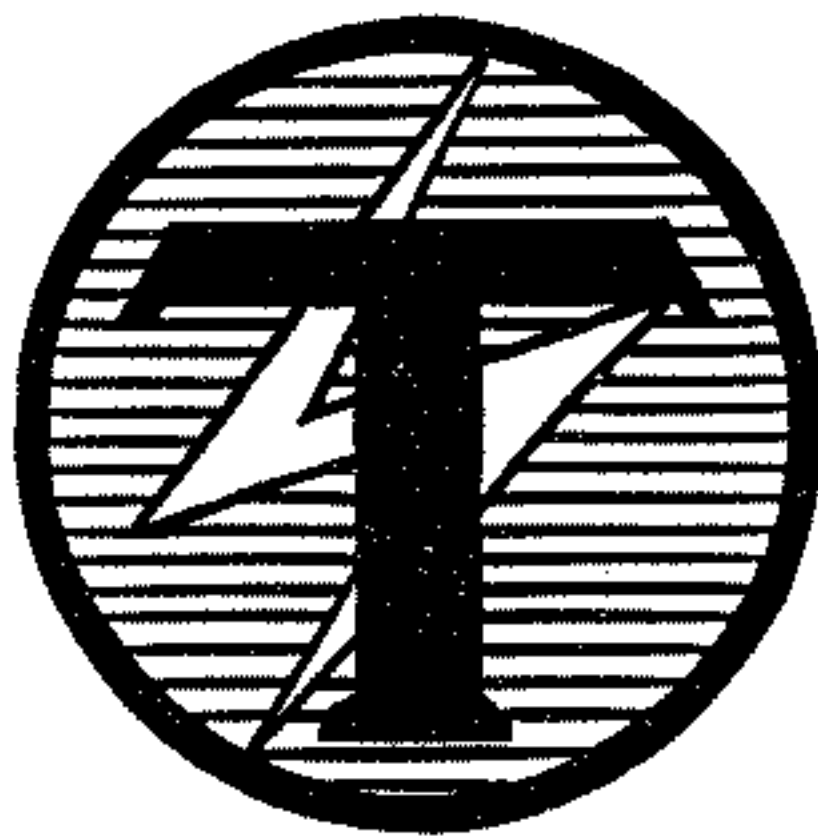


THORDARSON

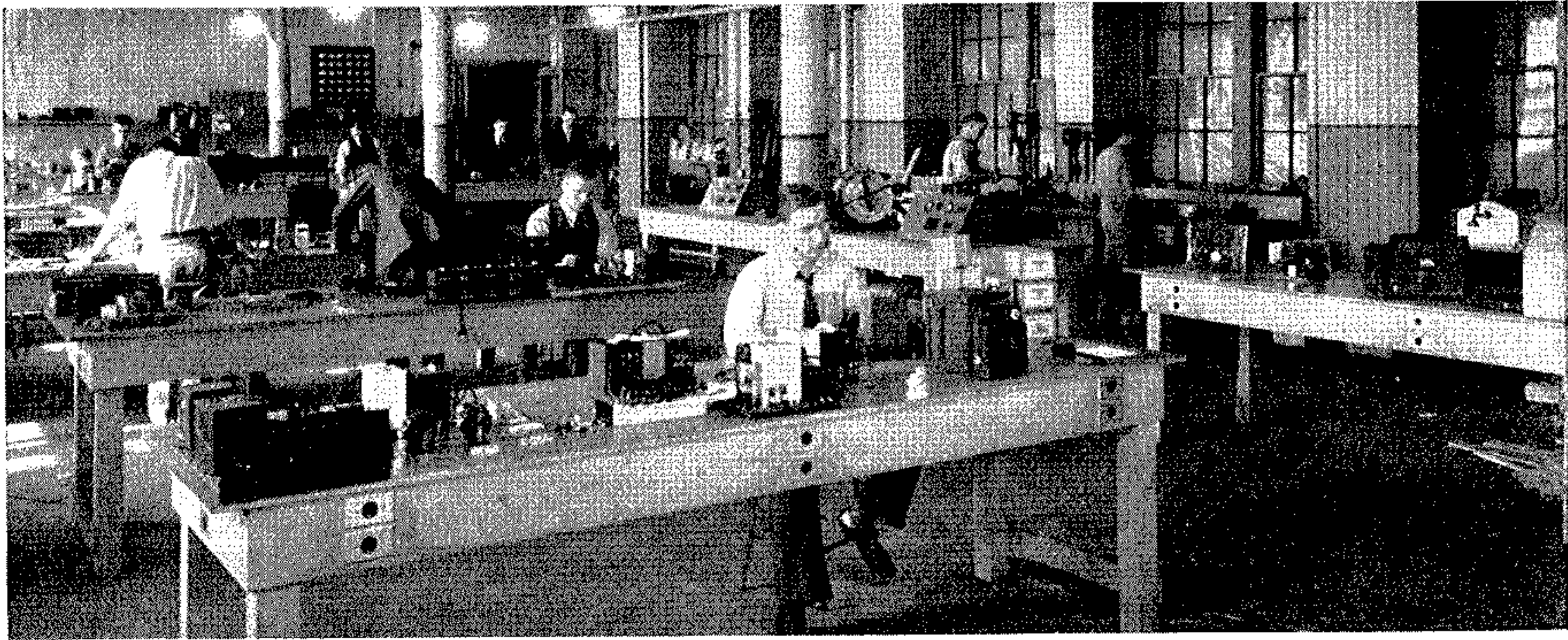


THORDARSON
ELEC. MFG. CO.
CHICAGO

No. 346-A

SOUND AMPLIFIER MANUAL

Price 15c



The THORDARSON Sound Laboratory in which new transformers are developed and tested.

The THORDARSON ELECTRIC MFG. CO. is now entering its forty-first consecutive business year. During this period it has grown from a small one-man shop to a place of leadership in the transformer field. Today it is the largest organization in the world devoted exclusively to the manufacture of transformers.

Chester H. Thordarson, founder and president, is entirely a self-made man. A native of Iceland, Mr. Thordarson came to this country at the age of five. As a young man of twenty-one he found employment in Chicago as an armature winder and became intensely interested in the study of physics. Six years later, with a capital of only seventy-five dollars, he founded the THORDARSON ELECTRIC MFG. CO.

Soon after the business was started, Mr. Thordarson began to invent and build larger electrical apparatus and to extend the THORDARSON line. During every one of its forty business years, the company has grown

and increased its prestige until today the THORDARSON trade-mark is recognized everywhere as a guarantee of dependable, efficient design and construction.

The THORDARSON factory is more than an assembly plant. All phases of transformer manufacturing, engineering, core and case stamping, coil winding, impregnating, enameling, assembly, and testing are conducted under one roof. Such features as heat treating laminations, use of special core materials, and high speed precision controlled winding machines, now being featured by many transformer manufacturers, were developed by THORDARSON many years ago and today are accepted as standard.

THORDARSON maintains a well-equipped Sound Laboratory in which trained technical men are constantly at work. Directly in charge of research in the THORDARSON Sound Laboratory is Jerome H. Kleker. Mr. Kleker has been closely associated with sound equipment development since its inception, and has traveled extensively in his work, supervising the installation of theatrical sound systems in Vienna, Bucharest, Prague, Constantinople, Warsaw, and other cities in Germany, Czecho-Slovakia, Poland, Austria, Hungary, Roumania, and Turkey; as well as in such South American states as Panama, Ecuador, and Columbia. With such an organization backing up every THORDARSON Transformer, the purchaser is assured of the most advanced design, reliable construction, and tested performance.



*Jerome Kleker,
Sound Engineer*



Mr. C. H. Thordarson at work in his library.

THORDARSON



SOUND AMPLIFIER MANUAL

No. 346-A

THE THORDARSON Sound Amplifier Manual has been compiled to assist the experimenter and amplifier constructor in building and installing public address and other sound systems incorporating matched components.

Years of experience in building sound equipment have proved to THORDARSON engineers that greatly increased efficiency and high fidelity reproduction are possible only through the use of matched transformers. The circuits given in the following pages are designed to bring these advantages to every constructor of sound amplifying equipment.

Every tube, every transformer, and every component part of the circuits shown are carefully matched in performance. Voltages, currents, resistances, and capacities have been designed to the highest theoretical efficiency, and then carefully checked from a practical operation

standpoint. As a result, the highest possible output is obtained without overloaded or underloaded circuits—every unit is fully balanced or matched. Thus the greatest power output is made available at the lowest expenditure for tubes and equipment, while distortion is reduced to a minimum.

Simplicity of design has been obtained without affecting quality of tone. From the diagrams and data given, a high quality amplifier can be constructed with definite assurance of satisfactory operation. Amplifiers are shown ranging from 2 watts to 100 watts in power output, covering practically all requirements. The input circuits have been treated separately, as experience has shown that different installations require different sources of sound.

The THORDARSON sound engineering staff will be glad to render any further assistance you may require in the solution of your sound problems. Do not hesitate to write.

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THORDARSON Audio Coupling Transformer Performance Charts

In high fidelity or wide-range transmission or amplification, it is of the greatest importance that the audio coupling transformers show the proper response over the entire audible frequency range.

The performance curves shown below were obtained from representative THORDARSON Coupling Transformers—line to line, line to grid, interstage coupling, and a complete amplifier—NOT from just a single unrepresentative model.

The shape of these frequency response curves is not just the result of empirical design, but is the shape that long experimentation has shown to give the most desirable

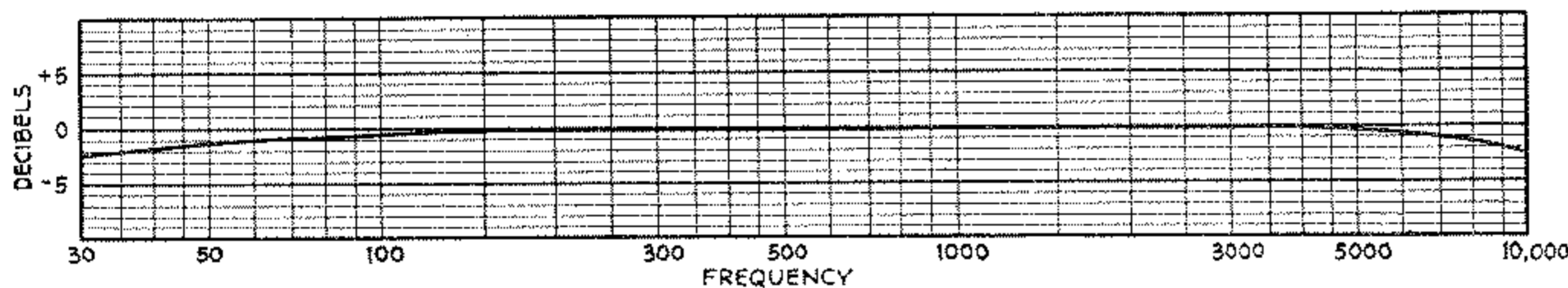
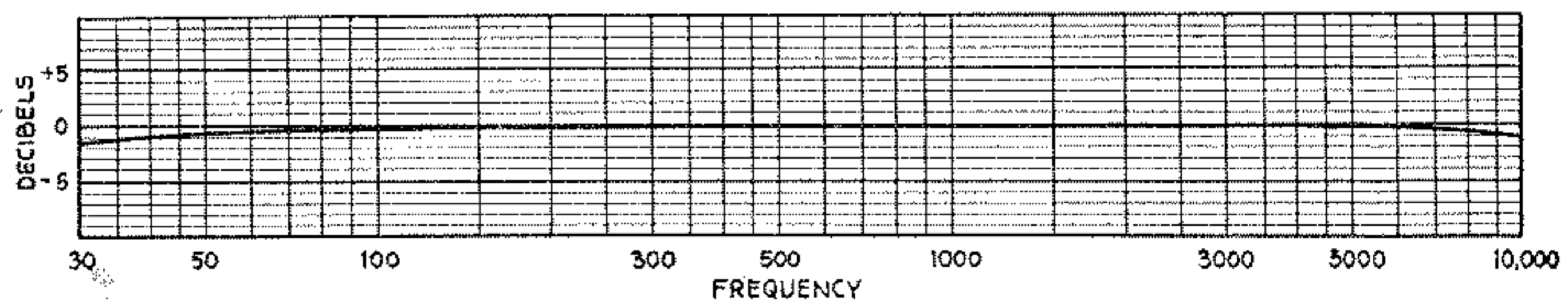
over-all response when incorporated in a complete amplifier.

THORDARSON transformers have been developed to afford both high and low note compensation—to give not just a linear relation between stages, but **ACTUAL LINEAR FREQUENCY OUTPUT** over the audible range—the true test of high fidelity reproduction.

Accurate, verified statements of performance are supplied with every THORDARSON transformer. All ratings of current, voltage, frequency response, and other important factors are the result of actual test in the THORDARSON laboratories.

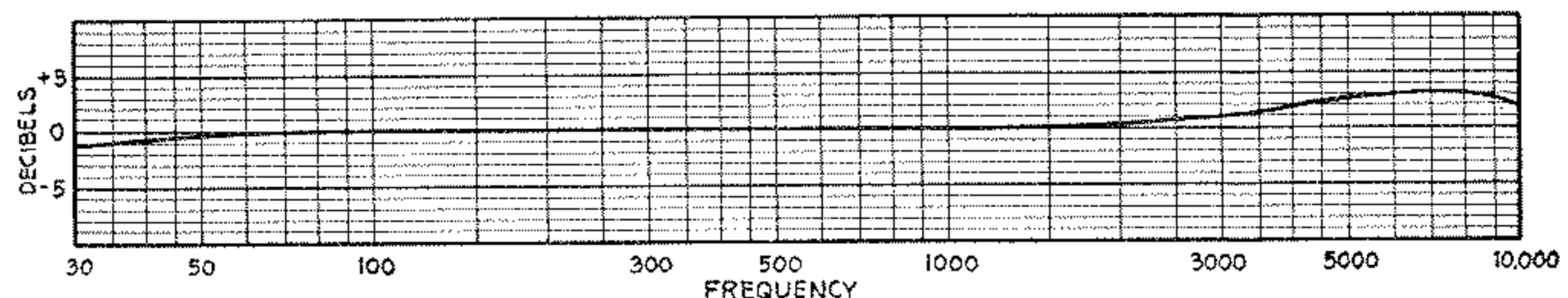
Representative THORDARSON Frequency Response Curves

T-6195
Line to Line
200 or 50-ohm to
200 or 50-ohm

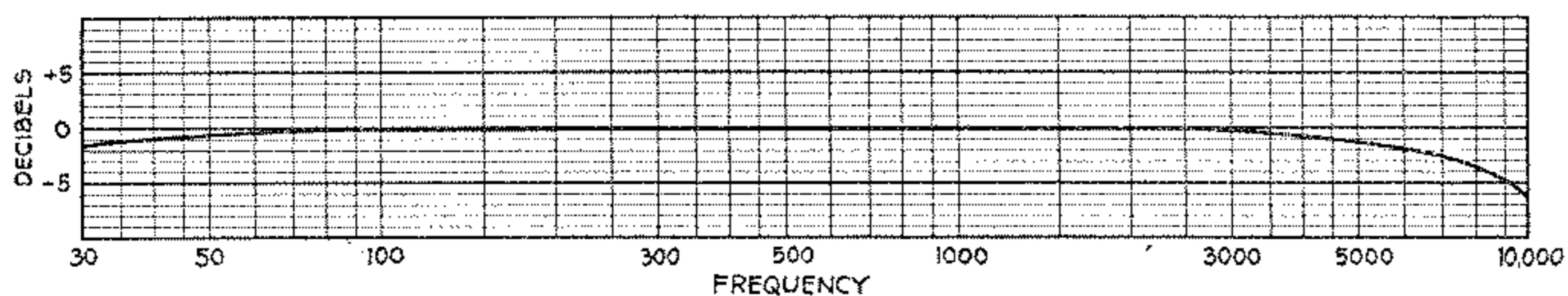


T-6193
Line to Grid

T-5870
Interstage
P.P. 56 to P.P. 2A3



Two-Stage Amplifier
using Type 56 and 2A3
Tubes
T-5870 and T-6754



Type 45 Tube Push-Pull Output

» » Class A Amplifier

Output: Five watts

Stages: Three

Tubes: Two 45's, two 56's, and one 80

This amplifier has been specially designed to provide extremely high quality amplification at low power output utilizing the dependable type 45 tubes in push-pull.

This tube, while not a recent development, has won ever increasing acceptance for low power high quality output. Two transformer coupled type 56 tube stages in front of the output stage provide ample gain for direct operation of high or low level carbon microphones, phonograph pickup, or direct connection from detector output of a radio tube. Pages 28 and 29 show suitable input and mixing circuits for this amplifier.

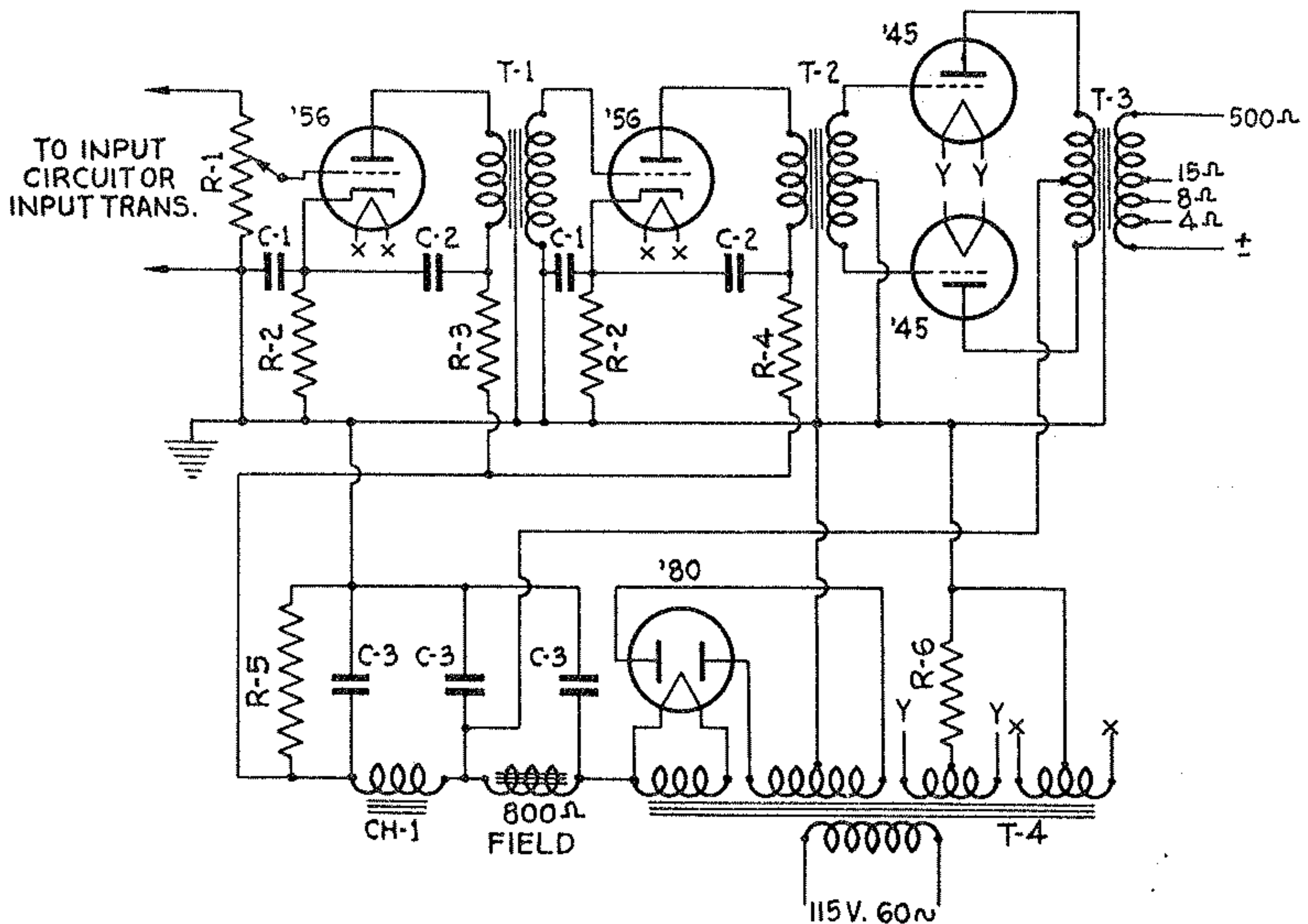
The output of the final stage is coupled to a THORDARSON T-6748 Universal Impedance Output Transformer. This provides secondary impedances of 4, 8, 15, or 500-ohm. The 4, 8, 15-ohm taps are for connecting directly to the voice coil of a dynamic speaker, and the 500-ohm tap is used where the speaker is located more than 30 feet from the amplifier. The 500-ohm tap may also be used to supply one or more magnetic speakers. See pages 30 and 31 for information on speaker circuits. Operation is entirely from a 115-volt, 60-cycle, A.C. line, with current supplied for an 800-ohm dynamic speaker field. If it is not convenient to employ the dynamic speaker field as a choke in the power supply as shown, it should be replaced with a T-1607 Filter Choke and a 400-ohm, 10-watt resistor connected in series.

THORDARSON Equipment

- T-1 T-5738 Interstage Transformer
- T-2 T-5741 Interstage Transformer
- T-3 T-6748 Output Transformer
- T-4 T-6363 Power Transformer
- CH-1 T-1892 Filter Choke

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 2,500-ohm carbon resistor—1 watt
- R-3 25,000-ohm carbon resistor—1 watt
- R-4 15,000-ohm carbon resistor—1 watt
- R-5 30,000-ohm wire wound resistor—10 watt
- R-6 750-ohm wire wound resistor—10 watt
- C-1 4-mfd. electrolytic condenser—25 volt
- C-2 2-mfd. electrolytic condenser—450 volt
- C-3 triple 8-mfd. electrolytic condenser—450 volt



Type 2A5 Tube (Pentode) Push-Pull Amplifier

« «

THORDARSON Equipment

- T-1 T-5741 Interstage Transformer
- T-2 T-6751 Output Transformer
- T-3 T-5003 Multiple Secondary Power Transformer
- CH-1 T-1892 Filter Choke

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 2,500-ohm carbon resistor—1 watt
- R-3 10,000-ohm carbon resistor—1 watt
- R-4 205-ohm wire wound resistor—10 watt
- R-5 25,000-ohm wire wound resistor—10 watt
- C-1 4-mfd. electrolytic condenser—25 volt
- C-2 2-mfd. electrolytic condenser—450 volt
- C-3 Triple 8-mfd. electrolytic condenser—450 volt

Output: Six watts

Stages: Two

Tubes: Two 2A5's, one 56, and one 80

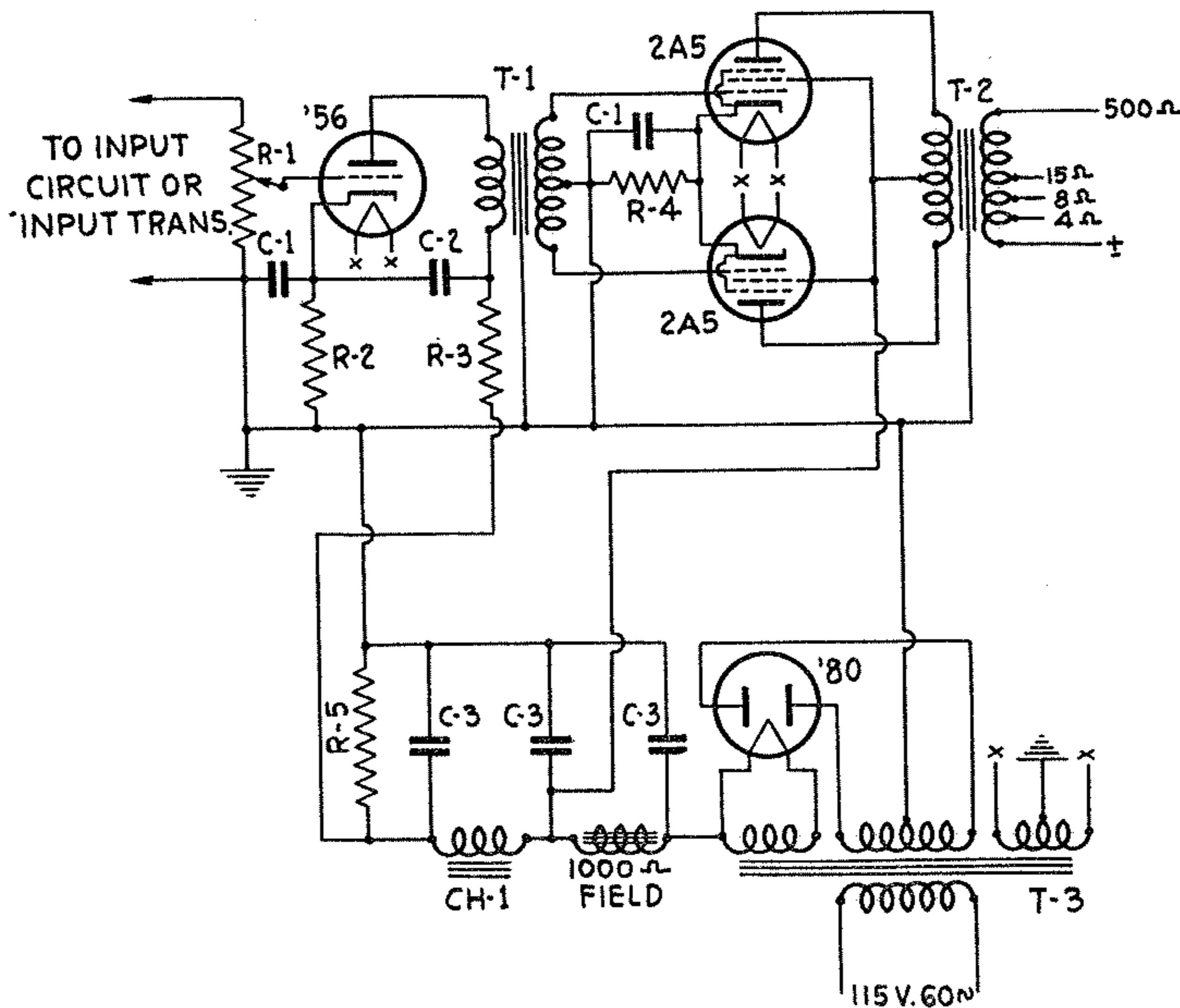
The exceptionally high gain of type 2A5 pentode tubes is utilized in this amplifier to make possible the reproduction from carbon microphone, magnetic phonograph pickup, or radio tuner with but two stages of amplification.

Extreme simplicity of circuit has been achieved. All amplifier tube filaments are operated at 2½ volts, requiring a power transformer with but two filament windings:

one for the amplifier tubes and one for the rectifier.

Gain or output is controlled by R1, a variable potentiometer type rheostat across the grid of the input tube. See pages 28 and 29 for suitable input circuits and input transformer recommendations.

Current for a 1000-ohm dynamic speaker field is supplied by the amplifier. If magnetic speakers only are to be used, or if it is not convenient to connect the speaker field in the circuit as shown, it should be replaced by a T-1607 Filter Choke and a 600-ohm, 10-watt resistor connected in series.



Type 53 Tube Push-Pull Class B Amplifier

Output: Ten watts

Stages: Three

Tubes: Two 53's, one 56, and one 80

Type 53 tubes are used by this amplifier in both the output and second driver stages. As a driver tube, the type 53 has its grids and plates connected in parallel, as may be seen in the accompanying diagram.

The first stage employs a type 56 tube resistance coupled to the type 53 tube, thus providing three stages—the overall gain of which is sufficient for reproduction from carbon microphone, magnetic pickup, or radio tuner. See pages 28 and 29 for input circuit data and input transformer recommendations.

The output is coupled to a variable impedance transformer which may be replaced by a transformer of single output impedance if desired.

The power supply employs a 1000-ohm field of a dynamic speaker as one choke, thus providing current for the operation of a dynamic speaker field.

The entire amplifier may be compactly constructed without danger of feed-back or other troubles frequently arising from close location of parts.

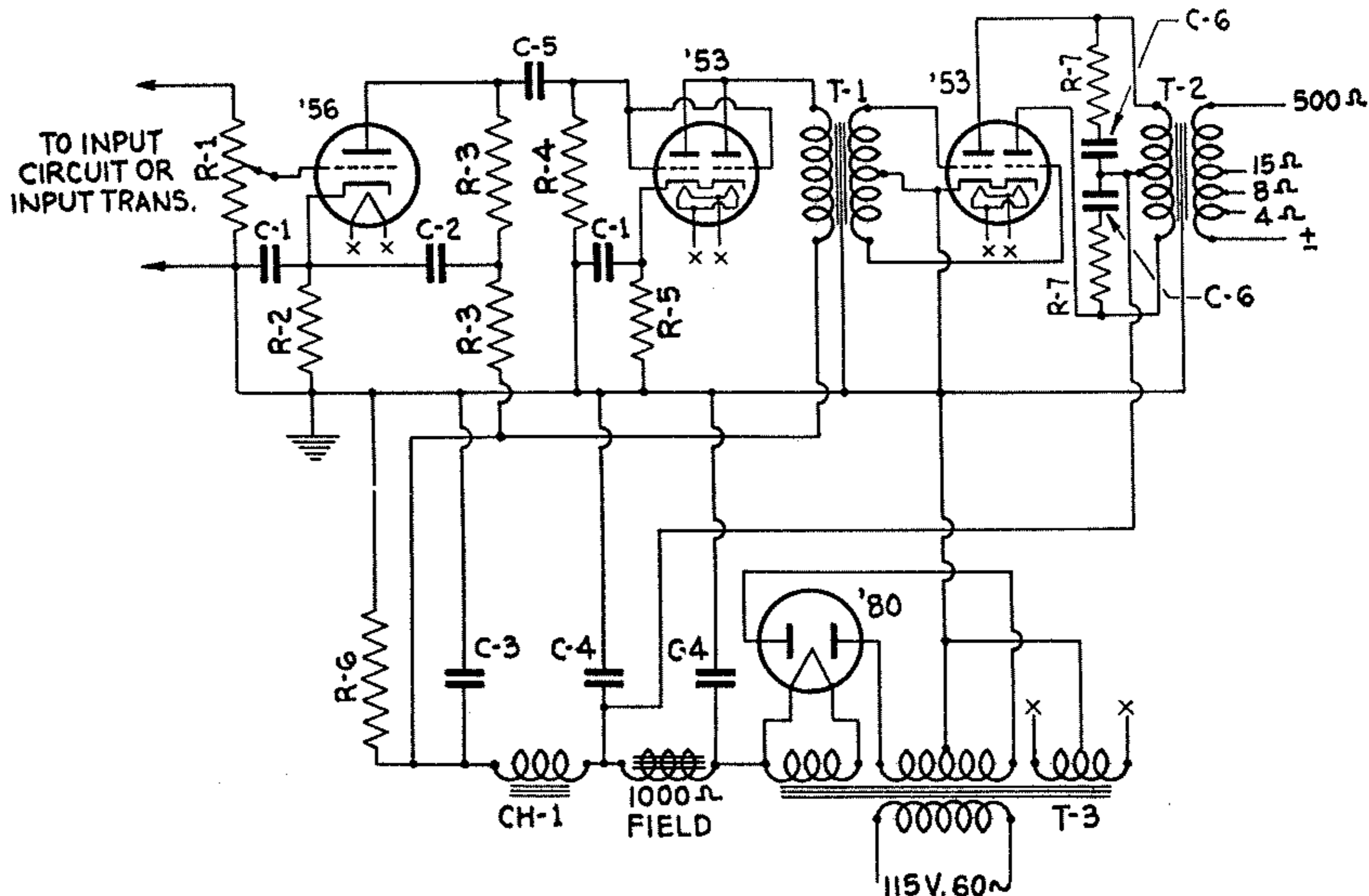
THORDARSON Equipment

- T-1 T-6747 Interstage Transformer
- T-2 T-6748 Output Transformer
- T-3 T-5003 Power Transformer
- CH-1 T-1892 Filter Choke

- R-3 50,000-ohm carbon resistor—1 watt
- R-4 500,000-ohm carbon resistor—1 watt
- R-5 950-ohm carbon resistor—3 watt
- R-6 30,000-ohm wire wound resistor—10 watt
- R-7 7,500-ohm wire wound resistor—10 watt
- C-1 4-mfd. electrolytic condenser—25 volt
- C-2 2-mfd. electrolytic condenser—450 volt
- C-3 4-mfd. electrolytic condenser—450 volt
- C-4 10-mfd. electrolytic condenser—450 volt
- C-5 .01-mfd. paper condenser—600 volt
- C-6 .03-mfd. paper condenser—600 volt

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 5,000-ohm carbon resistor—1 watt



Type 50 Tube Output Push-Pull Class A Amplifier

Output: Twelve watts

Stages: Three

Tubes: Two 50's, three 56's, and one 5Z3

This amplifier has been designed to provide high quality Class A amplification at medium power output.

The entire unit is operated from the 115-volt, 60-cycle, A.C. line. A 5Z3 rectifier tube is used in conjunction with a T-6826 Power Transformer having one high voltage winding and three filament windings. The cost of the filter system has been kept extremely low through the use of standard electrolytic condensers in series to afford sufficient voltage

rating for the high plate potential used on the type 50 tube. The positive (plus) side of the electrolytic condensers C-3 should be connected to the choke side of the filter system.

This amplifier as shown does not provide current for a dynamic speaker field. However, choke CH-2 may be replaced by a 500-ohm dynamic speaker field if the windings of the speaker field are capable of carrying 125 ma. Care should be taken that a speaker field of lower current rating is not connected.

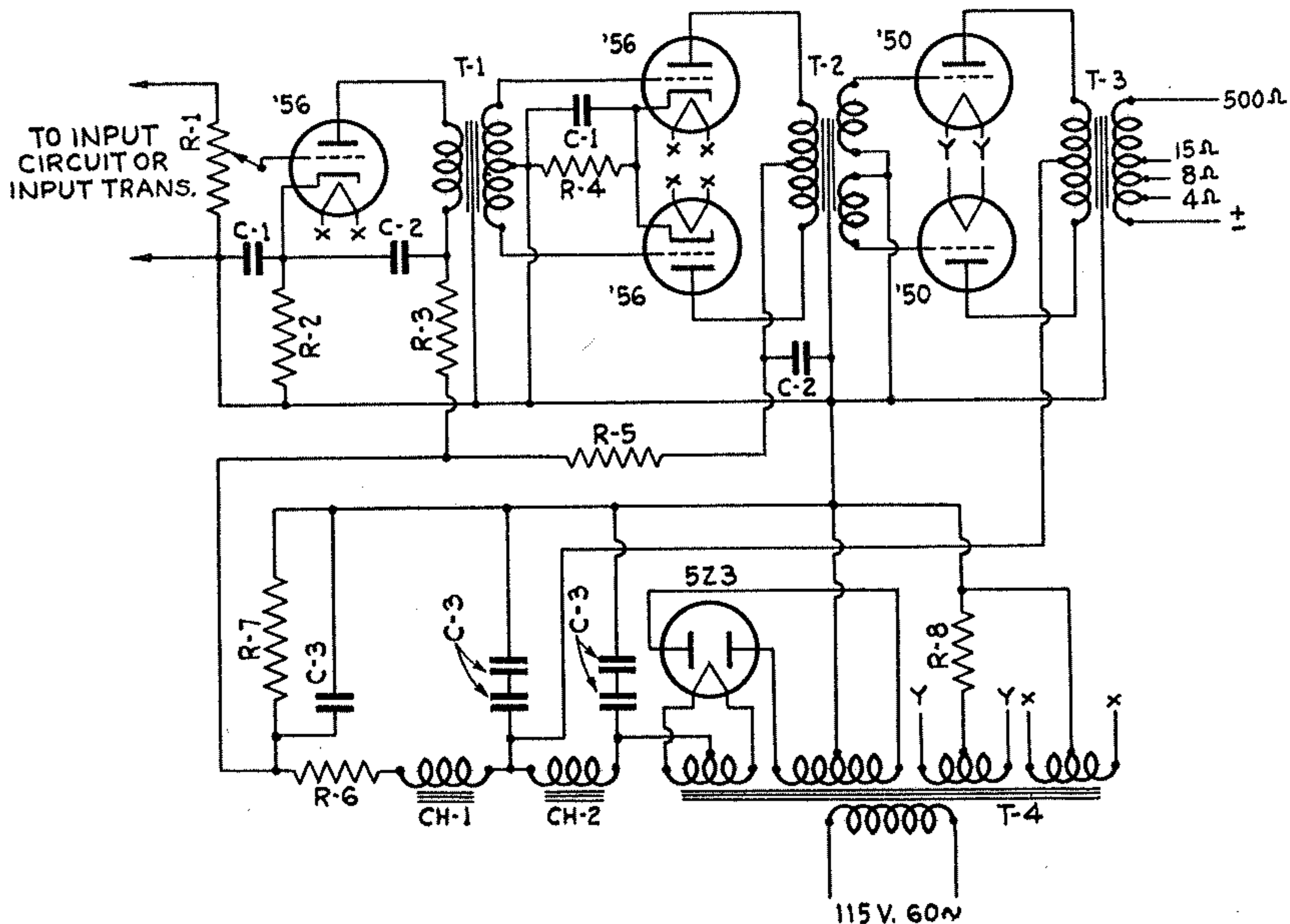
- CH-1 T-1892 Filter Choke
- CH-2 T-1700-B Filter Choke

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 2,500-ohm carbon resistor—1 watt
- R-3 25,000-ohm carbon resistor—1 watt
- R-4 1,300-ohm carbon resistor—1 watt
- R-5 5,000-ohm carbon resistor—3 watt
- R-6 10,000-ohm wire wound resistor—20 watt
- R-7 15,000-ohm wire wound resistor—20 watt
- R-8 750-ohm wire wound resistor—20 watt
- C-1 4-mfd. electrolytic condenser—25 volt
- C-2 2-mfd. electrolytic condenser—450 volt
- C-3 8-mfd. electrolytic condenser—450 volt

THORDARSON Equipment

- T-1 T-5741 Input Transformer
- T-2 T-5870 Interstage Transformer
- T-3 T-6594 Output Transformer
- T-4 T-6826 Power Transformer



Push-Pull Parallel Type 53 Tube Output Class B Amplifier

Output: Sixteen watts

Stages: Three

Tubes: Four 53's, one 56, and one 80

This amplifier has an output stage employing two type 53 tubes in push-pull parallel Class B to provide 16 watts audio output.

Two type 53 tubes in Class A push-pull parallel are used for the driver stage. A single type 56 tube transformer coupled forms the input stage. The transformers used are shielded with solder lugs and leads taken out of the bottom. This enables the constructor to mount all the parts on a metal base with all wiring out of sight.

Care should be taken when positioning the transformers to see that the input is located as far as possible from the power and output transformers. Such precautions help to eliminate the possibility of undue hum and feedback. The material used for the base should

be non-magnetic, such as Eraydo or aluminum. For input circuit and input transformer data, see pages 28 and 29.

The resistors and condensers shunting the primary of the output transformer tend to prevent distortion at the higher frequencies by holding the speaker impedance to a given value. All speaker systems increase their impedance as the frequency rises. With Class B amplifiers especially, this is not desirable. If it is found that there is insufficient high frequency amplification for a given installation, the condensers may be changed to a lower capacity. Likewise, if a lower amplification of the higher frequencies is wanted, larger condensers should be used. For speaker connections and output circuits, see pages 30 and 31.

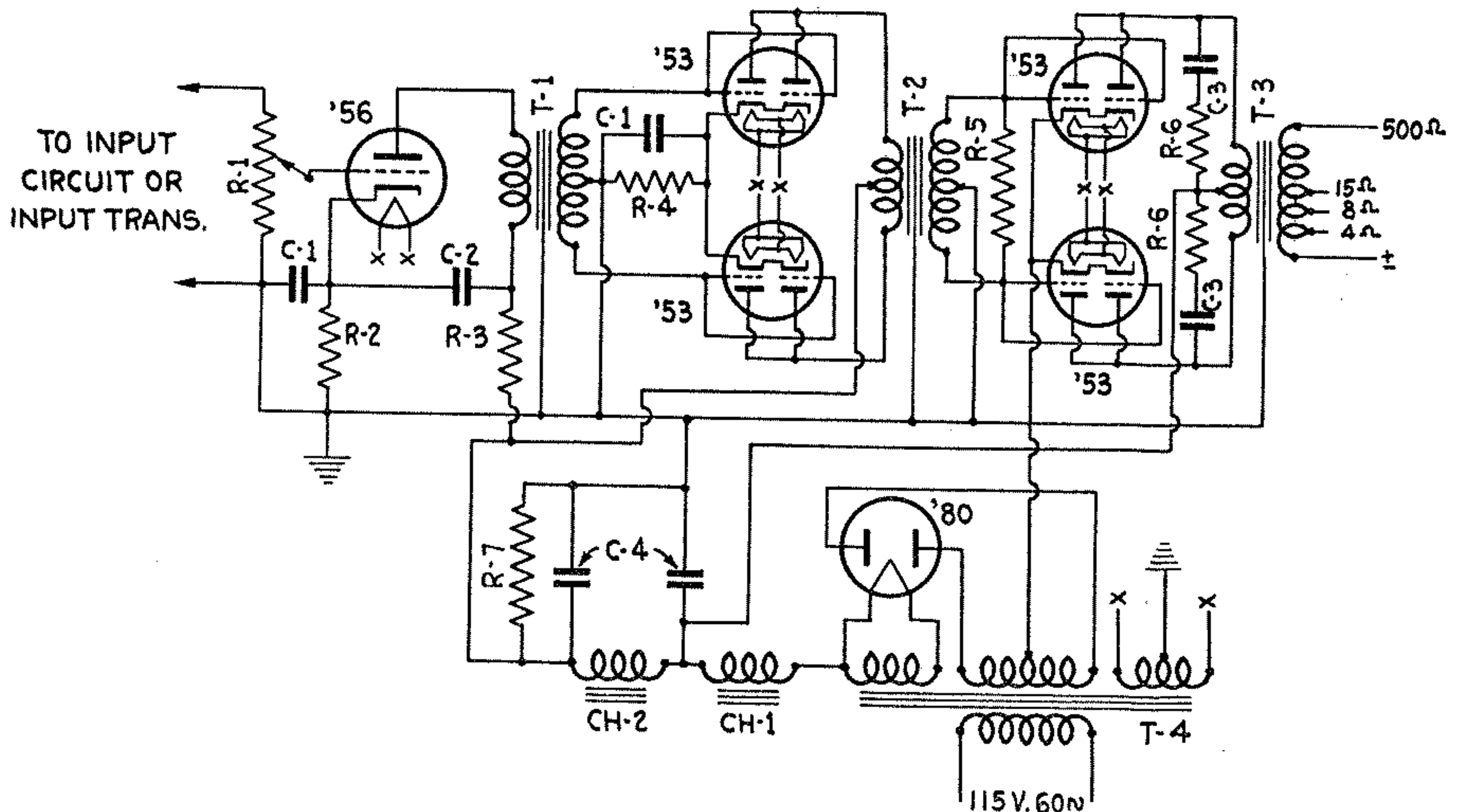
The circuit does not provide current for the excitation of a dynamic speaker field. Usually a speaker field is substituted for one of the chokes in the filter supply. In this circuit, the current fluctuation is so great that satisfactory operation is impossible. See page 31 for separate field supply.

THORDARSON Equipment

- T-1 T-5741 Interstage Transformer
- T-2 T-6790 Interstage Transformer
- T-3 T-6752 Output Transformer
- T-4 T-5604 Combination Plate & Filament Transformer
- CH-1 T-5754 Input Choke
- CH-2 T-1892 Filter Choke

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 2,500-ohm carbon resistor—1 watt
- R-3 25,000-ohm carbon resistor—1 watt
- R-4 475-ohm carbon resistor—3 watt
- R-5 100,000-ohm carbon resistor—1 watt
- R-6 3,500-ohm carbon resistor—3 watt
- R-7 30,000-ohm wire wound resistor—10 watt
- C-1 4-mfd. electrolytic condenser—25 volt
- C-2 2-mfd. electrolytic condenser—450 volt
- C-3 .03-mfd. paper condenser—400 volt
- C-4 Dual 8-mfd. electrolytic condenser—450 volt



Push-Pull Type 2A3 Tube Output » » Class A Amplifier

Output: Fifteen watts

Stages: Three

Tubes: Two 2A3's, three 56's, and one 5Z3

The new type 2A3 tube makes possible the construction of a Class A amplifier that will develop approximately 15 watts of audio power with only 2½% of harmonic distortion. The frequency response of the amplifier is equal to the standard of those used in most broadcast stations, the variation from 60 to 7000 cycles being a fraction of a decibel. Since the popular definition of the decibel is that it is the unit increase in power which can just be detected by the average ear, no frequency discrimination can be detected by ear.

The potentiometer type rheostat R1 affords control of output or gain. For input circuits or input transformer recommendations, see pages 28 and 29. Sufficient gain is provided for direct coupling by a transformer of magnetic phonograph pickup, microphone, and detector output of a radio tuner.

The frequency response curve shown was taken from the volume control to the plate circuit of the power tubes. These measurements were taken at a power level of 15 watts. The amplifier has an overall gain of 68.76 decibels at 1000 cycles.

The power supply unit is of the conventional type, using the new type 5Z3 rectifier tube. Electrolytic condensers may be employed throughout the filter system, since the plate potential to the power tubes is only 300 volts. The filament winding of the power transformer is designed to carry six additional heaters of the one-ampere tubes (56-57-58) in addition to the tubes of the amplifier. Bias for the type 2A3 tubes is secured by means of a resistor in the negative lead of the power supply. This makes the bias more stable, since it is affected less by changes in plate current than when self-bias is used. In case it is desired to supply plate current to the R. F. end of a receiver from the same supply, a 200-ohm variable and

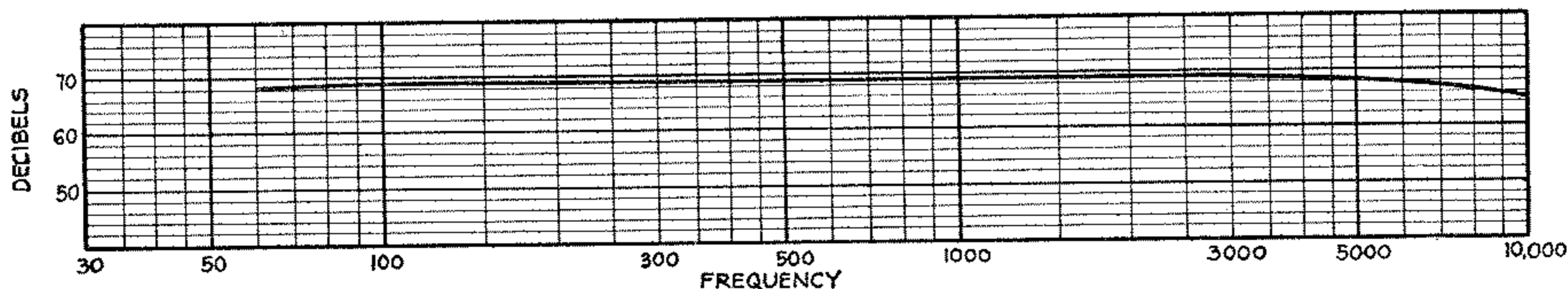
a 400-ohm fixed resistor are used in series as the 2A3 biasing resistors. With a milliammeter in the plate circuit of the power tubes, the bias should be adjusted until the pair of type 2A3 tubes draw 80 ma. without signal input. The amplifier, pickup, and phonograph motor should always be grounded to prevent spurious oscillation. Note the negative terminal of the three 8-mfd. electrolytic condensers is not connected to ground. Since the container of these condensers usually serves as this terminal, it is necessary to insulate when mounting on a metal chassis. Fiber or thin bakelite may be used for this purpose.

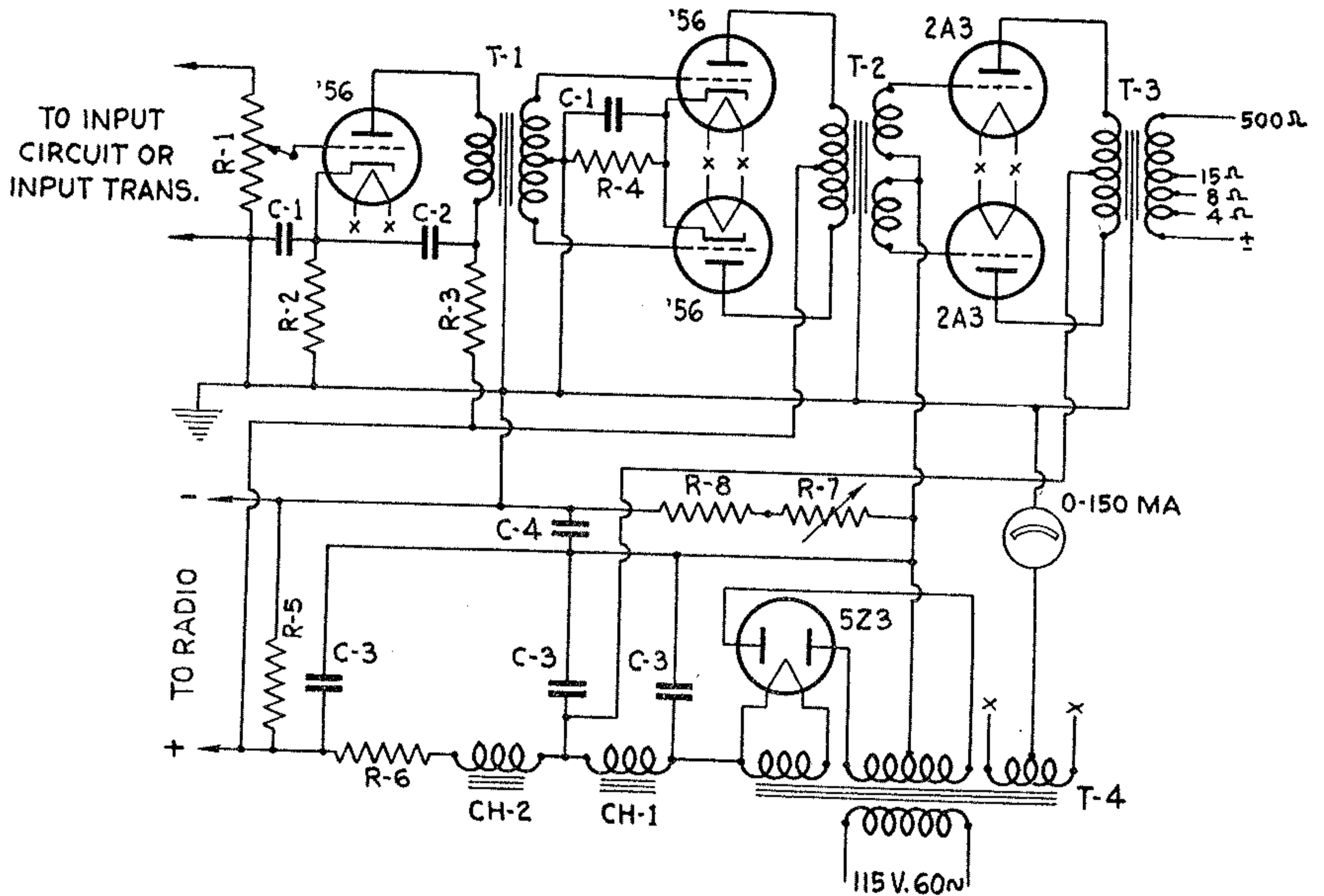
The secondary of the push-pull interstage transformer is split—that is, instead of having a single winding center tapped, each half of the winding has separate leads. This allows the constructor to incorporate separate bias control on each of the 2A3 tubes, and helps in minimizing distortion and hum. To accomplish this the 200-ohm variable bias resistor is replaced with two 400 or 500-ohm wire wound potentiometers, connected in parallel. One black wire of each secondary of the T-5870 Transformer should be connected to the slider tap of each of the potentiometers.

Although the bias for minimum hum can be balanced by listening to the loud speaker, it is better to insert a milliammeter in each of the 2A3 plate leads in turn and adjust the corresponding bias resistor so the reading is 40 ma. for the tube being tested. It will be found that when the plate currents of the tubes are alike, there is a minimum of hum.

The output transformer T-6754 provides secondary impedances of 4, 8, 15, or 500 ohms. When connecting directly to the voice coil of a speaker, one of the 4, 8, or 15-ohm taps is used, depending upon the voice coil impedance. Two 8-ohm speakers would be connected in series to the 15-ohm tap. The 500-ohm winding is used where there is a considerable distance between the amplifier and speakers. Pages 30 and 31 contain more detailed information on speaker output coupling circuits.

Frequency Response Curve of the Push-Pull 2A3 Amplifier



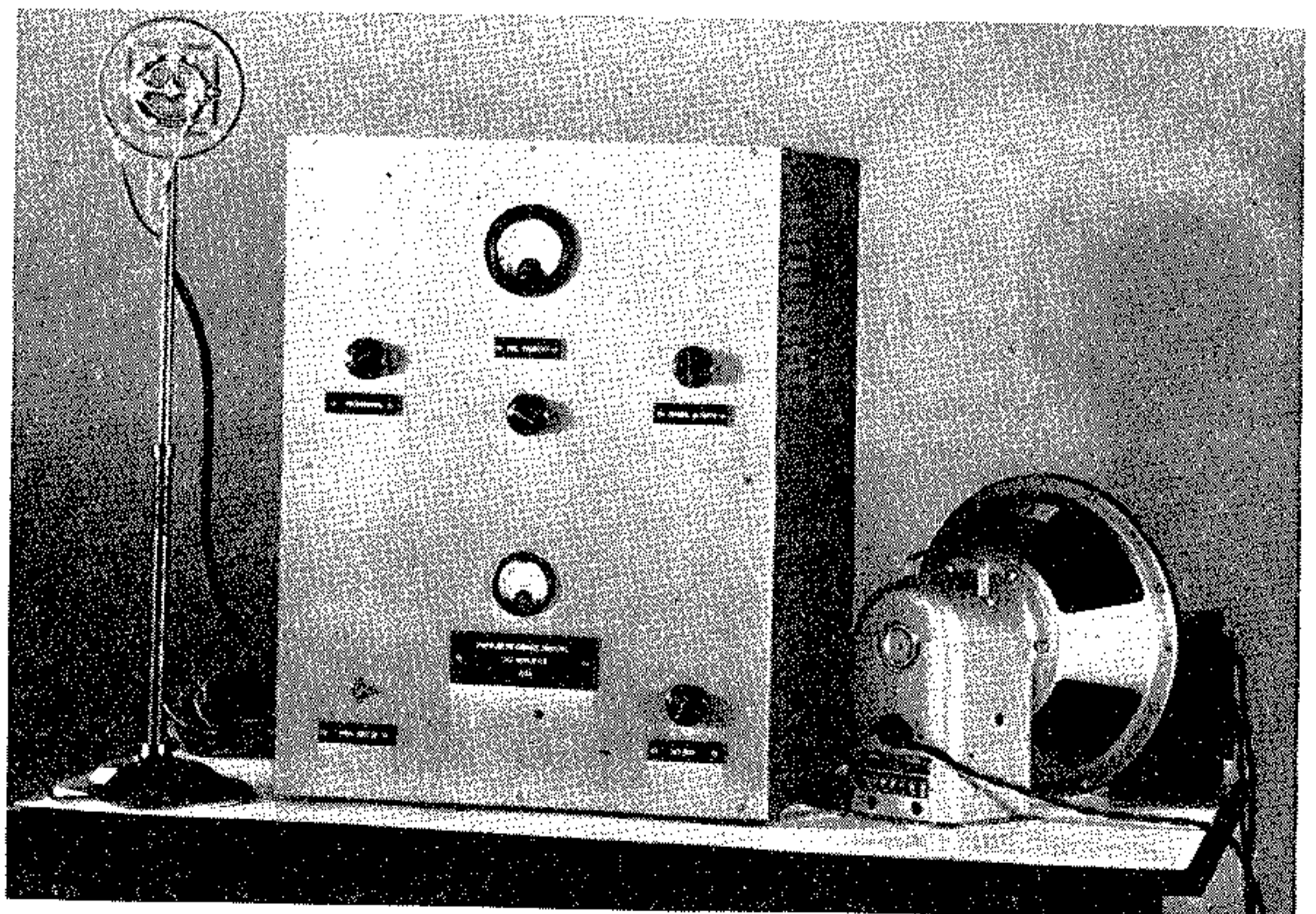


THORDARSON Equipment for P.P. 2A3 Amplifier

T-1	T-5741	Interstage Transformer
T-2	T-5870	Interstage Transformer
T-3	T-6754	Output Transformer
T-4	T-5822	Power Transformer
CH-1	T-1700-B	Filter Choke
CH-2	T-5754	Filter Choke

Miscellaneous Equipment

R-1	500,000-ohm volume control
R-2	2,500-ohm carbon resistor—1 watt
R-3	5,000-ohm carbon resistor—1 watt
R-4	1,300-ohm carbon resistor—1 watt
R-5	15,000-ohm wire wound resistor—20 watt
R-6	600-ohm wire wound resistor—10 watt
R-7	200-ohm wire wound potentiometer
R-8	400-ohm wire wound resistor—10 watt
C-1	4-mfd. electrolytic condenser—25 volt
C-2	2-mfd. paper condenser—400 volt
C-3	Triple 8-mfd. electrolytic condenser—450 volt
C-4	10-mfd. electrolytic condenser—100 volt



*Push-Pull Type 2A3 Tube Output
Class A Amplifier (Photo—Courtesy Popular Mechanics)*

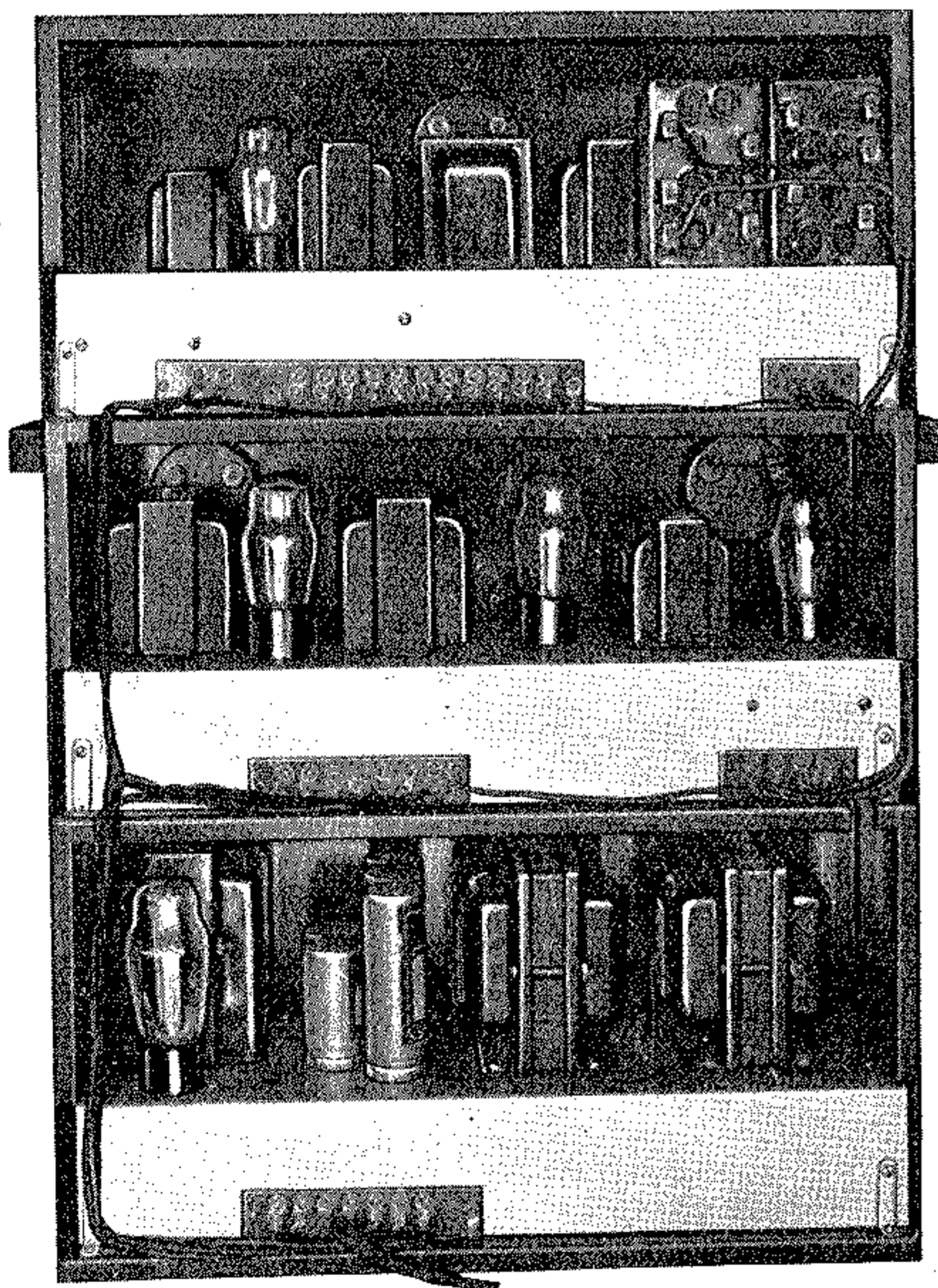
Type 2A5 Tube (Triode) Push-Pull Output Class A-Prime Amplifier

Output: Eighteen watts

Stages: Four

Tubes: Three 2A5's, two 56's, and one 5Z3

This eighteen-watt output Class A-prime amplifier employs the new type 2A5 tubes as triodes in push-pull for the final stage and as a driver in front of the output stage. Two stages with type 56 tubes are employed before the 2A5 driver stage to provide extremely high gain. This allows direct connection through suitable coupling transformers of carbon microphone, detector output of a radio tuner, magnetic phonograph pickup, crystal microphone, or crystal pickup. A THORDARSON Universal Output Transformer with impedances for 500, 15, 8, and 4-ohm loads is shown. A curve of the amplifier characteristic is given on the opposite page, showing the excellent frequency response.



Rear view of 2A5 amplifier for amateur station W9DCX, Chicago, owned by Frank Brittin.

The mixer system allows the operator to impose a background of music from radio or phonograph upon voice that is being amplified. This is accomplished by setting the main volume control about two-thirds of the way on, and bringing the voice to the proper level by adjusting the T-pad in the voice circuit. The T-pad controlling the source to be imposed is then set to the desired level. The main control in the grid circuit of the first 56 tube can be used to regulate the combined output to meet varying conditions.

It is advisable to locate the mixer transformers on a separate chassis that is shielded as a whole and placed several feet away from the power supply. The amplifier should also be built on a separate base from the power transformer and supply. This is to insure freedom of hum due to the strong field set up by the power transformer getting into the audio components. The three units—namely, the mixer circuit, amplifier, and power supply—may be built on bases having similar dimensions, so one may be placed above the other in rack form.

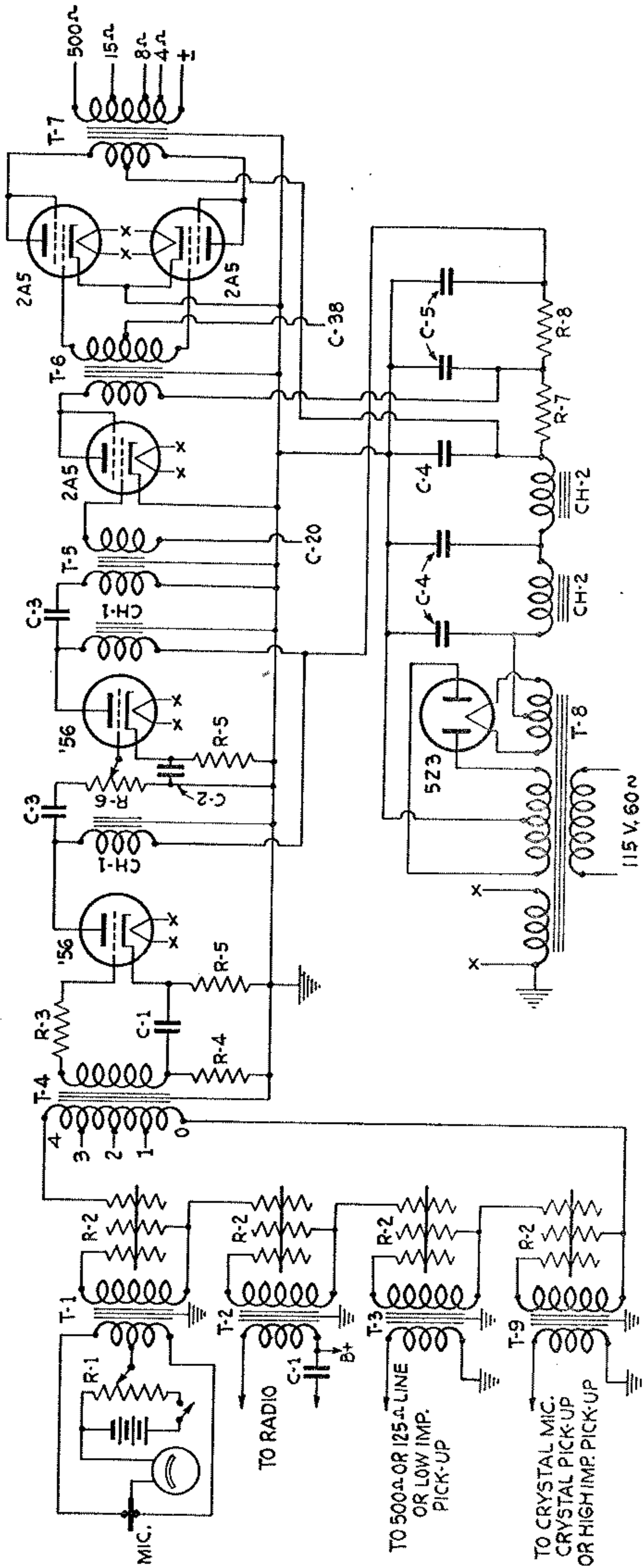
THORDARSON Equipment

T-1	T-6373	Microphone to 200-ohm Line Transformer
T-2	T-5515	Plate to 200-ohm Line Transformer
T-3	T-6196	500-ohm Line to 200-ohm Line Transformer
T-4	T-6371	Input Transformer
T-5	T-5738	Interstage Transformer
T-6	T-6578	Interstage Transformer
T-7	T-6594	Output Transformer
T-8	T-5822	Combination Plate and Filament Transformer
T-9	T-7083	Microphone to 200-ohm Line Transformer
CH-1	T-2927	Impedance Coupling Choke
CH-2	T-6409	Filter Choke

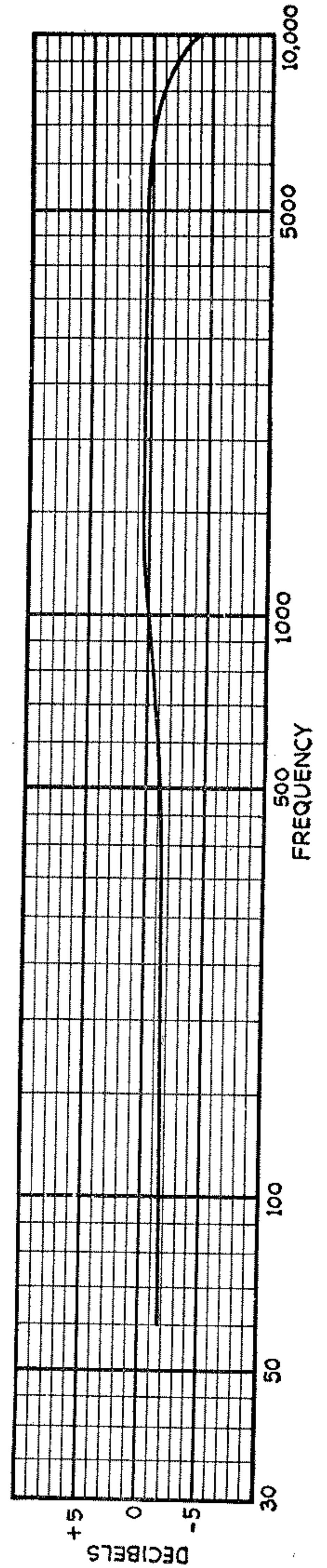
Miscellaneous Equipment

R-1	400-ohm wire wound potentiometer
R-2	200-ohm T-pad
R-3	75,000-ohm carbon resistor—1 watt
R-4	250,000-ohm carbon resistor—1 watt
R-5	2,500-ohm carbon resistor—1 watt
R-6	500,000-ohm volume control
R-7	3,000-ohm wire wound resistor—20 watt
R-8	5,000-ohm wire wound resistor—20 watt
C-1	1-mfd. paper condenser—400 volt
C-2	2-mfd. paper condenser—200 volt
C-3	.25-mfd. paper condenser—400 volt
C-4	8-mfd. electrolytic condenser—450 volt
C-5	4-mfd. electrolytic condenser—450 volt

Type 2A5 Tube (Triode) Push-Pull Output Class A Amplifier



Frequency Characteristic Curve of 2A5 Amplifier



Types 46 and 59 Tube Push-Pull Output Class B Amplifiers

Output: Twenty watts

Stages: Three

Tubes: Three 46's or three 59's, one 56, and one 83

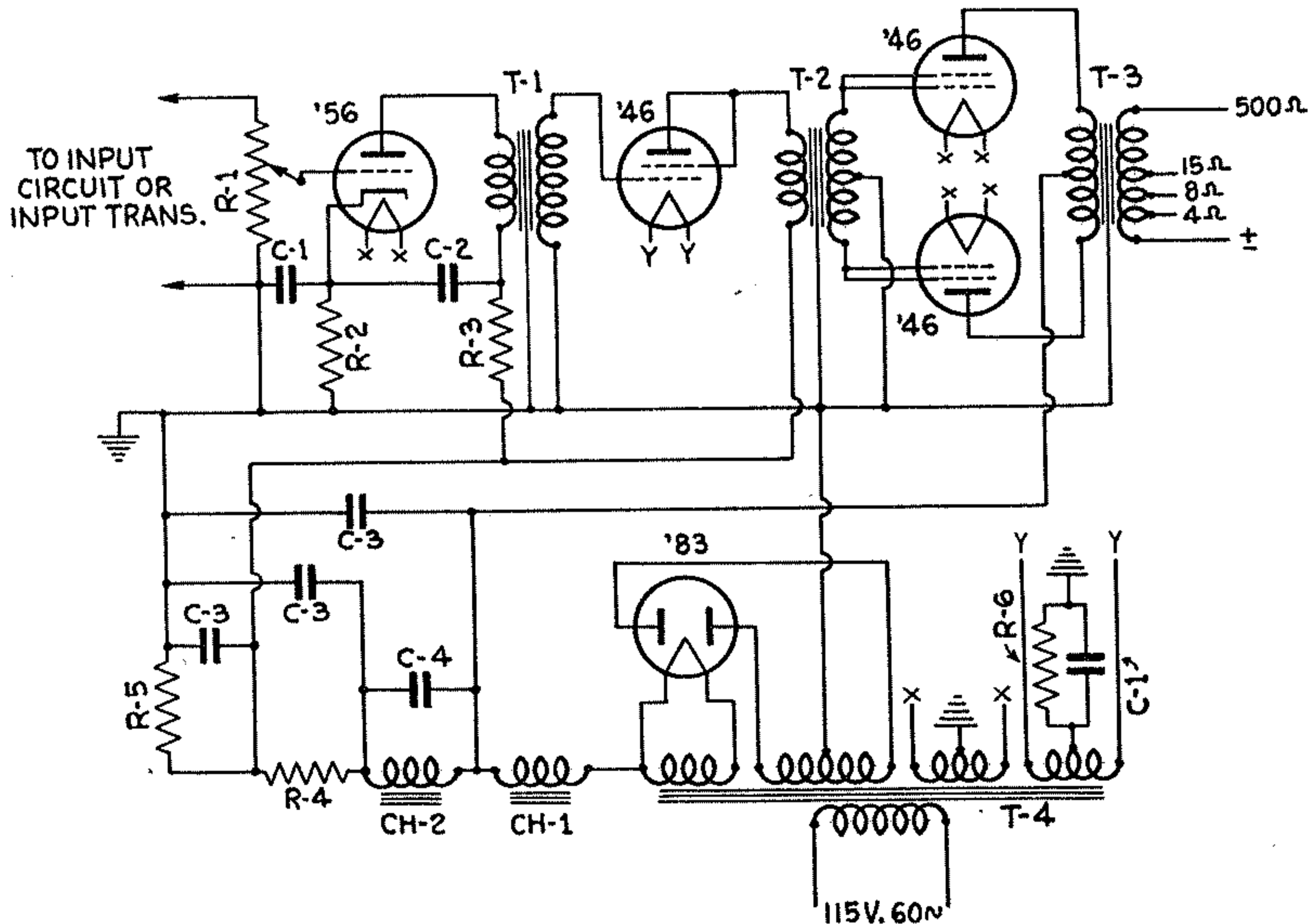
The Class B operation of tubes makes it possible to construct an amplifier having considerable output power with reasonably inexpensive equipment. The types 46 and 59 tubes were originally designed for this type of service and are used to advantage.

When tubes are operated in Class B, the grids are driven positive, causing grid current to flow. This necessitates using a driver tube having power output capable of swinging the Class B grids without distorting the signal. The design of the driver transformer is critical, since the secondary must be of low resistance to prevent distortion due to voltage drop. Then, too, the impedance ratio must be correct, so the reflected impedance to the driver tube remains high enough to prevent harmonic distortion, even when the grid impedance is the lowest, as on loud passages. THORDARSON Transformer T-6770 has been designed for this service and its use will insure high quality reproduction.

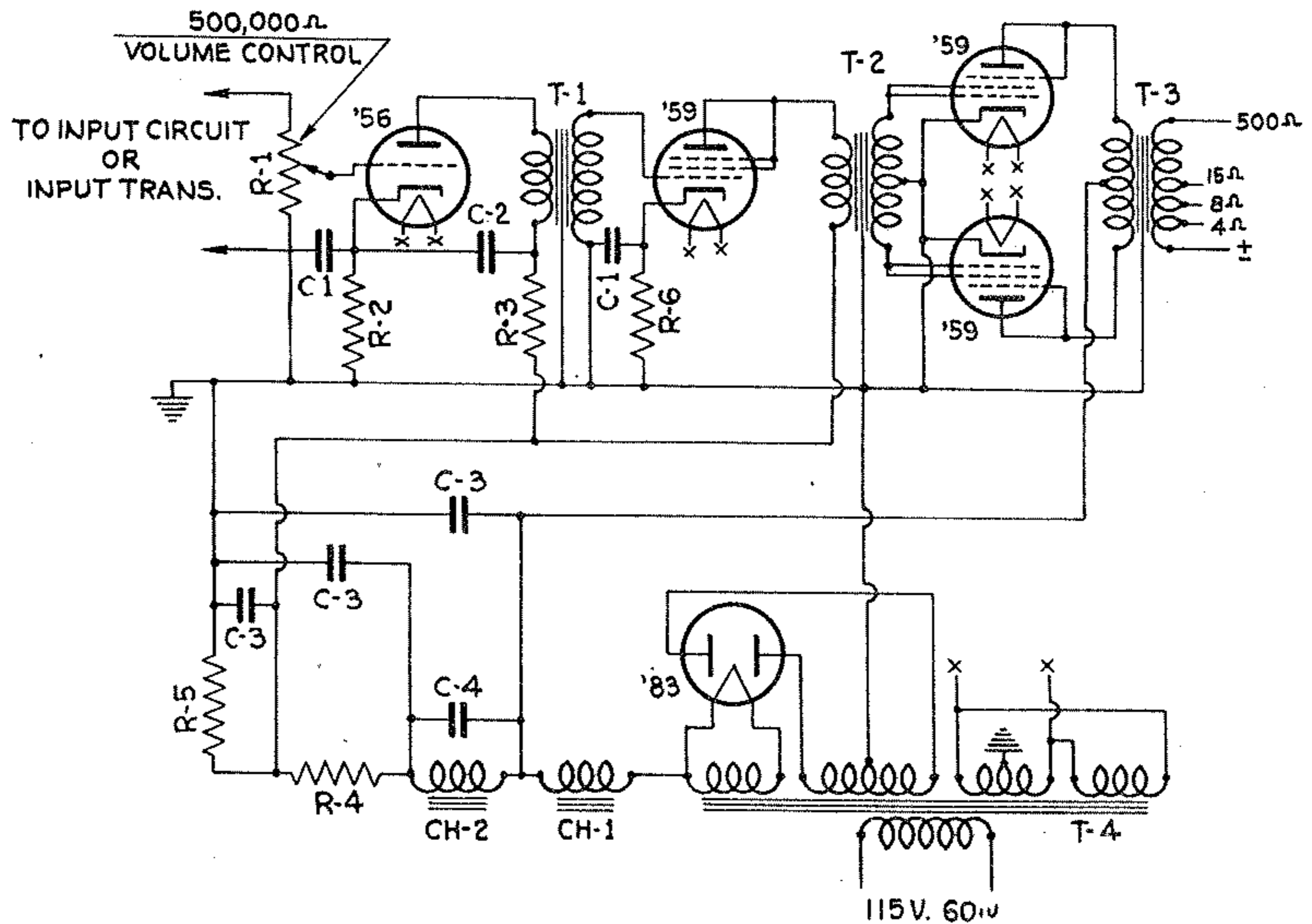
These amplifier circuits are basically the same, except that one employs the type 46 tube, which is a direct filament tube, and the other employs the type 59 tube, which is an indirect heater or cathode tube. The gain, power output, and frequency characteristics are practically identical.

In the circuit, employing the type 59 tubes, all amplifier

Type 46 Tube Push-Pull Output Class B Amplifier



Type 59 Tube Push-Pull Output Class B Amplifier



filaments are operated at a common potential, the two 2½-volt filament windings of the power transformer being connected in parallel. In this case the bias resistor and condenser are wired between ground and the cathode of the driver tube.

The circuit containing type 46 tubes requires the bias resistor and by-pass condenser R-6 and C-1 connected between ground and the center tap of the 2.5-volt filament winding supplying the single 46 driver tube.

Two type 46 or type 59 tubes are used in the output stage in push-pull Class B. They are preceded by a single type 46 or type 59 tube as a triode Class A driver. A type 56 input stage is used in both circuits. See pages 28 and 29 for input circuit and input transformer data. The power supply uses a type 83 mercury vapor rectifier tube with a choke input filter.

This amplifier provides moderately high power with a minimum number of tubes and very low cost power supply system. All plate, filament, and grid voltages are provided by the power supply.

Adequate gain is secured for reproduction from carbon microphone, magnetic phonograph pickup, radio tuner or dynamic, condenser, and velocity microphones with suitable pre-amplifier circuits. See pages 26 and 27.

THORDARSON Equipment

T-1	T-5738	Interstage Transformer
T-2	T-6778	Interstage Transformer
T-3	T-6752	Output Transformer
T-4	T-5514	Power Transformer
CH-1	T-6749	Input Choke
CH-2	T-5754	Filter Choke

Miscellaneous Equipment

R-1	500,000-ohm volume control
R-2	2,500-ohm carbon resistor—1 watt
R-3	10,000-ohm carbon resistor—1 watt
R-4	2,500-ohm wire wound resistor—10 watt
R-5	15,000-ohm wire wound resistor—10 watt
R-6	1,500-ohm wire wound resistor—10 watt (46 tubes)
R-6	1,000-ohm wire wound resistor—10 watt (59 tubes)
C-1	4-mfd. electrolytic condenser—25 volt
C-2	2-mfd. electrolytic condenser—450 volt
C-3	Triple 8-mfd. electrolytic condenser—450 volt
C-4	.1-mfd. paper condenser—500 volt

Push-Pull Parallel 2A3 Amplifier

Output: Thirty watts

Stages: Three

Tubes: Four 2A3's, three 56's, one 83, and one 80

Four of the very successful type 2A3 tubes are employed in the push-pull parallel output stage of this amplifier. They deliver a steady output of 30 watts.

High power output is made available at reduced cost through the development of this new amplifier design. Not only is the transformer equipment inexpensive for such high power output, but the tube equipment is correspondingly low.

The frequency range of from 50 to 10,000 cycles is covered by uniform, distortion-free reproduction. Over the normally usable voice and music frequency range, the amplifier response is flat to within a fraction of a decibel, less variation than the human ear can detect.

Overall gain is provided to secure maximum rated output from standard double-button carbon microphone, magnetic pickup, or radio tuner. See pages 28 and 29 for input circuits and transformers.

This amplifier is designed for reproduction of voice, music, and disc or film recordings (with suitable pre-amplifier for photo-cell—see pages 26 and 27). The diagram shows no input transformer to the first tube, since the proper transformer would be dependent upon the service for which the amplifier is intended to be used. Pages 28 and 29 show suitable input and mixing circuits for this amplifier. The output of the final stage is coupled to a THORDARSON T-6792 Output Transformer specially designed for use with four 2A3 tubes. It has output impedances to match 4, 8, and 15-ohm voice coils, and a 500-ohm speaker line.

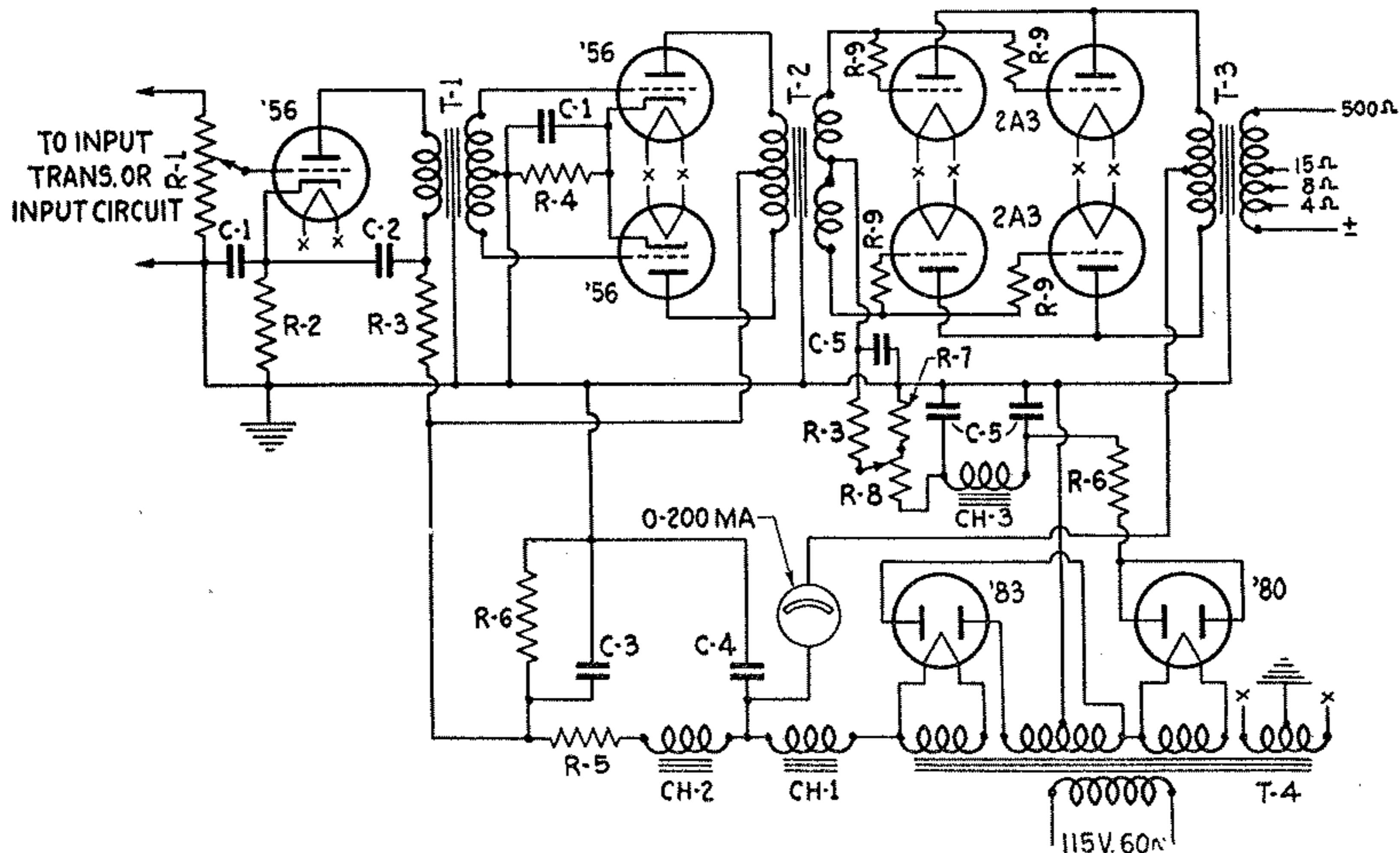
An unusual feature of the amplifier is the combination of self-bias on the first two stages and adjustable fixed bias on the output stage. This permits the bias current to be set so the plate current is exactly 160 ma. with no signal, the optimum operating condition for this output tube combination. This current reading may be made through a plug-in jack, eliminating the need for a permanently installed ammeter—since once grid bias is set, the no-signal current will not vary appreciably.

THORDARSON Equipment

T-1	T-5741	Interstage Transformer
T-2	T-5870	Interstage Transformer
T-3	T-6792	Output Transformer
T-4	T-6793	Power Transformer
CH-1	T-6749	Input Choke
CH-2	T-1607	Filter Choke
CH-3	T-6746	Filter Choke

Other Parts

R-1	500,000-ohm volume control
R-2	2,500-ohm carbon resistor—1 watt
R-3	10,000-ohm carbon resistor—1 watt
R-4	1,300-ohm carbon resistor—1 watt
R-5	2,000-ohm wire wound resistor—20 watt
R-6	20,000-ohm wire wound resistor—20 watt
R-7	10,000-ohm wire wound resistor—10 watt
R-8	5,000-ohm wire wound potentiometer
R-9	50-ohm carbon resistor—1 watt
C-1	4-mfd. electrolytic condenser—25 volt
C-2	2-mfd. electrolytic condenser—450 volt
C-3	8-mfd. electrolytic condenser—450 volt
C-4	16-mfd. electrolytic condenser—450 volt
C-5	10-mfd. electrolytic condenser—100 volt



» » Push-Pull Parallel Type 46 Tube Output Class B Amplifier

Output: Forty watts

Stages: Four

Tubes: Six 46's, two 56's, and two 83's

In this amplifier extremely high power output is developed, yet only receiver tubes are used throughout, keeping the cost of parts very low. The plate voltage is low, allowing the filter condensers C-3 to be of the electrolytic type—an important factor in securing low cost.

The final output stage delivers up to 40-watt power with four type 46 tubes in push-pull parallel Class B. The two grids are tied together, giving triode operation. This output is shown coupled through a THORDARSON Universal Output Transformer, the T-6753, a special heavy duty unit having ample rating to handle this large amount of energy. For

input and output circuit designs, see pages 28, 29, 30, and 31.

When it is desired to use the cathode heater type 59 tubes in place of the direct heating type 46's in the last two stages, no other changes will be necessary beyond substitution of the proper type of sockets and suitable alteration of connections. The left corner of the diagram shows the proper tube element wiring.

In addition the 750-ohm bias resistor, R-5, is to be taken out of the filament center tap lead. A 550-ohm bias resistor is connected from the cathode of the two type 59 driver tubes to ground.

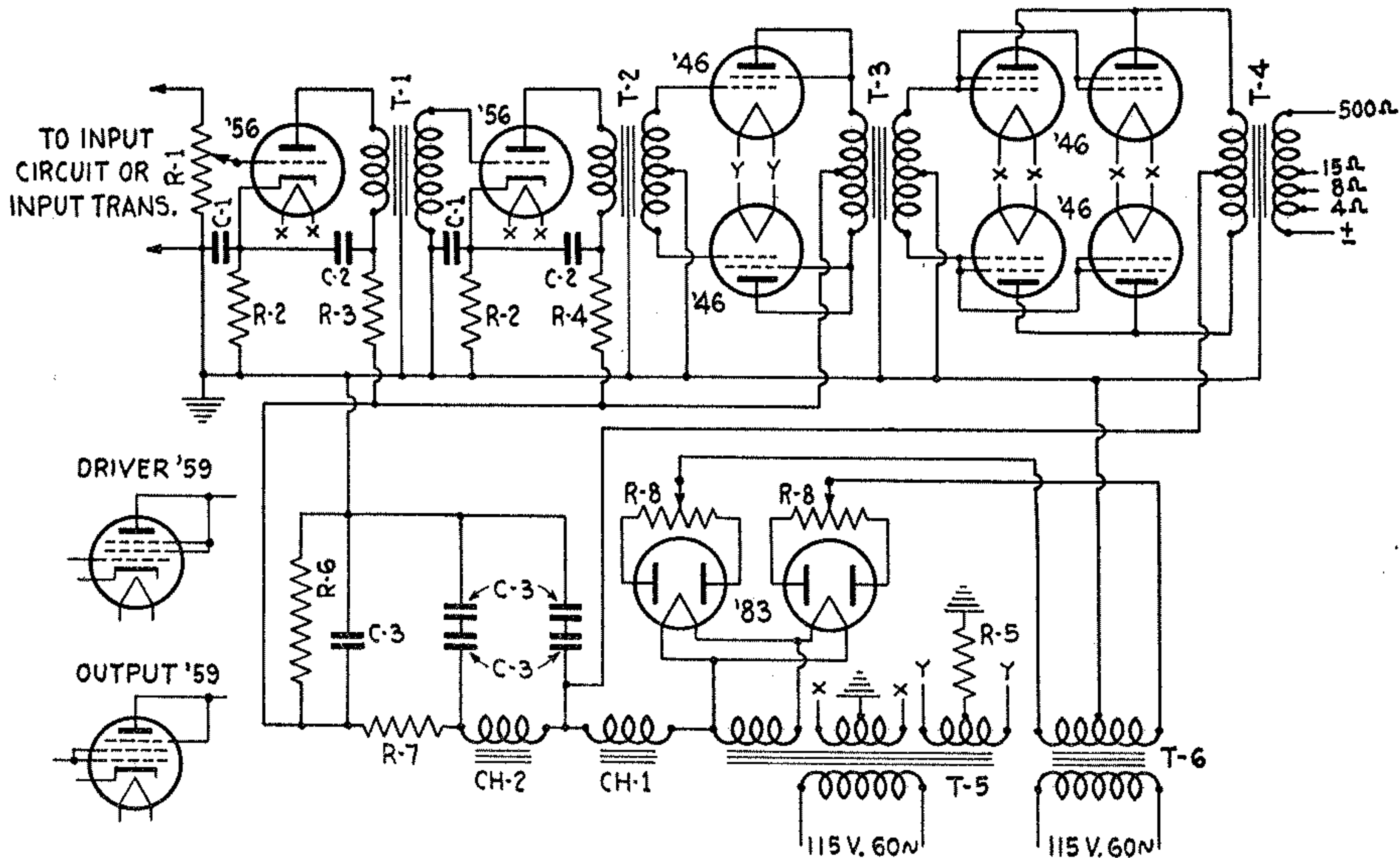
THORDARSON Equipment

T-1	T-5738	Interstage Transformer
T-2	T-5741	Interstage Transformer
T-3	T-6698	Interstage Transformer
T-4	T-6753	Output Transformer

T-5	T-6094	Filament Transformer
T-6	T-6095	Plate Transformer
CH-1	T-6315	Input Choke
CH-2	T-1607	Filter Choke

Miscellaneous Equipment

R-1	500,000-ohm volume control
R-2	2,500-ohm carbon resistor—1 watt
R-3	25,000-ohm carbon resistor—1 watt
R-4	10,000-ohm carbon resistor—1 watt
R-5	750-ohm wire wound resistor—10 watt (550-ohm if type 59 tubes are used. See text.)
R-6	30,000-ohm wire wound resistor— 10 watt
R-7	2,000-ohm wire wound resistor—25 watt
R-8	25-ohm wire wound potentiometer with insulated shaft.
C-1	4-mfd. electrolytic condenser—25 volt
C-2	2-mfd. electrolytic condenser—450 volt
C-3	8-mfd. electrolytic condenser—450 volt



Dual-Channel High Fidelity Amplifier

Designed by M. R. Jones, Jensen Radio Manufacturing Co., Chicago

This advanced amplifier design is outstanding in the new high standard of reproduction it introduces. It has been designed from the outset to provide the very finest music and voice reproduction that is now made possible by late developments in high fidelity speakers.

Though the proposed R.M.A. standards of high fidelity wide-range reproduction state that the frequency band of only 50 to 7,500 cycles must be covered with variations in output not to exceed 10 decibels, this amplifier provides reproduction greatly surpassing this standard.

Two entirely separate amplifying channels are incorporated in this unit: one for the lows, 20 to 1500 cycles; and the other from 1000 to 16,000 cycles. Since each channel covers only a given frequency band, the efficiency and power handling ability is greater, reducing the possibility of overloading the tubes or speaker.

This separate amplifying system for high and low frequencies carries all the way to the output, where the lows are reproduced by one speaker, and the highs by a special "tweeter" type speaker designed to give high efficiency and faithful reproduction of frequencies up to the highest delivered by this channel of the amplifier.

Volume and tone controls are incorporated, as shown in the accompanying diagram, to allow independent variation of both volume and frequency response for each amplifier, assuring flexibility to meet the operating needs of every installation.

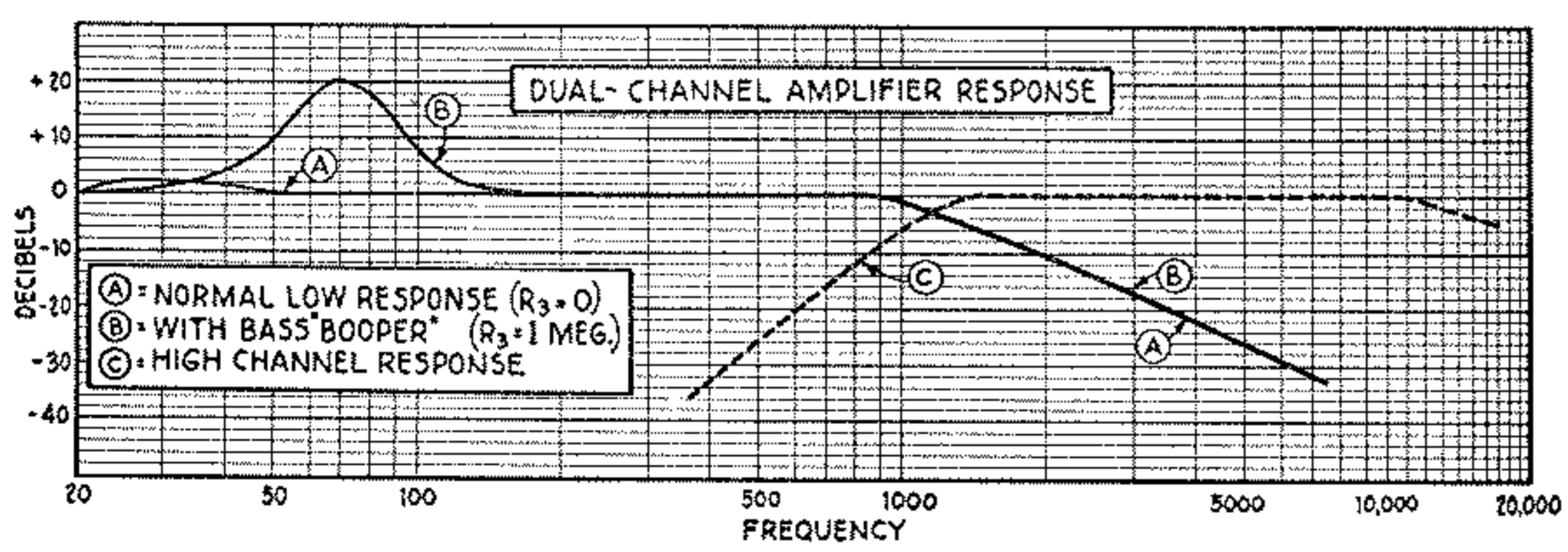
A 200-ohm input is provided for microphone or low impedance pickup, and a high impedance pickup and radio tuner input.

The full advantages of wide-range reproduction can be secured only with speaker equipment capable of reproducing all the frequencies that the amplifier supplies. For this reason, only the best available units are recommended for use with this amplifier for both high and low frequency speakers.

A bass "booper" circuit has been incorporated in the low channel for those who like to hear plenty of lows at all levels, and in order to compensate with the loss of lows at low volume levels. With this circuit, the harmonic content of the extreme lows (below 100 cycles) is slightly increased, but does not sound objectionable. If R-3 is made zero, the bass "booper" circuit, CH-2, CX, R-3, is removed and the bass response is held up the resonant circuits R-7, C-5, T-4, and C-6. As the resistance R-3 is increased, the bass response is increased to a peak—the peak occurring at approximately 70 cycles when the resistance is a maximum. If it is desired to push this peak up the frequency scale, it can be done by decreasing the capacity of CX (at .005-mfd. the peak occurs at about 100 cycles).

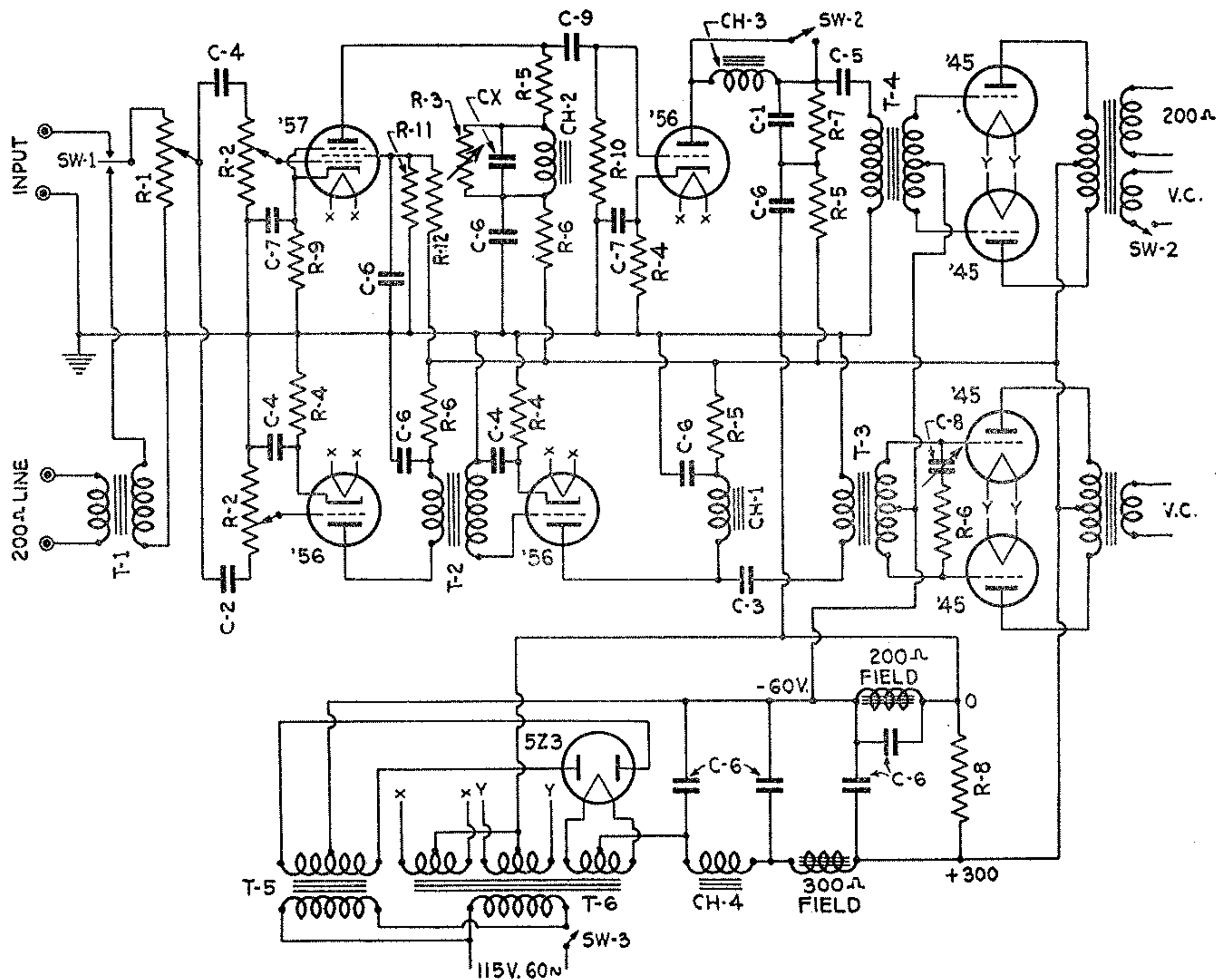
By rotating the variable condenser C-8, it is possible to cut off the extreme high frequency to suit operating conditions. The level of the entire high channel can also be adjusted, independent of the adjustment of C-8, by varying the resistor R-2. The most pleasing high frequency channel level can be determined by the listener.

It is best to build a power supply as an entirely separate unit so that hum may be reduced to a minimum. Because of the excellent response curve at low frequencies, and the many transformers in the amplifier, the positions of T-1 and CH-2 must be adjusted so the hum picked up by them is at a minimum. It is sometimes necessary to reshield them individually. Care must also be taken in the placement of the other parts in the connecting leads to reduce hum and feedback.



THORDARSON Equipment for Dual Channel Amplifier

T-1	T-5516	200 or 50-ohm Line-to-Grid Transformer
T-2	T-5736	Interstage Transformer
T-3	T-5739	Interstage Transformer
T-4	T-5741	Interstage Transformer
T-5	T-5303	Power Transformer
T-6	T-5338	Filament Transformer
CH-1	T-5751	Choke Coil
CH-2	T-3736	Choke Coil
CH-3	T-1892	Choke Coil
CH-4	T-6749	Choke Coil



Miscellaneous Equipment

- R-1 100,000-ohm tapered volume control
- R-2 500,000-ohm tapered volume control
- R-3 1-megohm tapered potentiometer
- R-4 3,000-ohm wire wound resistor—1 watt
- R-5 10,000-ohm wire wound resistor—1 watt
- R-6 25,000-ohm wire wound resistor—1 watt
- R-7 50,000-ohm wire wound resistor—1 watt
- R-8 20,000-ohm wire wound resistor—25 watt
- R-9 2,000-ohm wire wound resistor—1 watt
- R-10 1-megohm carbon resistor—1 watt
- R-11 20,000-ohm wire wound resistor—1 watt
- R-12 100,000-ohm wire wound resistor—1 watt
- C-1 .0004-mfd. mica condenser—pigtail type
- C-2 .0005-mfd. mica condenser—pigtail type
- C-3 .002-mfd. mica condenser—pigtail type

- C-4 .1-mfd. paper condenser—300 volt
- C-5 .25-mfd. paper condenser—300 volt
- C-6 8-mfd. dry electrolytic condensers—500 volt
- C-7 30-mfd. dry electrolytic condensers—25 volt
- C-8 Filtermatic "Octave" tone control
- C-9 .03-mfd. paper condenser—300 volt
- C-X .01-mfd. paper condenser—300 volt
- SW-1 S.P.D.T. Toggle Switch
- SW-2 D.P.D.T. Toggle Switch to close one circuit and open one circuit
- SW-3 S.P.S.T. Toggle Switch
- Jensen M-70 Speaker (Spec. No. 4599A includes output transformer and 300-ohm field coil.)
- Jensen Model Q Speaker (Spec. No. 4600A includes output transformer and 200-ohm field coil.)
- Tubes—One 57, three 56's, four 45's, and one 5Z3.

High Power Output Stages

THORDARSON engineers have included these amplifier designs to provide extremely high power output stages for use in conjunction with the amplifiers described on previous pages. The two designs offered are shown complete with their own power supplies.

The new THORDARSON Power Amplifier Transformer line includes a complete range of coupling transformers for use with these amplifiers, specially designed to withstand the most severe service.

Push-Pull Type 845 Tube Class A Output Stage

Output: Fifty watts
 Gain: Works out of Push-Pull Type 45 Tube or Similar Amplifier
 Tubes: Two 845's, and two 866's

This is a high quality Class A stage capable of delivering 50 watts of undistorted power output from any amplifier providing 4.5 watts or more of undistorted power output. For this purpose the THORDARSON Push-Pull 45 Tube Class A Amplifier is recommended. It may be used, however, with any other amplifier of similar quality and power output.

Input is shown as from a 500-ohm line. If it is desired to couple directly to the amplifier, the T-6422 Transformer may be substituted for the T-6265, which is shown in the parts list. Likewise any other THORDARSON Output Transformer of suitable rating and impedance may be used for applications where output to a 500-ohm line is not desired.

Two type 866 mercury vapor rectifiers are used in a full-wave power supply employing the input filter system. This will provide ample voltage, free from hum or fluctuation under the heaviest load conditions.

In wiring this power stage it is advisable to provide a means of turning on the rectifier and amplifier tube filaments before the high voltage is applied. It is only necessary to allow the tubes to warm up a minute or so. This prevents damage to the tubes resulting from applying the high voltage before an electron path has been formed to carry the current. To accomplish this an additional switch should be inserted in the supply lead to the plate transformer. This circuit should also be controlled by the main switch so that it will be impossible to turn off the filaments and not the high voltage.

THORDARSON Equipment

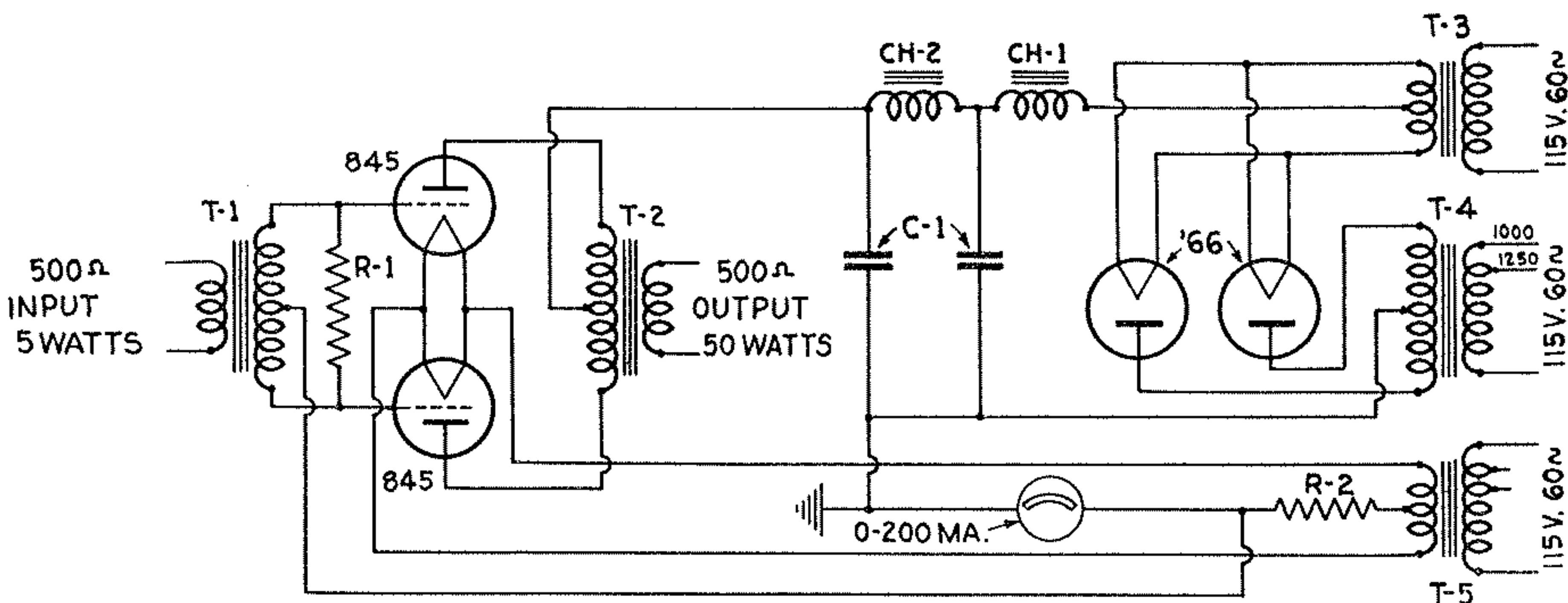
For Push-Pull 845 Class A Output Stage

- T-1 T-6265 Line to Grid Transformer
- T-2 T-6167 Output Transformer
- T-3 T-6433 Filament Transformer
- T-4 T-6411 Plate Transformer
- T-5 T-6414 Filament Transformer
- CH-1 & 2 T-6409 Filter Choke

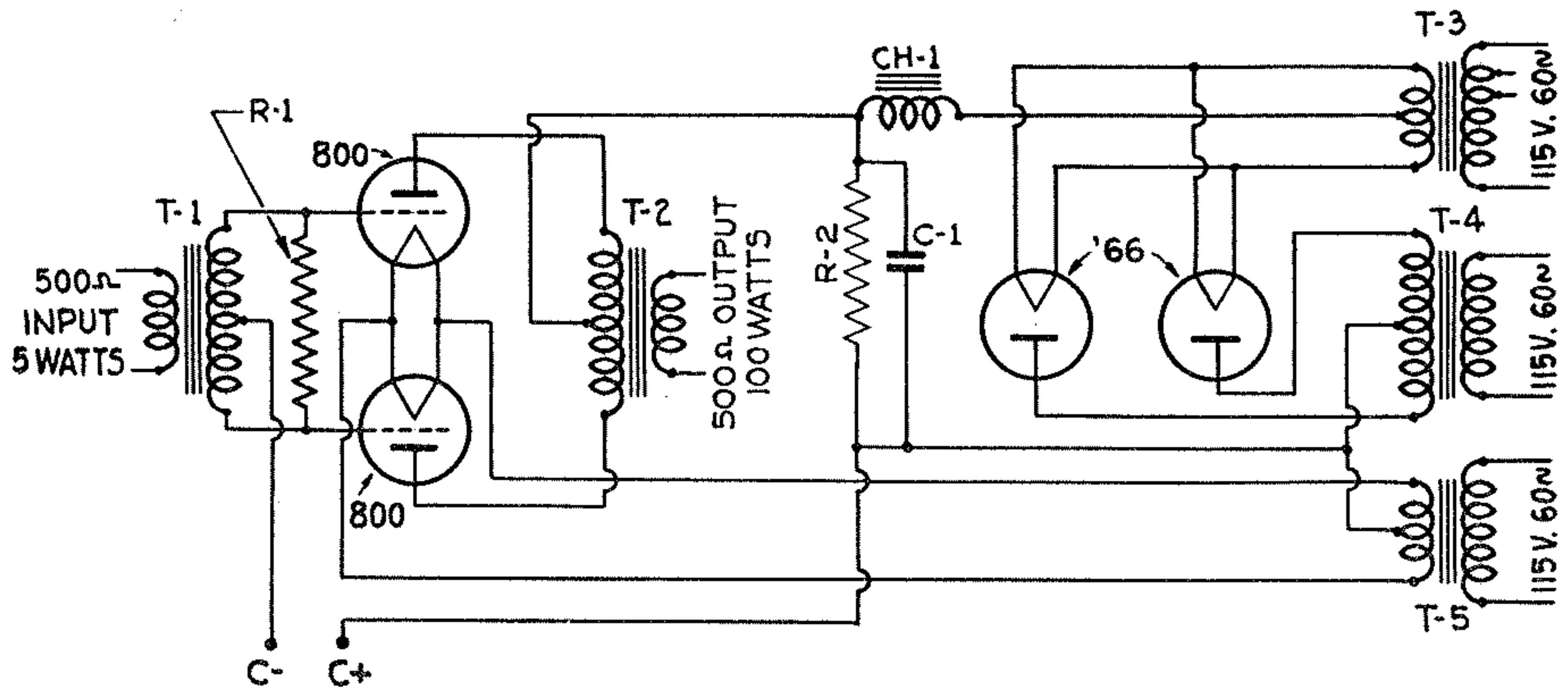
Miscellaneous Equipment

- R-1 20,000-ohm wire wound resistor—10 watt
- R-2 1,000-ohm wire wound resistor—50 watt
- C-1 2-mfd. high voltage condenser—2000 volt

Push-Pull Type 845 Tube Class A Output Stage



Type 800 Tube Class B Output Stage



Type 800 Tube Class B Output Stage

Output: One hundred watts

Gain: Works out of Push-Pull Type 45 Tube or Similar Amplifier

Tubes: Two 800's and two 866's

Tremendous audio power output, suitable for the largest outdoor installation or for use to energize multiple speaker sound systems, is provided by this output stage employing the new type 800 tubes in Class B.

The THORDARSON Push-Pull Type 45 Tube Output Amplifier, or another similar amplifier with a high quality output of 5 watts or more, may be used for input. With such an arrangement, it would be possible to utilize a low power amplifier as part of a high power system without the expense of two complete amplifiers.

The changes described in the other high power amplifier for input and output are also applicable to this amplifier. The power supply has been designed with adequate margin for operation at full rated load.

As there is no single line to voice coil transformer capable of transforming the 100-watt output of this amplifier, a number of transformers should be used. See pages 30 and 31 for output circuits. At least four transformers must be used so that not more than 25 watts are supplied to each unit.

The amplifier volume control should never be turned on unless the loud speakers are connected, or some type of load is provided. This is to prevent damage to the output transformer which is sure to result because of the high voltage developed on open circuit.

This power stage, like the one using 845 tubes, should be provided with a switch in the primary of the plate transformer, so the filaments can be allowed to warm up before applying the high voltage.

Class B amplifiers require a plate supply that has exceptionally good regulation. One having zero resistance would be ideal. To keep the resistance as low as possible, the mercury vapor type of rectifier tubes is used, together with a choke input filter system. The THORDARSON T-6315 Choke is of low resistance and designed to have a swinging inductance which lowers as more current is drawn and helps to maintain regulation.

THORDARSON Equipment
for 800 Class B Output

T-1	T-6265	Line to Grid Transformer
T-2	T-6755	Output Transformer
T-3	T-6433	Filament Transformer
T-4	T-5489	Plate Transformer
T-5	T-6435	Filament Transformer
CH-1	T-6315	Filter Choke

Miscellaneous Equipment

R-1	50,000-ohm wire wound resistor—10 watt
R-2	25,000-ohm wire wound resistor—75 watt
C-1	4-mfd. high voltage condenser—2000 volt
C- and C+	55 volt C battery

Direct Current Operated

Amplifiers

THORDARSON engineers offer the following amplifiers for use where 110-volt, 60-cycle A.C. supply is not available. The first is designed for operation with 110-volt D.C. without the necessity of using a converter. The second offers unusually high volume output from battery operation for the many applications where no other source of power is available.

115-Volt D.C. Operated Amplifier

Output: Four watts

Stages: Three

Tubes: Two 37's and two 48's

For sound amplifying, paging, and other applications in city districts supplied only with D.C., this amplifier is extremely useful. Three stages are used. A type 37 tube is transformer coupled to the second stage employing another 37, providing sufficient gain to operate directly from a microphone or phonograph. The second 37 is coupled to two power tubes by means of coupling transformer T-5741. Output transformer T-6754 provides impedance taps of 4, 8, 15, and 500 ohms to couple directly to the voice coil of dynamic speakers or to a 500-ohm line. Full four watts of output are provided through a push-pull output stage with two of the type 48 tubes. This is sufficient to operate one or two dynamic speakers at medium level. The speaker field should be

of the 110-volt D.C. type, and can be operated directly from the power line.

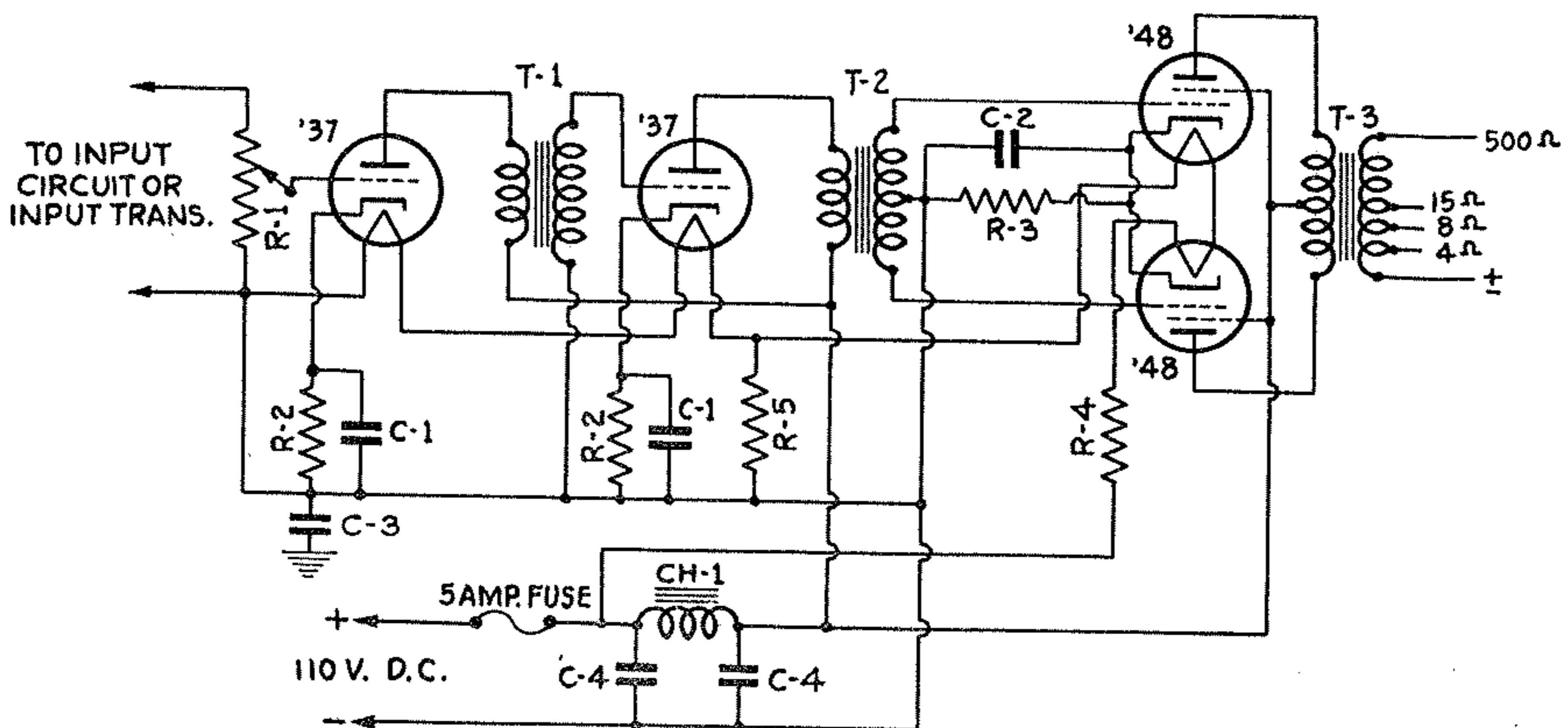
All filaments are connected in series with the resistor R-4 limiting the current. If desired, R-4 may be of the power cord type, which has the advantage of dissipating its heat outside of the chassis.

A choke and condenser are placed in the line input to filter out ripple and noises which may be in the supply and would otherwise be heard in the speakers. This choke, CH-1, has a very low resistance to minimize drop in line voltage.

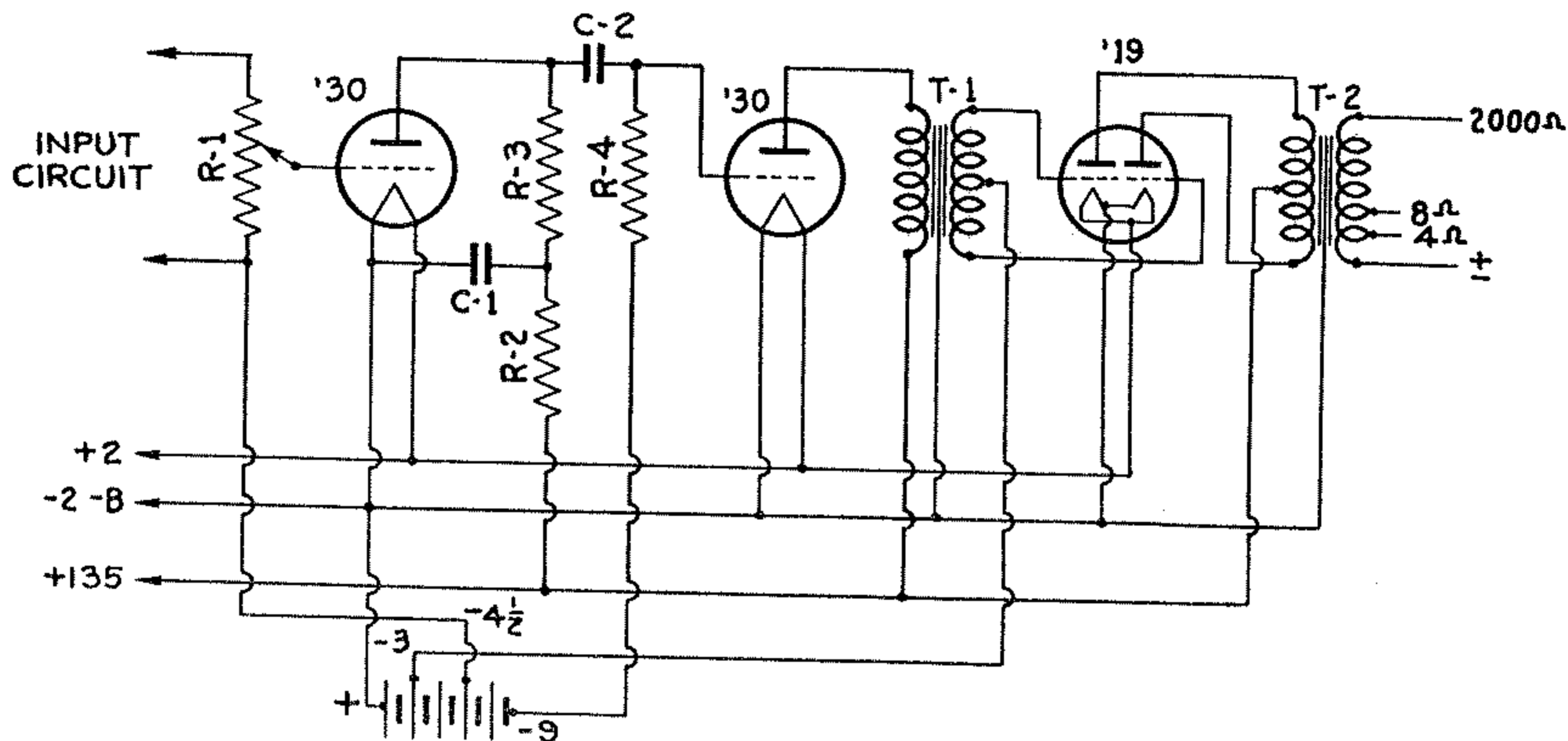
No part of the circuit is grounded directly to the chassis. Connection is made to the chassis through the condenser C-3, making it possible to ground the chassis without danger of shorting the line, regardless of the manner in which the power cord is plugged in the socket. The amplifier will merely be inoperative if improperly connected.

See pages 28, 29, 30, and 31 for complete description of input and output circuits.

Type 48 Tube (Pentode) Amplifier



Type 19 Tube Battery Operated Class B Amplifier



THORDARSON Equipment for 110-Volt D.C. Amplifier

- T-1 T-5738 Interstage Transformer
- T-2 T-5741 Interstage Transformer
- T-3 T-6754 Output Transformer
- CH-1 T-6749 Filter Choke

Miscellaneous Equipment

- R-1 500,000-ohm volume control
- R-2 2,500-ohm carbon resistor—1 watt
- R-3 190-ohm wire wound resistor—5 watt
- R-4 105-ohm wire wound resistor—25 watt
- R-5 125-ohm wire wound resistor—5 watt
- C-1 4-mfd. Electrolytic Condenser—25 volt
- C-2 2-mfd. Electrolytic Condenser—25 volt
- C-3 2-mfd. Paper Condenser—200 volt
- C-4 4-mfd. Electrolytic Condenser—200 volt

Type 19 Tube, Class B Amplifier
2-Volt Tubes

Output: Two watts
Stages: Three
Tubes: Two 30's and one 19

This amplifier has been designed around the Type 19 output tube to make possible a unit supplying a power output of 2 watts, operated from a 2-volt Air-Cell or storage battery. Plate voltage is supplied by three standard 45-volt B batteries. The Class B 19 tube is provided with 3 volts bias, which, although not necessary, is advantageous in prolonging the life of the B batteries. C voltage is provided by a tapped 9-volt battery.

The amplifier has three stages, the first being a type 30 tube which is resistance coupled to the second stage employing another type 30. The final stage, employing a type 19 tube in Class B, is coupled to this stage by a T-5463 Audio Transformer.

The output is fed to a T-6760 Transformer and is specially designed for coupling to the two plates of the type 19 tube in Class B. It has tapped impedances of 4 and 8 ohms for dynamic speakers and 2000 ohms for magnetic speakers. When used with dynamic speakers, unless the permanent magnet type is used, a separate source of field current will be necessary. This is usually a 6-volt storage battery.

Gain is sufficient for direct connection through a suitable coupling transformer of a single or two-button carbon microphone. For complete description of suitable input circuits, see pages 28 and 29.

Equipment for 19 Tube Class B Amplifier

- T-1 T-5463 Push-Pull Interstage Transformer
- T-2 T-6760 Output Coupling Transformer
- R-1 500,000-ohm volume control
- R-2 25,000-ohm carbon resistor—1 watt
- R-3 75,000-ohm carbon resistor—1 watt
- R-4 500,000-ohm carbon resistor—1 watt
- C-1 2-mfd. paper condenser—200 volt
- C-2 .01-mfd. paper condenser—500 volt
- Air-Cell or 2-volt storage cell
- 3 45-volt B batteries
- 2 4.5-volt C batteries

Mobile Amplifiers



The widespread use of sound trucks for operation while in motion and for portable set-ups to address street corner, park, and rural audiences has required the development of an entirely separate class of amplifiers.

The two designs shown here operate entirely from the motor car 6-volt battery system, without the expense of gasoline generators, short-lived B batteries, or bulky storage batteries.

Plate voltage is supplied by the popular motor-generator units (genemotors) which are available from nearly all supply dealers. These devices operate from 6 volts D.C. and supply high voltage D.C. of excellent purity that is ready for direct application to the tube plate with very little filtering. The efficiency of such units is approximately 50%, assuring low storage battery drain.

Either horn or baffle type dynamic speakers with 6-volt fields for direct operation from the car storage battery can be used with these amplifiers. For record reproduction, a number of manufacturers can supply turntables with 6-volt motors. Any auto-radio of good quality can be used to provide amplified radio programs.

Two amplifier designs are offered, both quite similar except that the larger supplies about twice the audio power the smaller does. Where it is necessary to have

greater output than can be supplied by these amplifiers, the 115-volt A.C. amplifiers described in this manual should be used. Most dealers can supply A.C. generators that are driven from the fan belt of the automobile engine. For extremely high power, a larger generator, driven by a small gasoline engine, may be used to supply the amplifier, phonograph turntable, and other equipment.

Type 79 Tube Output Class B Mobile Amplifier

Output: Eight watts

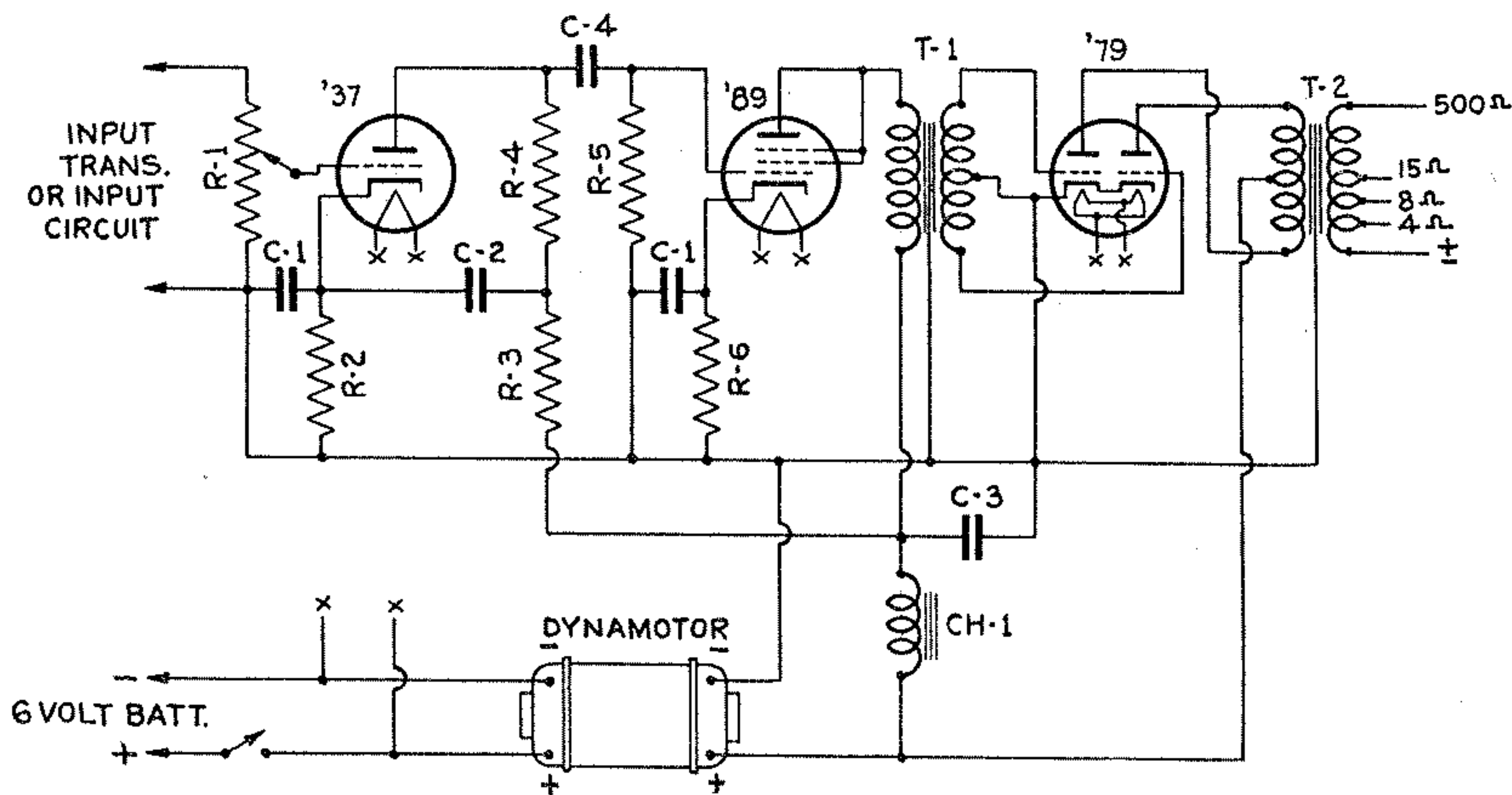
Stages: Three

Tubes: One 37, one 89, and one 79

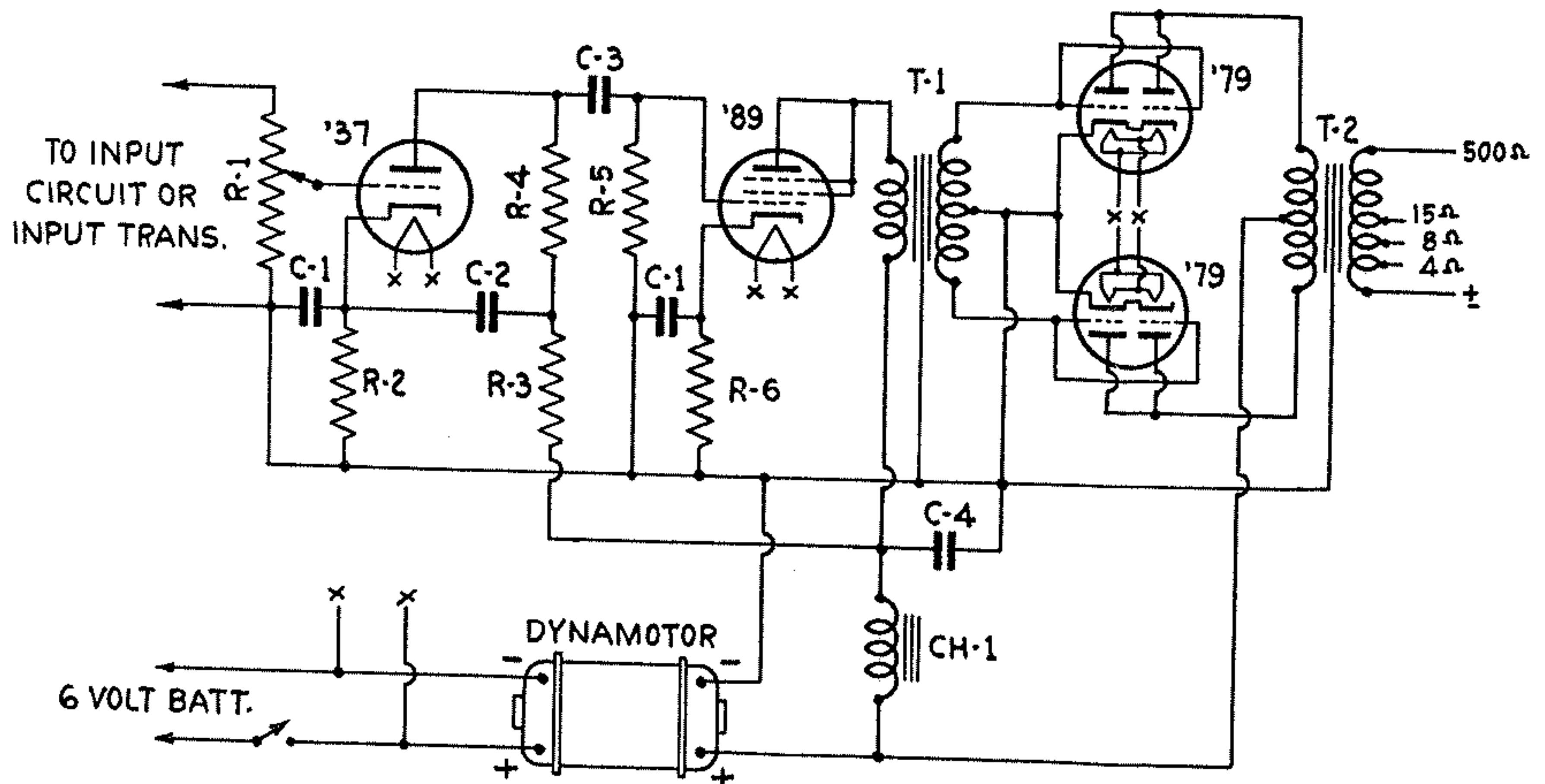
This amplifier is a complete unit ready for operation with only a 6-volt battery for power supply. A type 37 tube is resistance coupled to an 89, providing sufficient gain for use with microphone, phonograph, or radio. The 89 provides more than enough power to drive the 79 Class B tube, resulting in good quality. The output is sufficient to operate two medium-size dynamic speakers at high volume.

In constructing the unit, great care should be given to mechanical details in order that vibration and jolting will

Type 79 Tube Class B Mobile Amplifier



Type 79 Tube Push-Pull Parallel Class B Mobile Amplifier



not cause failures. The very best grade tube sockets should be used with good grips on tube prongs to avoid vibration causing the tubes to gradually work out of the sockets.

The genemotor for this amplifier will be required to deliver 265 volts D.C. at 75 ma. The total drain on the storage battery from tubes and genemotor will be only 6.3 amperes.

Equipment List for 79 Tube Output Amplifier

T-1	T-6750	Interstage Transformer
T-2	T-6751	Output Transformer
CH-1	T-1892	Input Choke
R-1	500,000-ohm	volume control
R-2	5000-ohm	carbon resistor—1 watt
R-3	25,000-ohm	carbon resistor—1 watt
R-4	50,000-ohm	carbon resistor—1 watt
R-5	500,000-ohm	carbon resistor—1 watt
R-6	1000-ohm	wire wound resistor—10 watt
C-1	4-mfd.	electrolytic condenser—25 volt
C-2	2-mfd.	electrolytic condenser—450 volt
C-3	8-mfd.	electrolytic condenser—450 volt
C-4	.01-mfd.	paper condenser—500 volt

DYN. 265-volt, 75 ma. motor-generator to operate from 6-volt battery.

Type 79 Tube Push-Pull Parallel Output Class B Mobile Amplifier

Output: Fifteen watts

Stages: Three

Tubes: One 37, one 89, and two 79's

This amplifier is identical with the one just described with the exception that the final output stage employs two type 79 tubes in push-pull parallel Class B output, making possible an audio power output of 15 watts with normal input.

The genemotor required for this amplifier must provide 300 volts D.C. at 100 ma. The total battery drain for the entire amplifier will then be 10.65 amperes.

Equipment List for 79 Tube Push-Pull Parallel Output Amplifier

T-1	T-6789	Interstage Transformer
T-2	T-6594	Output Transformer
CH-1	T-1892	Input Choke
R-1	500,000-ohm	volume control
R-2	5000-ohm	carbon resistor—1 watt
R-3	25,000-ohm	carbon resistor—1 watt
R-4	50,000-ohm	carbon resistor—1 watt
R-5	500,000-ohm	carbon resistor—1 watt
R-6	1000-ohm	wire wound resistor—10 watt
C-1	4-mfd.	electrolytic condenser—25 volt
C-2	2-mfd.	electrolytic condenser—450 volt
C-3	.01-mfd.	paper condenser—500 volt
C-4	8-mfd.	electrolytic condenser—450 volt

DYN. 300-volt, 100 ma. motor-generator to operate from 6-volt battery.

Pre-Amplifier Circuits



When the sources of sound pickup are at extremely low levels, such as is the case with a condenser microphone head or photo-electric cell, additional amplification is necessary before coupling to the main amplifier. This is provided by a pre-amplifier. These pre-amplifiers are usually located as close as possible to the source of sound pickup, as the level is so low that a line of any length would cause the introduction of extraneous noises and loss of power.

The following pre-amplifiers are suitable for use with a photo-electric cell and condenser microphone, and will provide a signal level that can be run over a line of considerable length.

Head Amplifier for Condenser Microphones

The high quality reproduction and absence of background noises have made the condenser microphone the frequent choice of sound engineers seeking the finest possible installations. Many manufacturers supply the head separately for those who wish to build their own head amplifier.

THORDARSON engineers have, therefore, designed this amplifier to meet the special needs of this application. The diagram shows complete battery operation, since in this manner complete absence of hum is secured and a more compact portable unit is possible. The current

consumption is only about 4 ma. on the plate batteries. Four ordinary dry cells connected in series provide 6 volts for the filament and grid bias.

When completed the amplifier should be mounted in a metal case to provide the necessary shielding. A five-prong socket may be installed in the case to receive a five-prong plug connecting the five-conductor shielded lead for connection to the main amplifier input and to the batteries.

The coupling condensers should be of the mica type to assure freedom from noise. Likewise, only the very best molded resistors should be used (except R-4, which is wire wound). If possible, the tube sockets should be cushioned to prevent tube microphonics.

THORDARSON Equipment for Head Amplifiers

- T-1 T-5516 tube to 200 or 50-ohm line transformer or T-6226 tube to 500 or 125-ohm line transformer

Miscellaneous Equipment

- R-1 10-megohm carbon resistor—1 watt
- R-2 100,000-ohm carbon resistor—1 watt
- R-3 500,000-ohm carbon resistor—1 watt
- R-4 35-ohm wire wound resistor—2 watt
- C-1 .006-mfd. mica condenser
- C-2 .01-mfd. mica condenser
- C-3 .5-mfd. paper condenser—300 volt

Condenser Microphone Pre-Amplifier

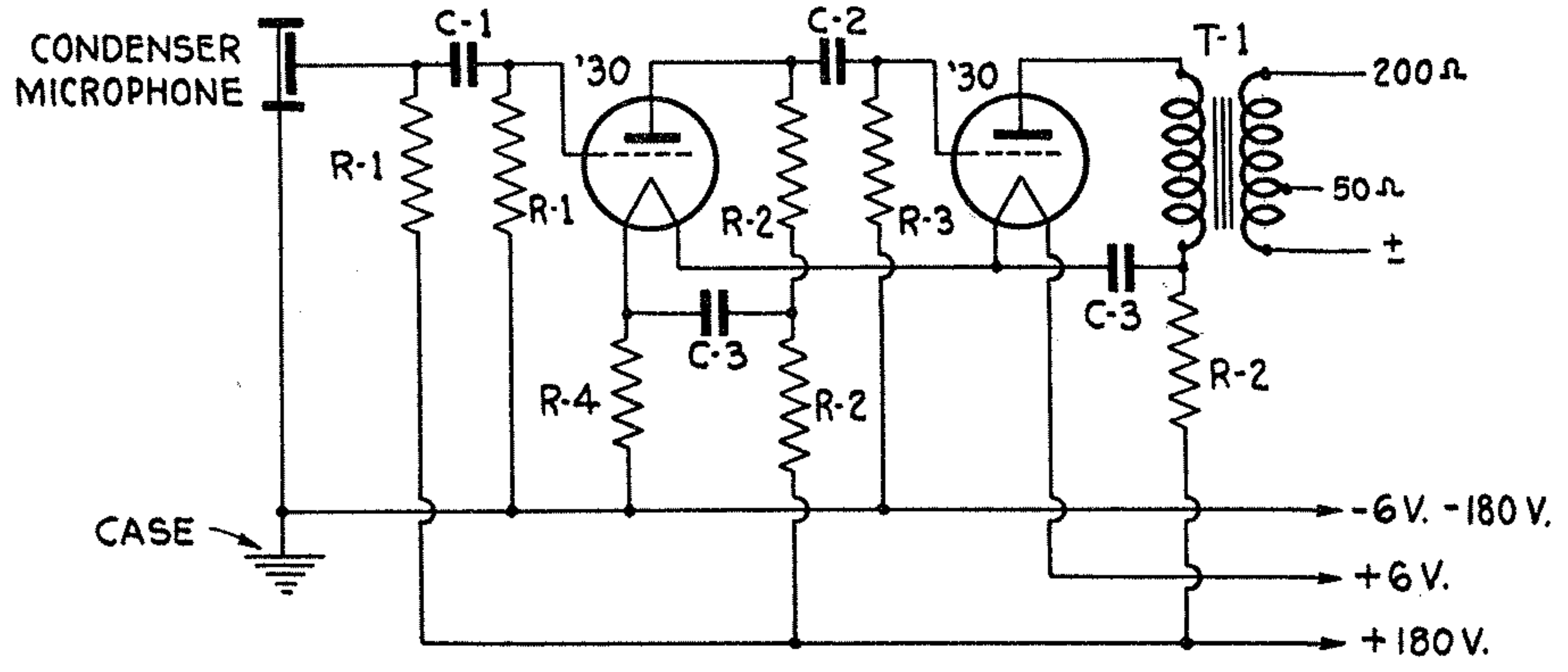


Photo-Electric Cell Pre-Amplifier

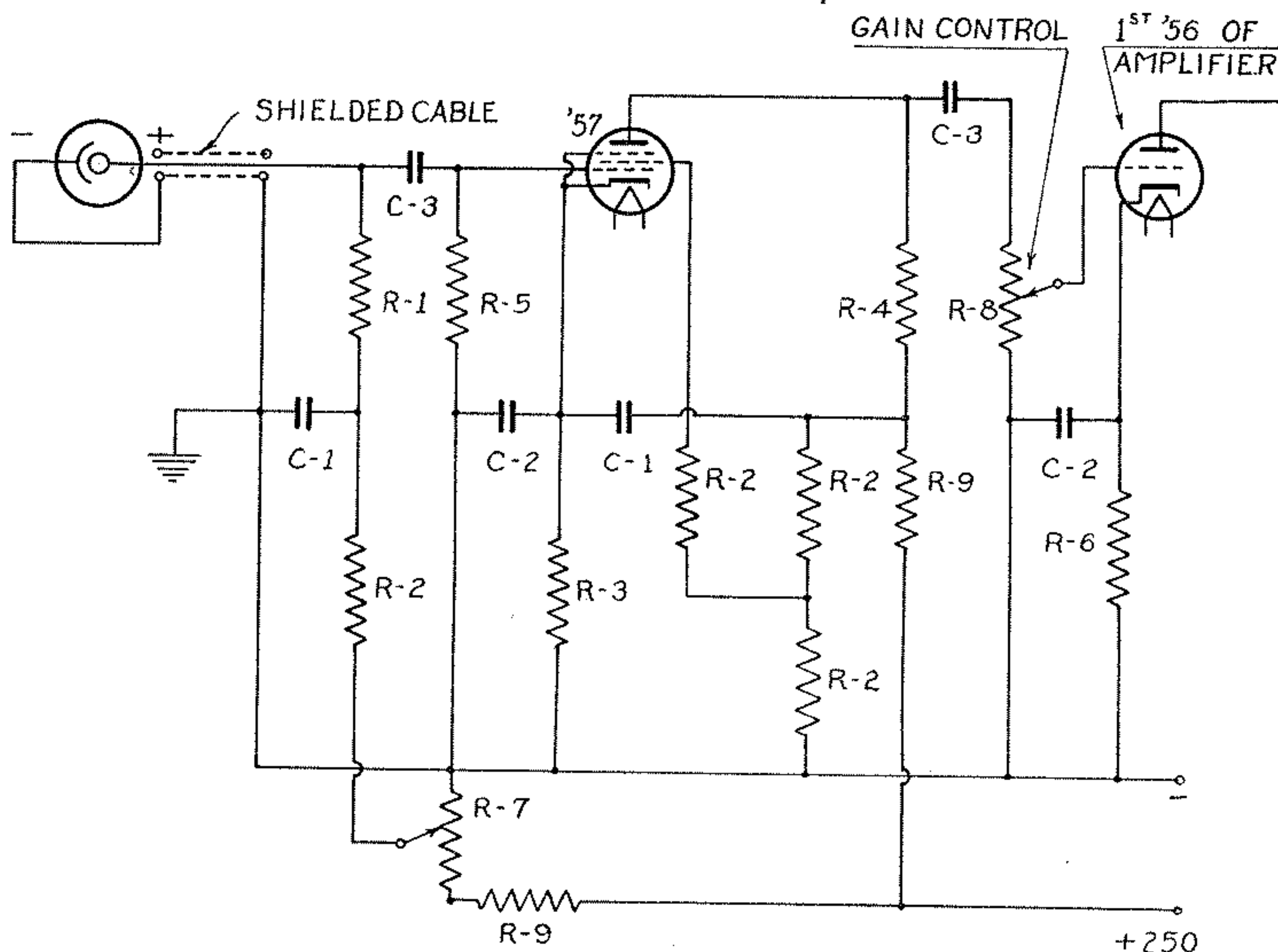


Photo-Electric Cell Pre-Amplifier for Sound-on-Film Reproduction

A specially designed pre-amplifier stage for reproduction of sound-on-film, planned for use in connection with any of the amplifiers shown in the THORDARSON Sound Manual. Where it is desired to place this pre-amplifier at the sound head, a separate unit should be built for each sound head. Where these heads are relatively close to the amplifier, the output of the final tube may be connected to a suitable transformer for coupling directly to the input stage of the main amplifier. If the amplifier, however, is placed at too great a distance from the projectors, it will be necessary to use a low level transmission line to cover the intervening space with suitable input and output coupling transformers.

Input from the P.E. cell to the type 57 amplifying tube is resistance coupled. The output of the amplifying tube is likewise resistance coupled to the fader R-8. When the main amplifier has a fader in conjunction with the change-over switch, the fader as shown in the above diagram may be omitted. The volume between heads is then balanced by adjusting the photo cell voltage control R-7 until the output from each pre-amplifier is the same. Care should be taken never to allow the photo cells to operate for more than a second or two while ionized. This greatly shortens cell life. Ionization is detected by a reddish glow about the cell plate.

THORDARSON Equipment

for P.E. Cell Pre-Amplifier—Low Level Line

- T-5515 Output transformer from tube to 200 or 50-ohm line
- T-6226 Output transformer from tube to 500 or 125-ohm line
- T-5516 Input transformer from 200 or 50-ohm line to single grid
- T-6193 Input transformer from 500 or 125-ohm line to single grid

See THORDARSON Bulletin 345-A for exciter lamp transformers

Miscellaneous Equipment

- R-1 1-megohm carbon resistor—1 watt
- R-2 100,000-ohm carbon resistor—1 watt
- R-3 4000-ohm carbon resistor—1 watt
- R-4 125,000-ohm carbon resistor—1 watt
- R-5 500,000-ohm carbon resistor—1 watt
- R-6 2500-ohm carbon resistor—1 watt
- R-7 50,000-ohm potentiometer
- R-8 500,000-ohm volume control
- R-9 50,000-ohm carbon resistor—1 watt
- C-1 2-mfd. paper condenser—200 volt
- C-2 4-mfd. electrolytic condenser—25 volt
- C-3 .01-mfd. mica condenser

Microphone, Mixing, and Input Circuits

On these pages is presented data for applying suitable input circuits to any of the THORDARSON amplifiers previously described. Choice of the proper input circuit will adapt any of these or other amplifiers to the exact application for which their use is desired.

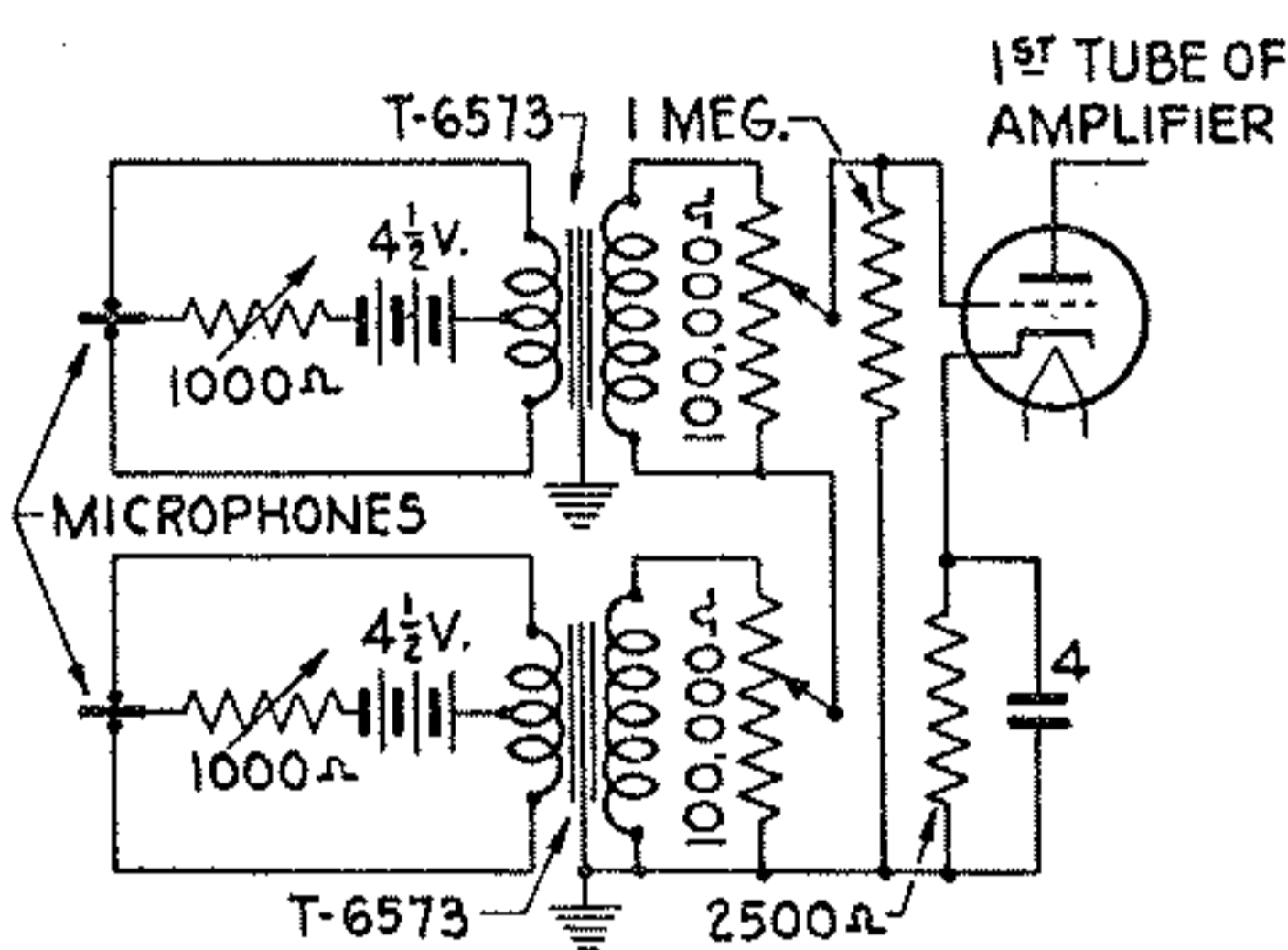


FIG. 1

All of the amplifiers shown have a 500,000-ohm potentiometer connected as a volume control in the grid circuit of the first tube. When a single source of input is to be used, such as a high impedance or crystal pick-up, it may be connected directly to the outside terminals of the volume control without the use of a transformer. A low impedance pick-up, condenser microphone, or line, would require a line-to-grid transformer having the proper primary impedance. (See line-to-grid transformers, THORDARSON Sound Amplifier Bulletin 345-A.)

If a carbon microphone is used, it should be wired to the primary of a microphone transformer with the necessary battery and volume control rheostat. The secondary of the line or microphone transformer is connected to the outside terminals of the volume control. It is often desirable to keep watch of the microphone current to see if it is within the rating specified by the manufacturer. This is accomplished by inserting an 0 to 50 D.C. milliammeter in series with the microphone battery. Most double button carbon microphones require 20 to 30 ma. total current.

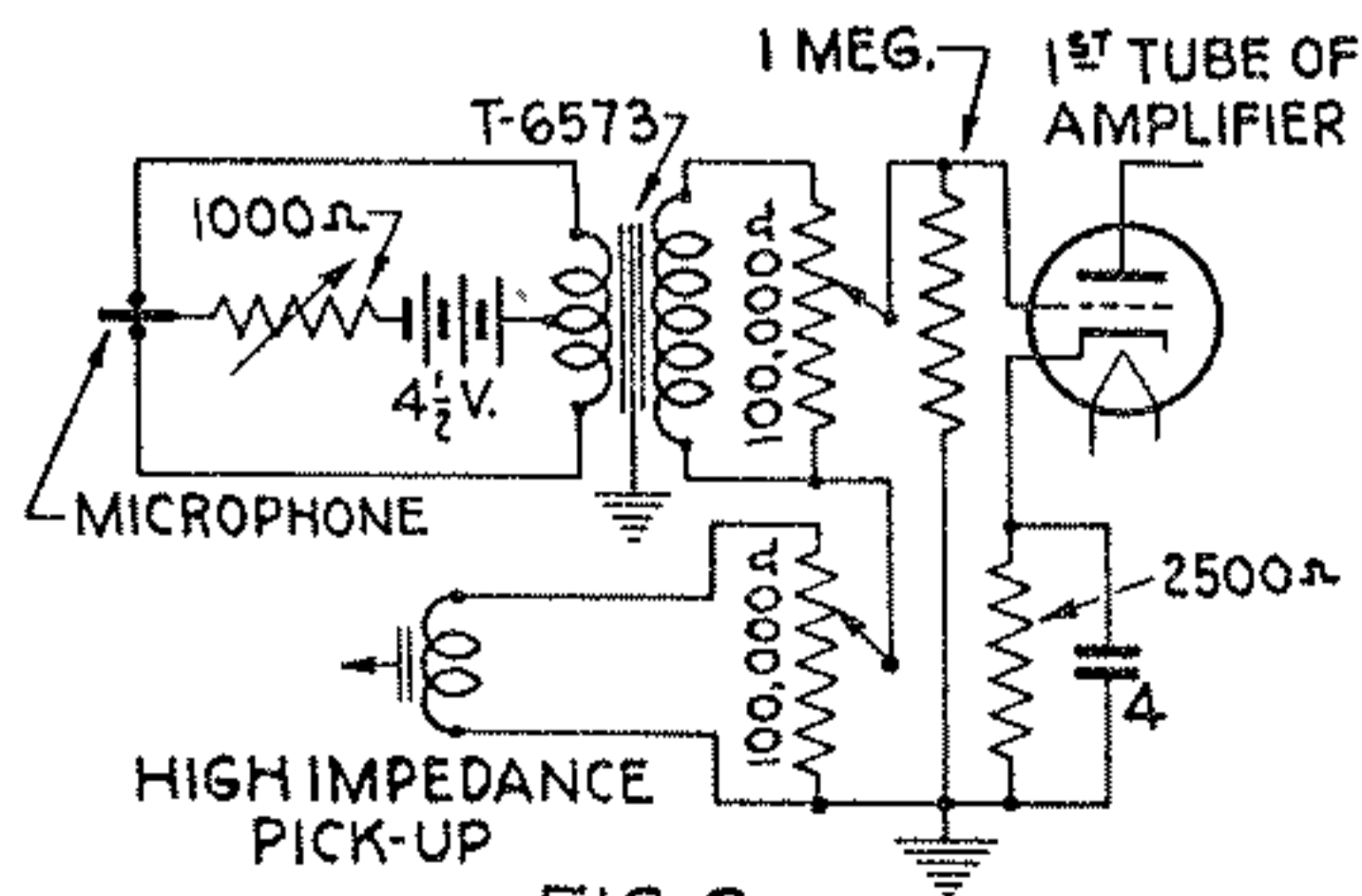


FIG. 2

Two Microphone Pick-up

Where two microphones are to be mixed for simultaneous operation with a single amplifier, the circuit shown in Fig. 1 will prove very efficient, yet is quite simple in construction. Provision is made for individual control of microphone button currents and for fading each microphone entirely independently of the other. The diagram shows the type numbers of suitable THORDARSON microphone transformers.

MIXER CIRCUIT USING 200-Ω PADS

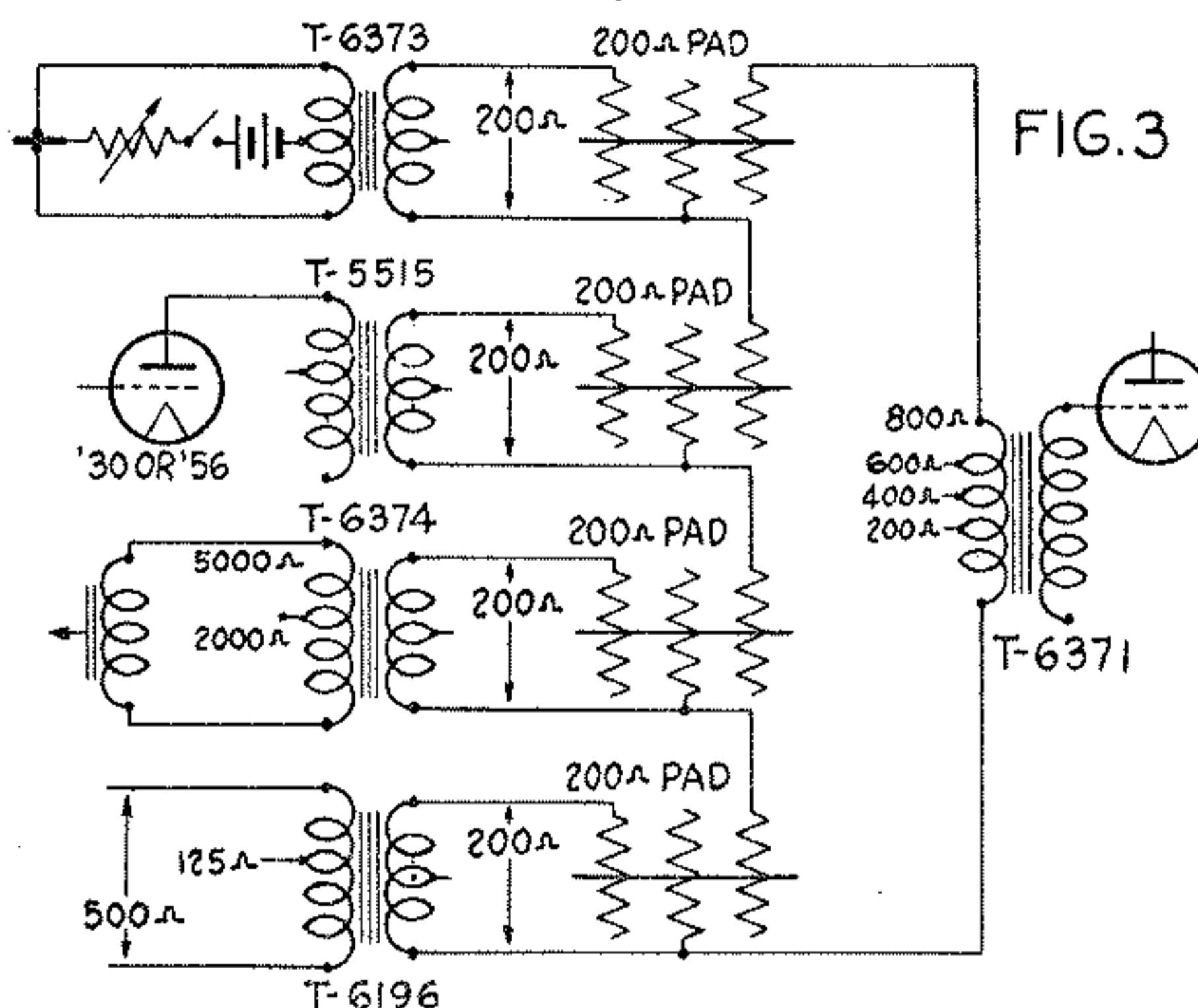


FIG. 3

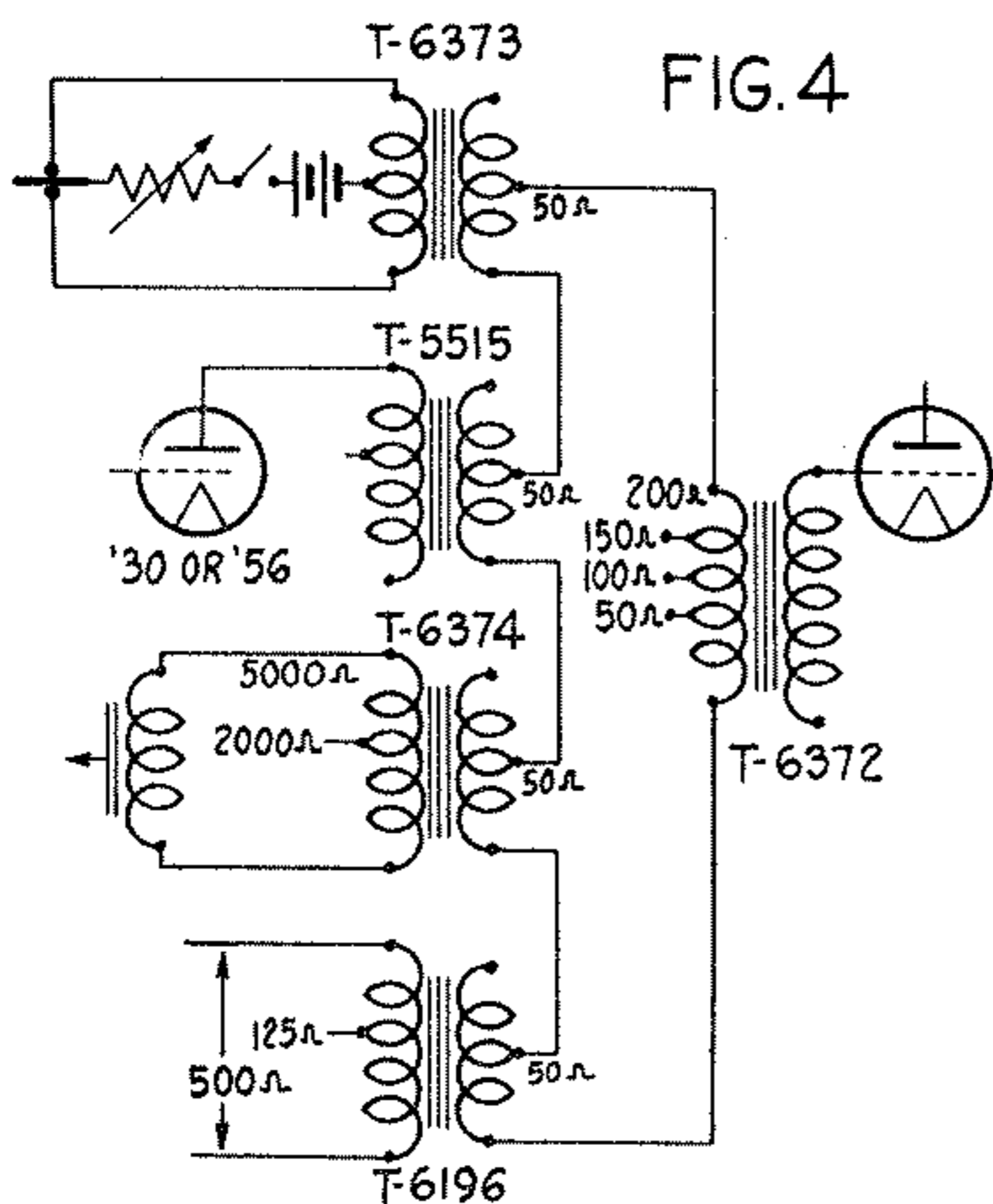
Microphone and Magnetic Pick-Up

This combination of inputs is utilized very frequently, as it enables a musical background to be provided for the speaker. Here also, each input may be faded independently. Fig. 2 shows the use of a high impedance pick-up, which today is almost universal in application. If a low impedance pick-up is to be used, a suitable THORDARSON coupling transformer must be employed in place of the direct connection to the circuit as now shown. A crystal pick-up may be substituted for the high impedance type shown, without alteration.

Four 200-ohm Channel Mixer Circuit

Fig. 3 shows a typical circuit for mixing four separate inputs to one amplifier. Each 200-ohm channel is regulated by a separate T-pad fader for volume control. The four channels are connected in series, giving a total impedance of 800 ohms which matches the primary impedance of the THORDARSON T-6371 Line-to-Tube Transformer. This transformer has taps at 200, 400, and 600 ohms to allow the use with one, two, or three 200-ohm channels when desired.

SIMPLE MIXER CIRCUIT
50-Ω PADS MAY BE USED AS IN FIG. 3



Four 50-ohm Channel Mixer Circuit

Fifty-ohm channels may be mixed in the same manner, as is shown in Fig. 4. Here the individual channel faders are not used. If this is done, provision must be made for adjusting volume previous to the mixer circuit. The THORDARSON T-6372 Line-to-Tube Transformer has taps at 150, 100, and 50 ohms to provide for coupling one, two, or three channel mixers when desired.

Pre-Amplifier for Use with Mixer Circuits

The loss that occurs in series connection of mixer circuits often requires the use of an additional stage of pre-amplification for use before the main amplifier. Fig. 5 illustrates a circuit suitable for this purpose. It is resistance coupled, using a single type 56 tube. All voltages are supplied by the main amplifier.

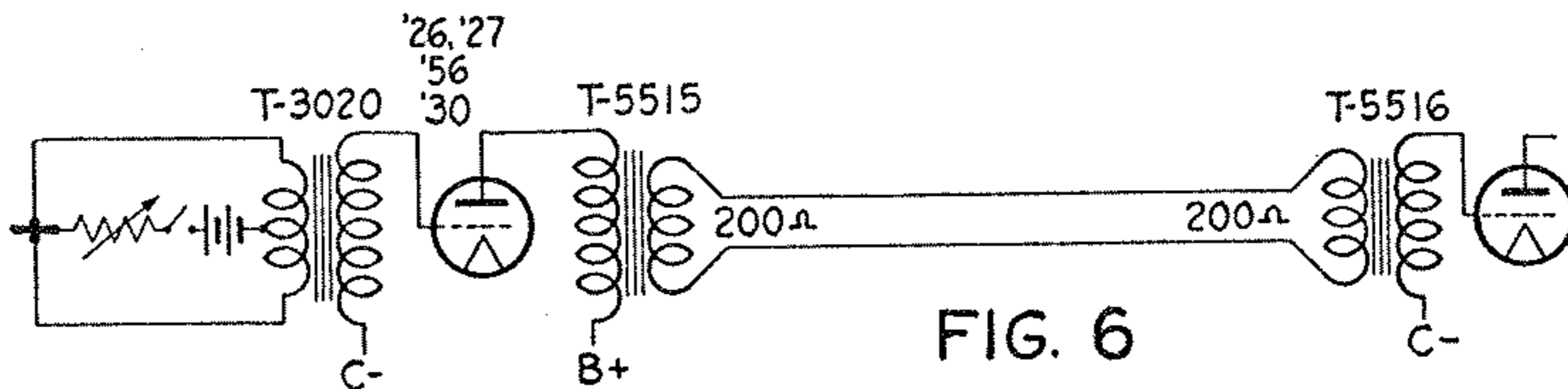
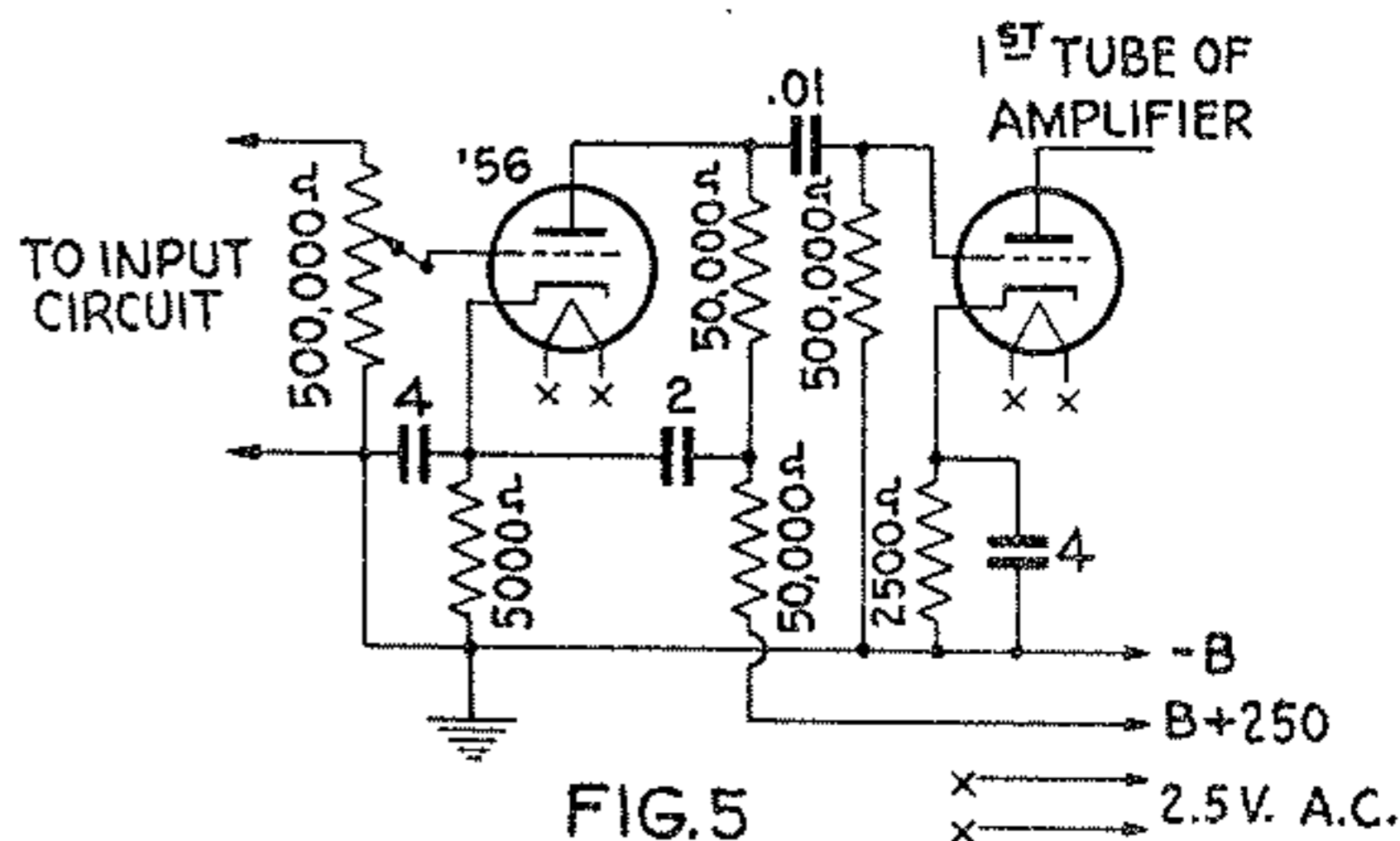
Transmission Lines

Low impedance lines of 50, 200, or 500 ohms are employed to make possible transmission of audio frequency currents over considerable distances between microphone or pre-amplifier and the main amplifier with negligible loss or attenuation of high frequencies.

In Fig. 6 is shown a typical line circuit coupling pre-amplifier stage at the point of microphone pick-up to the first amplifier tube such as is usually found in the station

rack. Both line wires act like the plates of a condenser, having capacity which partially by-passes the signal, the loss being greater on the high frequencies. The effect of this line capacity is reduced to a minimum by setting up a low impedance circuit between the amplifiers.

Thus, the pre-amplifier tube plate is coupled to the line with a transformer such as the T-5515, having a primary to secondary turn ratio of 8 to 1, and the main amplifier tube grid is coupled to the line with a T-5516 Transformer. The line voltage is then reduced to 1/8 and the attenuation is only 1/64 (the impedance ratio of the tubes to the line) of what it would be if the signal were carried through a line at high voltage and coupled directly to the tube plates and grids. It is frequently necessary to keep stray currents from getting into the line circuits by means of shielded conductors. The loss through capacity to ground or to the shielded conduit would cause extreme reduction of highs were not low impedance used. Telephone lines traveling for miles through cables are frequently utilized for transmission of



Speaker Output Coupling Circuits

The THORDARSON Line includes tube-to-speaker, tube-to-line, and line-to-speaker coupling transformers for every application, including heavy duty units with ample power handling capacity for type 800 and 845 tubes. For complete list and detailed specifications of each, see the latest THORDARSON Power Amplifier Transformer Bulletin.

For amplifier installations where some or all of the speakers are to be located at a dis-

high inductance so that up to six transformers may be connected in parallel across the line and by proper selection of terminals, keep a perfect impedance match with the line. Then by proper selection of secondary terminals, any dynamic speaker with voice coil impedance from .1 to 48 ohms may be properly matched to the 500-ohm line.

The accompanying table shows the wide range of dynamic speaker voice coil im-

The speakers "A" have 8-ohm voice coils while the two marked "B" are 12 ohms each. By using three of the THORDARSON T-6408 Line-to-Speaker Transformers, all transformers present the same impedance to the line and the power will be divided equally among the three. However, the speakers "A" divide the power from a single transformer, and thus have half the power each of the other two speakers.

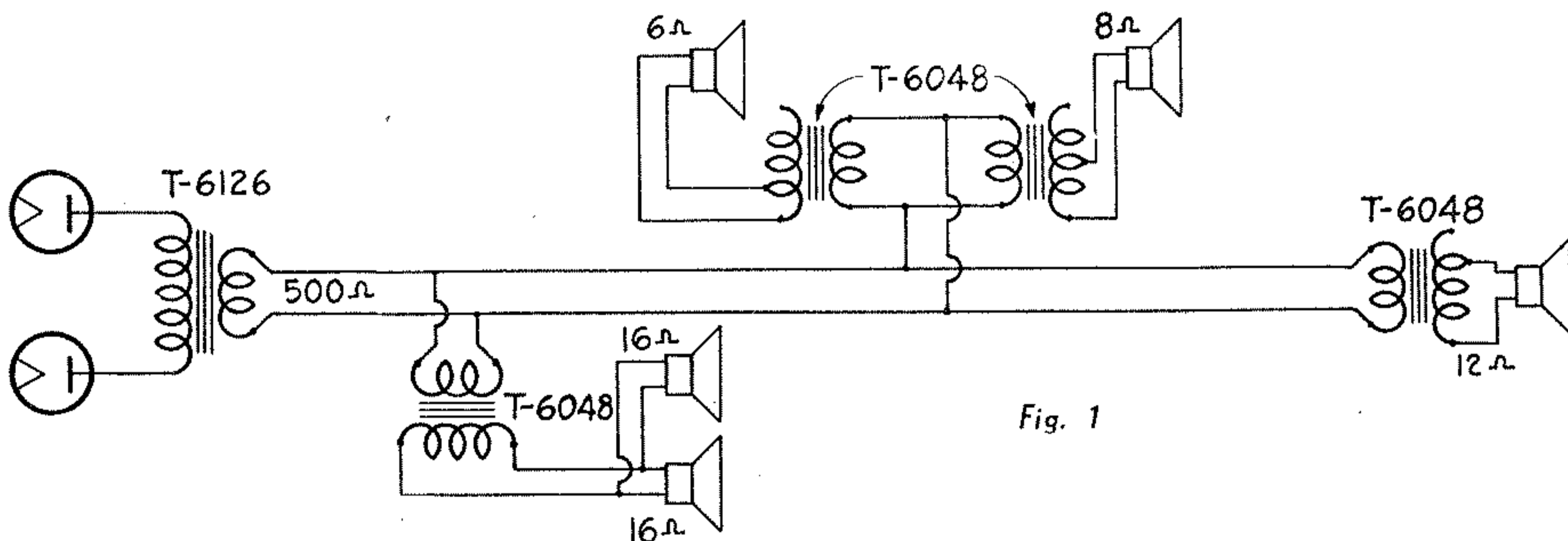


Fig. 1

tance from the amplifier, experience has shown that the installation of a 500-ohm transmission line offers greatest economy of sound energy, maximum ease of securing accurate impedance matches, and freedom from attenuation of any desired signal frequencies.

THORDARSON engineers have developed an unusual system for the setting up of 500-ohm transmission lines and a series of tube-to-line and line-to-speaker transformers that eliminate the guesswork previously existing in working out complicated speaker systems. Fig. 1 shows a typical multiple speaker installation employing dynamic units of varying impedances, all operated from a single amplifier through a 500-ohm line. In this case, a perfect impedance match has been secured at all points, both between line and amplifier, line and output transformers, and between the transformers and dynamic speaker voice coils.

Such simplified output circuits have been made possible by the development of the new THORDARSON T-6048 Universal Line-to-Speaker Transformer. The primary has

pedances that may be matched with this transformer.

In Fig. 2 is shown a common method of proportioning the sound energy between speakers. Here is represented a typical large auditorium installation where two speakers are to be located near the stage and operated at half power, and two more are to be placed toward the rear of the room to be operated at full power.

Where there are a number of speakers, each having a 500-ohm input transformer to be connected to a 500-ohm line, a series parallel circuit must be used. With four speakers, two are connected in series and the two pair are connected in parallel to the 500-ohm line. The resulting impedance is then 500 ohms. Likewise, with nine speakers, three speakers are connected in series and the three groups of three in series are connected in parallel to the line.

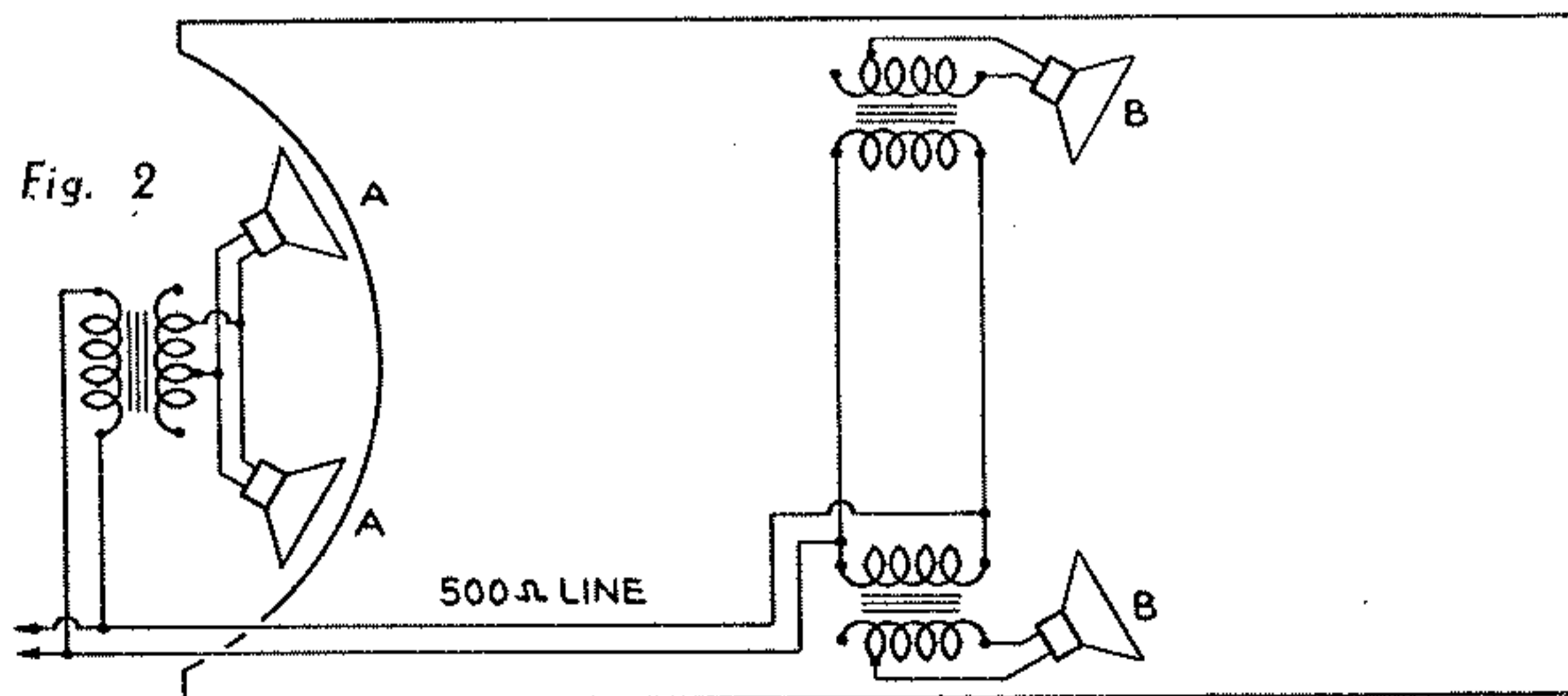


Fig. 2

THORDARSON Transformer T-5381 will couple a 500 or 250-ohm line to voice coils having 4, 8, or 15 ohms impedance. If desired, two of these transformers may be connected to a 500-ohm line by using a series connection and the 250-ohm tap. It is also possible to connect several speaker voice coils to one of the T-5381 Transformers. If the voice coils have 15 ohms impedance each, two of them could be connected in parallel to the 8-ohm tap. Four 15-ohm voice coils can be wired in series parallel to the 15-ohm tap or in parallel to the 4-ohm tap.

If it is impossible to make the impedances match, it is advisable to work into a load of a higher rather than a lesser impedance. For instance, if 4 and 8-ohm taps are available on the output transformer and the speaker impedance is 6 ohms, the 4-ohm tap should be used. This will result in only slight loss of power, whereas if the 8-ohm tap had been used, the peak current of the power tubes would be excessive, and distortion would result.

The wires connecting the transformer to the speaker voice coil should not be any longer than necessary. Long voice coil leads result in loss of power and low frequencies. Heavy wire should be used if the transformer is separated from the speaker more than a foot or so.

Table for Connecting Dynamic Speakers of Various Impedances in Same Output System

Secondary Terminals	Secondary Matching Impedance T-6048 Transformer					
	No. of Transformers in Parallel Across 500-ohm Line					
	1	2	3	4	5	6
2 - 4	.06	.1	.2	.2	.3	.4
5 - 6	.1	.2	.4	.5	.6	.7
2 - 5	.2	.4	.7	.9	1.1	1.3
4 - 6	.3	.6	1.0	1.3	1.6	1.9
3 - 6	.4	.7	1.1	1.4	1.8	2.1
2 - 6	.6	1.2	2.0	2.7	3.4	4.0
6 - 7	.7	1.4	2.2	2.9	3.6	4.3
1 - 2	1.3	2.7	4.	5.4	6.8	8.1
1 - 3	1.7	3.3	5.	6.7	8.4	10.
1 - 4	2.	4.0	6.	8.	10.	12.
3 - 7	2.4	4.8	7.2	9.6	12.	14.4
1 - 5	2.6	5.3	8.	10.6	13.3	16.
2 - 7	2.8	5.6	8.4	11.2	14.	16.8
1 - 6	4.	8.	12.	16.	20.	24.
1 - 7	8.	16.	24.	32.	40.	48.

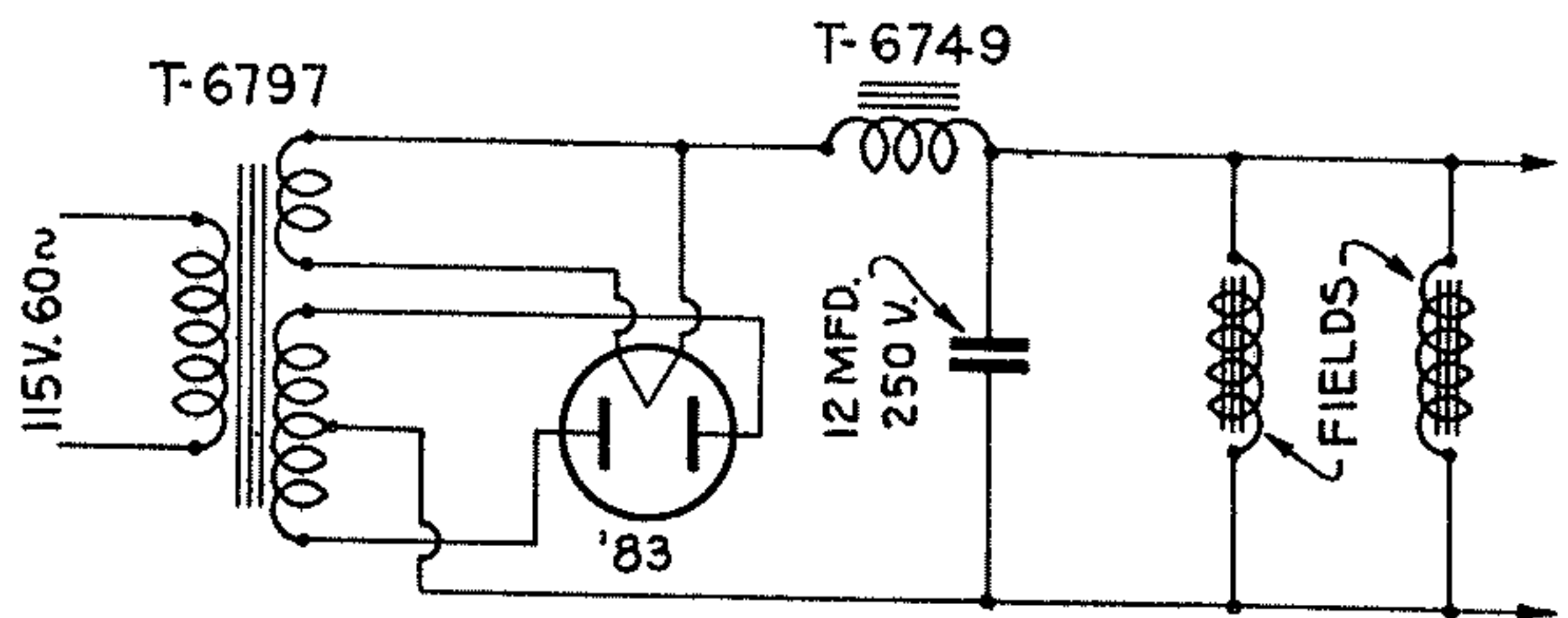
Dynamic Speaker Field Power Supply

This power supply unit is designed to furnish an energizing potential for the field of any dynamic speaker intended for operation at 115 volts D.C.

A filter choke and condenser are used to insure freedom of ripple in the direct current, which would cause objectionable hum. The power transformer is designed to have exceptionally good regulation so the voltage will not drop below 115 volts when the maximum current is taken from the supply. Sufficient power is available to operate the largest types of electro-dynamic speakers.

The maximum current output of the unit is 250 ma. Any number of speaker fields may be energized by a single power supply until the maximum current rating is reached.

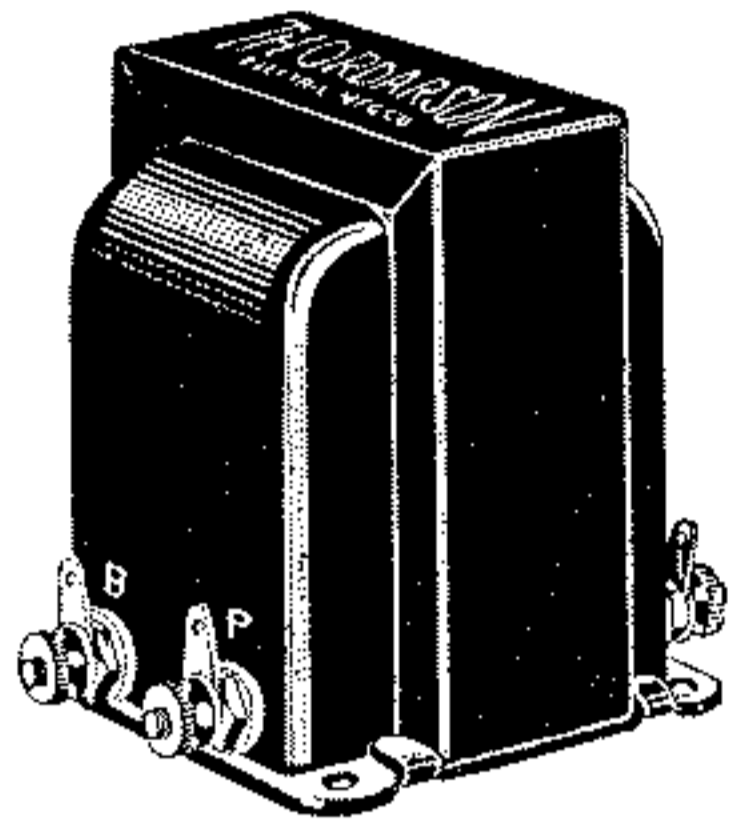
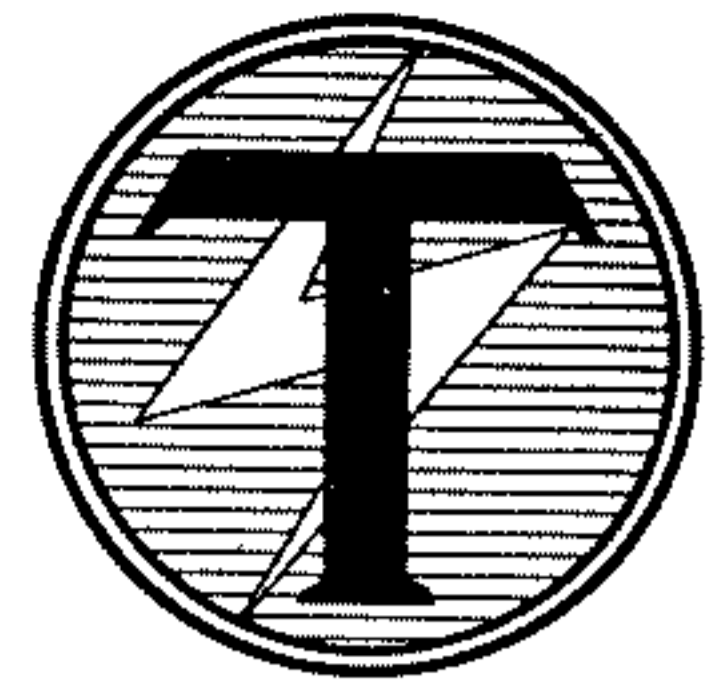
The accompanying table indicates the number of field windings of any resistance value that may be operated. If fields of various resistances are connected to the same power supply, the current drawn by each should be determined and care taken not to overload the unit.



THORDARSON'S Speaker Field Supply Transformer will deliver 30 watts D.C. at 115 volts when used with a type 83 rectifier tube, T-2353-A, or T-6749 Choke, and a 12-mfd. condenser. An input choke is necessary to provide correct voltage and filtering. The following combinations may be used:

- 1 to 6 115-volt 5-watt fields 2500 to 3000 ohms each
- 1 to 4 115-volt 8-watt fields 1800 to 2500 ohms each
- 1 to 3 115-volt 10-watt fields 1400 to 1800 ohms each
- 1 or 2 115-volt 15-watt fields 950 to 1400 ohms each
- 1 115-volt 30-watt field 450 to 950 ohms

For EVERY Sound Application . . .



there is a **THORDARSON** Transformer
—designed for the EXACT circuit in
which it is to be used

From microphone to speaker, at 2 watts or 100, THORDARSON has designed a special transformer to fit your amplifier needs. So wide is the range of amplifier coupling requirements that no general purpose transformer can ever be expected to offer satisfactory performance. Specify a THORDARSON Transformer—it is built for its job.

Audio Transformers

THORDARSON matched transformer design makes possible correct impedance matching, so necessary for the maximum transfer of energy from one circuit to another and for the elimination of distortion and frequency discrimination.

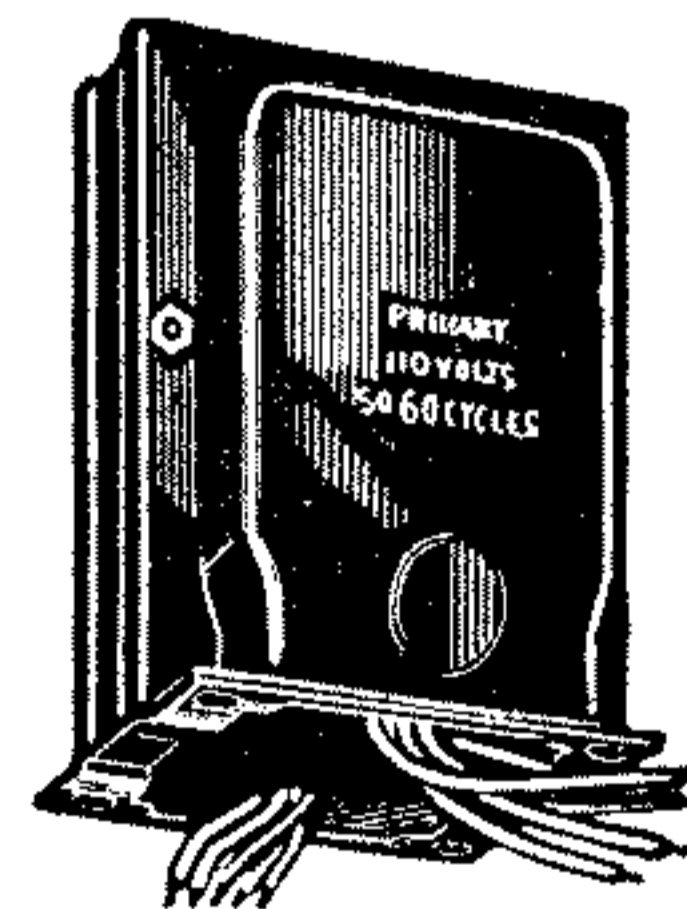
THORDARSON offers the most complete line of public address and sound amplifier system transformers—microphone-to-line, microphone-to-tube, line-to-tube, interstage coupling, impedance coupling, push-pull interstage, tube-to-line output, line-to-voice coil output, and tube-to-voice coil output.

Mounting styles to best match the mechanical requirements of every installation are available.

Power Transformers

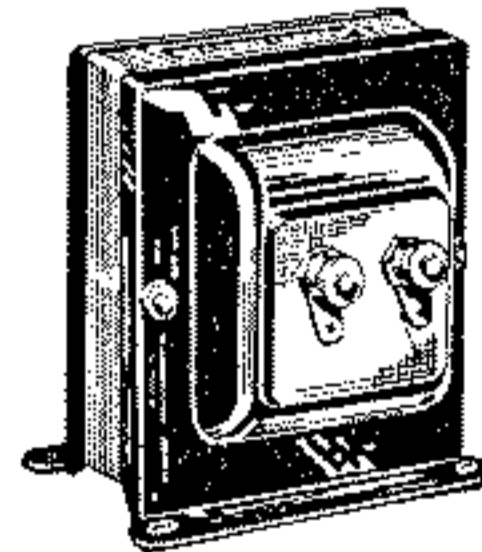
THORDARSON has designed a complete line of power transformers for every tube. Combined plate and filament transformers are available for power outputs up to 40 watts. Above this, separate plate and filament transformers can be supplied.

The THORDARSON "extra margin of safety"—greater thickness of core stack and oversize coil windings—keeps heating to a minimum, increasing transformer life and insuring efficient, trouble-free performance.



Choke Coils

THORDARSON Input and Smoothing Chokes have been designed especially for THORDARSON Power Transformers to make available complete power supplies of proven merit. With these matched units you are certain of satisfactory performance.



For Complete Information See Catalog 345-A

THORDARSON ELECTRIC MFG. CO.
500 W. HURON ST. CHICAGO, ILL.