CORP.

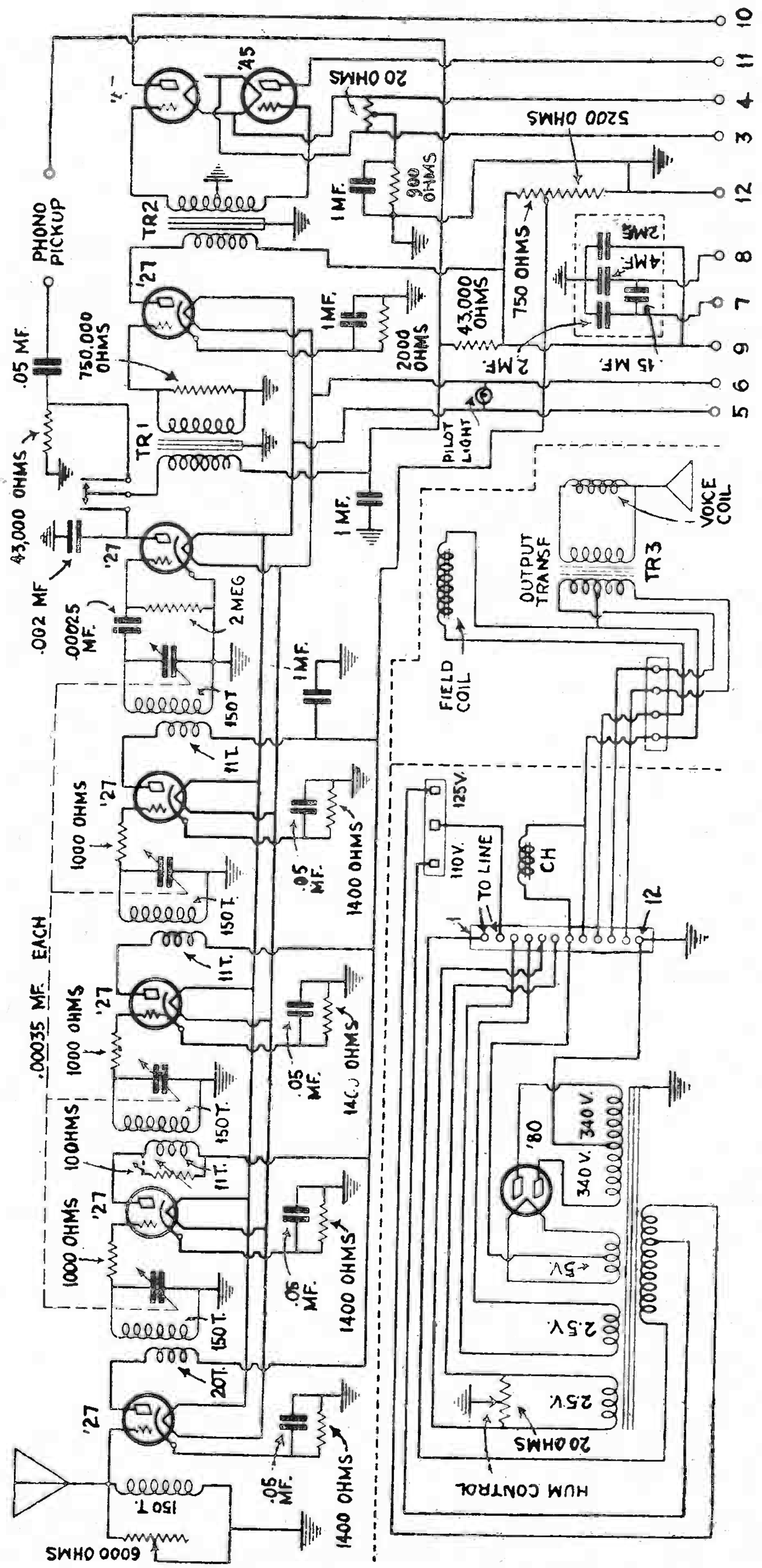


UNITED REPRODUCERS CORP.



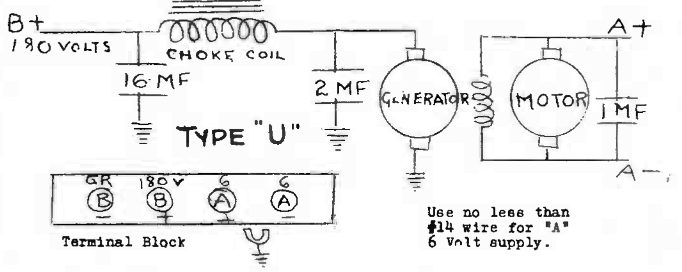
ARBORPHONE 45

UNITED REPRODUCERS CORP.



TEMPLE MODELS 8-60, 8-80, 8-90 (REVISED)

U. S. ELECTRIC WORKS



Use no less than #14 wire for "A" 6 Volt supply.

Type "U" is used with the Universal Radio Set and all others using B Negative as a common Ground.

Type "U" should not be used on sets where the C Bias current is from B negative to ground.

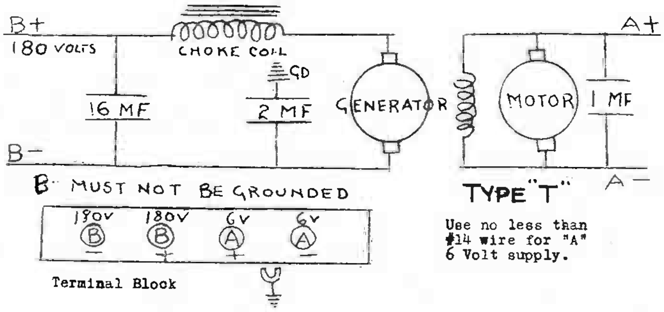
Type "U" is recommended for sets using Automobile Pentode tubes.

Type "U" is rated at 180 Volts at 35 Milliampere drain, at 6 Volt input. On the installation of Genemotor it is absolutely necessary that you have no less than 6 Volt supply at the Genemotor Terminal Block.

The Common ground connection is connected to the A+ when the positive side of the battery is grounded to the car frame or to the A- when the negative side of the battery is grounded to the frame of the car.

Genemotor requires no further lubrication for one year after installation, and then less than one drop in each bearing. String the rubber grommet on the cables before connecting to the terminal block.

The serial number is stamped on the bottom flange of the base. The live "A" line or input comes direct from the set control switch, so that when the set is turned off it automatically cuts the supply to the Genemotor.



Use no less than #14 wire for "A" 6 Volt supply.

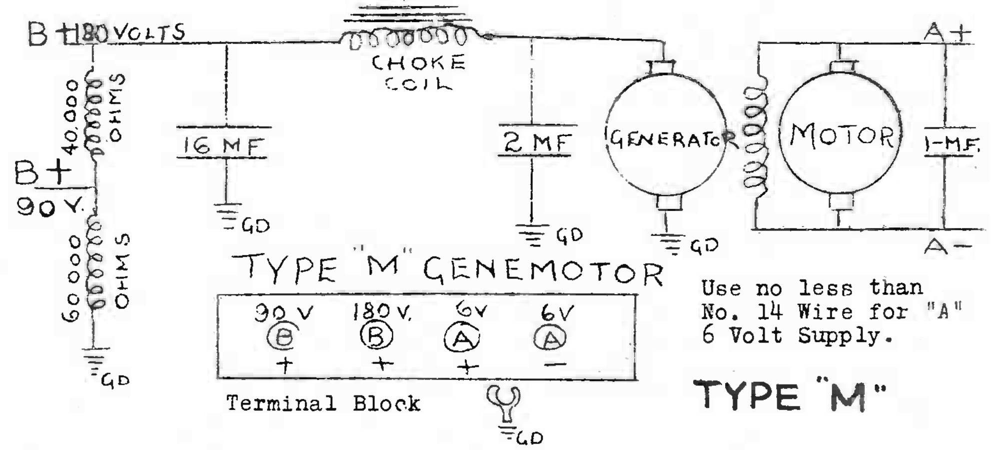
TYPE "T" is used with Philco- Transitone and all similar type sets, where the C Bias current is taken from B negative to the ground.

Type "T" is rated at 180 Volts at 35 Milliampere drain, at 6 Volt input. On the installation of Genemotor it is absolutely necessary to have no less than 6 volt supply at the Genemotor terminal block.

The common ground connection is connected to the A+ when the positive side of the battery is grounded to the car frame, or to the A- when the negative side of the battery is grounded to the frame of the car.

Genemotor requires no further lubrication for one year, after installation, and then less than one drop in each bearing. String the rubber grommet on the cables before connecting to the terminal block.

The serial number is stamped on the under side of flange of the base. The live "A" line or input comes direct from the set control switch, so that when the set is turned off it automatically cuts the supply from the Genemotor.



Use no less than No. 14 Wire for "A" 6 Volt Supply.

TYPE "M"

The common ground connection is connected to the A+ when the positive side of the battery is grounded to the car frame or to the A- when the negative side of the battery is grounded to the frame of the car.

Type M is used on the Majestic, Bosch and other sets using a 90 Volt tap at about 1/2 millampere drain. The Negative B is a common ground.

Type M is recommended where the Automobile Pentode Tubes are used. String the rubber grommet on the cables before connecting to the terminal block.

Genemotor requires no further lubrication for one year's service and then less than a drop in each bearing.

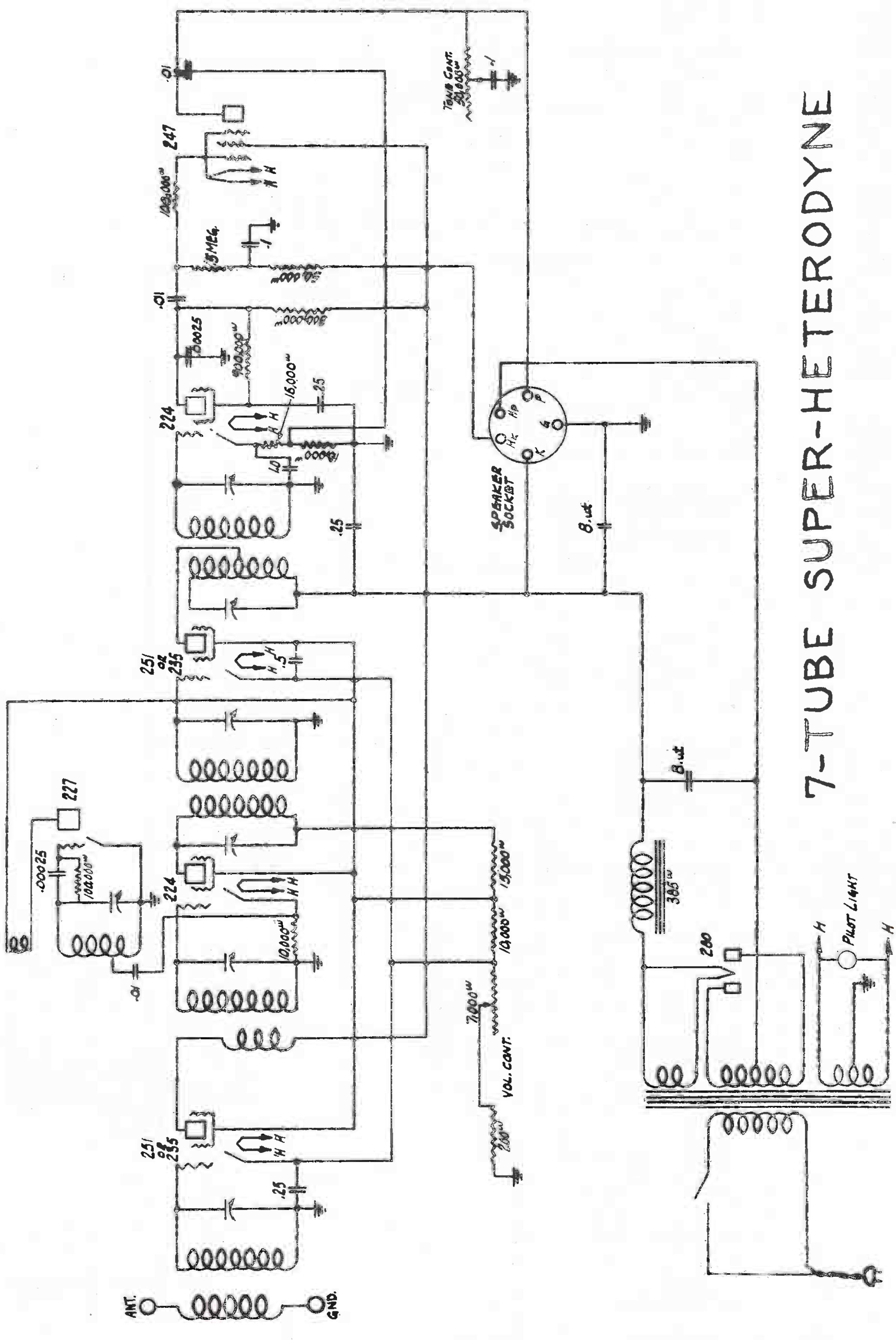
This Genemotor has been thoroughly tested at the factory, and is guaranteed against defective workmanship and material for a period of ninety days from date of installation.

Type M should not be used on sets where the C Bias current is from B negative to ground.

Serial number of the Genemotor is stamped under the bottom flange of the base. The live A line or input comes direct from the set control switch, so that when the set is turned off it automatical-ly cuts the supply to the Genemotor.

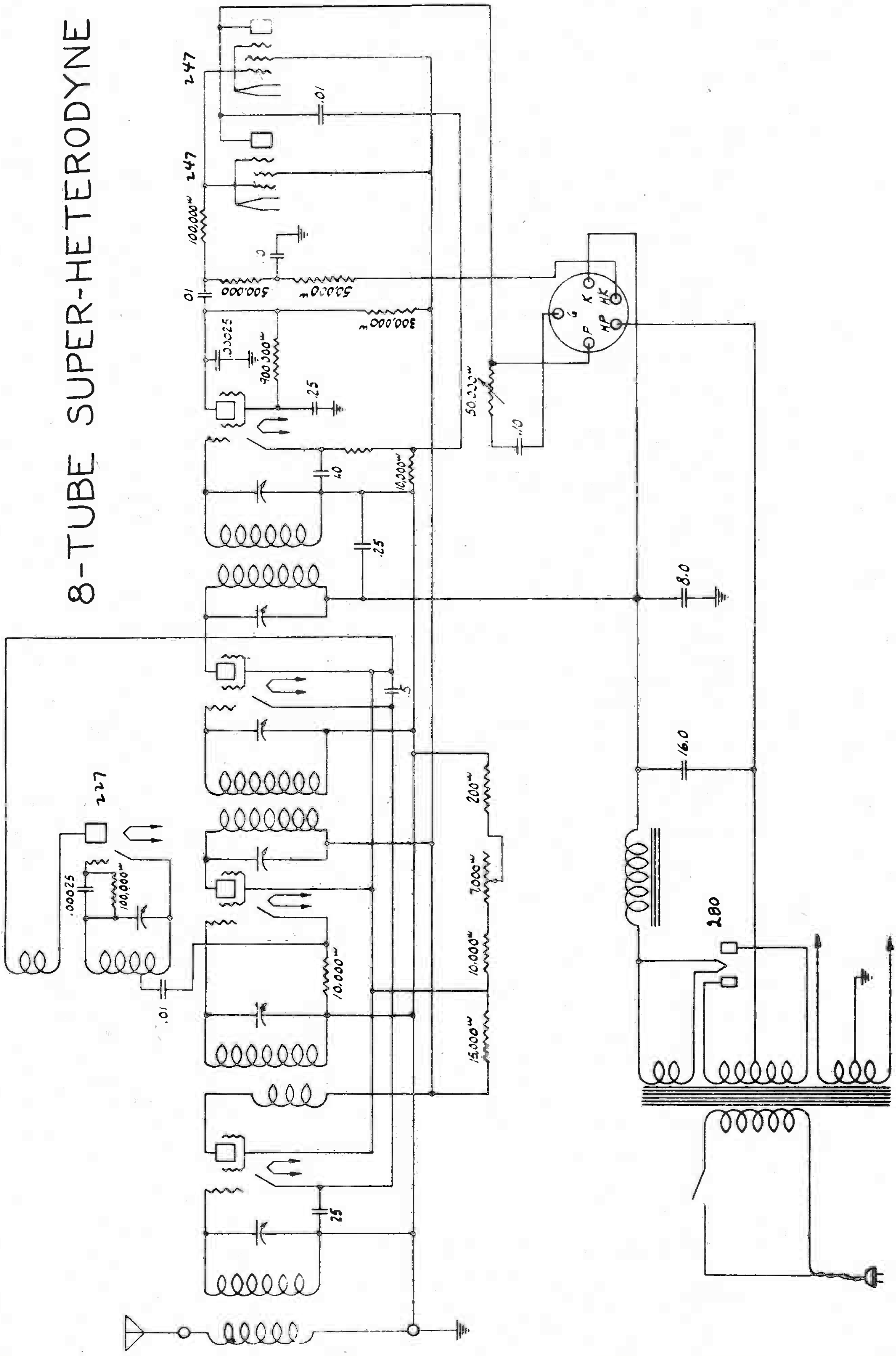
Type M Genemotor is rated at 180 volts at 35 Milliampere drain, at 6 volt input. On the installation of Genemotor it is absolutely necessary that you have no less than 6 Volt supply at the Genemotor terminal block.

UNITED AIR CLEANER CO.

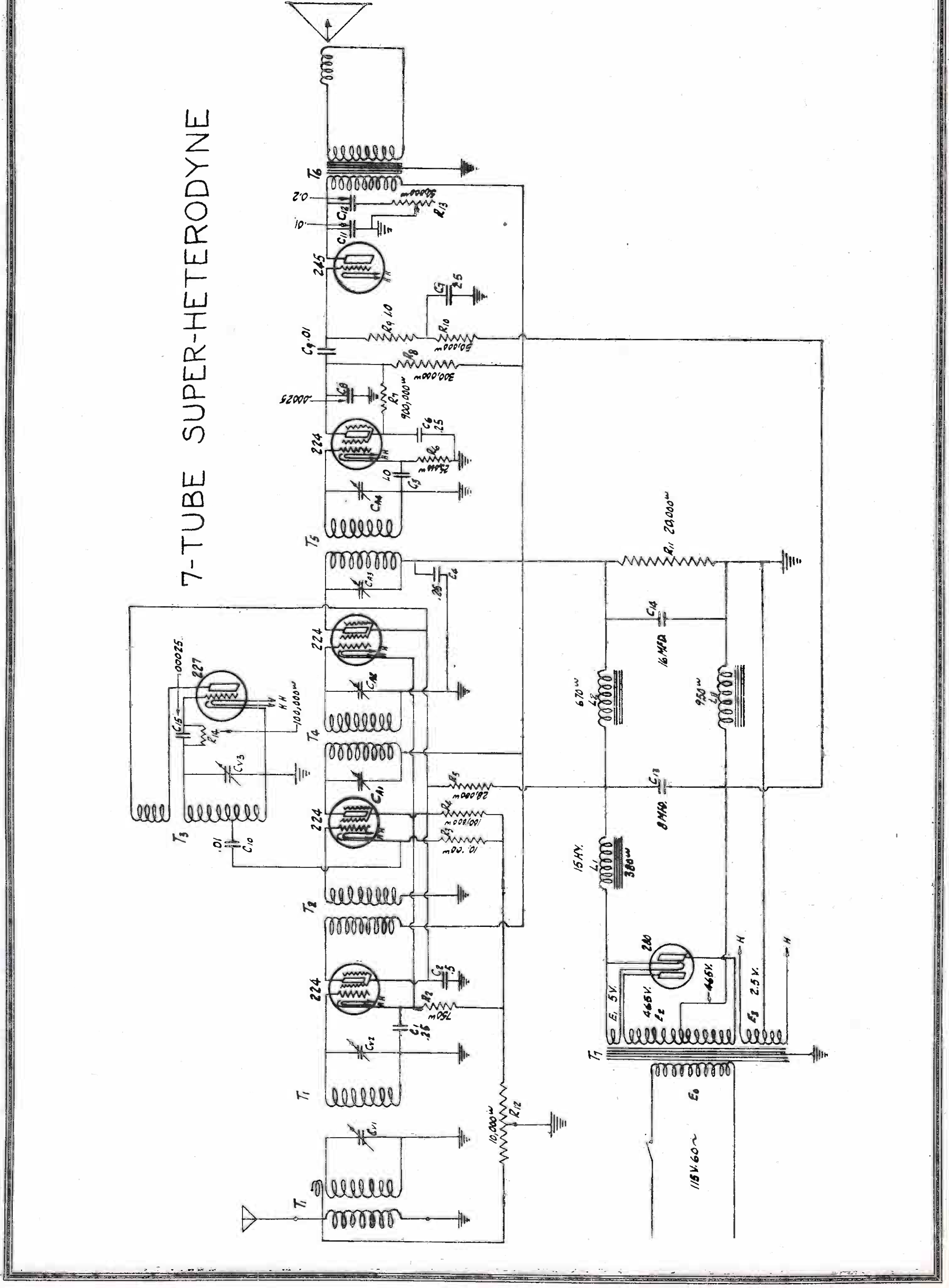


UNITED AIR CLEANER CO.

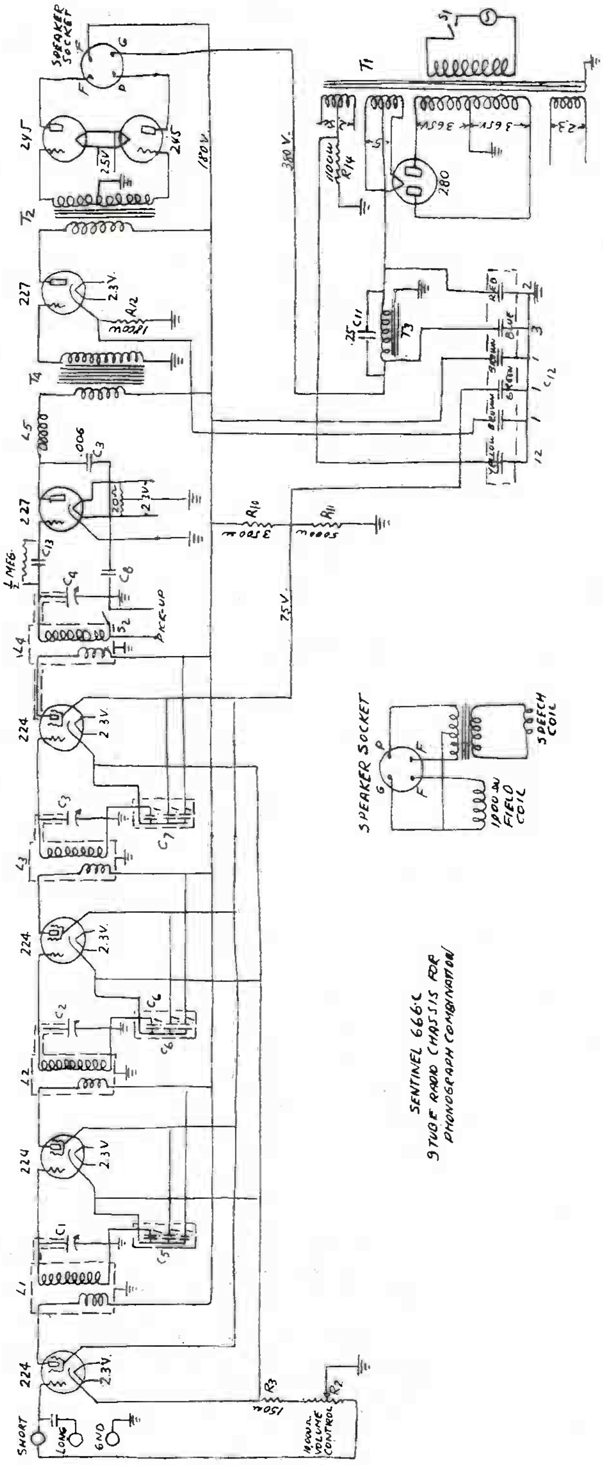
8-TUBE SUPER-HETERODYNE



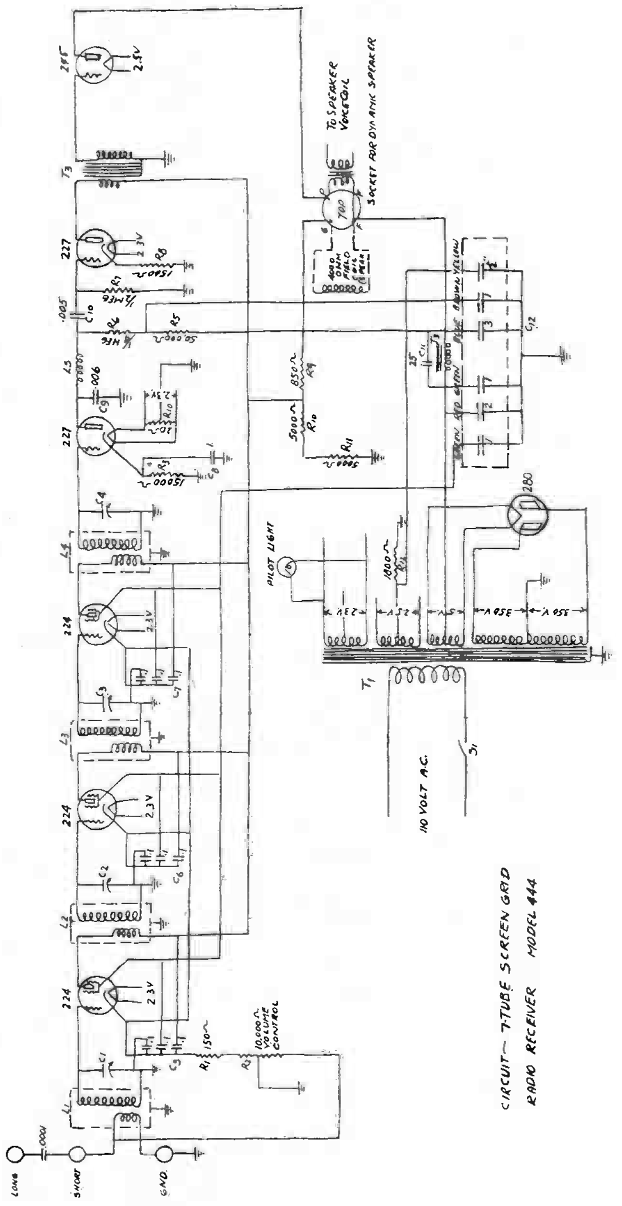
UNITED AIR CLEANER CO.



UNITED AIR CLEANER CO.



SENTINEL 666C
9 TUBE RADIO CHASSIS FOR PHONOGRAPH COMBINATION



CIRCUIT— 7-TUBE SCREEN GRID
RADIO RECEIVER MODEL 444

ZANEY - GILL CORPORATION

CAUTION: Before attempting to install or operate, ascertain if this receiver corresponds with the voltage and the cycles of your power supply. The voltage and cycle reading is marked plainly on the license plate. ("Check Same"). Information on the above figures can be ascertained by calling your local power company. In localities where extreme fluctuations of voltages occur, we recommend that a separate voltage compensator be used to maintain a steady power supply.

NOTE: We are not responsible for damage caused by excessive voltages or incorrect installation.

ANTENNA & GROUND

The quality and amount of reception depends on the correct use of both aerial and ground. In congested areas where several broadcasting stations are in operation, it is not necessary to have an outdoor aerial. Set can be operated on from 3 to 15 feet of aerial for all local reception. In outlying territories or where your relativity to a broadcasting station permits, an aerial of from 25 to 150 feet may be used properly insulated and with correct lead-ins.

A very important feature in connecting a radio is to have a good ground as close to the receiving set as possible. A poor ground is a producer of noises, fading and generally poor reception. Both aerial and ground should be inspected every six months for loose connections or broken strands.

Aerial and ground connections are marked on the binding posts at the back of the chassis.

TUBES

The equipment for this radio consists of 3-224, 1-227, 1-280 and 1-245.

CAUTION: Do not insert or remove tubes from sockets while current is turned on.

SWITCH & VOLUME

The switch and volume control are located on the lower right hand knob which, when turned completely to the left, will act as a switch. To increase volume gradually turn to the right until desired output is gained, being careful to see that the tuning indicator is directly on the station signal.

For distance reception it is well to turn the volume control to almost full capacity and weak signals will break through and can be cleared by compensating the sharpness of the dial to the volume required.

The lower left hand knob operates VITATONE and tone control. The principle of VITATONE is supplying the backward notes with vitality and bringing them to the proper required impetus so that all reception carries *breadth* as well as the other registers. A further use of VITATONE is the elimination of line noises and static, which also can be accomplished by turning the knob completely to the right. This latter feature is exceptionally desirable for distance reception.

HINTS NECESSARY FOR BETTER RADIO RECEPTION

Use only standard high grade tubes. Cheap tubes will result in poor reception, poor tone and break downs at inopportune moments.

FUSE

Should there be a short in the wiring or a defective tube installed in the set, the fuse, which is located on the right hand side of the chassis assembly, will be blown. This can be replaced by an ordinary 3 amp. automobile type fuse. There are two positions to install the fuse, the two rear clips being used for 110 volts and the two front clips being used where excessive voltages rises as high as 130 volts.

In case of any unusual disturbances in the set, do not attempt to operate same until advised by an experienced service man.

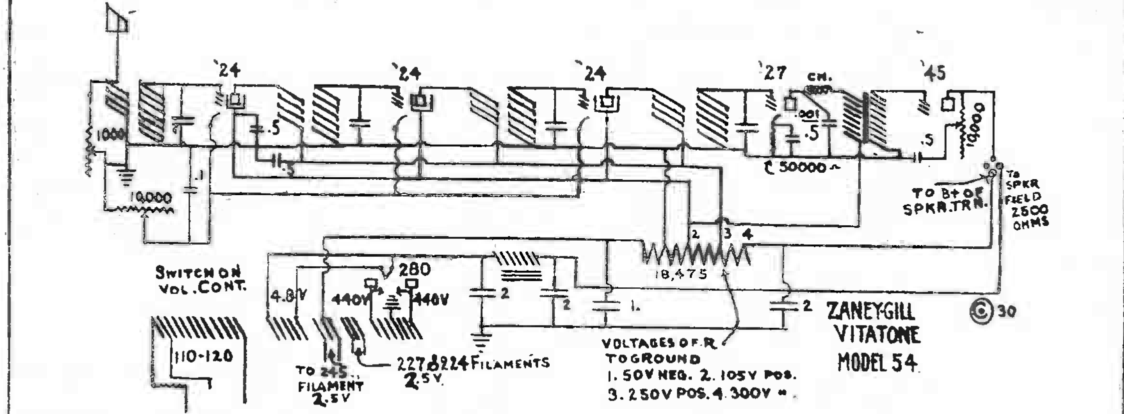
If set does not light, inspect plug connections to wall, also fuse.

If set lights and does not play, inspect speaker terminal and see if it is plugged into the holes marked speaker at the rear of the chassis.

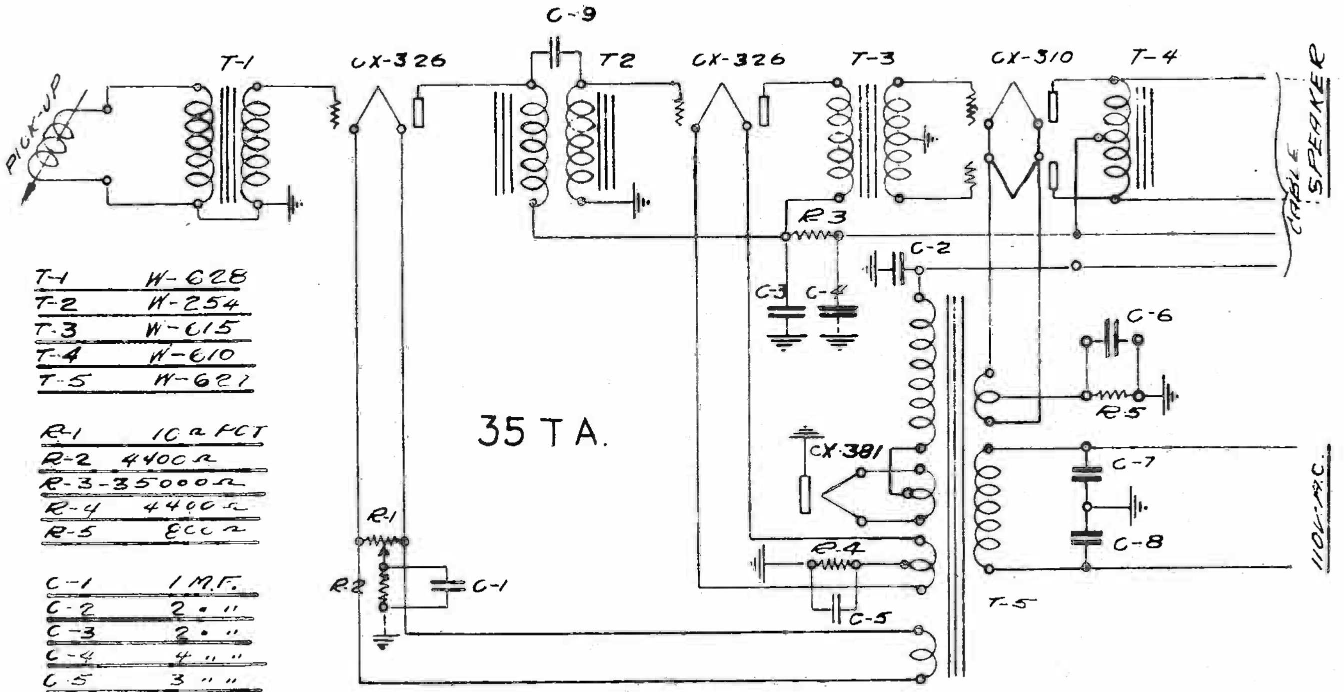
Also, have tubes tested for probable filament shorts.

In all cases, do not attempt to repair the set yourself. Call a competent service man, otherwise your guarantee will be nullified and void.

All parts of this receiver, excepting TUBES are guaranteed by the manufacturer for a period of 90 days against factory defects of workmanship and defective material.



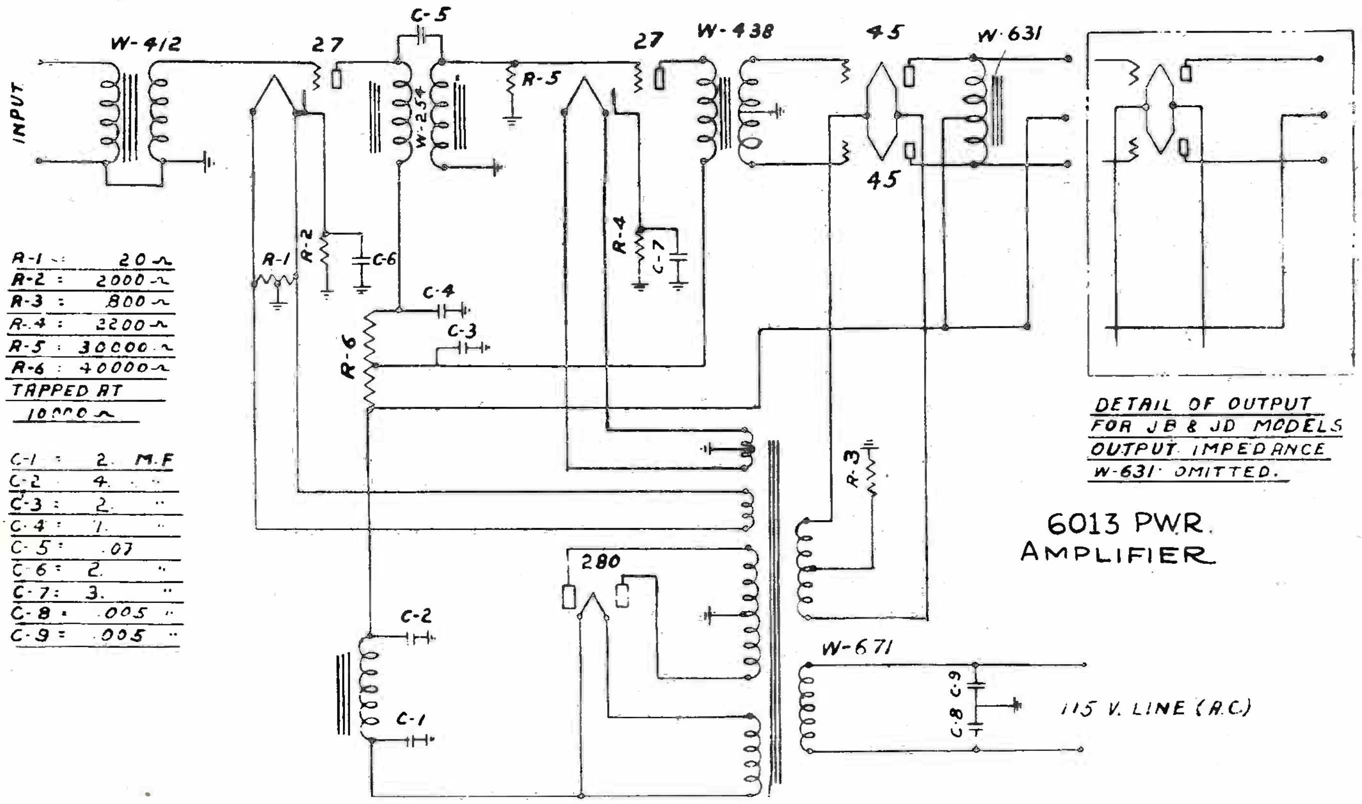
WEBSTER ELECTRICAL CORP.



T-1	W-628
T-2	W-254
T-3	W-615
T-4	W-610
T-5	W-621

R-1	10 Ω FCT
R-2	4400 Ω
R-3	35000 Ω
R-4	4400 Ω
R-5	800 Ω

C-1	1 M.F.
C-2	2 "
C-3	2 "
C-4	4 "
C-5	3 "
C-6	1 "
C-7	.005
C-8	.005
C-9	.07 M.F.



R-1	20 Ω
R-2	2000 Ω
R-3	800 Ω
R-4	2200 Ω
R-5	30000 Ω
R-6	40000 Ω TAPPED AT 10000 Ω

C-1	2. M.F
C-2	4. "
C-3	2. "
C-4	1. "
C-5	.07
C-6	2. "
C-7	3. "
C-8	.005 "
C-9	.005 "

DETAIL OF OUTPUT FOR JB & JD MODELS OUTPUT IMPEDANCE W-631 OMITTED.

6013 PWR. AMPLIFIER

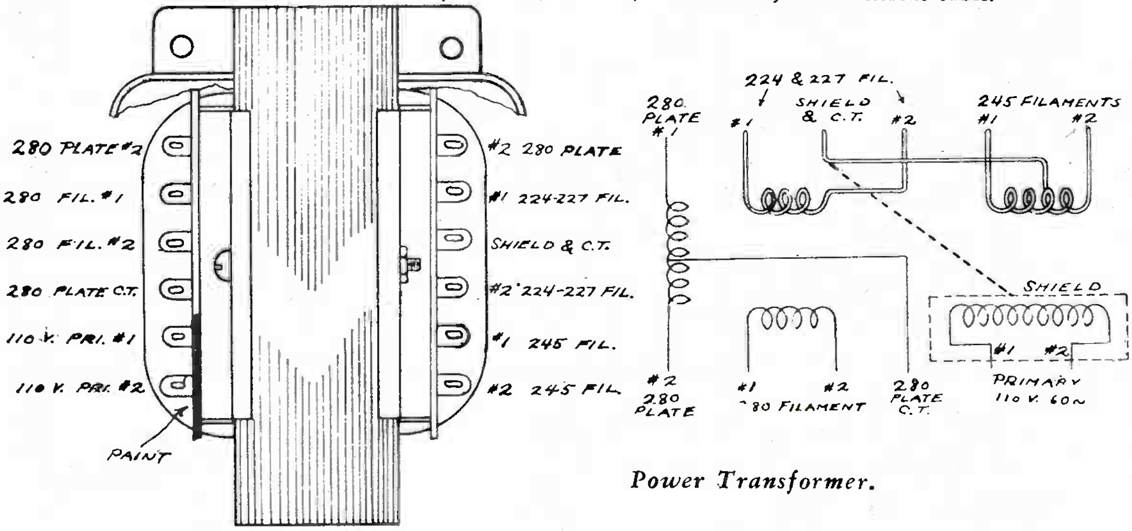
8-Tube A.C. Model

WELLS-GARDNER AND CO.

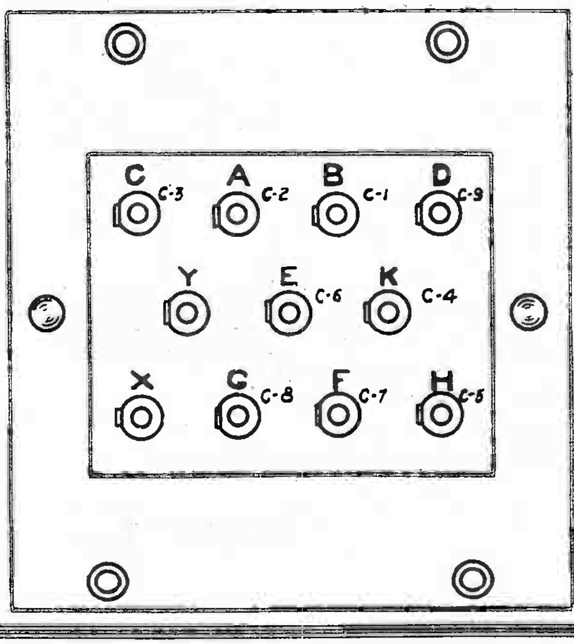
VOLTAGE CHARACTERISTICS

Tube Circuit Under Test		LINE VOLTAGE				
		90 V.	100 V.	110 V.	120 V.	130 V.
224	Fil.	1.7	1.9	2.1	2.3	2.5
	Plate	151	166	183	199	215
	Screen	72	79	84.7	93	100
	Grid*	–2.2	–2.6	–2.9	–3.2	–3.6
	Cathode	2.2	2.6	2.9	3.2	3.6
227 Det.	Fil.	1.7	1.9	2.1	2.3	2.5
	Plate	87	97	104	112	122
	Grid*	–13.4	–15.0	–16.5	–18.2	–20.0
	Cathode	13.4	15.0	16.5	18.2	20.0
227 1st A.F.	Fil.	1.8	1.9	2.2	2.4	2.6
	Plate	109	120	129	139	150
	Cathode	6.9	7.9	8.9	9.8	11.0
245 2nd A.F.	Fil.	1.8	1.9	2.2	2.4	2.6
	Plate	211	235	258	285	310
	Grid	36	42.4	47	53	59
280 Rect.	Fil.	3.6	4.0	4.5	4.8	5.2

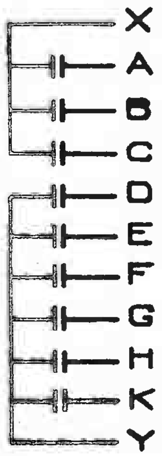
*NOTE: Grid voltages on the 224 and detector tubes are measured from grid to cathode terminals on the tube socket. The grid voltage on the first audio tube cannot be measured from grid to cathode, but is measured from cathode to ground. The above voltages are approximate, and will vary with different tubes.



Power Transformer.

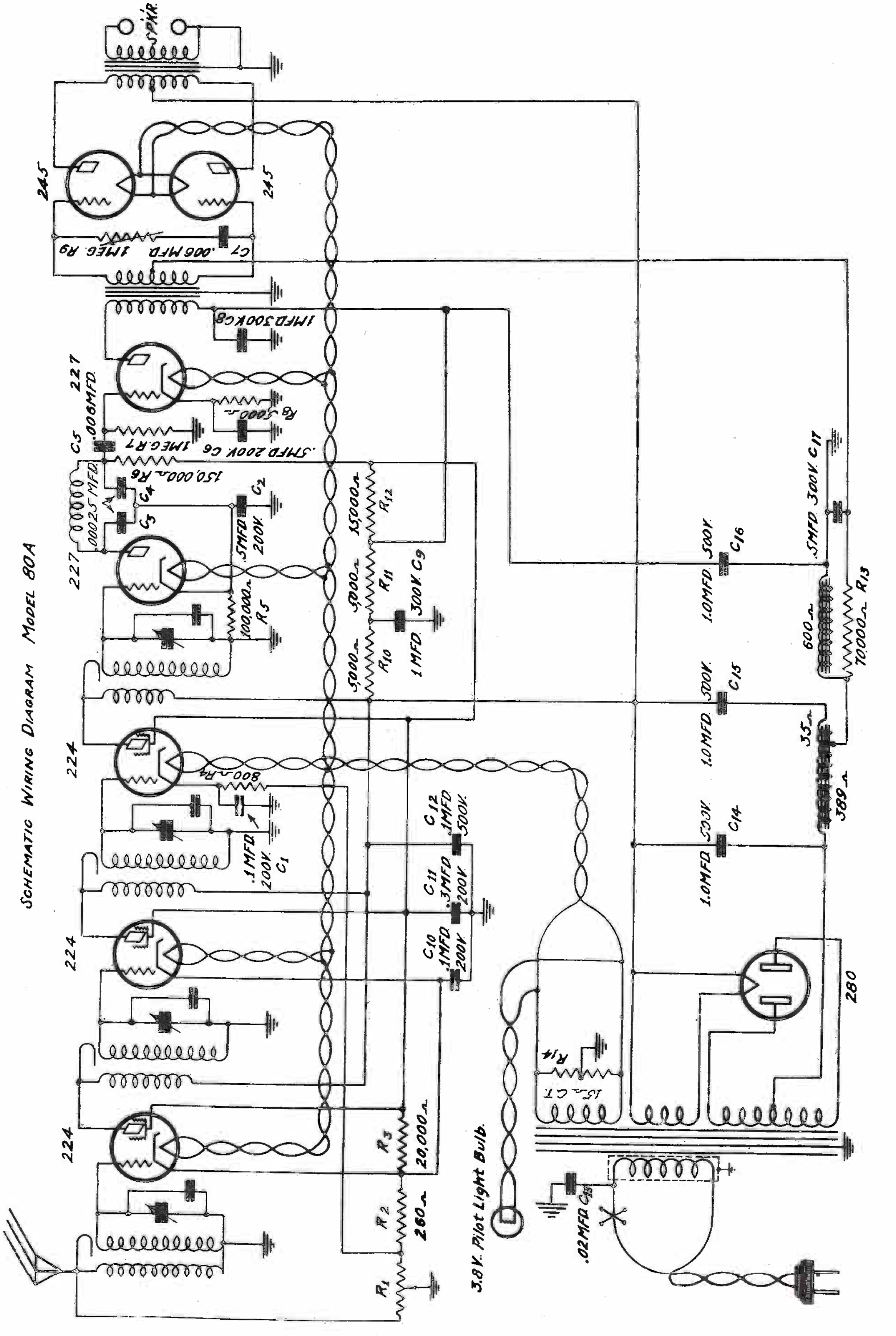


CAPACITY		
CODE	60 CYCLE	25 CYCLE
A	1.0 MF. C-2	
B	1.0 MF. C-1	2.5 MF. C-1
C	1.5 MF. C-3	4. MF. C-3
D	1.0 MF. C-9	1.0 MF. C-9
E	1.0 MF. C-6	1.0 MF. C-6
F	0.5 MF. C-7	0.5 MF. C-7
G	1.0 MF. C-8	1.5 MF. C-8
H	0.5 MF. C-5	0.5 MF. C-5
K	1.5 MF. C-4	2.0 MF. C-4
X	COMMON	COMMON
Y	COMMON	COMMON



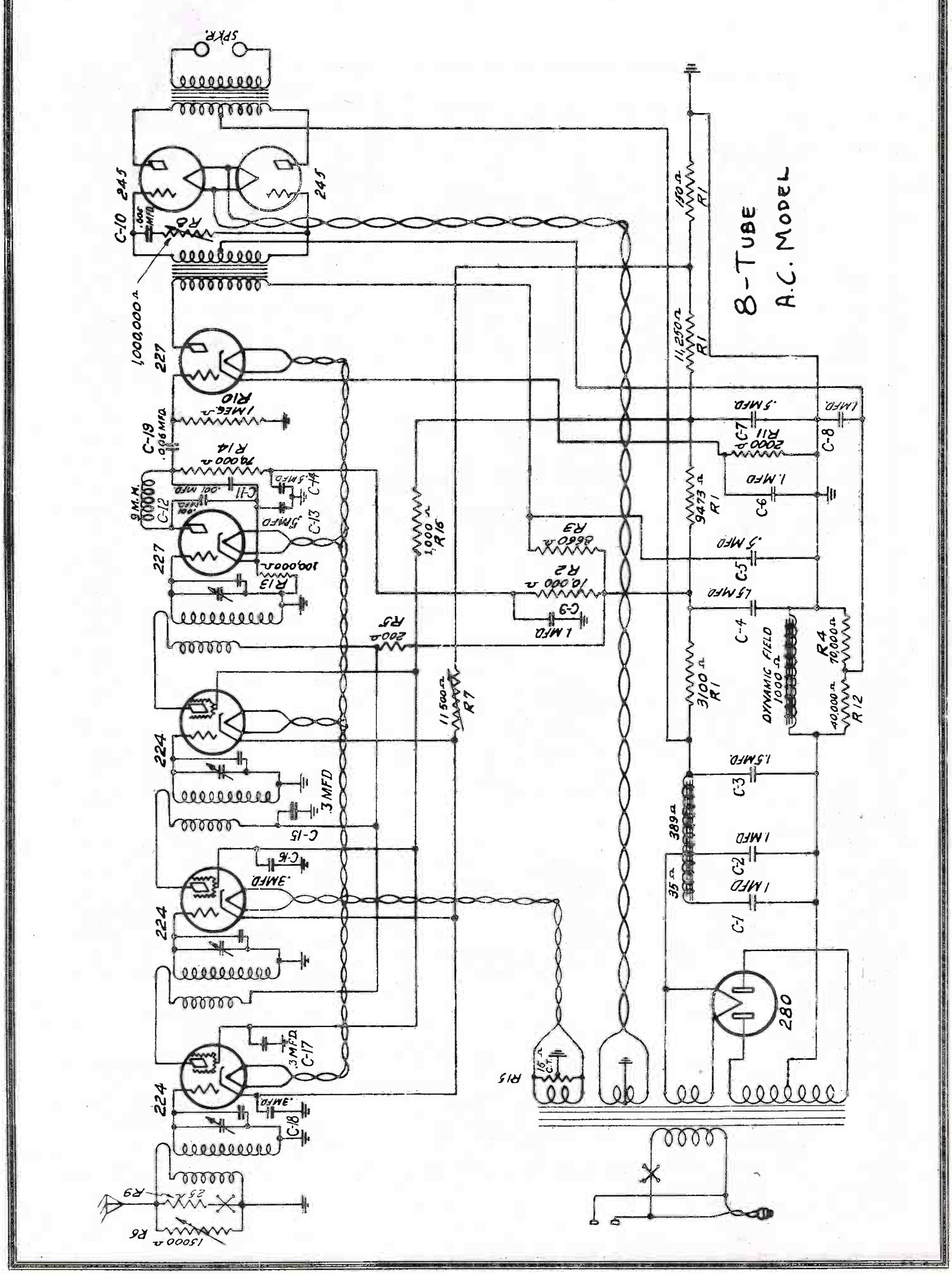
Filter Condenser (60 and 25 cycle receivers).

WELLS-GARDNER AND CO.

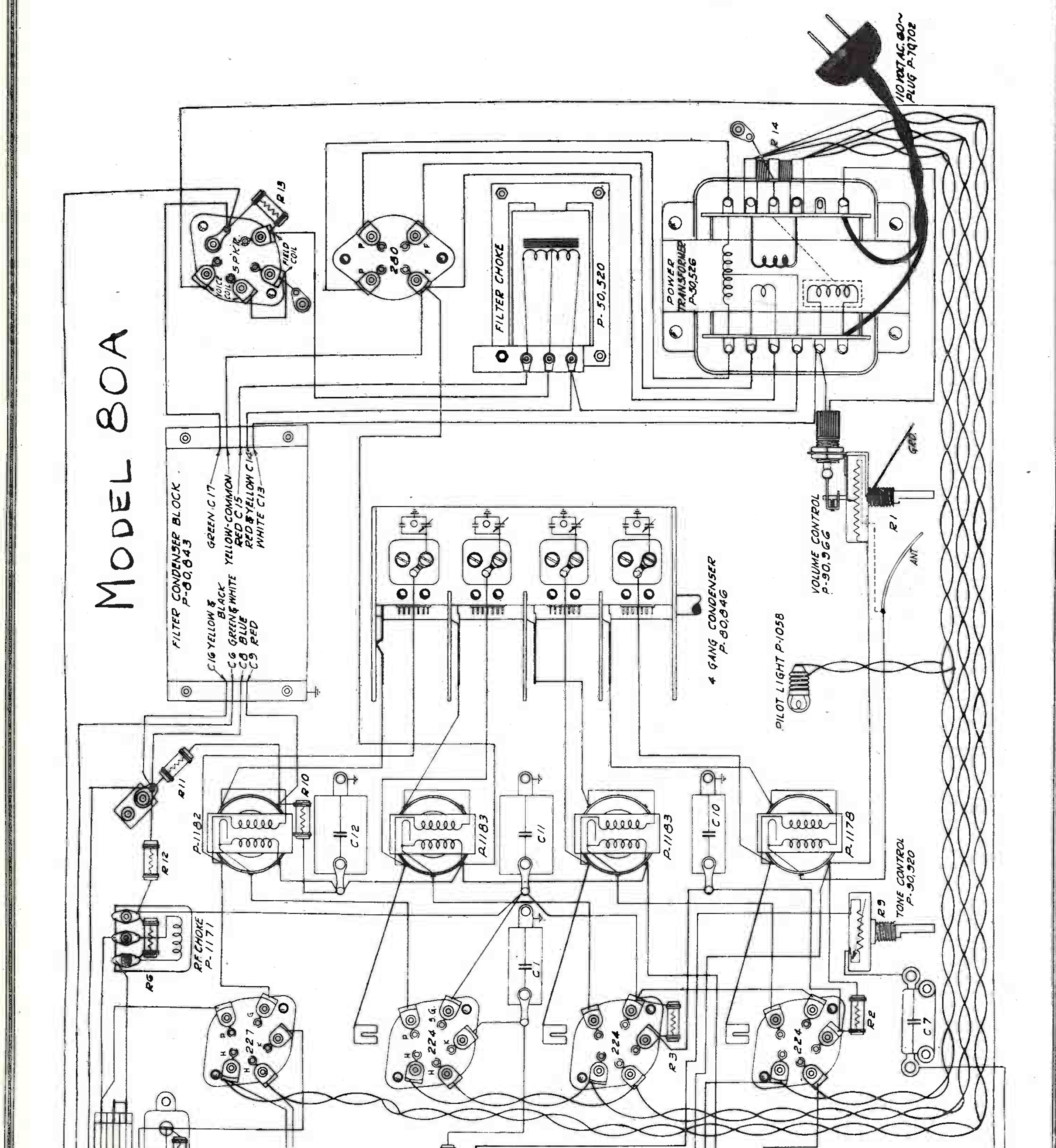


SCHEMATIC WIRING DIAGRAM MODEL 80A

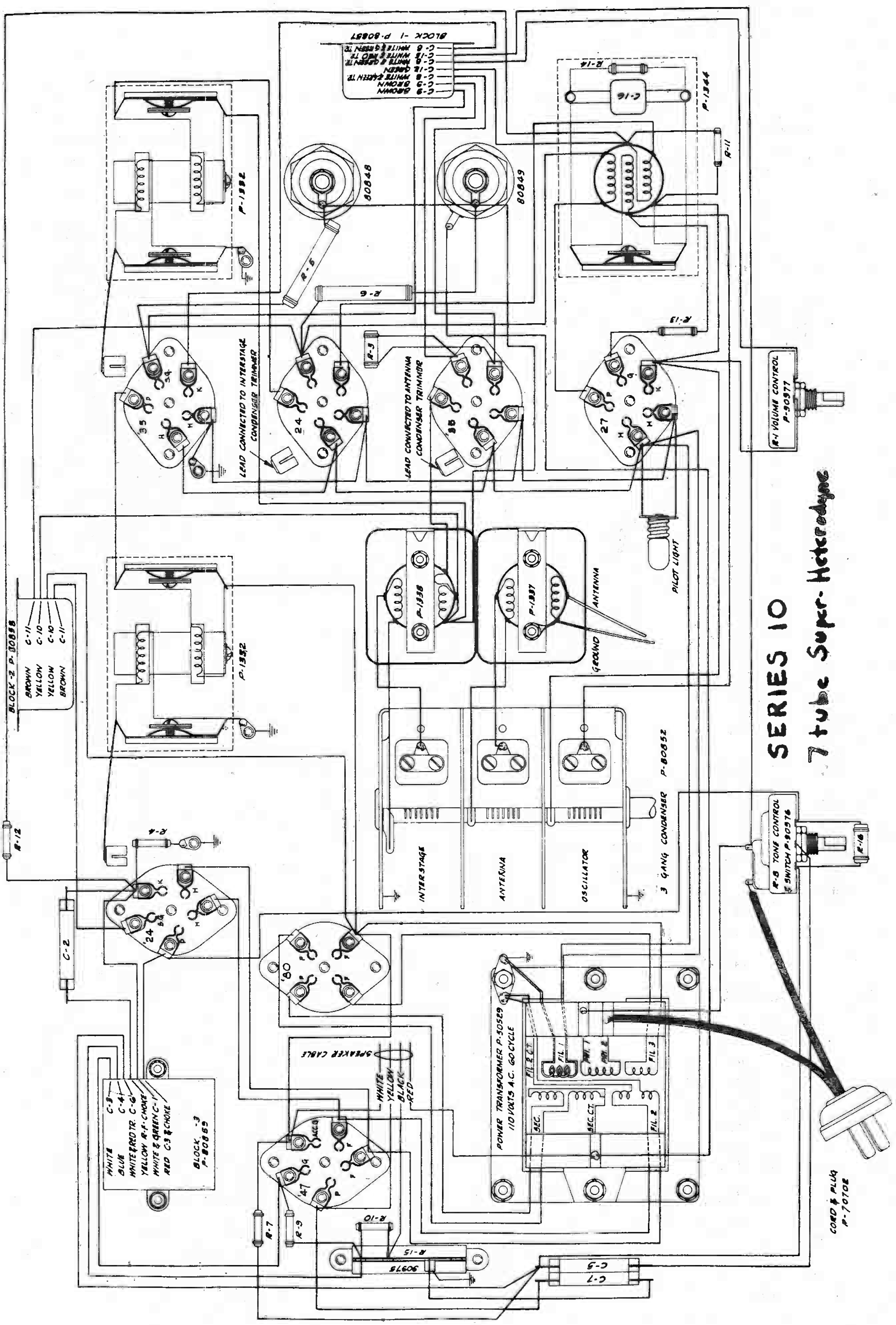
WELLS-GARDNER AND CO.



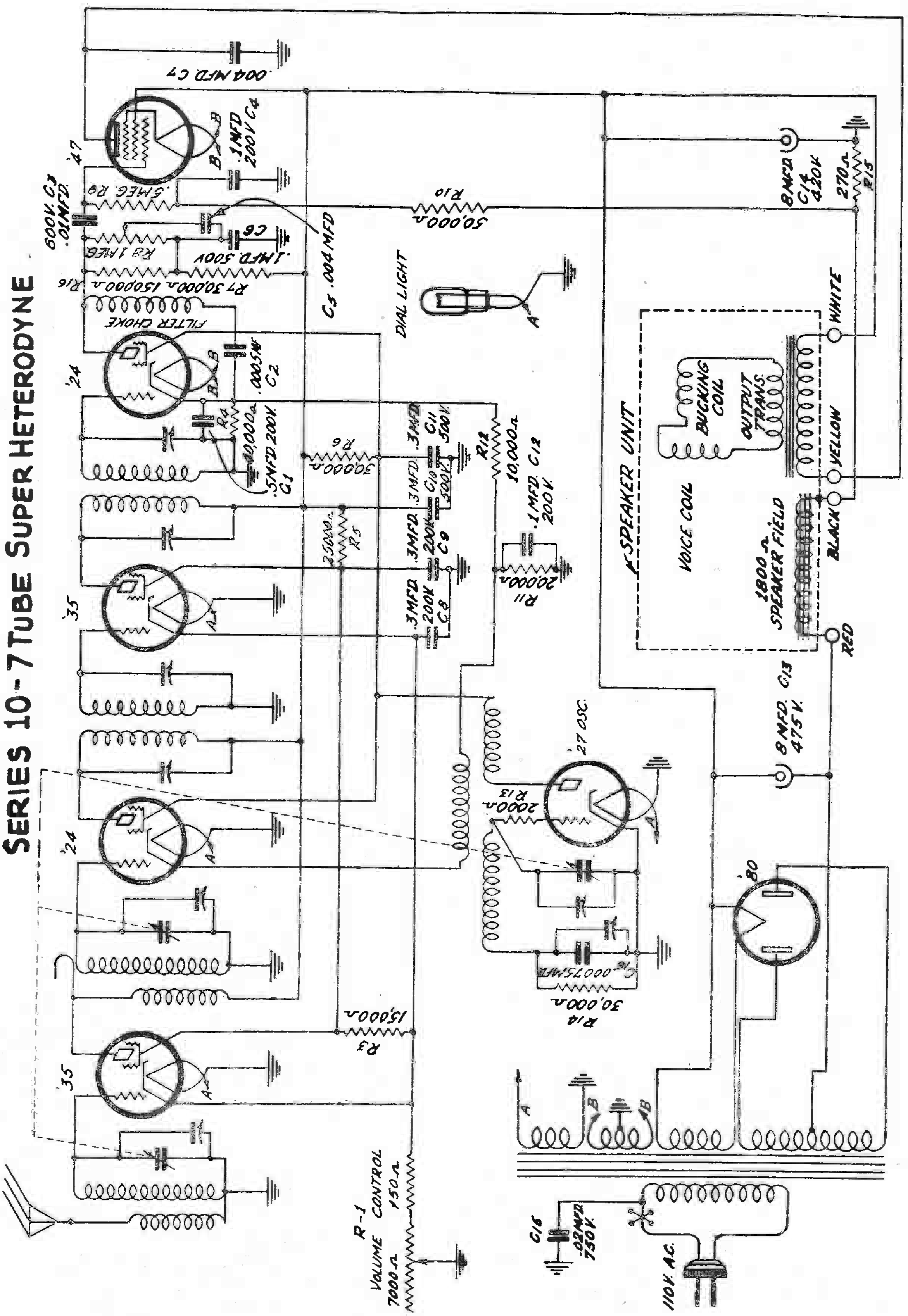
WELLS-GARDNER AND CO.



WELLS-GARDNER AND CO.

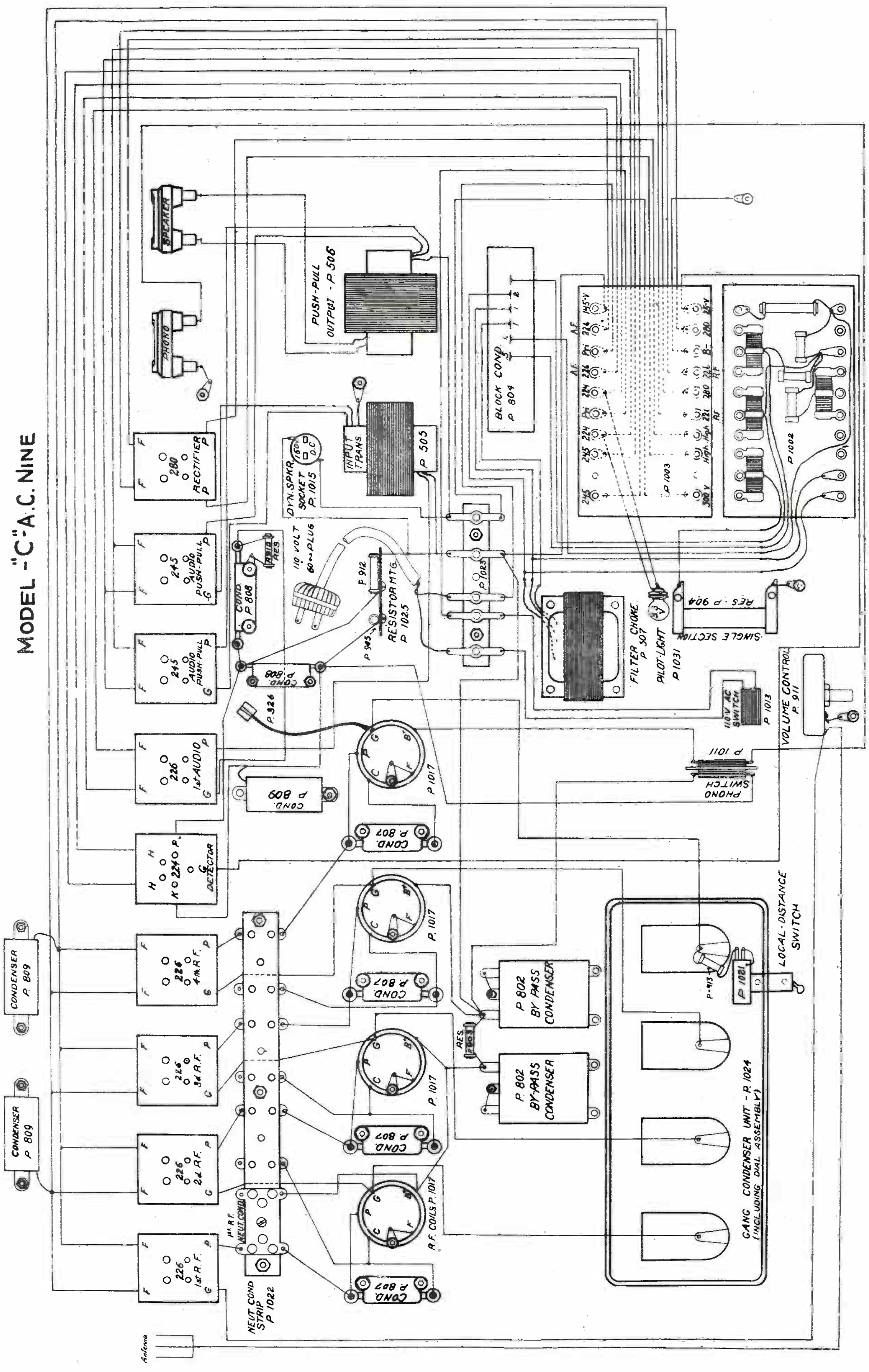


WELLS-GARDNER AND CO.



SERIES 10-7 TUBE SUPER HETERODYNE

WELLS-GARDNER AND CO.



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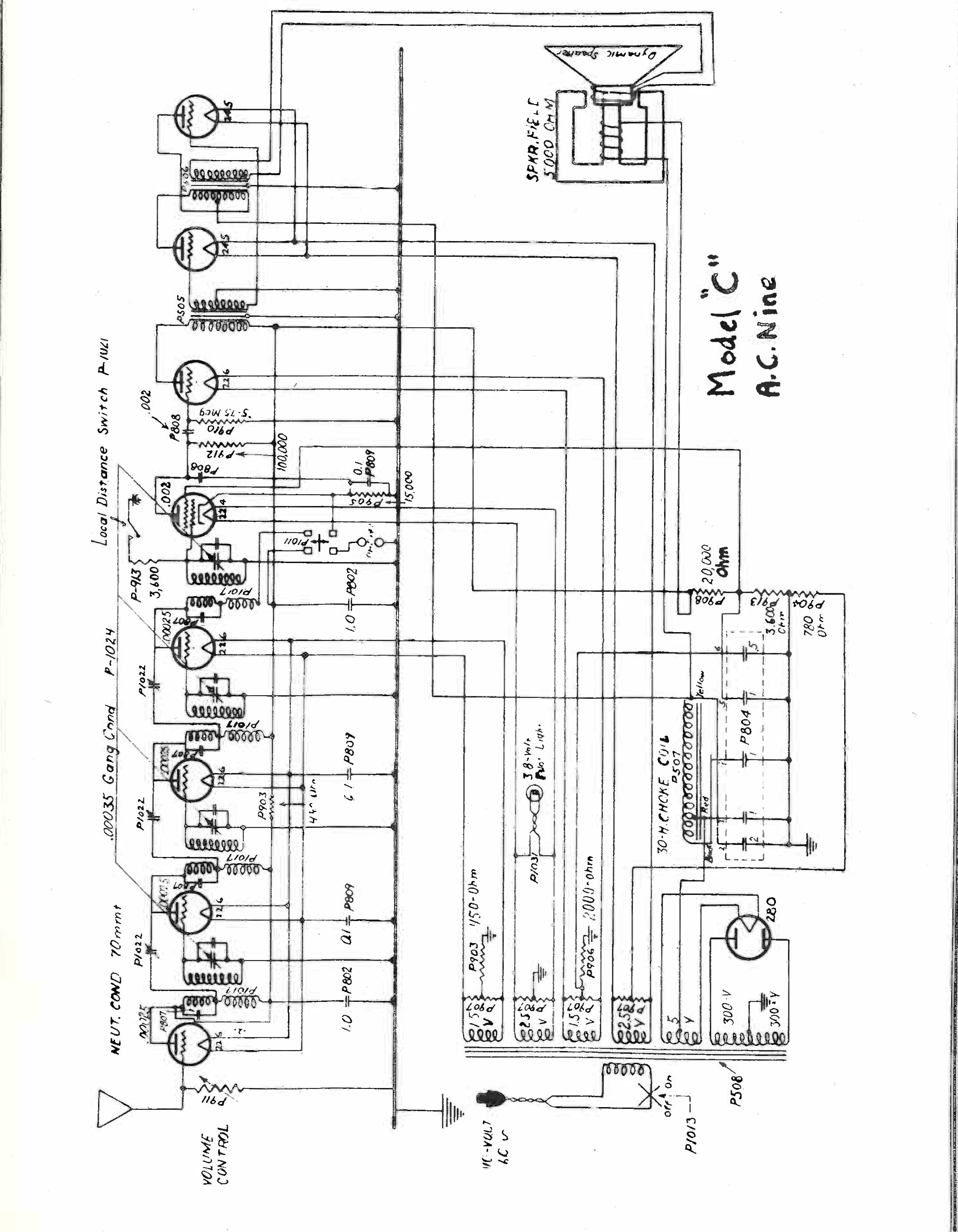
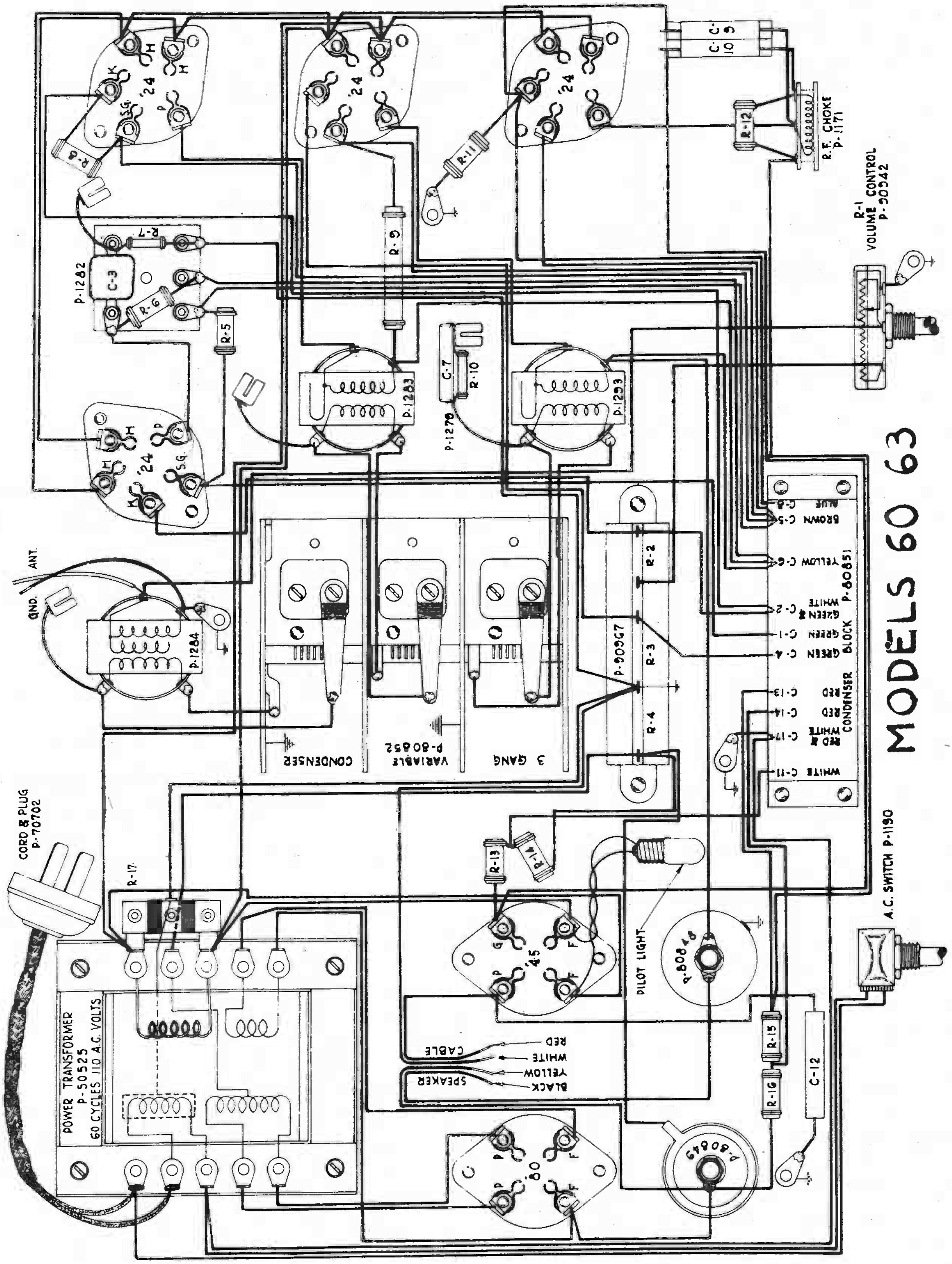
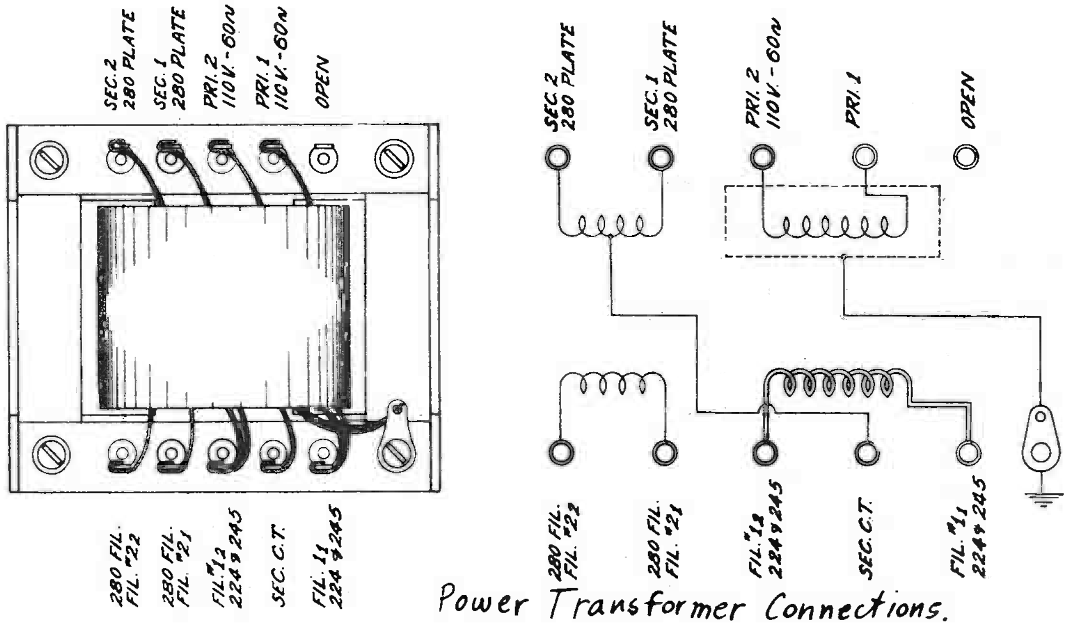


WELLS-GARDNER AND CO.

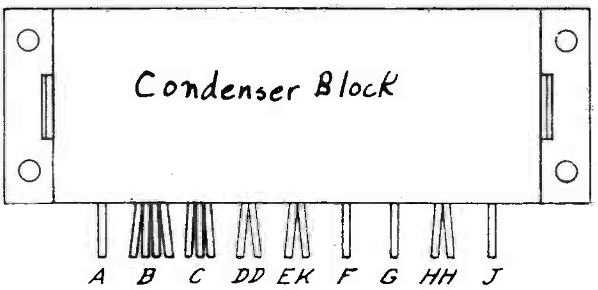


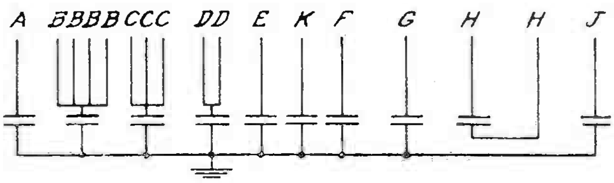
MODELS 60 63

WELLS-GARDNER AND CO.



Power Transformer Connections.





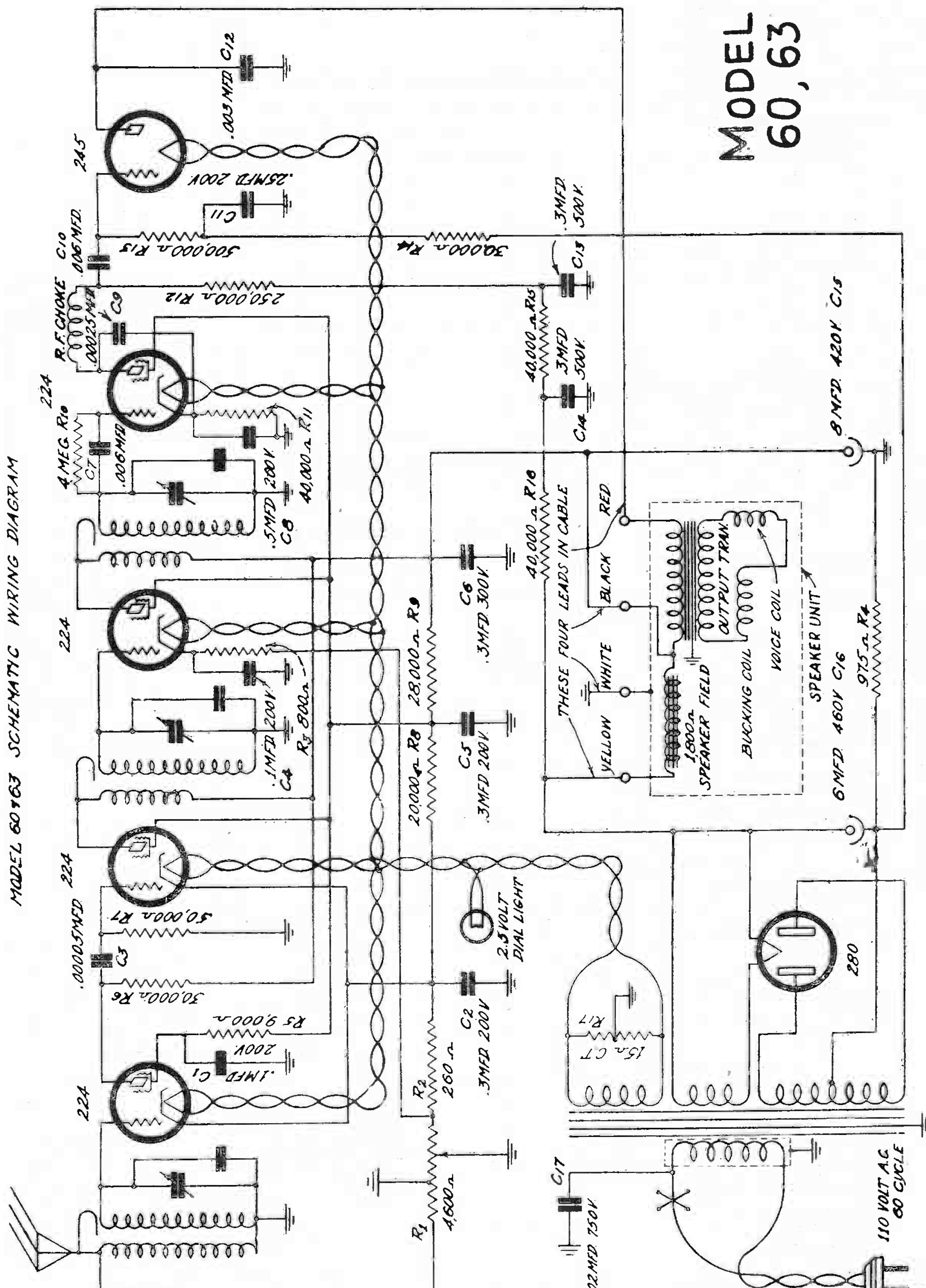
SPECIFICATIONS			
LEAD	CODE	COLOR	CAPACITY
A	C-8	BLUE	0.5 MFD.
B	C-5	BROWN	0.3 MFD.
C	C-6	YELLOW	0.3 MFD.
D	C-2	GREEN & WHITE	0.3 MFD.
E	C-4	GREEN	0.1 MFD.
F	C-14	RED	0.3 MFD.
G	C-13	RED	0.3 MFD.
H	C-17	RED & WHITE	0.02 MFD.
J	C-11	WHITE	0.25 MFD.
K	C-1	GREEN	0.10 MFD.

MODELS 60 63

Below: Analyzer Readings

Tube	Circuit	Meter Scale	90 V.	100 V.	110 V.	120 V.	130 V.
1st R.F. 224	Grid Screen Grid Plate	0—10 0—100 0—250	2 52 133	2.3 58 142	2.6 63 155	3 68 167	3.3 73 178
2nd R.F. 224	Grid Screen Grid Plate	0—10 0—100 0—1000	.4 60 190	.5 67 210	.6 72 230	.7 78 250	.8 83 278
3rd R.F. 224	Grid Screen Grid Plate	0—10 0—100 0—1000	2 60 190	2.3 67 210	2.6 72 230	3 78 250	3.3 83 278
Detector 224	Grid Screen Grid Plate	0—10 0—100 0—100	.08 48 58	.09 54 66	.1 59 72	.11 63 78	.12 67 87
Audio 245	Grid Plate	0—100 0—1000	23 202	27 222	31 242	35 262	40 282
280 Rectifier	Plate Current	0—100	40 mils.	45 mils.	50 mils.	56 mils.	64 mils.
280 Rectifier	Filament to Ground	0—1000	265	298	330	358	392

WELLS-GARDNER AND CO.



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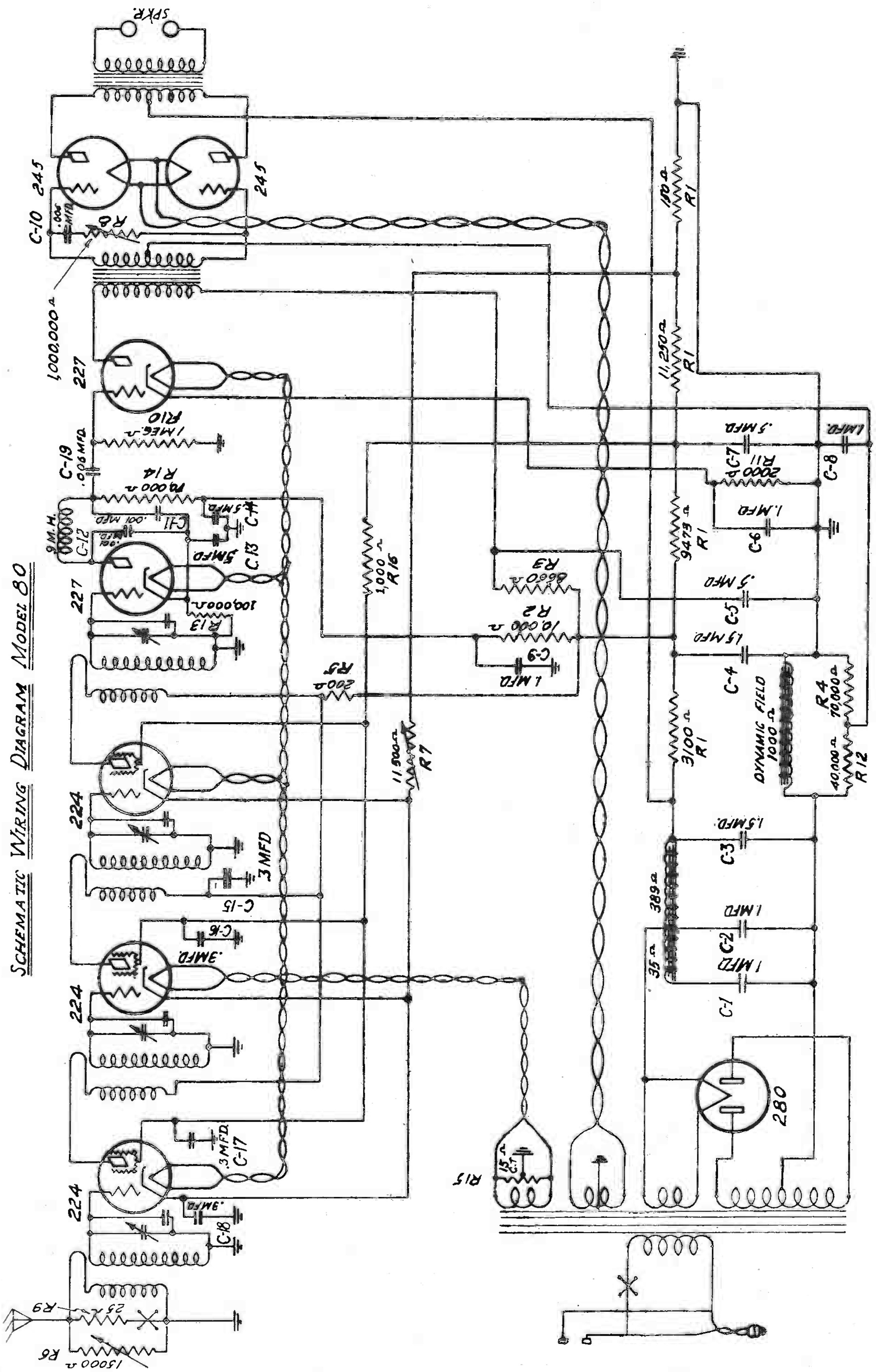

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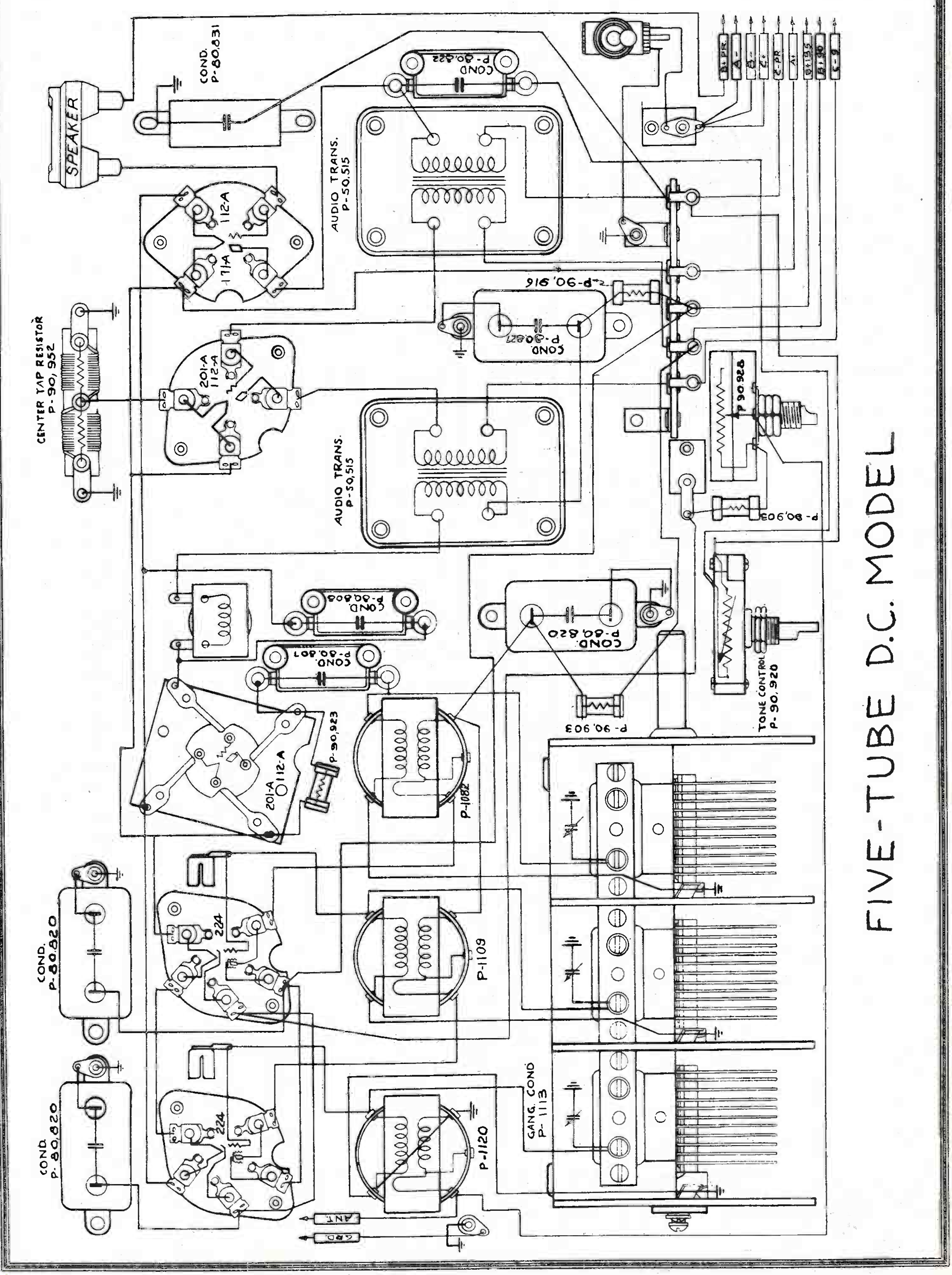
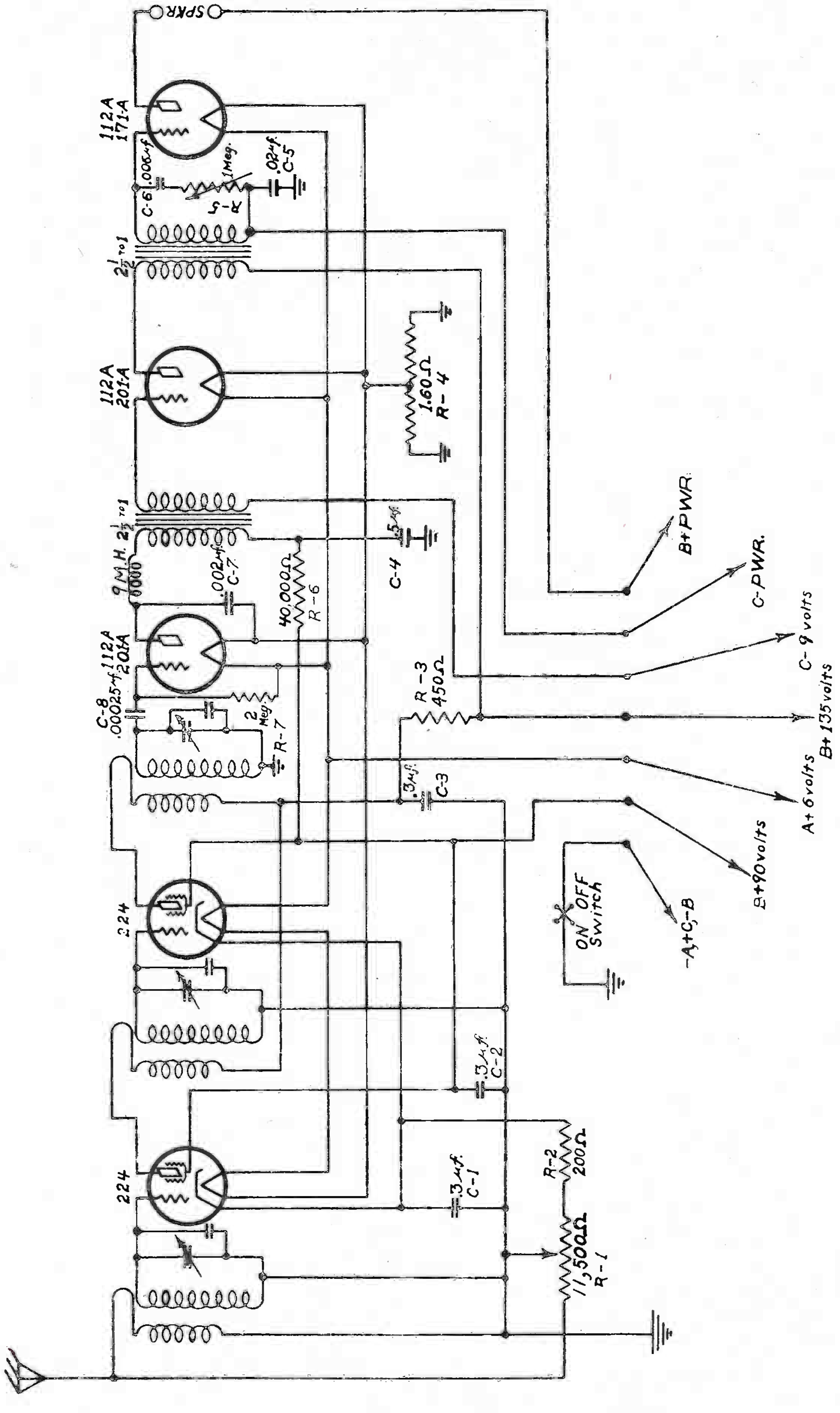


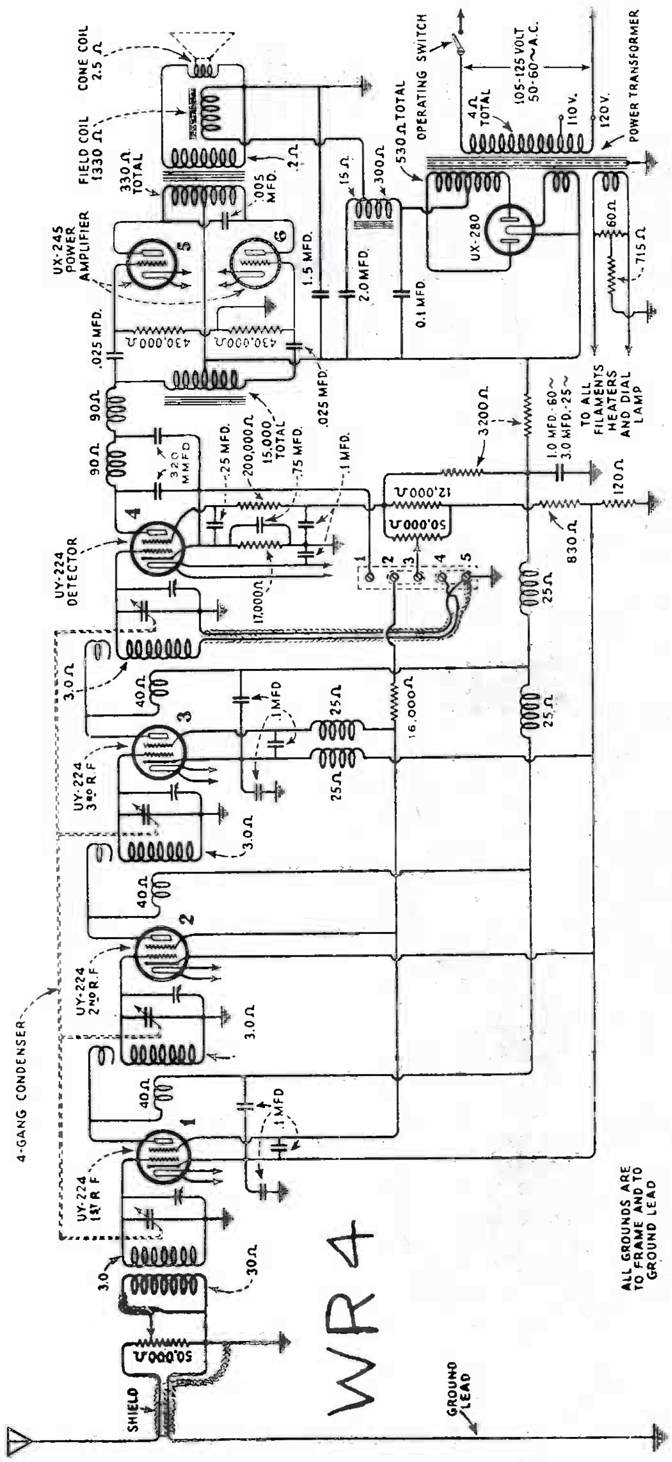
FIVE-TUBE D.C. MODEL

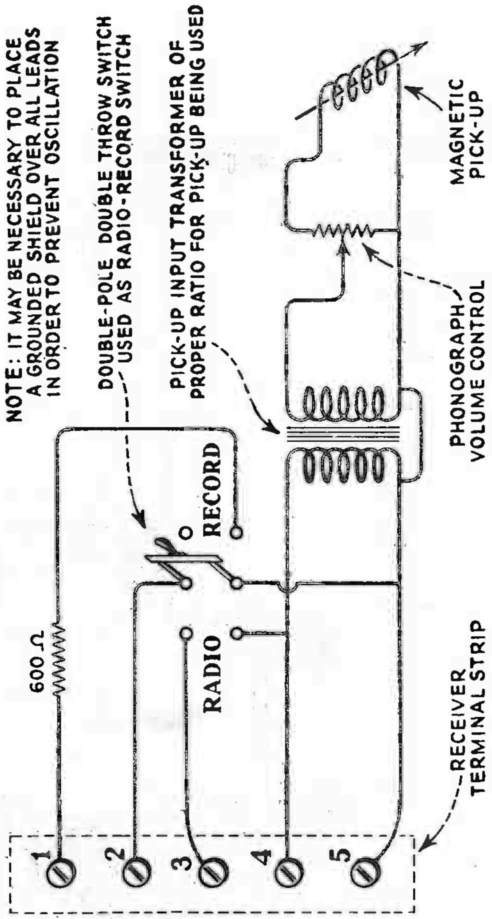
WELLS-GARDNER AND CO.



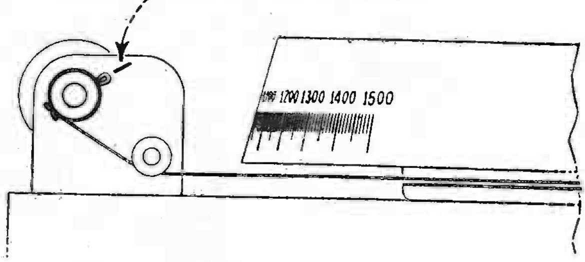
FIVE-TUBE D.C. MODEL

WESTINGHOUSE ELECTRIC AND MFG. CO.

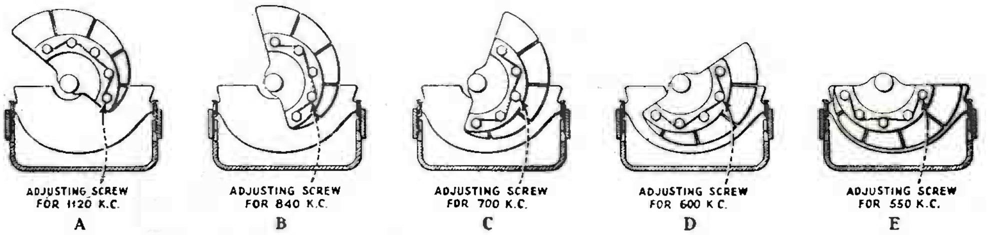




Connections for attaching a magnetic pick-up.

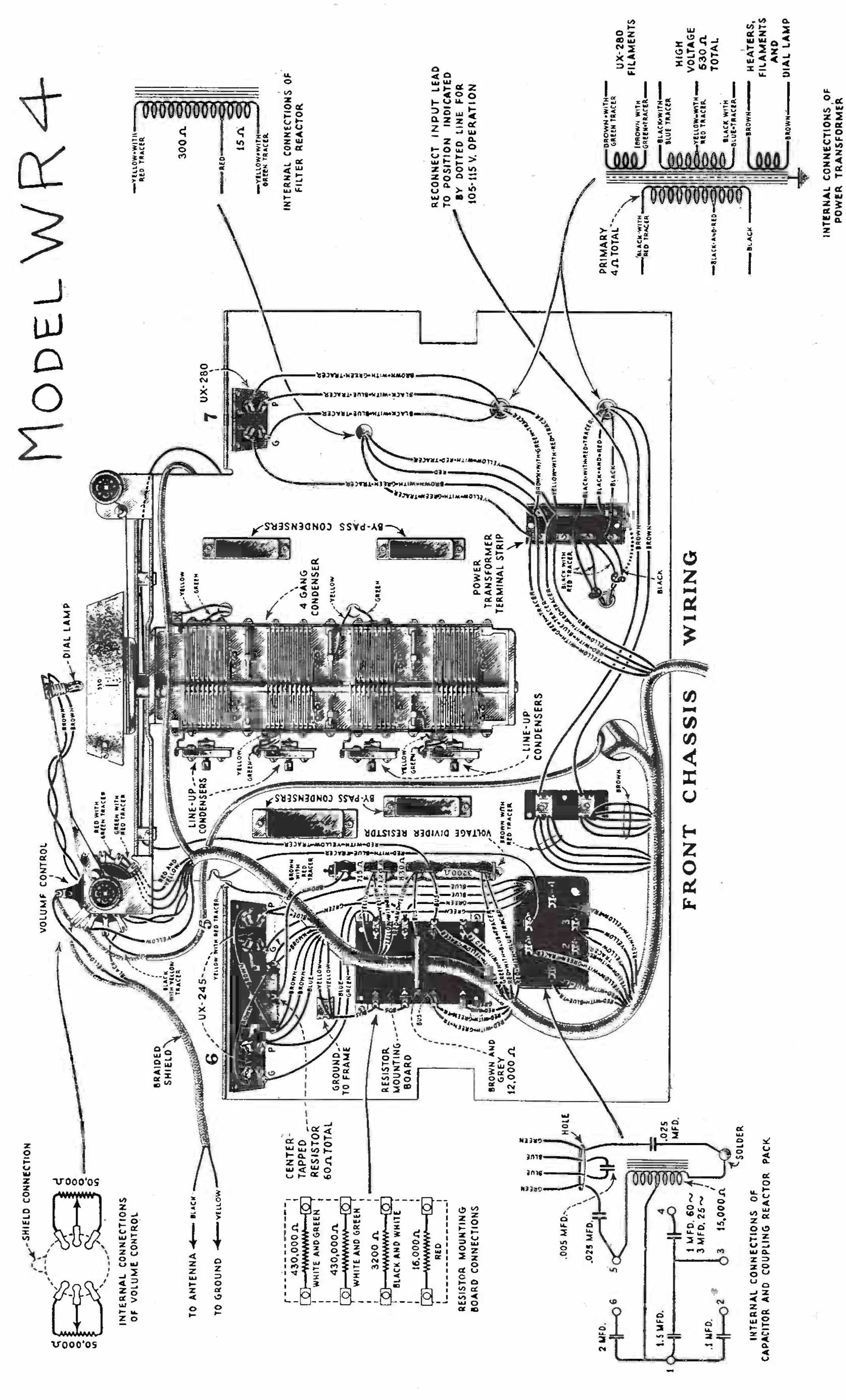


View showing method of checking position of dial.



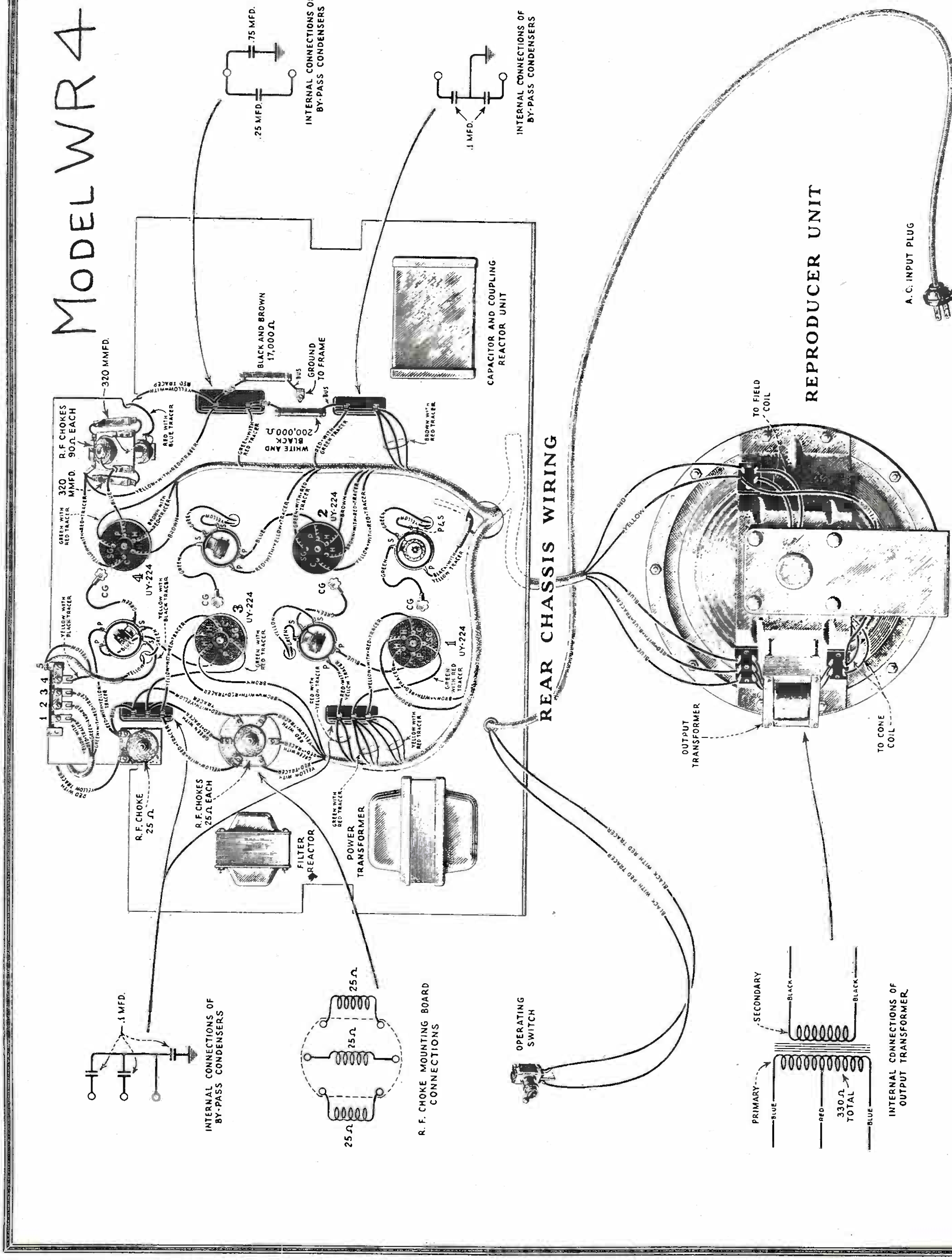
Gang condenser adjustment positions.

WESTINGHOUSE ELECTRIC AND MFG. CO.



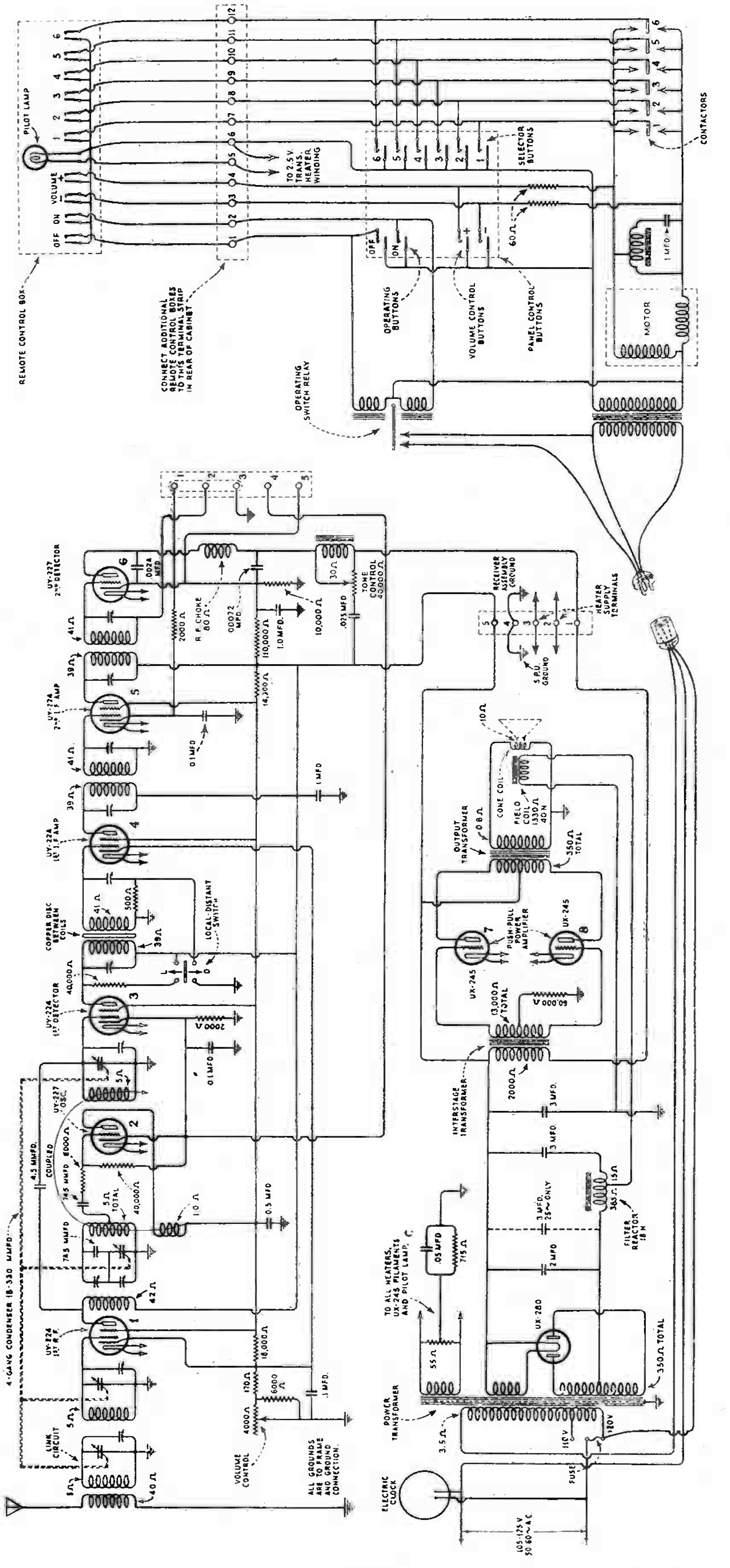
Layout and wiring diagram of the chassis (front)

WESTINGHOUSE ELECTRIC AND MFG. CO.



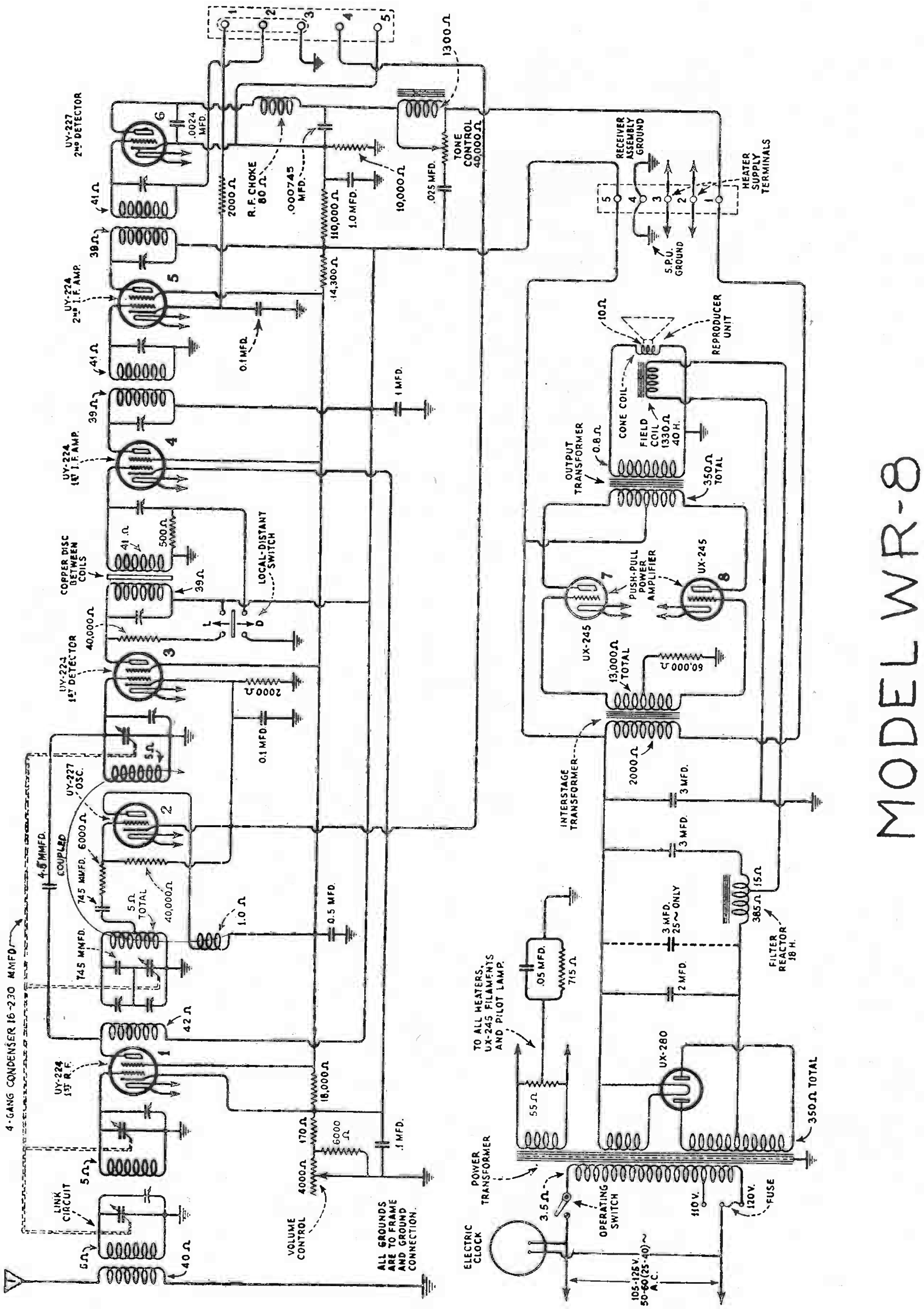
Complete layout and wiring diagram of the chassis (rear) and reproducer unit

WESTINGHOUSE ELECTRIC AND MFG. CO.

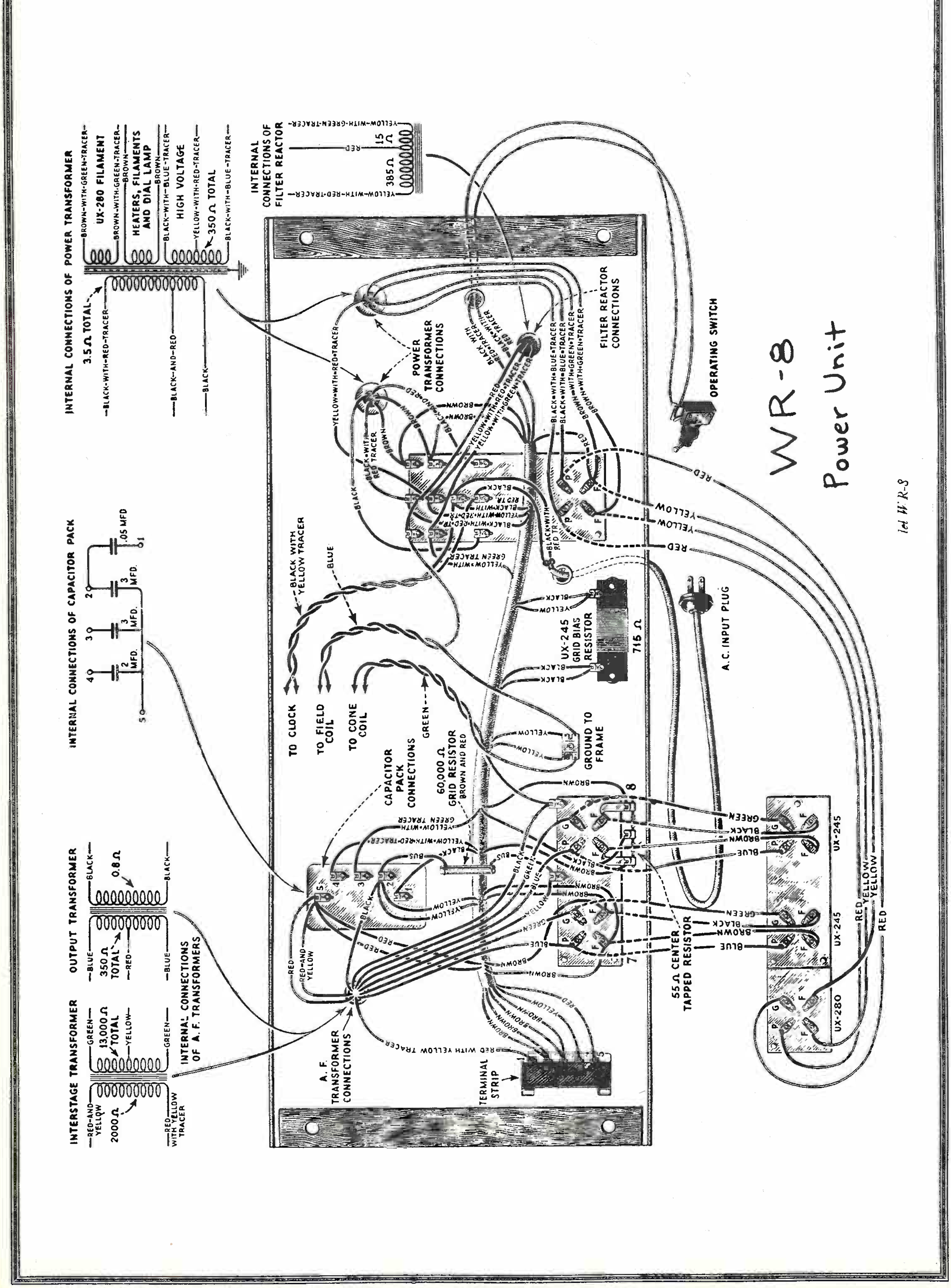


MODEL WR-8-R

WESTINGHOUSE ELECTRIC AND MFG. CO.

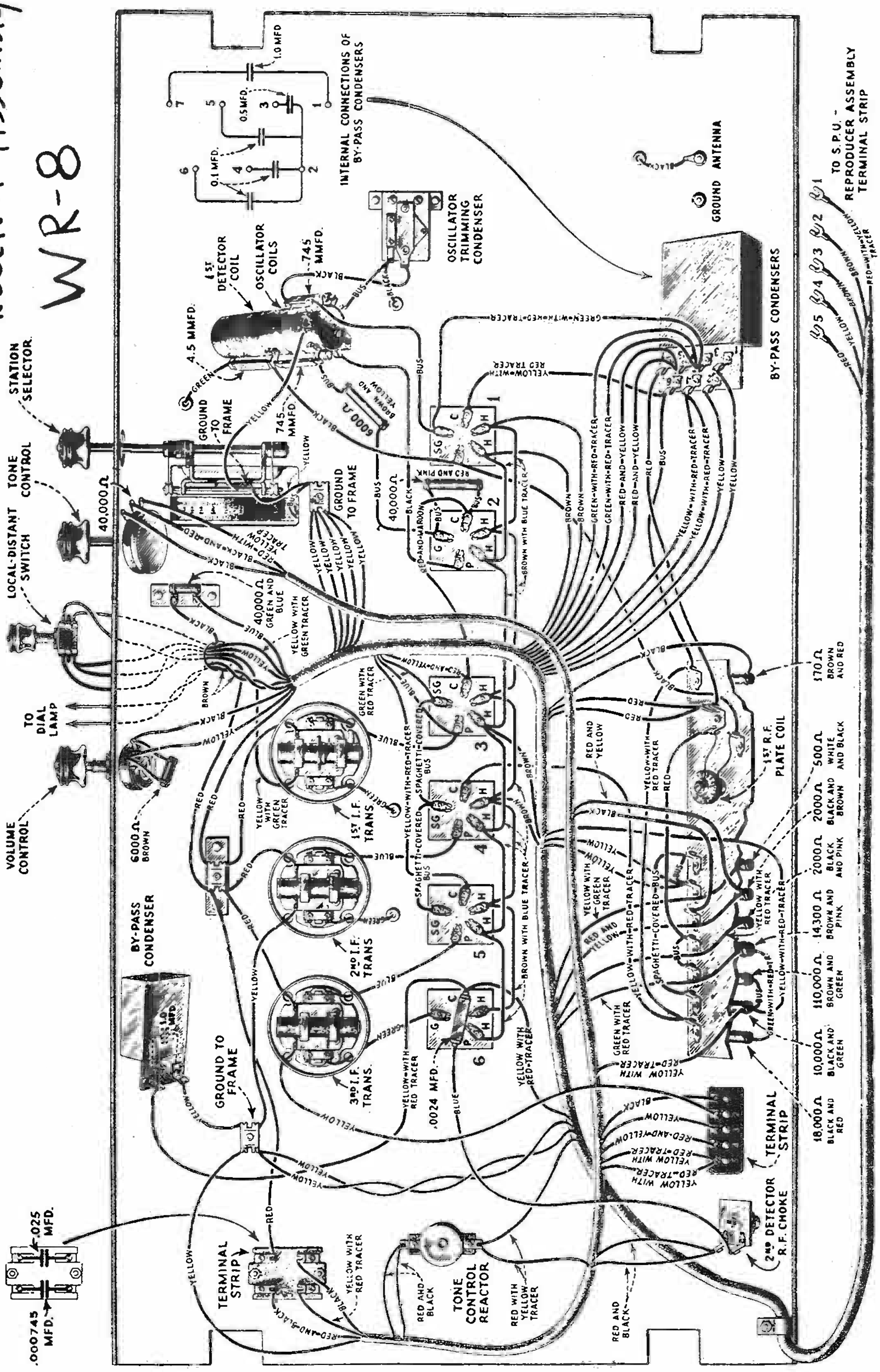


WESTINGHOUSE ELECTRIC AND MFG. CO.

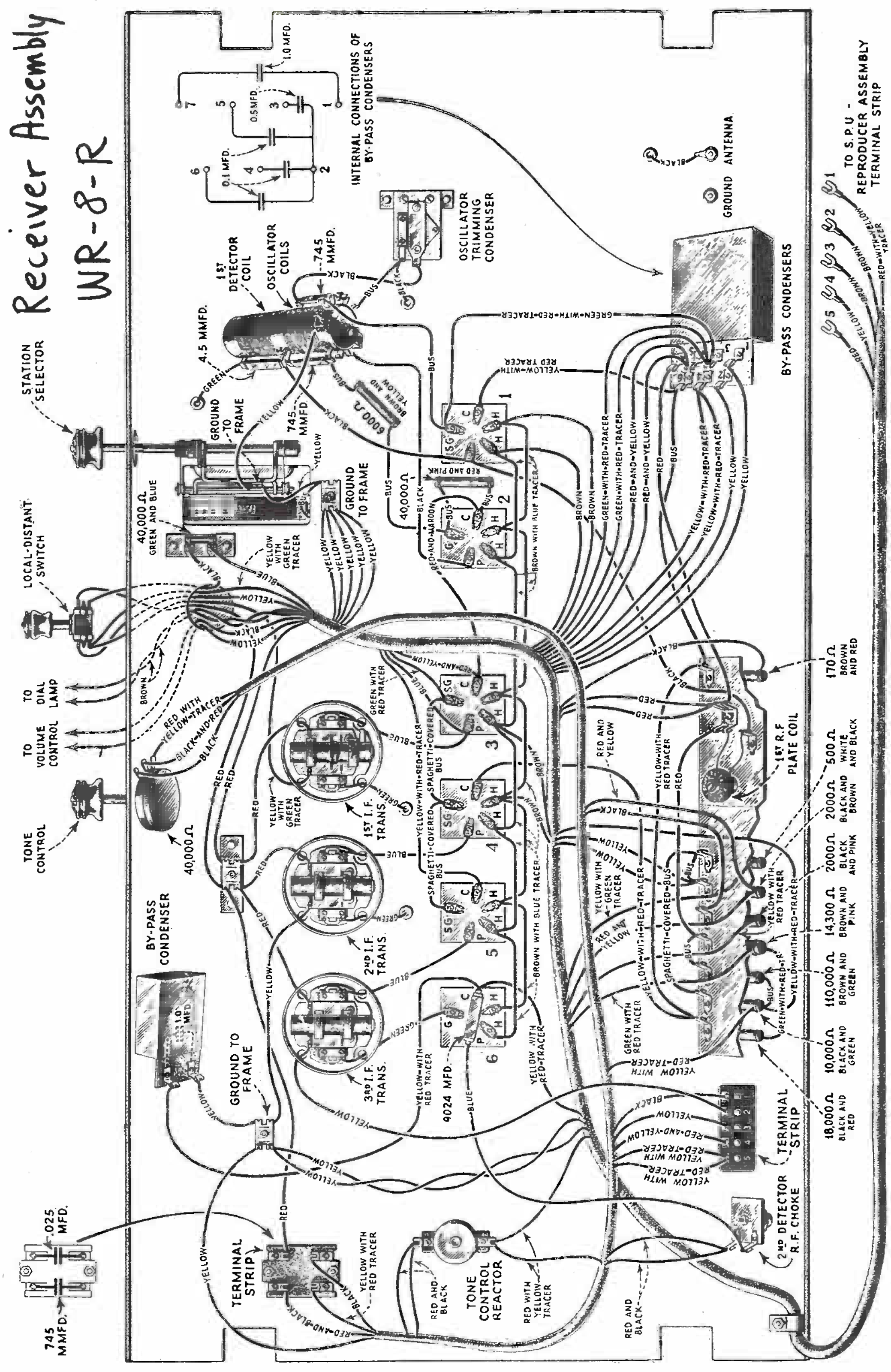


WESTINGHOUSE ELECTRIC AND MFG. CO.

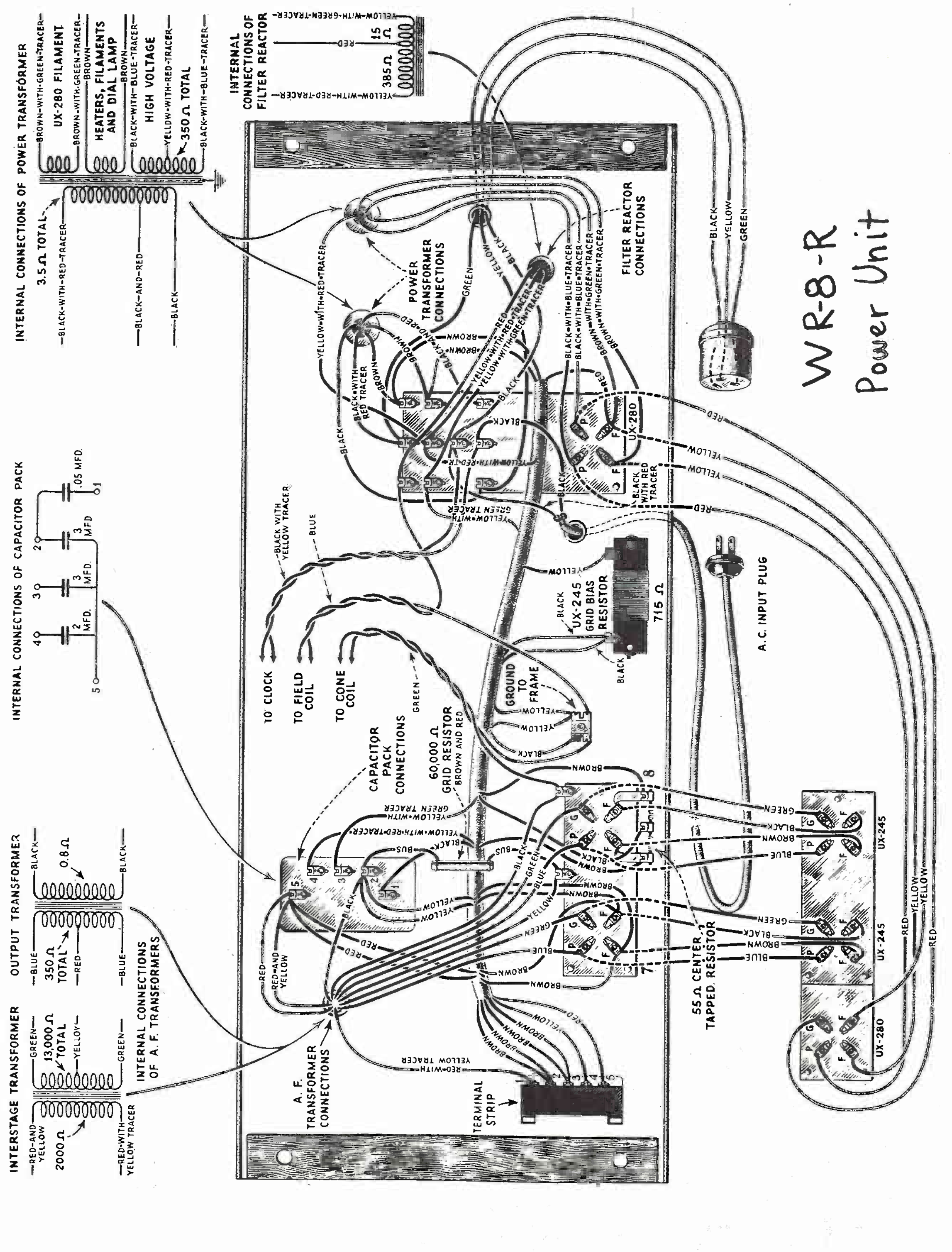
Receiver Assembly WR-8



WESTINGHOUSE ELECTRIC AND MFG. CO.



WESTINGHOUSE ELECTRIC AND MFG. CO.



WR-8-R Power Unit

WESTINGHOUSE ELECTRIC AND MFG. CO.

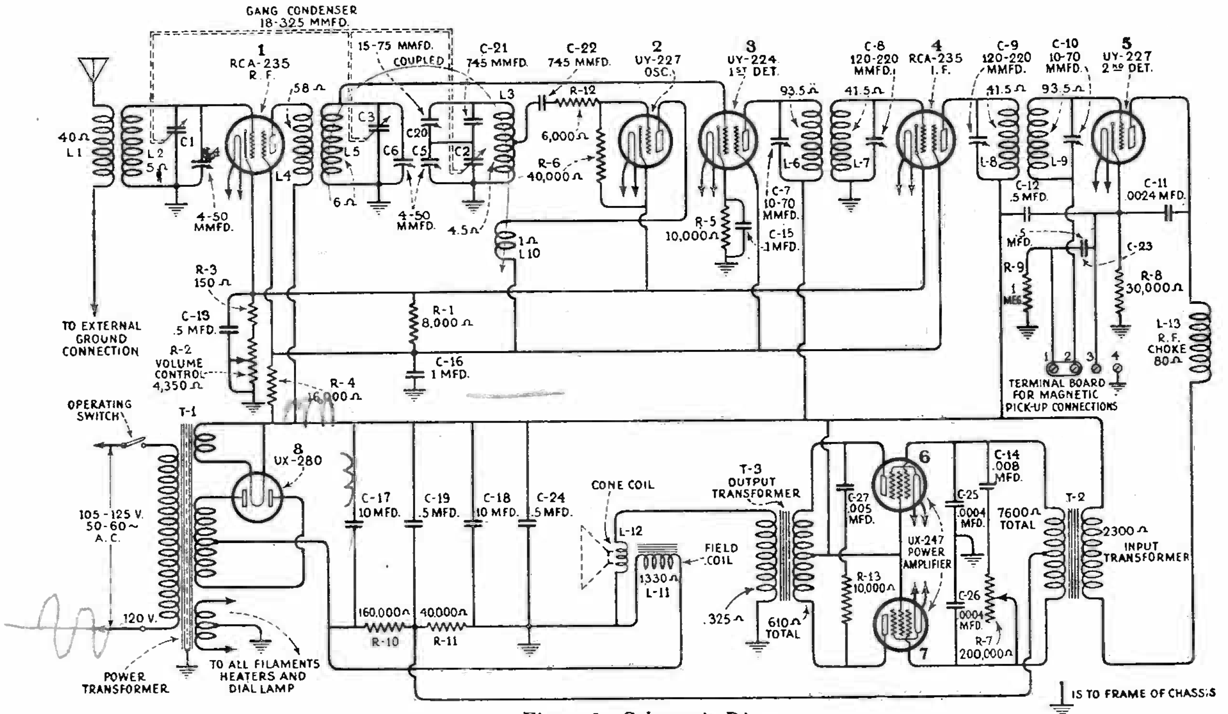
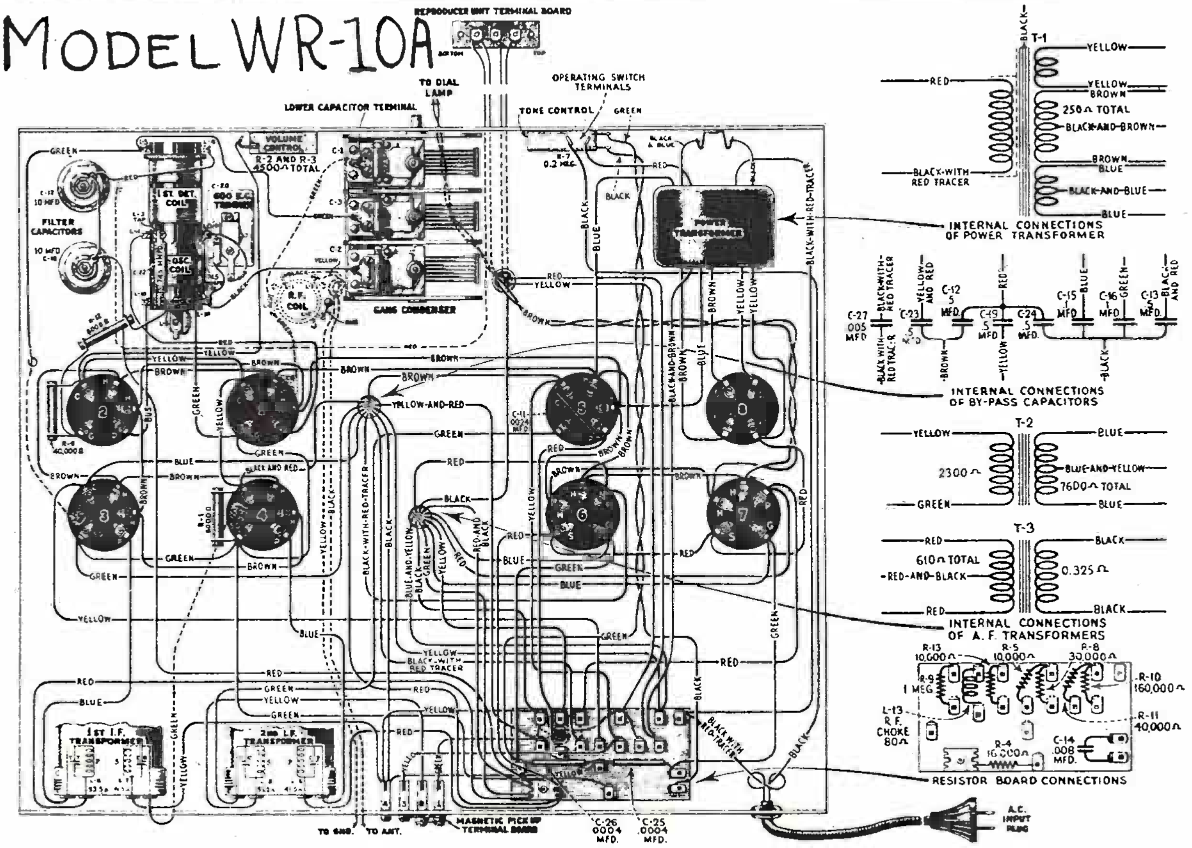


Figure 1—Schematic Diagram

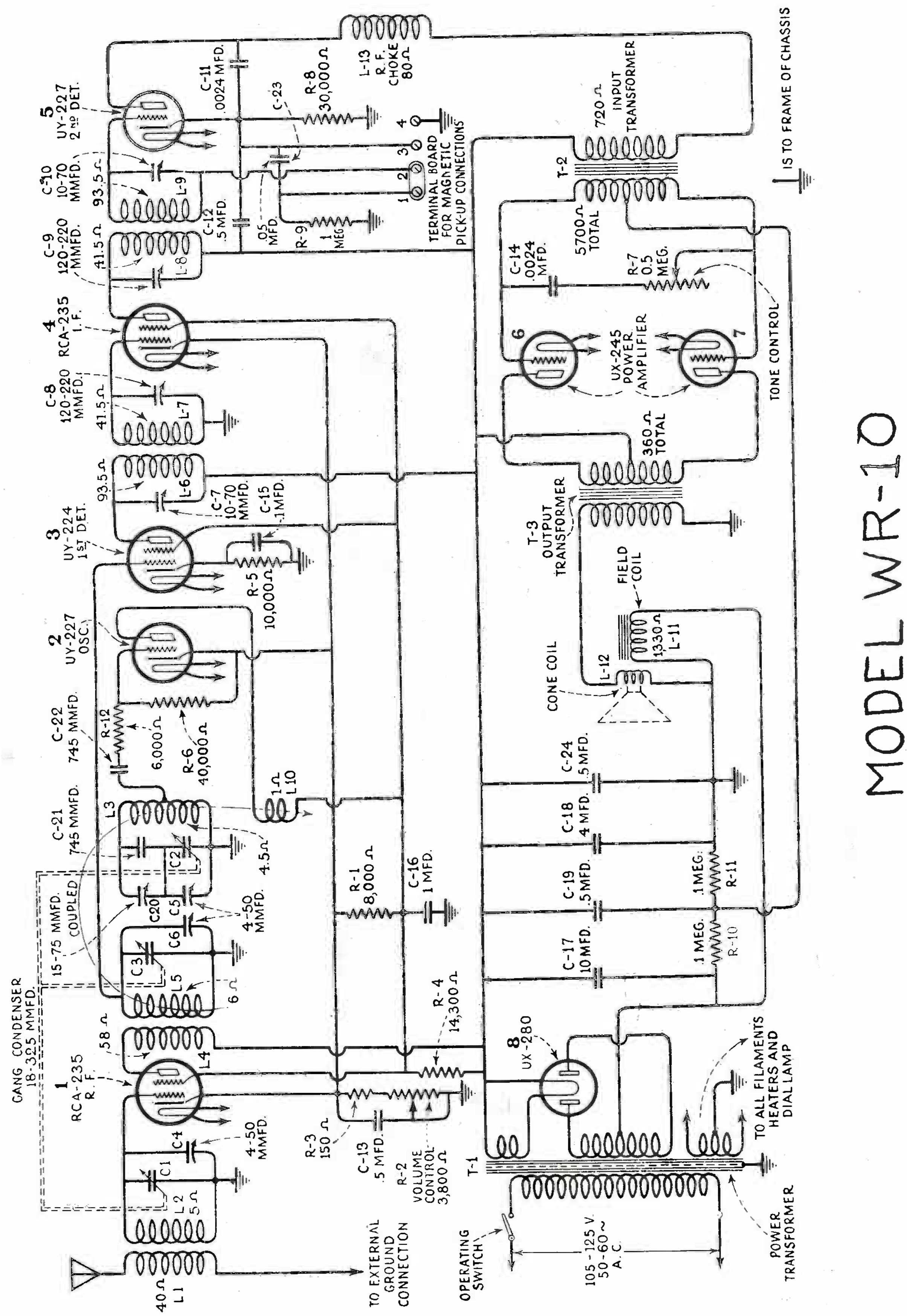
RADIOTRON SOCKET VOLTAGES—110 VOLT A. C. LINE

Radiotron No.	Cathode to Heater Volts D. C.	Cathode or Filament to Control Grid Volts D. C.	Cathode to Screen Grid Volts D. C.	Cathode or Filament to Plate Volts D.C.	Plate Current M. A.	Heater or Filament Volts A. C.	Radiotron No.	Cathode to Heater Volts D. C.	Cathode or Filament to Control Grid Volts D. C.	Cathode to Screen Grid Volts D. C.	Cathode or Filament to Plate Volts D.C.	Plate Current M. A.	Heater or Filament Volts A. C.
VOLUME CONTROL AT MINIMUM							**VOLUME CONTROL AT MAXIMUM**						
1	38	35	50	200	.0	2.2	1	2.0	2.5	60	235	3.5	2.2
2	38	0	—	50	3.5	2.2	2	2.0	.0	—	50	4.5	2.2
3	7	6	80	235	0.5	2.2	3	4.0	4.0	55	230	0.5	2.2
4	38	35	50	200	.0	2.2	4	2.0	2.5	58	235	3.5	2.2
5	22	8	—	210	0.7	2.2	5	22	8	—	210	0.7	2.2
6	—	12	225	220	30	2.2	6	—	12	225	220	30	2.2
7	—	12	225	220	30	2.2	7	—	12	225	220	30	2.2

MODEL WR-10A



WESTINGHOUSE ELECTRIC AND MFG. CO.



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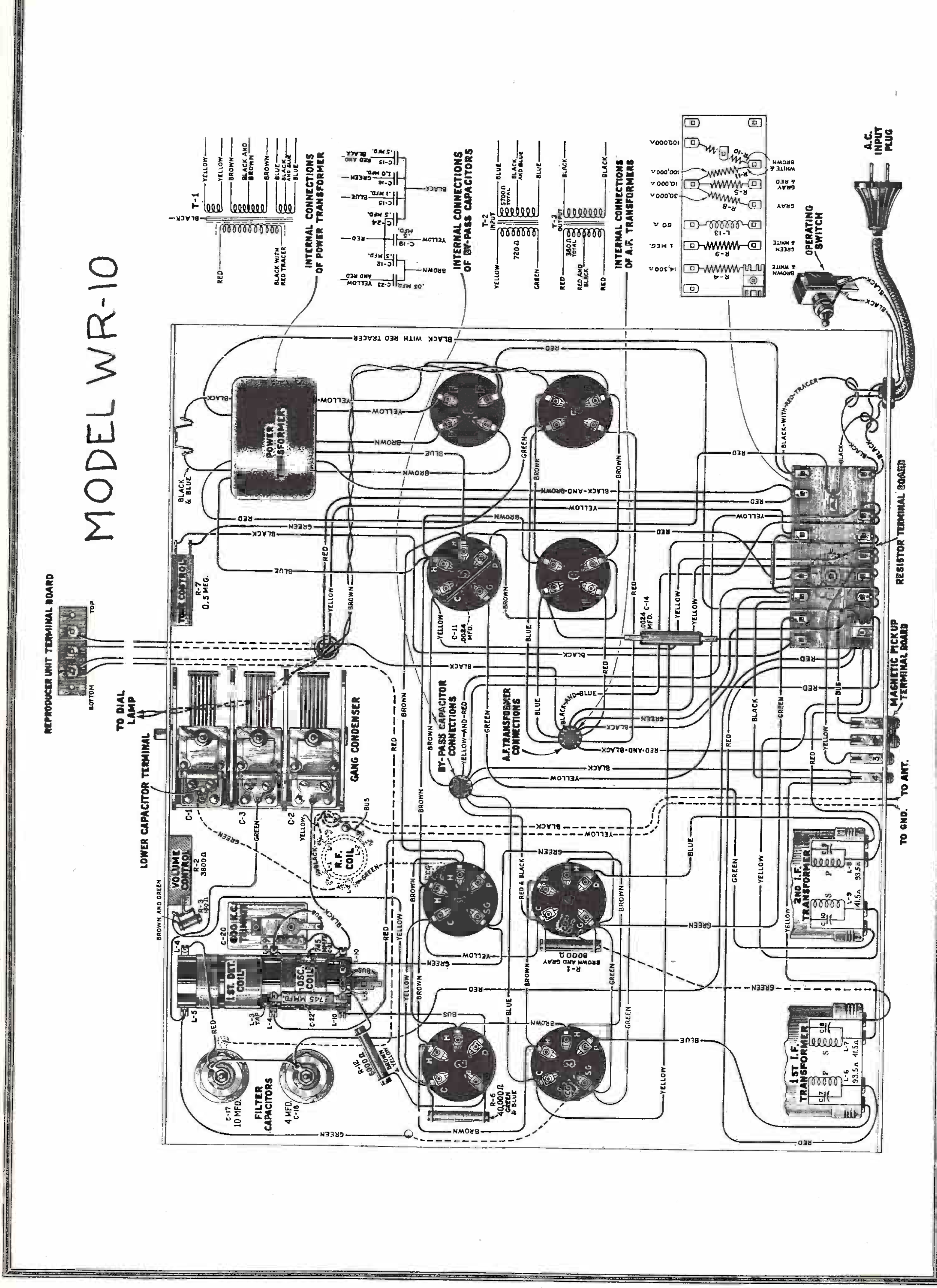
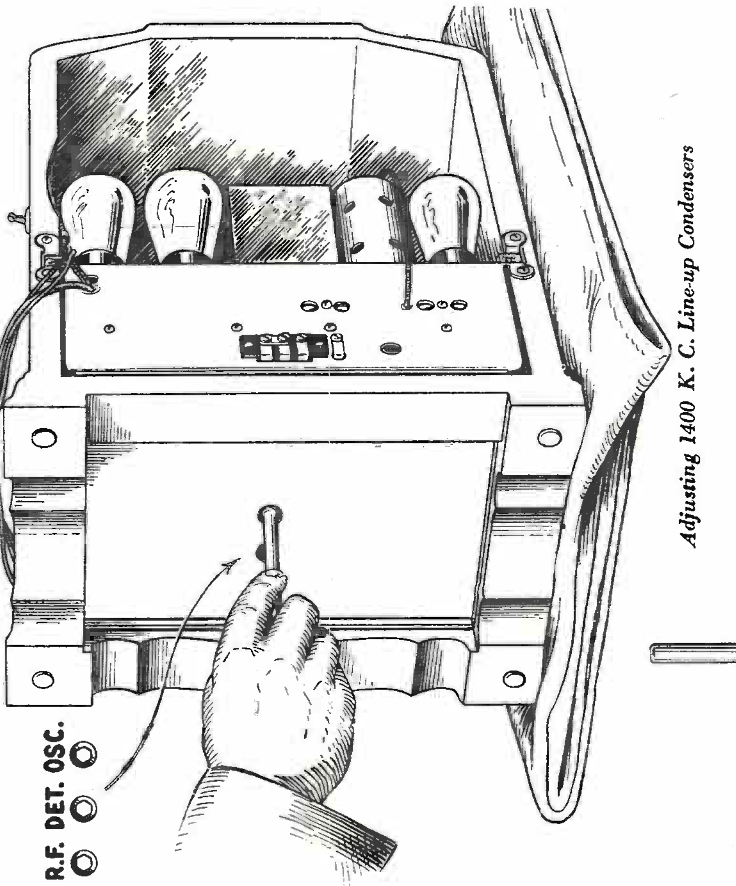
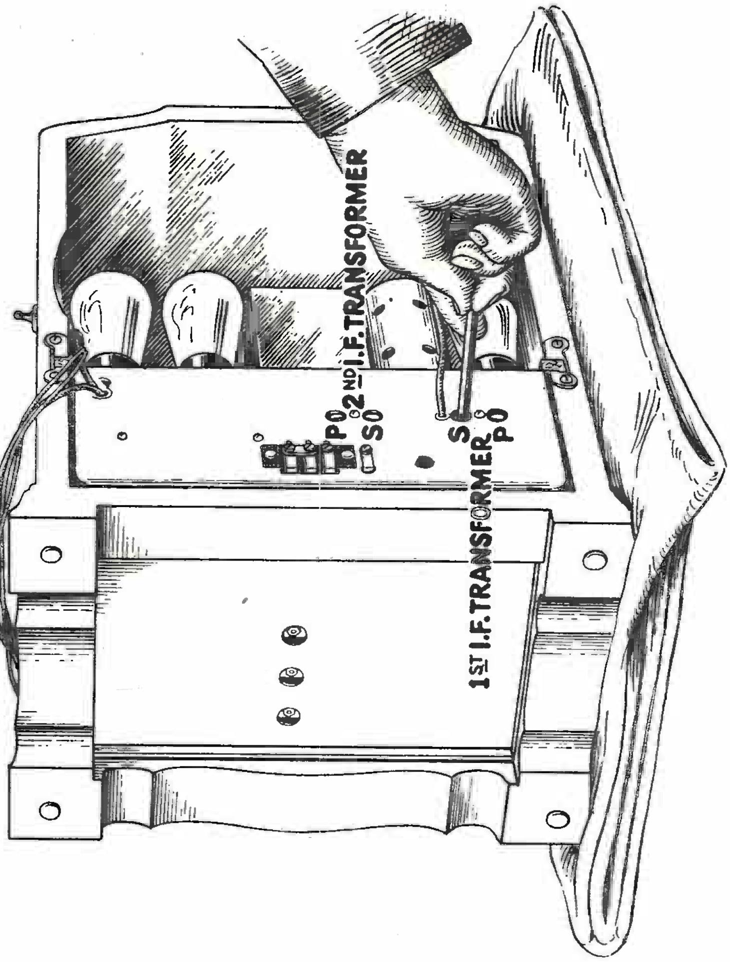


WESTINGHOUSE ELECTRIC AND MFG. CO.

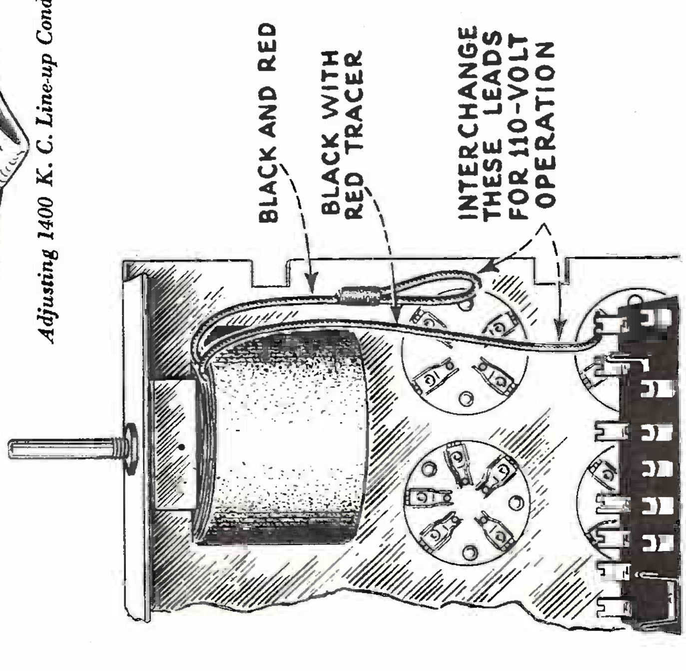
MODEL WR-10



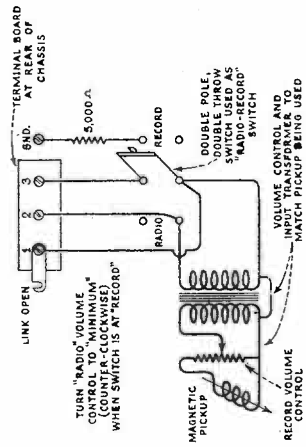
Adjusting 1400 K. C. Line-up Condensers



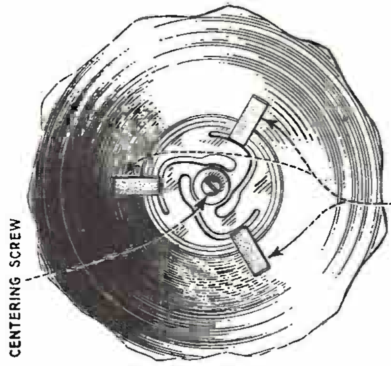
Adjusting I. F. Transformer Tuning Condenser

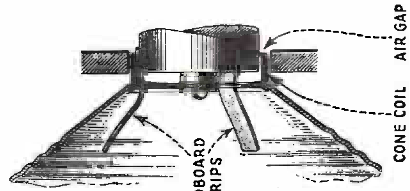


Changes Necessary for 110 Volt Operation on 25 Cycle Models



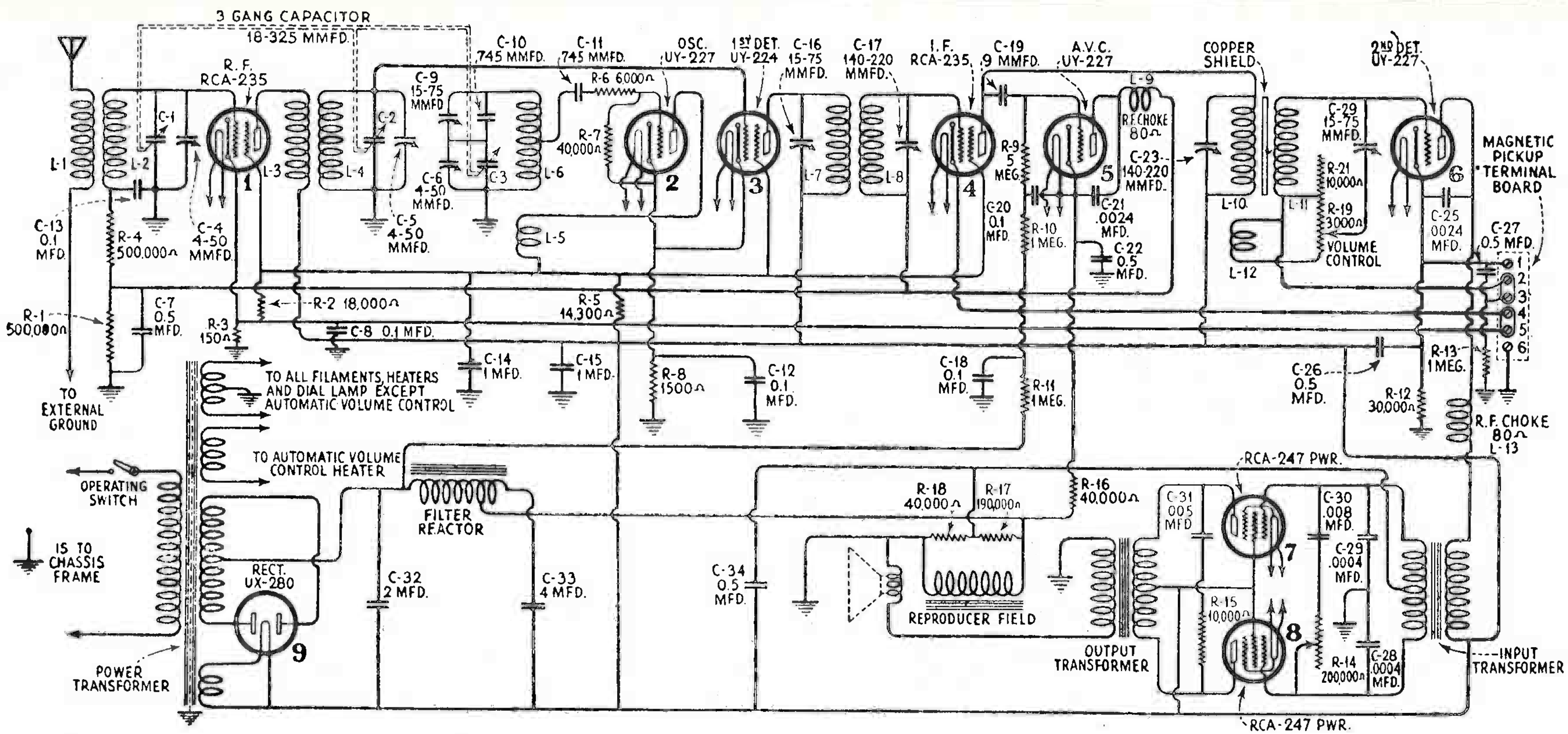
Connections for Attaching Magnetic Pick-up





View of Strips in Place for Centering Cone

WESTINGHOUSE ELECTRIC AND MFG. CO.



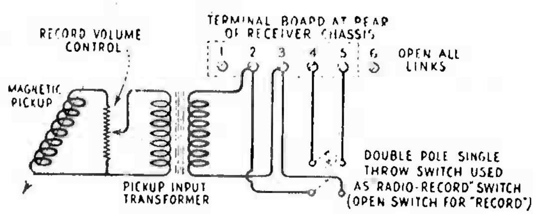
RADIOTRON SOCKET VOLTAGES

110 VOLT A. C. LINE

(Volume Control Setting Does Not Affect Voltages)

Radiotron No.	Cathode to Heater Volts D. C.	Cathode or Filament to Control Grid Volts, D. C.	Cathode or Filament to Screen Grid Volts, D. C.	Cathode or Filament to Plate Volts, D. C.	Plate Current M. A.	Screen Current M. A.	Heater or Filament Volts, A. C.
1	2	*0.1	75	205	5.0	0.5	2.2
2	8	0	—	60	5.0	—	2.2
3	7	7.0	70	200	0.5	0.1	2.2
4	2	*0.1	75	205	5.0	0.5	2.2
5	0	0	—	25	0	—	2.2
6	20	*8.0	—	180	0.5	—	2.2
7	—	10	210	205	25	—	2.2
8	—	10	210	205	25	—	2.2

* Not true reading due to resistance in circuit.



Magnetic Pickup Connections

MODEL WR-15

WESTINGHOUSE ELECTRIC AND MFG. CO.

MODEL WR-14

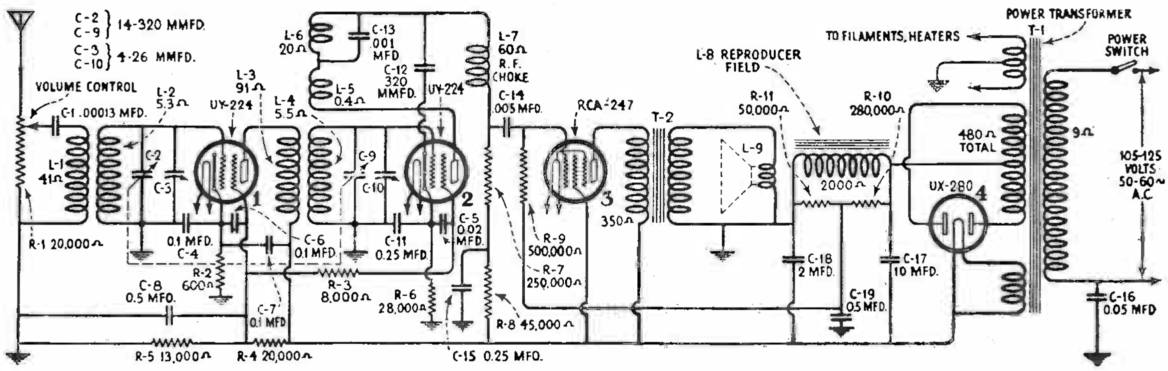


Figure 1—Schematic Circuit Diagram

SOCKET VOLTAGE READINGS

110-VOLT LINE

These are readings obtained with the usual Set Analyzers and are not true readings of the voltages at which the Radiotrons operate.

Radiotron No.	Heater to Cathode Volts	Cathode or Filament to Control Grid Volts	Cathode or Filament to Screen Grid Volts	Cathode or Filament to Plate Volts	Plate Current M. A.	Heater Volts
1	3.0	3.0	85	225	4.0	2.2
2	7.0	7.0	65	100	0.25	2.2
3	——	2.0	225	215	30.0	2.2

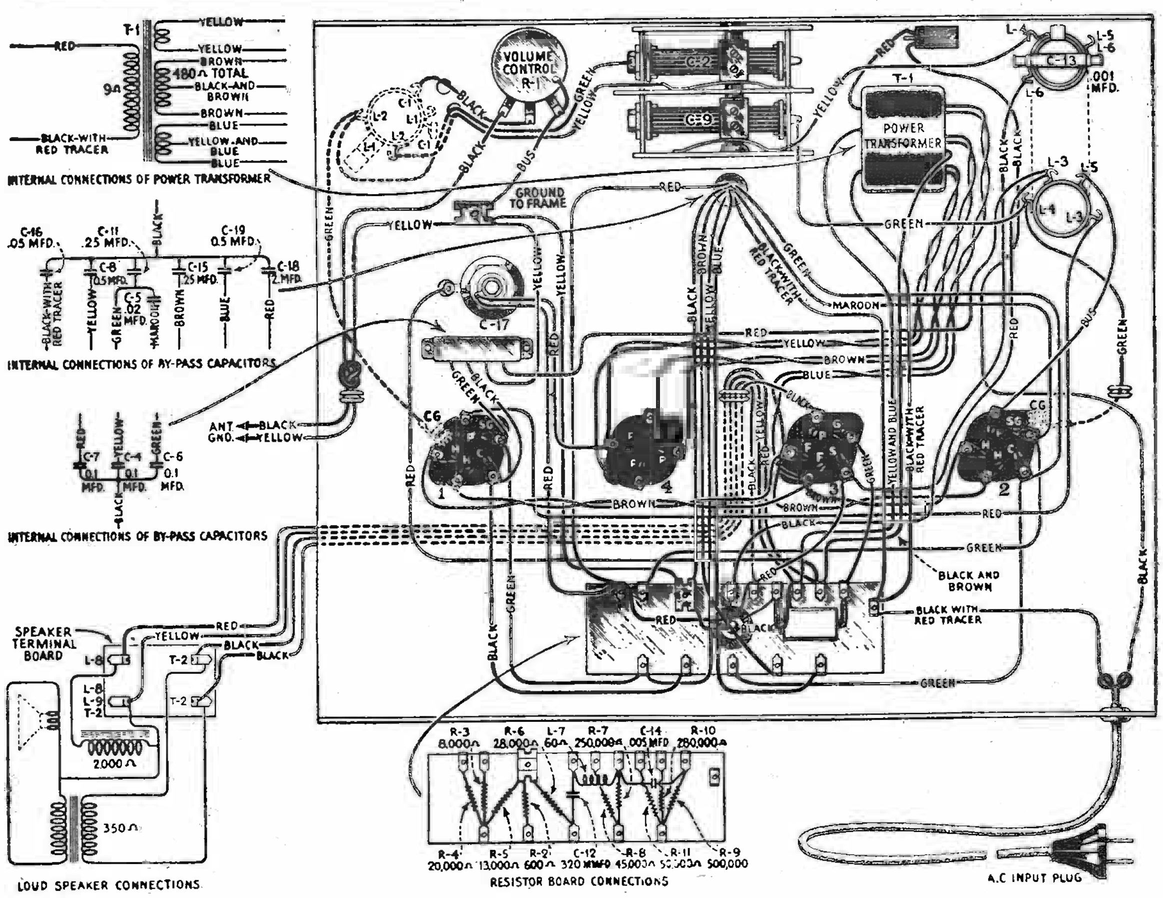
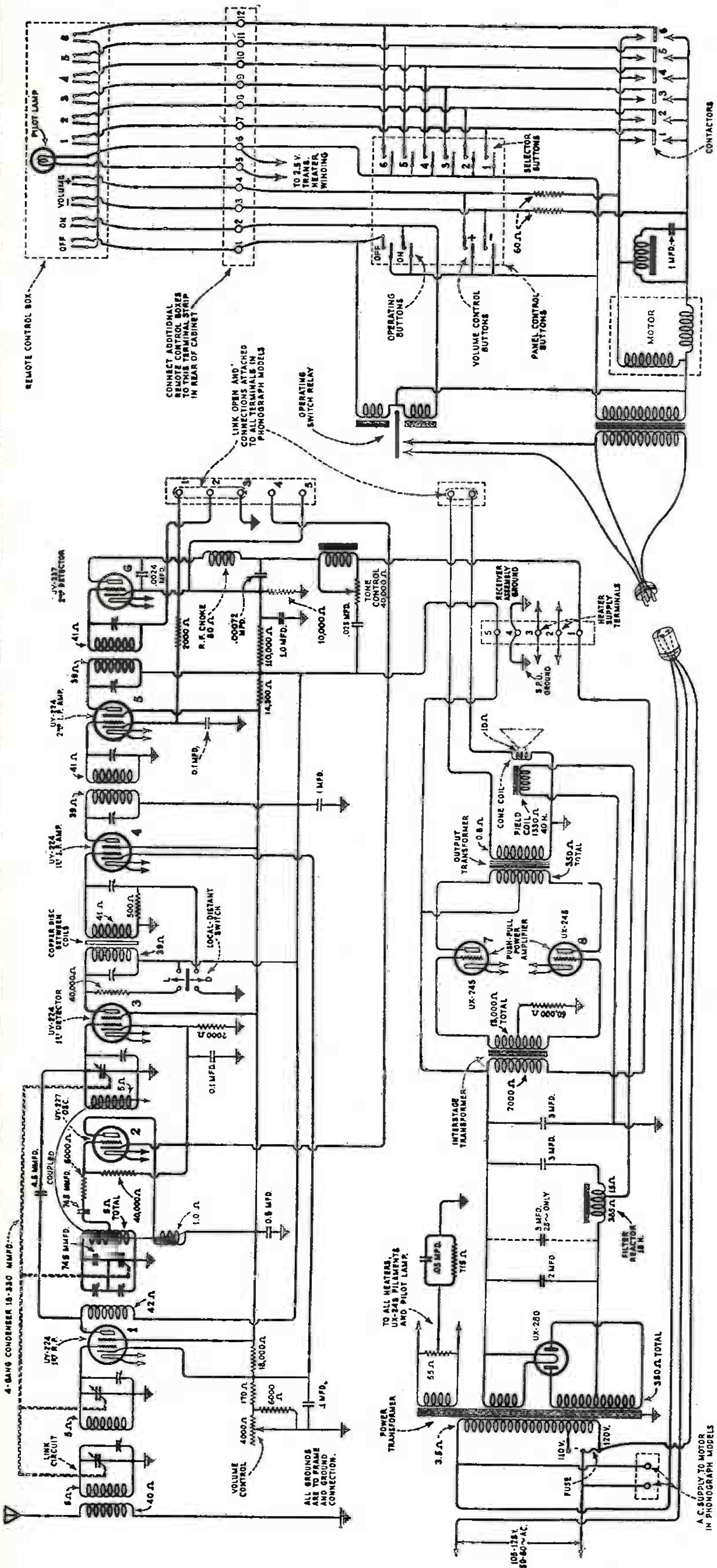
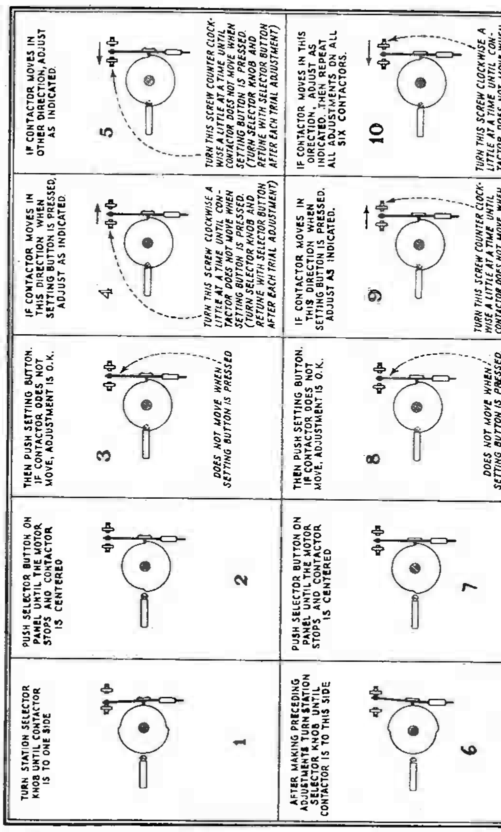


Figure 2—Wiring Diagram

WESTINGHOUSE ELECTRIC AND MFG. CO.

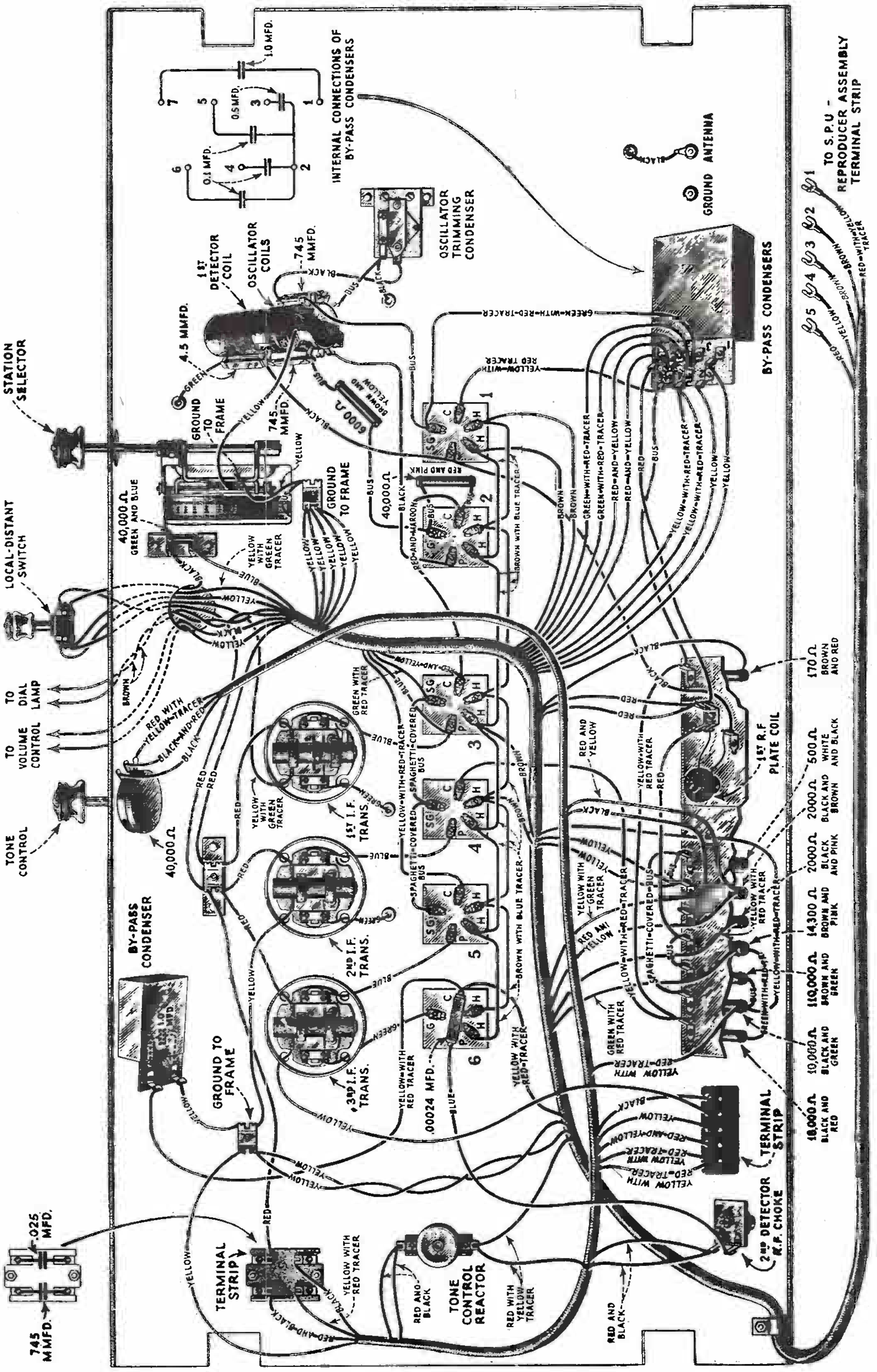


MODELS WR-6-R and WR-7-R



MOTOR CONTACTOR ADJUSTMENT CHART
Repeat Entire Procedure For All Contactors

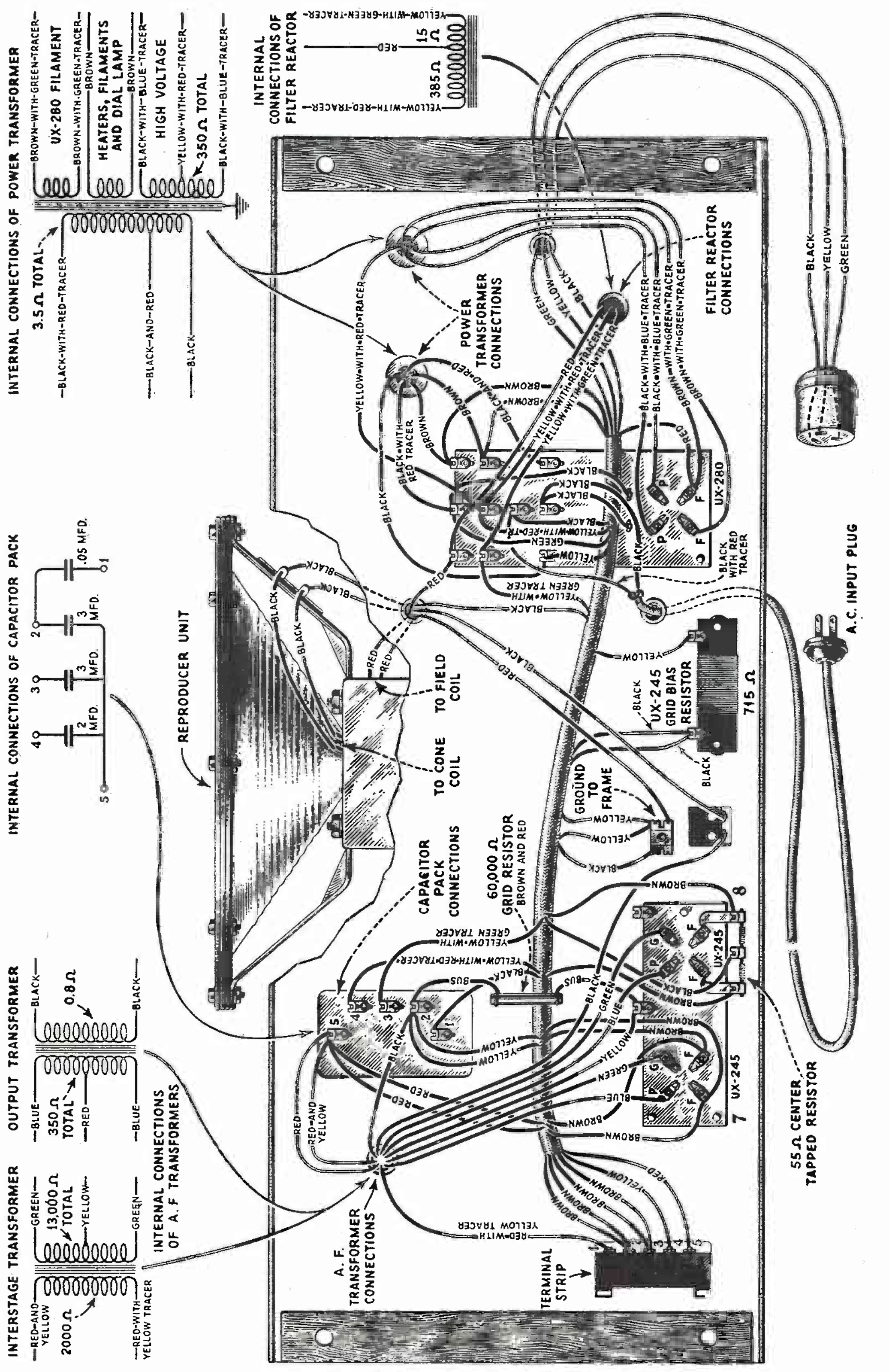
WESTINGHOUSE ELECTRIC AND MFG. CO.



Receiver Assembly

MODELS WR-6-R ; WR-7-R

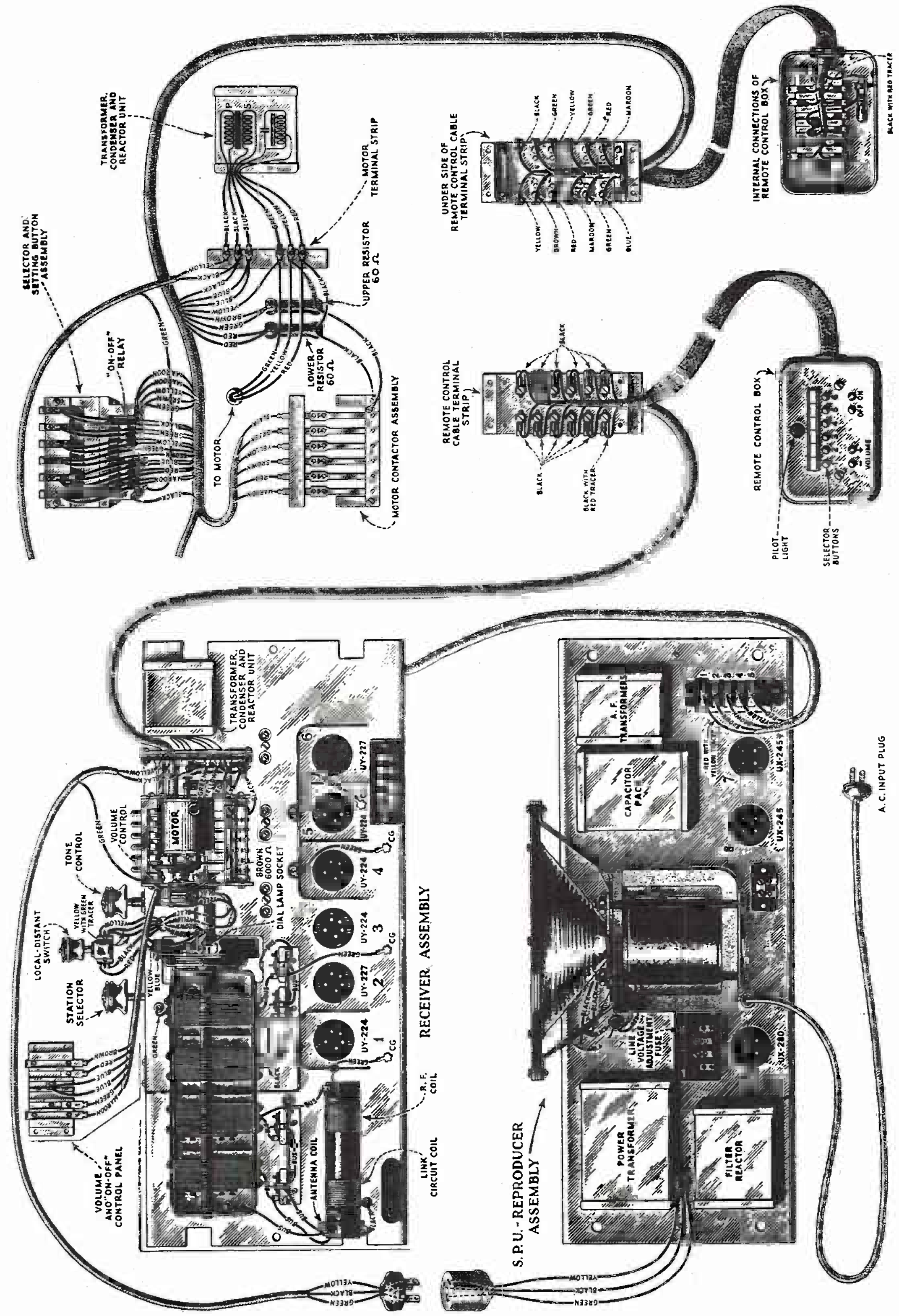
WESTINGHOUSE ELECTRIC AND MFG. CO.



Power Unit

MODELS WR-6-R; WR-7-R

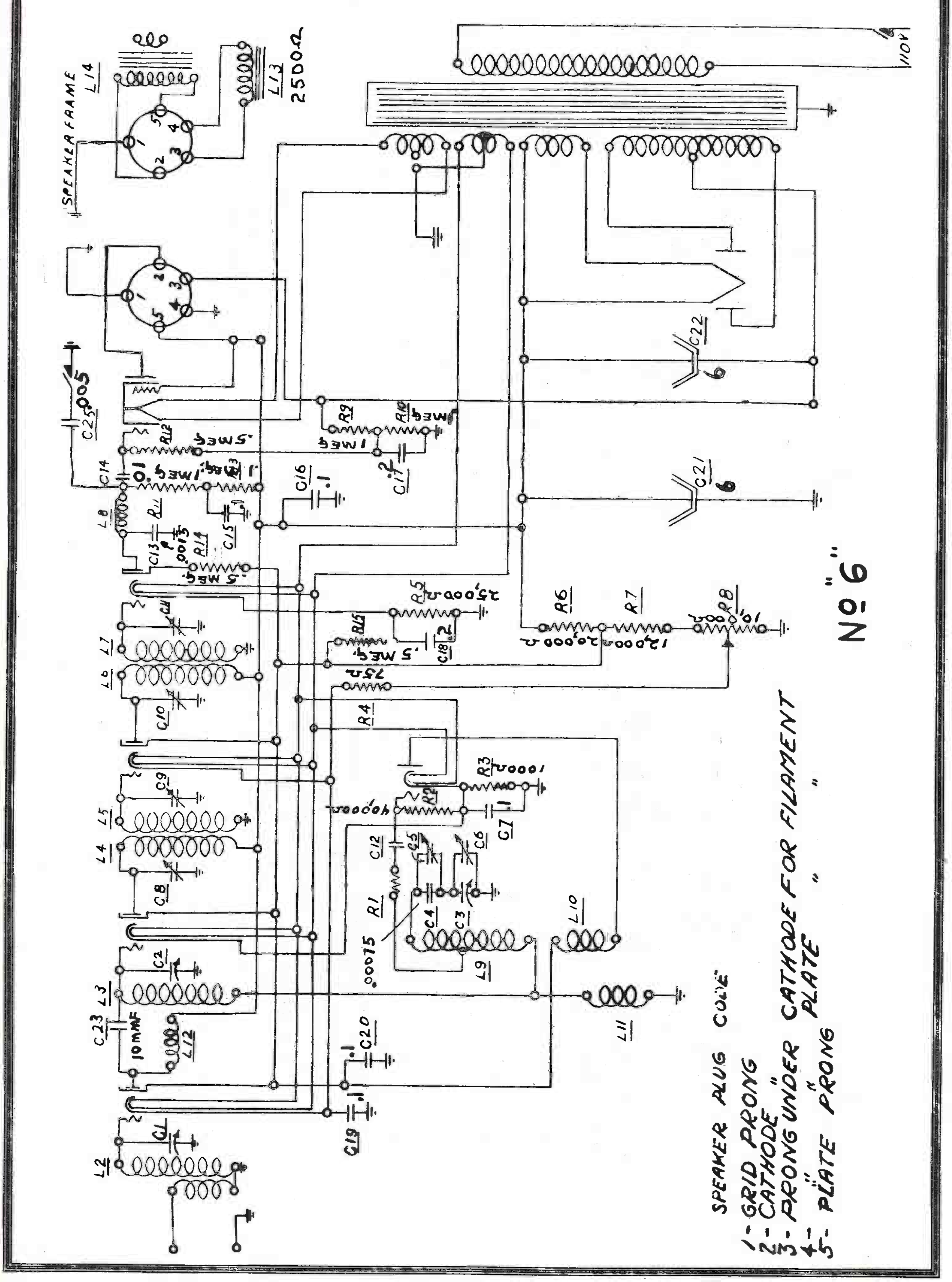
WESTINGHOUSE ELECTRIC AND MFG. CO.



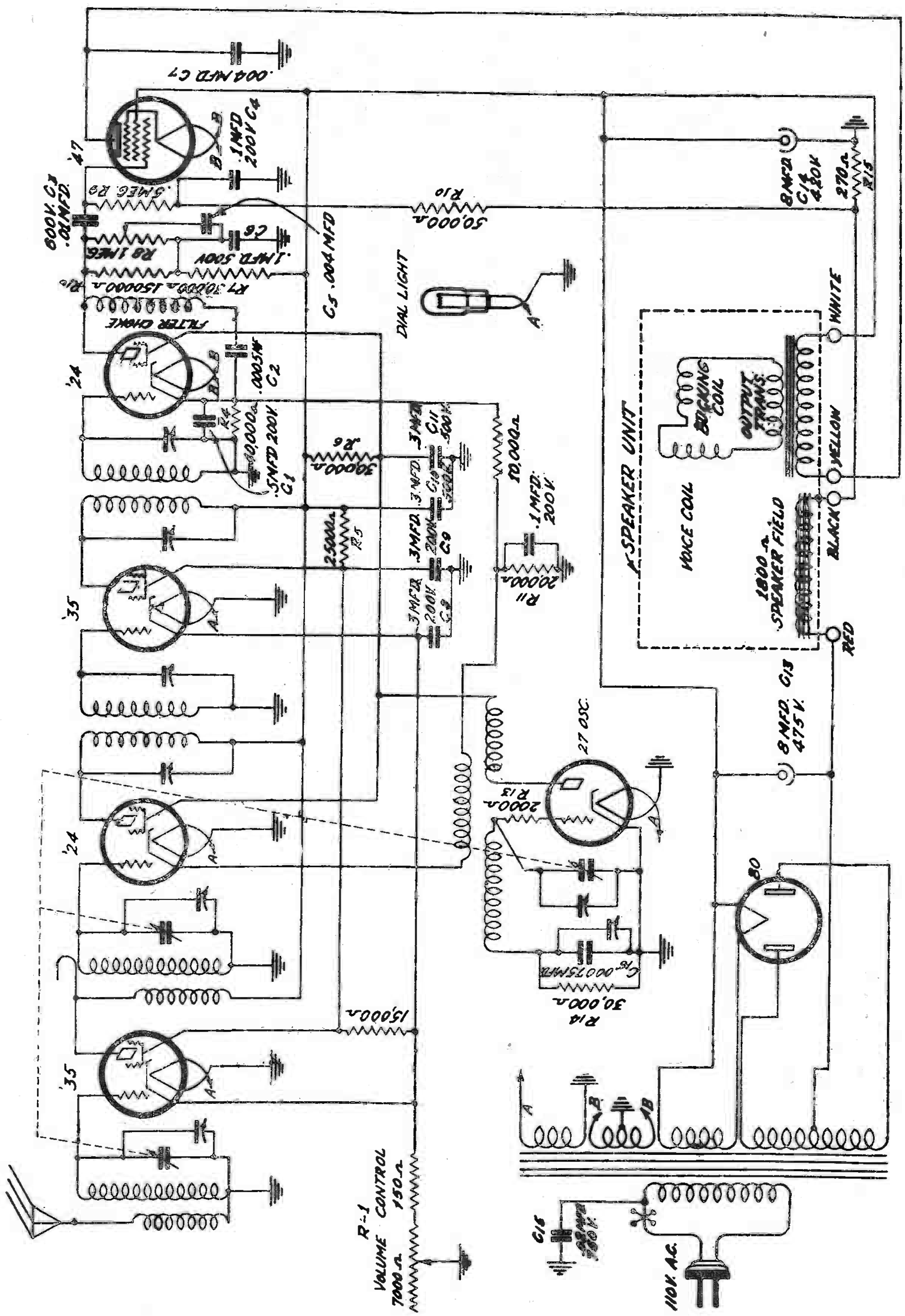
Complete layout and wiring diagram of remote control models

MODELS WR-6-R; WR-7-R

THE WILCOX LABS. INC.

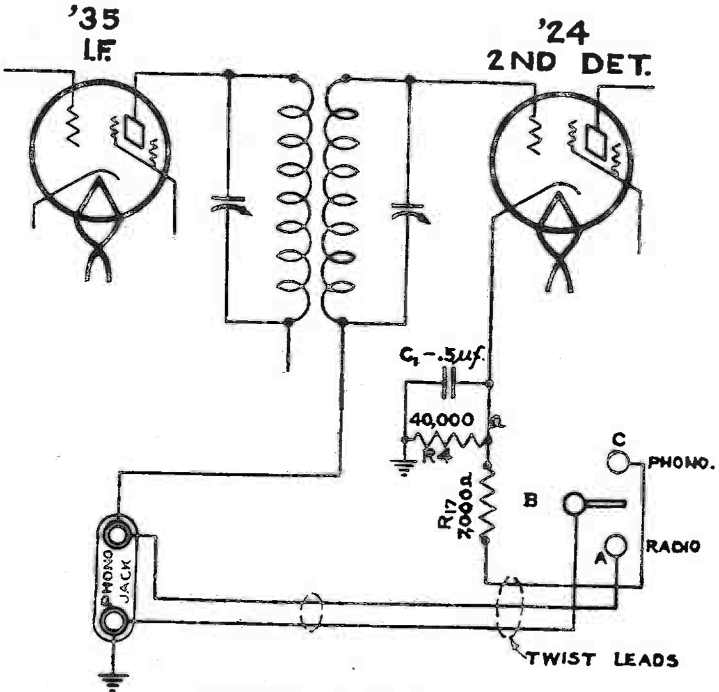


WHOLESALE RADIO SERVICE CO., INC.



LAFAYETTE "10" SERIES

WHOLESALE RADIO SERVICE CO., INC.

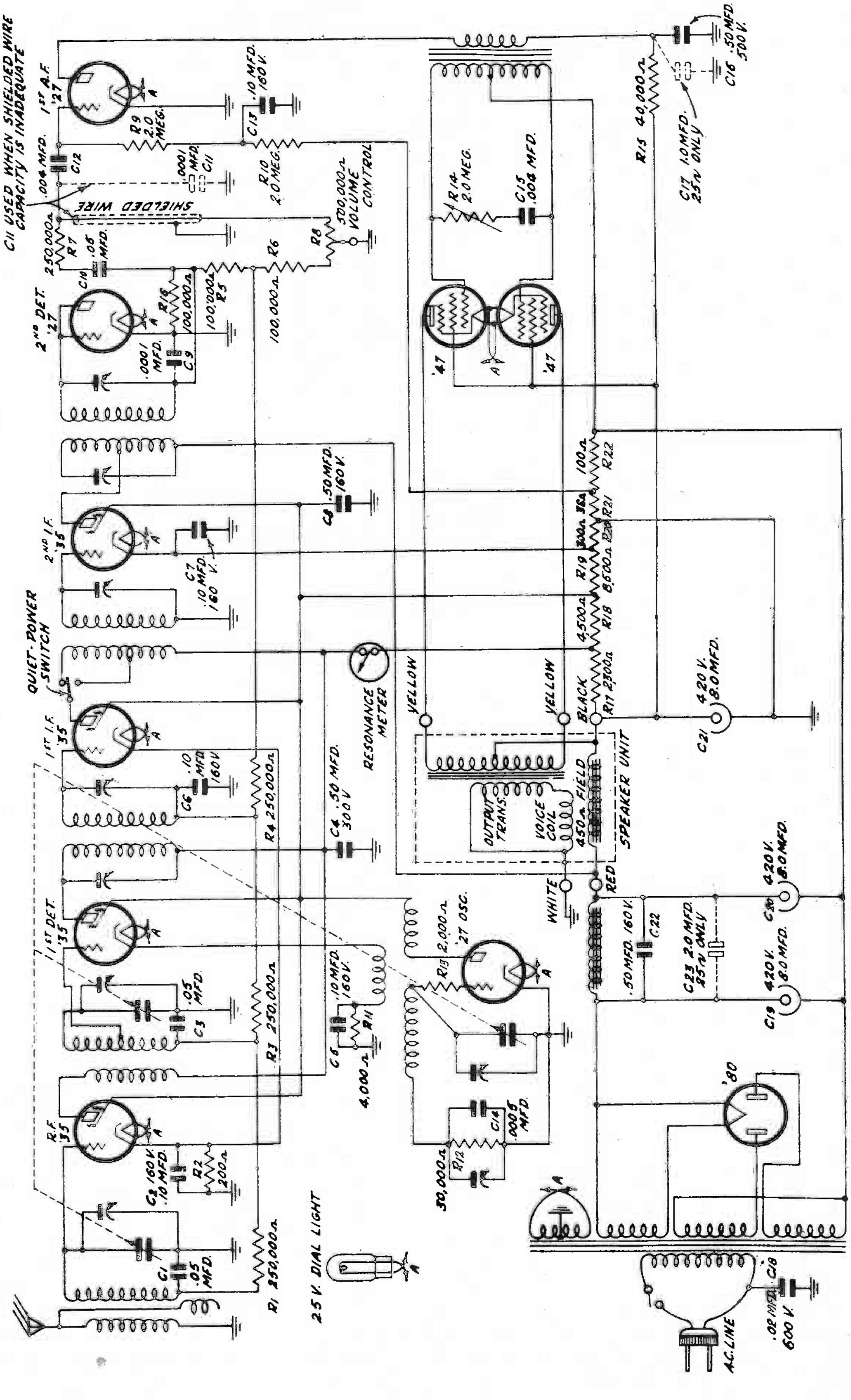


Phonograph Hook-up

SERIES "10"

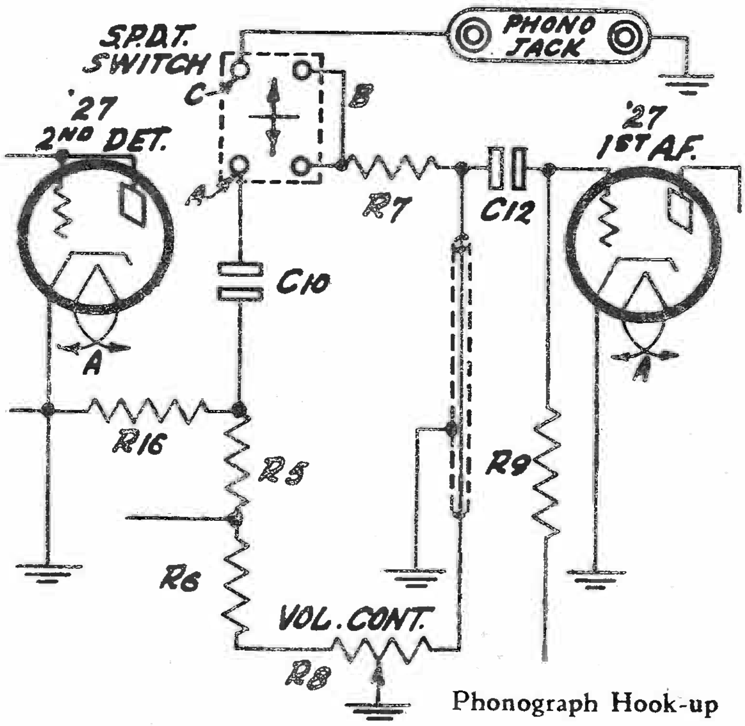
Tube	Circuit	Meter Scale	90 V.	100 V.	110 V.	120 V.	130 V.
R.F. (Ant.) '35	Grid	0—10	1.5	1.7	1.9	2.1	2.3
	Screen Grid	0—100	53.	58.	63.	66.	69.
	Plate	0—250	195.	210.	225.	238.	250.
1st Det. '24	Grid	0—25	14.	14.3	14.5	15.	16.
	Screen Grid	0—100	63.	64.	65.	67.	70.
	Plate	0—250	190.	205.	220.	233.	245.
Int. '35	Grid	0—10	1.5	1.7	1.9	2.1	2.3
	Screen Grid	0—100	53.	58.	63.	66.	69.
	Plate	0—250	195.	210.	225.	237.	250.
2nd Det. '24	Grid	0—25	14.	14.3	14.5	15.	16.
	Screen Grid	0—100	63.	64.	65.	67.	70.
	Plate	0—250	110.	123.	135.	145.	154.
Osc. '27	Grid Plate	0—100	76.	78.	80.	82.	84.
Aud. '47 (See Caution Above)	Grid	0—10	2.1	2.4	2.7	3.	3.3
	Accelerating Grid	0—250	188.	210.	225.	240.	250.
	Plate	0—250	170.	190.	205.	220.	230.
'80 Rect.	Filament to Ground	0—1000	198.	215.	233.	250.	263.

WHOLESALE RADIO SERVICE CO., INC.



LAFAYETTE SERIES "20"

WHOLESALE RADIO SERVICE CO., INC.

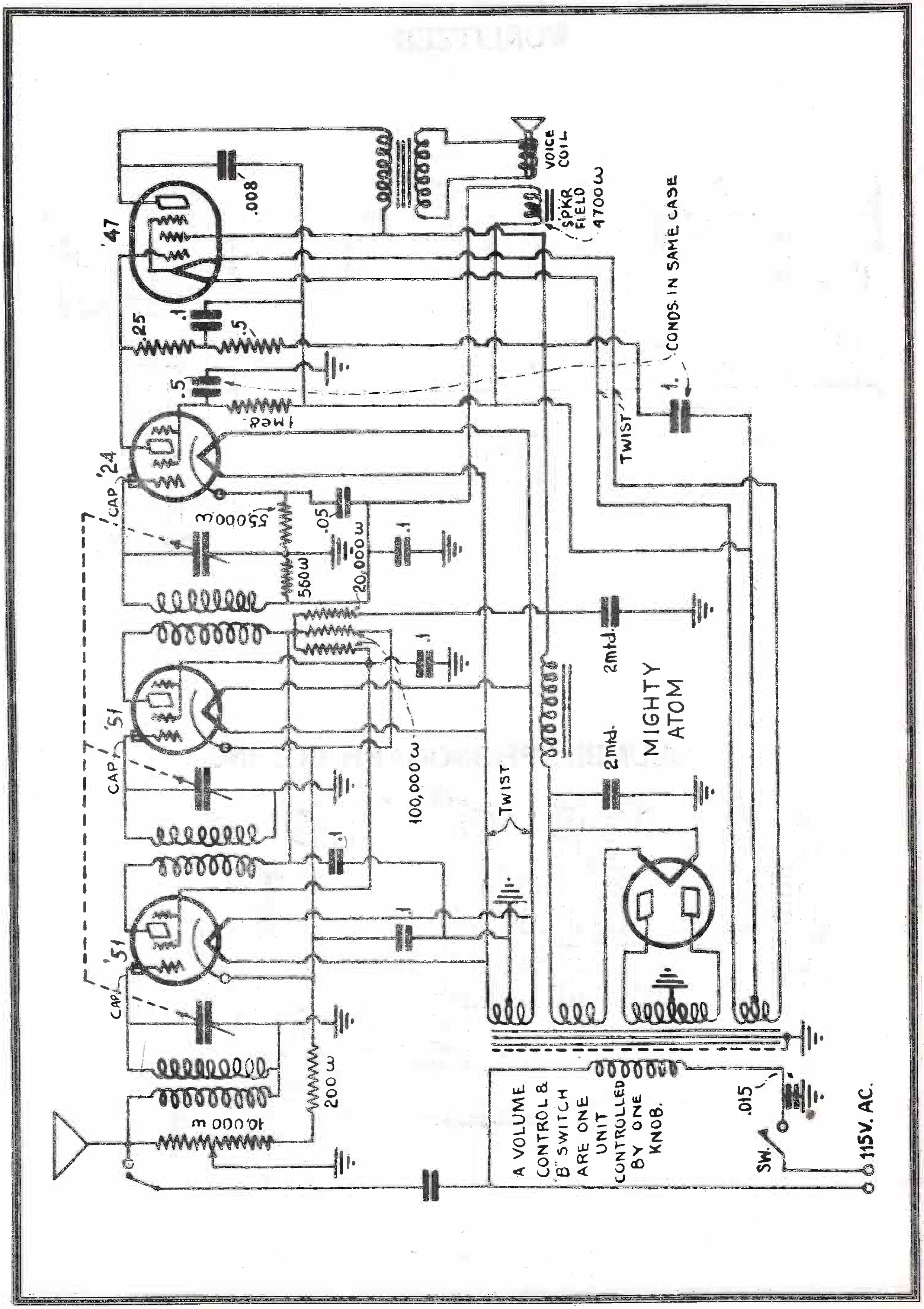


Phonograph Hook-up

SERIES "20"

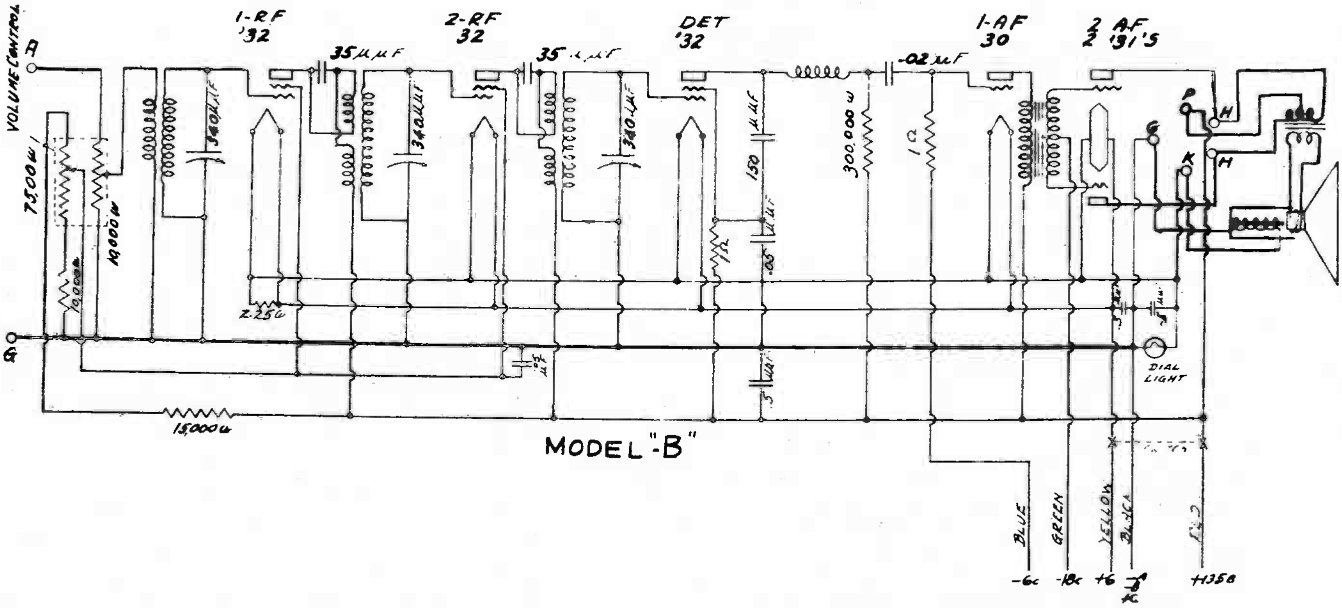
Tube	Circuit	Meter Scale	90 V.	100 V.	110 V.	120 V.	130 V.
R.F. '35	Screen Grid	0—100	67.	75.	82.	90.	97.
	Plate	0—250	136.	151.	166.	181.	196.
1st Det. '35	Screen Grid	0—100	63.	70.	77.	84.	91.
	Plate	0—250	132.	147.	163.	179.	194.
Oscillator '27	Plate	0—100	70.	77.	85.	92.	100.
1st I.F. '35	Screen Grid	0—100	67.	75.	82.	90.	97.
	Plate	0—250	136.	151.	166.	181.	196.
2nd I.F. '35	Screen Grid	0—100	65.	72.	79.	86.	94.
	Plate	0—1000	227.	252.	277.	303.	328.
1st A.F. '27	Plate	0-100	87.	95.	104.	115.	122.
2nd A.F. '47	Grid	0-25	12.7	14.	15.4	17.	18.3
	Accelerating Grid	0-1000	192.	208.	235.	252.	278.
	Plate	0-1000	180.	200.	220.	240.	261.
'80 Rect.	Current (Both Plates)	0-100	89. M.A.	98. M.A.	108. M.A.	118. M.A.	128. M.A.
(See below)	Plate to Plate voltage	0-1000	547.	568.	690.	712.	733.

The '80 rectifier plate voltages shown are the totals of both plates, measured from each plate to center tap of high voltage secondary.



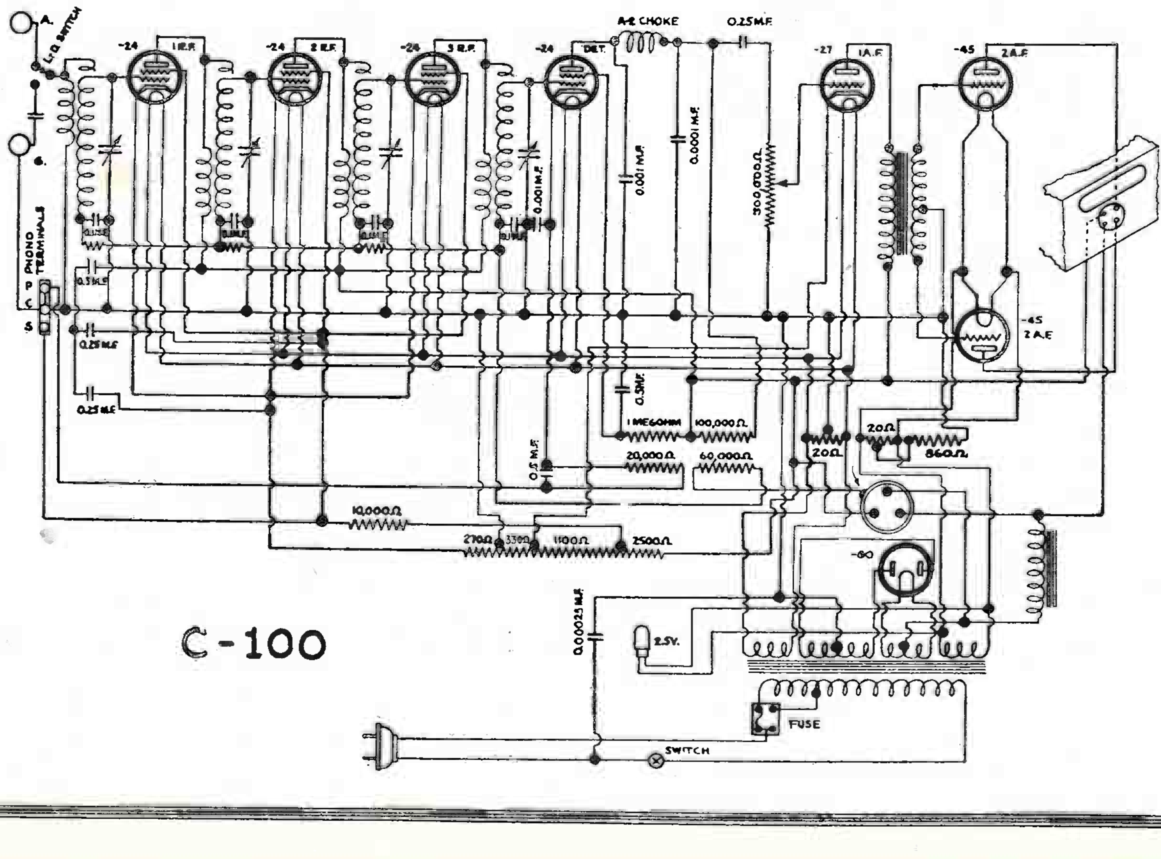
'47
.008
VOICE COIL
SPKR FIELD 4700 ω
CONDS IN SAME CASE
1.
TWIST
.25
.1
.5
.5
1 meg.
'24
CAP
55000 ω
.05
560 ω
20,000 ω
.1
'51
CAP
.1
2mfd.
2mfd.
MIGHTY ATOM
100,000 ω
TWIST
.1
.1
'51
CAP
200 ω
10,000 ω
A VOLUME CONTROL & "B" SWITCH ARE ONE UNIT CONTROLLED BY ONE KNOB.
.015
SW.
115V. AC.

WURLITZER



MODEL "B"

COLUMBIA PHONOGAPH CO., INC.

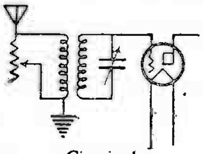


C-100

CENTRAL RADIO LABORATORIES

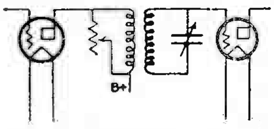
Fundamental Circuits Used for Volume Control

Antenna or R. F. Primary Radiohm



Circuit 1

Circuits numbers one and two were widely used on electric sets during 1928 and early in 1929. The volume control shunts the primary of an R.F. transformer having a tuned secondary, and has essentially, the same resistance taper whether used at the antenna input or between two of the R.F. tubes. Circuit number one is the simplest and best to use in



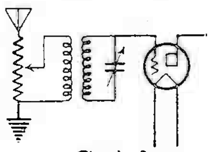
Circuit 2

servicing any type receiver when in doubt about the proper volume control. It always works, and cannot interfere with the proper operation of any circuit.

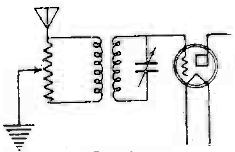
Use Centralab Replacement Control number 70-200.

(A 100,000 ohm left hand tapered Radiohm.)

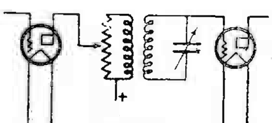
Antenna or R. F. Potentiometer



Circuit 3



Circuit 4



Circuit 5

Circuits numbers three, four and five are quite similar to the first two except that a potentiometer is used rather than a two terminal resistor. Some models may deviate from circuit four by connecting the antenna rather than the ground to the variable contact. These are all circuit arrangements that can be used with the type —26 or type —27 tubes. Adjusting the volume control will have no effect on the apparent A.C. hum, and will not change the selectivity of the set. Use Centralab Replacement Control number 72-100.

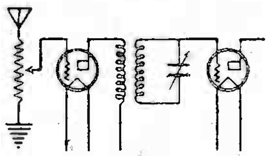
(A 10,000 ohm left hand tapered potentiometer.)

Untuned Antenna Circuit Potentiometer

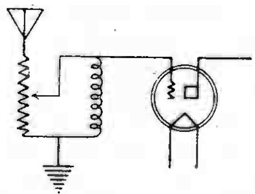
Circuit number six was used on several early A.C. models sold in large quantities, including those of R.C.A. The volume control potentiometer has a resistance of 2,000 ohms, and the grid of the first tube is directly connected without tuning.

Use Centralab Rpelacement Control number 72-101.

(A left hand tapered 2,000 ohm potentiometer.)



Circuit 6



Circuit 7

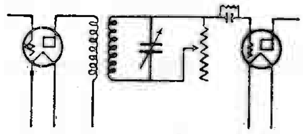
The gain and selectivity of receivers using this control circuit can often be improved by adding an inductance loading coil per circuit number seven.

A potentiometer of 10,000 ohms is then desirable, using Centralab Replacement Control number 72-100.

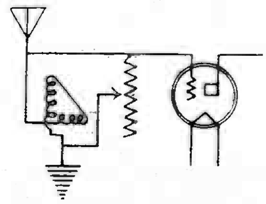
(A left hand tapered 10,000 ohm potentiometer.)

Radiohm in Tuned R. F. Circuits

Circuit number eight proved a helpful and reliable volume control for those —26 type sets that oscilated excessively. The control for this particular circuit has many uses as a replacement control. It is a shunt resistance with a high maximum before going to infinity. It is also used



Circuit 8



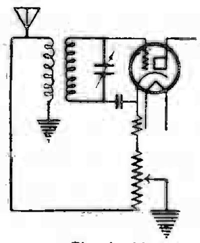
Circuit 9

in the antenna circuit where a high resistance is needed with a tuned coupling transformer, or where a variometer is used per circuit number nine.

Use Centralab Replacement Control number 70-201.

(A left hand Radiohm.)

Potentiometer "C" Bias and Antenna Control



Circuit 10

This circuit is more widely used than any other arrangement using a single control with type 27 or screen grid tubes, as it gives a double control effect at the cost of a single potentiometer. The variable contact is usually grounded through the bushing and the terminal at the clockwise end, is connected through a fixed bias resistor to the cathodes of two or three R.F. tubes or the I.F. tubes in case the circuit is a "Super." The other terminal connects to the antenna, shorting it to ground at minimum volume adjustment to avoid the grid overloading that might otherwise occur on loud signals.

Satisfactory volume controls for this circuit must be carefully tapered and are apt to prove critical or noisy under some extreme conditions. Where the very best control is desired, re-

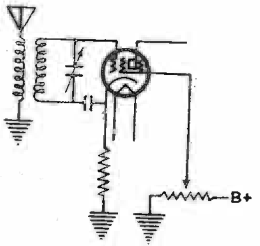
CENTRAL RADIO LABORATORIES

place the single potentiometer with Twin control 74-601 connected as shown by circuit twenty.

Circuit ten uses Centralab Replacement Control number 79-006 or 51-010.

(A 15,000 ohm left-hand tapered potentiometer.)

Screen Grid Potentiometer



Circuit 11

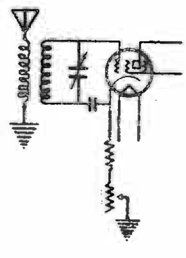
A single potentiometer providing volume control by varying the voltage applied to the screens of the R.F. tubes. Connection to only one tube is illustrated, but the screens of all the R.F. tubes are usually connected to the slider of the control. A 50,000 ohm Centralab has been most used for this service. Some receivers, however, use a wire wound control of such low resistance it passes considerable current and is made part of the voltage divider circuit. Better volume control will result from using a high resistance shunting the voltage divider. When these wire wound controls require replacement because of noise or wear, it is best to use the Centralab 100,000 ohm potentiometer with the two outside terminals bridged with a fixed resistor of approximately the same value as the old wire wound potentiometer.

50,000 ohm potentiometer. Part number 72-103.

100,000 ohm potentiometer. Part number 72-104.

(Straight taper potentiometers.)

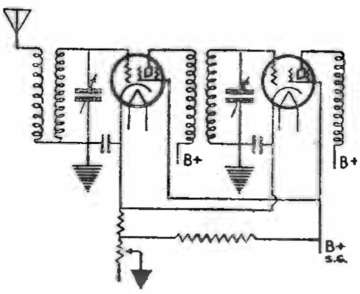
R. F. "C" Bias Radiohm



Circuit 12

A popular circuit used effectively with all heater type of tubes. Circuit 12 was widely used in 1929 and 1930 in tuned R.F. circuits with the type —24 or type —27 tubes. The cathode current of all R.F. tubes passes through the single control and the additional fixed resistor which supplies the bias at maximum volume. Control depends upon the tube characteristic that increasing the negative C-bias beyond the normal three volts, will decrease the plate current and amplification of the tube until the signal is effectively blocked. The variable resistance must be heavily tapered for uniform attenuation since the voltage drop of the cathode current alone is depended upon for full range control. The proper Centralab control for circuit twelve is Centralab number 70-202, a 75,000 ohm right-hand tapered Radiohm.

Variable Mu tubes, such as type —51 or —35, require such a high negative bias to fully control the signal it is customary to obtain the required voltage drop by passing bleeder current through the control in additior



Circuit 12A

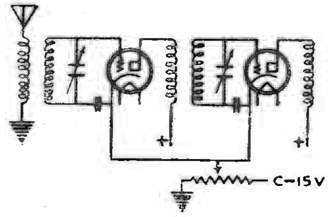
to the cathode current. This arrangement is illustrated as circuit 12A. Two fixed resistors are shown in addition to the volume control variable resistance. The one between the volume control and the cathodes is of low resistance and provides the minimum bias for maximum volume. The other resistor has a two-fold purpose of stabilizing the screen voltage and metering a definite amount of "bleeder" current through the volume control. Its resistance, and that of a third resistance between the screens and the high potential lead, not shown in the print, is normally adjusted to apply about 100 volts on the screens and pass sufficient current through the total resistance of the volume control to provide a drop of about 40 volts across the volume control at minimum volume.

This type control is used on both tuned R.F. and Super heterodyne circuits. On Supers, it is customary to control the bias of the I.F. tubes while tuned R.F. circuits will control two or three tubes. The most popular control is a right-hand tapered Radiohm, maximum resistance 10,000 ohms, Centralab part number 70-205. A few receivers originally used a wire wound control with a much lower maximum resistance. Replace these with a Centralab Potentiometer of similar resistance (see list on page 47) and connect the center and right terminal only.

Volume Control circuits like figure 12 or 12A, sometimes cause distortion or cross talk, due to overloading, in sections where local broadcast stations are powerful and numerous. This may be corrected by using a potentiometer of similar resistance for the replacement control, and connecting the left terminal to the antenna as illustrated in figure 10. Part number 79-006 is correct for most receivers when so changed.

R. F. "C" Bias Potentiometer

Another method of controlling volume by changing the R.F. "C" Bias

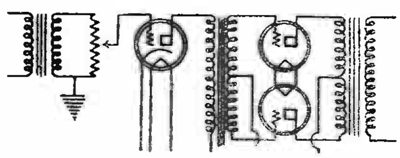


Circuit 13

that will be found on some receivers. Replacements must have the same total resistance of the original to insure the correct voltage drop. This resistance is usually low, such as Centralab part numbers 72-101, 72-107 or 72-108.

This method of control is no longer considered as good as circuit ten or twelve. It is suggested that one of these circuits be substituted in making replacements.

Audio Circuit Volume Level Potentiometer



Circuit 14

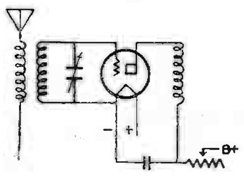
Potentiometer across audio stage is a very old form of control dating back to 1926. Yet many modern receivers will be found with this as an auxiliary control to another in the set; as the manual control used with automatic

CENTRAL RADIO LABORATORIES

volume control circuits; and as the volume control on amplifiers sold for theatre and school installations. Centralab replacement Part number 72-105.

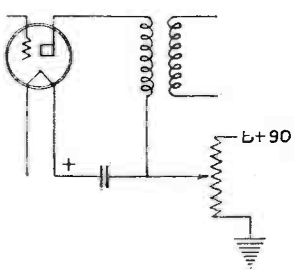
Where space permits, as on separate amplifiers, use the Centralab Standard M-500 Modulator, having a diameter of 2¼ inches.

R. F. Plate Circuit Contro'



Circuit 15

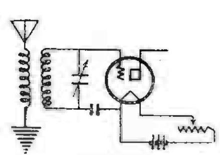
These illustrate the plate circuit controls widely used several years ago. Connections for one tube only are shown, but the plates of two R.F. tubes are commonly connected to the control. Circuit number fifteen uses a 500,000 ohm right hand tapered Radiohm. Centralab replacement Part number 70-203.
Circuit number sixteen used a 50,000 ohm potentiometer. Centralab replacement Part number 72-103. Both the above circuits may require frequent volume control replacement because a poor tube will practically short circuit the control. A tube with



Circuit 16

loose grid that may accidentally short to plate causes the trouble and this tube is hard to locate because it will normally continue to function and be apparently O.K. It is therefore, desirable to replace these volume controls with the number 70-201 control connected as per circuit number eight or with circuit number one. The former volume control connections are then soldered together and taped

R. F. Filament Rheostat



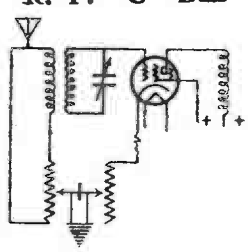
Circuit 18

A Rheostat in the filament circuit to control any one or all of the tubes is the oldest method of volume control. There is a choice of two types of rheostats for replacement, Standard Power or Giant Power. The first is for low voltage and low current control; the second is for low voltage and higher current so that the maximum power does not exceed 50 watts. Smoother volume control for these receivers will always be obtained by fixing the filament voltage and using replacement control number 70-200 as per circuit number one or replacement control number 70-201 as per circuit number eight.

Twin Volume Controls

Volume controls that provide two separate resistances on the same shaft are commonly termed twins and the Centralab replacement controls of this type represent the highest development in radio receiver volume controls. Twin controls were used on many popular receivers during 1929 and are on a majority of the 1930 receivers, since screen grid models now have such high gain per stage that a single control will seldom handle a loud local signal without excessive overloading, distortion, or cross talk. When having any of these troubles with a receiver originally equipped with a single control it will be well to replace the original with a Twin as illustrated in any of the following circuit sketches. Centralab twins have all terminals insulated from each other and from the shaft and bushing.

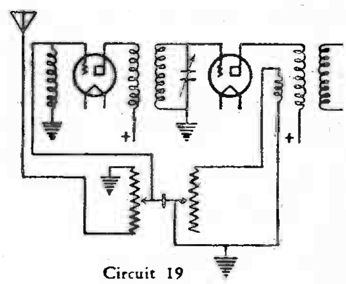
Twin—Antenna and R. F. "C" Bias



Circuit 20

A popular twin control application used on screen grid and high gain type twenty-seven receivers. The control varying the C-bias is usually connected to the cathodes of two or three R.F. tubes, although only one is illustrated. There are two variations from the connections shown in sketch number twenty, both being to the antenna potentiometer. Some sets may have the ground connected to the left terminal and the antenna connected to the center terminal which is the variable contact. Other sets may have one end of the inductance connected to the center terminal. Variations of these antenna potentiometer connections are shown by sketches 3, 4, and 5. The antenna potentiometer is the base with the shaft and bushing in it. Centralab twin replacement control number 74-601.

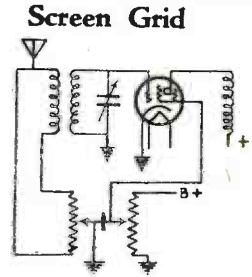
Twin—Antenna and R. F. Primary



Circuit 19

The volume control circuit used on the 1929 and early 1930 Victor receivers. The original control was a twin wire wound potentiometer. The noise and wear of this type may be eliminated by replacing the Centralab especially designed twin control part number 74-600.

Twin—Antenna and Screen Grid



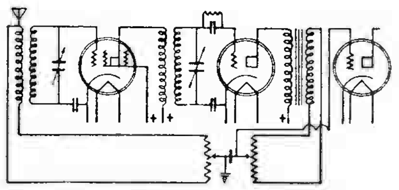
Circuit 21

This twin control has the same antenna potentiometer as the one used for circuit number twenty and the same variation of connections apply. The antenna potentiometer is the one

CENTRAL RADIO LABORATORIES

having the shaft and bushing in it The back base is also a potentiometer, used to vary the screen grid voltage of the R F. tubes. These two circuits are insulated from each other in the control. Centralab twin replacement control number 74-602. (Shaft base potentiometer 10,000 ohms. Back base potentiometer 50,000 ohms.)

Twin—Antenna and Audio Secondary

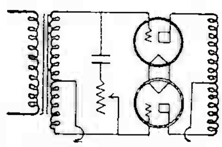


Circuit 22

This twin control reduces volume by varying the antenna input and at the same time reducing volume in the first audio stage. This has the advantage of lowering the hum level with the volume level, but is best used with a power detector circuit as otherwise that tube might overload and cause distortion on some loud signals. The shaft base is the antenna potentiometer with a maximum resistance of 10,000 ohms, and the back base the 500,000 ohm audio potentiometer. Centralab twin replacement control number 74-515.

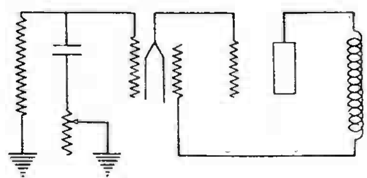
"lows." Actually boosting the "lows" is a difficult problem requiring careful engineering in the original design of the amplifier, and can seldom be accomplished with satisfaction by any attachment made later. Even when incorporated in the original design, it can have no practical advantage over a simple tone control on a full range amplifier when the tone and volume control knobs are properly adjusted.

The most widely used and simple circuit is illustrated at number 23. A Centralab one megohm Radiohm number 41-010 is shunted, in series with a fixed condenser, from grid to grid of the push pull output tubes. The condenser capacity commonly used is .01 mfd. If greater high frequency cut off is desired, use a larger capacity, such as .02 mfd., while less cut off results from a smaller capacity, such as .005 mfd.



Circuit 23

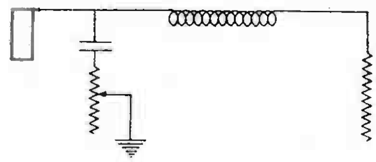
While circuit 23 illustrates a —45 output, the same parts and connections are used with a Pentode push pull, except that the condense capac-



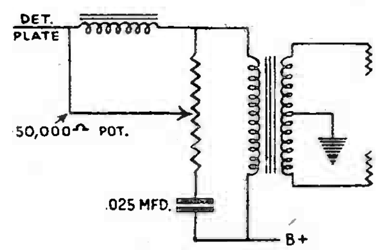
Circuit 24

ity should be about .004 mfd. The proper connection for a single Pentode is shown as circuit 24, and the same connection is used with a single —45 or —50. All of these grid circuit applications, which we recommend as best, use the same Centralab 1 megohm 41-010 control with a condenser capacity of about .01 mfd. for the —45 and about .004 mfd. for the Pentode.

Some receivers locate the tone control in the detector plate per circuit 25. Centralab number 41-050 Radiohm has the correct taper for this location, while the condenser capacity is about .05 mfd. Circuit 26, also located in the detector plate, is designed to boost the "lows" as well as cut the "highs." The inductances and



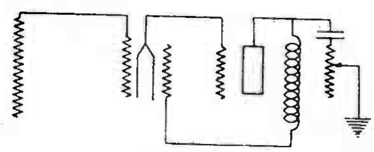
Circuit 25



Circuit 26

capacities are part of the receiver design. The control is a Centralab 72-103 potentiometer.

Some tone controls have been located in the plate circuit of the output



Circuit 27

tubes, either Pentode or —45, as shown by circuit 27. This circuit is not recommended because the high voltage and possible surges in this location may break down the condenser or the control. Where such trouble requires replacement parts, use a Centralab 41-010 located on the grid side per circuit 23 or 24.

CENTRAL RADIO LABORATORIES

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
ACME MANUFACTURING CO.			
A.C. 7	Radiohm across first srage audio secondary	Fourteen	72-105
88	Potentiometer controls screen voltage	Eleven	72-103
AERO COIL CO.			
Unit 6	Rheostat controls 201A filament circuit	Eighteen	47-006
International Short Wave	Rheostat controls 201A filament circuit	Eighteen	47-006
AERIO PRODUCTS CO.			
Aerio 7	Rheostat controls filament 3-201A R.F. tubes	Eighteen	47-006
Aerio 6	Rheostat controls filament 3-201A R.F. tubes	Eighteen	47-006
Aerio 5	Radiohm controls plate voltage of 3-201A tubes	Fifteen	70-203
Aerio 4	Rheostat controls filament 2-201A tubes	Eighteen	47-006
Aerio Short Wave Set	Rheostat controls 1-201A tubes	Eighteen	47-015
ALL AMERICAN MOHAWK CORP. (LYRIC)			
80-83-84-85-86 58	Radiohm across detector tuned circuit	Eight	70-201
60-61-62-65-66	Radiohm across detector input circuit. 227 tubes	Eight	70-201
96-90	Potentiometer across antenna coil and varying C-bias	Ten	79-006
THE AMRAD CORP.			
81	Controls screen voltage of 3-224 tubes	Eleven	72-103
70-7100	Potentiometer across aerial coupler coil	Three	72-100
84	Potentiometer shunts audio secondary	Fourteen	72-105
1928	Radiohm varies R.F. C-bias		70-205
1929	Potentiometer controls screen grid voltage	Eleven	72-103
APEX (U. S RADIO & TELEVISION)			
36	Radiohm across aerial and ground	One	70-200
80	Radiohm across aerial loading coil	One	70-201
44-46-47-41-42-48	400 ohms potentiometer controls C-bias	Thirteen	24-110
Battery Models	Radiohm control R.F. plate voltage	Fifteen	26-500
31B	Potentiometer controls antenna and C-bias	Ten	79-005
32A-32B	Potentiometer controls antenna and C-bias	Sevenreen	41-009
70	Potentiometer antenna to ground controls grid	One	70-100
R Radiotrope	Potentiometer antenna to ground controls grid	One	70-200
26	Potentiometer controls antenna and C-bias	Ten	79-006
ARBORPHONE			
45	Radiohm across primary of second R.F. tube. 226 tubes.	Two	70-200
ATCHISON RADIO			
	Potentiometer controls cathode voltage and antenna	Ten	79-006
8430	Potentiometer conttols antenna and C-bias (Switch Type)	Ten	62-100
ATWATER KENT MFG. CO.			
10-B	Potentiometer across A battery controls grids of R.F. tubes 201-A		24-110
32-33-35-48-49-12 and 20-30	Rheostat controls 2-201-A R.F. tubes, filament	Eighteen	47-015
33 Series-filament	Potentiometer across secondary of last audio transformer.	Fourteen	72-105
36	Radiohm across first and second R.F. primaries	Two	70-200
50	Rheostat controls 4-201-A tubes	Eighteen	47-006
55-55C	Potentiometer controls screen voltage and Radiohm in aerial circuit	Twenty-one	Special
60-60C 67C	Potentiometer controlling screen voltage and grid circuit of 2d R.F. tube. Dual unit	Twenty-one	Size Controls should be ordered
61-61C-66	Potentiometer in B circuit controlling screen voltage of 3-224 tubes	Eleven	direct from manufacturer
	Radiohm controls screen voltage	Eleven	72-104
	Radiohm across first stage audio secondary.	Fourteen	72-105
	Potentiometer controls screen grid voltage and potentiometer across pick-up unit	Eleven	74-616
	Potentiometer controls screen grid voltage and radiohm across R.F. secondary	Twelve	25-425

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
BREMER TULLY RADIO CO.			
7-70-7-71	Potentiometer controls C-bias of 2d R.F. tube and aerial coil	Ten	79-006
81-82-14-21-31	Controls C-bias voltage of 3-227 tubes. Power switch	Eight	70-201
8-6-40	Potentiometer across 3rd R.F. serondary stage	Eight	72-105
8-20A	Potentiometer across first stage R.F. secondary	Ten	52-202
85-36	Potentiometer controls screen grid voltage	Eleven	62-108
820-A, 821-A	Potentiometer across secondary and feedback	Eight	24-200
7A, 7B, W81	Potentiometer controls antenna and C-bias	Ten	79-006
BROWNING DRAKE (NATIONAL RADIO CO.)			
34-36-38	Radiohm across aerial and ground	One	70-200
MB30	Potentiometer controls screen grid voltage	Eleven	72-103
69	Potentiometer controls screen grid voltage	Eleven	72-100
70-71	Potentiometer shunts audio secondary	Fourteen	72-105
BRUNSWICK-BALKE-COLLENDER CO.			
3-KR8	Potentiometer in antenna circuit	Four	72-100
S-14, S-21, S-31, S-81, S-82	Potentiometer controls screen voltage. Switch type	Ten	52-202
3-5 NC 8	Potentiometer controls R.F. C-bias. Super Het	Four	72-101
2-5-KRO	Potentiometer in antenna circuit	Four	72-100
5-NO	Potentiometer controls, intermediate C-bias. Super Het.	Four	72-101
14	Radiohm varies R.F. C-bias (Switch Type)	Eleven	62-102
3N-W8	Potentiometer across aerial and ground, automatic control tube	One	72-101
S-32 Cavac	Potentiometer antenna to ground controls grid	Six	72-101
15-22-R1	Potentiometer controls antenna and C-bias	Ten	79-006
BUCKINGHAM			
1928	Radiohm shunts R.F. primary	Two	72-100
CAVAC CORP (CRESCENT)			
	Potentiometer controls antenna and C-bias	Ten	79-006
Year 1930	Potentiometer controls screen grid voltage	Eleven	62-103
Year 1929	Radiohm shunts tuned grid	Eight	70-201
	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
10 tube set	Radiohm varies R.F. C-bias	Twelve	70-202
950	Potentiometer shunts antenna primary	Four	72-100
C6, C7	Radiohm shunts tuned antenna circuit	Nine	70-201
	Potentiometer with switch controls screen voltage	Eleven	62-103
	Potentiometer controls aerial and cathode circuits (With Switch)	Ten	79-006
CLARION (TRANSFORMER CORP. OF AMERICA)			
Midget AC61	Potentiometer controls antenna and C-bias	Ten	79-006
60	Potentiometer controls screen grid voltage	Eleven	72-111
Midget 61	Potentiometer controls antenna and C-bias	Ten	72-012
CAMEO			
	Potentiometer controls antenna and C-bias	Ten	79-006
CANADIAN WESTINGHOUSE			
1928	Radiohm shunts R.F. primary	Two	70-204
20	Radiohm varies R.F. C-bias	Eleven	72-107
21	Potentiometer controls screen grid voltage	Eleven	72-110
23	Radiohm shunts tuned antenna circuit	Nine	72-105
80	Pad across aerial coil and pad control C-bias		
89, 90, 99	Radiohm varies R.F. C-bias	Twelve	70-202
110	Radiohm varies R.F. C-bias	Twelve	70-202
CLAGO RADIO			
4131, 5134, 8235, 9342	Radiohm varies R.F. C-bias	Twelve	72-108
CLEARTONE			
110	Twin control	Twelve & Fourteen	74-608
112	Potentiometer across detector secondary	Eight	72-106

Volume controls of many receivers may be replaced to best advantage with Centralab 70-200 shunted from antenna to ground regardless of the circuit location of the original control.

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
ATWATER KENT MFG. CO.—Continued			
Battery 222 tubes	Potentiometer controls screen grid voltage to R.F. tubes	Eleven	72-104
37, 38, 40, 41, 42, 43, 44, 45, 46, 47, 52, 53, 56, 57,	Potentiometer across aerial and ground	Three	72-112
67	Potentiometer shunts audio secondary	Fourteen	72-104
	Potentiometer antenna to ground controls grid	Six	72-101
	Twin: * Potentiometer shunts antenna primary; * potentiometer controls screen grid voltage	Twenty-one	25-425
	Twin: Potentiometer controls screen grid—Potentiometer connected across pickup		74-516
H2	Radiohm across grid of 1st I.F. stage—Potentiometer controls screen grid voltage of R.F. stage	Eight & Eleven	74-609
70, 74, 75, 76,	Potentiometer shunts antenna primary		
72	Super Het radiohm control grid and grd, 1st R F and I F		
	Midget		
84, 12	Radiohm varies R.F. C-bias	Twelve	72-109
AUDIOLA RADIO CO.			
30-B, 7330	Potentiometer controls screen voltage.	Eleven	72-103
31, 62, 72 82	Potentiometer controls antenna and C-bias	Ten	79-005
AUTOMATIC ELECTRIC CO.			
Tom Thumb Model B	Potentiometer controlling C-bias.	Thirteen	24-110
BALDWIN			
Hube	Potentiometer controls cathode voltage and antenna	Ten	79-006
BALKITE (FANSTEEL MFG. CO.)			
A3-A4-A5-A7	Potentiometer across B supply. Controls plate voltage of 3-227 tubes	Sixteen	72-103
Model F-C	Potentiometer in antenna circuit and C-bias control	Ten	79-006
Model C	Potentiometer controls C-bias and antenna.	Ten	79-006
BELMONT			
	Potentiometer controls screen grid voltage	Eleven	72-103
BOSCH (AMERICAN-BOSCH MAGNETO CORP.)			
49	Potentiometer across antenna and ground	Four	72-100
54-48-56	Potentiometer controlling screen voltage and	Twenty-one	74-602
28-29	Potentiometer across antenna and ground	Seven	72-102
96	Radiohm across detector secondary	Eight	70-201
146-166-176-46-66-96-107-126-116-136	Radiohm across detector secondary	Eight	70-201
	Radiohm across aerial coupler	Nine	72-102
	Radiohm across first stage detector secondary	Eight	70-201
	Radiohm across detector secondary	Eight	72-106
28	Potentiometer across aerial and ground 226 tubes	Four	72-102
35 battery set	Rheostat in filament lead	Eighteen	47-006
48	Potentiometer across aerial and potentiometer controls screen grid voltage	Twenty-one	74-602
54 D.C.	Potentiometer controls aerial and cathode voltage	Ten	72-102
58	Potentiometer controls R.F. C-bias	Thirteen	72-108
60	Potentiometer shunts audio secondary	Fourteen	72-105
5A-58, 73A-73B	Potentiometer controls antenna and C-bias	Ten	79-006
BUSH & LANE			
10	Potentiometer controls R.F. plate voltage	Sixteen	72-103
12	Potentiometer controls screen voltage	Eleven	72-103
BRANDES RADIO	(See Kolster Radio. Models and controls are the same.)		

Volume controls of many receivers may be replaced to best advantage with Centralab 70-200 shunted from antenna to ground regardless of the circuit location of the original control.

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
COLONIAL RADIO CORP.			
26	Rheostat controls R.F. tubes. 5-201A tubes	Eighteen	47-003
S.G. 32	Controls C-bias voltage and aerial coil	Twenty	74-601
D.C. 31	Rheostat controls filament of R.F. tubes	Eighteen	47-020
COLUMBIA RADIO CORP.			
961-902-C-11	Potentiometer across aerial coil which is inductively coupled	Seven	72-102
C4-980-K24-C1-C3-C2	Radiohm across first R.F. secondary coil	Nine	70-201
S.G. 8	Potentiometer controls aerial and cathode circuits	Ten	79-006
C-5, C-6, C-7, SG-5 SG-7	Radiohm shunts tuned grid	Eight	70-201
SG-9, AC-950	Potentiometer shunts antenna primary	Three	72-100
COURIER RADIO (UNITED REPRODUCERS CORP.)			
653	Potentiometer Controls C-bias	Twelve	72-107
CROSLEY RADIO CORP.			
40S-41S-42S-43S-82S Late Model	2 Potentiometers 15M in antenna circuit and 25M screen voltage. Dual unit	Twenty-one	72-102
60S-61S-62S D.C.	Potentiometer controlling screen voltage	Eleven	72-103
3R3-401-90-601	Rheostat controls filament voltage	Eighteen	47-006
608-704-705-706-609-610	Potentiometer across aerial coil	Three	72-100
Roamio	Radiohm controls detector plate		72-107
Chum & Buddy	Radiohm controls C-bias	Twelve	70-202
	Potentiometer controls screen grid voltage	Eleven	72-104
804 A.C.	Radiohm controls C-bias	Twelve	70-202
20-21-22	Radiohm controls C-bias	Twelve	70-202
30S-31S-33S-34S	Potentiometer controls screen voltage	Eleven	72-103
602-41A and 42AC	Potentiometer across antenna and ground	Three	72-100
40S-41S	2 Potentiometers 15M in antenna circuit and 25M screen voltage. Dual unit	Twenty-one	74-601
84	Potentiometer shunts audio secondary	Fourteen	72-105
53, 54, 57, 120	Potentiometer controls antenna and C-bias	Ten	79-006
71A	Spec. Control		70-503
20	Radiohm shunts tuned grid	Eight	70-201
22, 23	Potentiometer shunts antenna primary	Three	72-100
76-DC-77 400, 410, 420	Radiohm varies R.F. C-bias	Twelve	24-110
Midget Wigit 48	Potentiometer controls antenna and C-bias	Ten	79-006
Johnny Smoker Buddy Boy 54 Super Buddy 122	Potentiometer controls antenna and C-bias	Ten	72-101
124	Potentiometer Controls C-bias and Antenna (Switch Type)	Ten	62-109
DAYFAN (GENERAL MOTORS RADIO CORP.)			
6 AC	Potentiometer controls R.F. plate and across 1st stage A.F. primary	Fourteen	72-111
72	Radiohm shunts tuned grid	Eight	70-200
5091-48	Radiohm across aerial and ground 226 tubes	One	70-200
8 A.C.	Potentiometer across aerial and ground 226 tubes	Four	72-102
Oem 74-54	Rheostat controls 3-201A R.F. and audio tubes	Eighteen	47-006
8 A.-C.	Potentiometer across aerial coil. 226 tubes	Three	72-100
6-DC-32-DC-110-6 M. G.	Potentiometer controls plate voltage to 3-201A R.F. tubes	Sixteen	72-103
DAYTON RADIO CO.			
XL70, XL60, XL30	Radiohm varies R.F. plate voltage	Fifteen	70-203
XL50	Radiohm varies R.F. plate voltage	Fifteen	72-111
A.C. XL61	Radiohm varies R.F. plate	Fifteen	26-500
A.C. Dayton	Controls C-bias voltage to 5-227 tubes	Twelve	70-202
A.C.-63-65-66	Radiohm across R.F. secondary 226 tubes	Eight	72-101

CENTRAL RADIO LABORATORIES

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
DEFOREST CROSLEY RADIO CORP.			
DeForest	Potentiometer from A+ to A—		24-110
700	Potentiometer controls screen voltage to R.F. tubes	Eleven	72-103
800-810	Potentiometer in A.F. secondary circuit	Fourteen	72-105
	Potentiometer controls screen voltage	Eleven	72-103
750-800-810	Connected in audio secondary circuit	Seventeen	41-010
605	Potentiometer across detector R.F. secondary	Eight	72-012
Tone Control	Connected in audio secondary circuit	Seventeen	41-009
DIAMOND COIL CO.			
Diamond of Air	Radiohm controls C-bias to 222 tubes	Twelve	70-202
EARL RADIO CORP.			
33S	Twin control	Twenty	74-601
31DC-24DC-33DC	Twin control	Nineteen	72-106
31-32-21-22-41	Twin control—2 controls	Twelve & Fourteen	25-416
315, 371	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
271	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	76-006
ECHOPHONE RADIO MFG. CO.			
5 S, E, F Midget	Radiohm varies R.F. C-bias	Twelve	79-006
S3, S4, S5	Potentiometer controls antenna and C-bias	Ten	79-006
THOS. A. EDISON, INC.			
R-122	Potentiometer used in first R.F. stage	Five	72-101
R-4, R-5	Potentiometer across antenna and ground and R.F. bias	Twenty	74-601
C-4	Potentiometer across antenna and ground and R.F. bias	Twenty	74-601
R-1, R-2 Chassis, Jr., and Jc. 60 Cycles and 25 Cycles	Radiohm across primary of second R.F. stage (Spec.)	Two	24-008
C-1 Chassis Sc.	Radiohm across primary of second R.F. stage (Spec.)	Two	24-008
R4, R5 DC	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
R6, R7	Potentiometer shunts audio secondary	Fourteen	72-105
250	Radiohm shunts R.F. primary	Two	70-200
ELECTRICAL RESEARCH LABORATORIES (ERLA)			
R-1	Potentiometer across aerial and ground	Three	72-100
224-A.C.	Potentiometer controls screen voltage	Thirteen	72-110
	Potentiometer controls antenna and C-bias (Switch Type)	Eleven	62-104
R61, S61	Potentiometer controls screen grid voltage (Switch Type)	Eleven	62-111
271	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	76-006
	Potentiometer shunts audio secondary	Fourteen	51-105
	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	74-602
224	Potentiometer controls screen grid voltage	Eleven	72-110
EMERSON			
Emerson	Potentiometer controls antenna and C-bias	Ten	79-006
EVEREADY (NATIONAL CARBON CO.)			
All Series 50	Controls C-bias and grid of first R.F. Stage Secondary	Twenty	74-503
1, 2, and 3	Potentiometer across R.F. secondary	Eight	72-106
Series 30, 40	Potentiometer to control C-bias	Eleven	See P. 6
31	Radiohm controls cathode voltage	Twelve	70-202
FADA (F.A.D. ANDREA, INC.)			
16-17-32	Potentiometer control C-bias voltage to 2-227 tubes	Thirteen	72-111
18 D.C.	Potentiometer connected across aerial coil. Arm goes to ground	Four	74-601
S.F. 45/75 UA or CA	Radiohm across secondary of 2d R.F. transformer 227 tubes	Eight	70-201

Volume controls of many receivers may be replaced to best advantage with Centralab 70-200 shunted from antenna to ground regardless of the circuit location of the original control.

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
GENERAL MOTORS RADIO CORP. (See Day Fan)			
120A	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-602
	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-602
	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-517
	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	74-514
All 1930	Twin potentiometer controls antenna and screen grid		74-602
	Tone control—Spec. Shaft Length		70-019
GILFILLAN RADIO CO.			
10	Potentiometer controlling C-bias to 4-227 tubes and aerial	Ten	79-006
100	Potentiometer across primary of first R.F. transformer	Five	72-100
60	Radiohm controls plate voltage to last stage R.F. tubes	Fifteen	70-203
	Potentiometer controls screen grid voltage	Eleven	72-102
44	Potentiometer controls screen grid voltage	Eleven	72-103
GRAYBAR			
311, 700, 770 900	Radiohm varies R.F. C-bias	Twelve	72-109
A. H. GREBE & CO., INC.			
SK-4, A.C. early and late models	Potentiometer controls C-bias. Radiohm across primary of last R.F. stage	Twenty-two	74-515
SK-4 D.C.	Radiohm controls grid bias	Twelve	70-202
MU-1	Rheostat controls filaments of 201A R.F. tubes	Eighteen	47-006
MU-2	Double resister in rheostat base and controls R.F. and audio tubes	Twenty-two	74-515
No. 5	Rheostat controls filament of R.F. tubes which are 201A	Eighteen	47-006
AC 7, 428 AC 6	Radiohm connected across primary of last R.F. stage	Two	70-200
GULBRANSEN (WELLS GARDNER & CO.)			
Model C 1929	Potentiometer across antenna and ground and Potentiometer controlling grid of first audio. Dual control	Twenty-two	74-509
1930	Twin Control. Controls aerial and screen grid	Twenty-one	74-603
HALLDARSON			
Halldarson	Radiohm connected across aerial coil	One	70-200
HAMMARLUND MFG. CO.			
H.I.Q 30	Potentiometer controls screen voltage 3-224 tubes	Eleven	72-103
H.I.Q 29	Potentiometer across aerial and ground	Four	72-101
HIGH FREQUENCY LABORATORIES			
Mastertone	Potentiometer controlling screen voltage of 224 tubes	Eleven	72-103
H.F.L. Super	Potentiometer controls screen voltage to 3-222 tubes	Eleven	72-103
HOLMES JORDAN			
A.C.	Potentiometer controls C-bias voltage and antenna	Ten	79-006
Battery	R.F. plate circuit radiohm	Fifteen	70-203
HOLLISTER			
AC 8	Potentiometer controls screen voltage of intermediate stages	Eleven	72-103
A.C. 8	Potentiometer controls aerial input and cathode	Ten	79-006
HOWARD			
	Potentiometer controls screen grid voltage	Eleven	72-104
SGA	Twin radiohm controls C-bias voltage and potentiometer across aerial and ground	Twenty	74-601
35AC	Radiohm varies R.F. C-bias. (Ground Type.)	Twelve	70-202
	Twin Potentiometer shunts antenna primary; Potentiometer shunts audio secondary	Three & Fourteen	74-602
8	Radiohm shunts antenna to ground	One	72-101
	Radiohm varies R.F. C-bias	Twelve	72-113

Volume controls of many receivers may be replaced to best advantage with Centralab 70-200 shunted from antenna to ground regardless of the circuit location of the original control.

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
FADA (F.A.D.) ANDREA, INC.)—Continued			
50-70-71-72	Radiohm across secondary of 2d R.F. transformer 227 tubes	Eight	70-201
75-77	Potentiometer controlling screen voltage of 3-224 tubes	Eleven	72-103
10-11-30-31	Radiohm across 2d R.F. secondary coil	Eight	70-201
22 D.C.	Rheostat in filament circuit	Eighteen	47-006
35 and 35Z	Potentiometer controlling screen grid voltage	Eleven	72-103
35B	Twin control	Twenty-one	74-602
	Potentiometer controls screen grid voltage	Eleven	72-111
41, 42, 44, 46, 47	Potentiometer shunts audio secondary	Fourteen	72-105
43	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-604
	Potentiometer controls antenna and C-bias	Ten	79-006
35C	Twin potentiometer across aerial and ground controls C-bias voltage	Twenty	72-111
20-20Z	Potentiometer controlling C-bias	Twelve	79-006
	Potentiometer across aerial and ground and potentiometer in C-bias circuit	Twenty	76-007
25-25Z	Potentiometer controls cathode voltage	Twelve	72-106
FEDERAL RADIO CORP.			
Type E 10	Potentiometer controls R.F. plate voltage (Switch Type)	Sixteen	20-053
Type M	Radiohm controls grid of second R.F. stage	Eight	70-201
Type L	Potentiometer varying C-bias voltage to 3-224 tubes and Potentiometer across detector secondary	Eight	74-514
Type D-BA	Potentiometer A— to B70+ controlling plate voltage to 2-201A tubes	Sixteen	24-064
Type H	Potentiometer controlling grid of volume control tube	Fourteen	72-105
E	Potentiometer controls plate voltage	Sixteen	70-203
FREED EISEMANN			
NR-70, NR-57	Potentiometer connected across aerial coupler	Four	72-100
NR 80 DC	Radiohm connected across aerial coupler	One	70-200
NR 95	Radiohm controlling C-bias to 4-227 tubes	Twelve	70-202
NR5-11-FE18-F-10, NR-7, NR-30, 32, 40, 48, 50	Rheostat to control filament	Eighteen	47-006
470	Radiohm shunts antenna to ground	One	70-200
90SAG-NR657, NR879	Potentiometer across first stage R.F. secondary and radiohm controls cathode voltage	Twenty	74-506
NR 60	Radiohm shunts tuned grid	Eight	70-201
CHAS. FRESHMAN CO.			
L-LS-G60S	Potentiometer across first stage audio secondary	Fourteen	51-105
Equaphase	Rheostat controls 2-201A R.F. tubes	Eighteen	47-006
H-M-K-K60S	Potentionmeter across first stage audio secondary	Fourteen	51-105
N-12, N-17,	Radiohm across aerial and ground	One	51-200
Q15-G-QD16	Potentiometer across first R.F. secondary and radiohm controls C-bias voltage	Twenty	74-506
31-32	Radiohm controls C-bias to 227 tubes	Twelve	70-202
21AC-22	Potentiometer across first R.F. secondary and potentiometer across last stage R.F. primary	Twelve & Fourteen	25-416
G	Radiohm shunts antenna to ground	One	70-204
GALVIN			
	Potentiometer controls antenna and C-bias (Switch Type)	Ten	62-102
	Radiohm varies R.F. C-bias	Twelve	70-202
	Potentiometer controls cathode voltage	Twelve	70-202
GAROD			
Garod E-A	Potentiometer across secondary of last A.F. transformer	Fourteen	72-105
GENERAL ELECTRIC			
H31, H51, H71	Radiohm varies R.F. C-bias	Twelve	72-109
T41	Twin: Potentiometer shunts antenna; Potentiometer controls screen grid	Twenty-one	74-526

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
JACKSON BELL			
62	Potentiometer controls antenna and C-bias	Ten	72-101
KELLOGG SWITCHBOARD & SUPPLY CO.			
	Potentiometer shunts antenna primary	Three	72-100
533, 534, 535, 536	Potentiometer controls R.F. C-bias	Thirteen	72-103
	Potentiometer controls screen grid voltage	Eleven	72-103
K24-25-27-28	Potentiometer B supply controls cathode voltage	Ten	79-006
523-526	Potentiometer across aerial and ground and automatic volume control tube	Four	72-103
523-526	Automatic volume control	Fourteen	72-105
KENNETH HARKNESS CO.			
Harkness AC 7	Potentiometer in aerial and grid circuit of first R.F. tube	Ten	79-006
Harkness AC 7	Potentiometer in audio circuit	Fourteen	72-105
COLIN B. KENNEDY CORP.			
Royal 80	Potentiometer across secondary of first audio transformer	Fourteen	72-105
Model 10	Potentiometer controls plate voltage to 3-227 R.F. tubes	Sixteen	76-008
Model 20, 20B	Potentiometer controls screen grid voltage	Eleven	76-008
220	Rheostat controls filament voltage	Eighteen	47-006
1930	Combination twin control	Twenty-one	76-008
30, 32	Potentiometer controls screen grid voltage	Eleven	72-111
42, 526, 826	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	74-602
826 Short wave	Potentiometer controls screen grid voltage	Eleven	72-100
826 Short wave	Radiohm used as tone control	Seventeen	72-103
KR15	Radiohm shunts antenna to ground	One	72-101
12 S.G.	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	76-008
KING ELECTRIC CO.			
53	Potentiometer controls antenna and C-bias	Ten	79-006
SGA	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
10 KI, 25, 71	Rheostat R.F. stages in filament circuit	Eighteen	47-006
E-80-81-FGH 218	Potentiometer across aerial and ground	Four	72-100
82	Radiohm across 2nd R.F. primary	Two	70-204
J & H, 1929	Radiohm across aerial coil	One	70-200
9798, Monarch	Potentiometer across aerial and controls C-bias	Ten	51-010
KOLSTER RADIO CORP.			
1928	Radiohm connected across primary of last stage R.F. 226.		
K28-24-2-23-20-22-25-27	Radiohm across primary of third R.F. tube—226 tubes	Two	70-200
15 and 16	Potentiometer across aerial coil	Seven	72-102
8-A 44-K-42-43-45	Rheostat controls R.F. filament	Eighteen	47-003
1929 1930 Models	Twin Potentiometer controls screen grid voltage and antenna	Twenty-one	76-006
40, 60, 7K	Radiohm shunts tuned grid	Eight	70-201
21	Radiohm shunts tuned grid	Eight	70-204
1924-1925	Radiohm varies R.F. plate voltage	Fifteen	70-203
6K-7	Radiohm shunts antenna to ground	Two	72-100
LINCOLN ELECTRIC CO.			
Lincoln 8-80	Potentiometer controls screen voltage to 3-222 tubes	Eleven	72-103
Lincoln 40	Controls C-bias voltage to 2-224 tubes in intermediate	Twelve	70-202
LYRIC (MOHAWK RADIO LTD.)			
90	Potentiometer across antenna and ground to cathode. Single unit	Ten	79-006
D-L	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
H			70-201
280	Radiohm across detector secondary		
B94	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage		74-602

CENTRAL RADIO LABORATORIES

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
LYRIC (MOHAWK RADIO LTD.)—Continued			
Heterodyne	Potentiometer controls R.F. C-bias	Thirteen	72-101
Heterodyne	Tone control, Radiohm in series with condenser between 2 grids or grid to ground	Seventeen	72-106
714AC, 742AC	Radiohm varies R.F. C-bias	Twelve	72-108
712, 722, 39, 41	Potentiometer controls screen grid voltage	Eleven	72-111
MAGNOVOX COMPANY			
Magnovox	Rheostat controls filament voltage	Eighteen	47-003
MAJESTIC (CRICSBY GRUNOW CO.)			
60-70, 70B-80	Potentiometer across fixed condenser in aerial circuit		72-100
181	Radiohm controls C-bias voltage of 3-227 and one unit across pick-up		74-618
90-91-92	Radiohm in C-bias circuit connects in series with equalizer controlling 3-227 tubes	Twelve	70-202
130	Potentiometer in divider circuit controls cathode voltage R.F. tubes	Twelve & Fourteen	72-107
100b	Radiohm in C-bias circuit and potentiometer across pick-up of secondary	Twelve & Fourteen	74-612
180-181-90-91-92	Equalizer on condenser shaft (Spec.)		78-007
100B	Radiohm varies R.F. C-bias and Equalizer	Twelve	74-612
50, 51, 52	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-603
30, 31, 131, 132, 233	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-537
90B	Radiohm varies R.F. C-bias	Twelve	70-202
60, 61, 62, 163	Potentiometer controls R.F. C-bias		72-107
Midget 20, 21, 22, 23	Radiohm varies R.F. C-bias (Switch Type)	Twelve	62-004
1930 Midget Super	Antenna potentiometer and C-bias	Twenty	74-603
MANAFORMER			
A.C. 29	Radiohm controls cathode voltage	Twelve	70-202
MASTER RADIO MFG. CO., LTD.			
424 Midget	Potentiometer controls antenna C-bias	Ten	79-006
METRO			
	Radiohm across aerial and ground	One	70-200
McMILLAN			
900	Radiohm across aerial coil choke	One	72-100
MONTGOMERY-WARD			
Screen Grid	Potentiometer controlling C-bias and antenna	Ten	79-006
2822, 2827, 3035, 3037, 3065, 3067	Potentiometer controls antenna and C-bias	Ten	79-006
2895, 2897	Potentiometer controls R.F. C-bias	Thirteen	24-110
2955, 2957	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-606
Battery set	Potentiometer controls antenna and C-bias	Ten	79-006
NATIONAL TRANSFORMER MFG. CO.			
Mantel	Potentiometer controls antenna and C-bias	Ten	79-006
OZARKA RADIO CORP.			
	Radiohm across aerial and ground and C-bias potentiometer	Twenty	74-601
	Potentiometer controls screen grid voltage	Eleven	72-103
Lincoln Super	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
31	Radiohm varies R.F. C-bias	Twelve	74-202
DC8	Potentiometer controls screen grid voltage	Eleven	72-103

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Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
RCA (RADIO CORP. OF AMERICA)—Continued			
80, 82, 86	Radiohm varies R.F. C-bias	Twelve	72-109
42, 48	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	74-524
14	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	74-601
Midget	Radiohm varies R.F. C-bias	Twelve	72-109
16-20-25-28-30-32	Rheostat controls filament voltage	Eighteen	47-003
Radiola 17-18-33			
Radiola	Potentiometer across aerial circuit	Six	72-101
41 Radiola	Potentiometer across aerial and ground	Four	72-100
50-51 Radiola	Potentiometer controls aerial circuit	Four	72-100
60-62 Radiola	Potentiometer controls C-bias of two intermediate stages	Thirteen	72-000
64 Radiola	Automatic control tube. Potentiometer across aerial and ground	Four	72-100
66 Radiola	Radiohm controls C-bias voltage of 3-227 tubes	Twelve	70-202
RADIO NEWS ELCO BATTERY SET			
Elco	Potentiometer controls screen voltage of 3-224 tubes	Eleven	72-104
REMLER MFG. CO.			
111	Controls screen voltage of 3-224 tubes	Eleven	72-103
SCOTT SUPER			
Scott Super	Rheostat controls 3-222 filament circuits	Eighteen	47-003
AC10	Radiohm varies R.F. C-bias	Twelve	70-202
SEARS-ROEBUCK			
53, Silvertone 100	Potentiometer controls antenna and C-bias	Ten	51-010
FG, H, J, F, G	Radiohm shunts antenna to ground	One	30-200
Screen Grid	Potentiometer controlling C-bias and antenna	Ten	51-010
SENTINEL (UNITED AIR CLEANERS)			
	Radiohm shunts antenna to ground	Sixteen	72-100
29-30	Potentiometer controlling R.F. C-bias and antenna	Ten	79-006
11, 10, 12, 15, 16, 8, 9, 440, 660, 104, 666C, 106	Potentiometer controls antenna and C-bias	Ten	79-006
Portrola 3	Potentiometer across antenna and C-bias (Switch Type) (Spec.)		44-059
Midget 108	Radiohm varies R.F. C-bias	Twelve	72-113
SILVER-MARSHALL CO.			
34A, 35, 36A	Potentiometer controls R.F. C-bias	Thirteen	72-108
710 Sargent	Potentiometer controls screen grid voltage	Eleven	72-103
Rayment Seven S-M-690	Potentiometer across secondary of input transformer	Fourteen	72-105
Theater Amp. S-M-740 and 740 A.C. Coast to Coast	Potentiometer controls C-bias	Thirteen	24-110
S-M-730 Around the world 4	Radiohm in cathode circuit	Twelve	70-202
S-M-9 tube set	Potentiometer controls screen voltage of 3-222 tubes	Thirteen	72-108
30	Potentiometer controls screen voltage of 3-224 tubes	Thirteen	72-108
SONORA MFG. CO.			
A-30, A-32	Radiohm across primary of third R.F. transformer	Two	70-200
B-31	Potentiometer to vary screen voltage	Eleven	72-108
A-36, A-44	Radiohm across primary of fourth R.F.	Two	70-200
A-40	Radiohm across primary of third R.F.	Two	70-200

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Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
PEERLESS (UNITED PRODUCERS)			
Peerless Electrostatic	Potentiometer shunted across first audio stage	Fourteen	72-105
65	Radiohm in cathode circuit controls C-bias	Twelve	70-202
K-70	Potentiometer across aerial coil and controls cathodes	Ten	79-006
PHILCO			
No. 40	Potentiometer controls R.F. C-bias	Thirteen	24-110
41, 220A	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Fourteen	74-603
20, 20A, 220	Potentiometer across aerial coil		
1, 2, 3	Radiohm shunts tuned antenna circuit	Nine	72-106
82, 83	Potentiometer shunts antenna primary	Three	72-100
3 Transitone	Radiohm varies R.F. C-bias	Twelve	72-106
92, 95, 95A, 95E, 96E, 96, 296, 296A, 111, 211, 11A, No. 3, 30, Superheterodyne	Potentiometer shunts audio secondary	Fourteen	72-105
Midget Baby Grand	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-603
82-83-86-87	Potentiometer connected across aerial coil	Four	72-100
Series 5	Radiohm across aerial and ground	One	70-200
65	Potentiometer controls screen voltage of R.F. tubes 224	Eleven	72-103
95-96-96A 296-296A	Potentiometer controls grid of first A.F. and automatic control tube	Fourteen	72-105
Philco 76	Potentiometer to vary grid bias	Thirteen	24-110
41-77-77A	Twin control	Twenty	74-602
511-512-513-514-515-531-551-571	Potentiometer across aerial coil	Four	72-100
PHONIX RADIO			
Midget 31, 32	Potentiometer controls antenna and C-bias (Switch Type)	Ten	62-102
PIERCE-AIRO (UNITED SCIENTIFIC)			
724, 727	Potentiometer controls antenna and C-bias	Ten	79-006
732 DC	Potentiometer shunts antenna primary	Three	72-100
624, 747	Radiohm varies R.F. C-bias	Twelve	72-110
PATTERSON			
	Radiohm across aerial and ground	One	70-200
PILOT ELECTRIC CO.			
P.E. 6	Potentiometer controls screen grid voltage	Eleven	72-103
Pilot 5	Radiohm controls 2-201A tubes plate voltage	Fifteen	70-203
POWRAD			
Powrad	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twenty	74-601
	Potentiometer controls screen voltage	Eleven	72-103
RADIETTE			
F14	Potentiometer controls antenna and C-bias	Ten	72-100
RADIO FINANCE			
	Potentiometer controls antenna and C-bias	Ten	79-006
R. C. A. (RADIO CORP. OF AMERICA)			
Victor 60	Potentiometer controls R.F. C-bias	Thirteen	24-110
15, WR4	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	74-526
Radio Royal 21, 22, B2	Potentiometer controls screen grid voltage	Eleven	72-103
Radiola RE17, RE57, R35, R39, RE34	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Twelve	74-524

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
SPARKS WITHINGTON CO. (SPARTON)			
49B-39	Radiohm in R.F. plate circuit	Fifteen	70-203
931, 301 D.C., 301 AC. A.C. 89 and 89A, 930, 109-235	Radiohm controls C-bias voltage	Twelve	70-202
AC62-63-7 Kellogg tubes	Radiohm in C-bias circuit	Twelve	70-202
SPARTON			
589 or	Radiohm varies R.F. C-bias	Twelve	72-110
589	Radiohm varies R.F. C-bias	Twelve	72-113
31, 55, 101, 103, 110, AR19	Radiohm controls screen voltage of R.F.	Thirteen	70-203
235, 235DC	Potentiometer controls screen grid	Thirteen	72-103
111, 111A, 564, 570, 574, 589, 591, 593, 600, 610, 620, 600DC, 620DC, 737, 740, 750, 740DC, 750DC, 870	Radiohm controls C-bias	Twelve	70-202
SPLITDORF RADIO CORP.			
P.A.D. No. 4 M5	Potentiometer shunts R.F. primary	Two Shaft 2⅜, Bush ½	24-008
C1	Potentiometer across detector tuned stage	Eight	70-201
R4-R5-C4	Radiohm controls C-bias voltage of 2-227 tubes and aerial circuit. (Dual unit.)	Twenty	74-601
ES-62	Radiohm used in second and first R.F. stages	Two	24-008
STEIN RADIO			
	Potentiometer controls antenna and C-bias	Ten	79-006
STEINITE MFG. CO.			
Superheterodyne	Potentiometer controls antenna and C-bias		51-012
30	Potentiometer controls R.F. C-bias	Thirteen	24-110
261	Radiohm across primary of second R.F. tube	Two	70-200
40-50-102	Radiohm controls C-bias to 3-227 tubes	Twelve	70-202
X927AC990	Rheostat in series with filaments of 199 tubes	Eighteen	47-125
991-992-993	Radiohm controls plate voltage to R.F. tubes	Fifteen	70-203
STERLING			
3A-4	Potentiometer controls screen voltage	Eleven	72-103
A2	Potentiometer controls aerial input and cathode voltage	Ten	79-006
Model F	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	74-602
STEWART WARNER CORP.			
R100 DC	Potentiometer controls screen grid voltage	Eleven	51-102
970, 980	Twin: Potentiometer shunts antenna primary; potentiometer controls screen grid voltage	Twenty-one	74-616
110 series	Potentiometer across aerial coil and controls screen voltage	One-Thirteen	28-031
300 to 500	Rheostat used in filament circuit	Eighteen	47-006
500-520-525	Radiohm in plate circuit of 3-201A tubes	Fifteen	70-203
530-535	Radiohm in L and C circuit of second R.F. tube 226 tube	Eight	70-201
700-705-710	Radiohm in plate circuit of 3-201A tubes	Fifteen	28-031
715-720	Radiohm across aerial coil 226 tube	One	70-200
750.	Potentiometer controls L and C circuit of second R.F. and platefeedback circuit of next R.F. tube. Single unit	Requires control of smaller size than standard replacement unit.	

CENTRAL RADIO LABORATORIES

Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
STEWART WARNER CORP.—Continued			
801-802	Potentiometer controls L and C circuit of 2d R.F. and aerial coil 226 tube. Single unit	One	72-100
806	Radiohm controls plate voltage to 3-201A tubes	Fifteen	70-203
811	Radiohm controls R.F. C-bias	Twelve	70-202
900 Series	Radiohm controls C-bias to 3-227 tubes	Twelve	70-202
950 Series	Potentiometer controlling screen voltage of 3-224 tubes and series aerial resistance in one unit. Single unit		28-031
305-315-320	Potentiometer across A Battery controls C-bias to 2-201A tubes in R.F. circuit		24-110
300-310-325	Potentiometer across aerial coil controlling C-bias to 2-224 tubes	Ten	79-006
363	Radiohm across antenna and ground	One	70-200
STROMBERG-CARLSON CO.			
501-502	Rheostat controls 2 R.F. 201A filament circuits	Eighteen	47-006
1A-1B-501-502-523-524DC-635-636-638	Potentiometer across aerial coil and radiohm across primary of last R.F. stage. 2 single controls	Four-Two	72-100
641-652-654	Potentiometer across inductive coupled aerial coil and Potentiometer controlling C-bias voltage to 2-224 tubes. Dual unit	Twenty	74-001
10-11	Potentiometer in grid circuit of R.F. tubes	Twelve	72-107
523, 524DC	Potentiometer controls plate voltage	Sixteen	72-103
12, 14	Potentiometer shunts audio secondary	Fourteen	72-105
L41A	Potentiometer shunts antenna primary	Three	72-102
846-642	Potentiometer across antenna and ground	Four	72-100
Automatic volume control	Potentiometer across audio secondary	Fourteen	72-105
TEMPLE CORP.			
8-60, 8-80, 8-90	Radiohm across antenna and ground	One	70-200
8-61, 8-91, 8-81	Potentiometer across aerial coil and potentiometer across first stage audio secondary	Twenty-two	74-515
Battery set	Potentiometer shunts audio secondary	Fourteen	72-105
THOMAS ENGINEERING			
	Potentiometer controls screen grid voltage	Eleven	72-100
TRAVELER			
C, DX, K	Potentiometer controls antenna and C-bias	Ten	79-006
	Potentiometer controls screen grid voltage	Eleven	51-103
	Potentiometer controls screen grid voltage	Eleven	72-103
TYRMAN RADIO CO			
Tyrman 60	Rheostat controls filament voltage to 2-222 intermediate tubes	Eighteen	47-006
Tyrman 72-80	Radiohm controls C-bias to 2-222 intermediate tubes	Twelve	70-202
UNITED STATES RADIO & TELEVISION CO.			
Apex 36	Radiohm across aerial and ground	One	70-200
Panatrope 1929	Potentiometer shunts antenna primary	Two	72-100
Midget 27, 32	Potentiometer controls antenna and C-bias	Ten	51-010
UNITED STATES ELECTRIC CORP.			
Workrite 6-8	Rheostat controls second R.F. 201A tubes	Eighteen	79-201
VICTOREEN RADIO CO.			
Victoreen Super	Potentiometer controls C-bias to 3-201A tubes in intermediate stages	Twelve	24-111
Victoreen A.C.	Radiohm controls C-bias to 3-227 intermediate tubes	Twelve	70-202

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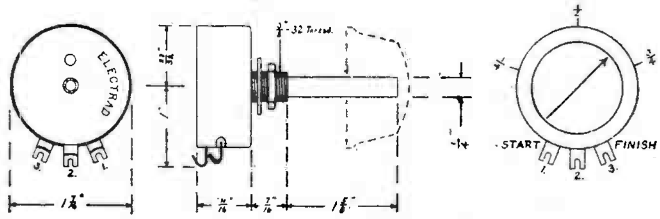
Model No.	Volume Control Circuit	Circuit No.	Replacement Control No.
VICTOR RCA CORP.			
1929 & 1930: R 32, R 52, RE 45, RE 75, RE 154			
	Resistor across aerial coil and losser coil in second stage R.F. transformer	Nineteen	74-600
1930: Screen grid battery set			
	Potentiometer controls screen voltage	Eleven	72-103
Four Circuit—R15, R17			
	Twin, controlling screen grid and antenna	Twenty-one	74-526
Five Circuit—R35, R39, RE57			
	Twin, controlling C-bias and antenna	Twenty	74-524
WALBERT			
27	Plate Circuit Radiohm	Fifteen	70-203
WARE			
T	Rheostat controls filament	Eighteen	47-006
WELLS GARDNER			
1929-30	Potentiometer controls C-bias and shunts antenna	Ten	79-006
1929	Twin radiohm controls carhode volrage and radiohm aerial and ground	Twenry	74-601
1928-29 type, 226 tubes	Radiohm shunts antenna to ground	One	70-204
80A	Radiohm varies R.F. C-bias (Switch Type)	Twelve	52-205
80	Potentiometer controls antenna and C-bias	Ten	79-006
WESTINGHOUSE			
WR5-WR6 WR7	Radiohm varies R.F. C-bias	Twelve	72-109
WR4	Twin: Potentiometer shunts antenna primary; Potentiometer controls screen grid voltage	Twenty-one	74-526
WURLITZER			
1929-7 tube	Potentiometer across aerial and ground and controls C-bias	Ten	79-006
ZANEY-GILL			
54. Queen Anne, Music Box	Twin: Potentiometer shunts antenna primary; Radiohm controls C-bias	Two & Twelve	70-200
ZENITH RADIO CO.			
52, 53, 54	Potentiometer controls screen grid voltage	Eleven	72-103
41, 42, 412, 422	Potentiometer across aerial and grid		
	Potentiomerer controls R.F. Plate voltage	Twenty-three	74-602
50, 60	Potentiometer controls screen grid voltage (Switch Type)	Eleven	62-104
42, 41, 11E,	Potentiometer shunts antenna primary	Three	72-101
14E, 70	Potentiometer shunts antenna primary (Switch Type)	Four	75-614
10, 11, 12, 17, 33, 362, 342, 352, 352A, 392 392A	Potentiometer controls plate voltage	Sixteen	72-104
35-36-37A-39-39A-40A-31-32-33-34-362	Potentiometer controls plate voltage	Sixteen	72-104
1929	Twin control shunting antenna and R.F. primary. Specify if wanted with A.C. switch	Nineteen	74-600
All 1930	Tone control	Seventeen	41-009

ELECTRAD INC.

A B C



THE above sketches show dimensions of Electrad Replacement Volume Controls. View "A" shows the back view and location of terminals, the numbers of which are referred to in diagrams and tables which follow. View "B" shows depth of unit and lengths of shafts and bushing. The shaft is made long enough for most cases. When a shorter shaft is needed it can be cut to proper length. View "C" shows the knob end and location of terminals after mounting the unit on set.

In order to make each type control as universally applicable as possible, all types are potentiometers except where an off position is desirable as in RI-204. Where a rheostat type is needed only two of the terminals are used. The proper terminals are indicated in circuits. When connecting in receiver, reference should be made to above drawings.

View "C" also indicates quarter positions knob rotation. These positions are used to determine the type of taper of the resistance. When a volume control is used in a series circuit such as Nos. 8 and 9, it has a regular or right-hand taper. This means that the resistance of the first quarter-section is higher than that of the second quarter-section, etc. When control is used in a shunt circuit such as Nos. 2 and 3, it has a reverse or left-hand taper. That is, the first quarter-section has lower resistance than the second quarter-section, etc. When resistance of all sections is equal, the taper is linear or uniform.

All RI and FB type replacement controls have insulated bushings. There is no connection between terminal No. 2 and bushing or shaft. No insulating washers are needed when mounting the unit on metal panel. In circuits Nos. 3, 5, 7 and 8 a connection must be made externally between terminal No. 2 and chassis or ground.

In many receivers the volume control is not smooth, or appears to be defective even when replaced by new control. This may be due to the set having gain which cannot be practically controlled by a single unit, or the fact that at certain volume control positions tube distortion, cross-talk or oscillation occurs. This can be corrected by the addition of a switch and fixed wire resistance as shown in circuit No. 19. The resistor should be a Truvolt Wire Grid Resistor with a nominal value of 50 ohms. *In cases of extremely high gain a 25 ohm resistor should be used.* The switch is then used as a local-distance switch, closed for local and open for distance. A much more convenient method of doing this, however, is to use an RI type resistor with switch attached.

Figure No. 1 shows appearance of RI type volume controls *without* switch. Figure No. 2 shows the same control *with* switch. The switch is so arranged that when the knob is turned completely to the right (*full clockwise position*) the switch opens and stays open until knob is turned completely to the left (*full counter-clockwise position*) when switch will close. This feature makes these units ideally suited for combination local and distance switch and volume control. A representative diagram is shown in circuit No. 20. Circuit No. 19, however, can be used in combination with any one of circuits Nos. 1 to 15 inclusive.

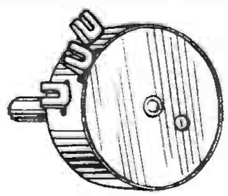


FIG. 1

If it is desired to use the switch as a line switch the locknut on switch should be loosened and switch turned one-half turn in counter clockwise direction which will reverse the operation of the switch. That is, the switch will connect the current to the set when turned fully clockwise and disconnect when turned fully counter-clockwise.

Circuit No. 18 shows use of rheostat and condenser for tone control. RI-206 can be used for replacement in this circuit or can be used to add tone control to any receiver. Circuit shows connections for push-pull audio. Where a single power tube is used, terminal No. 2 should be connected to ground. R207P has the condenser enclosed in unit and is supplied with leads that can be connected to the two grids of push-pull output or to grid and ground of single tube output. R207P is furnished with insulating washers which must be used when mounted on metal panel or chassis.

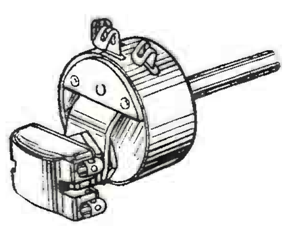
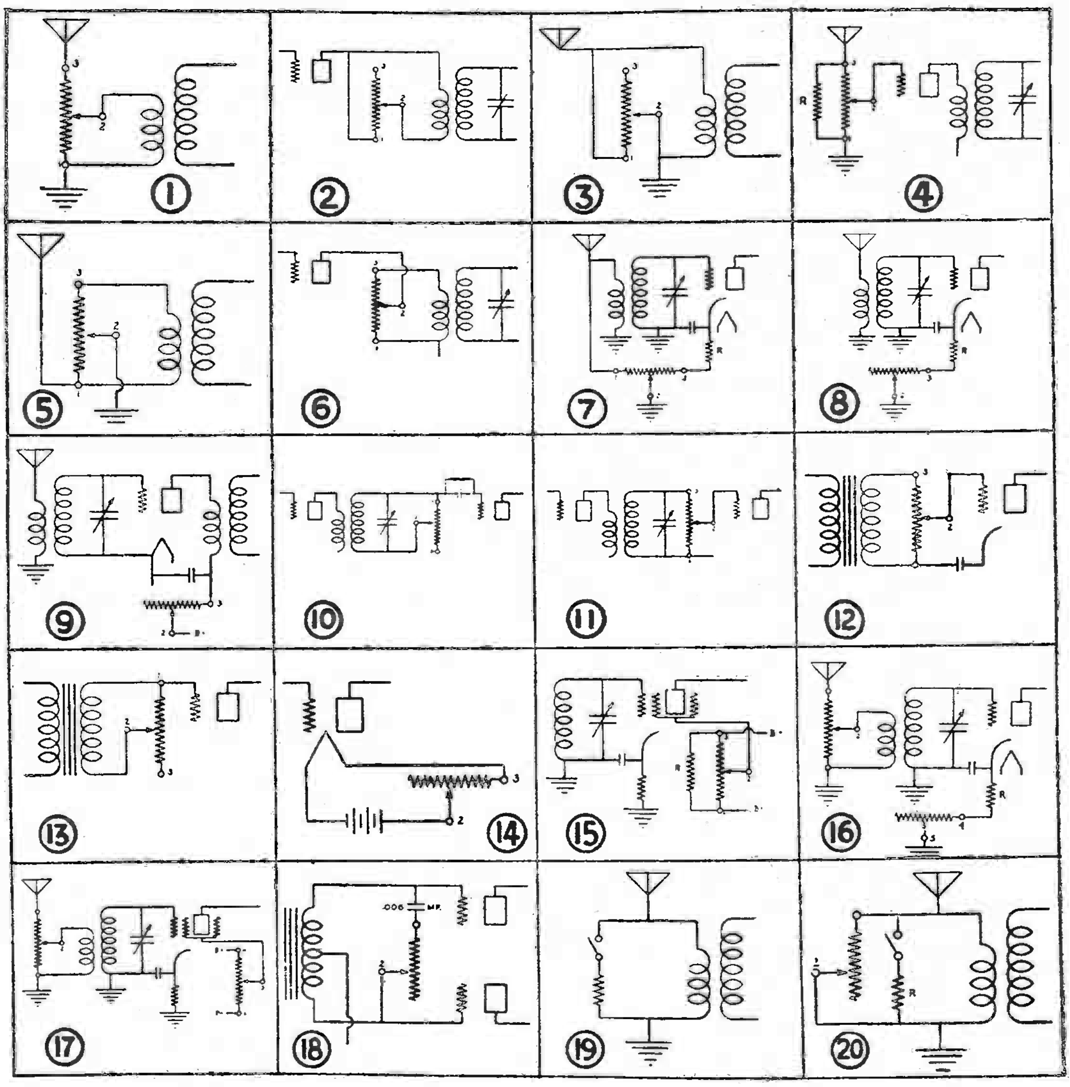


FIG. 2

VOLUME CONTROL	HOW USED	CIRCUIT NUMBER
RI-201 15,000 ohm reverse potentiometer	Antenna Potentiometer—center arm to coil	1
	RF Primary shunt	2
	Antenna and ground rheostat shunt	3
	Untuned Antenna potentiometer — 2000 ohm grid resistor must be connected between terminals No. 1 and No. 3	4
	Antenna Potentiometer—center terminal to ground	5
	RF Primary Potentiometer—center terminal to plate	6
	Antenna Cathode Potentiometer	7
RI-201S	With Switch.	
RI-202 75,000 ohm regular potentiometer	Cathode series resistor	8
	RF Plate Voltage series resistor	9
RI-202S	With Switch.	
RI-203 500,000 ohm reverse potentiometer	RF Secondary shunt	10
	RF Secondary potentiometer — center arm to grid	11
	AF Secondary potentiometer — center arm to grid	12
	AF Secondary shunt	13
RI-203S	With switch.	
RI-204 10 ohm regular rheostat	Filament rheostat	14
RI-205 50,000 ohm Uniform Potentiometer	Screen Grid Potentiometer	15
RI-205S	With switch.	
FB-478-T	Antenna potentiometer and Cathode series resistor	16
FB-479-T	Antenna potentiometer and screen grid potentiometer	17
RI-206	Tone Control rheostat (condenser not supplied)	18
RI-206S	With Switch	18-19
R-207P	Tone Control unit (rheostat and condenser with leads)	18

ELECTRAD INC.

BASIC CIRCUITS For Which Electrad Replacement Volume Controls Are Designed



TYPE NO.	Number of Receivers Listed Using This Control
RI-201	133
RI-202	60
RI-203	67
RI-204	52
RI-205	31
TOTAL	343

ELECTRAD INC.

ELECTRAD VOLUME CONTROLS ARE AVAILABLE FOR THE FOLLOWING RECEIVERS

(Important Note—All controls listed below must be used only in circuit indicated)

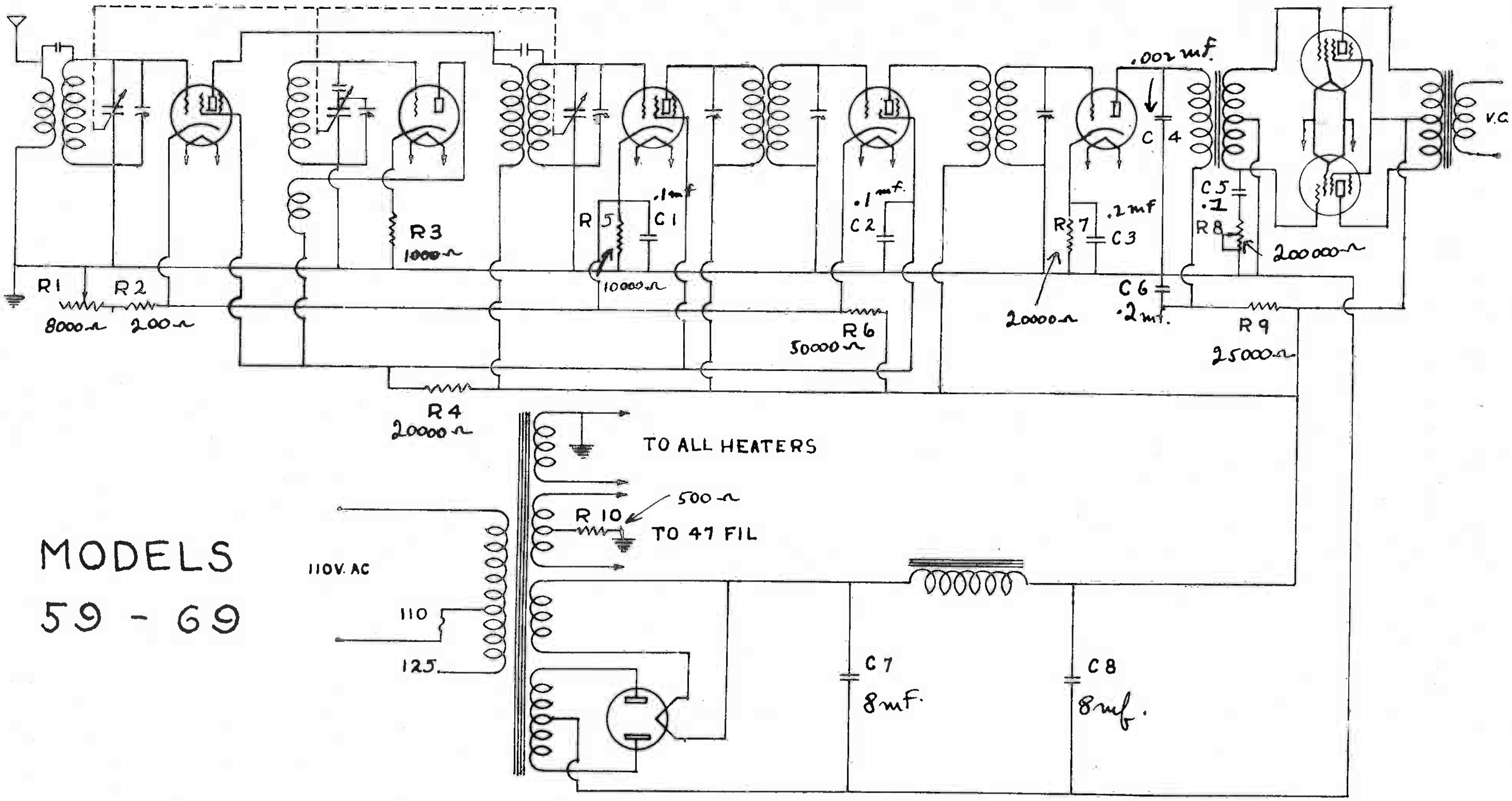
RECEIVERS	MODEL NO.	CIRCUIT NO.	VOLUME CONTROL TYPE NO.
Acme Mfg. Co.	AC 7	12	RI-203
	88	15	★RI-205
Aero Coil Co.	Unit 6, Short Wave	14	RI-204
Aero Prod. Co.	Aero 5	9	RI-202
	Aero 4, 6, 7, Short Wave	14	RI-204
All-Amer. Mohawk	96, 90	7	RI-201
	60, 61, 62, 65, 66, 80, 83, 84, 85, 86, 88	10	RI-203
Amrad	70, 7100	1	RI-201
	81	15	RI-205
Apex	36	7	RI-201
	80	3	RI-201
	Battery Models	9	RI-202
Arborphone	45	2	RI-201
Atwater Kent	37, 38	3	RI-201
	36	2	RI-201
	40, 42, 44, 52	5	RI-201
	33 series filament	12	RI-203
	12, 20, 30, 32, 33, 35, 48, 49, 50	14	RI-204
	61, 61C, 66, Battery 222 Tubes	15	RI-205
Audiola	30B, 7330	15	RI-205
Baldwin		7	RI-201
Balkite	FC, C	7	RI-201
Belmont	Belmont	15	RI-205
Bosch	49	5	RI-201
	28, 29	1	RI-201
	54 DC	7	RI-201
	46, 66, 96, 107, 116, 126, 136, 146, 166	10	RI-203
	35 Battery Set	14	RI-204
	48	15	★RI-205
Bremer-Tully	7-70, 7-71	7	RI-201
	4, 6, 8, 8-20A	11	RI-203
	14, 21, 31, 81, 82	8	RI-202
Browning-Drake	34, 36, 38	3	RI-201
Brunswick	3, KR8, 2, 5, KRO	5	RI-201
Bush & Lane	12	15	★RI-205
Cavac		7	RI-201
Cleartone	112	11	RI-203
Colonial	26, DC31	14	RI-204
Columbia	961, 902, C-11	1	RI-201
	SG8	7	RI-201
Crosley	42AC, 706, 609, 610	1	RI-201
	804AC, 20, 21, 22, Chum, Buddy	8	RI-202
	3R3, 90, 401, 601	14	RI-204
	30S, 31S, 33S, 34S	15	RI-205
Dayfan	5091-48	3	RI-201
	8AC early models	5	RI-201
	8AC late models	1	RI-201
	OEM54, 74	14	RI-204
A. C. Dayton	XL61	9	RI-202
	AC-63, 65, 66	10	RI-203
DeForest-Crosley	605	11	RI-203
	800, 810	12	RI-203
Diamond Coil	Diamond	8	RI-202
Edison	R-122	6	RI-201
	R-1, R-2, C-1, C-2	2	RI-201
Elect. Res. Lab.	R-1	1	RI-201
Eveready	31	8	RI-202
Fada	18DC	5	RI-201
	SF 4575 UA or CA, 10, 11, 30, 31, 50, 70, 71, 72	10	RI-203
Federal Radio	Type M	10	RI-203
	Type H, Type L	11	RI-203
Freed-Eisemann	NR57, NR70	5	RI-201
	NR80, DC470	3	RI-201
	NR95	8	RI-202
	F-10, NR7, 30, 32, 40, 48, 50	14	RI-204
Chas. Freshman	N-12, N-17	3	RI-201
	L, LS, G60S, H, M, K, K60S	12	RI-203
	Equaphase	14	RI-204
Garod	E-A	12	RI-203
Gilfillan	10	7	RI-201
	100	6	RI-201
A. H. Grebe	AC-7, 428, AC-6	2	RI-201
	SK-4DC	8	RI-202
	Syncrophone, MU1, No. 5	14	RI-204
Halldarson		3	RI-201
Hammarlund	HiQ-29	5	RI-201
	HiQ-30	15	RI-205
Kenneth Harkness	AC-7 Control A	12	RI-203
	AC-7 Control B	7	RI-201
High Frequency	Mastertone, HFL Super	15	RI-205
Hollister	AC 8 Control A	15	RI-205
	AC 8 Control B	7	RI-201
Holmes Jordan	AC	7	RI-201
Howard		15	RI-205
Kellogg	K-24, 25, 27, 28	7	RI-201
	523, 526 Control A	5	RI-201
	523, 526 Control B	12	RI-203
Colin B. Kennedy	Royal 80	12	RI-203
	220	14	RI-204
	20	15	RI-205
King Elec. Co.	E-80, 81, FGH	5	RI-201
	82	2	RI-201
	J & H	3	RI-201
	9798, Monarch	7	RI-201
	10K-1, 25, 71	14	RI-204
Kolster	K-20, 22, 23, 24, 25, 27, 28	1	RI-201
	8A	14	RI-204
Lincoln Elec.	Lincoln 40	8	RI-202
	8-80	15	RI-205
Lyric	90	7	RI-201
Magnavox	Magnavox	14	RI-204
Majestic	90, 91, 92, 100B	8	RI-202
McMillan	900	3	RI-201
Metro		3	RI-201
Montgomery Ward	Screen Grid	7	RI-201
Ozarka		15	RI-205
Peerless Courier	K-70	7	RI-201
	65	8	RI-202
	Peerless	12	RI-203
Patterson		3	RI-201
Philco	82, 86, 87, 511, 512, 513, 514, 515, 531, 551, 571	5	RI-201
	Series 5	3	RI-201
	296, 296A	12	RI-203
	65	15	RI-205
Pilot	Pilot 5	9	RI-202
	PE-6	15	RI-205
Powrad		15	RI-205
RCA	17, 18, 33	4	RI-201
	41, 50, 51, 64	5	RI-201
	16, 20, 25, 28, 30, 32	14	RI-204
	44, 46, 47	15	★RI-205
	66 Radiola	8	RI-202
Radio News Elco	Elco	15	RI-205
Remler Mfg. Co.	111	15	RI-205
Scott Super	Scott Super	14	RI-204
Sears, Roebuck	Screen Grid	7	RI-201
Silver-Marshall	Around World 4	8	RI-202
	SM 690	12	RI-203
Sonora	A-30, A-32, A-36, A-40, A-44	2	RI-201
Sparks-Withington	49B, 39, 931, 301	9	RI-202
	390, 110, 109, 89, 89A	8	RI-202
Splitdorf	ES 62	2	RI-201
	CI	11	RI-203
Steinite	261	2	RI-201
	40, 50, 102	8	RI-202
	991, 992, 993	9	RI-202
Stewart-Warner	715, 720	3	RI-201
	500, 520, 525, 700, 705, 710, 806	9	RI-202
	811, 900	8	RI-202
	530, 535	10	RI-203
	300 to 500	14	RI-204
Sterling	A2	7	RI-201
Stromberg-Carlson	300, 310, 325	7	RI-201
	363	3	RI-201
	846, 642	5	RI-201
	Automatic Volume Control	12	RI-203
	501, 502	14	RI-204
Temple	860, 880, 890	3	RI-201
Tyrman Radio	Tyrman 72-80	8	RI-202
	60	14	RI-204
Victor-RCA	R-52	7	RI-201
Victoreen	AC	8	RI-202
Walbert	27	9	RI-202
Ware	T	14	RI-204
Wells-Gardner	1929-30	7	RI-201
	1928	3	RI-201
Wurlitzer	1929 Seven Tube	7	RI-201

★ Value of R of Circuit No. 15

Acme	Model 88	5000 ohms
Bosch	Model 48	5000 ohms
Bush & Lane	Model 12	10000 ohms
RCA	Models 44, 46, 47	3000 ohms

HORN RADIO CO.

MODELS 59 - 69



VOLTAGE READINGS AT TUBE SOCKETS

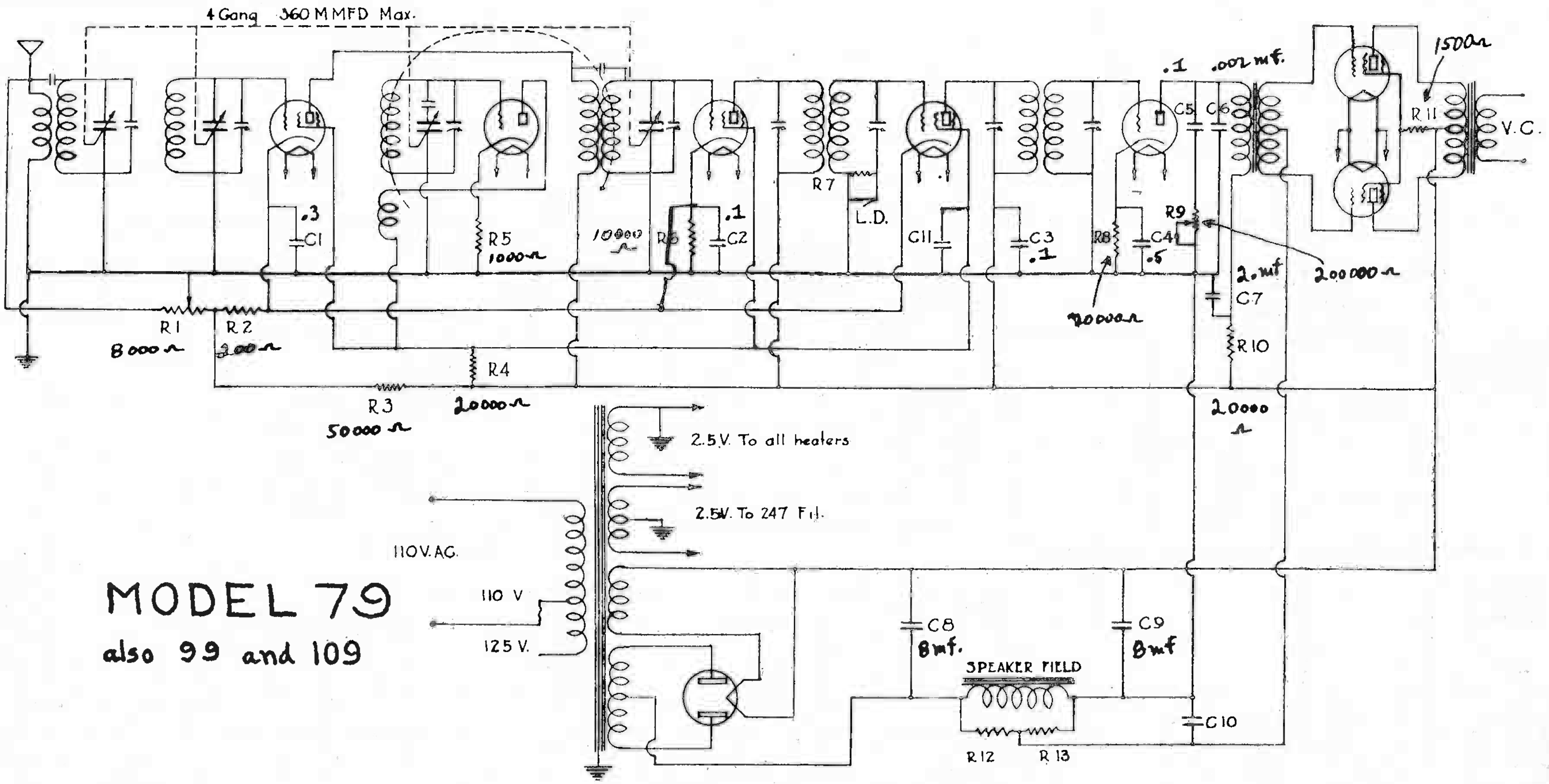
VOLUME CONTROL AT MINIMUM

No.	Position	Plate to ground	Screen to ground	Cathode to ground	Heater or Fil. Voltage	Grid to ground
1	R.F. Amp	240	105	*26	2.4 AC	0
2	Translator	240	105	*26	2.4 AC	0
3	Oscillator	105			2.4 AC	0
4	Int. Amp.	240	105	*26	2.4 AC	0
5	Detector	180		*22	2.4 AC	0
6-7	Power Tubes	230	240	Fil *16	2.4 AC	0
8	Rectifier	0		Fil.380	4.8 AC	0

VOLUME CONTROL AT MAXIMUM

No.	Position	Plate to ground	Screen to ground	Cathode to ground	Heater or Fil. Voltage	Grid to ground
1	R.F. Amp	215	70	*3	2.4 AC	0
2	Translator	215	70	*3	2.4 AC	0
3	Oscillator	70		*4	2.4 AC	0
4	Int. Amp	215	70	*3	2.4 AC	0
5	Detector	160		*20	2.4 AC	0
6-7	Power Tubes	205	215	Fil.16*	2.4 AC	0
8	Rectifier	0		Fil.360	4.8 AC	0

HORN RADIO CO.



MODEL 79
also 99 and 109

VOLTAGE READINGS AT TUBE SOCKETS

VOLUME CONTROL AT MAXIMUM

No.	Position	Plate to ground	Screen to ground	Cathode to ground	Heater or Fil. Voltage	Grid to ground
1	R.F. Amp	225	94	3.5*	2.1	-
2	Translator	225	94	3.5*	2.1	-
3	Oscillator	94	-	4*	2.1	-
4	Int. Amp.	225	94	3.5*	2.1	-
5	Detector	180	-	20*	2.1	-
6-7	Power Tubes	225	215	16.5*	2.3	-

VOLUME CONTROL AT MINIMUM

No.	Position	Plate to ground	Screen to ground	Cathode to ground	Heater or Fil. Voltage	Grid to ground
1	R.F. Amp	250	112	33*	2.1	-
2	Translator	250	112	33*	2.1	-
3	Oscillator	112	-	5*	2.1	-
4	Int. Amp	250	112	33*	2.1	-
5	Detector	195	-	22*	2.1	-
6-7	Power Tubes	243	235	17.5*	2.3	-

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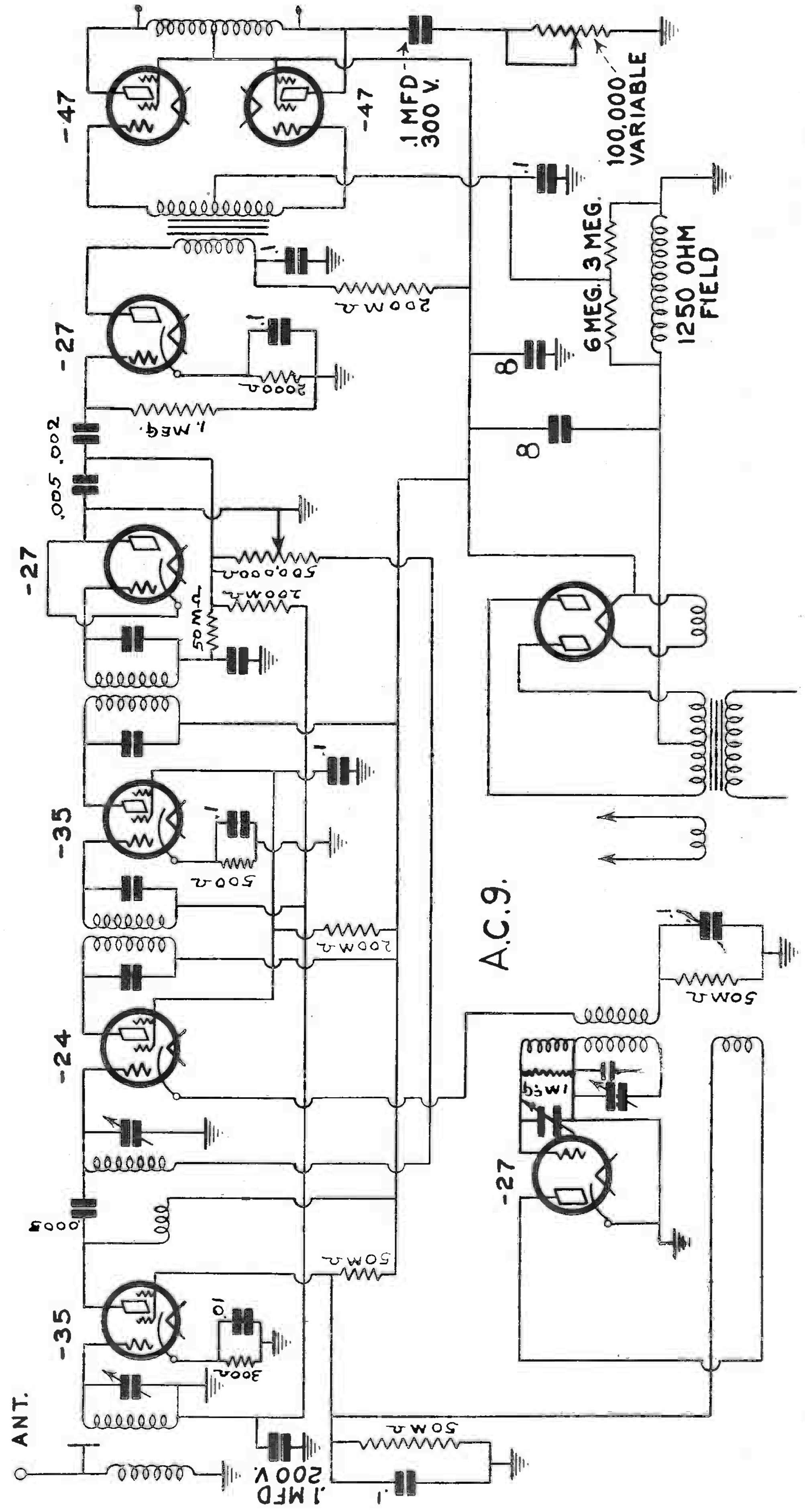

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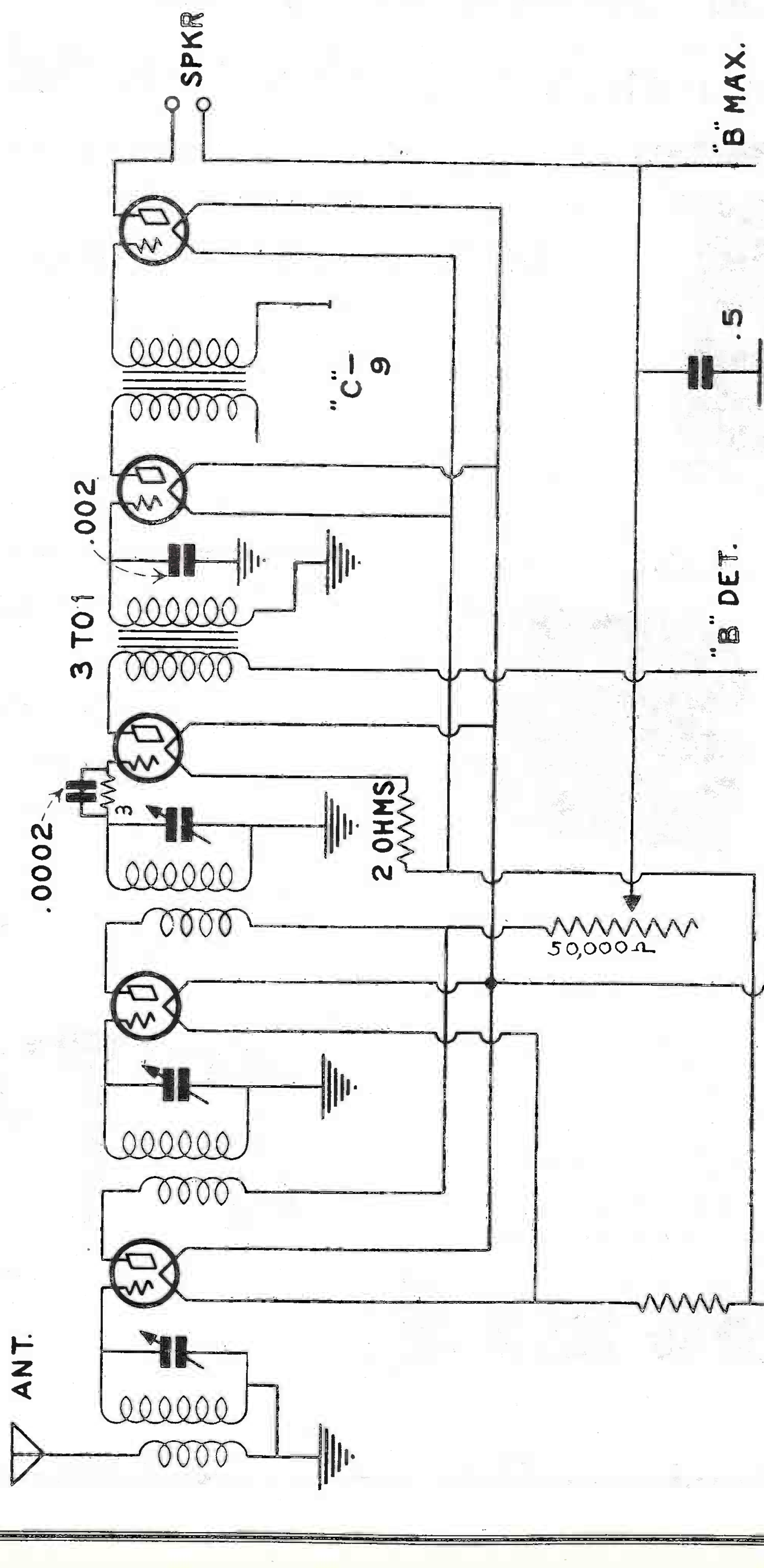

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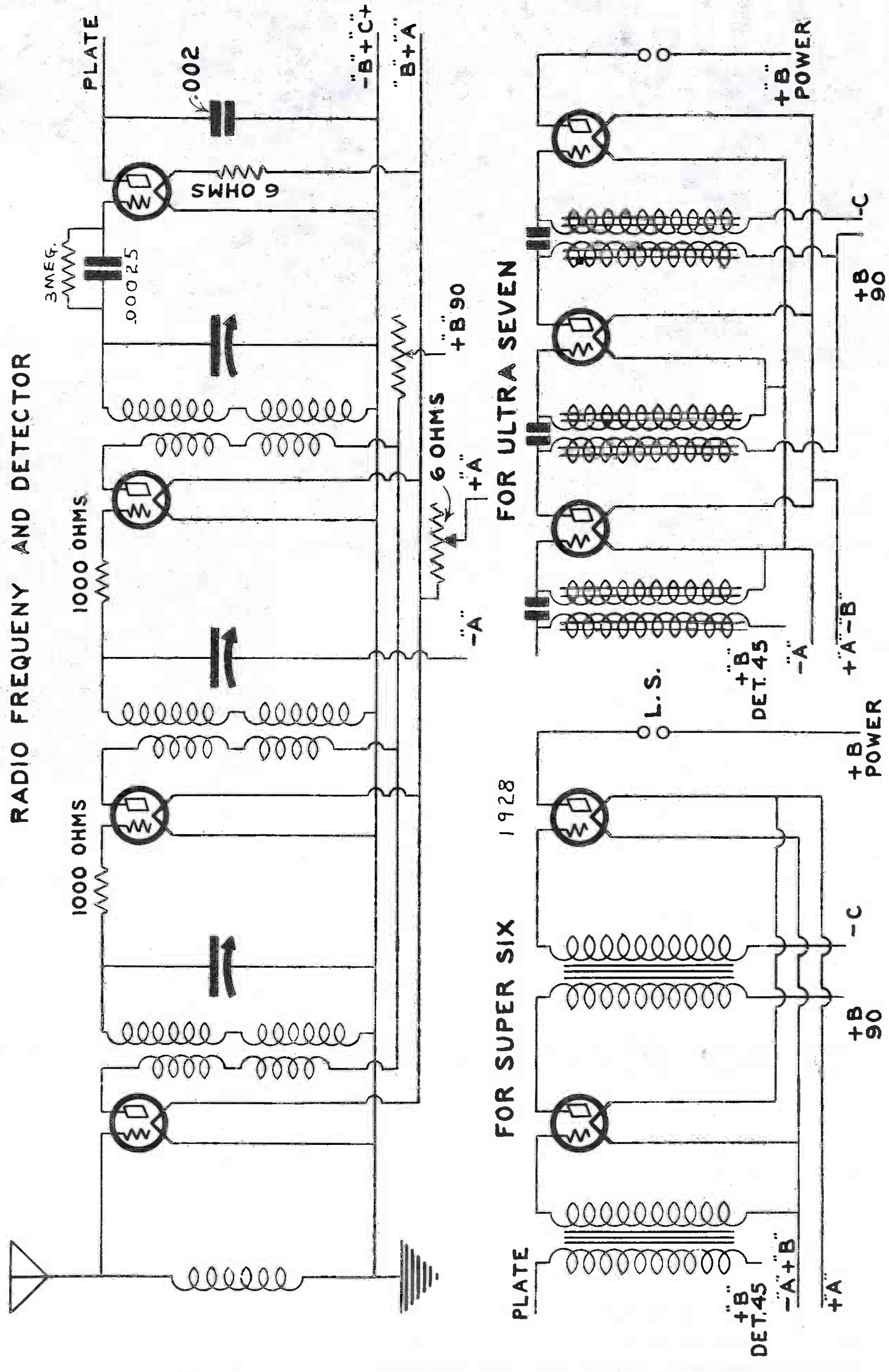

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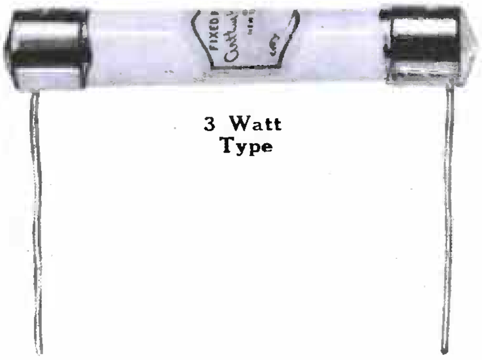

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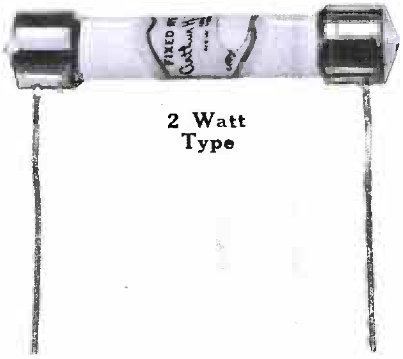
3—Pigtails are tinned copper, molded into the caps, not soldered or strapped—thus insuring positive contact and proof against noise caused by faulty connection.



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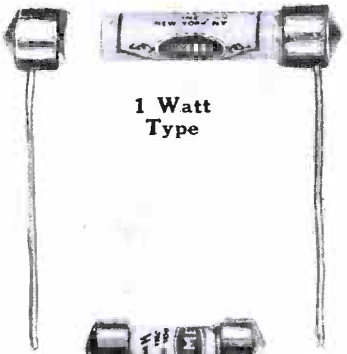
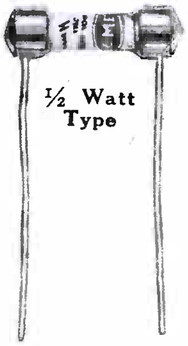


1 Watt Type



½ Watt Type

Pigtail and Cartridge Types

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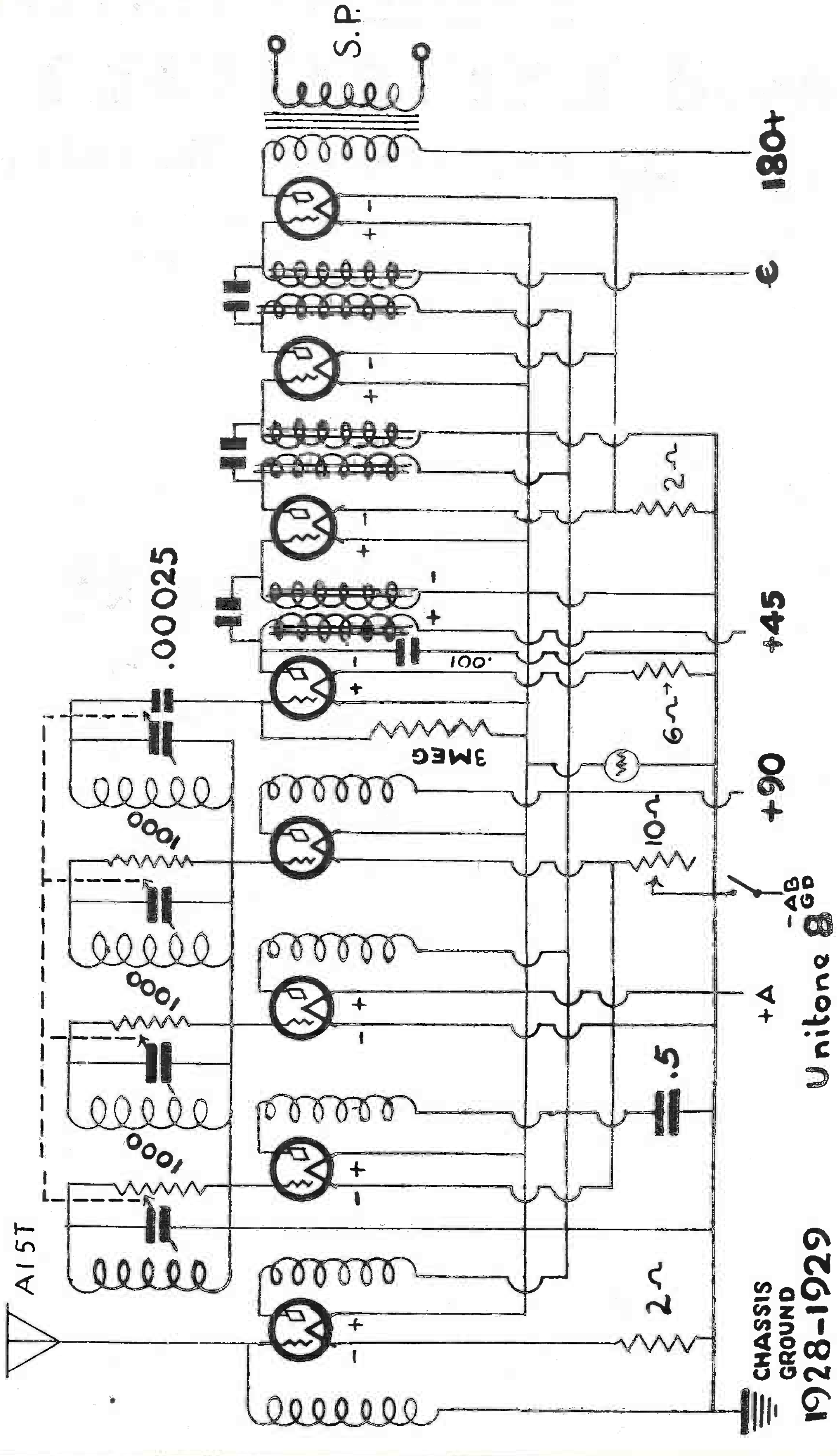

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This is the fundamental purpose of the OFFICIAL RADIO SERVICE MEN'S ASSOCIATION, which is not a money-making institution, or organized for private profit; to unite, as a group with strong common interests, all well qualified Radio Service Men; to make it readily possible for them in keeping up with the demands of their profession; and, above all, to give them a recognized standing in that profession, and acknowledged as such by radio manufacturers, distributors and dealers.

To give Service Men such a standing, it is obviously necessary that they must prove themselves entitled to it; any Service Man who can pass the examination necessary to demonstrate his qualifications will be elected as a member and a card will be issued to him under the seal of this Association, which will attest his ability and prove his identity.

The terms of the examination have been drawn up in co-operation with a group of the best-known radio manufacturers, as well as the foremost radio educational institutions.

We shall not attempt to grade the members into different classes. A candidate will be adjudged as either passing or not passing. If the school examining the papers passes the prospective member as satisfactory, we shall issue to him an identification card with his photograph.

If the candidate does not pass this examination the first time, he may apply for another examination three or six months later.

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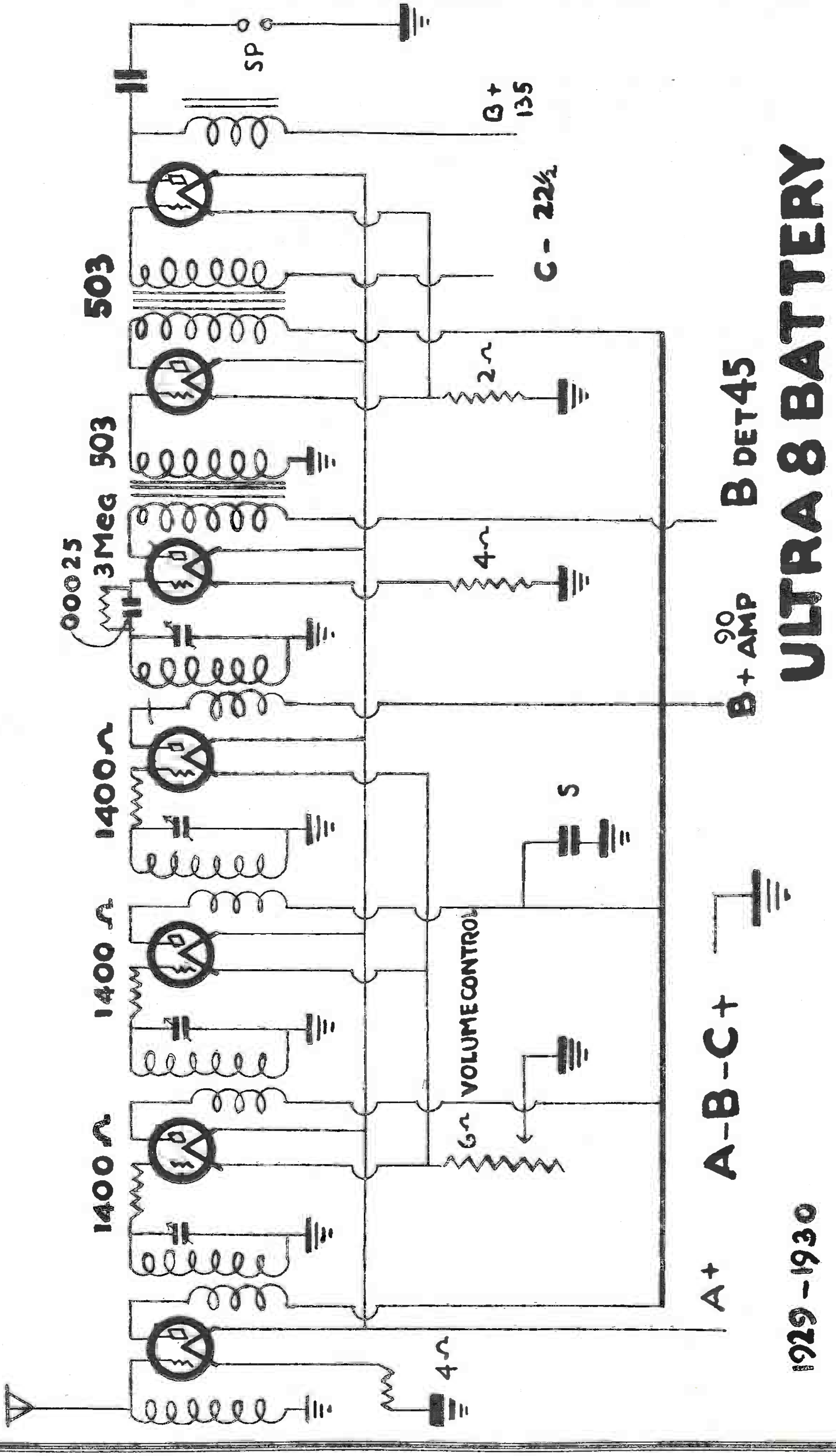

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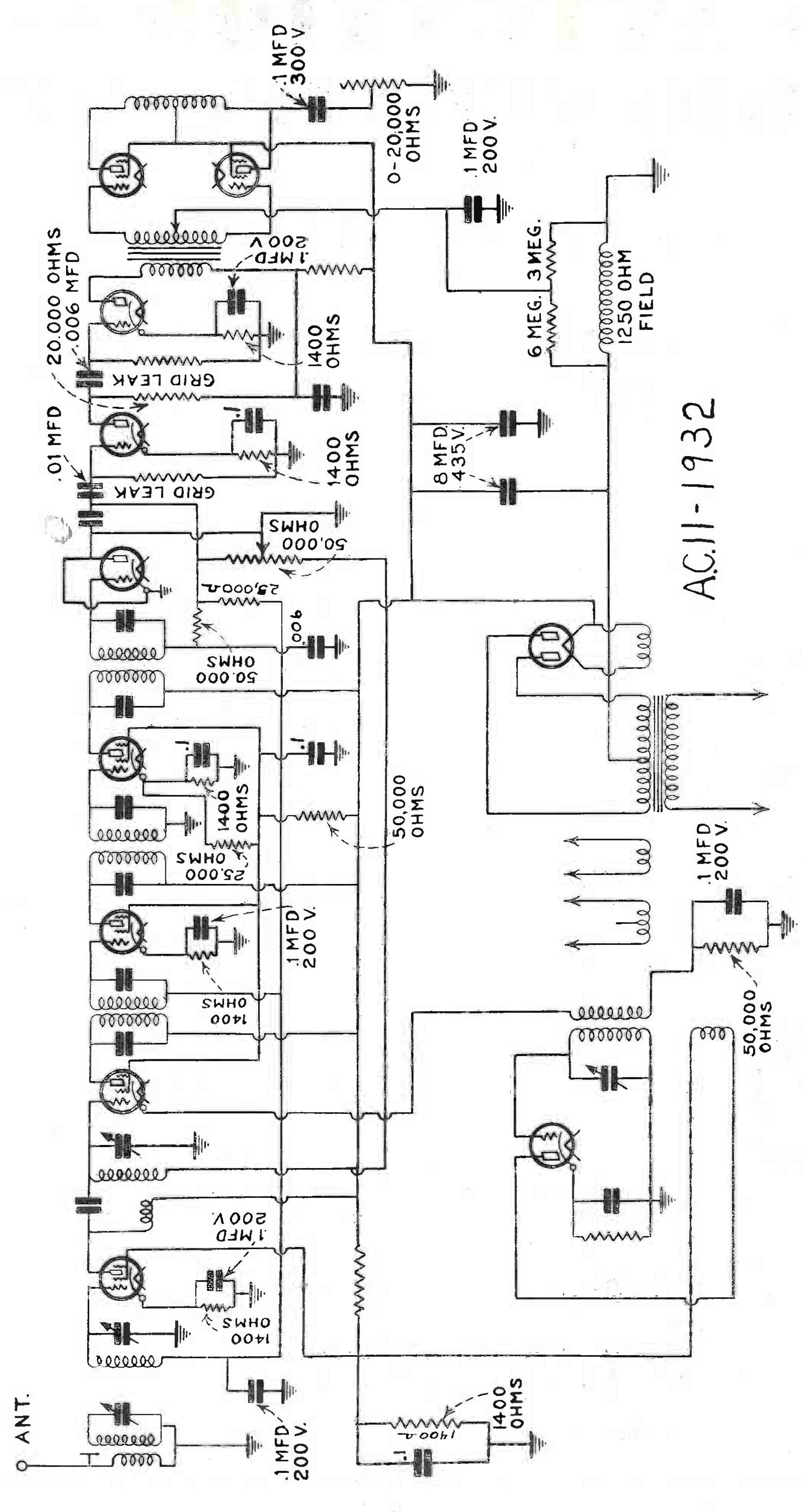

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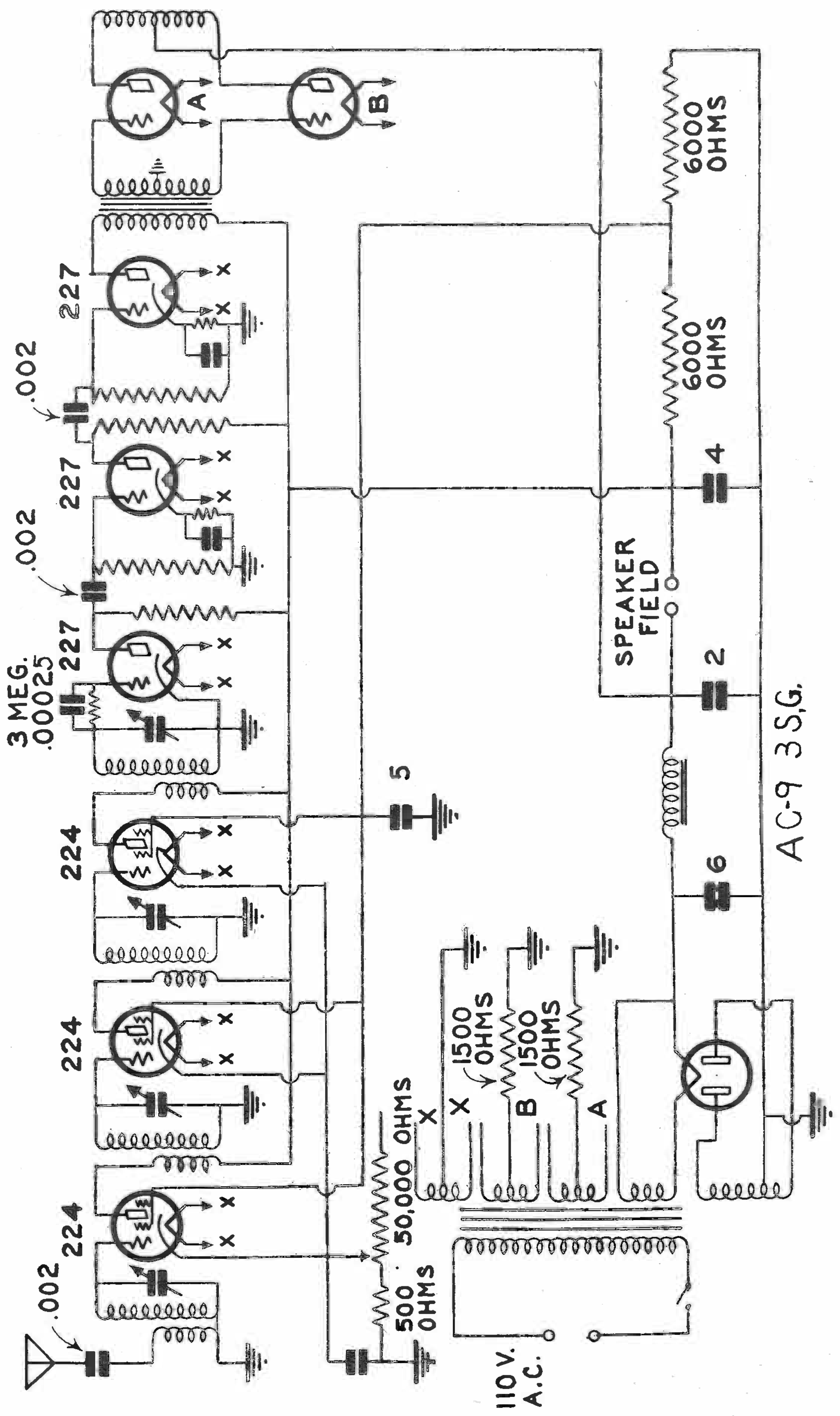

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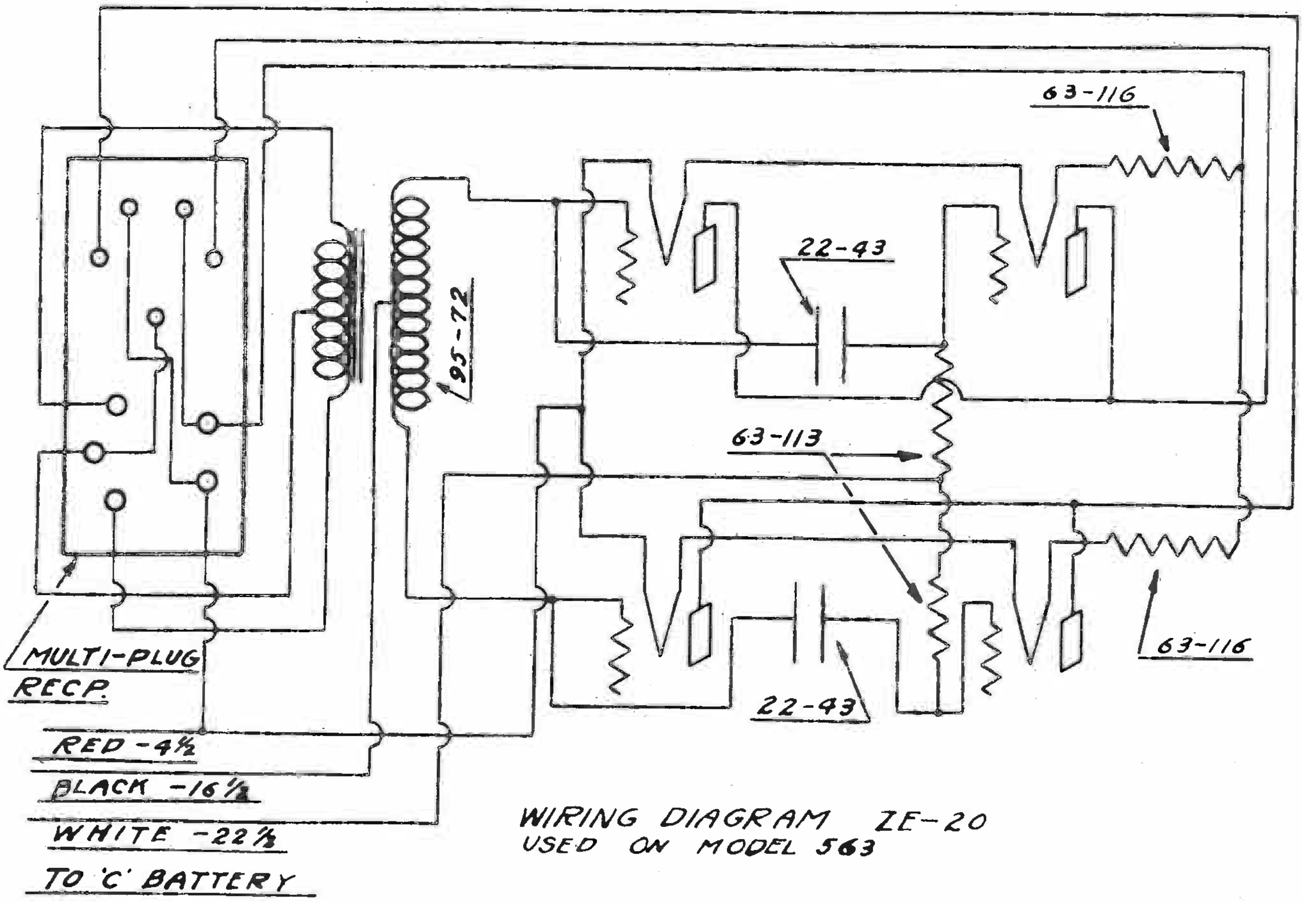
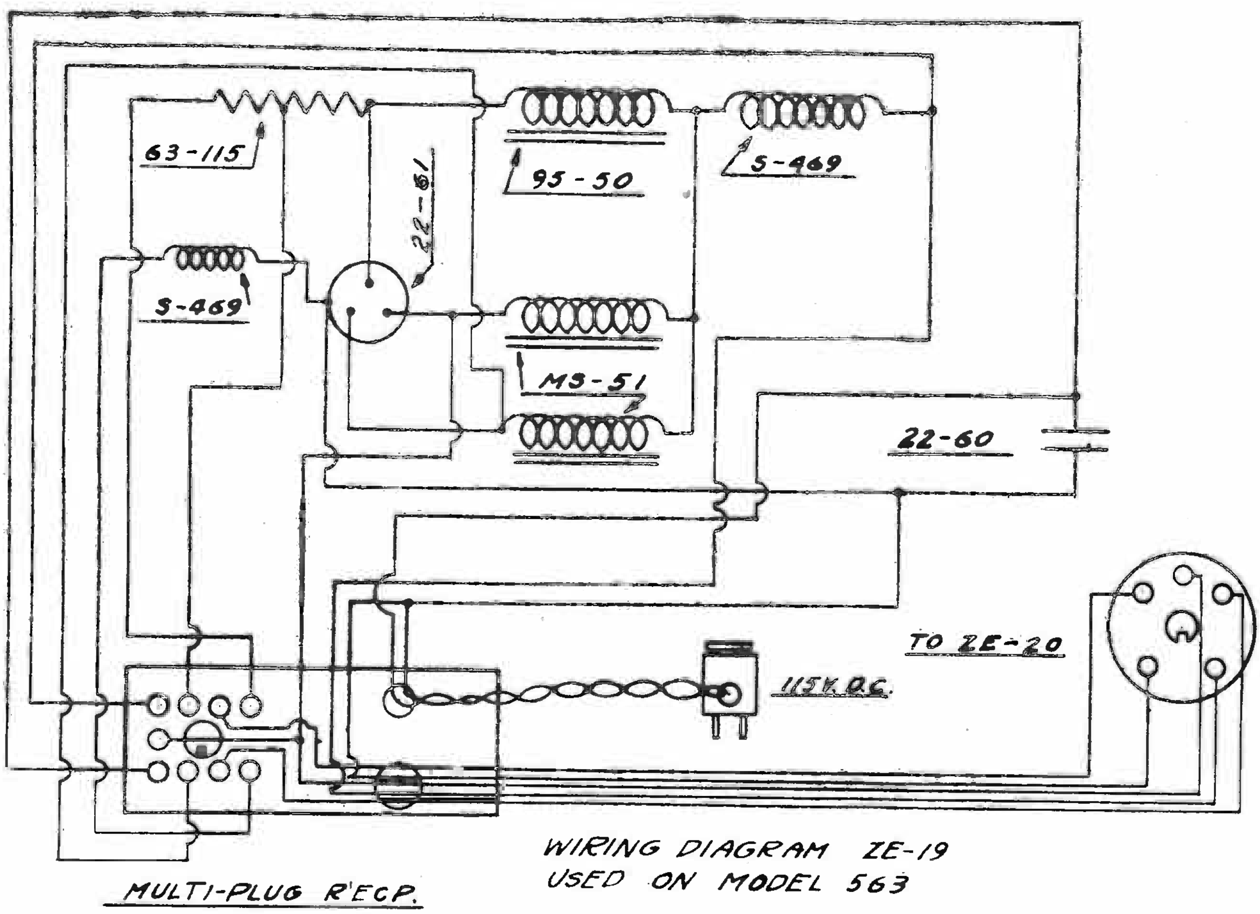


WIRING DIAGRAM ZE-20
USED ON MODEL 563

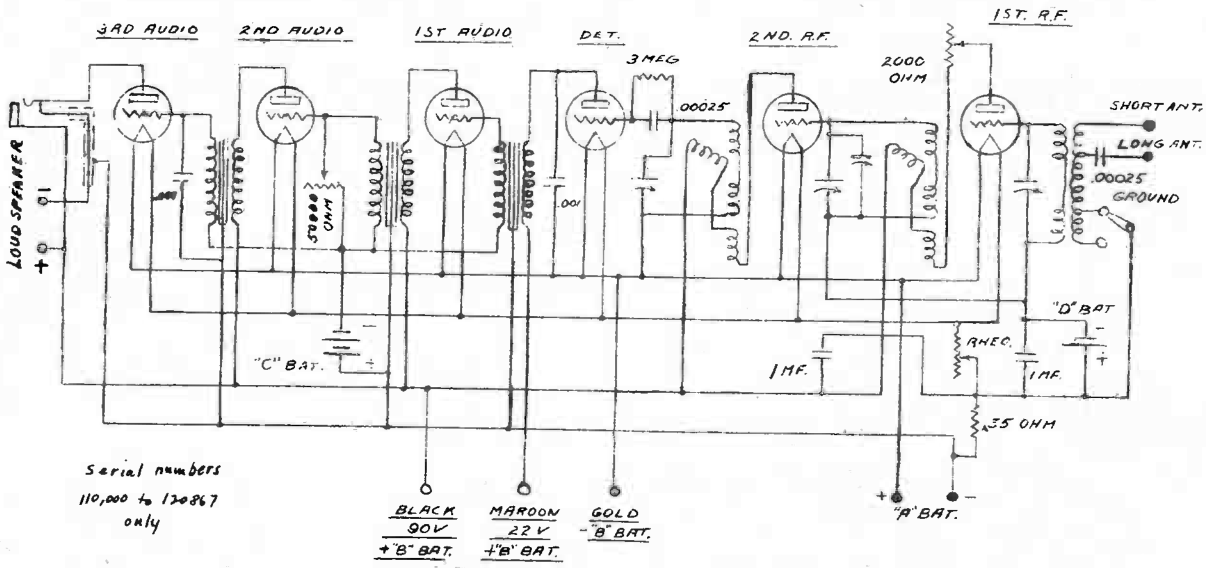


WIRING DIAGRAM ZE-19
USED ON MODEL 563

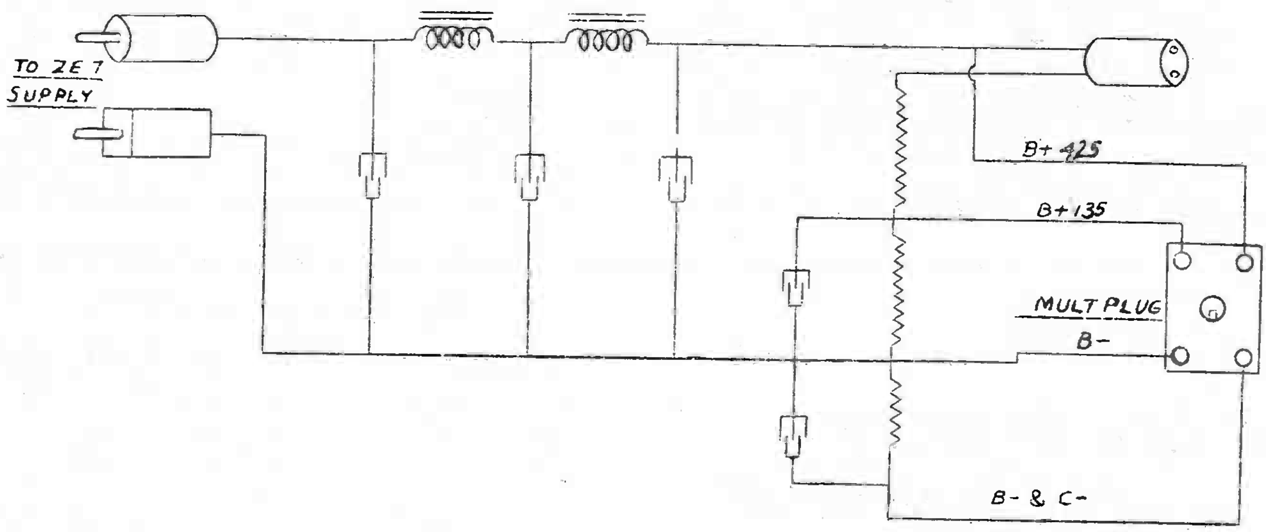
ZENITH RADIO CORP.

SUPER ZENITH
Model VII

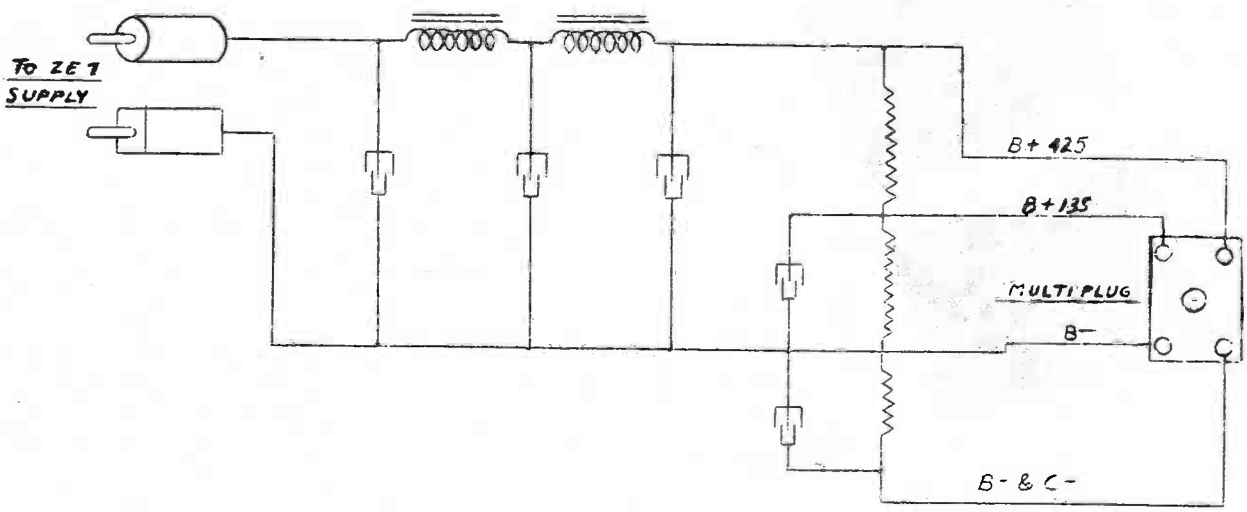
VOLUME CONTROL TYPE -



Serial numbers 110,000 to 120867 only

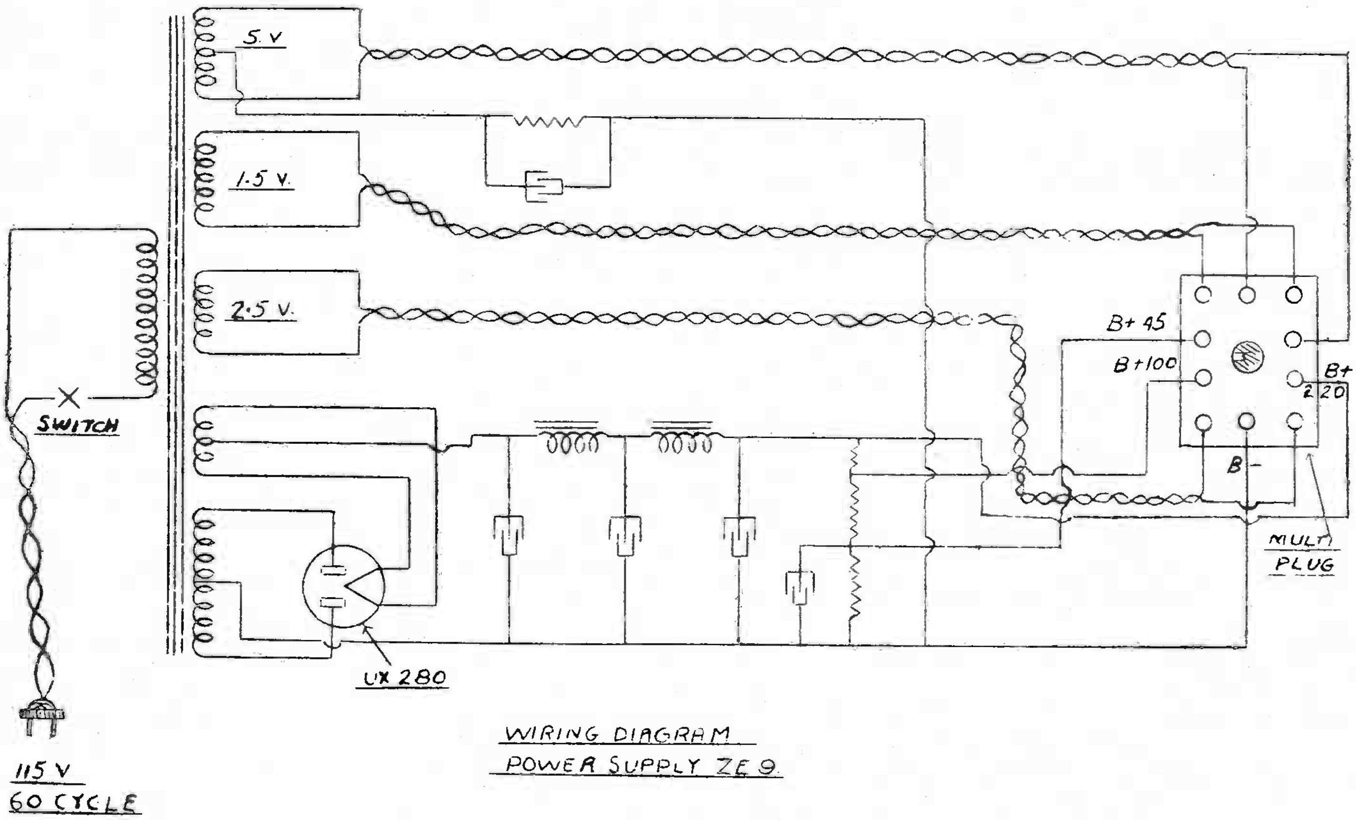


WIRING DIAGRAM
MODEL ZE8P FILTER UNIT For use on 16EP A.C. deluxe models

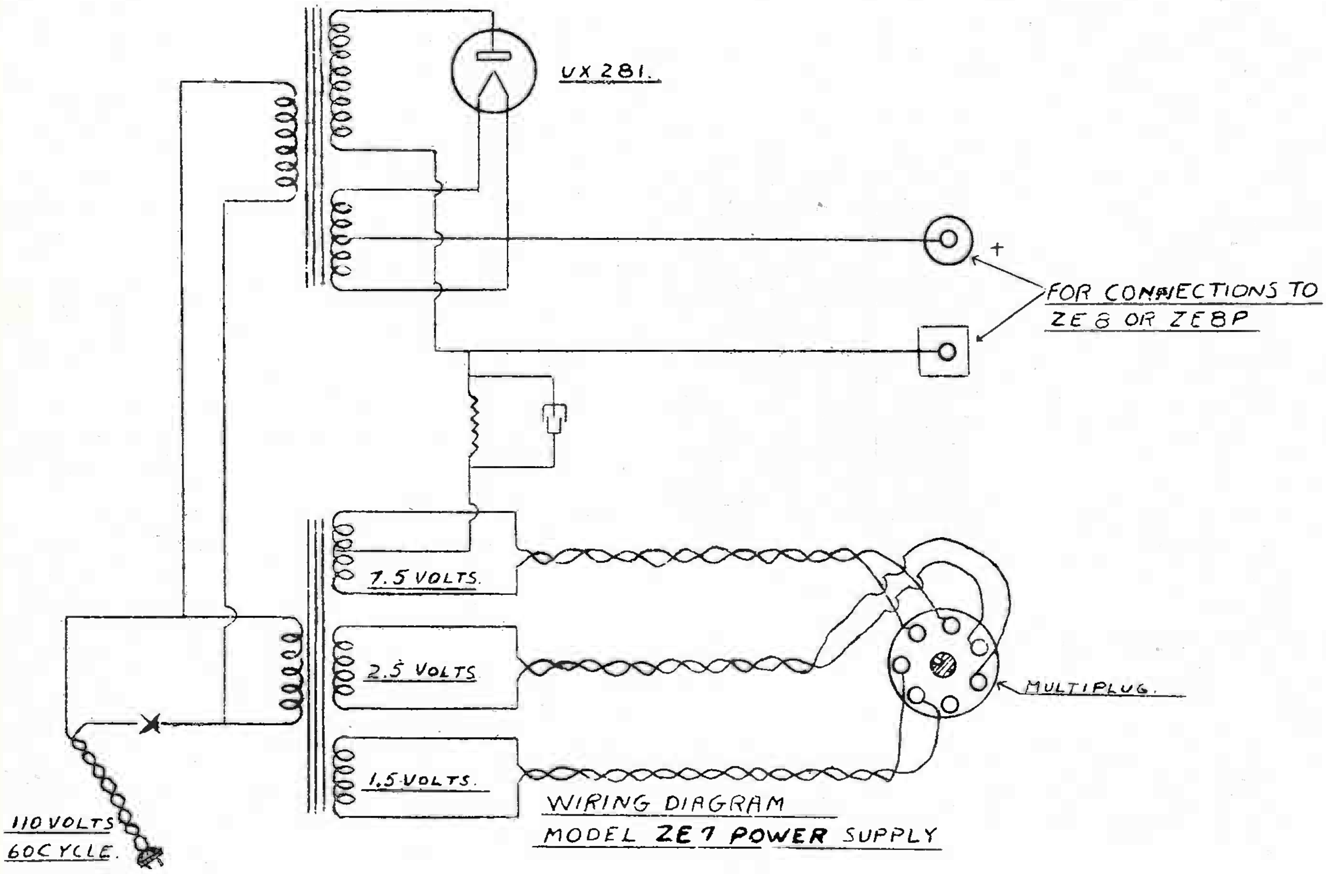


WIRING DIAGRAM
MODEL ZE 8 FILTER UNIT For use on Model 15E

ZENITH RADIO CORP.

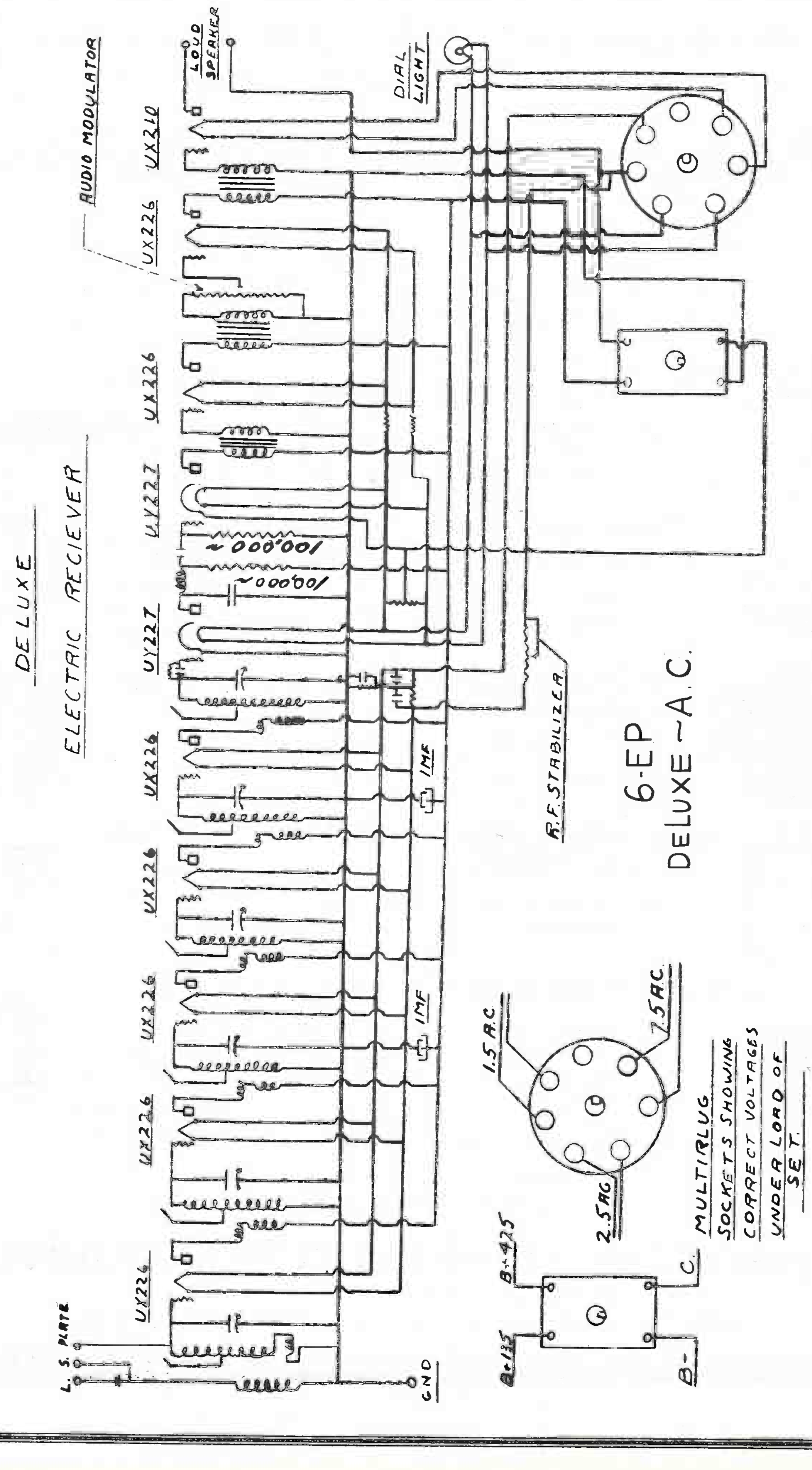


WIRING DIAGRAM
POWER SUPPLY ZE 9.



WIRING DIAGRAM
MODEL ZE 7 POWER SUPPLY

ZENITH RADIO CORP.



SERVICE— What Does It Mean?

SERVICE may mean many things to many men.

Say "SERVICE" to some men and they think only of *speed*. To others service means courtesy, accommodation, large stocks, low prices, or exceptional values.

FEW MEN think of service in terms of QUALITY, even though they are sincere in their effort to do their work well.

BUT QUALITY is the very *essence* of service—or *should* be. Nothing else counts for so much in satisfying a customer and retaining his good will. Speed, courtesy and other things help and are valuable—but without QUALITY, they count for little in the long run.

WHEN you have radio building to do, or are called on to replace worn or defective parts in a receiver, it pays to choose parts with a reputation for fine workmanship, accurate performance and long life.

HAMMARLUND CONDENSERS, Chokes and Shields are the highly perfected products of more than thirty years' experience in designing precision instruments for radio, telephone and telegraph use. They are internationally known and respected for their high standard of excellence. Plan to use them in your next service job.

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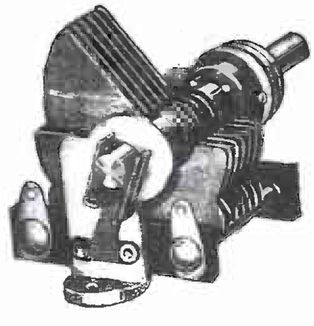
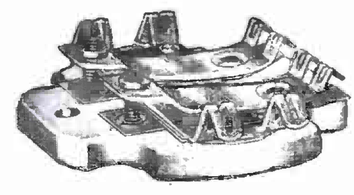
Hammarlund
PRECISION
PRODUCTS

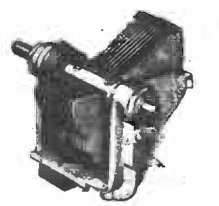
The new Hammarlund Midget Condenser is vibration proof and is particularly suited for aircraft, police car and marine work. Soldered brass plates. Aluminum end plates. Fitted bearings. Noiseless brush-type contact. Stock sizes, covering 20 to 325 mmf. $1.50 to $3.50.



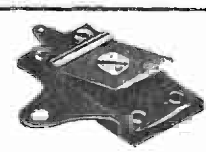
Hammarlund Intermediate Transformer Tuning Condensers are used by the majority of superheterodyne manufacturers. Insolantite base. Phosphor bronze spring plates with self-aligning adjusting screws. Finest imported mica insulation. Single and dual models in four stock ranges; 10 to 70 mmf., 70 to 140 mmf; 140 to 220 mmf. and 700 to 1000 mmf. 70c to $1.50.



Four years' leadership attest to the engineering perfection of Hammarlund "Midline" Condensers. Special shaped brass plates. Full floating rotor. Removable shaft. Ball and Cone bearings. Bronze pigtail. Rib-reinforced aluminum alloy frame. "Parmica" low-loss insulation. .00025 mfd., .00035 mfd., .0005 mfd. $5.00 to $5.50.



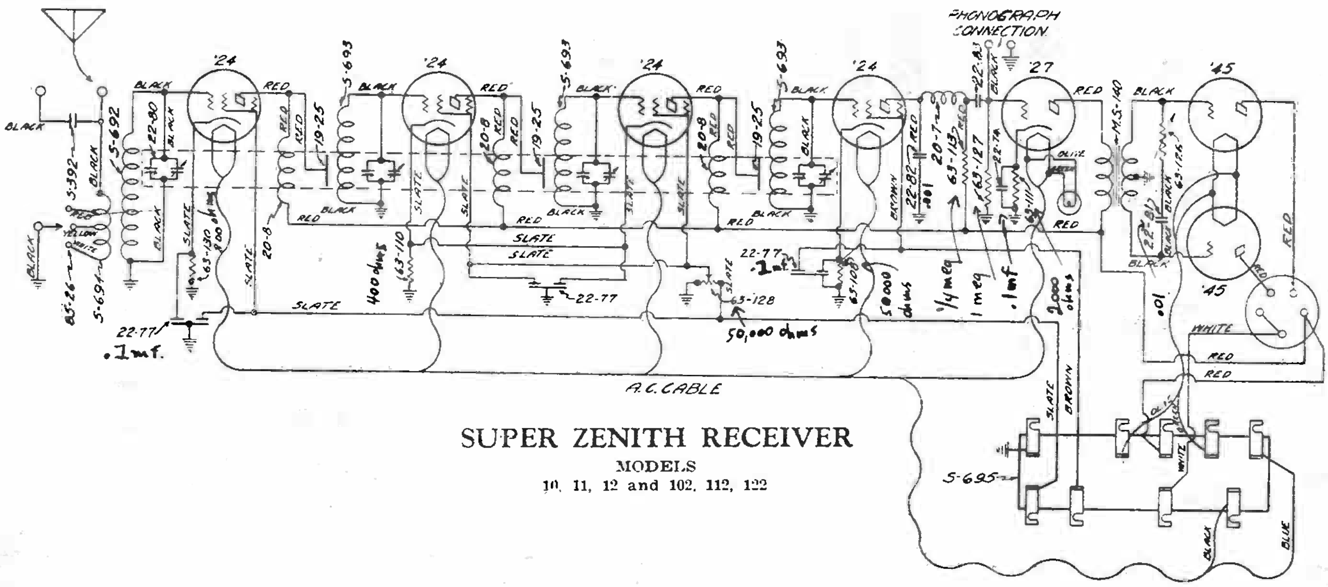
A Sturdy, Accurate Neutralizing, Balancing or Trimming Condenser. May be attached to socket binding post or tuning condenser. 2 to 35 mmf. 50c; 20 to 80 mmf. 60c.



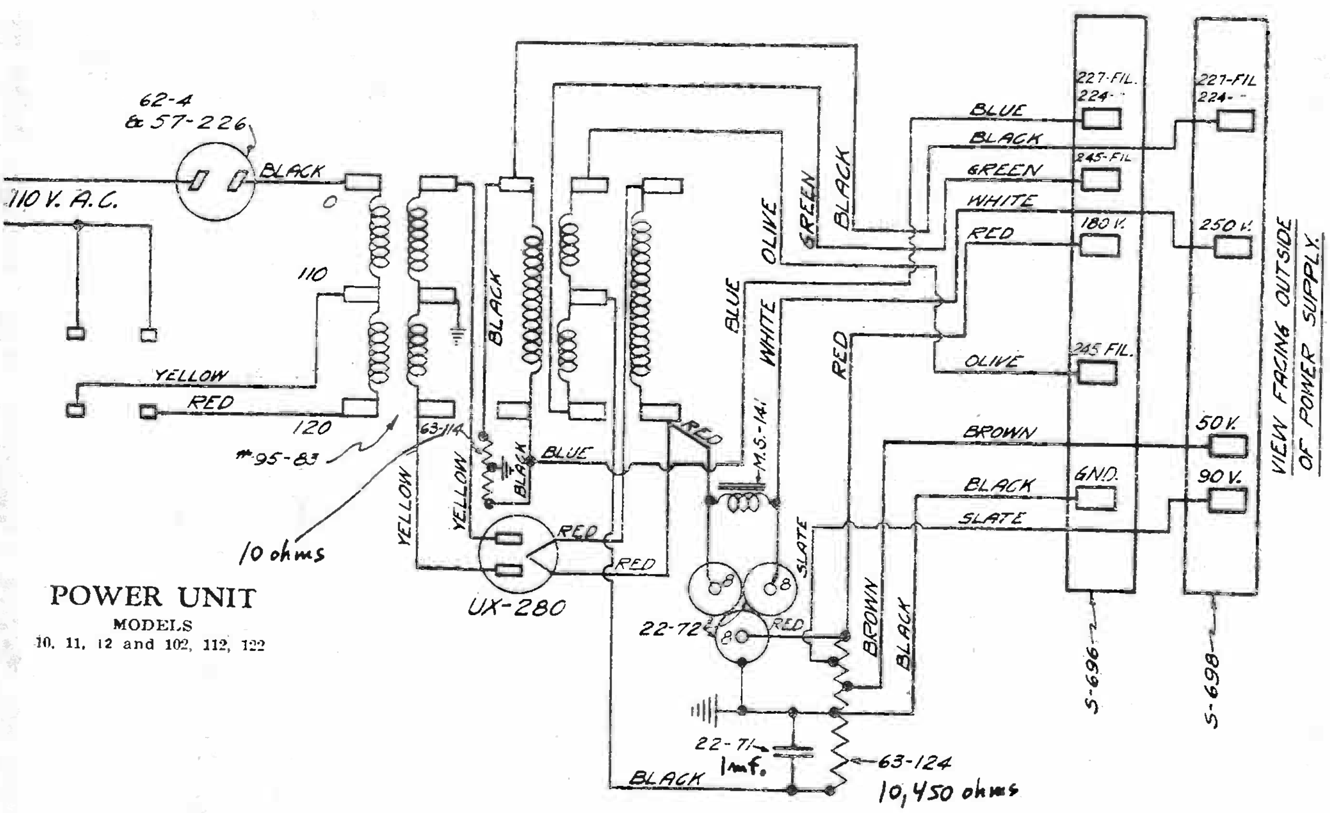
The new Hammarlund Screen-Grid Tube Shield is designed with special cut-outs for maximum cooling of the tube by up-draft of air, and at the same time provides the full-extent of shielding required for most efficient operation. Aluminum shell and base with large hole at the top for access to control grid of tube. Designed for use with sub-panel sockets. 60c each.

A radio-frequency Choke specially developed for modern high-gain screen-grid receivers. Aluminum shielded and polarized. Minimum external field. No undesired coupling to cause circuit instability or feed back. High inductance, low distributed capacity. Efficient, compact. Sub-panel connections. $1.50.

ZENITH RADIO CORP.



SUPER ZENITH RECEIVER
MODELS
10, 11, 12 and 102, 112, 122

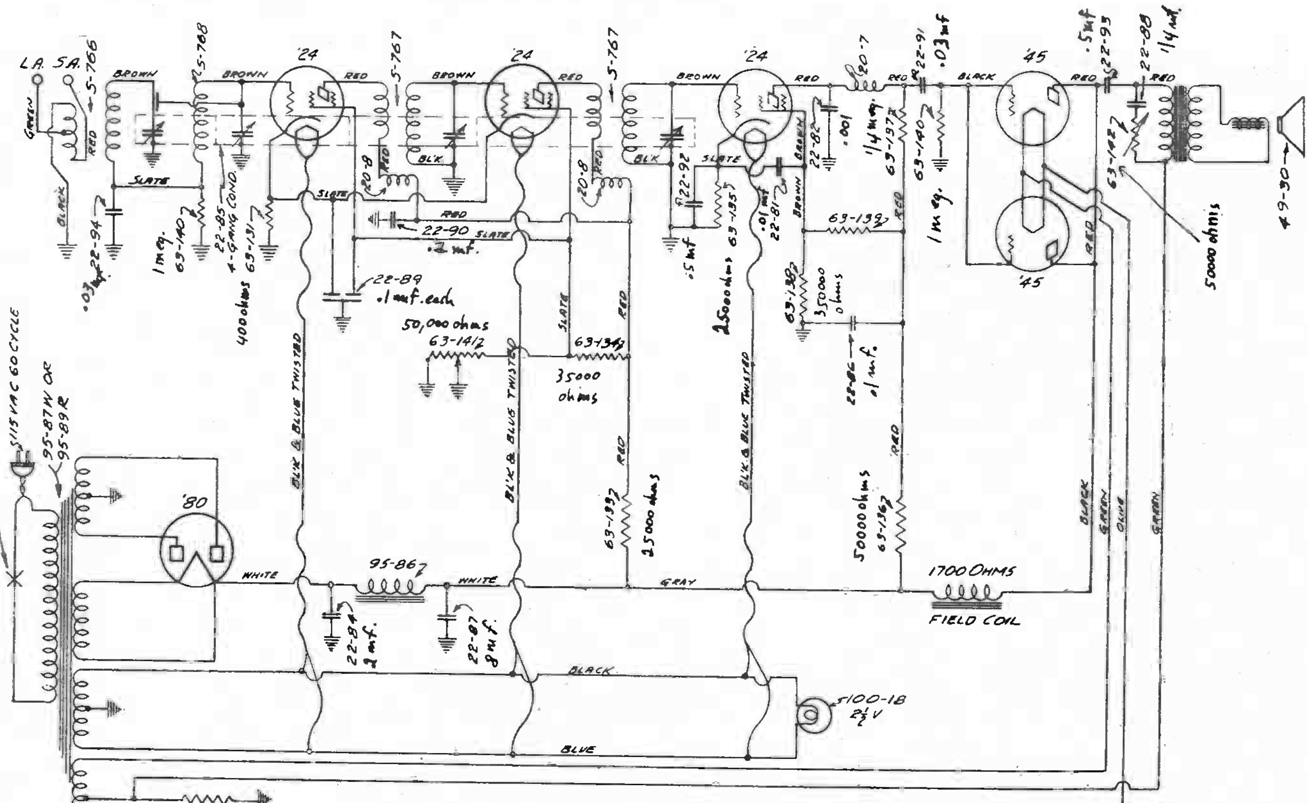


POWER UNIT
MODELS
10, 11, 12 and 102, 112, 122

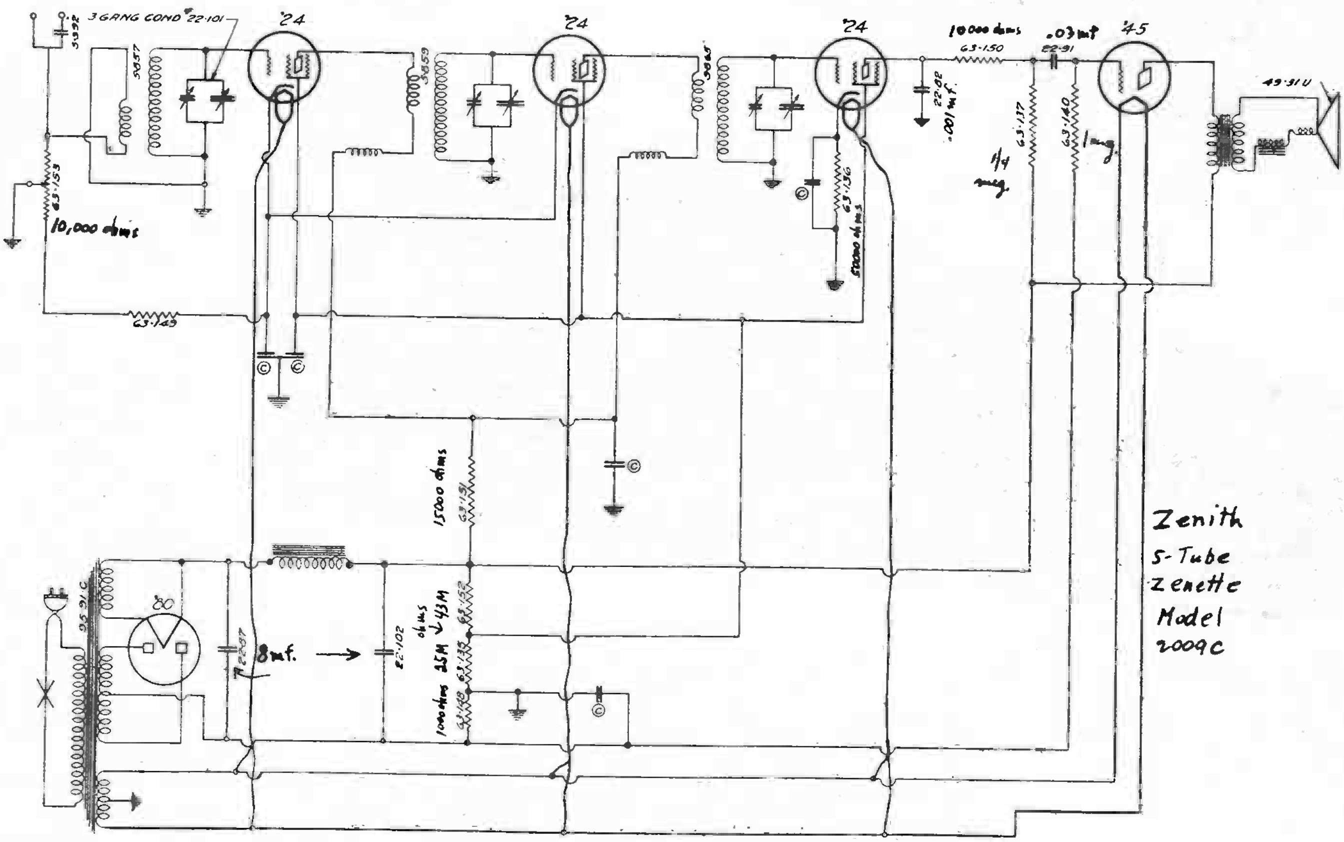
VOLTAGE READINGS AT SOCKETS USING WESTON 547 ANALYZER
Line Voltage 115. Fuse in 120 Volt Clips.

TYPE	POSITION	FIL. VOLTS	PLATE VOLTS	GRID VOLTS	SCREEN VOLTS	NORMAL PLATE M.A.	GRID TEST M. A.
224	1st R.F.	2.3	185	3.25	90	4	7
224	2nd R.F.	2.3	185	3.4	90	4	7.5
224	3rd R.F.	2.3	185	3.3	90	4	7.5
224	Det.	2.3	90	3	30	.25	.75
227	1st A.F.	2.3	170	12	—	6	7
245	P.P.	2.3	245	50	—	28	37
245	P.P.	2.3	245	50	—	28	37

ZENITH RADIO CORP.



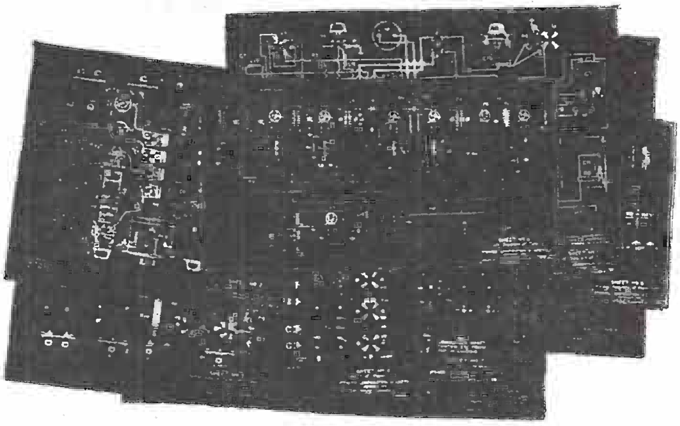
ZENITH 6 Tube Zenette Models A-B-C-D



Zenith 5-Tube Zenette Model 2009C

ALL FIXED CONDENSERS MARKED © INCLOSED IN ONE CONTAINER PART 22-103

All You Need to Know



to Build the World's Best Receiver

STENODE

Designed by Stenode Engineers under the direction of Dr. James Robinson

The absolutely revolutionary receiver which makes possible for the first time Superheterodyne reception so quiet you can hear no noise between stations . . . all musical tones as no other method can reproduce them.

Dr. James Robinson, former Chief of Wireless Research, British Royal Air Force, has given you an *entirely new* principle of radio reception in the STENODE, not merely a rehash of *worn out principles.* Build a STENODE! Be a radio leader in your community. Learn for yourself and prove to your friends what it means to have

500% Better Selectivity

STENODE tuning is so sharp that it requires a 300 to 1 ratio dial. Turned up to full sensitivity there is no noise in tuning the STENODE until a station is reached. Stations come in "crystal clear"—an absolute replica of the studio performance, whether 5 or 500 miles away. There is nothing else like it in all radio. STENODE owners are the envy of their friends—no matter what other circuits they use. A STENODE log is not merely a log of stations painfully identified, but of stations listened to with pleasure. Because—on locals or DX—the STENODE gives—

1000% More Freedom from Noise

By the STENODE principle the highest selectivity ever attained does not cut down tonal range or audio quality, which all engineers agree must be the case with other receivers. You can tune out heterodyne whistles on a STENODE while keeping your station clear and full in volume. STENODE gives—

Infinitely Better Quality

The STENODE opens up new fields for short-wave and television work, as well as broadcasting. Full details of all sorts of applications are given in the STENODE Data Book. Nine full-sized diagrams show where to place every part. How to make every connection is clearly told in STENODE Book of Directions. Your finished STENODE will put you into a new field of radio. Fill in and mail the coupon with your money order for the biggest value ever offered custom set builders.

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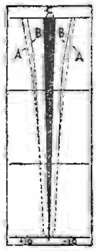
HEMPSTEAD GARDENS, L. I., N. Y.
(FORMERLY AMERICAN RADIOSTAT CORP.)



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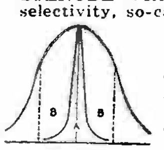
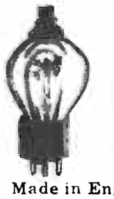
STENODE selectivity curve makes 10KC selectivity, so-called, look like broad tuning.



STENODE selectivity is compared, above, to that of ordinary receivers. All background noise is contained in outer curve. Stenodes curve, shaded, contains but 1-10 the total noise.



STENOTUBE. Only one required in each Stenode. This heart of the Stenode circuit consists of a quartz crystal ground to 175KC frequency and mounted in tube form for easy handling. Standard UX socket base. Price \$15.

None genuine without the inventor's signature.

Made in England

James Robinson

STENODE CORP. OF AMERICA
Hempstead Gardens, L. I., N. Y.

Enclosed find ☐ Money Order, ☐ Check, for \$.............. Please forward me ☐ STENOTUBE, ☐ BLUE PRINTS, DATA BOOK and DIRECTION BOOK for building STENODE.

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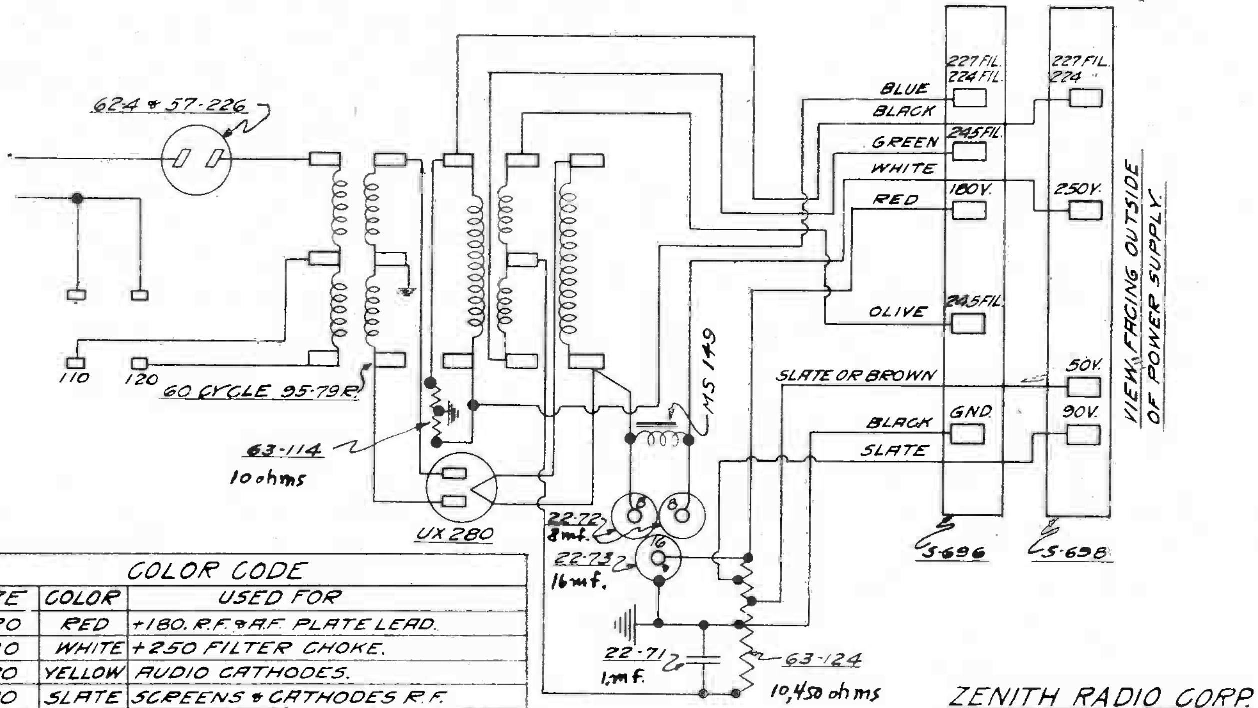
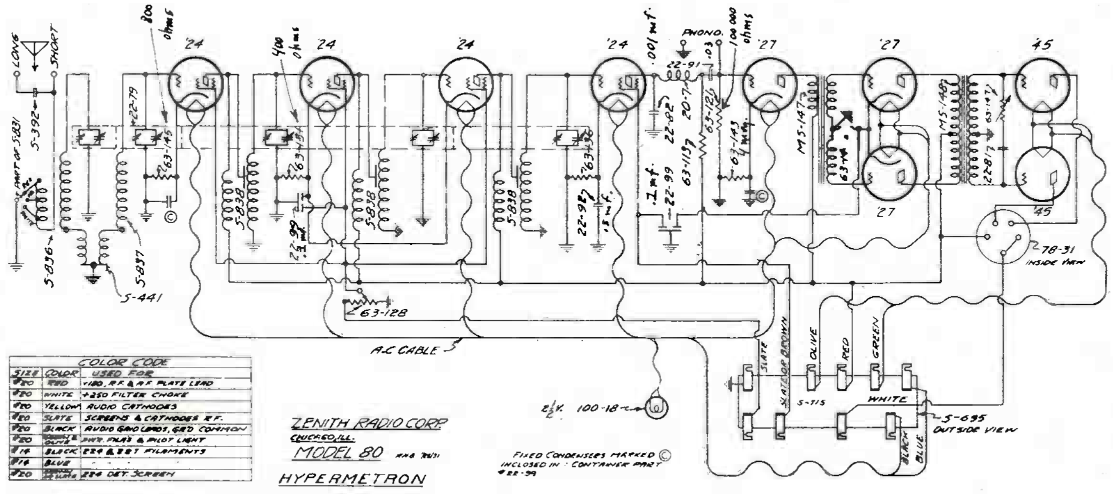
IF IT ISN'T A STENODE IT ISN'T A MODERN RECEIVER

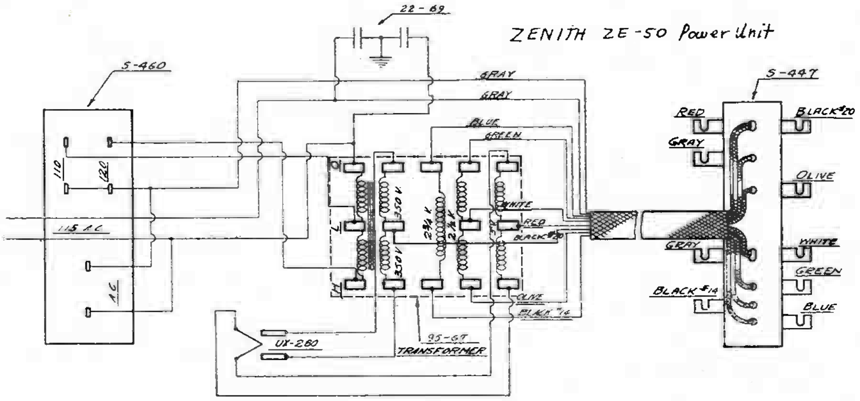
ZENITH RADIO CORP.



COLOR CODE		
SIZE	COLOR	USED FOR
#20	RED	+180. R.F. & A.F. PLATE LEAD.
#20	WHITE	+250 FILTER CHOKE.
#20	YELLOW	AUDIO CATHODES.
#20	SLATE	SCREENS & CATHODES R.F.
#20	BLACK	AUDIO GRID LEADS, GRD COMMON.
#20	GREEN & OLIVE	POWER FILA'S. & PILOT LIGHT.
#14	BLACK	224 & 227 FILAMENTS.
#14	BLUE	" "
#20	BROWN OR SLATE	224 DET. SCREEN.

ZENITH RADIO CORP.
CHICAGO, ILL.
MODEL 80
Power Unit





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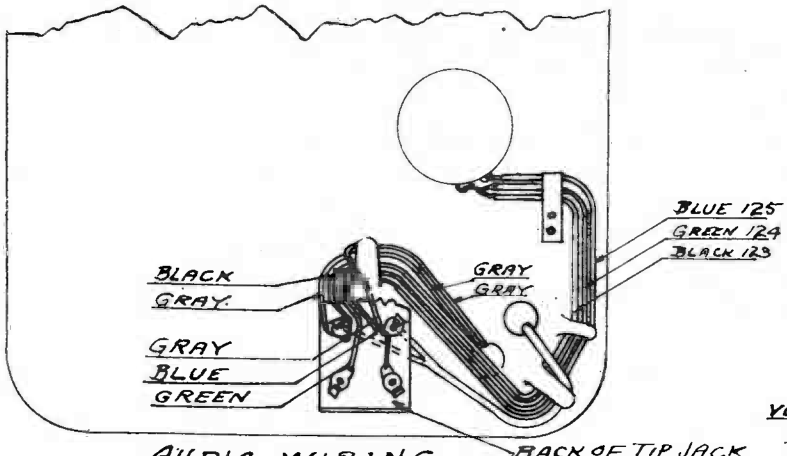
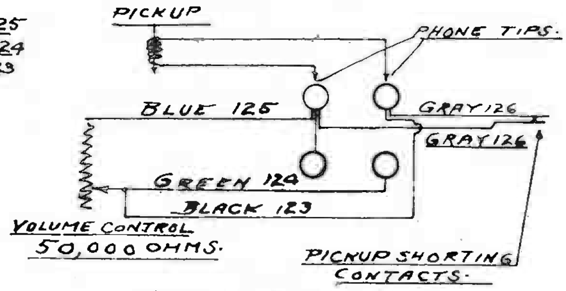
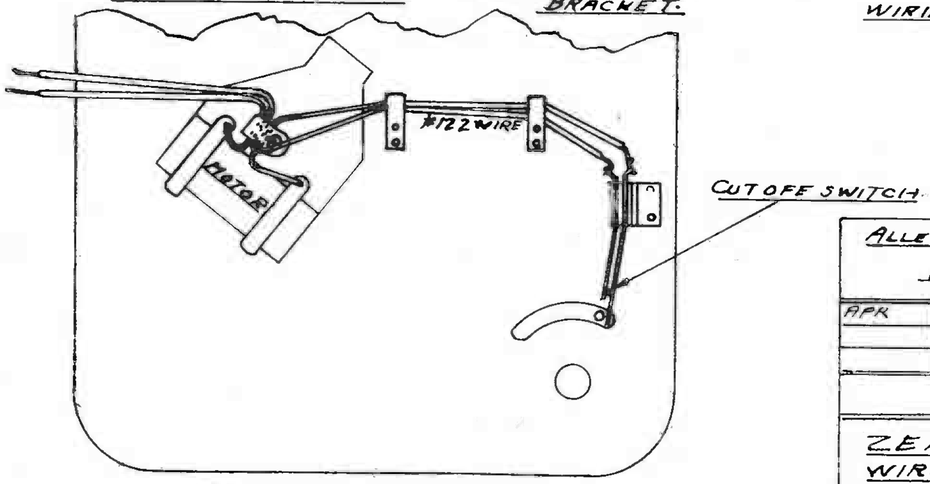


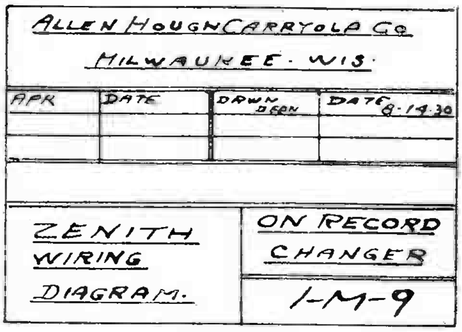
AUDIO WIRING.

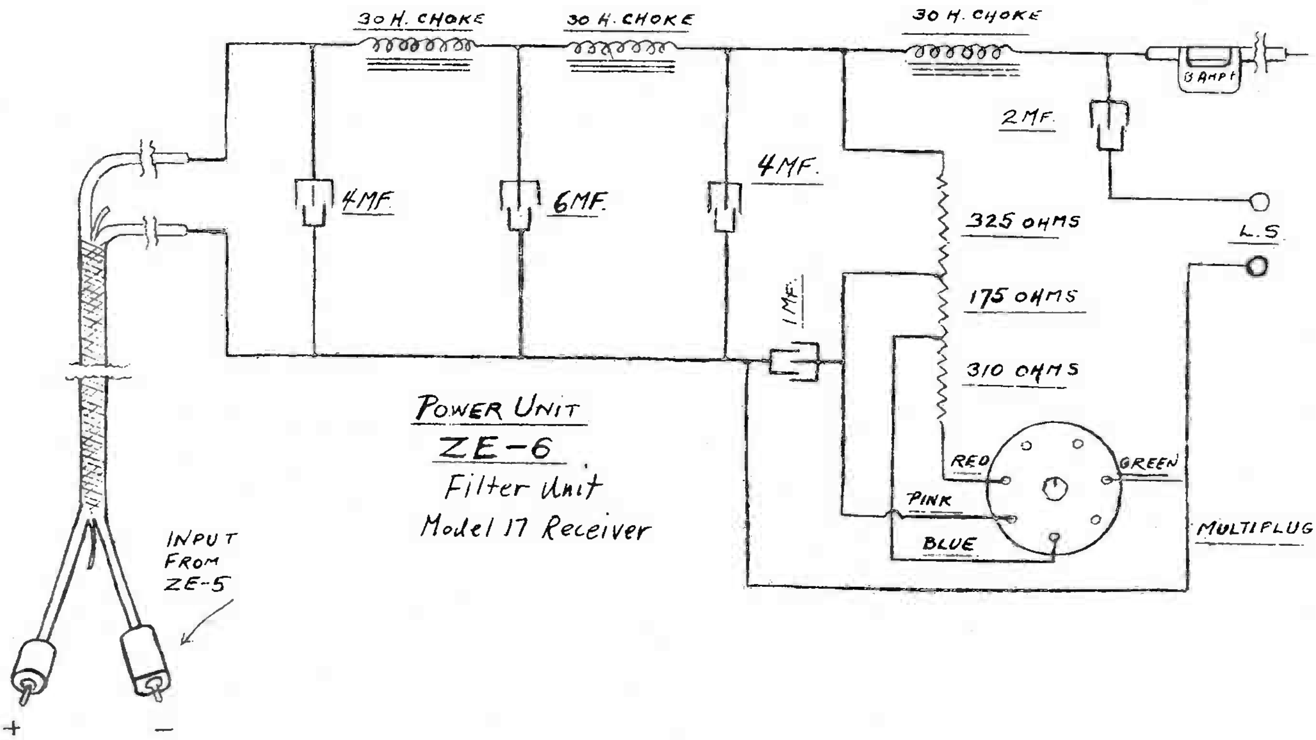


WIRING DIAGRAM.



MOTOR WIRING.





Power Unit
ZE-6
Filter Unit
Model 17 Receiver

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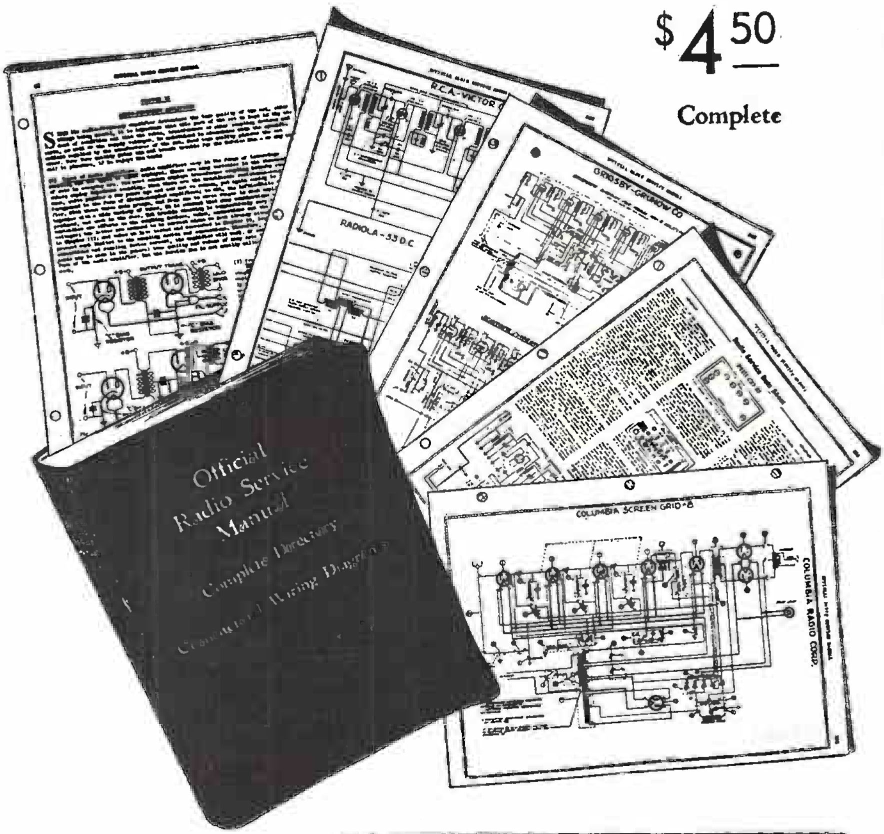

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INDEX TO COMMERCIAL WIRING DIAGRAMS

WITH the issuance of each set of supplements, a completely revised and up-to-date index is furnished. To use this first remove all of the pages from the cover; throw away the old index pages and replace them with the new ones;and then insert the supplement pages in their numerical and alphabetical order. Then replace the cover and the book is complete.

Often, the trade name of a set is known by the user of this book but the name of the manufacturer not known.

In searching for diagrams, if the particular diagram you desire cannot be found, be sure to look through the Miscellaneous section at the end of this index. If it is not listed there look through the *Trade Name Index;* this gives the name of the manufacturer for each trade name. Since all diagrams are listed in the index in alphabetical order in accordance with the manufacturers' names, it is absolutely necessary to know the name of the manufacturer before a particular diagram can be found.

In the supplements are included diagrams for which we have received requests. Wherever the diagrams that have been requested are not included in one set of supplements, they will appear in the first set published after we receive them. Many diagrams of obsolete sets are difficult to obtain, but we are using every possible effort to procure them.

We wish to express our thanks to the many subscribers who have taken such extreme interest in the MANUAL, and especially to those who have voluntarily submitted diagrams for publication in the supplements.

—THE PUBLISHERS.

A

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THIS COUPON IS GOOD FOR ONE QUESTION.

OFFICIAL RADIO SERVICE MANUAL 23
Question Coupon
NAME........
ADDRESS........
THIS COUPON IS GOOD FOR ONE QUESTION.

OFFICIAL RADIO SERVICE MANUAL 24
Question Coupon
NAME........
ADDRESS........
THIS COUPON IS GOOD FOR ONE QUESTION.

OFFICIAL RADIO SERVICE MANUAL 25
Question Coupon
NAME........
ADDRESS........
THIS COUPON IS GOOD FOR ONE QUESTION.