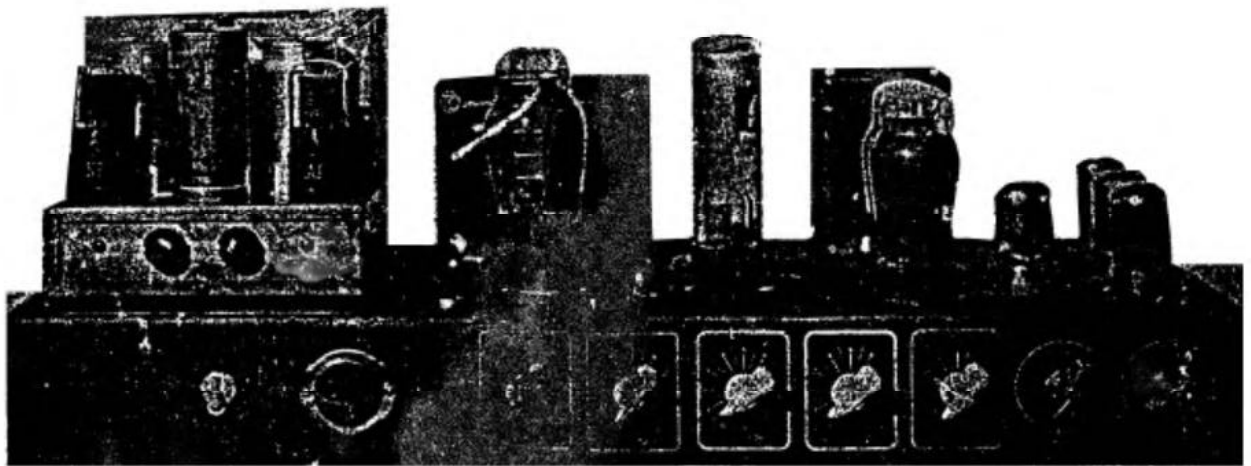


PRACTICAL AMPLIFIER DIAGRAMS



PROVEN CIRCUITS
FOR THE TECHNICIAN
AND EXPERIMENTER

PRACTICAL AMPLIFIER DIAGRAMS

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PRACTICAL AMPLIFIER DIAGRAMS

INTRODUCTION

In this electronic age, one of the most commonly used devices is the amplifier. It has made possible magnification of minute indications of voltage, current and power into levels high enough to perform many useful tasks.

It is the primary purpose of this manual to present a series of amplifiers designed to cover the audio frequencies, frequencies that affect the human ear and cover the entire range of sound. The average listener is most sensitive to sound from about 100 cycles (a low pitch) to 7000 cycles (a high pitch). In some instances, one can hear sound frequencies as low as 20 cycles and perhaps as high as 20,000 cycles. An audio frequency (A.F.) amplifier, then, operates within this band of frequencies, either entirely or in part, depending upon the purpose for which it was designed.

The majority of A.F. amplifiers described in this manual are for purposes of amplifying the usual range of recorded, broadcast and voice frequencies, or from 50 to 12,000 cycles. There are a few amplifiers described to operate to 20,000 cycles which are designated as High-Fidelity amplifiers. All amplifiers shown are of standard design and typical of their type. A comprehensive listing of such A.F. amplifiers consisting of from one to 20 tubes each is to be found in Part I of this manual.

Of course, an amplifier will only be useful if it has something to magnify, and so in Part II is presented a variety of radio tuners, pickups, microphones and other detecting devices suitable as inputs for the average amplifier. The devices shown are by no means all possible types that may be used but are representatives. As to the output requirements of the amplifiers, it is usually assumed the amplifier will operate into a properly matched speaker. Again, the amplifier is not necessarily restricted to sound

INTRODUCTION (CONTINUED)

applications, but may be used to operate recorders, solenoids and many other load sources at the discretion of the user.

No attempt has been made to specify any but standard parts in the diagrams. These are generally procurable in a number of reputable brands from any reliable radio supply house or radio jobber. Each schematic diagram carries a listing of parts necessary to build the amplifier so that substitutions can be made if the exact part specified cannot be obtained. In substituting parts it is necessary that they be within tolerance so that the completed amplifier will operate satisfactorily. Unless otherwise indicated in the particular schematic, the following fairly wide electrical tolerances are acceptable when substituting:

Capacity of electrolytic condensers - - - - -	50%
Capacity of paper condensers - - - - -	30%
Capacity of mica condensers - - - - -	10%
Resistance of fixed resistors - - - - -	20%
Resistance of potentiometers - - - - -	30%
Voltage insulation of condensers - - - - -	Minimum specified
Wattage rating of resistors - - - - -	Minimum specified
Current rating of transformers - - - - -	Minimum specified
Wattage rating of transformers - - - - -	Minimum specified

It is assumed the prospective constructor has sufficient background to read and interpret schematic diagrams. No physical parts layout is specified for the amplifiers, but rather stress is placed upon the complete schematic. This was deliberately done since constructors seldom build their equipment alike - particularly when many items of the same electrical specifications have entirely different physical shapes.

INTRODUCTION (CONTINUED)

For those of you who have had little or no experience in building amplifiers, it is advisable to build the more simple types of one, two or three tube amplifiers, making certain that the completed amplifier is functioning properly before attempting to construct a more complicated type. If trouble does persist, it is suggested a good servicing manual be studied for ideas. There are a number of excellent books of this type on the market with complete data for analyzing all types of service problems. To you more experienced constructors, it is hoped the following pages will provide the information you desire. Good luck.

- The Author -

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Part I

A. F. AMPLIFIER DIAGRAMS AND EXPLANATORY NOTES

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In order to simplify and standardize the arrangement of the diagrams, a ground symbol (⏏) is used to show common connections. These common connections are generally fastened to the chassis unless otherwise noted on the individual diagrams. Likewise, to lessen the confusion of filament wires appearing on the diagrams, an arrow with a letter ($\rightarrow x$) will denote continuity between other identical symbols.

1 TUBE 1 WATT AC/DC AMPLIFIER

The compact amplifier shown in Fig. 1, utilizing a dual power output-rectifier tube, is suitable for speaker volume from a phonograph pickup having about two volts output. Although it is designed for use with a permanent magnet type speaker, a dynamic speaker may be used with equal results, provided the field coil is replaced for filter resistor R3. The usual operation for this type amplifier is from a 115 volt a.c. or d.c. source. When connected to d.c., it may be necessary to reverse the power plug to operate the amplifier. Because of the few parts used, this amplifier can be built very small, making it ideal to mount into a small phonograph case.

Parts List

C1, ✓ 5 mfd 400 V paper condenser
 C3: ✓ .05 mfd 400 V paper condenser
 C2: ✓ 10 mfd 25 V elec. condenser
 C4, C5: ✓ 40 mfd 150 V elec. condenser
 C6: ✓ .005 mfd 400 V paper condenser
 J1: Input jack
 R1: 1 megohm volume control
 R2: ✓ 100 ohm 1 watt resistor
 R3: ✓ 500 ohm 5 watt WW resistor
 S1: SPST switch
 T1: Output transformer, 3000 ohm to voice coil
 Socket: Octal

2 TUBE 2 WATT AC/DC AMPLIFIER

Because of its greater gain, the amplifier in Fig. 2 is capable of good volume with any type crystal phonograph pickup or radio tuner. It delivers up to 2 watts output, which is about all an average small cone speaker can handle. The amplifier is of the ac/dc type and features a selenium rectifier, eliminating the need of a rectifier tube. As is customary with all amplifiers shown, the power switch (S1) may be either a toggle, rotary or push type, or may be attached to the volume or tone control shafts as part of the operation of that particular control if desired. There should be no particular problem in getting the completed amplifier to operate properly.

Parts List

C1, C6, C7: .05 mfd 400 V paper condenser
 C2, C4: ✓ .01 mfd 400 V paper condenser
 C3, C5: 40 mfd 150 V elec. condenser
 J1: Input jack
 R1: 500K ohm volume control
 R2: 10 megohm 1/2 watt resistor
 R3: 270K ohm 1/2 watt resistor
 R4: 350 ohm 10 watt WW resistor
 R5: 470K ohm 1/2 watt resistor
 R6: 150 ohm 1 watt resistor
 R7: 1500 ohm 2 watt resistor
 R8: 47 ohm 1/2 watt resistor
 R9: 100K ohm tone control
 RA: Selenium rectifier, 75 MA min.
 S1: ✓ SPST switch
 T1: Output transformer, 2500 ohm to voice coil
 Sockets: 2 miniature 7-pin

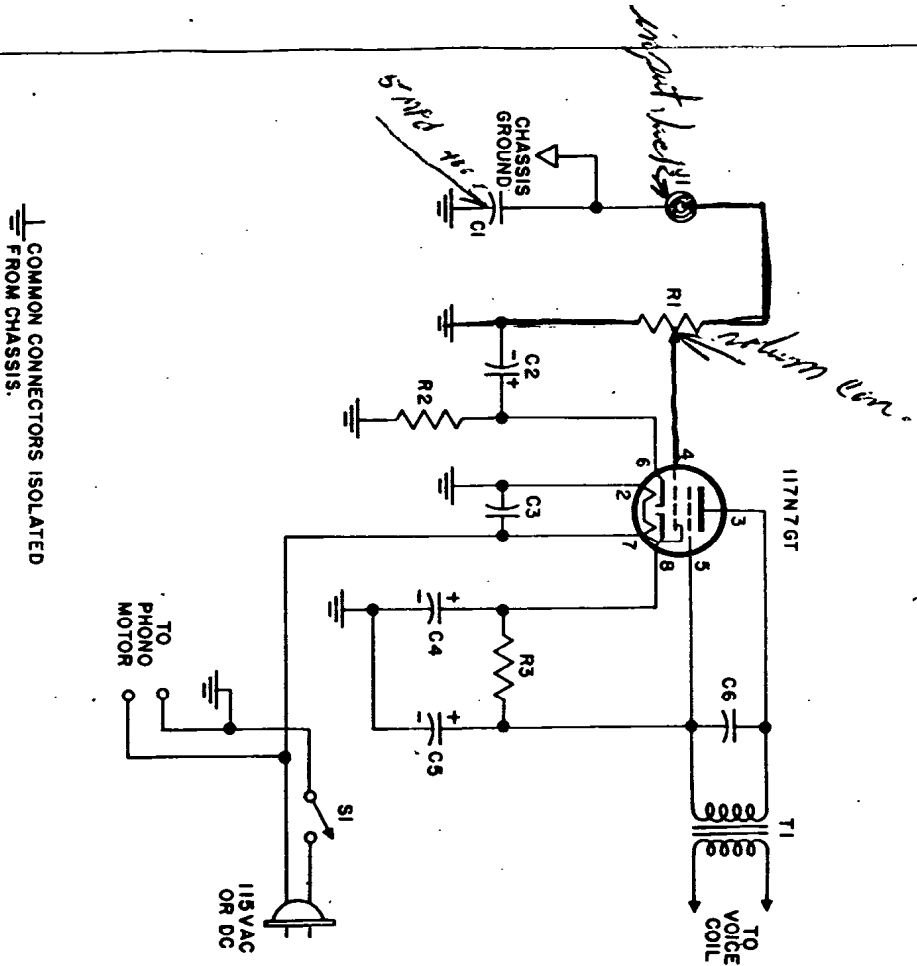


FIG. 1

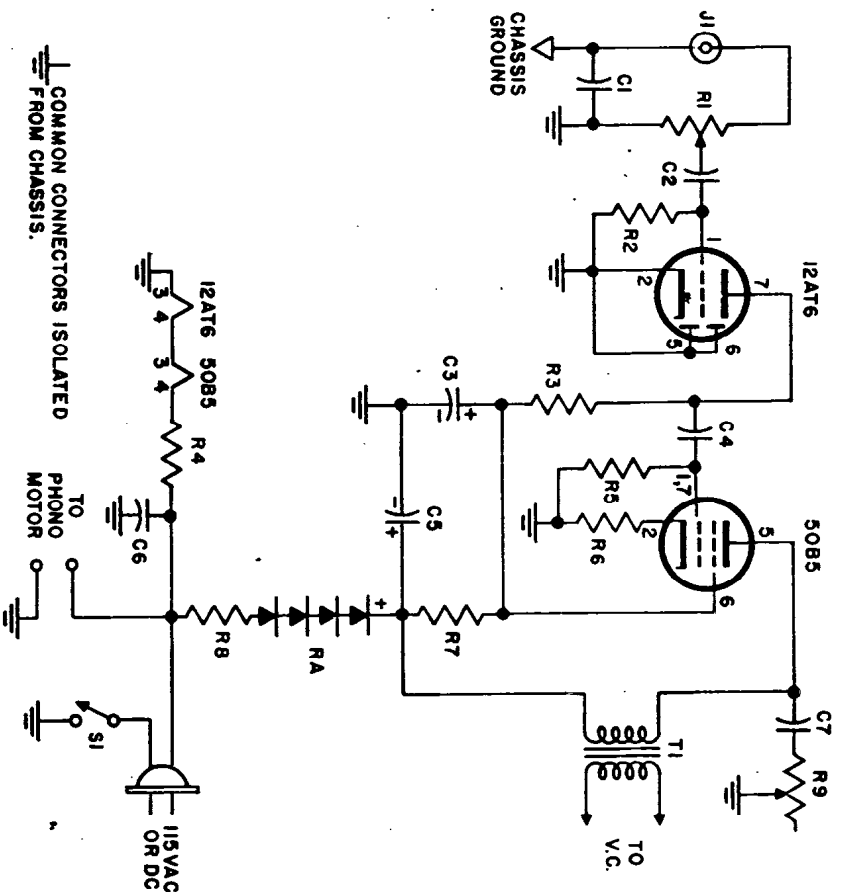


FIG. 2

2 TUBE 4 WATT AC BOOSTER AMPLIFIER

The purpose of the low gain, one stage amplifier (Fig. 3), is to boost the output of a radio tuner or pre-amplifier to good room volume. Although this is a "transformerless" AC amplifier using a single power tube, about 4 watts output can be obtained due to the use of a voltage doubler rectifier circuit. Any type of permanent magnet (PM) speaker can be used to the amplifier, provided the output transformer is properly matched. Likewise, the input transformer will depend upon the type of input used. If a radio tuner output is connected to the primary of T1, a 3:1 ratio audio transformer may be used; if a magnetic phonograph pickup is required, the primary of T1 must match this pickup unit. Fair quality can be expected from this circuit. In constructing the amplifier, be certain T1 is located as far as possible from the output transformer to minimize inductive hum problem.

2 TUBE 5 WATT AC BOOSTER AMPLIFIER

Fig. 4 is the "power transformer" version of the previous amplifier. Slightly more power output is available due to higher plate voltages used, and somewhat better stability is realized due to the isolation of the amplifier and the AC power source. However, the overall gain is less due to degeneration applied to the 6V6GT cathode circuit. This degeneration aids in improving the fidelity of the amplifier but at a sacrifice in its gain. As a result the amplifier requires a fairly high input level in order to realize its 5 watt output possibility. The overall fidelity will depend upon the quality of T1, T2, and the particular speaker used.

2 TUBE 4 WATT AC/DC BOOSTER AMPLIFIER

Parts List

C1: 10 mfd 25 V elec. condenser
 C2: .005 mfd 600 V paper condenser
 C3: 20 mfd 350 V elec. condenser
 C4; C5: 20 mfd 250 V elec. condenser
 C6: .01 mfd 400 V paper condenser
 R1: 150 ohm 1 watt resistor
 R2: 500 ohm 2 watt WW resistor
 R3: 47 ohm 1/2 watt resistor
 R4: 225 ohm line cord or 25 watt resistor
 S1: SPST switch
 T1: A.F. input transformer
 T2: Output transformer, 3000 ohm to voice coil, 4 watt
 Sockets: 2 octals

2 TUBE 5 WATT AC BOOSTER AMPLIFIER

Parts List

C1: .01 mfd 600 V paper condenser
 C2, C3: 20 mfd 450 V elec. condenser
 C4: .02 mfd 400 V paper condenser
 R1: 270 ohm 1 watt resistor
 R2: 1000 ohm 5 watt WW resistor
 S1: SPST switch
 T1: A.F. input transformer
 T2: Output transformer, 8500 ohm to voice coil, 5 watt
 T3: Power transformer, 300-0-300 V 70 MA, 5 V 2 A, 6.3 V 1 A
 Sockets: 2 octals

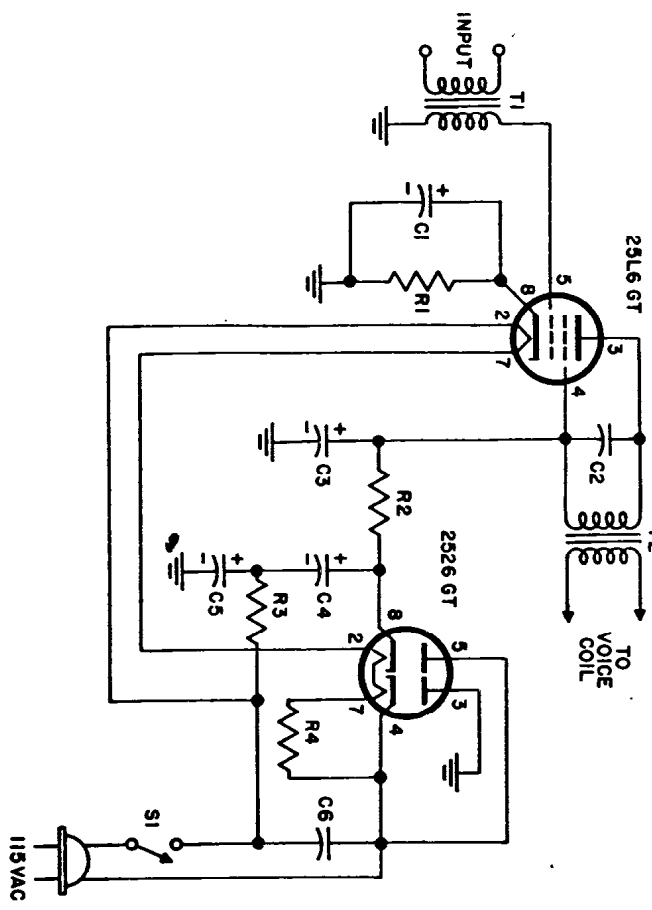


FIG. 3

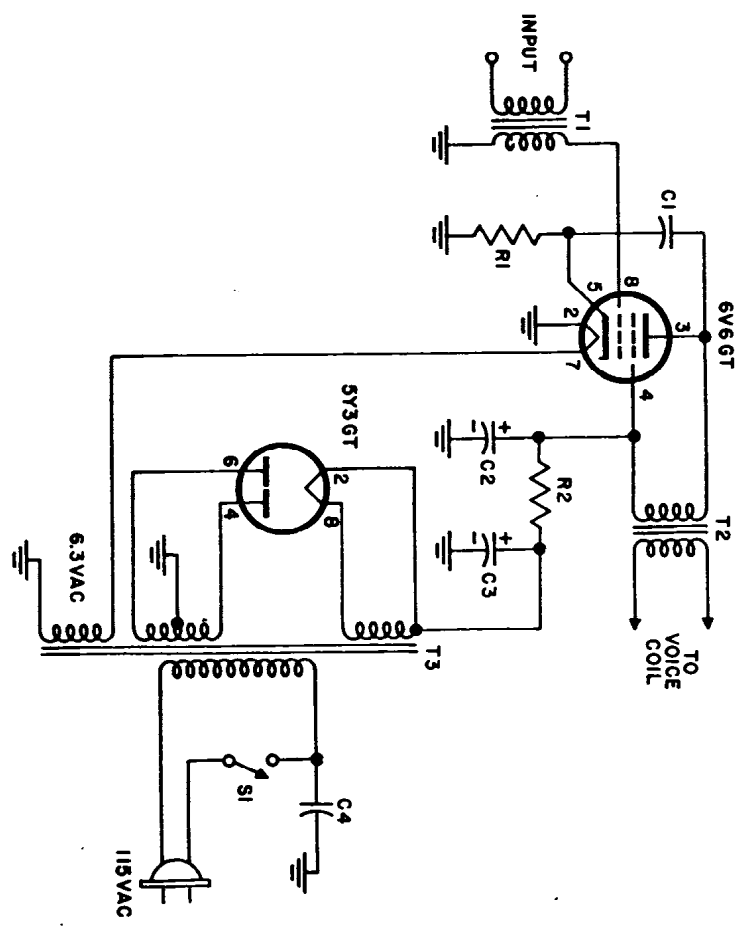


FIG. 4

2 TUBE BATTERY INTERCOM AMPLIFIER & 2 TUBE AC/DC INTERCOM AMPLIFIER

These two intercommunication type amplifiers are similar except for the power supply. Fig. 5 is designed for battery operation and is therefore instantly useable by pressing the push-to-talk switch on either speaker unit. This connects the voice coil to the amplifier properly and also turns on the tube filaments. A 4-wire cable is necessary on this system and for best results is limited to 100 feet between remote speaker and amplifier. Fig. 6 is designed for AC/DC operation from 115 volts source, therefore is characteristically a slow heater. It is best used as shown, a master (local) station having all control and located in the amplifier case, and a slave (remote) station normally open to the master. A 2-wire cable is all that is necessary with this arrangement and up to 500 feet can be used without difficulty.

The speakers are 2" to 5" PM units, and the push-to-talk switches are of the push button spring return types. In assembly, especially in Fig. 6, care should be taken in locating the input transformer T1. If hum persists regardless of its location, try reversing either primary or secondary winding of T1. Incidentally, if an intercom input transformer T1 is not obtainable, a suitable substitute consists of a 2500 ohm to voice coil output transformer connected in reverse (high impedance winding to grid).

2 TUBE BATTERY INTERCOM AMPLIFIER (FIG. 5)

Parts List

C1, C2: .01 mfd 200 V paper condenser
 C3: 1.0 mfd 50 V paper condenser
 R1: 220K ohm 1/2 watt resistor
 R2: 1 megohm 1/2 watt resistor
 R3: 680 ohm 1 watt resistor
 R4: 1 megohm volume control
 S1, S2: DPDT push-to-talk switch
 T1: Intercom. input transformer
 T2: Output transformer, 5000 ohm to voice coil
 Speaker: 3" to 6" PM
 Sockets: 2 miniature 7-pin
 A: 1-1/2 v dry cell, flashlight type
 B: 67-1/2 v miniature "B" battery

2 TUBE AC/DC INTERCOM AMPLIFIER (FIG. 6)

Parts List

C1, C3: 10 mfd 25 V elec. condenser
 C2, C4: .01 mfd 400 V paper condenser
 C5, C7: 40 mfd 150 V elec. condenser
 C6: .005 mfd 600 V paper condenser
 R1: 2200 ohm 1/2 watt resistor
 R2: 220K ohm 1/2 watt resistor
 R3: 1 megohm volume control
 R4: 150 ohm 1 watt resistor
 R5: 235 ohm 10 watt WW resistor
 R6: 100 ohm 1 watt resistor
 R7: 1000 ohm 2 watt resistor
 S1: DPDT push-to-talk switch
 S2: SPST power switch
 T1: Intercom. input transformer
 T2: Output transformer, 2000 ohm to voice coil
 Speaker: 3" to 6" PM
 Sockets: 2 octals

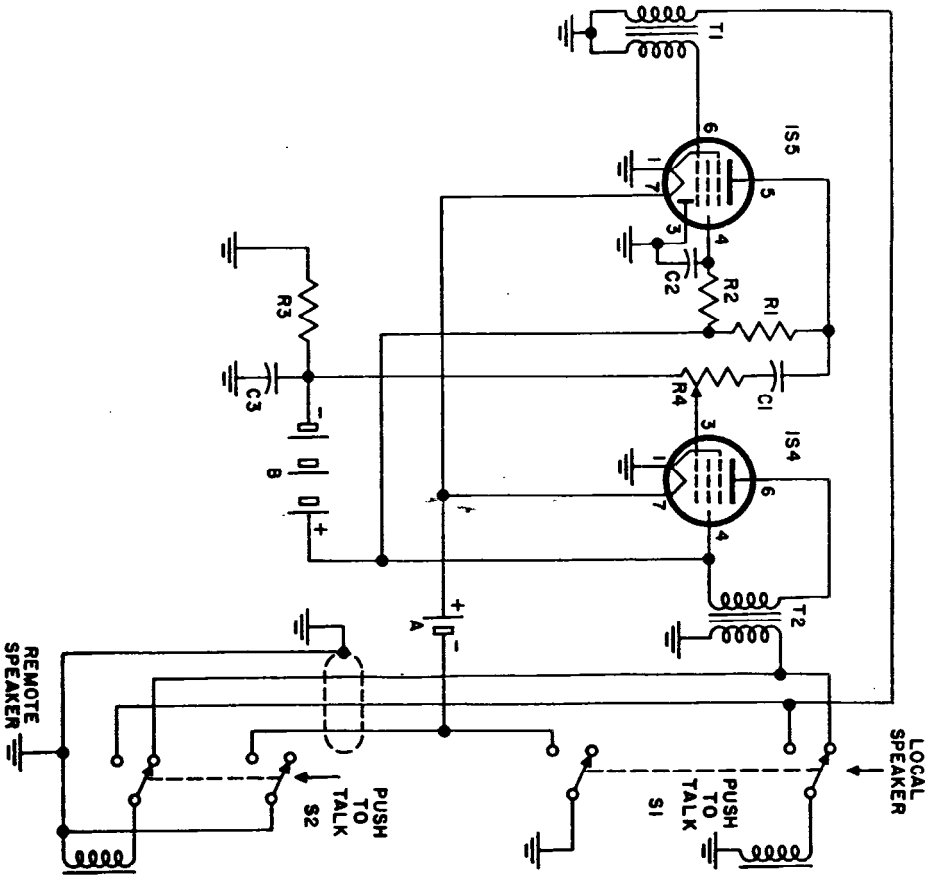
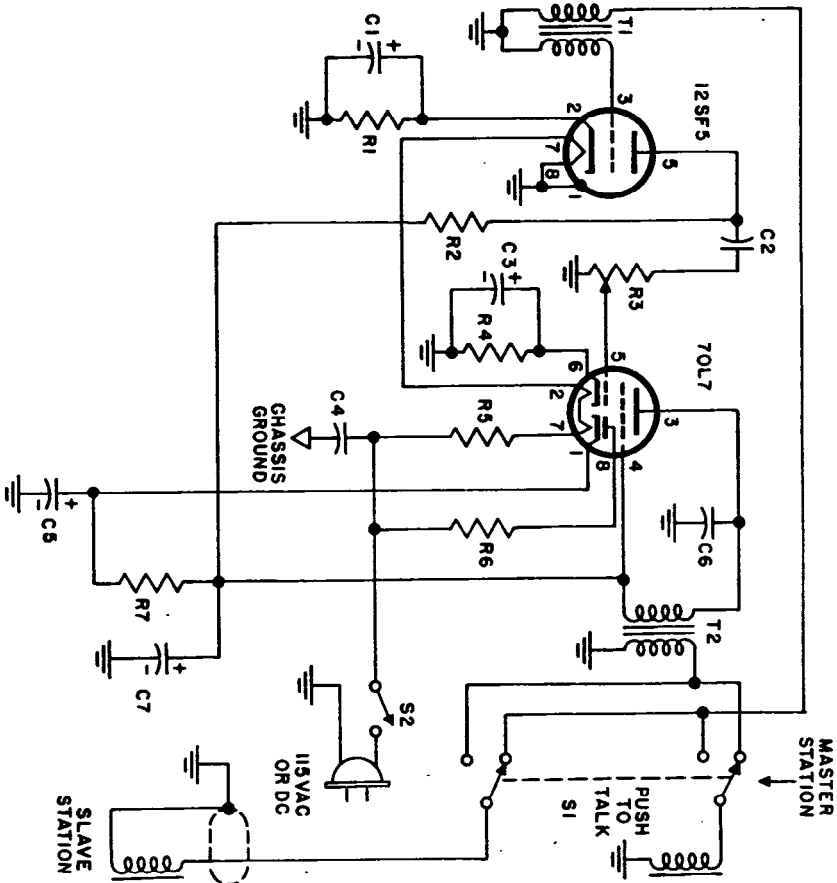


FIG. 5



NOTE: $\text{---}\text{---}\text{---}$ INDICATES COMMON CONNECTIONS
 $\text{---}\text{---}\text{---}$ INDICATES CONNECTIONS ISOLATED FROM CHASSIS.

FIG. 6

3 TUBE 3 WATT AC DIRECT COUPLED AMPLIFIER

The direct coupled amplifier is always a difficult type of amplifier to construct and keep in adjustment, but is presented here (fig. 7) for the more ambitious constructor. As you know, the direct coupled circuit consists of the plate of an amplifier tube directly connected to the grid of the next amplifier tube, thereby allowing a complete transfer of signal variations with a minimum of frequency distortion. With the proper choice of tubes and transformers, a high-fidelity amplifier can be constructed, provided it is adjusted properly. The adjustment consists of varying R5 to such a position that 60 volts can be measured across R3 by means of a vacuum tube voltmeter. This adjustment must be made after the amplifier has been on for at least one minute. If it is not possible to measure 60 volts across R3, try varying the value of this resistor over a limited range. This type of amplifier is highly adaptable for very low-frequency applications such as driving an oscillograph, etc. Three watts undistorted power output can easily be realized with a phonograph pickup or radio tuner connected to the input.

Parts List

C1:	10 mfd 25 V elec. condenser	R6:	20 ohm 5 watt WW resistor, center-tapped.
C2, C3, C4:	20 mfd 450 V elec. condenser	R7:	25K ohm 10 watt WW resistor
C5:	.05 mfd 400 V paper condenser	S1:	SPST switch
J1:	Input jack	T1:	Output transformer, 2500 ohm to voice coil, 3 watt
R1:	500K ohm volume control	T2:	Power transformer, 375-0-375 V 75 MA, 5 V 2 A, two 6.3 V 1 A
R2:	2200 ohm 1/2 watt resistor	Sockets:	3 octals
R3:	100K ohm 1 watt resistor		
R4, R8:	1000 ohm 10 watt WW resistor		
R5:	2000 ohm 10 watt WW resistor semi-adjustable		

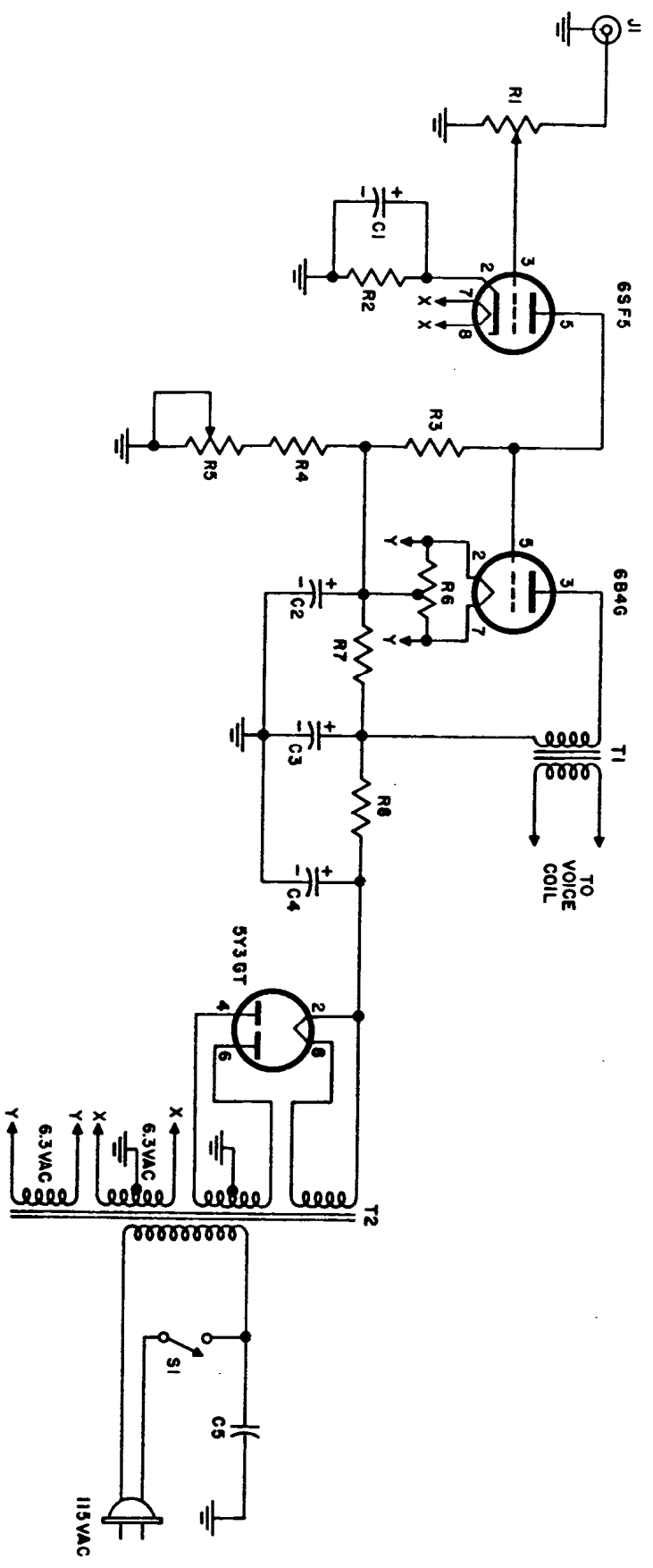


FIG. 7

3 TUBE 4 WATT AC AMPLIFIER

For a small amplifier having good gain and tone, the reliable circuit of Fig. 8 is very satisfactory. It will operate well from either a phonograph pickup or radio tuner and deliver good room volume. Very little difficulty should be experienced in constructing this unit. Due to the use of the decoupling resistor R7 and feedback resistor R5, stability is greatly improved. A tone control is incorporated to provide for a reduction of the higher audio frequencies when desired. The circuit is designed for use of a PM type speaker but if a field type dynamic speaker is desired, replace resistor R11 with a speaker having a 1000-ohm field winding. The amplifier can be built very compactly, making a small general purpose amplifier useful in a variety of applications.

Parts List

<p>C1, C2, C3, C4: 8 mfd 450 V elec. condenser</p> <p>C5, C6: .01 mfd 600 V paper condenser</p> <p>C7, C8: 25 mfd 25 V elec. condenser</p> <p>C9: .1 mfd 400 V paper condenser</p> <p>C10: 8 mfd 450 V elec. condenser</p> <p>C11: 20 mfd 450 V elec. condenser</p> <p>J1: Input jack</p> <p>R1: 500K ohm volume control</p> <p>R2: 2200 ohm 1/2 watt resistor</p> <p>R3, R5: 1 megohm 1/2 watt resistor</p> <p>R4: 270K ohm 1/2 watt resistor</p> <p>R6: 470K ohm 1/2 watt resistor</p>	<p>R7: 27K ohm 1 watt resistor</p> <p>R8: 270 ohm 1 watt resistor</p> <p>R9: 100K ohm tone control</p> <p>R10: 25K ohm 10 watt WW resistor</p> <p>R11: 1000 ohm 10 watt WW resistor</p> <p>S1: SPST switch</p> <p>T1: Output transformer, 5000 ohm to voice coil, 4 watt</p> <p>T2: Power transformer, 300-0-300 V 60 MA, 5 V 2 A, 6.3 V 2 A</p> <p>Sockets: 3 octals</p>
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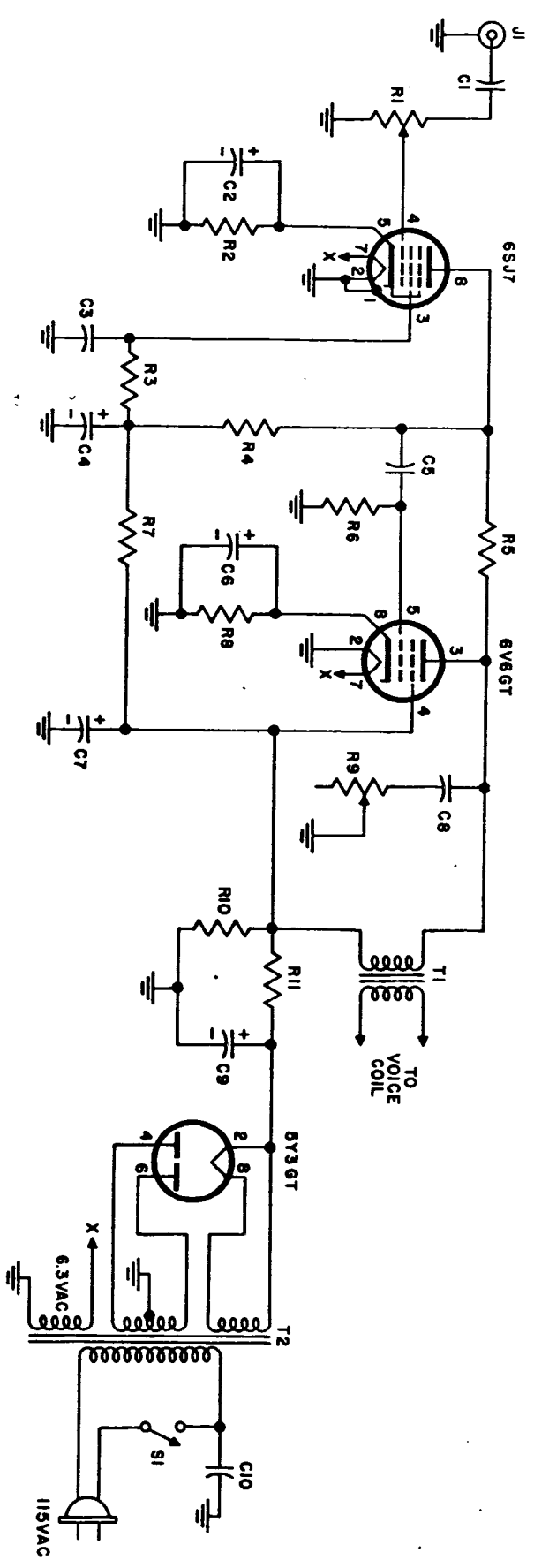


FIG. 8

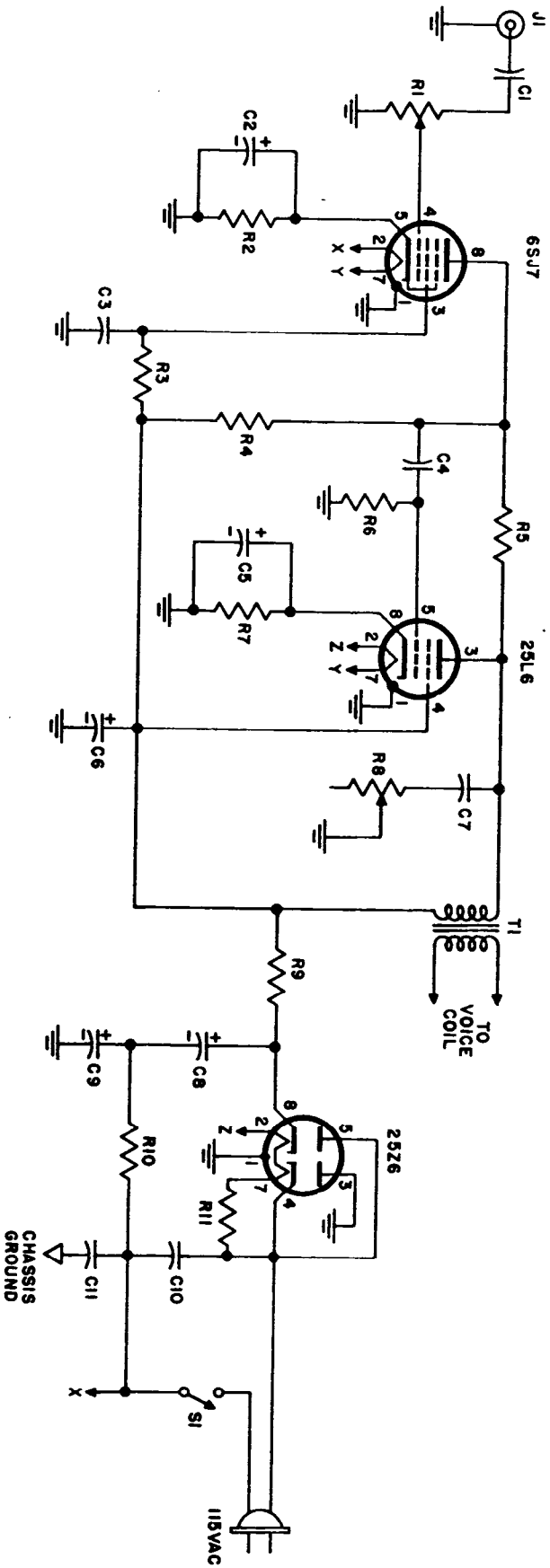
3 TUBE 4 WATT AC "TRANSFORMERLESS" AMPLIFIER

Although the amplifier circuit in Fig. 9 is very similar to Fig. 8, its chief difference lies in the power supply. It uses a voltage doubler rectifier circuit to furnish the higher voltages necessary to obtain the 4 watts output from a 25L6 tube. This is made possible without the aid of a power transformer, consequently the size and weight of the amplifier will be much less than the former. R11 can be either a line cord resistor, ballast tube, or fixed resistor, depending upon the constructors choice. Again, a tone control R8 provides tonal adjustment to suit the listener.

Parts List

C1, C4: .01 mfd 600 V paper condenser
C2, C5: 10 mfd 25 V elec. condenser
C3: .05 mfd 400 V paper condenser
C6: 20 mfd 350 V elec. condenser
C7: .05 mfd 600 V paper condenser
C8, C9: 20 mfd 250 V elec. condenser
C10, C11: .02 mfd 400 V paper condenser
J1: Input jack
R1: 500K ohm volume control
R2: 2200 ohm 1/2 watt resistor
R3, R5: 1 megohm 1/2 watt resistor

R4: 270K ohm 1/2 watt resistor
R6: 470K ohm 1/2 watt resistor
R7: 180 ohm 1 watt resistor
R8: 100K ohm tone control
R9: 1500 ohm 2 watt resistor
R10: 47 ohm 1/2 watt resistor
R11: 200 ohm line cord resistor
S1: SPST switch
T1: Output transformer, 3000 ohm to voice coil, 4 watt
Sockets: 3 octals



⏏ INDICATES COMMON CONNECTIONS
⏏ ISOLATED FROM CHASSIS.

FIG. 9

3 TUBE QUICK HEATING AC PAGING AMPLIFIER

The amplifier in Fig. 10 is an AC communication type featuring battery type amplifier tubes for fast operation. This particular amplifier is convenient where only occasional operation is desired as a paging system. When ready to operate, the switch is first closed, turning on the amplifier. After approximately five seconds, it is permissible to talk into the system as it will then be in full operation. Any reasonable number of remote stations may be used in this system if care is taken in matching the output transformer to the speakers. Low volume is to be expected from the amplifier, but a volume control is incorporated in order to have complete control of the output.

In assembling the amplifier, carefully separate input transformer T1 from the other transformers to eliminate inductive hum pickup. In adjusting R5 for correct filament voltage, start the tap from the ground end. With a DC voltmeter connected across C2, move the tap on R5 away from the grounded end until 4-1/2 volts is indicated on the meter.

Parts List

C1, C3:	.006 mfd 600 V paper condenser	SP1:	PM speaker or low impedance
C2:	100 mfd 10 V elec. condenser	SP2, SP3,	dynamic microphone
C4:	20 mfd 450 V elec. condenser	etc.:	
C5:	30 mfd 450 V elec. condenser	T1:	5" PM remote speakers
C6:	.05 mfd 400 V paper condenser		Intercom. input transformer, or
R1:	1 megohm volume control		output transformer connected in
R2:	470K ohm 1/2 watt resistor	T2:	reverse
R3:	1 megohm 1/2 watt resistor		Output transformer, 8000 ohm to
R4, R6:	1500 ohm 20 watt WW resistor	T3:	voice coil
R5:	500 ohm 10 watt WW resistor		Power transformer, 200-0-200 V
S1:	semi-adjustable	Sockets:	90 MA, 5 V 2 A
	SPST switch, normally off		3 octals
	momentary on		

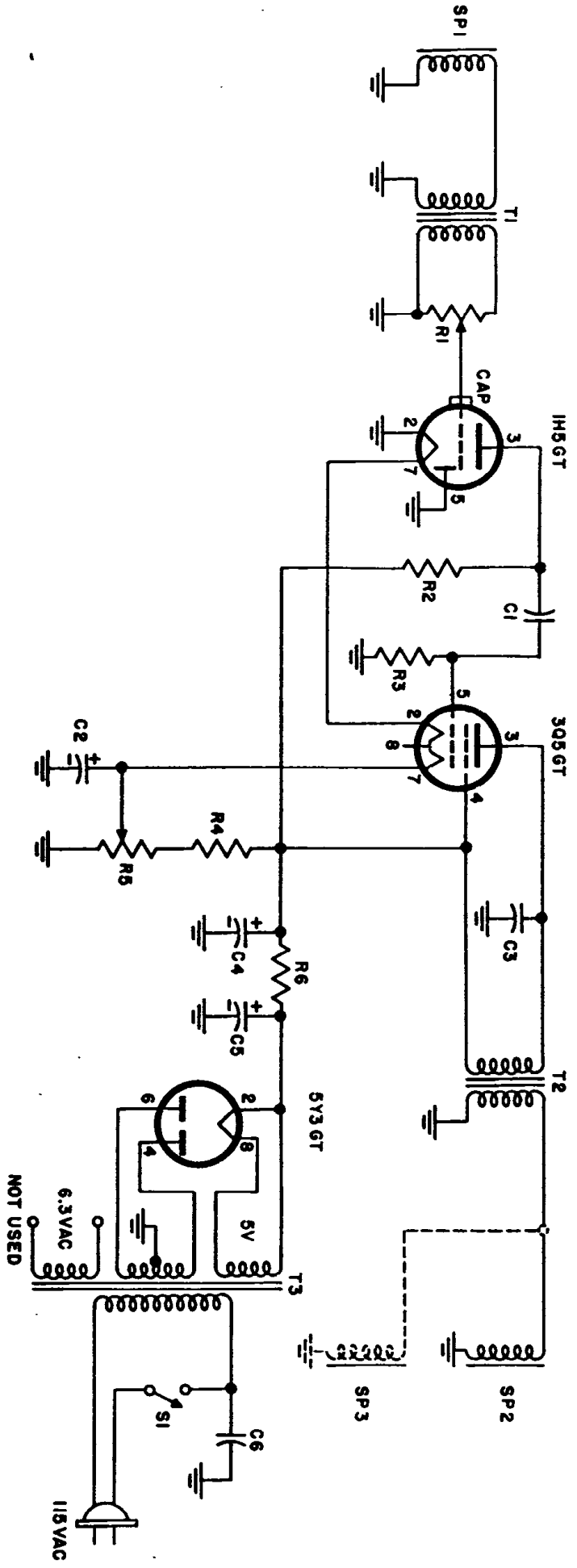


FIG. 10

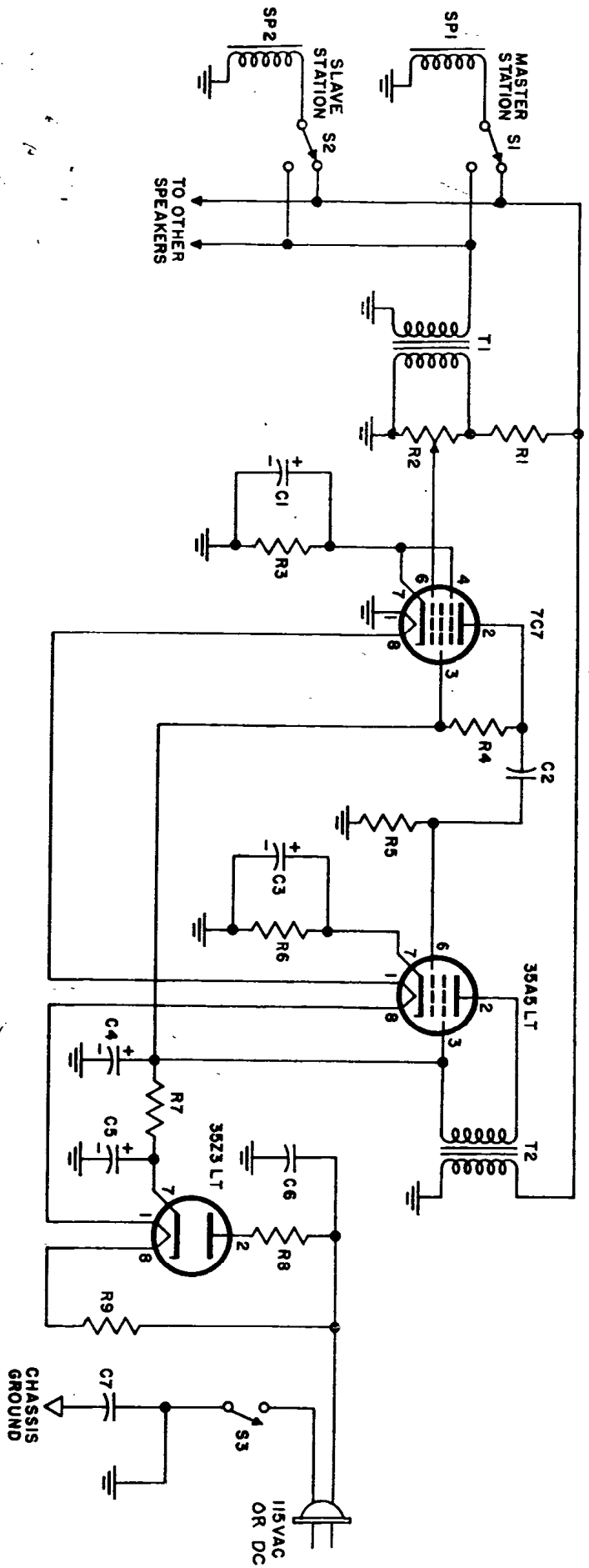
3 TUBE 1-1/2 WATT AC/DC INTERCOMMUNICATION AMPLIFIER

Fig. 11 is a reliable AC/DC intercommunication amplifier which is easy to build and simple to operate. It is designed around loctal type tubes and therefore can be made quite small and compact. Up to 5 or 6 remote stations can be used in the system, any one of which may talk to all the others by operation of S1, S2, etc. The master station speaker (SP1) is designed for use as an integral part of the amplifier assembly, whereas the remote (slave) stations are generally the individual speaker and switch (similar to S2) mounted in a small baffle case. Note only a 3-wire cable is needed to connect the stations together, one of which is a ground wire. A shielded 2-wire cable is recommended with the shield being the ground wire. The amplifier is quite stable due to the use of inverse feedback (through R1).

PARTS LIST

- C1, C3: 10 mfd 25 V elec. condenser
- C2: .01 mfd 600 V paper condenser
- C4, C5: 20 mfd 150 V elec. condenser
- C6, C7: .05 mfd 400 V paper condenser
- R1, R4: 270K ohm 1/2 watt resistor
- R2: 500K ohm volume control
- R3: 1500 ohm 1/2 watt resistor
- R5: 470K ohm 1/2 watt resistor
- R6: 180 ohm 1 watt resistor
- R7: 1500 ohm 2 watt resistor
- R8: 47 ohm 1 watt resistor

- R9: 250 ohm 10 watt WW resistor
- S1, S2: SPDT push-to-talk switch
- S3: SPST toggle switch
- SP1, SP2: 3" to 6" PM speakers
- T1: Intercom. input transformer, or output transformer connected in reverse
- T2: Output transformer, 25000 ohms to voice coil
- Sockets: 3 loctals



⏏ INDICATES COMMON CONNECTIONS
 ⏏ ISOLATED FROM CHASSIS.

FIG. 11

3 TUBE HEARING AID BATTERY AMPLIFIER

A high-gain battery operated hearing aid amplifier is shown in Fig. 12 consisting of miniature type tubes for compactness and light weight. With a good microphone and earpiece, excellent results can be obtained. It is usually desirable to construct the amplifier so that it can be carried in a side pocket or strapped to the waist of the user. The batteries are generally assembled in a separate container so that the amplifier bulk may be reduced. A volume and tone control is provided for adjusting the response of the amplifier to suit individual taste. Very good volume is obtained by the use of 3 amplifier stages. In fact, this type of amplifier lends itself very well to other applications, such as sound detecting devices, probes, magnetic or inductive detectors, etc., with attachment of the proper type pickup head in place of M1.

Parts List

C1, C2, C3, C6, C8:	
.01 mfd 200 V paper condenser	
C4:	22K ohm 1 watt resistor
10 mfd 50 V elec. condenser	2 megohm volume control
C5:	500K ohm tone control
C7:	4.7 megohm 1/2 watt resistor
C9:	2.2 megohm 1/2 watt resistor
E1:	1000 ohm 1 watt resistor
M1:	6800 ohm 2 watt resistor
R1:	DPST switch
R2, R7:	3 miniature 7-pin
3 megohm 1/2 watt resistor	1-1/2 V "A"
R3, R8, R13:	45 V "B"
1 megohm 1/2 watt resistor	

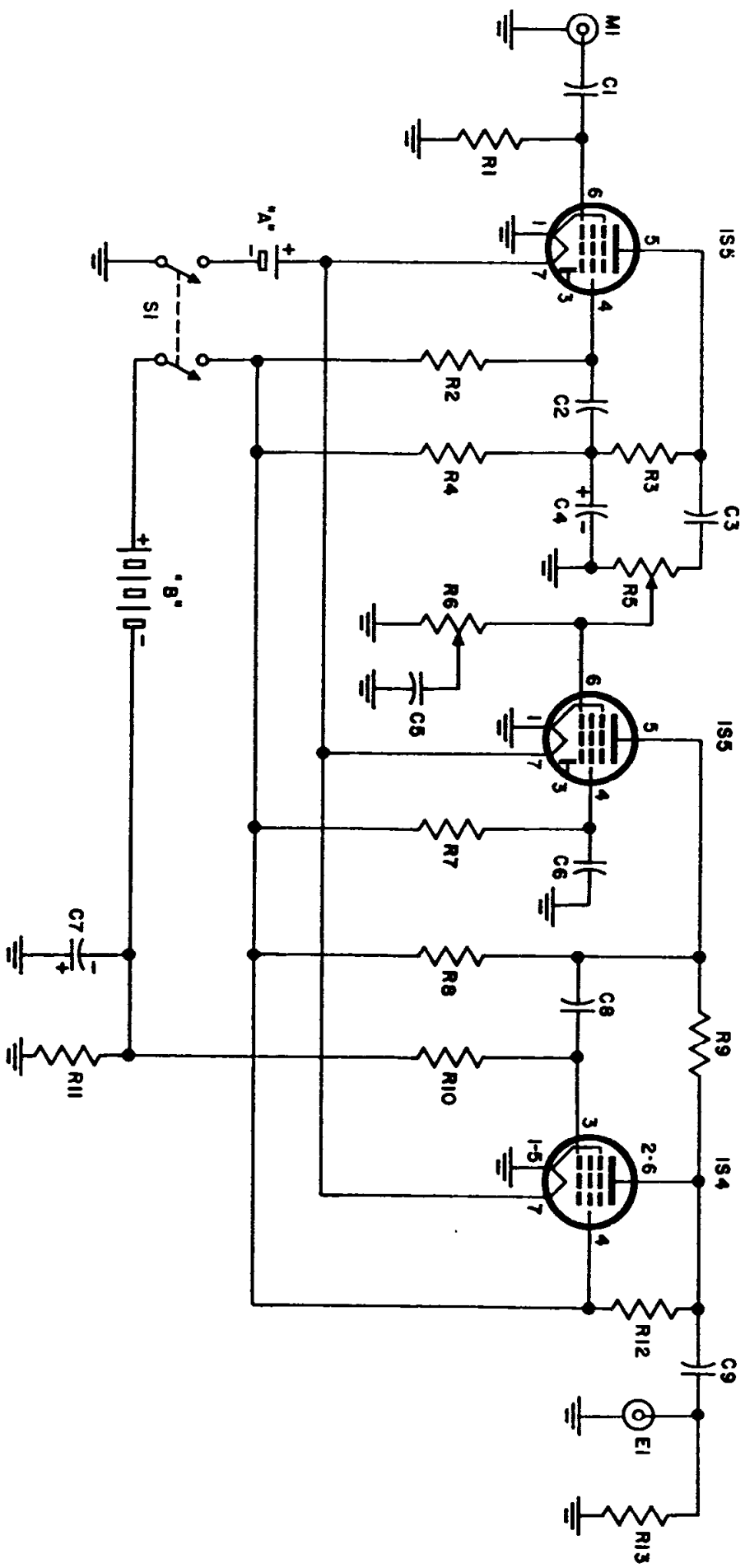


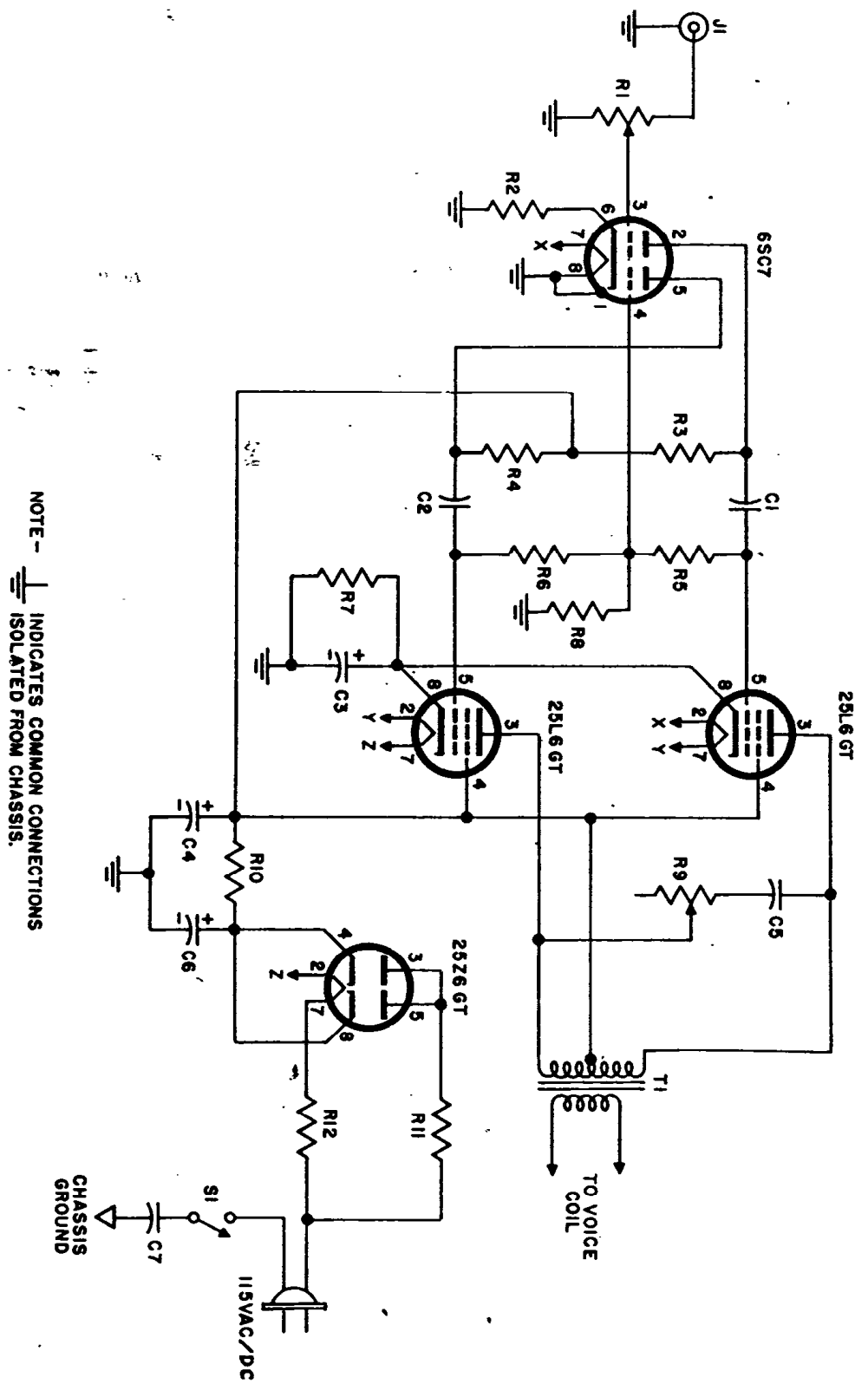
FIG. 12

4 TUBE 5 WATT AC/DC AMPLIFIER

The amplifier in Fig. 13 is of the push-pull type, suitable for operation from a phonograph pickup or radio tuner. It is capable of good room volume and fine tone quality due largely to its power output circuit. Having a "transformerless" AC/DC rectifier, the amplifier can be built very compactly, making it ideal for portable purposes. It also operates from either 110 volts AC or DC. (On DC power it may be necessary to reverse the power plug to obtain plate voltages.) Little trouble should be experienced with this amplifier as the circuit is quite conventional.

Parts List

C1, C2:	.01 mfd 600 V paper condenser	R8:	180K ohm 1/2 watt resistor
C3:	10 mfd 25 V elec. condenser	R9:	100K ohm tone control
C4, C6:	20 mfd 150 V elec. condenser	R10:	500 ohm 2 watt resistor
C5, C7:	.05 mfd 400 V paper condenser	R11:	47 ohm 1/2 watt resistor
J1:	Input jack	R12:	125 ohm 20 watt resistor
R1:	500K ohm volume control	S1:	SPST switch
R2:	1800 ohm 1/2 watt resistor	T1:	Output transformer, 3000 ohm to voice coil
R3, R4:	270K ohm 1/2 watt resistor	Sockets:	4 octals
R5, R6:	330K ohm 1/2 watt resistor		
R7:	100 ohm 1 watt resistor		



NOTE -  INDICATES COMMON CONNECTIONS
 ISOLATED FROM CHASSIS.

FIG. 13

4 TUBE 5 WATT AC/BATTERY P. A. AMPLIFIER

Fig. 14 is an amplifier suitable for low power output from a six volt storage battery of 115 volt AC supply. Switching from the 6 volt DC to the 115 volt AC is done by means of S1. Both a phonograph pickup and double button carbon microphone can be used simultaneously in the input circuits. Microphone current is obtained from the cathode circuit of the 6V6 tube, and as a result, a separate excitation battery is not required. Inverse feedback is supplied to the last two amplifier stages for better control.

Building this amplifier requires sufficient chassis area so that the components will not be crowded. Be careful not to place T1 too close to T3. All primary leads to T3 should be as heavy and direct as possible. RFC1 and 2, 6X5GT, the vibrator, R18, C11, C12, C13 and C14, should all be located as close to the power transformer as possible. These conditions plus good bonding can not be overly emphasized in an amplifier of this type in order to reduce power supply "hash".

Parts List

C1:	100 mfd 25 V elec. condenser	R13:	220 ohm 2 watt resistor
C2, C7:	25 mfd 25 V elec. condenser	R14:	100K ohm 2 watt resistor
C3, C5:	8 mfd 450 V elec. condenser	R15:	47 ohm 1 watt resistor
C4, C6, C9:	.05 mfd 600 V paper condenser	R16:	22K ohm 1/2 watt resistor
C8, C10:	20 mfd 450 V elec. condenser	R17:	100K ohm tone control
C11, C13:	.5 mfd 200 V paper condenser	R18:	100 ohm 1 watt resistor
C12, C14:	.01 mfd 1600 V paper condenser	RFC1:	50 turns #12 enamel wire on 1" form
F1:	3 ampere fuse and holder	RFC2:	10 millihenry RF choke
F2:	10 ampere fuse and holder	S1:	TPST switch
J1:	Open circuit input jack	T1:	Double-button microphone transformer, 200 ohm center-tapped to grid
J2:	3-circuit jack for carbon mic.	T2:	Output transformer, 5000 ohms to voice coil, 5 watt
L:	Filter choke, 250 ohm 75 MA	T3:	Power transformer, primary 115 V AC and 6-0-6 V, secondary 300-0-300 V 75 MA and 6.3 V 3 A
R1, R4:	500K ohm volume control	V:	Non-synchronous vibrator, for use with .01 mfd buffer
R2, R3, R8, R11:	470K ohm 1/2 watt resistor	Sockets:	4 octals, 1 4-prong
R5:	3900 ohm 1/2 watt resistor		
R6, R10:	270K ohm 1/2 watt resistor		
R7:	100K ohm 1/2 watt resistor		
R9:	2200 ohm 1/2 watt resistor		
R12:	10K ohm 1 watt resistor		

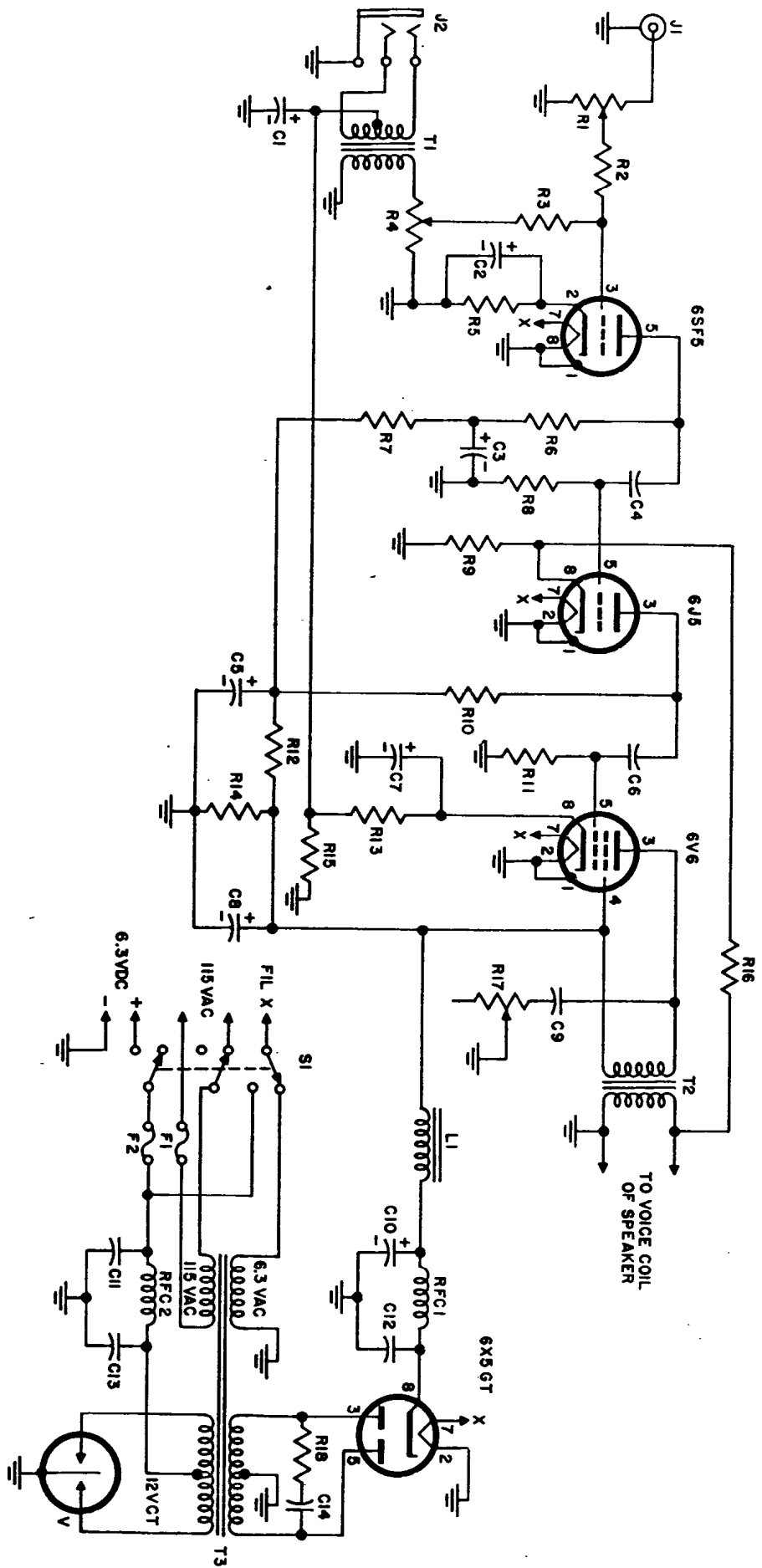


FIG. 14

4 TUBE 6 WATT AC HIGH-FIDELITY AMPLIFIER

In Fig. 15 is shown a high-gain high-fidelity amplifier capable of excellent volume from a phonograph or radio tuner. It has a dual tone control system consisting of R2 and C1 controlling the high frequencies, and R6 and C3 the low frequencies. Each half of the 6SC7 tube is fed the tone controlled signals, and the signals are remixed in the two plate circuits. This results in any degree of tone compensation by adjusting the two controls individually. Inverse feedback is applied over two stages through resistor R19. As is usual with this type of inverse feedback, connecting R19 into the circuit should result in a reduction of volume. If not, reverse one set of connections to transformer T1.

Parts List

<p>C1: 500 mmfd mica condenser C2: 25 mfd 25 V elec. condenser C3: .01 mfd 200 V paper condenser C4: 8 mfd 450 V elec. condenser C5, C8: .1 mfd 600 V paper condenser C6: .005 mfd 600 V paper condenser C7, C9: 30 mfd 450 V elec. condenser C10: 50 mfd 50 V elec. condenser C11: .1 mfd 400 V paper condenser J1: Input jack R1: 500K ohm volume control R2: 500K ohm treble tone control R3, R5, R16: 270K ohm 1/2 watt resistor R4: 1500 ohm 1 watt resistor R6: 1 megohm bass tone control R7, R8, R10, R11: 220K ohm 1/2 watt resistor</p>	<p>R9: 22K ohm 1 watt resistor R12: 1 megohm 1/2 watt resistor R13: 3300 ohm 1/2 watt resistor R14: 25K ohm 10 watt WW resistor R15: 180K ohm 1/2 watt resistor R17: 180 ohm 2 watt resistor R18: 1000 ohm 10 watt WW resistor R19: 39K ohm 1 watt resistor S1: SPST switch T1: Output transformer, 2500 ohm to voice coil, 6 watt T2: Power transformer, 300-0-300 V 100 MA, 5 V 2 A, 6.3 V 2 A.</p> <p>Sockets: 4 octals</p>
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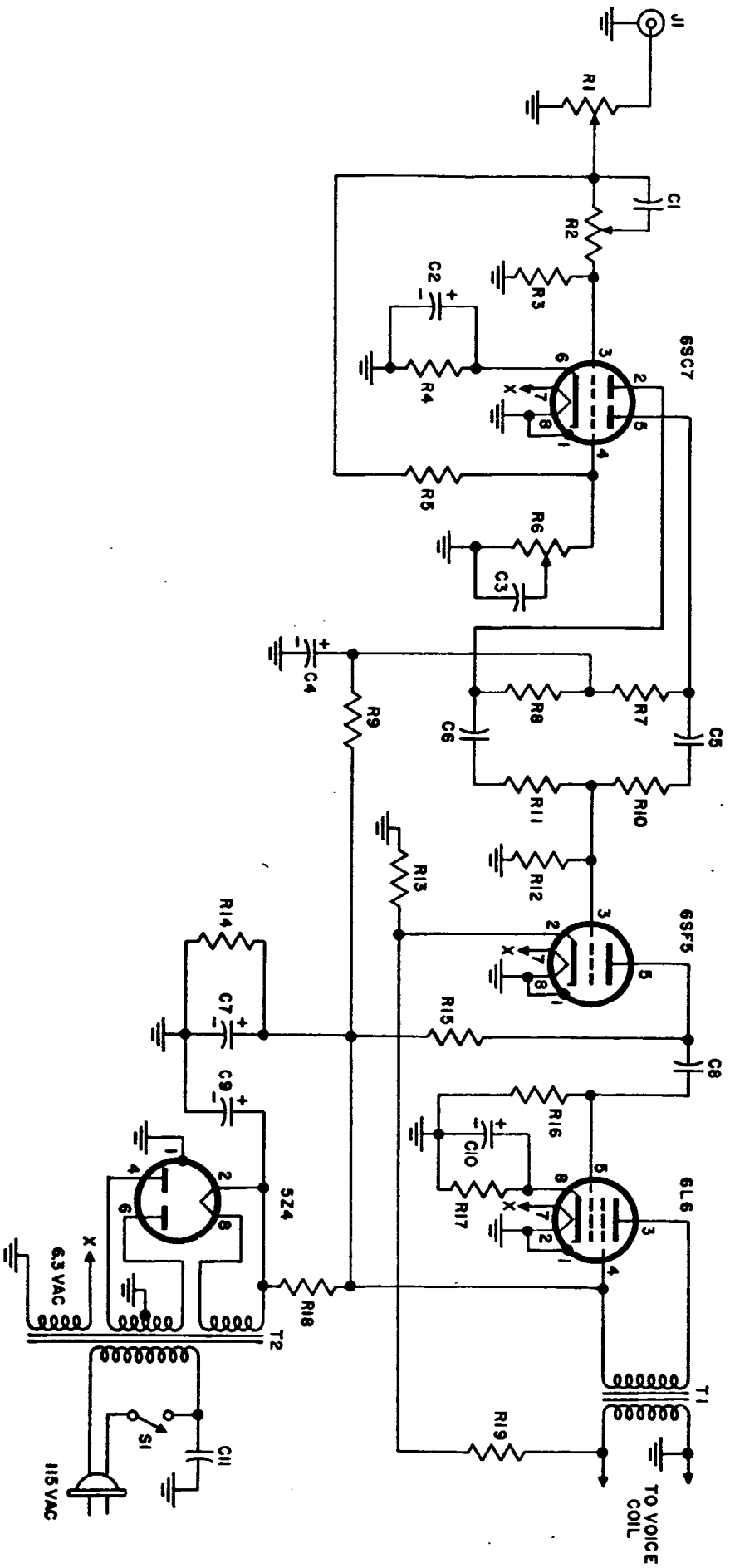


FIG. 1B

4 TUBE 6 WATT AC HOME RECORDING AMPLIFIER

For an amplifier suitable to home recording and playback, the amplifier in Fig. 16 is highly recommended. The input circuits handle a crystal or dynamic high impedance microphone and a phonograph pickup. The output feeds into a speaker or crystal recording head. Switch S1 controls the amplifier for either the microphone and recorder, or the phonograph pickup and speaker as desired. When recording, the over-modulation indicator N will be very helpful in showing by intensity the amount of volume necessary to record properly. In initially adjusting this indicator, make test cuts on a recording blank, adjusting the volume control R8 and indicator R17 until the recording head just begins to overcut a groove. R17 is now set for proper operation and need not again be adjusted. A radio tuner may be fed into J1 for recording radio programs, provided the input signal level does not overload the 6SJ7 tube. Inverse feedback provided by R19 aids in providing smooth operation.

Parts List

<p>C1, C6: 10 mfd 25 V elec. condenser C2, C7, C13: .05 mfd 600 V paper condenser C3, C9: .02 mfd 600 V paper condenser C4, C8: 8 mfd 450 V elec. condenser C5, C14: .05 mfd 400 V paper condenser C10: 25 mfd 50 V elec. condenser C11, C12: 20 mfd 450 V elec. condenser J1: Input jack (microphone) J2: Input jack (phonograph) N: 1/4 watt neon lamp R1, R4, R19: (overmodulation indicator) R2, R8: 2.2 megohm 1/2 watt resistor R3: 1 megohm volume control R5, R13: 3300 ohm 1/2 watt resistor R6: 470K ohm 1/2 watt resistor 47K ohm 1 watt resistor</p>	<p>R7: 25K ohm 10 watt WW resistor R9, R18, R20: 1 megohm 1/2 watt resistor R10: 4700 ohm 1/2 watt resistor R11: 50K ohm tone control R12: 270K ohm 1/2 watt resistor R14: 2700 ohm 2 watt resistor R15: 180 ohm 2 watt resistor R16: 1500 ohm 5 watt WW resistor R17: 1 megohm linear control S1: 3-pole 2-position rotary switch S2: SPST power switch T1: Output transformer, 2500 ohm to voice coil, 6 watt T2: Power transformer, 325-0-325 V 100 MA, 5 V 2 A, 6.3 V 2 A Sockets: 4 octals</p>
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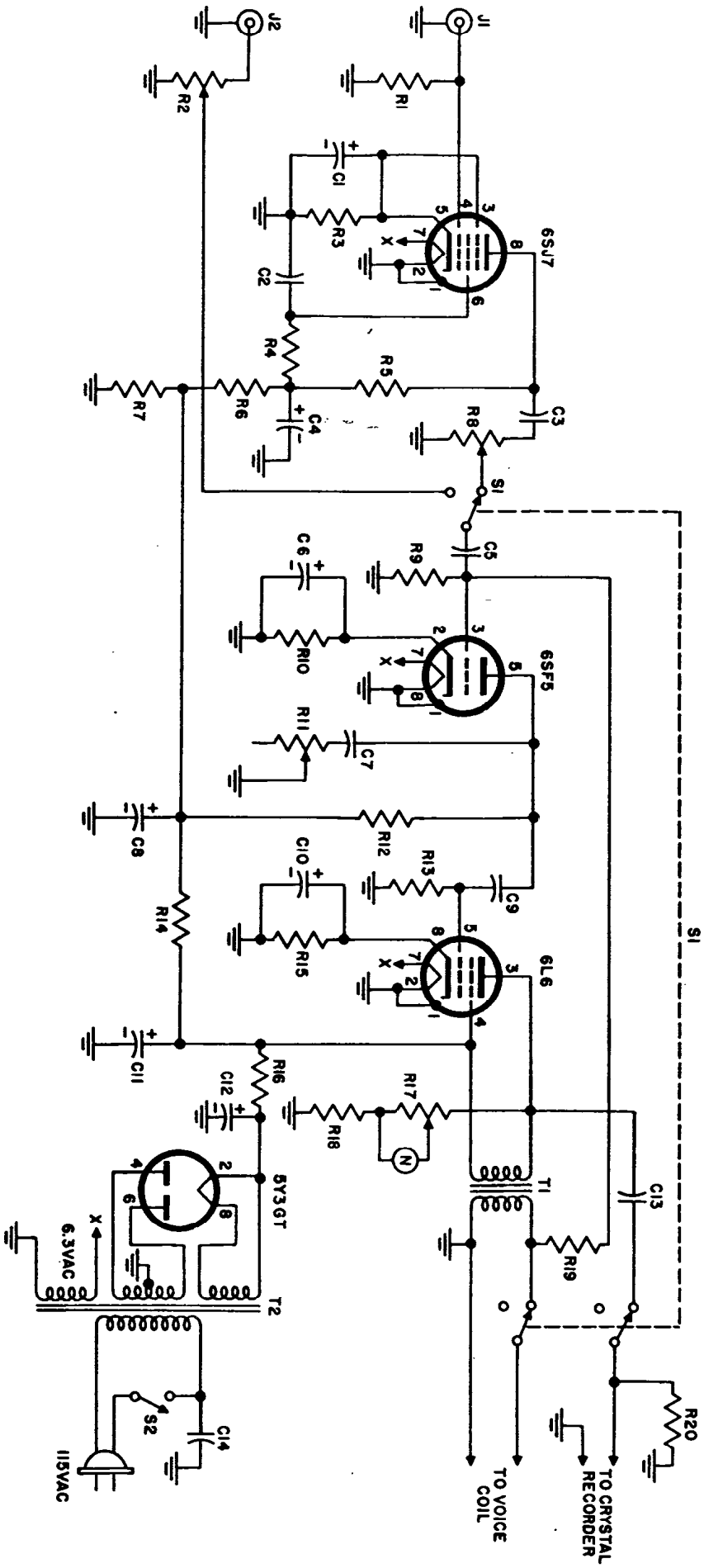


FIG. 16

4 TUBE 10 WATT AC HIGH-FIDELITY AMPLIFIER

Fig. 17 is a medium gain phonograph or radio-tuner amplifier for high-fidelity reproduction. It features a 6N7 phase inverter and 6V6GT push-pull power output tubes, together with an over all inverse feedback network. A high frequency tone control is provided to reduce the high response when desired. This control is completely cut out by having S1 mounted on the control R4. Of course, high quality parts are necessary to obtain high fidelity response in any amplifier, so care should be taken in their choice. Construction of this amplifier should offer no particular problem if normal design is followed. Uncontrollable "howling" is generally an indication that inverse feedback is positive; to correct, reverse either primary or secondary connections to transformer T1.

Parts List

<p>C1, C5: 25 mfd 25 V elec. condenser C2, C3, C4: .05 mfd 600 V paper condenser C6, C7: 30 mfd 450 V elec. condenser C8: .05 mfd 400 V paper condenser J1: Input jack R1: 500K ohm volume control R2: 1200 ohm 1/2 watt resistor R3: 1000 ohm 1/2 watt resistor R4: 100K ohm tone control R5, R6: 220K ohm 1/2 watt resistor R7, R8: 470K ohm 1/2 watt resistor R9: 27K ohm 1/2 watt resistor</p>	<p>R10: 220 ohm 2 watt resistor R11: 25K ohm 10 watt WW resistor R12: 1000 ohm 20 watt WW resistor R13: 120K ohm 1/2 watt resistor S1: SPST switch on R4 S2: SPST power switch T1: Output transformer, 8000 ohm to voice coil, 10 watt T2: Power transformer, 350-0-350 V 100 MA, 5 V 2 A, 6.3 V 2 A Sockets: 4 octals</p>
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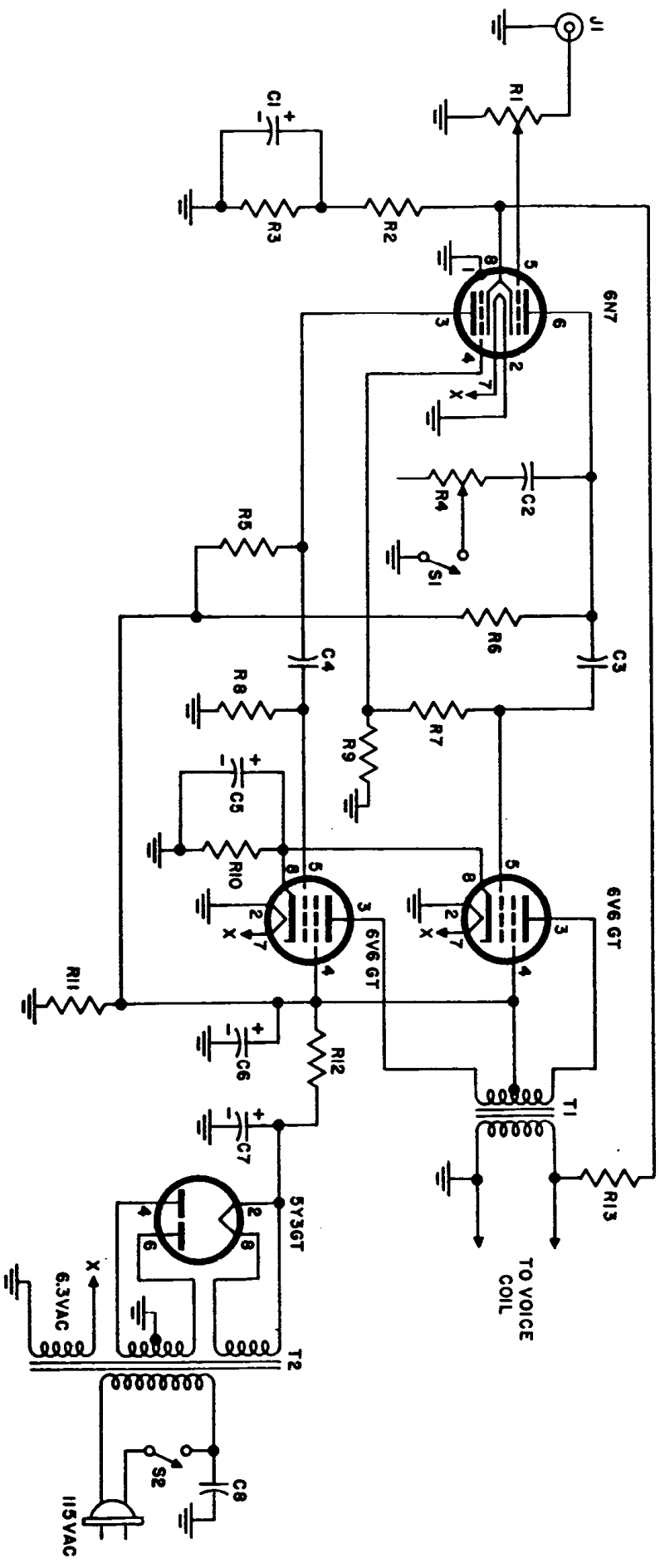


FIG. 17

4 TUBE 15 WATT AC LOW-GAIN AMPLIFIER

A fully transformer-coupled amplifier is shown in Fig. 18, having fixed bias 6B4G push-pull power tubes for distortionless amplification and good power output. It operates from a radio tuner, the power for which may be supplied by the amplifier power supply. The fidelity of the amplifier is dependent almost entirely by the quality of the transformers T1, T2, and T3.

It may be difficult to construct this amplifier with its power supply on one chassis, since inductive hum pickup is quite possible. A separate chassis for the power supply will correct this condition. Small amounts of hum can be balanced out of the amplifier by adjusting R7. In practice, R6 is adjusted so that a total of 80 MA is flowing in the plate circuits of the two 6B4G tubes.

Parts List

C1: 10 mfd 25 V elec. condenser
 C2, C7: .05 mfd 400 V paper condenser
 C3, C5: 16 mfd 450 V elec. condenser
 C4: 20 mfd 150 V elec. condenser
 C6: 16 mfd 575 V elec. condenser
 L1: Filter choke, 150 ohm 150 MA
 R1: 500K ohm volume control
 R2: 2700 ohm 1/2 watt resistor
 R3: 100K ohm tone control
 R4: 10K ohm 20 watt WW resistor
 R5: 3000 ohm 10 watt WW resistor
 R6: 800 ohm 20 watt semi-adjustable
 WW resistor

R7: 50 ohm 10 watt semi-adjustable
 WW resistor
 S1: SPST switch
 T1: A.F. input transformer, 3:1
 T2: A.F. transformer, single plate
 to push-pull grids, 3:1
 T3: Output transformer, 3000 ohm
 to voice coil, 15 watt
 T4: Power transformer, 400-0-400 V
 125 MA, 5V 3 A, two 6.3 V 3 A
 Sockets: 4 octals

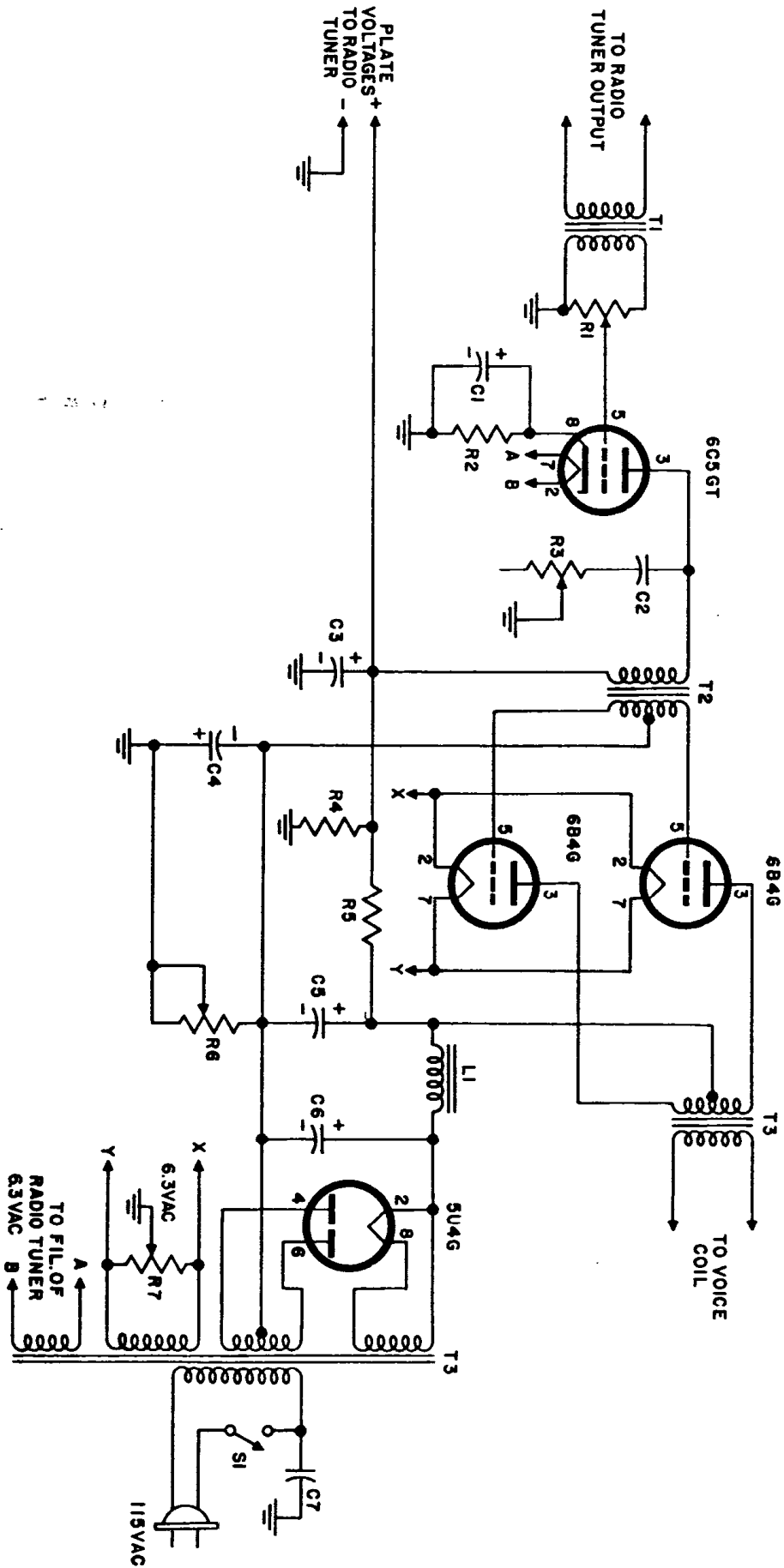


FIG. 18

4 TUBE 3-CHANNEL PREAMPLIFIER

A normally low-gain amplifier can be operated from a preamplifier similar to the one shown in Fig. 19. It is designed for a phonograph pickup and two high impedance microphone inputs. These three inputs can be mixed at will to feed either the low or high impedance output circuits. For low impedance matching, the amplifier following this preamplifier must have an input transformer designed for 500 ohms input.

Good filtering is supplied throughout the high voltage circuits, and an entirely separate power supply makes the preamplifier self sufficient. Little trouble should be encountered in constructing this unit if care is exercised in placing the various parts.

Parts List

C1, C6, C8:	10 mfd 25 V elec. condenser	R7:	47K ohm 1 watt resistor
C2, C4, C5, C10:	.05 mfd 600 V paper condenser	R12, R13:	470K ohm 1/2 watt resistor
C3:	8 mfd 450 V elec. condenser	R14:	2700 ohm 1/2 watt resistor
C7, C9:	20 mfd 450 V elec. condenser	R15:	150K ohm 2 watt resistor
C11:	.01 mfd 400 V paper condenser	R16:	5K ohm 10 watt WW resistor
J1:	Input jack (phonograph)	R17:	10K ohm 1 watt resistor
J2, J3:	Input jack (microphone)	S1:	SPST switch
P:	6.3 V indicator lamp	T1:	Output transformer, 10,000 ohm plate to 500 ohm line
R1, R9, R10:	500K ohm volume control	T2:	Power transformer, 300-0-300 V 40 MA, 5 V 2 A, 6.3 V 1 A
R2, R3:	2.2 megohm 1/2 watt resistor	Sockets:	4 octals
R4:	1000 ohm 1 watt resistor		
R5, R6, R8, R11:	270K ohm 1/2 watt resistor		

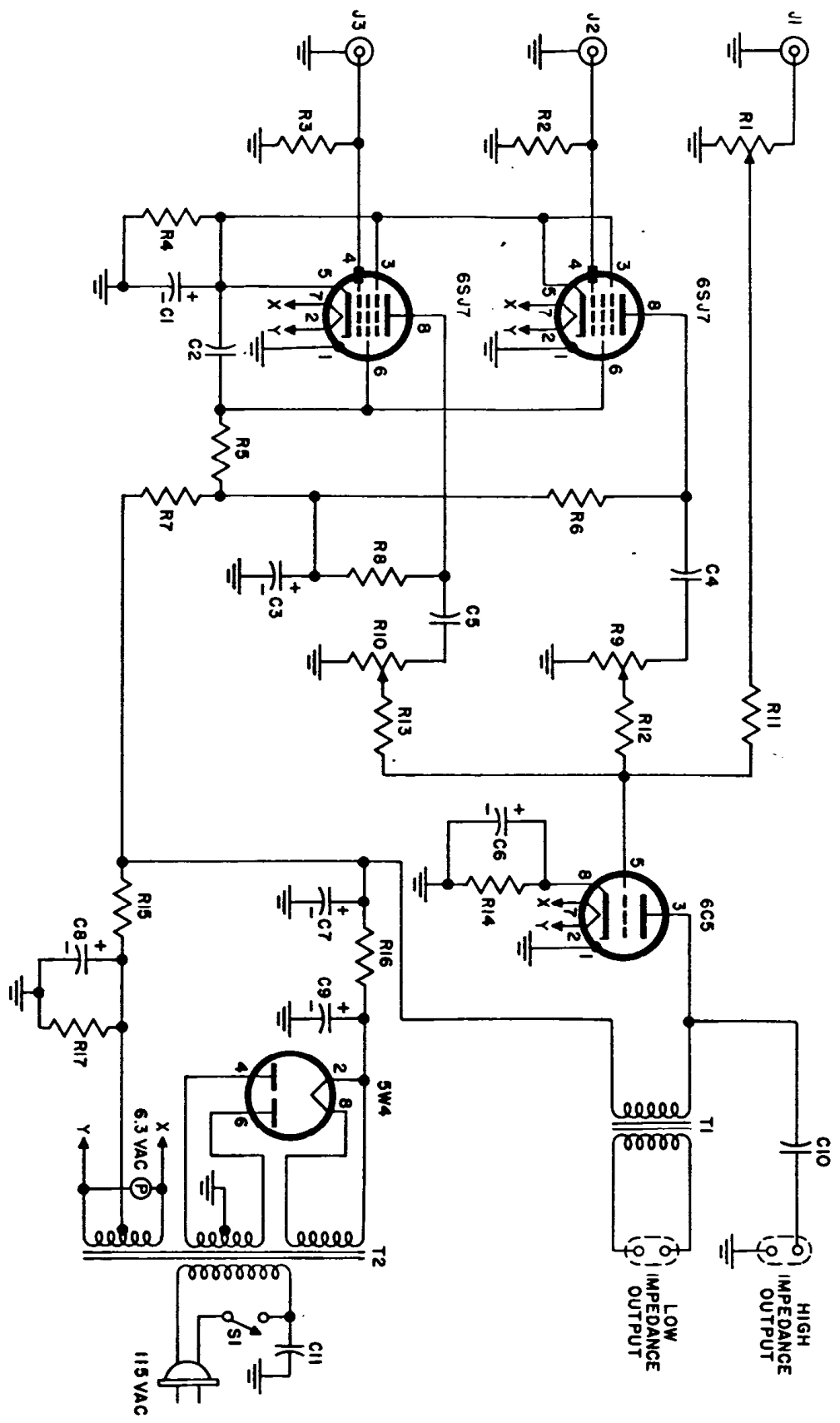


FIG. 19

5 TUBE 10 WATT CLASS-B 6-VOLT DC AMPLIFIER

For a six volt battery operated amplifier, the arrangement shown in Fig. 20 will provide good volume and power output from a crystal or dynamic microphone and phonograph pickup. It is satisfactory for use in a sound truck or car if great speaker coverage is not demanded. Three 6N7 and two 6X5 tubes are used throughout the amplifier, simplifying the number of replacement tubes to carry. Be certain a heavy duty vibrator is used, as the primary current consumption may be 10 amperes. Since it is seldom necessary to operate the phonograph and microphone simultaneously, a switch S1 selects the input desired.

If, after completing the amplifier you are dissatisfied with the tone, try shunting the secondary winding of T1 to ground with equal resistors of 100,000 ohms, 1/2 watt each. In any class "B" amplifier, the tone is always improved when the power tubes are driven fairly hard, consequently the amplifier sounds better when the volume is high. Objectionable vibrator "hash" is generally due to insufficient shielding or poor grounds, and at times, can only be corrected by trial and error.

Parts List

<p>C1, C6: 25 mfd 25 V elec. condenser C2, C5, C7, C10: .02 mfd 600 V paper condenser C3, C4: 8 mfd 450 V elec. condenser C8, C9: 20 mfd 450 V elec. condenser C11, C12: .01 mfd 1500 V paper condenser C13: 40 mfd 450 V elec. condenser C14: .5 mfd 100 V paper condenser F1: 20 ampere fuse and holder J1: Input jack (phonograph) J2: Input jack, (microphone) L1, L2: Filter choke, 75 MA 250 ohms R1, R2: 500K ohm volume control R3: 1 megohm 1/2 watt resistor R4: 3300 ohm 1 watt resistor R5: 2.2 megohm 1/2 watt resistor R6, R8: 270K ohm 1/2 watt resistor R7: 100K ohm 1/2 watt resistor R9: 470K ohm 1/2 watt resistor</p>	<p>R10: 1500 ohm 2 watt resistor R11: 100K ohm tone control R12: 10K ohm 1 watt resistor R13: 25K ohm 10 watt WW resistor RFC1: 10 millihenry RF choke RFC2: 50 turns #12 enamel wire on 1/2" form S1: SPST toggle switch S2: SPST power switch (20 amp) T1: A.F. input transformer, 6N7 parallel to 6N7 push-pull T2: A.F. class-B output transformer, 8000 ohm to voice coil, 10 watt T3: Power transformer (vibrator), 6-0-6 V primary, 300-0-300 V 100 MA secondary V: Vibrator, heavy duty non-synchronous, for .01 buffers Sockets: 5 octals, 1 4-prong</p>
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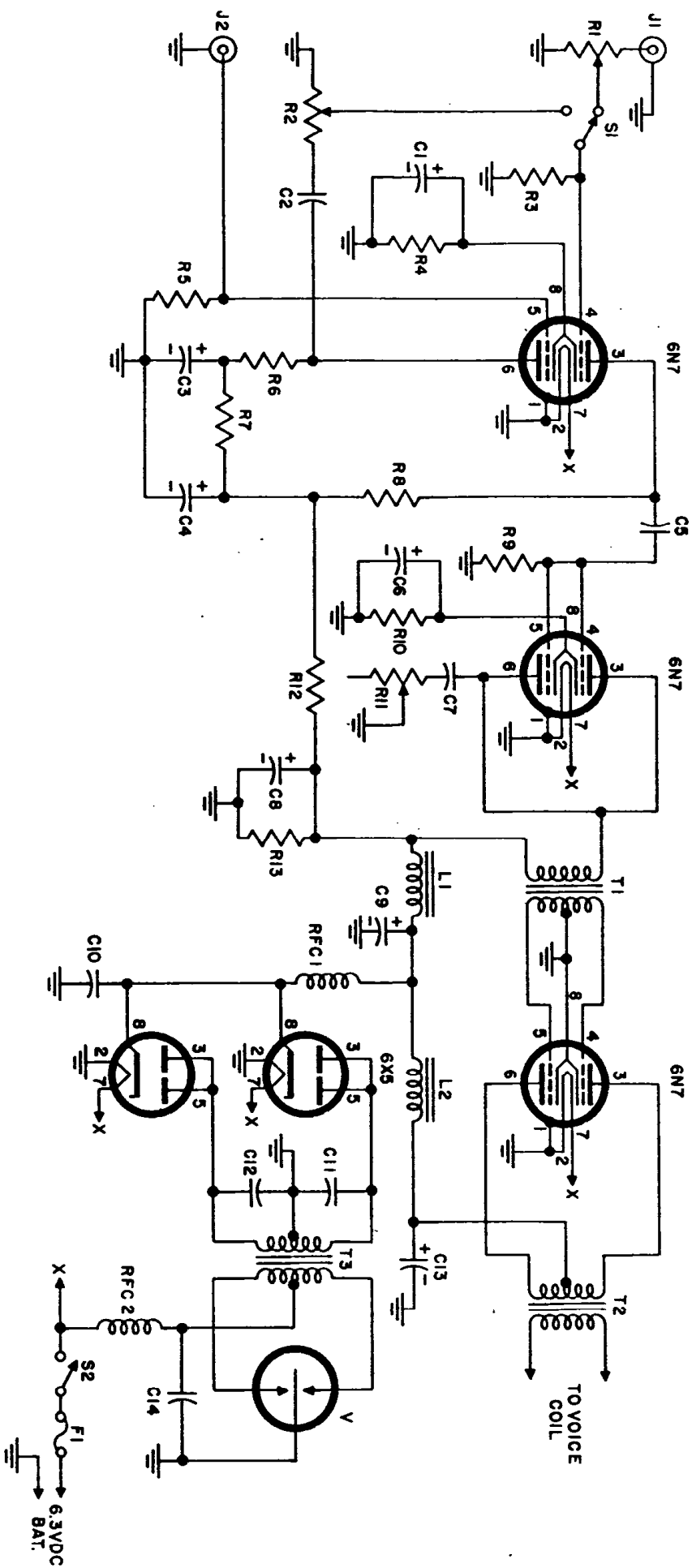


FIG. 20

5 TUBE 10 WATT AC COMPACT AMPLIFIER

A high-gain amplifier designed for microphone amplification is shown in Fig. 21. It features miniature type tubes (except the rectifier) with push-pull output. The 6J6 tube is a combination amplifier and phase inverter tube, for which service it is ideally suited. For best results the 6AU6 and 6J6 tubes should be shielded to reduce stray pickup. The resistance-capacity filter adequately provides pure DC voltages to the amplifier, and of course the usual precautions of separating T1 and T2 prevails. If the amplifier input is sufficiently strong to overload the first tube (noticeable by a "hashy" tone) a 500K ohm series resistor with the input should clear this up, with some sacrifice in overall gain, however.

Parts List

<p>C1: 10 mfd 25 V elec. condenser</p> <p>C2, C5, C6, C9: .05 mfd 600 V paper condenser</p> <p>C3: 8 mfd 450 V elec. condenser</p> <p>C4: .02 mfd 600 V paper condenser</p> <p>C7: 25 mfd 25 V elec. condenser</p> <p>C8, C10, C11: 20 mfd 450 V elec. condenser</p> <p>C12: .02 mfd 400 V paper condenser</p> <p>J1: Input jack</p> <p>R1, R3: 1 megohm 1/2 watt resistor</p> <p>R4, R10, R11: 330K ohm 1/2 watt resistor</p> <p>R5: 47K ohm 1 watt resistor</p> <p>R6: 500K ohm volume control</p>	<p>R7: 1200 ohm 1/2 watt resistor</p> <p>R8, R9, R12: 100K ohm 1/2 watt resistor</p> <p>R13: 220 ohm 2 watt resistor</p> <p>R14: 50K ohm tone control</p> <p>R15: 3000 ohm 5 watt WW resistor</p> <p>R16: 1000 ohm 10 watt WW resistor</p> <p>S1: SPST switch</p> <p>T1: Output transformer, 10000 ohm to voice coil, 10 watt</p> <p>T2: Power transformer, 350-0-350 V 100 MA, 5 V 2 A, 6.3 V 2 A</p> <p>Sockets: 4 miniature 7-pin, 1 octal</p>
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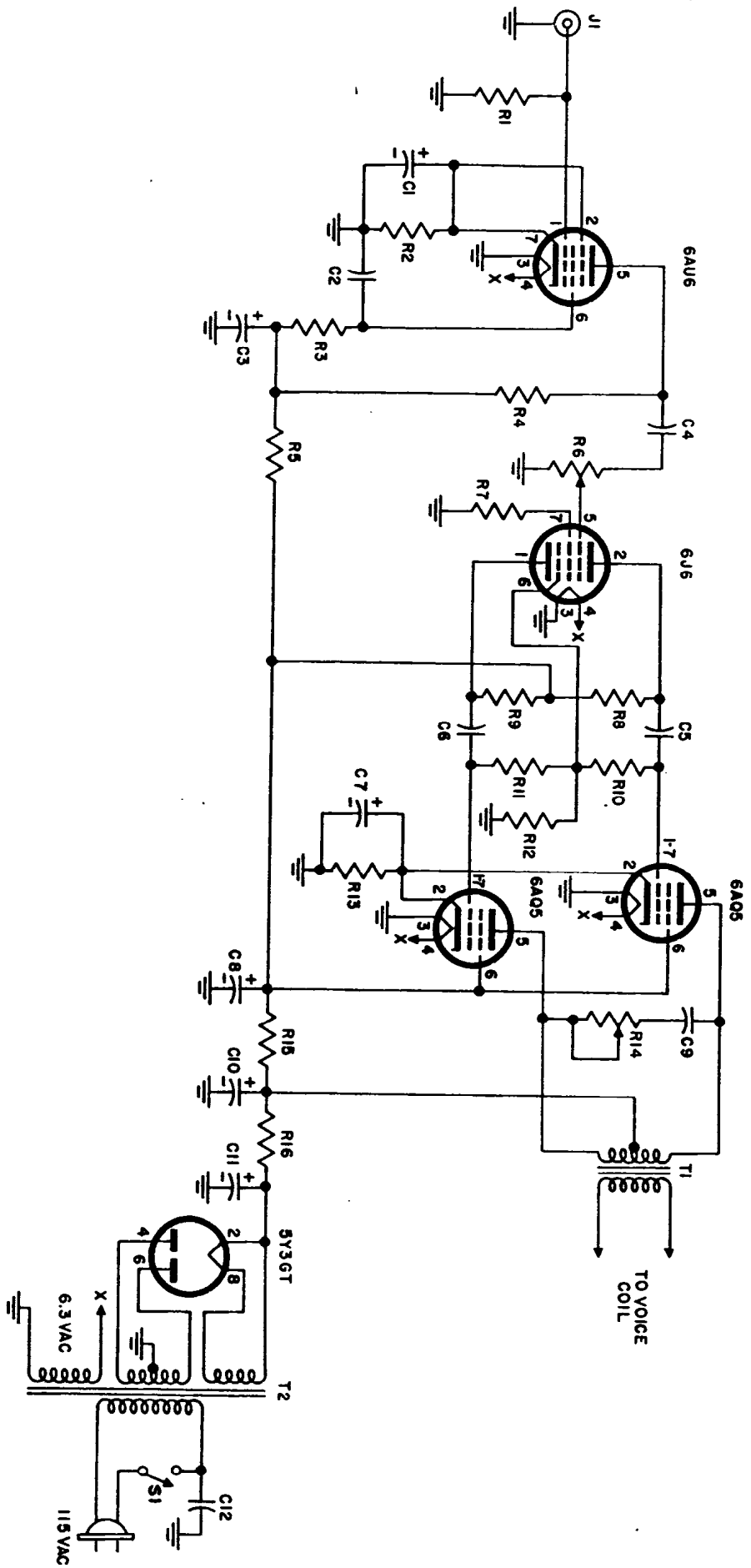


FIG. 21

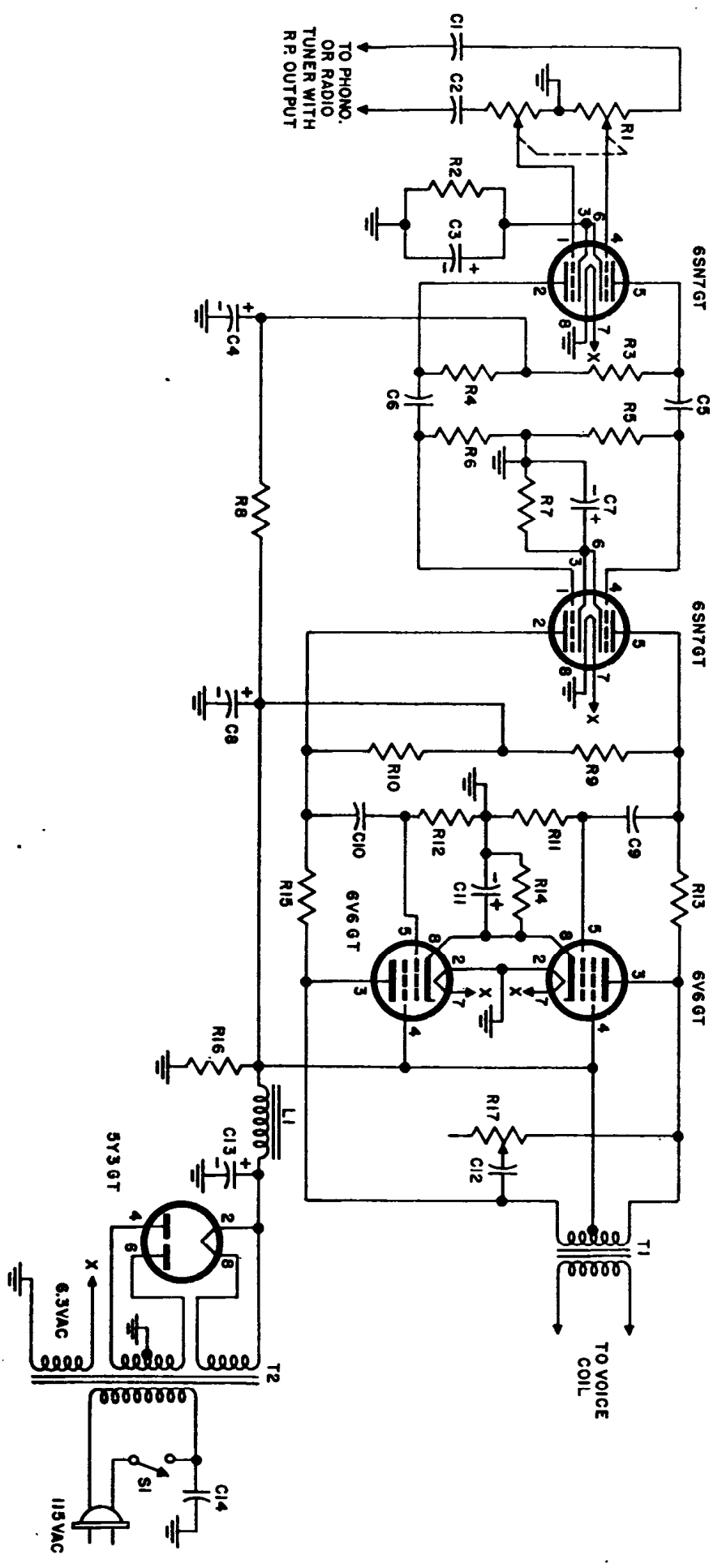


FIG. 22

5 TUBE 13 WATT AC P. A. AMPLIFIER

This public address amplifier (Fig. 23) having both phonograph and high-impedance microphone inputs, is capable of very good tone and output. It features separate bass (R10) and treble (R12) tone controls, and separate microphone (R1) and phonograph (R2) volume controls. When it is desired to operate the phonograph without the microphone, R1 should be turned to the left until S1 opens so that R1 will have not any shunting effect on the grid of the 6SJ7 tube. However, the position of R2 has no effect on the microphone volume. Constructional problems are not too severe although there are quite a few parts to assemble. The combination of good filtering and inverse feedback aids considerably in the smoothness of this amplifier.

Parts List

C1, C7:	10 mfd 25 V elec. condenser	R6, R8:	270K ohm 1/2 watt resistor
C2, C4, C9, C10:	.05 mfd 600 V paper condenser	R7:	47K ohm 1 watt resistor
C3, C8:	8 mfd 450 V elec. condenser	R9:	22K ohm 1/2 watt resistor
C5:	500 mmfd mica condenser	R10:	3 megohm bass tone control
C6, C14:	.01 mfd 400 V paper condenser	R12:	1 megohm treble tone control
C11:	25 mfd 25 V elec. condenser	R13:	470K ohm 1/2 watt resistor
C12:	40 mfd 450 V elec. condenser	R15, R16:	100K ohm 1/2 watt resistor
C13:	20 mfd 450 V elec. condenser	R17:	25K ohm 10 watt WW resistor
F:	3 ampere fuse and holder	R20:	330K ohm 1/2 watt resistor
J1:	Input jack (phonograph)	R23:	3300 ohm 2 watt resistor
J2:	Input jack (microphone)	R24:	220 ohm 2 watt resistor
L:	Filter choke, 200 ohm 120 MA	S1:	SPST switch on R1
P:	6.3 V indicator lamp	S2:	SPST power switch
R1:	1 megohm volume control	T1:	Output transformer, 8000 ohm to voice coil, 13 watt
R2:	500K ohm volume control	T2:	Power transformer, 350-0-350 V 120 MA, 5 V 2 A, 6.3 V 2 A
R3, R5, R18, R19, R21, R22:	1 megohm 1/2 watt resistor	Sockets:	5 octals
R4, R11, R14:	2200 ohm 1/2 watt resistor		

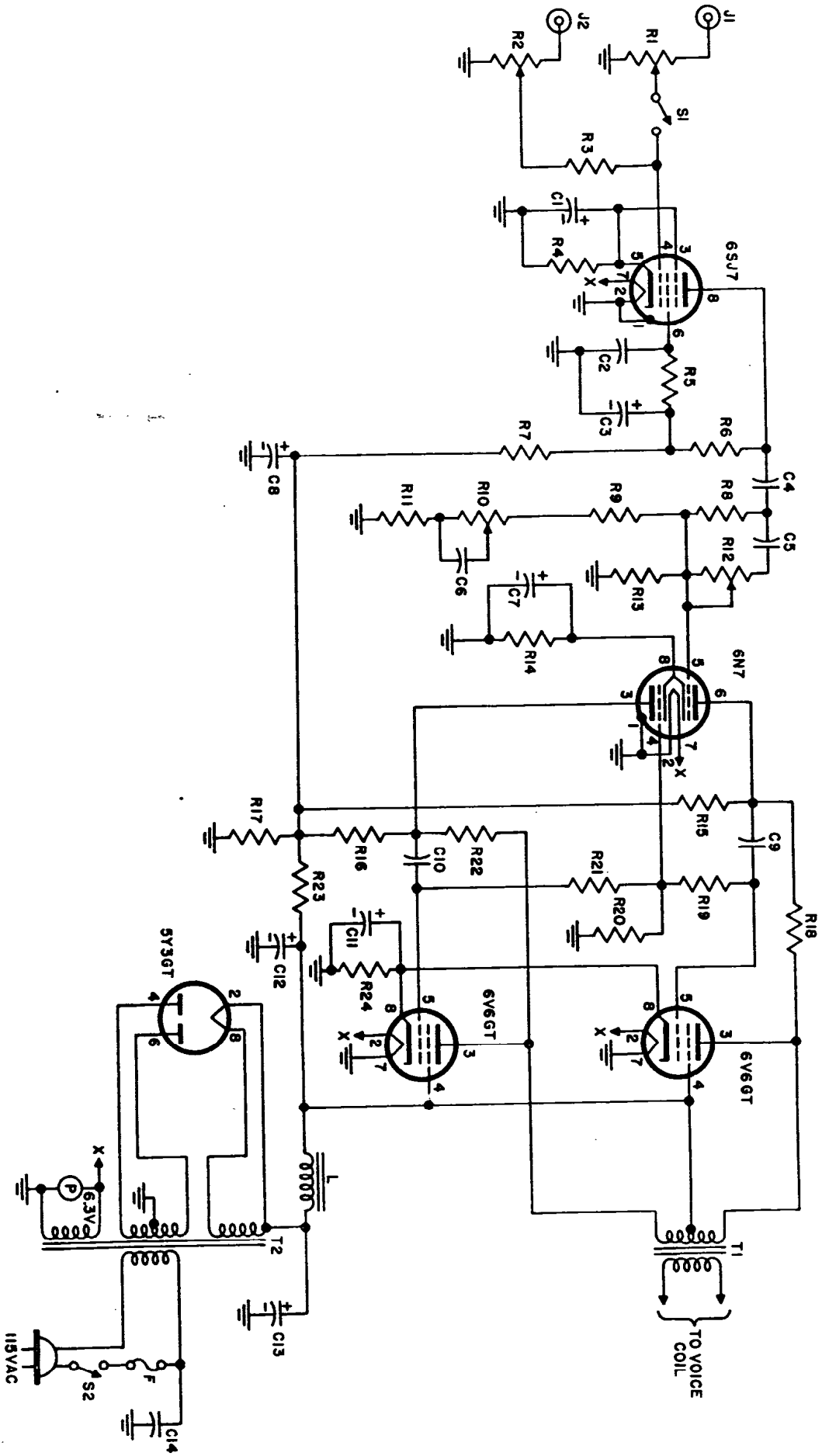


FIG. 23

5 TUBE 15 WATT AC QUICK-HEATING PHONOGRAPH AMPLIFIER

Fig. 24 is a quick heating, all push-pull, phonograph amplifier, capable of good volume and tone. It is especially desirable for use in intermittent automatic phonograph players - commonly called a "juke box." When turned on, the amplifier is fully ready to operate within 15 seconds, as all tubes operate from a fixed bias power stage. With 300 volts on the plates of the power tubes, strong output power without distortion is obtained. A dual volume control R1 adjusts the input level and tone control R14 sets the high-frequency response. Hum may be balanced by adjusting R15.

Parts List

- | | | | |
|-------------|-------------------------------|-------------------|--|
| C1, C4: | 8 mfd 450 V elec. condenser | R7: | 10K ohm 10 watt WW resistor |
| C2, C3, C9: | .05 mfd 600 V paper condenser | R8, R9, R12, R13: | 100K ohm 1/2 watt resistor |
| C5: | 500 mfd 6 V elec. condenser | R10: | 12K ohm 10 watt WW resistor |
| C6, C7: | .1 mfd 600 V paper condenser | R11: | 550 ohm 20 watt WW resistor |
| C8: | 20 mfd 150 V elec. condenser | R14: | 250K ohm tone control |
| C10: | 40 mfd 450 V elec. condenser | R15: | 50 ohm 10 watt semi-adjustable
WW resistor |
| C11: | 20 mfd 450 V elec. condenser | S1: | SPST switch |
| C12: | .05 mfd 400 V paper condenser | T1: | Output transformer, 3000 ohm
to voice coil, 15 watt |
| F: | 3 ampere fuse and holder | T2: | Power transformer, 350-0-350 V
120 MA, 5 V 3 A, 6.3 V 3 A |
| L1: | Filter choke, 200 ohm 120 MA | Sockets: | 5 octals |
| P: | 6.3 V indicator lamp | | |
| R1: | Dual 500K ohm volume control | | |
| R2, R3: | 270K ohm 1/2 watt resistor | | |
| R4: | 100K ohm 1 watt resistor | | |
| R5, R6: | 470K ohm 1/2 watt resistor | | |

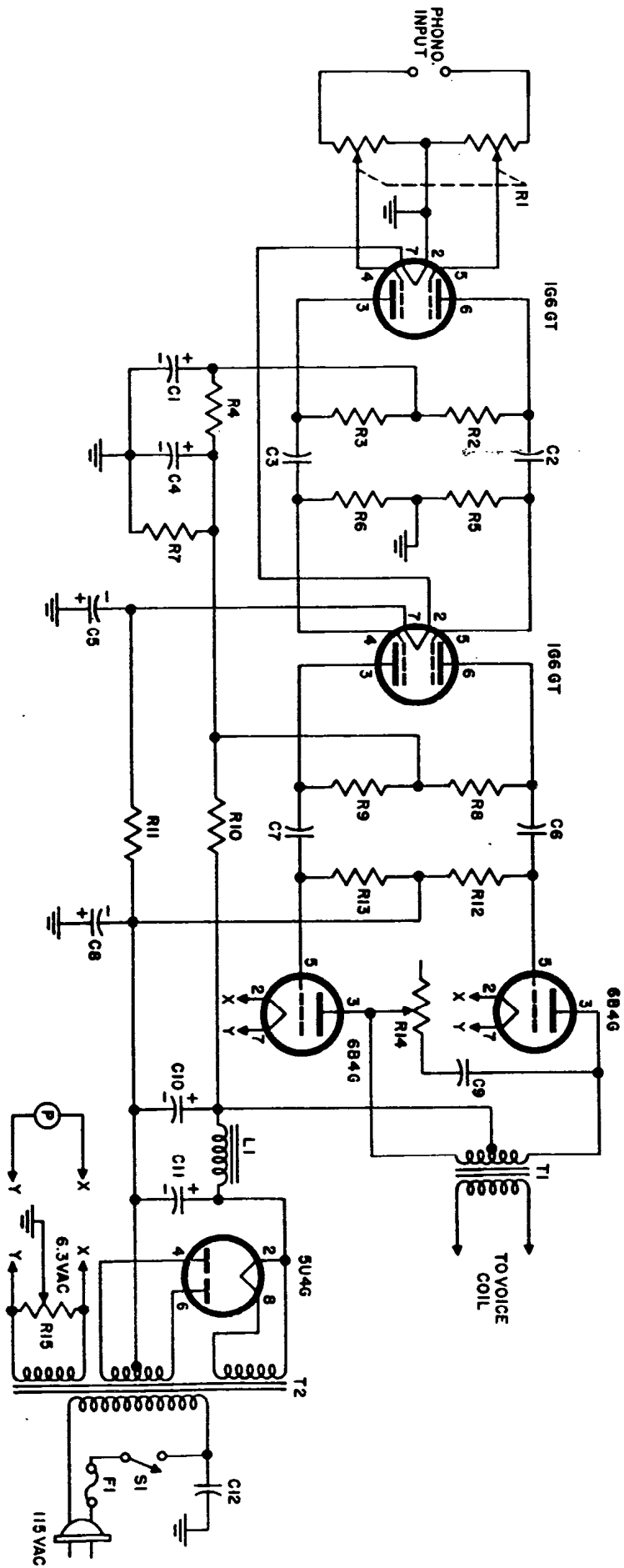


FIG. 24

5 TUBE 25 WATT P. A. AMPLIFIER

Fig. 25 is a public address amplifier with good power output designed for simultaneous use of both a phonograph and a crystal or dynamic microphone with separate volume controls for each (R2 and R8). The 6N7 tube is used as an electronic mixer of the two input channels feeding the push-pull input transformer T1. No DC flows in this transformer which materially aids in the fidelity of the circuit. Inverse feedback applied through R12 likewise adds to the amplifier's smooth operation. In construction, be certain the input transformer T1 is isolated from power transformer T3, or hum may result.

Parts List

C1, C5:	25 mfd 25 V elec. condenser	R6:	47K ohm 1 watt resistor
C2, C4, C8:	.05 mfd 600 V paper condenser	R7:	25K ohm 10 watt WW resistor
C3:	8 mfd 450 V elec. condenser	R9:	2200 ohm 1/2 watt resistor
C6, C7:	.1 mfd 600 V paper condenser	R10, R11:	100K ohm 1/2 watt resistor
C9:	25 mfd 50 V elec. condenser	R12:	470K ohm 1/2 watt resistor
C10, C11:	25 mfd 450 V elec. condenser	R13:	50K ohm tone control
C12:	16 mfd 575 V elec. condenser	R16:	250 ohm 5 watt WW resistor
C13:	.05 mfd 400 V paper condenser	R17:	1500 ohm 5 watt WW resistor
F1:	3 ampere fuse and holder	R18:	500 ohm 10 watt WW resistor
J1:	Input jack (microphone)	S1:	SPST switch
J2:	Input jack (phonograph)	T1:	A.F. transformer, single plate to push-pull grid, 2:1
P:	6.3 V indicator lamp	T2:	Output transformer, 9000 ohm to multi-tap secondary, 25 watt
R1:	2.2 megohm 1/2 watt resistor	T3:	Power transformer, 400-0-400 V 125 MA, 5 V 3 A, 6.3 V 3 A
R2, R8:	500K ohm volume control	Sockets:	5 octals
R3:	1200 ohm 1/2 watt resistor		
R4:	1 megohm 1/2 watt resistor		
R5, R14, R15:	180K ohm 1/2 watt resistor		

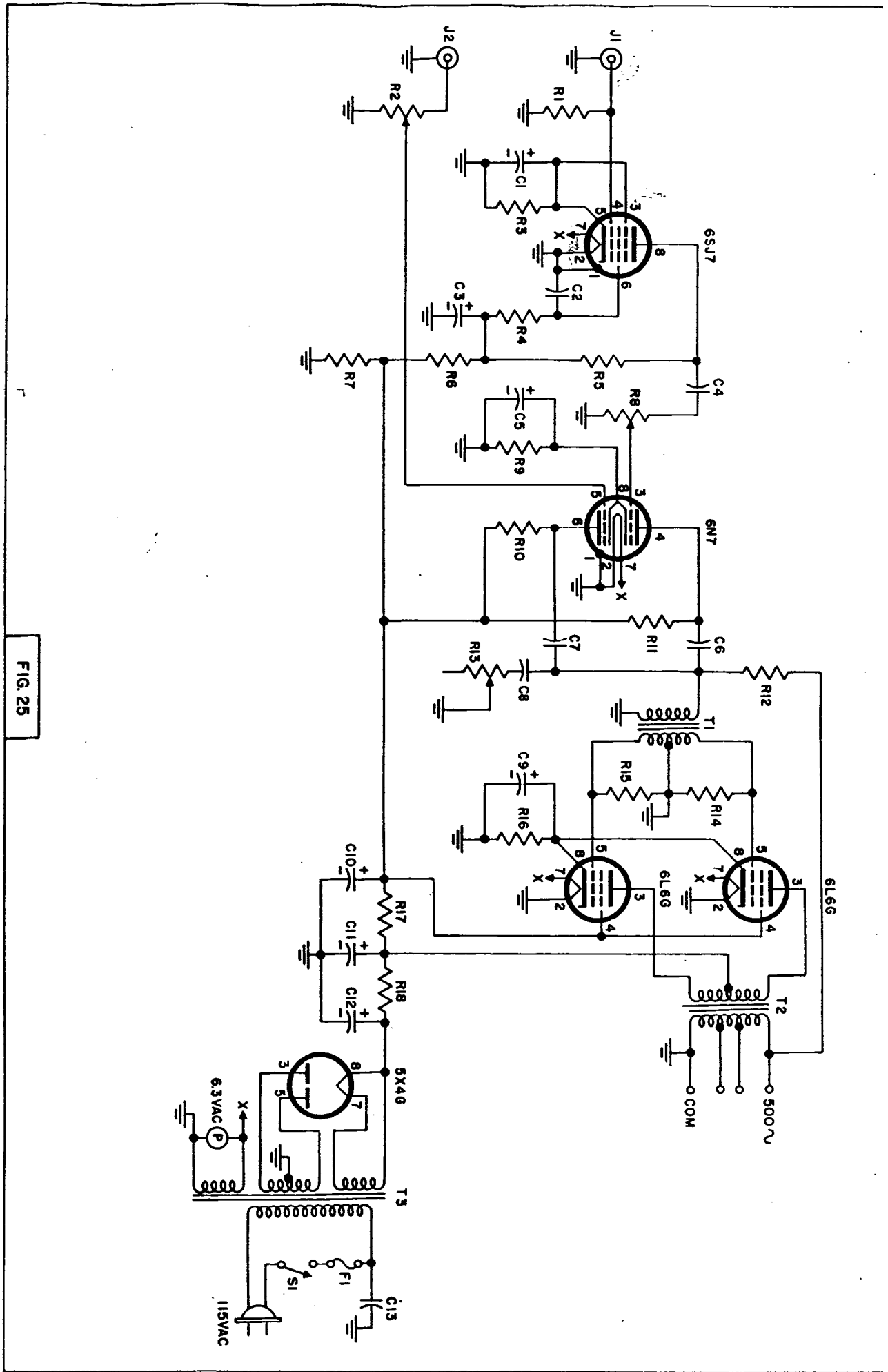


FIG. 25

6 TUBE 6 WATT AC 2-CHANNEL AMPLIFIER

Fig. 26 is a two channel 6 watt amplifier suitable for operation from a radio tuner or phonograph pickup. One channel is designed to pass the lower audio frequencies while the other passes the higher frequencies. The degree of volume in each channel is controlled by tone controls R4 and R9 so that the constructor may compensate for room conditions. R1 is the overall volume control for the system, while R5 is preliminarily adjusted for tone balance. With one large speaker for low frequencies and a small one for high frequencies, the system is capable of excellent tone quality.

Parts List

C1, C5:	25 mfd 25 V elec. condenser	R11, R12:	1 megohm 1/2 watt resistor
C2:	8 mfd 450 V elec. condenser	R13, R15, R16:	270K ohm 1/2 watt resistor
C3:	.05 mfd 600 V paper condenser	R14:	100K ohm 1/2 watt resistor
C4, C8, C14:	.01 mfd 600 V paper condenser	R17:	470K ohm 1/2 watt resistor
C6:	.5 mfd 100 V paper condenser	R18:	1.8 megohm 1/2 watt resistor
C7, C9:	.1 mfd 600 V paper condenser	R19:	180 ohm 2 watt resistor
C10:	.005 mfd 600 V paper condenser	R20:	270 ohm 2 watt resistor
C11, C12:	50 mfd 50 V elec. condenser	R21:	4700 ohm 1 watt resistor
C13:	40 mfd 450 V elec. condenser	S1:	SPST switch
C15:	20 mfd 450 V elec. condenser	T1:	Output transformer, 2500 ohm to voice coil, 50 watt
C16:	.05 mfd 400 V paper condenser	T2:	Output transformer, 5000 ohm to voice coil, 50 watt
J1:	Input jack	T3:	Power transformer, 325-0-325 V 150 MA, 5 V 3 A, 6.3 V 4 A
L1:	Filter choke, 100 ohm 150 MA	Sockets:	6 octals
R1:	500K ohm volume control	Speaker #1:	Low freq. PM cone
R2, R6, R7:	2200 ohm 1/2 watt resistor	Speaker #2:	High freq. tweeter
R3, R8:	47K ohm 1 watt resistor		
R4:	500K ohm bass tone control		
R5:	1 megohm treble volume control		
R9:	10K ohm treble tone control		
R10:	10K ohm 20 watt WW resistor		

6 TUBE 10 WATT 6-VOLT DC P. A. AMPLIFIER

Shown in Fig. 27 is a small 10 watt amplifier suitable for use in an auto or sound truck. A phonograph pickup and microphone can be used simultaneously in this system without interaction. This is due to the electronic mixing circuit of the first 6SC7 tube. Volume controls R2 and R6 adjust the level of each input circuit, while a tone control R14, adjusts the amplifier for proper tone. Inverse feedback is applied over two stages of amplification for improved fidelity. More care than usual must be exercised in constructing this amplifier if power noises developed by the vibrator circuit is not to be objectionable. Generally, close bonding and shielding of the rectifier and vibrator circuits will clear up this condition.

Parts List

C1:	10 mfd 25 V elec. condenser	
C2, C6, C7, C8, C9:	.05 mfd 600 V paper condenser	R9, R10, R18, R19:
C3, C5:	8 mfd 450 V elec. condensrr	R13:
C4, C13:	.02 mfd 600 V paper condenser	R14:
C10:	10 mfd 50 V elec. condenser	R17:
C11, C12:	20 mfd 450 V elec. condenser	R20, R21:
C14, C15:	.01 mfd 1500 V paper condenser	R22:
C16:	.1 mfd 100 V paper condenser	R23:
F1:	10 ampere fuse and holder	S1:
J1:	Input jack (microphone)	RFC1:
J2:	Input jack (phonograph)	RFC2:
L1:	Filter choke, 200 ohm 75 MA	T1:
R1, R4, R16:	1 megohm 1/2 watt resistor	T2:
R2, R6:	500K ohm volume control	Sockets:
R3, R8, R15:	1800 ohm 1/2 watt resistor	
R5, R11:	220K ohm 1/2 watt resistor	
R7, R12:	47K ohm 1 watt resistor	

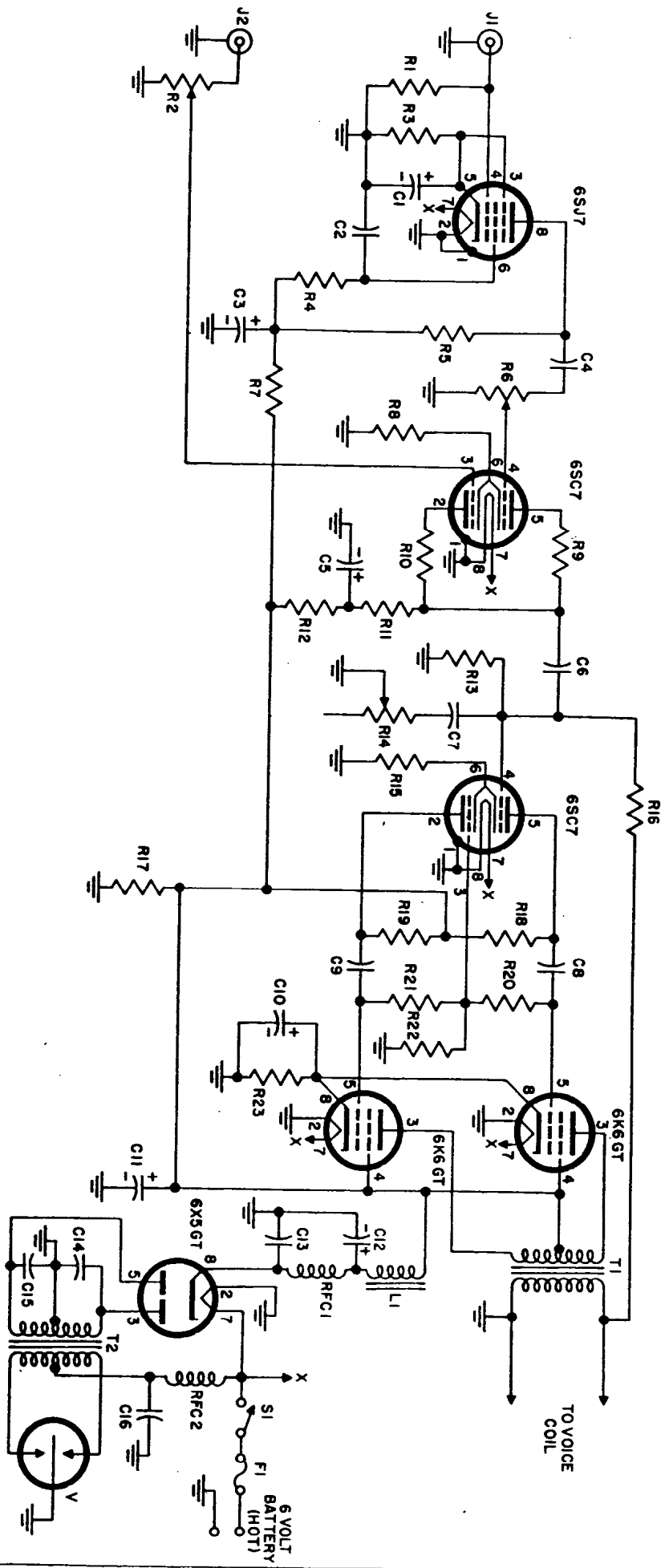


FIG. 27

6 TUBE 10 WATT AC HIGH-FIDELITY AMPLIFIER

Fig. 28 is a 10 watt high-fidelity amplifier which is designed to operate from a high impedance microphone and phonograph pickup simultaneously. A phase inverter tube is used to provide push-pull operation to the power output tubes. The output tubes can be either 6A3 or 6B4G types for six volt operation, or 2A3 tubes if 2-1/2 volts is available for filament operation. The control R24 can be adjusted to balance out hum present in the speaker.

The fidelity of the amplifier will depend almost entirely upon the grade of output transformer T1. Its location on the chassis should be separate from the power transformer and filter choke to keep inductive hum at a minimum.

Parts List

C1:	10 mfd 25 V elec. condenser	R8, R10, R17, R18:	220K ohm 1/2 watt resistor
C2, C10, C11:	.1 mfd 600 V paper condenser	R9, R11:	47K ohm 1 watt resistor
C3, C8:	8 mfd 450 V elec. condenser	R12:	25K ohm 10 watt WW resistor
C4, C7:	.02 mfd 600 V paper condenser	R13:	500K ohm tone control
C5, C6:	.05 mfd 600 V paper condenser	R14, R15:	470K ohm 1/2 watt resistor
C9:	20 mfd 450 V elec. condenser	R21:	7500 ohm 10 watt WW resistor
C12, C13:	16 mfd 575 V elec. condenser	R22:	100K ohm 1/2 watt resistor
C14:	50 mfd 150 V elec. condenser	R23:	800 ohm 5 watt WW resistor
C15:	.05 mfd 400 V paper condenser	R24:	50 ohm 10 watt semi-adjustable WW resistor
J1:	Input jack (microphone)	S1:	SPST switch
J2:	Input jack (phonograph)	T1:	Output transformer, 5000 ohm to multi-tap voice coil, 10 watt
L1:	Filter choke, 100 ohm, 125 MA	T2:	Power transformer, 400-0-400 V 125 MA, 5 V 3 A, 6.3 V 1 A (x) 6.3 V 2 A (yz)
P:	6.3 V indicator lamp	Sockets:	5 octals, 1 4-prong
R1:	2.2 megohm 1/2 watt resistor		
R2, R6:	500K ohm volume control		
R3:	1200 ohm 1/2 watt resistor		
R4:	1 megohm 1/2 watt resistor		
R5, R19, R20:	270K ohm 1/2 watt resistor		
R7, R16:	1500 ohm 1 watt resistor		

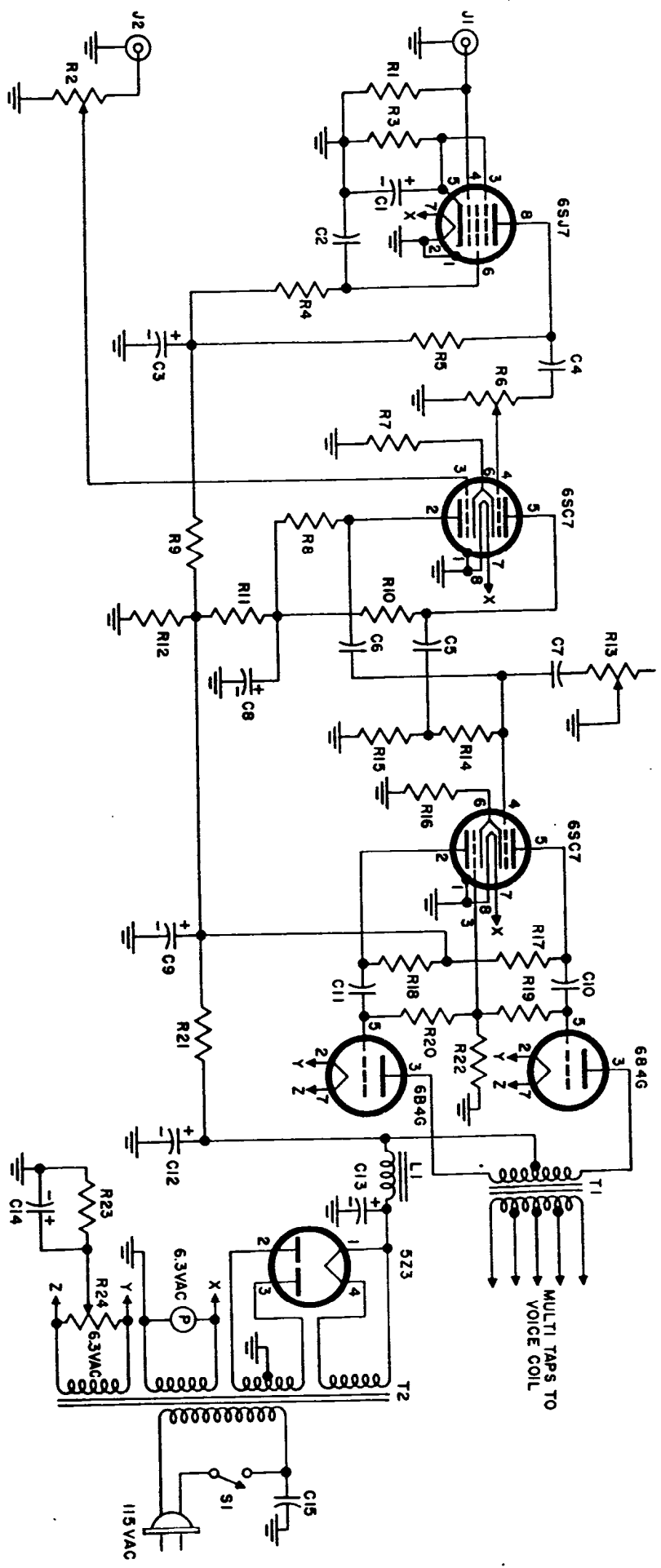


FIG. 28

6 TUBE 12 WATT AC RECORDING AMPLIFIER

Shown in Fig. 29 is an amplifier suitable for semi-professional recording and playback, having both high gain and output. A phonograph pickup and two similar high impedance microphones can be used in the system; R1 controls the phonograph volume and R4 the microphones. This system is designed for an 8-ohm magnetic recording head. S1 controls the output for either recording or speaker service. A separate treble (R19) and bass (R22) tone control adjusts the amplifier tone to suit the operator. Two modulation indicators are provided, N2 for normal modulation and N1 for peaks. To adjust the peak indicator, a record is cut and R27 adjusted so that N1 flashes just as the record groove is overcut. The first 6SN7 tube plate mixing circuit is designed for proper mixing of the two input channels without frequency discrimination, otherwise the amplifier is quite conventional.

Parts List

C1, C2:	25 mfd 25 V elec. condenser	R6, R14, R28:	1 megohm 1/2 watt resistor
C3, C4, C5, C7, C8, C10, C12:	.1 mfd 600 V paper condenser	R7, R8:	39K ohm 1/2 watt resistor
C6:	8 mfd 450 V elec. condenser	R9:	180K ohm 1/2 watt resistor
C9:	500 mmfd mica condenser	R10, R11:	22K ohm 1/2 watt resistor
C11:	.5 mfd 600 V paper condenser	R12:	15K ohm 1 watt resistor
C13:	50 mfd 50 V elec. condenser	R13:	47K ohm 1 watt resistor
C14:	16 mfd 575 V elec. condenser	R15, R16, R21:	4700 ohm 1 watt resistor
C15:	40 mfd 450 V elec. condenser	R17, R18:	33K ohm 1 watt resistor
C16:	.1 mfd 400 V paper condenser	R19:	1 megohm treble tone control
J1:	Input jack (phonograph)	R20:	680K ohm 1/2 watt resistor
J2, J3:	Input jack (microphone)	R22:	50K ohm bass tone control
M1:	Magnetic cutter, 8 ohm	R23:	25K ohm 10 watt WW resistor
N1:	1/4 watt neon overmodulation indicator	R24, R25:	270K ohm 1/2 watt resistor
N2:	1/4 watt neon normal modulation indicator	R26:	220 ohm 2 watt resistor
P:	6.3 V indicator lamp	R27:	250K ohm modulation control
F1:	3 ampere fuse and holder	R29:	39K ohm 1 watt resistor
R1:	1 megohm volume control	S1:	SPDT speaker-recorder switch
R2:	2.2 megohm 1/2 watt resistor	S2:	SPST power switch
R3:	2200 ohm 1 watt resistor	T1:	Output transformer, 8000 ohm to voice coil, 12 watts
R4:	500K ohm volume control	T2:	Power transformer, 325-0-325 V 125 MA, 5 V 3 A, 6.3 V 2.5 A
R5:	1000 ohm 1/2 watt resistor	Sockets:	6 octals

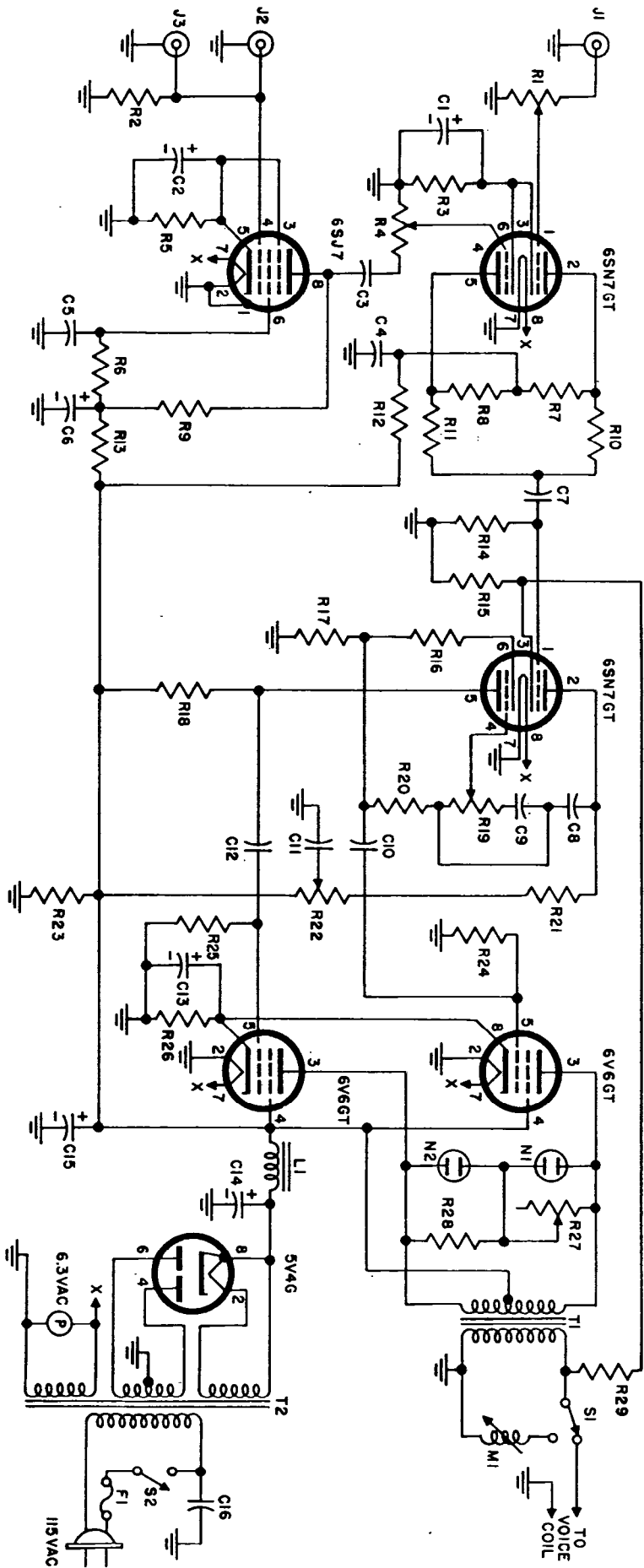


FIG. 29

6 TUBE 25 WATT AC HIGH-FIDELITY AMPLIFIER

The amplifier in Fig. 30 uses a combination of loctal and octal type tubes for high gain, high output, and compactness. Two microphones and a phonograph pickup, all separately controlled, can be used at will, and with a properly designed output transformer high fidelity results can be realized. Inverse feedback applied over three stages of amplification aids in obtaining the good response and gives the amplifier smooth operation. A tone control (R17) can be adjusted to lower the fidelity if desired. A minimum of constructional problems should be encountered in this amplifier, and by the use of a multi-tap output transformer (T1) a number of speakers can be matched to the amplifier. Note the feedback resistor R28 connects to the 500-ohm output tap.

Parts List

C1:	10 mfd 25 V elec. condenser	R7, R8:	180K ohm 1/2 watt resistor
C2, C5:	8 mfd 450 V elec. condenser	R11, R13,	R14, R15, R16:
C3, C4:	.05 mfd 600 V paper condenser	R12:	100K ohm 1/2 watt resistor
C6, C8, C9:	.1 mfd 600 V paper condenser	R17:	1200 ohm 1/2 watt resistor
C7:	.005 mfd 600 V paper condenser	R18:	500K ohm tone control
C10:	50 mfd 50 V elec. condenser	R19:	470K ohm 1/2 watt resistor
C11:	20 mfd 450 V elec. condenser	R20:	5000 ohm 5 watt WW resistor
C12:	30 mfd 450 V elec. condenser	R23:	2200 ohm 1 watt resistor
C13:	16 mfd 575 V elec. condenser	R24:	330K ohm 1/2 watt resistor
C14:	.05 mfd 400 V paper condenser	R25:	27K ohm 1/2 watt resistor
F1:	3 ampere fuse and holder	R26:	330K ohm 1/2 watt resistor
J1, J2:	Input jack (microphone)	R27:	250 ohm 5 watt WW resistor
J3:	Input jack (phonograph)	S1:	5000 ohm 10 watt WW resistor
L1:	Filter choke, 100 ohms, 150 MA	T1:	SPST switch
P:	6.3 volt indicator lamp	T2:	Output transformer, 9000 ohm to multi-tap voice coil, 25 watt
R1, R2, R28:	1 megohm 1/2 watt resistor	Sockets:	Power transformer, 400-0-400 V 150 MA, 5 V 3 A, 6.3 V 4 A
R3, R9, R10:	500K ohm volume control		3 octals, 3 loctals
R4:	1500 ohm 1/2 watt resistor		
R5, R21, R22:	47K ohm 1 watt resistor		
R6:	25K ohm 10 watt WW resistor		

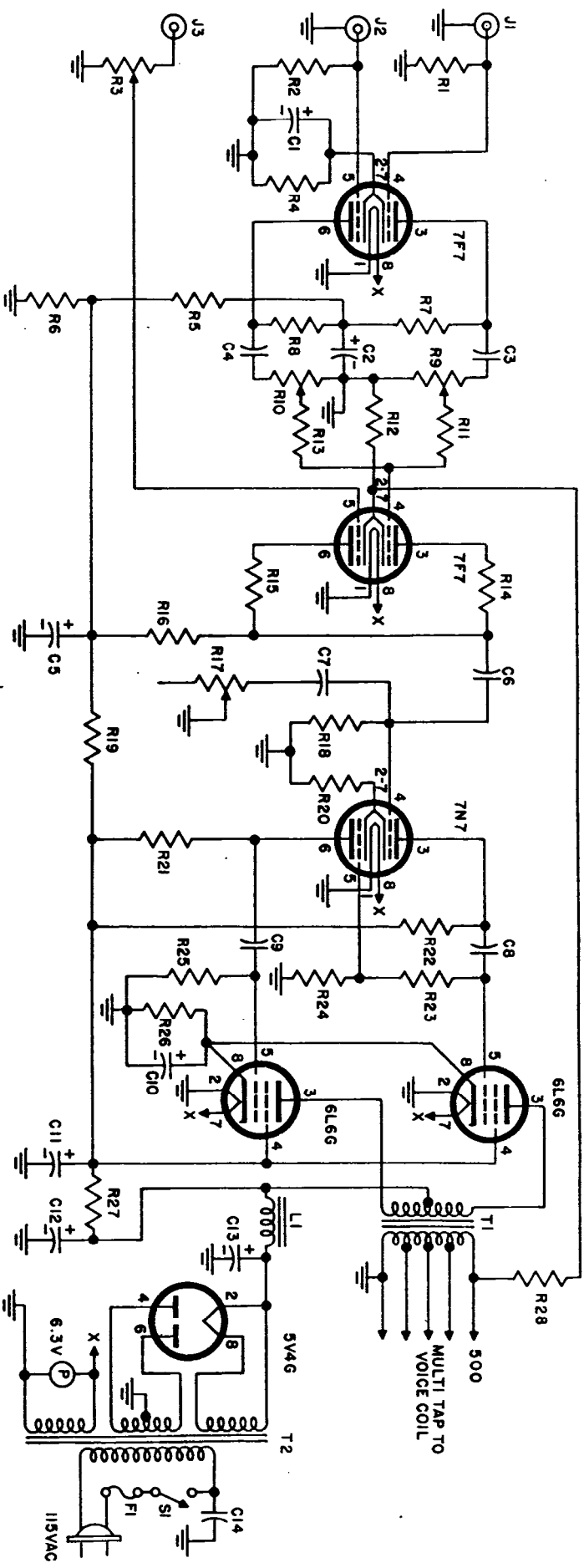


FIG. 30

6 TUBE 45 WATT AC FIXED-BIAS AMPLIFIER

Fig. 31 is an all-transformer coupled amplifier that is capable of high power output from any desired input source. Push-pull operation is provided throughout the amplifier, and with good audio-frequency transformers, fine response can be obtained. Two rectifiers are used, one for plate supply, the other for bias supply of the 6L6G tubes. In adjusting the circuits, R12 is adjusted for minus 22-1/2 volts and R17 for plus 275 volts. It is usually advisable to provide a separate power supply chassis from the amplifier chassis to keep hum problems at a minimum. It may also be necessary to stagger the positions of the A.F. transformers for the same reason. It is advisable to use well shielded transformers for T1 and T2 in any case to keep internal noises to a minimum.

Parts List

C1, C3:	.05 mfd 600 V paper condenser	R10, R11:	47K ohm 1 watt resistor
C2, C5:	10 mfd 25 V elec. condenser	R12:	750 ohm 10 watt semi-adjustable WW resistor
C4, C6:	8 mfd 450 V elec. condenser	R15:	2500 ohm 5 watt WW resistor
C7, C8:	.25 mfd 600 V paper condenser	R16:	7500 ohm 20 watt WW resistor
C9, C10:	20 mfd 250 V elec. condenser	R17:	10K ohm 50 watt semi-adjustable WW resistor
C11, C12:	20 mfd 450 V elec. condenser	S1:	SPST switch
C13, C14:	.001 mfd 1000 V paper condenser	T1:	A.F. input transformer, plate to push-pull grids, 1:1 ratio
C15:	30 mfd 450 V elec. condenser	T2:	A.F. interstage transformer, push-pull plates to push-pull grids, 2:1 ratio
C16:	16 mfd 575 V elec. condenser	T3:	A.F. interstage transformer, push-pull plates to push-pull grids, class-B
C17, C18:	.02 mfd 400 V paper condenser	T4:	Output transformer, 3800 ohm to multi-tap voice coil, 45 watt
F1:	3 ampere fuse and holder	T5:	Power transformer, 400-0-400 V 200 MA, 5 V 3 A, 6.3 V 2 A
J1:	Input jack	T6:	Power transformer, 200-0-200 V 40 MA, 5 V 2 A, 6.3 V 2 A
L1:	Filter smoothing choke, 100 ohm 200 MA	Sockets:	4 octals, 2 4-prong
L2:	Filter swinging choke, 3-30 henry 200 MA		
P:	6.3 V indicator lamp		
R1:	500K ohm volume control		
R2, R3, R6, R7, R13, R14:	220K ohm 1/2 watt resistor		
R4:	820 ohm 1 watt resistor		
R5:	100K ohm tone control		
R8:	27K ohm 1 watt resistor		
R9:	1000 ohm 1 watt resistor		

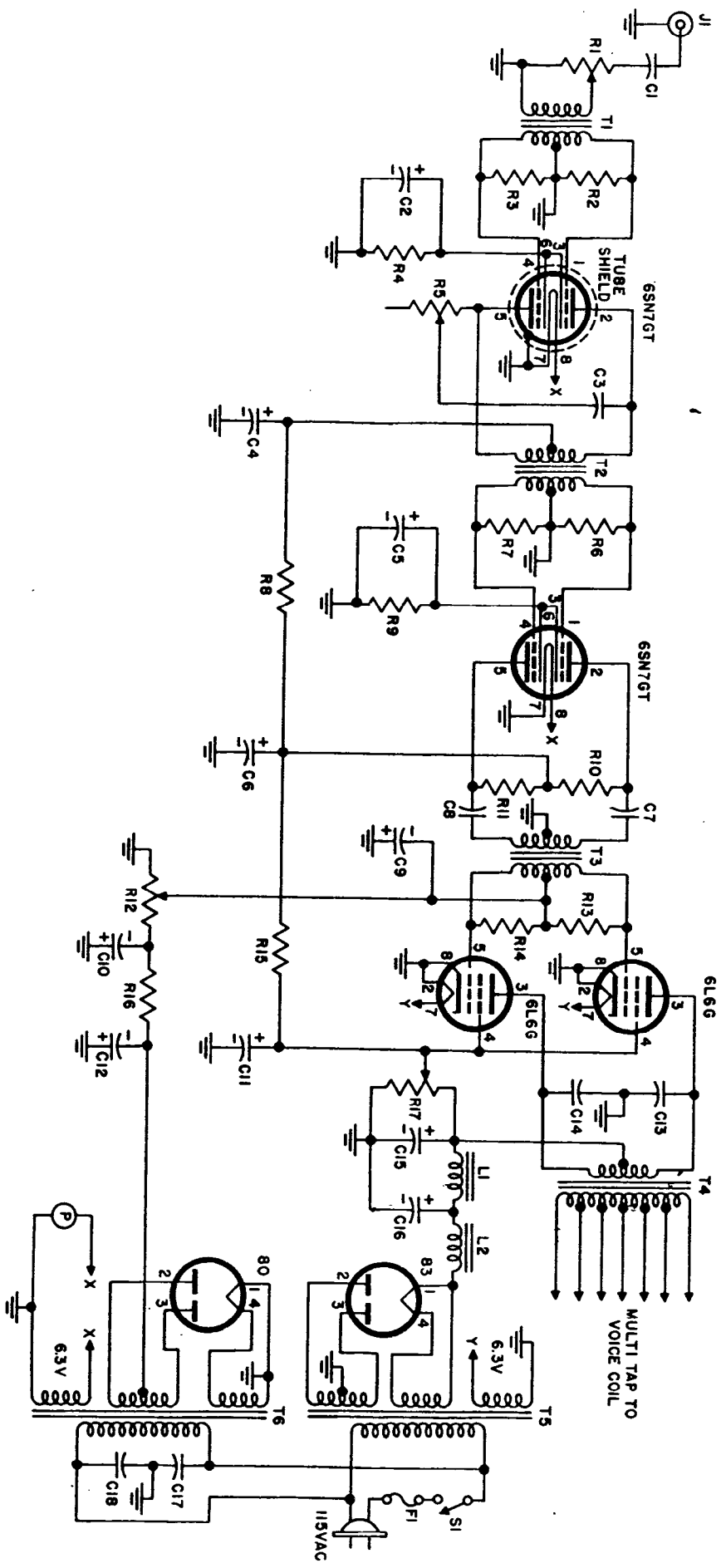


FIG. 31

7 TUBE 14 WATT AC RECORDING AMPLIFIER

Fig. 32 is a recording amplifier somewhat more elaborate than the one shown in Fig. 29. A recording-playback switch (S1) connects the microphone and recorder to the amplifier on "record," and the phonograph and speaker on "playback" positions. A magnetic recorder is again specified. Separate treble and bass tone controls are provided, and a "magic eye" tube is used as a modulation indicator. R19 is adjusted so that the eye will close just at the point of over-modulation. Two microphone jacks J1 and J2 are available if two microphones are to be used. R2 controls the phonograph level and R6 the microphones, R10 treble tone and R20 bass tone. A low impedance recording head is specified for use with this amplifier due to its more rugged construction than the higher impedance crystal type.

Parts List

C1:	10 mfd 25 V elec. condenser	R10:	10K ohm treble tone control
C2:	.1 mfd 600 V paper condenser	R11:	25K ohm 10 watt WW resistor
C3, C6:	8 mfd 450 V elec. condenser	R12:	3300 ohm 1/2 watt resistor
C4:	.02 mfd 600 V paper condenser	R17:	4700 ohm 1/2 watt resistor
C5, C11:	.5 mfd 200 V paper condenser	R18, R24:	47K ohm 1/2 watt resistor
C7, C8, C9, C12:	.05 mfd 600 V paper condenser	R19:	1 megohm modulation control
C10:	.001 mfd 800 V paper condenser	R20:	500K ohm bass tone control
C13:	25 mfd 50 V elec. condenser	R21:	5000 ohm 10 watt WW resistor
C14:	40 mfd 450 V elec. condenser	R22, R23:	4.7 megohm 1/2 watt resistor
C15:	20 mfd 450 V elec. condenser	R25, R26:	470K ohm 1/2 watt resistor
C16:	.05 mfd 400 V paper condenser	R27:	200 ohm 5 watt WW resistor
J1, J2:	Input jack (microphone)	R28:	500 ohm 10 watt WW resistor
J3:	Input jack (phonograph)	S1:	DPDT record-playback switch
R1, R4, R15, R16:	1 megohm 1/2 watt resistor	S2:	SPST power switch
R2, R6:	500K ohm volume control	S3:	SPST motor switch
R3, R13:	1000 ohm 1/2 watt resistor	T1:	Output transformer, 8000 ohm to 8 ohm voice coil, 14 watt
R5, R14:	270K ohm 1/2 watt resistor	T2:	Power transformer, 350-0-350 V 100 MA, 5 V 2 A, 6.3 V 2 A
R7:	100K ohm 1 watt resistor	Sockets:	6 octals, 1 6-prong
R8:	15K ohm 1 watt resistor		

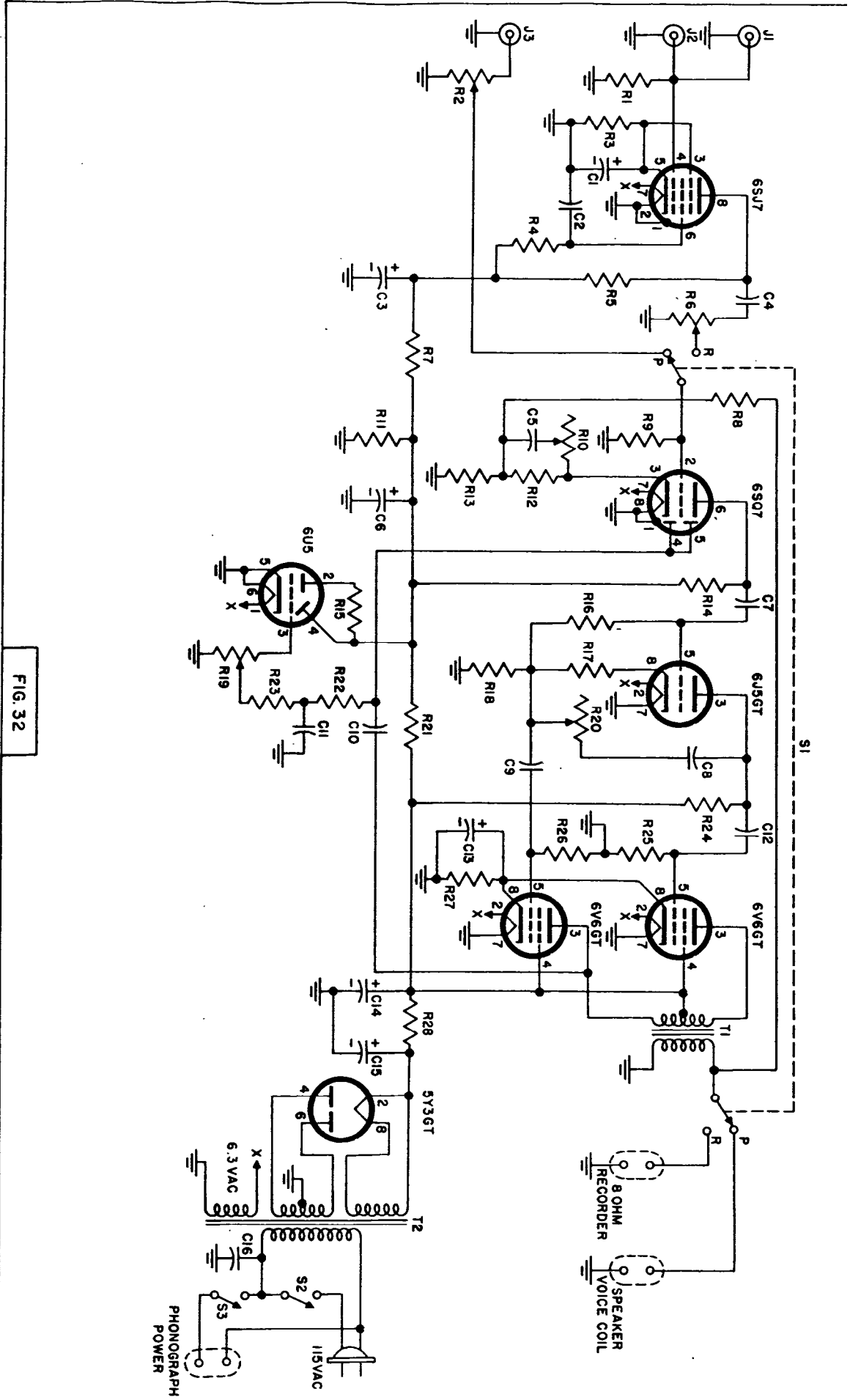


FIG. 32

7 TUBE 20 WATT AC HIGH FIDELITY AMPLIFIER

A phonograph or radio output can be amplified to high levels with the 20 watt high-fidelity amplifier shown in Fig. 33. It features push-pull parallel 6B4G tubes in a circuit requiring a very low load impedance. This low impedance, together with a good quality output transformer, will provide high fidelity response, making the amplifier especially suitable for a frequency modulated tuner. R1 is the volume control, R19 is the bias adjusting resistor that is set for 160 milliamperes of current as measured by a DC milliammeter in J2, and R20 is the hum balancing resistor. A good quality speaker is necessary for high quality response and it should be capable of handling the amplifier power of 20 watts for best efficiency.

Parts List

C1, C5:	25 mfd 25 V elec. condenser	R7:	2200 ohm 1 watt resistor
C2, C4:	.1 mfd 600 V paper condenser	R9:	25K ohm 10 watt WW resistor
C3, C6:	8 mfd 550 V elec. condenser	R13:	100K ohm 1/2 watt resistor
C7, C8:	.25 mfd 600 V paper condenser	R14:	5000 ohm 10 watt WW resistor
C9:	40 mfd 450 V elec. condenser	R15, R16:	180 ohm 1/2 watt resistor
C10:	25 mfd 575 V elec. condenser	R17, R18:	68 ohm 2 watt resistor
C11:	20 mfd 150 V elec. condenser	R19:	500 ohm 10 watt semi-adjustable WW resistor
C12:	.05 mfd 400 V paper condenser	R20:	50 ohm 10 watt semi-adjustable WW resistor
F1:	3 ampere fuse and holder	S1:	SPST switch
J1:	Input jack	T1:	Output transformer, 2500 to voice coil, 20 watt
J2:	Metering jack, normally shorted	T2:	Power transformer, 375-0-375 V 200 MA, 5 V 3 A, 6.3 V 4 A
L1:	Filter choke, 75 ohm 200 MA	Sockets:	7 octals
R1:	500K ohm volume control		
R2:	1000 ohm 1/2 watt resistor		
R3:	1.5 megohm 1/2 watt resistor		
R4, R11, R12:	270K ohm 1/2 watt resistor		
R5:	470K ohm 1/2 watt resistor		
R6, R8, R10:	47K ohm 1 watt resistor		

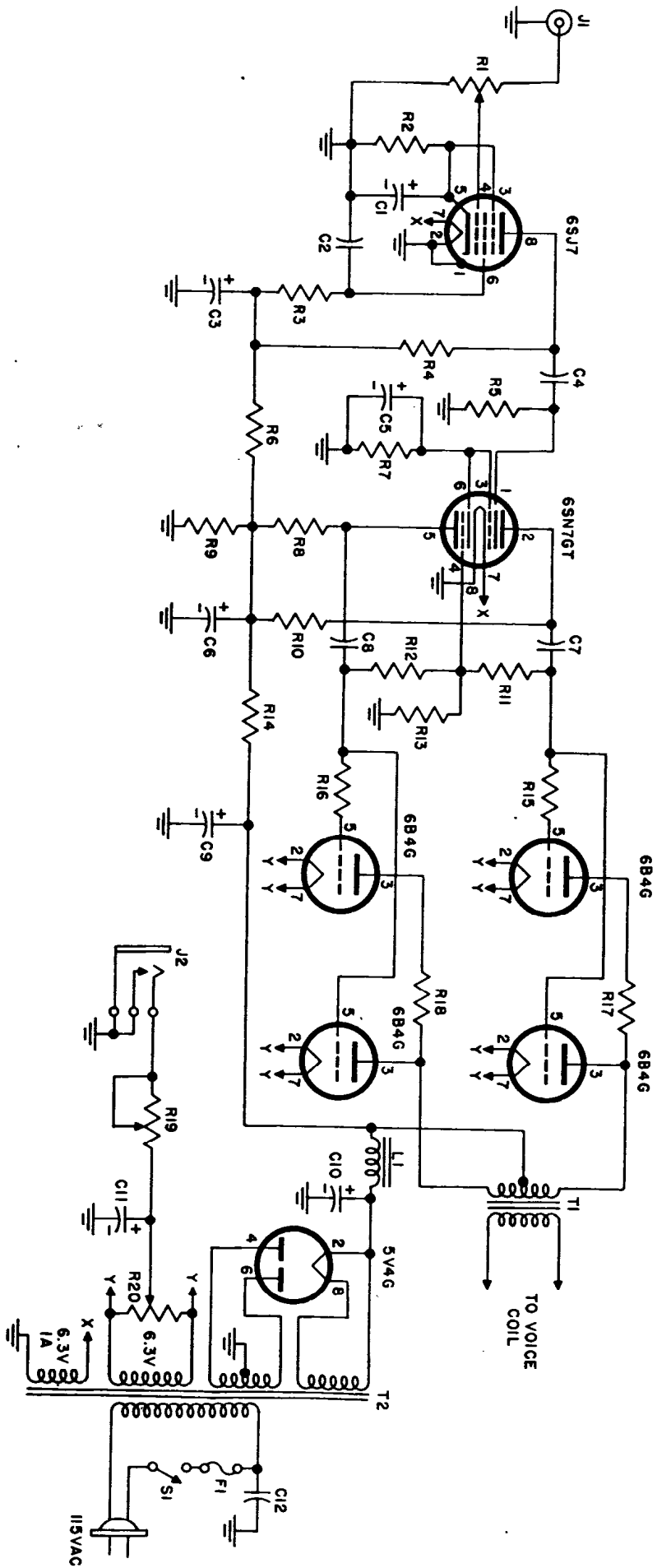


FIG. 33

7 TUBE 45 WATT AC P. A. AMPLIFIER

A high power output public address amplifier utilizing push-pull 6L6G tubes is shown in Fig. 34. Fixed bias and sufficient driving power for the output tubes provides this high power to the speakers. Voltage dividing resistor R17 is adjusted for minus 22-1/2 volts on the tap. A high impedance microphone and phonograph pickup may be used simultaneously and adjusted separately by means of R6 and R2; R16 is a tone control.

Parts List

C1, C5, C8:	10 mfd 25 V elec. condenser	R13:	20K ohm 10 watt WW resistor
C2, C9:	.05 mfd 600 V paper condenser	R14:	1000 ohm 1 watt resistor
C3, C6:	8 mfd 450 V elec. condenser	R15:	5000 ohm 10 watt WW resistor
C4, C7, C13:	.02 mfd 600 V paper condenser	R16:	100K ohm tone control
C11, C12, C15:	20 mfd 450 V elec. condenser	R17:	750 ohm 10 watt semi-adjustable WW resistor
C10:	20 mfd 150 V elec. condenser		
C14:	40 mfd 450 V elec. condenser	R18:	2500 ohm 10 watt resistor
C16:	16 mfd 575 V elec. condenser	R19:	10K ohm 10 watt WW resistor
C17, C18:	.02 mfd 400 V paper condenser	R20:	3000 ohm 20 watt WW resistor
F1:	5 ampere fuse and holder	R21:	5000 ohm 20 watt WW resistor
J1:	Input jack (microphone)	R22:	500 ohm 20 watt WW resistor
J2:	Input jack (phonograph)	S1:	SPST switch
P:	6.3 V indicator lamp	T1:	A.F. input transformer, Class AB, plate to push-pull grids, 1:1
R1:	2.2 megohm 1/2 watt resistor	T2:	Output transformer, 3800 ohm to voice coil, 45 watt
R2, R6:	500K ohm volume control	T3:	Power transformer, 400-0-400 V
R3:	3300 ohm 1/2 watt resistor	T4:	200 MA 5 V 3 A, 6.3 V 2 A
R4, R12:	470K ohm 1/2 watt resistor		Power transformer, 200-0-200 V
R5:	270K ohm 1/2 watt resistor		40 MA, 5 V 2 A, 6.3 V 2 A
R7, R9, R10, R11:	100K ohm 1/2 watt resistor		7 octals
R8:	1500 ohm 1/2 watt resistor		

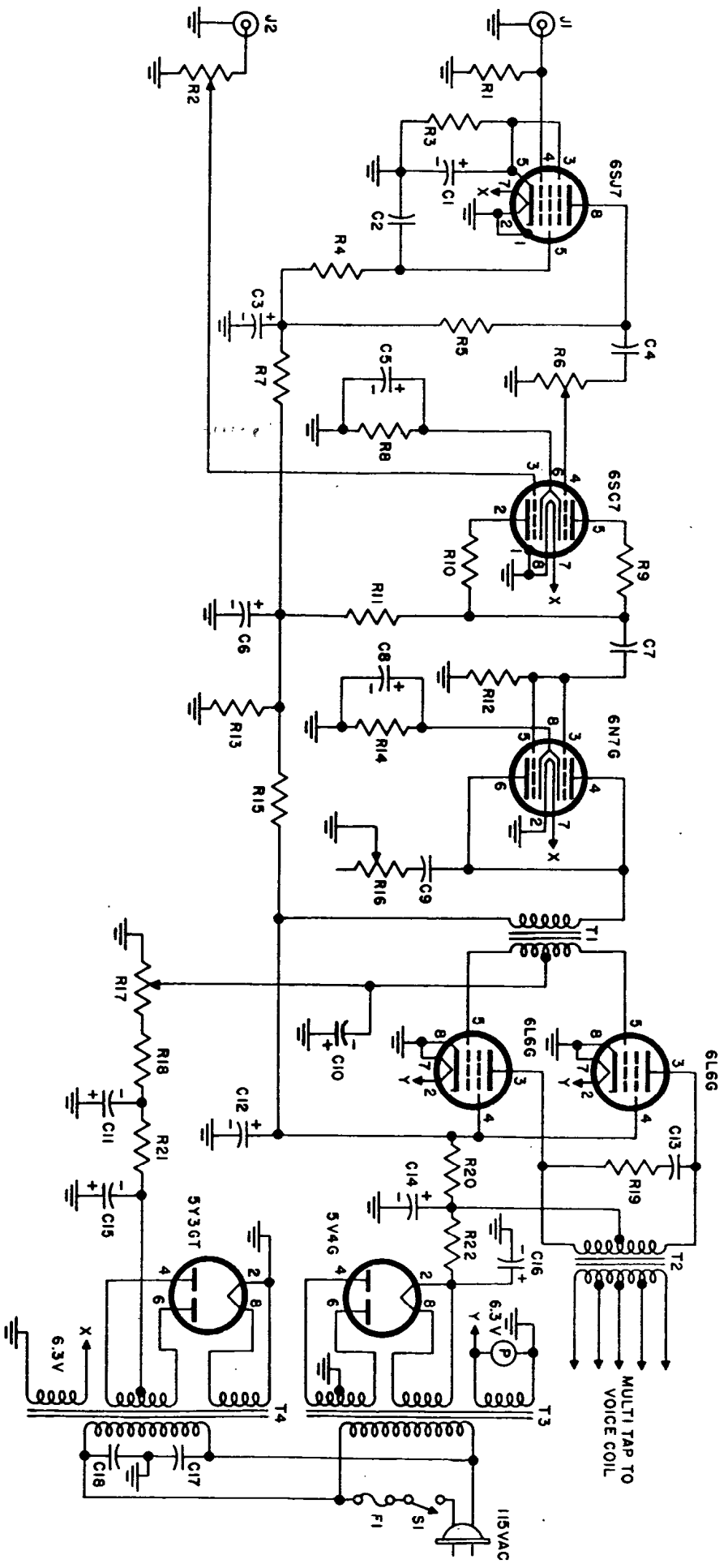


FIG. 34

8 TUBE 10 WATT AC HIGH-FIDELITY AMPLIFIER

For you who want a really good all-triode high-fidelity amplifier suitable for all around applications, the amplifier in Fig. 35 should meet your needs. High stability is obtained by the use of reliable triode tubes for all amplifier stages. Note the filament return on all 6J5 tubes operate with a positive voltage to ground (determined by R22 and R23). This voltage (about 20 volts) is somewhat higher than the normal cathode voltage on the tubes effectively blocking any static hum pickup by the tubes. Each 6B4G tube has separately adjustable bias controls (R30 and R31) and meter jacks so each tube can be individually adjusted to the proper 40 milliamperes plate current. R35 can be used to balance out minute hum appearing in the amplifier. The overall response of this amplifier is limited to the quality of the output transformer used, so don't stint here. A bass tone control R3 and treble control R2 further enhances the usefulness of the amplifier. It is highly advisable to mount the power supply for this amplifier on a separate chassis if full frequency characteristics and low noise levels are to be realized.

Parts List

C1:	.01 mfd 400 V paper condenser	R7:	1 megohm volume control
C2:	.5 mfd 200 V paper condenser	R8, R14, R20, R21:	2200 ohm 1/2 watt resistor
C3, C7:	.1 mfd 600 V paper condenser	R9:	10K ohm treble tone control
C4, C6, C9:	8 mfd 450 V elec. condenser	R11, R17, R23:	10K ohm 1 watt resistor
C5:	25 mfd 25 V elec. condenser	R12:	100K ohm 1/2 watt resistor
C8, C10:	.25 mfd 600 V paper condenser	R18, R19:	330K ohm 1/2 watt resistor
C11:	10 mfd 50 V elec. condenser	R22:	100K ohm 2 watt resistor
C12, C13:	.5 mfd 600 V paper condenser	R24, R25:	82K ohm 1/2 watt resistor
C14, C15:	40 mfd 450 V elec. condenser	R27, R28:	220K ohm 1/2 watt resistor
C16, C17:	40 mfd 150 V elec. condenser	R30, R31:	200 ohm 10 watt semi-adjustable WW resistor
C18:	16 mfd 575 V elec. condenser	R32:	5000 ohm 10 watt WW resistor
C19:	.05 mfd 400 V paper condenser	R33, R34:	1500 ohm 10 watt WW resistor
F1:	5 ampere fuse and holder	R35:	100 ohm 10 watt semi-adjustable WW resistor
J1:	Input jack	S1:	SPST switch
J2, J3:	Metering jack, normally shorted	T1:	Output transformer, 5000 ohm to voice coil, 10 watt
L1:	Filter choke, 100 ohm 125 MA	T2:	Power transformer, 350-0-350 V 125 MA, 5 V 3 A, 6.3 V 2 A
R1, R13, R26, R29:	1 megohm 1/2 watt resistor	T3:	Filament transformer, two 6.3 V 1 A each.
R2:	10K ohm treble tone control	Sockets:	8 octals
R3:	250K ohm bass tone control		
R4:	3300 ohm 1/2 watt resistor		
R5, R10, R15, R16:	33K ohm 1/2 watt resistor		
R6:	22K ohm 1/2 watt resistor		

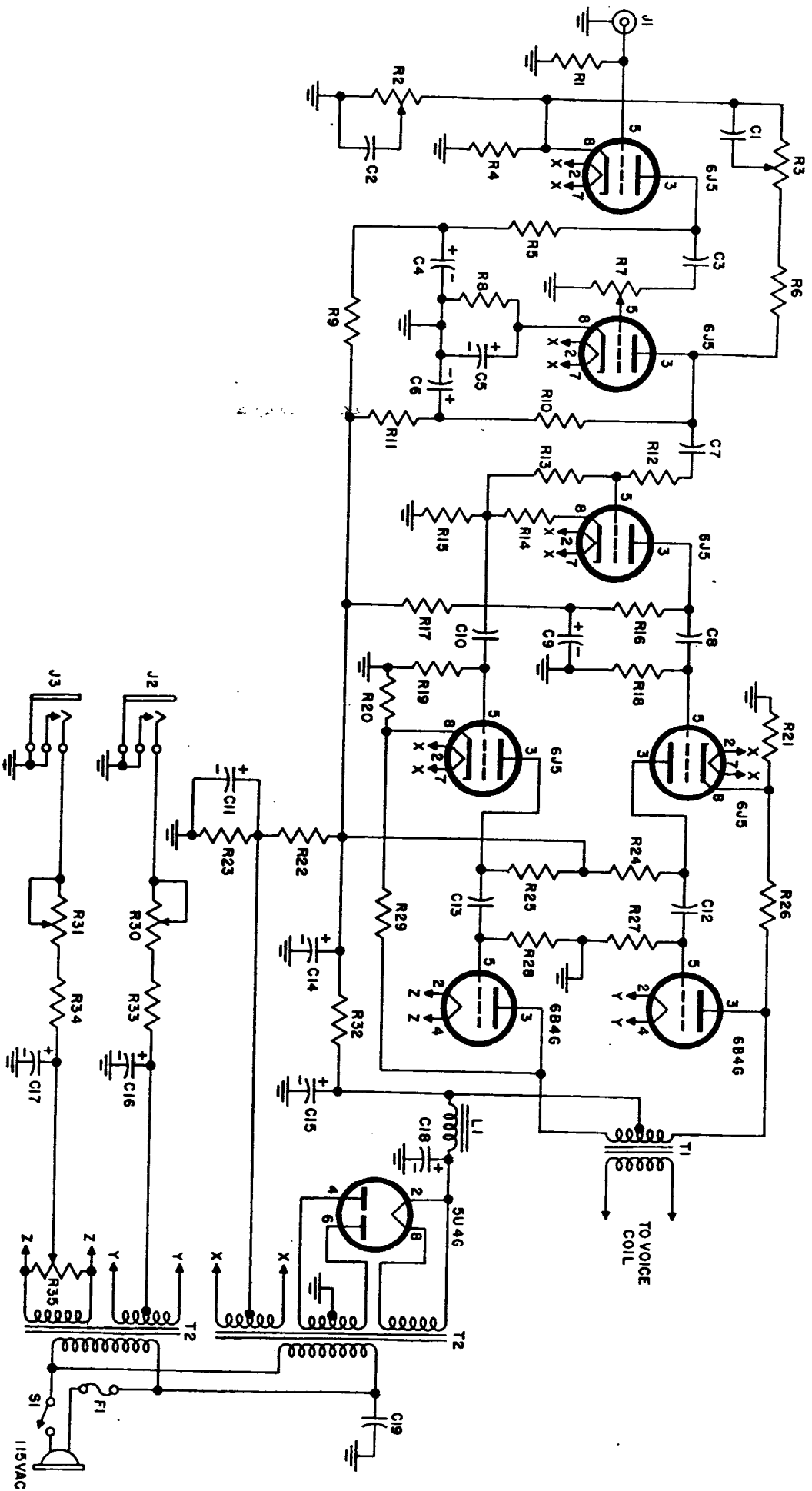


FIG. 35

8 TUBE 12 WATT AC PHONOGRAPH EXPANDER AND COMPRESSOR AMPLIFIER

Fig. 36 unit is a special phonograph amplifier designed for either expansion or compression of the normal volume level of the recording to any degree. Expansion is sometimes desired to bring out more vividly the heavy passages of a recording than would otherwise appear. Compression is likewise occasionally used to flatten out the response of a recording having too great a variation in volume. Either condition can be obtained by varying R16; moving the control from the center to the left increases the volume compression, and to the right increases volume expansion. Sufficient gain may be realized in this amplifier to easily reach the 12 watts output at any setting of R16. Volume is controlled by R1; tone by R4.

Parts List

C1, C3, C9: 25 mfd 25 V elec. condenser
 C2, C10, C12, C15, C16: .05 mfd 600 V paper condenser
 C4, C13: 8 mfd 450 V elec. condenser
 C5, C8: .1 mfd 600 V paper condenser
 C6: .01 mfd 600 V paper condenser
 C7: .5 mfd 200 V paper condenser
 C11, C14: .25 mfd 200 V paper condenser
 C17: 50 mfd 50 V elec. condenser
 C18: 40 mfd 450 V elec. condenser
 C19: 20 mfd 450 V elec. condenser
 C20: .1 mfd 400 V paper condenser
 J1: Input jack
 L1: Filter choke, 150 ohm 120 MA
 R1: 500K ohm volume control
 R2: 3300 ohm 1/2 watt resistor
 R3, R11, R17, R24, R25: 470K ohm 1/2 watt resistor
 R4: 250K ohm tone control
 R5: 47K ohm 1/2 watt resistor

R6: 1000 ohm 1/2 watt resistor
 R7, R8, R10: 270K ohm 1/2 watt resistor
 R9, R15: 27K ohm 1 watt resistor
 R12: 3300 ohm 1 watt resistor
 R13: 47K ohm 1 watt resistor
 R14: 33K ohm 1/2 watt resistor
 R16: 1 megohm center-tapped potentiometer, linear taper
 R18: 1500 ohm 1 watt resistor
 R19, R20: 220K ohm 1/2 watt resistor
 R21: 25K ohm 10 watt WW resistor
 R22, R23: 1 megohm 1/2 watt resistor
 R26: 100K ohm 1/2 watt resistor
 R27: 200 ohm 5 watt WW resistor
 S1: SPST switch
 T1: Output transformer, 8000 ohm to voice coil, 12 watt
 T2: Power transformer, 300-0-300 V 120 MA, 5 V 2 A, 6.3V 3 A
 Sockets: 8 octals

8 TUBE 25 WATT AC 4-CHANNEL P. A. AMPLIFIER

A high power public address amplifier is shown in Fig. 37, having two microphone and two phonograph inputs with complete electronic mixing provided on all channels. A separate tone control for the microphone and phonograph channels is used for greater flexibility. High gain and up to 25 watts output is easily obtained, making this a good all-around amplifier.

Again a separate chassis for the power supply is desired in constructing the amplifier so as to reduce the interaction between the power supply and input circuits. If this precaution is taken, little trouble should be experienced in getting this amplifier to function properly.

Parts List

C1, C7, C11, C18: 25 mfd 25 V elec. condenser
 C2, C8, C17: 8 mfd 450 V elec. condenser
 C3, C4, C5, C6, C12, C13: .05 mfd 600 V paper condenser
 C9, C10, C15, C16, C19, C20: .1 mfd 600 V paper condenser
 C14: .05 mfd 400 V paper condenser
 C21: 50 mfd 50 V elec. condenser
 C22: 20 mfd 450 V elec. condenser
 C23: 25 mfd 575 V elec. condenser
 C24: .01 mfd 1000 V paper condenser
 C25: 16 mfd 575 V elec. condenser
 F1: 5 ampere fuse and holder
 J1, J2: Input jack (microphone)
 J3, J4: Input jack (phonograph)
 L1: Filter choke, 100 ohm 200 MA
 P: 6.3 V indicator lamp
 R1, R2, R3, R4, R14, R16, R17, R18, R23, R24: 1 megohm 1/2 watt resistor
 R5: 820 ohm 1 watt resistor
 R6, R7, R8, R9: 220K ohm 1/2 watt resistor

R10, R11, R12, R13: 500K ohm volume control
 R15: 1800 ohm 1/2 watt resistor
 R19: 47K ohm 1 watt resistor
 R20, R28: 27K ohm 1 watt resistor
 R21, R22, R29, R30, R34, R35: 47K ohm 1/2 watt resistor
 R25: 3300 ohm 1/2 watt resistor
 R26, R27: 100K ohm tone control
 R31: 100K ohm 1/2 watt resistor
 R32, R37, R38: 470K ohm 1/2 watt resistor
 R33: 4700 ohm 1/2 watt resistor
 R36: 15K ohm 20 watt WW resistor
 R39: 250 ohm 10 watt WW resistor
 R40: 2000 ohm 20 watt WW resistor
 R41: 7500 ohm 10 watt WW resistor
 S1: SPST switch
 T1: Power transformer, 375-0-375 V
 200 MA, 5 V 3 A, 6.3 V 4 A
 T2: Output transformer, 9000 ohm to
 multi-tap voice coil, 25 watt
 8 octals
 Sockets:

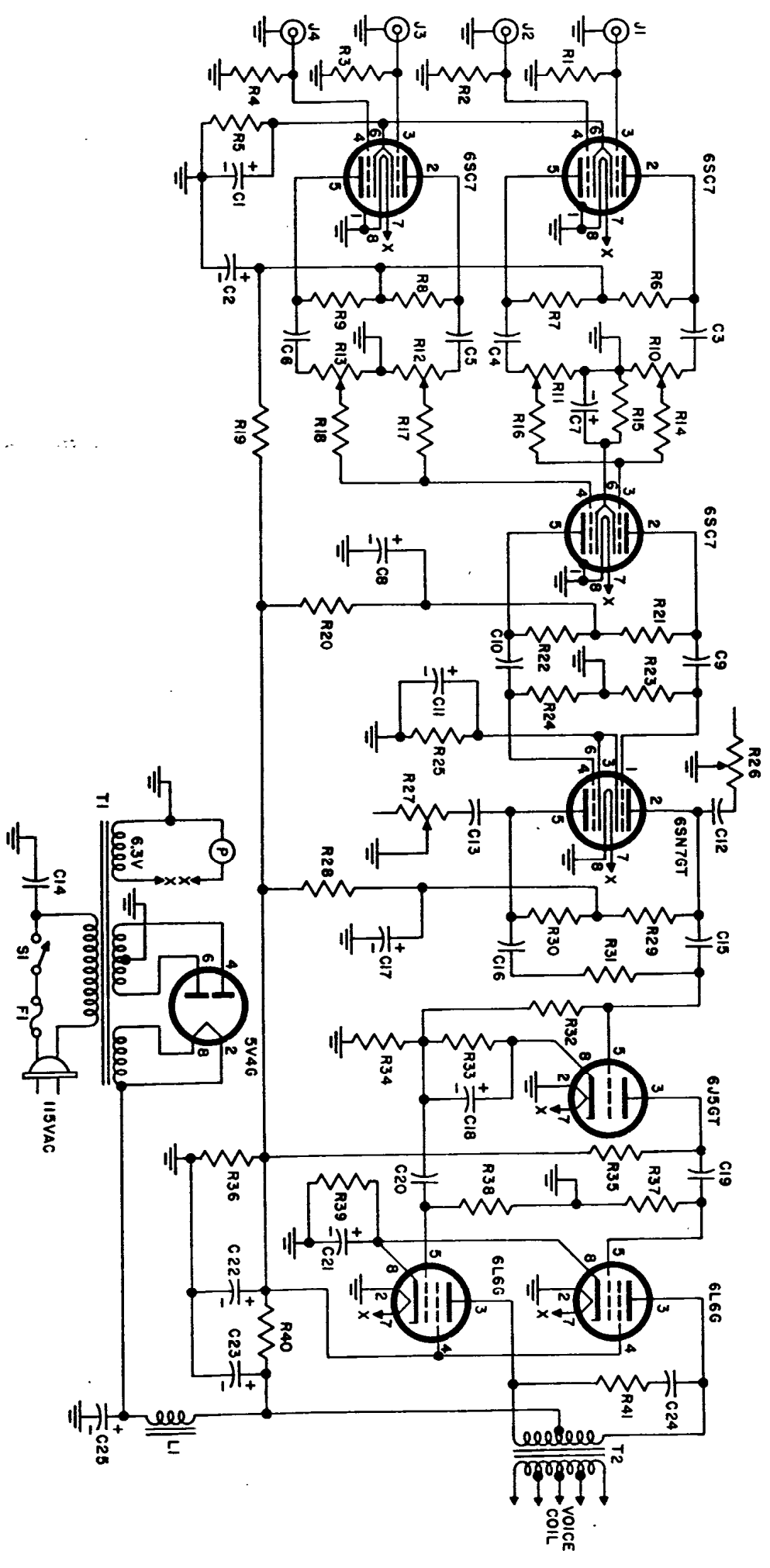


FIG. 37

8 TUBE 50 WATT AC TRANSMITTER MODULATOR

Fig. 38 is a 50-watt modulator suitable for amateur radio service using fairly low voltage type tubes considering the power obtained. No audio driver transformer is needed for the push-pull parallel 6L6G tubes, thereby reducing the size and cost of the unit. A single high impedance microphone input is shown which is the usual practice for an amateur radio station. If it is desired to use two microphones, another jack could be connected parallel to the input jack J1. S1 is used to turn the modulator on during transmissions; it may be replaced by a relay if desired.

Parts List

C1:	.001 mfd 400 V paper condenser	R6, R8, R10:	100K ohm 1/2 watt resistor
C2, C6, C13:	10 mfd 25 V elec. condenser	R11:	27K ohm 1/2 watt resistor
C3:	.05 mfd 600 V paper condenser	R13:	10K ohm 1 watt resistor
C4, C7, C12:	8 mfd 450 V elec. condenser	R14:	4700 ohm 1/2 watt resistor
C5, C8, C11, C14, C15:	.01 mfd 600 V paper condenser	R15, R17:	47K ohm 1/2 watt resistor
C9, C10:	.02 mfd 400 V paper condenser	R18:	25K ohm 20 watt WW resistor
C16:	10 mfd 50 V elec. condenser	R20:	100 ohm 10 watt WW resistor
C17:	20 mfd 450 V elec. condenser	R21, R22:	220 ohm 1/2 watt resistor
C18:	25 mfd 575 V elec. condenser	R23:	2000 ohm 20 watt WW resistor
J:	Input jack	R24, R25:	100 ohm 2 watt resistor
L1:	Filter choke, 100 ohm 100 MA	S1:	SPST communication switch
L2:	Swinging choke, 3-30 henry 300 MA	S2:	SPST power switch
P:	6.3 V indicator lamp	T1:	Power transformer, 400-0-400 V 300 MA, 5 V 3 A, 6.3 V 4 A 6.3 V 1.5 A
R1:	2.2 megohm 1/2 watt resistor	T2:	Output transformer, 4500 ohm to multi-tap secondary, 50 watt
R2, R7:	1500 ohm 1/2 watt resistor	RFC:	2-1/2 millihenry radio frequency choke
R3, R9, R12, R16, R19:	470K ohm 1/2 watt resistor	Sockets:	8 octals
R4:	270K ohm 1/2 watt resistor		
R5:	500K ohm volume control		

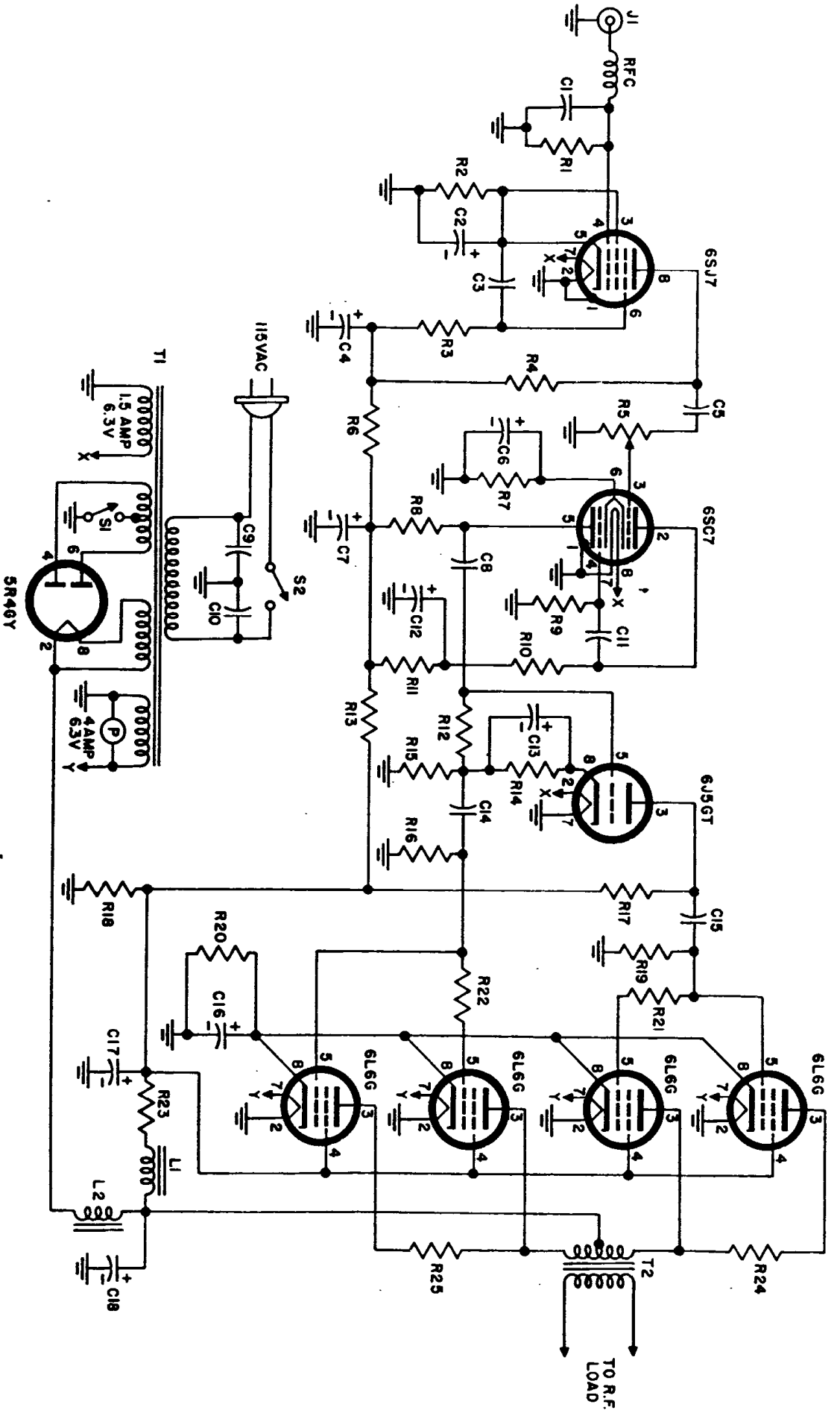


FIG. 38

9 TUBE 45 WATT AC P.A. AMPLIFIER

A 45 watt public address amplifier is shown in Fig. 39 having two microphones and a phonograph input. The amplifier uses fixed bias in its output circuit for greater power; R26 is pre-adjusted for minus 22-1/2 volts bias on the 6L6G tubes by measuring the voltage from tap on R26 to ground. An inverse feedback network consisting of R29 is incorporated for improved tone quality. For best results it is advisable to assemble the power supplies on a separate chassis from the amplifier proper.

Parts List

<p>C1, C4: 25 mfd 25 V elec. condenser C2, C5, C6, C9, C12: .05 mfd 600 V paper condenser C3, C7, C10, C11: 8 mfd 450 V elec. condenser .005 mfd 400 V paper condenser C8: 20 mfd 150 V elec. condenser C14: 20 mfd 250 V elec. condenser C15: 20 mfd 450 V elec. condenser C13, C16: 40 mfd 575 V elec. condenser C17: 20 mfd 575 V elec. condenser C18: .02 mfd 400 V paper condenser C19, C20: 5 ampere fuse add holder F1: Input jack (microphone) J1, J2: Input jack (phonograph) J3: Filter smoothing choke, 100 ohm 200 MA L1: Filter swinging choke, 3-30 henry, 200 MA L2: 6.3 V indicator lamp P: 1 megohm 1/2 watt resistor R1, R2, R7, R19: 500K ohm volume control R3, R11, R12: 1800 ohm 1/2 watt resistor R4, R5: R6, R8, R9, R10, R14, R16: 270K ohm 1/2 watt resistor</p>	<p>R13: 47K ohm 1 watt resistor R15, R17: 47K ohm 1/2 watt resistor R18: 1 megohm tone control R20: 25K ohm 10 watt WW resistor 421: 3900 ohm 1/2 watt resistor R22: 68K ohm 1/2 watt resistor R23: 470K ohm 1/2 watt resistor R24: 680 ohm 2 watt resistor R25: 2000 ohm 10 watt WW resistor R26: 2000 ohm 10 watt semi-adjustable WW resistor R27: 3500 ohm 20 watt WW resistor R28: 10K ohm 20 watt WW resistor R29: 220K ohm 1 watt resistor S1: SPST switch T1: A. F. transformer, class AB2 input, plate to push-pull grids, 1:1 T2: Output transformer, 3800 ohm to multi-tap voice coil, 45 watt T3: Power transformer, 375-0-375 V 200 MA, 5V 3 A, 6.3 V 2 A T4: Power transformer, 200-0-200 V 40 MA, 5 V 2 A, 6.3 V 2 A Sockets: 8 octals, 1 4-prong</p>
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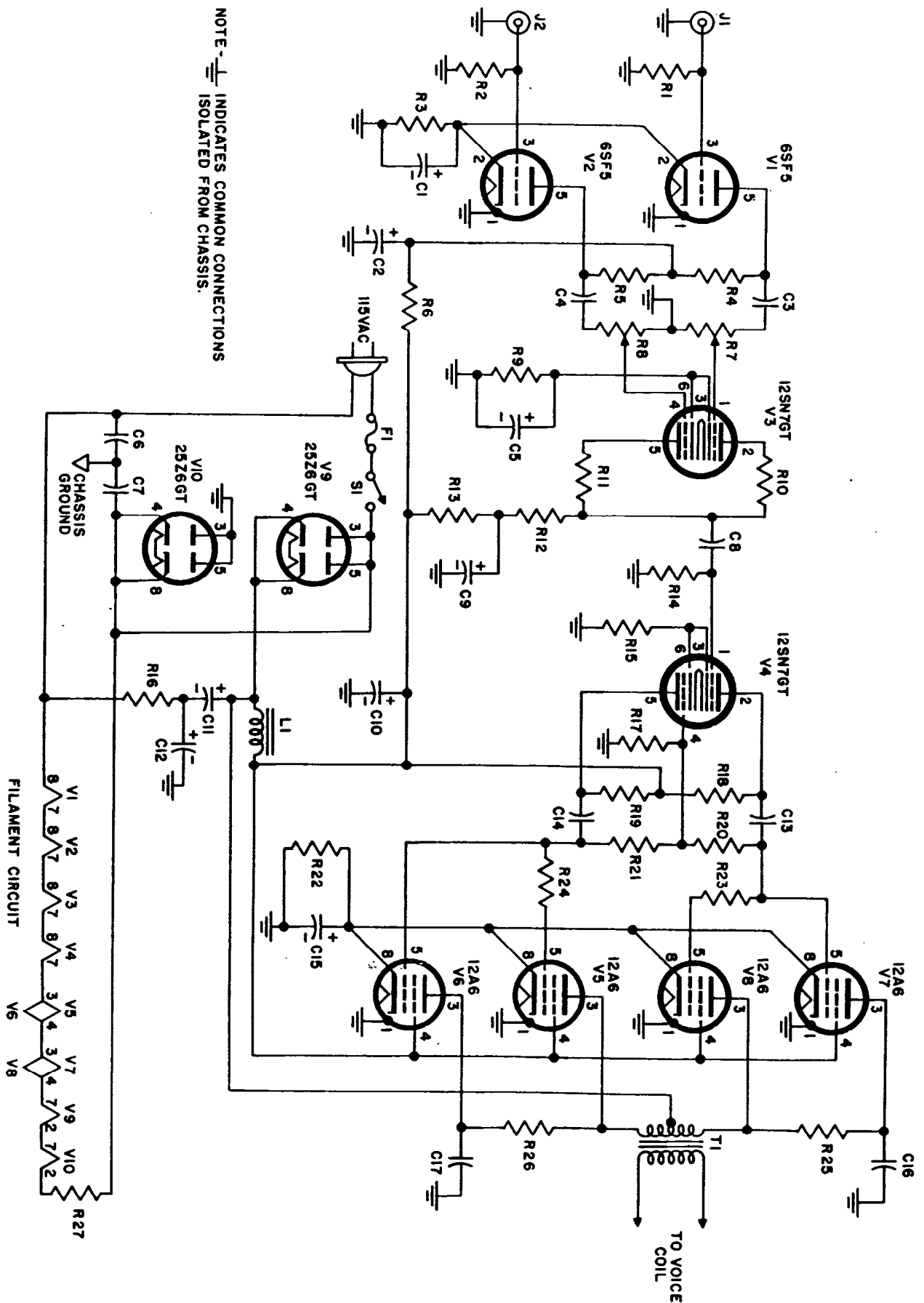
10 TUBE 15 WATT COMPACT AC P. A. AMPLIFIER

Fig. 40 is a special "transformerless" amplifier capable of 15 watts output. It features a series filament circuit and a voltage doubler rectifier to develop higher plate voltages. It has sufficient gain for high impedance microphone operation and is designed to handle two of them through an electronic mixing circuit. A low level phonograph pickup may be used in one channel if desired.

Hum is usually the most difficult problem to overcome in this type of amplifier, but if reasonable care is exercised in placing components, and if good parts are used plus provision for efficient bonding, good results should be obtained. If you desire to place the amplifier in a metal case, take necessary safety precautions so that the power line is not connected to the case at any point.

Parts List

<p>C1, C5, C15: 25 mfd 25 V elec. condenser C2, C9: 10 mfd 250 V elec. condenser C3, C4, C8, C13, C14: .05 mfd 600 V paper condenser C6, C7: .02 mfd 400 V paper condenser C10: 50 mfd 250 V elec. condenser C11, C12: 30 mfd 250 V elec. condenser C16, C17: .005 mfd 600 V paper condenser F1: 5 ampere fuse and holder J1, J2: Input jack L1: Filter choke, 100 ohm 150 MA R1, R2: 1 megohm 1/2 watt resistor R3: 1800 ohm 1 watt resistor R4, R5: 270K ohm 1/2 watt resistor R6, R13: 47K ohm 1 watt resistor</p>	<p>R7, R8: 500K ohm volume control R9, R15: 2200 ohm 1 watt resistor R10, R11, R12: 220K ohm 1/2 watt resistor R14: 470K ohm 1/2 watt resistor R16: 47 ohm 1/2 watt resistor R17, R18, R19: 150K ohm 1/2 watt resistor R20, R21: 330K ohm 1/2 watt resistor R22: 750 ohm 5 watt WW resistor R23, R24: 100 ohm 1/2 watt resistor R25, R26: 47 ohm 1 watt resistor R27: 10 ohm 10 watt WW resistor S1: SPST switch T: Output transformer, 5000 ohm to voice coil, 15 watt Sockets: 10 octals</p>
--	---



NOTE -  INDICATES COMMON CONNECTIONS
 ISOLATED FROM CHASSIS.

FIG. 40

11 TUBE 75 WATT AC P. A. AMPLIFIER

This last A.F. amplifier (Fig. 41) is a high power, high gain unit, having two microphone and two phonograph inputs, separate bass and treble tone controls, inverse feedback, and a fixed bias push-pull parallel output circuit. A 22-1/2 volt battery is used for bias purposes rather than a bias power supply. A battery so used will give long service, but periodic checks are advisable to prolong power tube life. Note the location of the tone controls. Being in the inverse feedback circuit, they serve to attenuate the amount of feedback at some frequencies more than others, giving tone control effects. It is best to mount the power supply on a separate chassis from the amplifier so as to eliminate all possibilities of coupling between them.

Parts List

C1, C2:	10 mfd 25 V elec. condenser	R15, R29, R30, R33, R34:	470K ohm 1/2 watt resistor
C3, C4, C5:	.05 mfd 600 V paper condenser	R17, R18:	220K ohm 1/2 watt resistor
C6, C7, C10, C11:	8 mfd 450 V elec. condenser	R19:	5 megohm bass tone control
C7:	.005 mfd 400 V paper condenser	R20:	1500 ohm 1 watt resistor
C8:	.25 mfd 200 V paper condenser	R21:	10K ohm treble tone control
C12, C13:	.1 mfd 600 V paper condenser	R22, R23, R24:	47K ohm 1 watt resistor
C14:	.05 mfd 400 V paper condenser	R25, R27:	47K ohm 1/2 watt resistor
C15:	20 mfd 450 V elec. condenser	R26, R28:	10K ohm 20 watt WW resistor
C16, C17:	25 mfd 575 V elec. condenser	R31:	330 ohm 2 watt resistor
F1:	5 ampere fuse and holder	R35, R36:	220 ohm 1/2 watt resistor
J1, J2:	Input jack (phonograph)	R37, R38:	100 ohm 2 watt resistor
J3, J4:	Input jack (microphone)	R39:	2000 ohm 25 watt WW resistor
L1:	Filter swinging choke, 3-30 henry 375 MA	S1:	SPST switch
L2:	Filter smoothing choke, 75 ohms 375 MA	T1:	Power transformer, 400-0-400 V 375 MA, 5 V 6 A, 6.3 V 3 A 6.3 V 4 A
P:	6.3 V indicator lamp	T2:	A.F. input transformer, class B push-pull plates to grids
R1, R2, R10, R14:	500K ohm volume control	T3:	Output transformer, 2000 ohm to multi-tap voice coil, 75 watt 9 octals, 2 4-prong 22-1/2 volt dry battery
R3, R4, R40:	1 megohm 1/2 watt resistor	Sockets:	
R5, R6, R9, R13:	270K ohm 1/2 watt resistor	Battery:	
R7, R8:	1500 ohm 1/2 watt resistor		
R11, R12, R16, R32:	100K ohm 1/2 watt resistor		

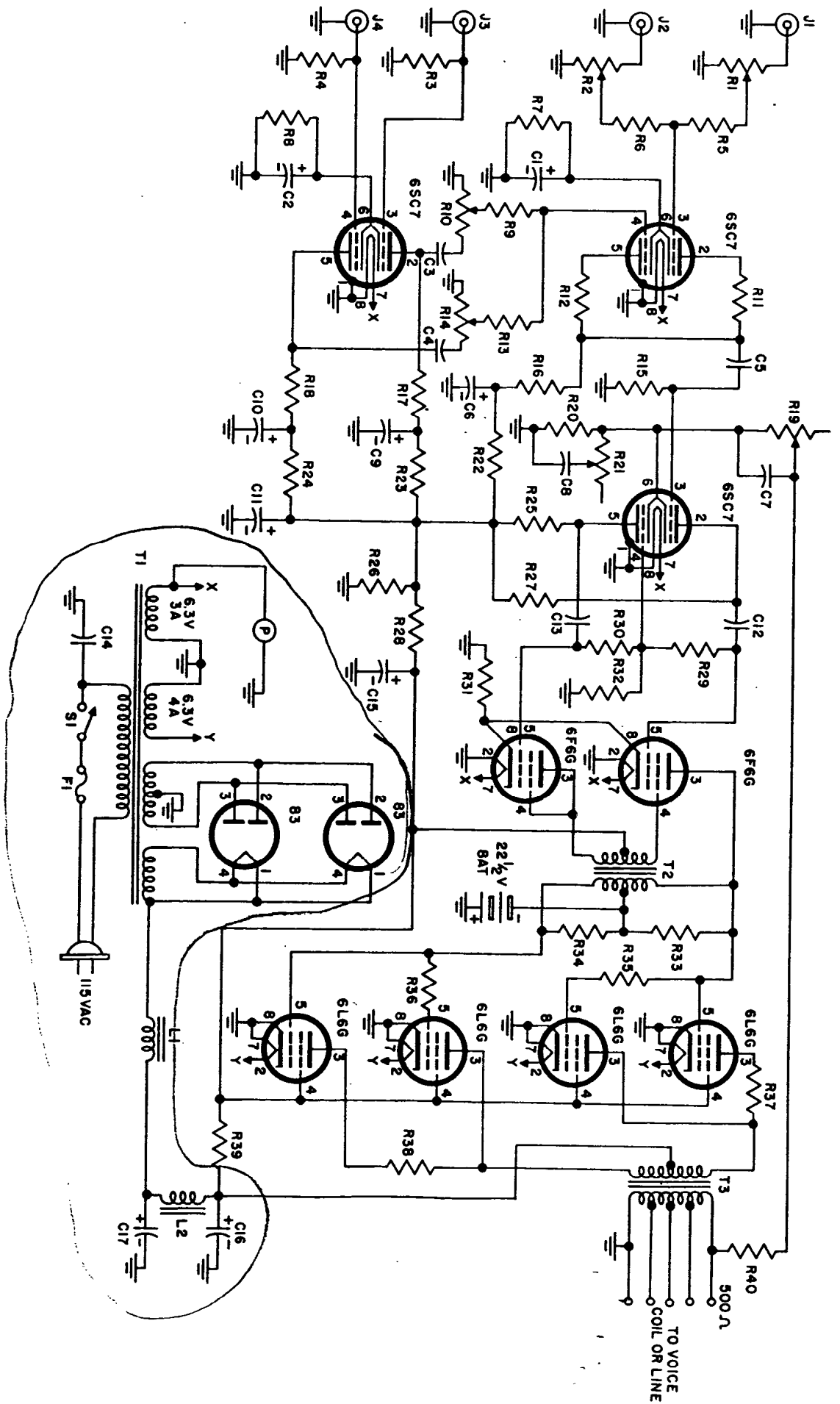


FIG. 41

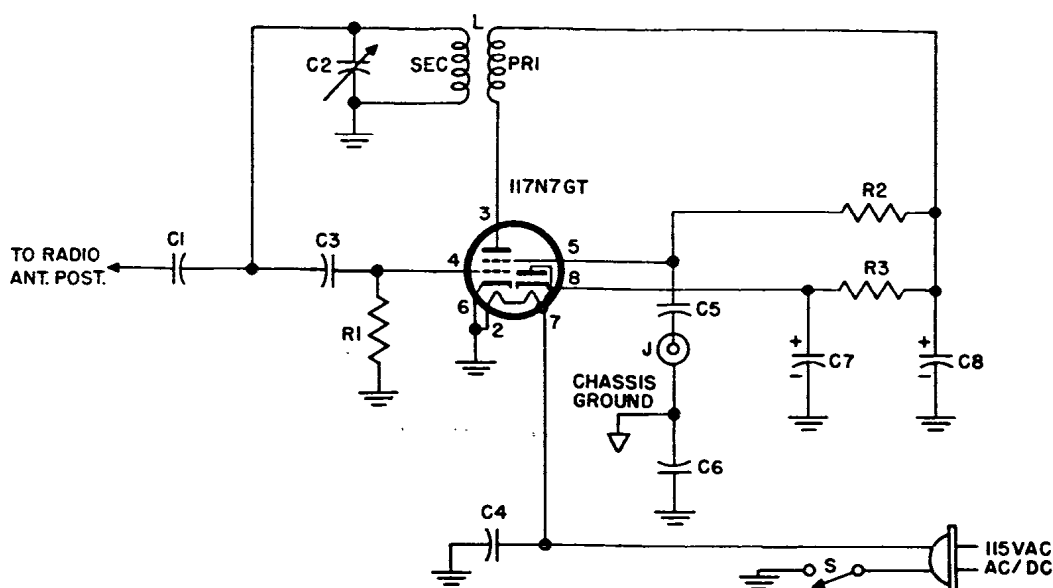
Part II.

ASSOCIATED CIRCUITS AND TESTING DATA

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1 TUBE PHONOGRAPH OSCILLATOR

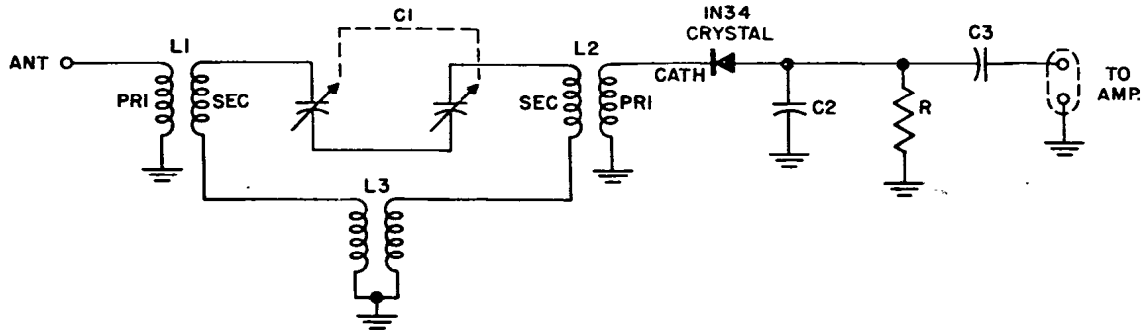


An oscillator capable of reproducing phonograph records through any radio receiver is shown. It is essentially a small broadcast transmitter capable of operation within a radius of 100 feet or so. For best results the oscillator should be built within or placed near the phonograph case, and a single wire connected to the antenna post or around the loop aerial of the nearby radio receiver. The circuit calls for fairly simple construction and only a few parts. Screen grid modulation is applied to the oscillator portion of the 117N7GT tube, thereby providing a good quality of modulation in a simple manner. Coil L is a standard broadcast oscillator coil having both a primary and secondary winding, and may be shielded or not. To operate, adjust the receiver tuning control to a clear frequency around 1500 KC, set the volume control to normal, start a record playing through the oscillator and adjust C2 for best reception through the radio receiver. If the recording cannot be received anywhere on the dial try reversing the connections to either winding of coil L.

Parts List

- | | |
|--|--|
| <p>C1: 50 mfd mica condenser</p> <p>C2: 100 - 400 mmfd trimmer condenser</p> <p>C3: 100 mmfd trimmer condenser</p> <p>C4, C5, C6: .01 mfd 400 V paper condenser</p> <p>C7, C8: 20 mfd 150 V elec. condenser</p> <p>J1: Phonograph input jack</p> | <p>L: Broadcast oscillator coil</p> <p>R1: 1 megohm 1/2 watt resistor</p> <p>R2: 3 megohm 1/2 watt resistor</p> <p>R3: 3000 ohm 2 watt resistor</p> <p>S: SPST switch</p> <p>Socket: 1 octal</p> |
|--|--|

CRYSTAL BROADCAST TUNER

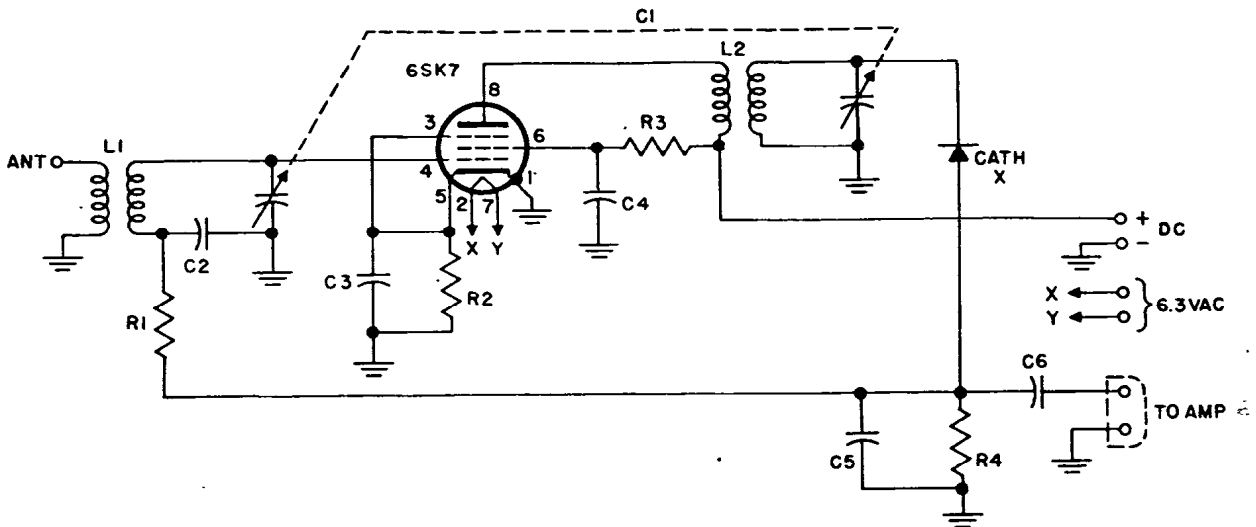


Presented here is a small crystal-detector type broadcast tuner especially desirable for the city dweller desiring high quality reception from one or two local broadcast stations. It can be built into or close to a good high-fidelity amplifier, and when connected to a good aerial will provide remarkably fine results from the more powerful stations. Tuning is fairly broad so no condenser tracking problem should arise. Coils L1 and L2 may be alike with L2 connected in reverse of the usual direction. Coil L3 may be purchased or constructed of a few turns of wire on each winding, and the windings close wound on a 3/4 inch form. For best selectivity the coils should all be shielded. Any type of germanium, silicon or galena crystal may be substituted for the 1N34 crystal shown.

Parts List

- | | |
|--|--------------------------------------|
| C1: 2-gang variable condenser,
365 mmfd per section | L2: Antenna broadcast coil |
| C2: 100 mmfd mica condenser | L3: Negative mutual
coupling coil |
| C3: .01 mfd 200 V paper condenser | R: 470K ohm 1/2 watt
resistor |
| L1: Antenna broadcast coil | |

1 TUBE BROADCAST TUNER

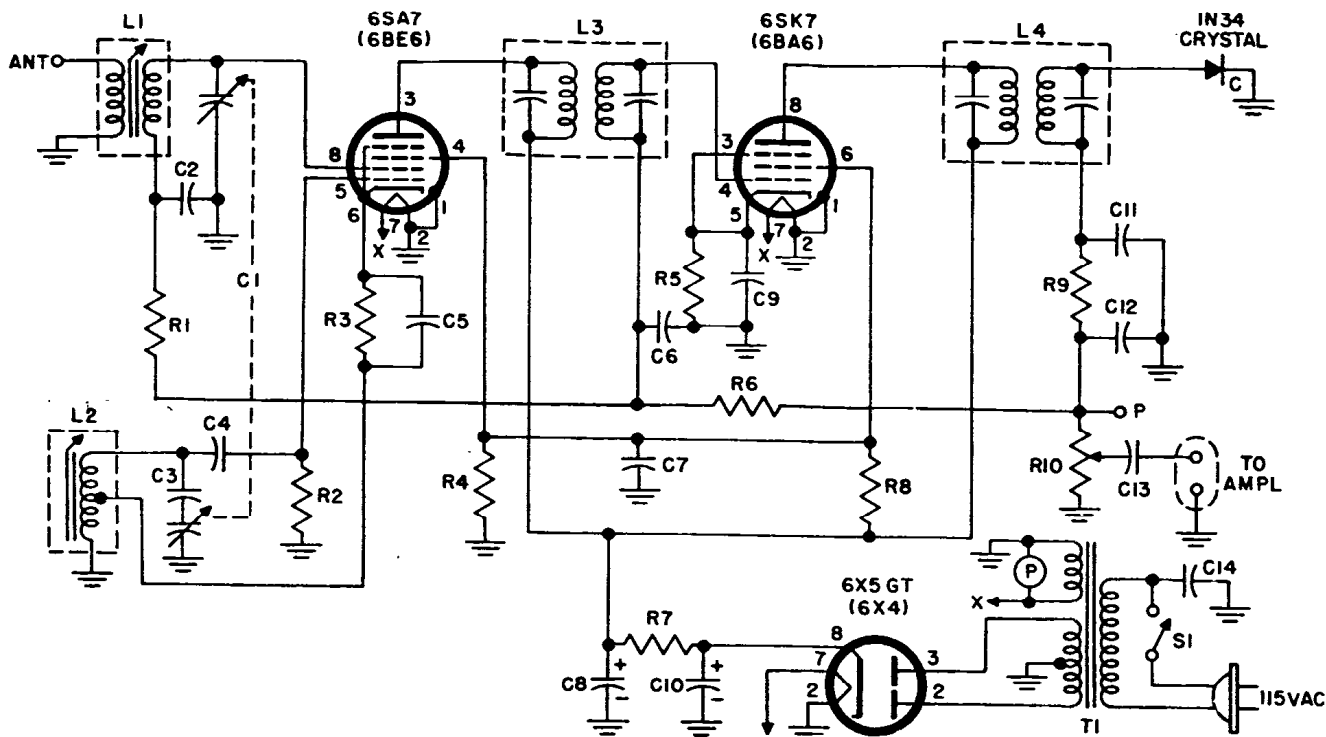


A comparatively simple method of converting an existing A.F. amplifier to include a radio tuner for broadcast reception is this one tube circuit. It consists of a tuned radio frequency amplifier having a 6SK7 tube, and a tuned detector stage having a 1N34 germanium crystal. The detector provides limited automatic volume control voltages to the 6SK7 tube which is developed across R4. The filament and plate voltages for the tube are supplied by the attached amplifier, as almost any AC powered amplifier can supply the additional 6.3 volts AC at 0.3 ampere and 100 to 250 volts DC at 5 milliamperes. The output of the tuner can be fed into the amplifier at medium level (such as the phonograph jack) when receiving local stations. Selectivity and sensitivity of this tuner will depend largely upon the quality of the coils used and the accuracy of the 2-gang condenser tracking. See section on "Tuner Alignment" for help in initially aligning the newly constructed tuner. Best results will be obtained if only four or five stations are located in the immediate area, and if the aerial length is limited to about 50 feet.

Parts List

- C1: 2-gang variable condenser, 365 mmfd per section, with trimmers
- C2, C3, C4, C5, C6: .01 mfd 400 V paper condenser
- L1: Antenna broadcast coil
- L2: RF broadcast coil
- R1, R4: 1 megohm 1/2 watt resistor
- R2: 390 ohm 1/2 watt resistor
- R3: 68K ohm 1/2 watt resistor

3 TUBE BROADCAST TUNER

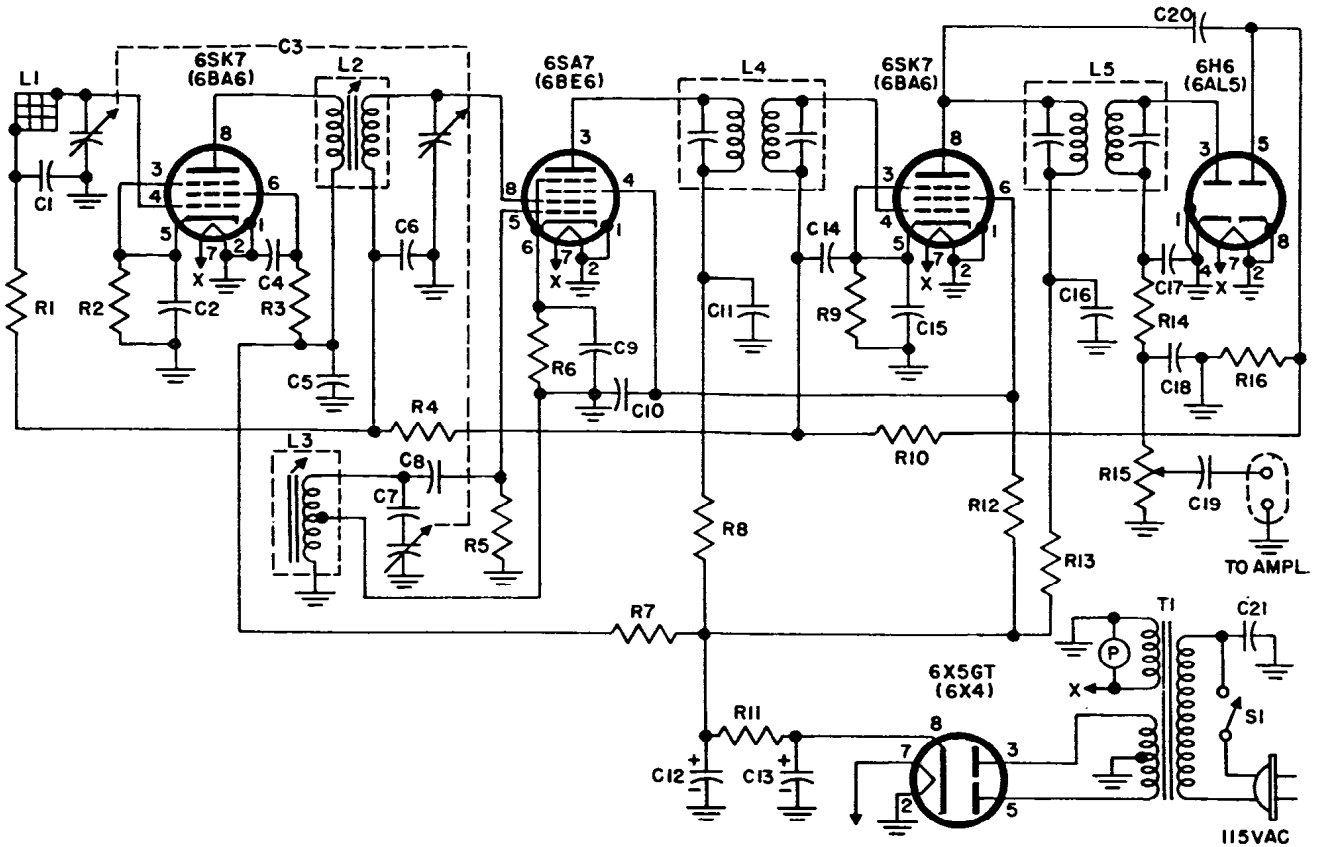


A reliable and efficient broadcast tuner having very good sensitivity, selectivity and volume is the self-powered super-heterodyne circuit shown above. By carefully following the schematic diagram and planning the parts layout for short lead lengths, good results may be expected both on selectivity between crowded local stations and sensitivity for receiving weak distant stations. The use of the germanium diode (1N34 or 1N34A as a second detector eliminates the need of a tube for this position (watch polarity when connecting in place). If a special two-gang superheterodyne tuning condenser having a smaller oscillator section is obtained, condenser C3 may not be necessary. For balancing the tuner follow the procedure under "Tuner Alignment".

Parts List

- | | |
|---|--|
| <p>C1: 2-gang variable condenser, 365 mmfd per section, with trimmers</p> <p>C2, C6: .05 mfd 200 V paper condenser</p> <p>C3: 400 mmfd 1% padder condenser</p> <p>C4: 50 mmfd mica condenser</p> <p>C5, C9, C14: .01 mfd 400 V paper condenser</p> <p>C7, C13, C10: .01 mfd 600 V paper condenser</p> <p>C8: 20 mfd 450 V elec. condenser</p> <p>C11, C12: 100 mmfd mica condenser</p> <p>L1: Antenna broadcast coil, iron core, shielded</p> <p>L2: Oscillator broadcast coil, tapped, iron core, shielded</p> <p>L3: Input IF coil, 456 KC, shielded</p> <p>L4: Output IF coil, 456 KC, sh'ld</p> | <p>P: 6.3 V dial light</p> <p>R1: 100K ohm 1/2 w. resistor</p> <p>R2: 22K ohm 1/2 w. resistor</p> <p>R3: 270 ohm 1/2 w. resistor</p> <p>R4: 100K ohm 1 w. resistor</p> <p>R5: 390 ohm 1/2 w. resistor</p> <p>R6: 2.2 megohm 1/2 w. resistor</p> <p>R7: 33K ohm 1 w. resistor</p> <p>R8: 2200 ohm 2 w. resistor</p> <p>R9: 10K ohm 1/2 w. resistor</p> <p>R10: 500K ohm volume control</p> <p>S1: SPST switch</p> <p>T1: Power transformer, 300-0-300 V 50 MA, 6.3 V 1.5 A</p> <p>Sockets: 3 octals (or min. 7)</p> |
|---|--|

5 TUBE BROADCAST TUNER



Here is a very selective and sensitive broadcast tuner especially useful in crowded metropolitan areas. Due to its high selectivity, the tone quality may be lacking in the higher audio frequencies, consequently after alignment slightly stagger the IF trimmer condensers for tone improvement. More care than usual in locating parts is necessary because of the higher gain and greater number of tuned circuits. However, adequate filtering is provided to keep RF coupling at a minimum. A loop aerial is shown for signal pickup thereby requiring no outside aerial.

Parts List

- | | | |
|-----------------------------------|-------------------|--------------------------|
| C1, C6, C14: | L5: | Output IF coil, 456 KC |
| .05 mfd 200 V paper condenser | P: | 6.3 V dial light |
| C2, C9, C15, C21: | R1, R4: | 100K ohm 1/2 w. resistor |
| .01 mfd 400 V paper condenser | R2: | 390 ohm 1/2 w. resistor |
| C3: 3-gang variable condenser 365 | R3, R5, R12, R14: | 47K ohm 1/2 w. resistor |
| mmfd per section with trimmer | R6: | 270 ohm 1/2 w. resistor |
| C4, C5, C10, C11, C16, C19: | R7, R8, R13: | 1000 ohm 1/2 w. resistor |
| .01 mfd 600 V paper condenser | R9: | 470 ohm 1/2 w. resistor |
| C7: 400 mmfd 1% padder condenser | R10, R16: | 1 megohm 1/2 w. resistor |
| C8: 50 mmfd mica condenser | R11: | 1500 ohm 2 w. resistor |
| C12, C13: | R15: | 500K ohm volume control |
| 20 mfd 450 V elec. condenser | S1: | SPST switch |
| C17, C18, C20: | T1: | Power transformer |
| 100 mmfd mica condenser | | 300-0-300 V 50 MA, |
| L1: Loop antenna, high-impedance | | 6.3 V 2 A |
| type, for broadcast coverage | Sockets: | 5 octal (or miniature |
| L2: RF coil, iron core, shielded | | 7-pin) |
| L3: Oscillator broadcast coil, | | |
| tapped, iron core, shielded | | |
| L4: Input IF coil, 456 KC, sh'ld | | |

TUNER ALIGNMENT

There are many methods of receiver alignment, some using elaborate testing equipment and some the more simple varieties. In general, alignment accuracy will depend upon the accuracy of the equipment used; signal generators, voltmeters, etc. However, in the absence of more elaborate test equipment the following brief procedure can be followed in the alignment of the tuners described.

The crystal and one tube broadcast tuners can be aligned without the aid of any testing apparatus as follows. Tune in a station at the high frequency end of the dial (condenser plates open) and adjust both trimmers for best volume and selectivity. Tracking should be fairly good over rest of the dial.

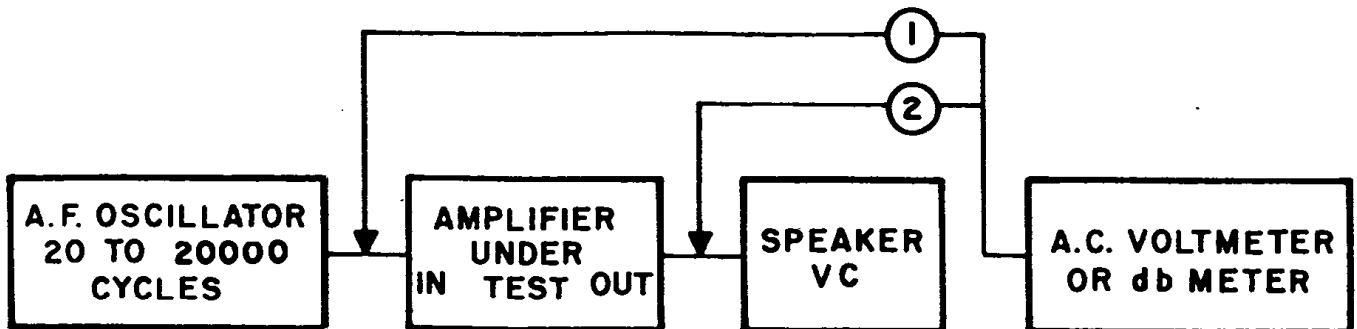
The three and five tube broadcast tuners should use alignment equipment consisting of a signal generator and a DC vacuum tube voltmeter (VTVM). Follow this procedure.

1. Connect signal generator to control grid (terminal 8) of 6SA7 tube through a .01 mfd condenser and turn modulation off. Connect VTVM between test point P and ground (with positive lead grounded).
2. Set signal generator frequency to 456 KC and adjust all IF coil trimmers for maximum VTVM output, holding generator output voltage as low as possible.
3. Connect signal generator to antenna post through a 100 mmfd condenser (if loop aerial used connect to grid of RF tube) and leave modulation off. VTVM should be connected as in step 1.
4. Set signal generator frequency to 1500 KC and turn dial also to 1500 KC. Adjust oscillator trimmer to maximum VTVM output. Adjust all RF trimmers for maximum output.
5. Reset frequency generator frequency to 600 KC and turn dial also to 600 KC. Adjust oscillator core adjustment to maximum VTVM output. Adjust RF core adjustment for maximum output also.
- 6 Repeat steps 4 and 5 until good tracking is obtained over dial.

The seven tube frequency modulation tuner will require a signal generator having a top frequency range of 108 mc.

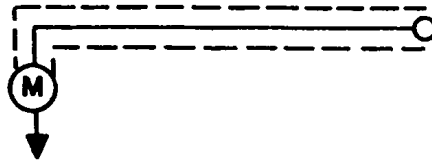
1. Connect signal generator to control grid (terminal 1) of mixer tube through a 100 mmfd condenser. Connect VTVM between test point P and ground (with positive lead grounded).
2. Set signal generator frequency to 10.7 mc and adjust primary and secondary cores of L3, L4, and L5 for maximum VTVM output.
3. Connect VTVM between terminal 1 of 6AL5 tube and ground. Adjust the discriminator secondary core for zero VTVM output. Adjust the discriminator primary core for maximum and equal deviation as the signal generator frequency is varied from 10.5 to 10.9 mc.
4. Connect signal generator to antenna post through a very small coupling condenser. Reconnect VTVM as in step 1.
5. Set signal generator frequency to 108 mc and condenser gang full open. Adjust oscillator trimmer to maximum VTVM output. If two indications are received choose the one on the higher dial setting. Adjust mixer trimmer for maximum VTVM output

MEASUREMENT OF FREQUENCY RESPONSE (FIDELITY)



1. Connect meter to output of oscillator (connection -1), vary oscillator frequency over range and record at regular intervals, including at 1000 cycles, the output voltage indicated.
2. Reconnect meter to speaker voice coil (connection -2), adjust amplifier gain control for same output voltage at 1000 cycles as in previous reading, and vary oscillator over same range as previously, recording the output voltages indicated.
3. Differences in output readings between steps 1 and 2 can be translated into db's for an accurate picture of the fidelity of the amplifier.

MICROPHONES



There are five types of microphones in common use today. Carbon, Condenser, Crystal, Dynamic and Velocity microphones. The carbon, dynamic and velocity types are essentially low impedance devices, and to connect them to a high impedance source, a transformer is used. This transformer is either contained in the microphone case or in the amplifier unit. Where the transformer is external to the microphone case, long lines may be run between the microphone and the amplifier with very little loss. If a high impedance matching transformer is contained in the microphone case, or in the case of the Crystal and Condenser microphones, only about 25 or 30 feet of cable can be used without affecting the fidelity of the entire unit.

The carbon microphone is the most sensitive type of all; its voltage output, especially at voice frequencies, is the greatest. Nevertheless it has the disadvantage of being noisy in operation and has the poorest frequency response curve. It also requires an external source of "button" current to operate correctly which is not convenient for the ordinary requirements of public address work.

The velocity microphone is the least sensitive of all types but has best frequency response. In using a velocity microphone care must be taken not to speak directly into it. A minimum distance of 8 inches should be maintained by the person speaking into it.

The crystal microphone has good frequency response, but because of its fragility, caution must be exercised in its handling. Care must also be taken with regard to its operation in high temperatures and high humidity.

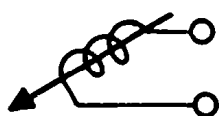
The condenser microphone is an old type which has recently been revived in modern dress. It is essentially an electrostatic device with an inherent tendency to be unstable.

The dynamic microphone is the sturdiest type of all, and if well constructed, has the advantage of ruggedness combined with good response. It is probably the best all-around microphone for public address work.

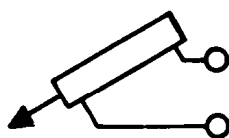
Another type of microphone used specially in intercommunication systems is the ordinary permanent-magnet type speaker (a form of dynamic microphone). By means of switching, this speaker can be connected into the input or output of an amplifier, making its application quite satisfactory as well as convenient.

In all cases, when connecting the microphone to the amplifier, it is advisable to use low capacity shielded cable; otherwise hum may be picked up in the line or the frequency response may be poor.

PHONOGRAPH PICKUPS



MAGNETIC



CRYSTAL

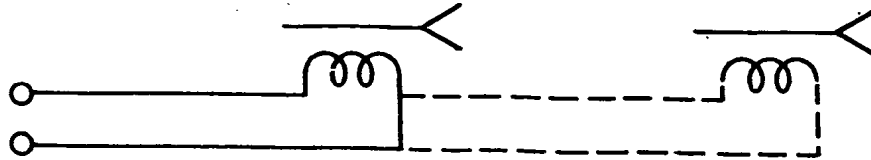


**VARIABLE
RELUCTANCE**

Of the many methods of converting recorded sound on disc to corresponding electrical impulses, the field seems to have narrowed to one of the three diagrammed forms; magnetic, crystal and variable reluctance type pickups. The magnetic pickup, if of good quality, has excellent frequency characteristics and a low impedance output making it ideal for studio uses. Its disadvantages are its relative expensiveness and the need of precise balancing due to its heavy magnetic head. By far the most used phonograph pickup today is the crystal type. It is designed to develop a voltage proportional to stylus movement, and in a high quality crystal cartridge this voltage will average about 1/2 volt and a frequency top of about 10000 cycles. The crystal cartridge however is very fragile, particularly in high temperature ambients. It will not stand much mechanical abuse and will fracture in almost every case if DC voltages are applied across its leads. The variable reluctance pickup is a form of magnetic pickup without the encumbering steel magnet assembly. Its output varies with the square of the frequency of the stylus movement, consequently a frequency filter must be built into its output circuit to compensate for the voltage per frequency buildup. The output of the compensated variable reluctance pickup has excellent frequency response, low gain and low noise level.

Going back once more to the crystal type pickup, it is advisable to use the pickup as close as possible to the amplifier, in order not to lose the higher frequencies. These pickups generally have a tendency to overaccentuate the higher frequencies sometimes to the extent of reproducing noise above the recording frequency level. It is best to put a "compensating" filter usually consisting of a 100,000 ohm resistor in series with a .001 mfd condenser across the output of the pickup in such cases.

SPEAKERS



For proper output and fidelity matching the speakers to the output transformer is very important. Most cone speakers are marked as to their impedance, but if not, one can assume an 8 ohm voice coil for speakers having a six inch diameter and larger cone, and 2 ohms for five inch and smaller cones.

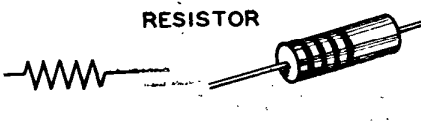
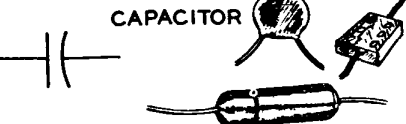
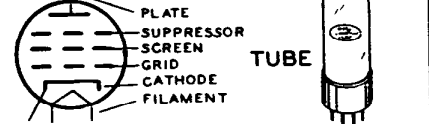
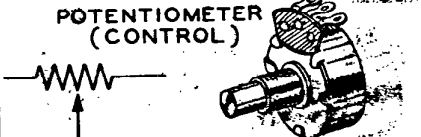

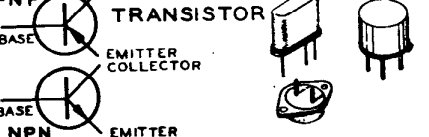

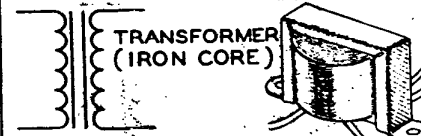

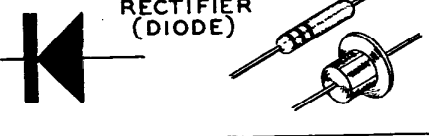
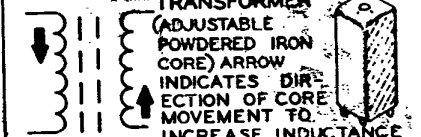
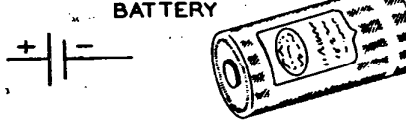
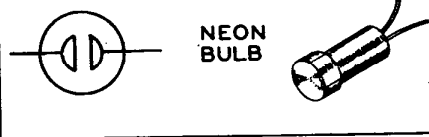
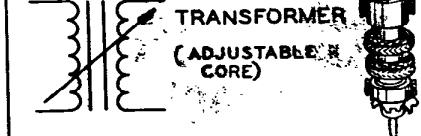
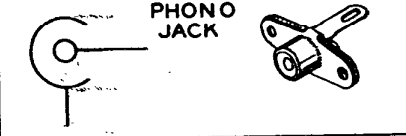
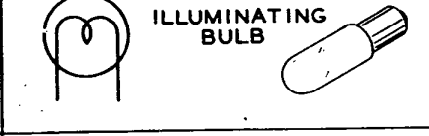
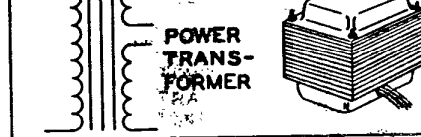

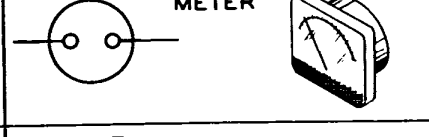
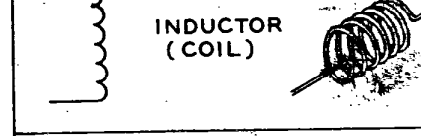
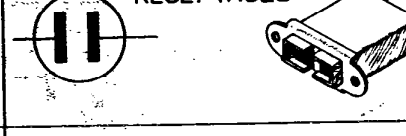
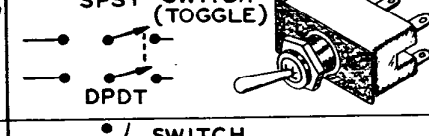
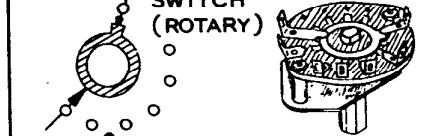
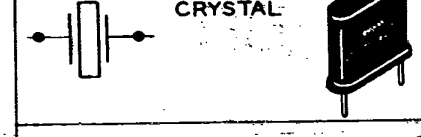
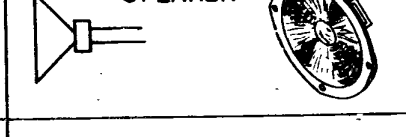

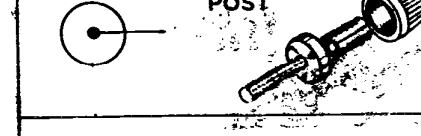
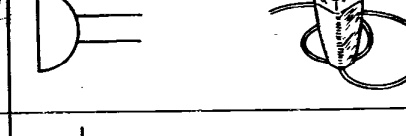
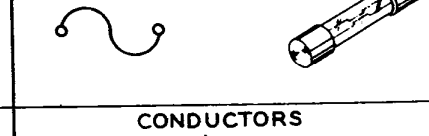






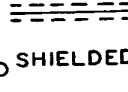
Matching is equally important if two or more equivalent speakers are used. For example, to parallel two 8 ohm speakers they should be matched to a 4 ohm output transformer; in series the two 8 ohm speakers should be matched to a 16 ohm transformer. For multiple speaker use it is important that all units are in phase; that is, the instantaneous excursions of the cones are all in the same direction. A simple method of phasing is to connect a 1-1/2 volt dry cell to each voice coil in turn, noting the direction of cone movement at the instant of contact. With the voice coil leads oriented so that all cones move in the same direction, the speakers then are all in phase.

Most of the speakers indicated for use in the amplifier diagrams are cone type permanent-magnet speakers. These are low impedance types having strong magnets for field supply. These speakers require only two wire leads to connect to the voice coils. The leads need not be shielded, and for long lines, AC type lamp cord or equal can be ideally used. Another type of cone speaker is the dynamic speaker consisting of an electromagnet-type field coil in place of the magnet. This field coil requires a direct current through the coil to properly energize; the amount of current required depending upon the required magnetic flux, which in turn is dependent upon the power requirements of the speaker. This current may be furnished by the amplifier if so designed. A few examples are shown in the amplifier diagrams.

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations

should prove helpful in identifying most parts and reading the schematic diagrams.

<p style="text-align: center;">RESISTOR</p> 	<p style="text-align: center;">CAPACITOR</p> 	<p style="text-align: center;">TUBE</p> 
<p style="text-align: center;">POTENTIOMETER (CONTROL)</p> 	<p style="text-align: center;">ELECTROLYTIC CAPACITOR</p> 	<p style="text-align: center;">PNP TRANSISTOR</p>  <p style="text-align: center;">NPN TRANSISTOR</p> 
<p style="text-align: center;">TRANSFORMER (IRON CORE)</p> 	<p style="text-align: center;">VARIABLE CAPACITOR</p> 	<p style="text-align: center;">RECTIFIER (DIODE)</p> 
<p style="text-align: center;">TRANSFORMER (ADJUSTABLE POWDERED IRON CORE) ARROW INDICATES DIRECTION OF CORE MOVEMENT TO INCREASE INDUCTANCE</p> 	<p style="text-align: center;">BATTERY</p> 	<p style="text-align: center;">NEON BULB</p> 
<p style="text-align: center;">TRANSFORMER (ADJUSTABLE CORE)</p> 	<p style="text-align: center;">PHONO JACK</p> 	<p style="text-align: center;">ILLUMINATING BULB</p> 
<p style="text-align: center;">POWER TRANSFORMER</p> 	<p style="text-align: center;">PHONE JACK</p> 	<p style="text-align: center;">METER</p> 
<p style="text-align: center;">INDUCTOR (COIL)</p> 	<p style="text-align: center;">RECEPTACLE</p> 	<p style="text-align: center;">SPST SWITCH (TOGGLE)</p>  <p style="text-align: center;">DPDT</p> 
<p style="text-align: center;">PIEZOELECTRIC CRYSTAL</p> 	<p style="text-align: center;">SPEAKER</p> 	<p style="text-align: center;">SWITCH (ROTARY)</p> 
<p style="text-align: center;">BINDING POST</p> 	<p style="text-align: center;">MICROPHONE</p> 	<p style="text-align: center;">FUSE</p> 
<p style="text-align: center;">ANTENNA</p> <p style="text-align: center;">GENERAL  LOOP </p>	<p style="text-align: center;">EARTH GROUND</p>  <p style="text-align: center;">CHASSIS GROUND</p> 	<p style="text-align: center;">CONDUCTORS</p> <p style="text-align: center;">NOT CONNECTED  CONNECTED  SHIELDED </p>