

HIGH FIDELITY AMPLIFIER

MODEL
HF-20

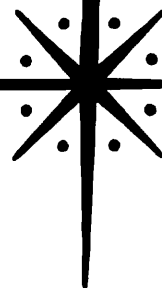


EICO

INSTRUCTION

MANUAL

HF 20-1



ELECTRONIC INSTRUMENT CO. INC.
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MODEL HF20

HIGH FIDELITY AMPLIFIER

The EICO Model 20 is the result of a program aimed at bringing together in one integrated unit the finest pre-amplifier control, and power amplifier circuitry. Please read the following instructions before installing or using the amplifier, particularly if you are not thoroughly familiar with equipment of this type. You will learn how to install the amplifier properly and how the controls and facilities should be used to obtain the best results.

You may skip over the installation section if your amplifier is installed by a competent technician, but this section contains important specific instructions and a mounting template which should be made available to the person performing the installation. In any case, it is important that this manual be retained since it contains essential servicing information which will be needed by any person who undertakes to service the amplifier.

DESCRIPTION

The Model 20 consists of a high quality preamp-equalizer and control section plus a 20 watt Ultra-Linear Williamson type power amplifier. Details are as follows:

THE PREAMPLIFIER-EQUALIZER CIRCUIT possesses extremely low distortion due to equalization entirely by feedback—it was chosen deliberately because of its ability to match the low-distortion performance of the Ultra-Linear Williamson-type amplifier circuit. It has a balanced selection of equalizations which, together with the wide-range bass and treble tone controls, permits correct compensation for practically any microgroove or 78 recording characteristic, foreign or domestic.

FOUR HIGH LEVEL INPUTS AND 2 LOW-LEVEL INPUTS (1 switch position) enable the #20 to accommodate TV, tape recorder, AM-FM tuner, and crystal cartridge (or separate AM and FM tuners), as well as any leading magnetic or FM pickup without the necessity of component changes. A low impedance, logically-placed tape output jack is a valuable convenience for those owning or planning to own a tape recorder.

THE BASS AND TREBLE TONE CONTROLS are of the new feedback type for exceptionally low distortion and wide frequency range. They do not affect the volume or interact with each other—providing the easiest possible control settings. As turnover on both ends varies with the amount of boost and attenuation, boost or cut at the extremes of the audio range is possible without affecting the mid-range.

THE LOUDNESS CONTROL, a Centralab Compentrol, raises or lowers volume in strict accordance with the accepted Fletcher-Munson ear-response curve. Operation together with front panel level control provided is widely held as one of the most flexible and sensible arrangements.

THE POWER AMPLIFIER: The power amplifier in the #20 is of the Ultra-Linear Williamson type. Its superb performance characteristics are augmented by the high-quality output transformer, which is conservatively rated at 25 watts.

SPECIFICATIONS

Power Output: 20 watts (34 watts peak)

IM Distortion (60 & 6000 cps/4:1, 20W): 1.3%

Mid-Band Harmonic Distortion (20W): 0.3%

Power Response (20W) +0, -1 db 20 to 20,000 cps
+0, -3 db 10 to 40,000 cps

Frequency Response (1/4W): +0, -1 db 13-35,000 cps
+0, -3 db 7-50,000 cps

Damping Factor: 7:1

Inverse Feedback: 14 db

Speaker Connection Taps: 4, 8, and 16 ohms

Tone Controls: Bass: 15 db boost or cut at 50 cps
Treble: 15 db boost or cut at 10 kc

Phono Equalizations: RIAA, Columbia, London, European 78, American 78.

Sensitivity: Mag. Phono — 0.004 V rms (at 1 kc)
for 20W output
Tuner, etc. — 0.4 V rms for 20W output

* **Hum & Noise:** Mag. Phono** — 60 db below 20W
Tuner, etc. — 75 db below 20W

** Includes 16 db boost at 60 cps due to RIAA compensation.

* Maximum gain and tone controls set at flat positions.

Power Line Requirements: 105-125 volts, 50/60 cps AC only

Power Consumption: 100 watts

Size: 8 1/2" high, 15" wide, 10" deep

Weight: 24 lbs.

INSTALLATION

1. GENERAL FACTORS

a) **HEAT DISSIPATION (VENTILATION):** In common with other electronic equipment, the Model 20 produces a great deal of heat in normal operation. Unless continuous and adequate air flow is obtained around the heat producing elements, these elements will over-heat and their useful life will be greatly curtailed.

It is useful to understand the process of convection whereby heat is removed in judging the suitability of a location. Air heated by the heat-producing elements expands and rises; cool air is drawn from beneath to take the place of the heated air. In this manner, a stream of air is set in motion which continually removes heat from the amplifier. (In particular, we are mainly concerned with the major heat-producing elements; the two 6L6GB output tubes and the 5U4GB rectifier tube.) If there is any impediment to or constriction of the air flow, the essential process of heat removal will be adversely affected.

Adequate ventilation will be provided if the amplifier is installed in an open-back console provided that the top of the amplifier is spaced at least two inches below any shelf mounted above it. If the cabinet is enclosed at the rear, provide several large holes or slots as low down and as high up in the cabinet back as possible. As an alternate, holes may be provided in the sides, bottom, or top of the cabinet. The important thing to remember is that effective ventilation requires provision for cool air to enter at the bottom and hot air to leave at the top.

If the amplifier is not installed in a console, it should be situated preferably on an open surface, not on a shelf of a bookcase. An attractively finished matching cover for the Model 20 is available which will provide a "finished" appearance as well as protection when the amplifier is not installed in a console. Four rubber feet are also provided so that the amplifier will not mar the surface of furniture on which it is placed.

b) **EASY ACCESS TO CONTROLS:** Mount the amplifier at a height which will permit easy manipulation of the controls. Tuner controls should be located nearby.

c) **ACCESSIBILITY TO PARTS:** Tubes are the most frequently replaced items in electronic equipment. If the amplifier is installed in a console, sufficient space should be allotted to reach and remove any tube in the amplifier. Furthermore, input and output terminals of the amplifier should be accessible to permit easy interchanging of system components for comparison, and connection or disconnection of a portable tape recorder which is stored away when not in use. If antennas are strung around the back of the console in which the amplifier is installed, arrange them so they will not interfere with access to the amplifier.

d) **ACOUSTICAL ISOLATION:** If amplifier and speaker are installed in the same cabinet (not recommended), provide sufficient separation to minimize mechanical speaker vibration reaching the amplifier. The minimum separation is about one foot.

1. CHASSIS MOUNTING IN CONSOLE

a) Operations on console front panel preliminary to amplifier mounting: (1) Tape the panel template provided to the face of the console so that the top of the mounting surface line on the template is level with the top of the amplifier mounting shelf. (2) Use an awl or a nail to

pierce the centers of the five 5/8" diameter holes for the controls and the two small holes for mounting the control plate, to transfer their locations to the console panel beneath. (3) Remove the panel template. (4) Drill the holes for the panel controls only (the two small holes which have been marked are for wood screws).

b) Amplifier mounting in console: (1) Pull off the control knobs (a second set of knobs with long shanks has been provided for console installation). (2) Remove the control plate, which is attached to the chassis apron by two screws. (These may be discarded since they are unsuitable for attaching the control plate to the console panel and two #4 X 3/8 wood screws have been supplied for this purpose.) (3) Fasten the control plate to the console panel with the 2 #4 X 3/8 wood screws. (4) If the rubber feet have been inserted in the bottom plate, remove them. (They may be pried out with a thin screwdriver.) (5) Place the unit on the mounting shelf and slide it as far forward as possible, so that the controls penetrate the panel holes as far as possible. (6) Place a long shank knob on each control, pressing each knob toward the chassis firmly so that each control shaft enters fully into its knob. (7) Draw the chassis back evenly and carefully until the back rims of all the knobs are equally spaced from the control plate about 1/8". (8) With a sharp pencil, placed with its point directly against the edge of the lower surface of the bottom plate, draw the outline of the bottom plate on the chassis shelf. (9) Now remove the knobs and take the chassis off the shelf. (10) Remove the 8 screws which fasten the bottom plate to the chassis. (11) Place the bottom plate exactly in the outline drawn on the shelf (bumps facing up) and mark the positions of the two holes on the left side and the two holes on the right side. (12) Remove the bottom plate and drill each of the marked holes on the shelf to a diameter of 1/4". (13) Refasten the bottom plate to the chassis, with the 4 #8 X 3/8 screws previously removed, using the 2 holes at the rear and the 2 holes at the front of the chassis. (14) Replace the chassis on the shelf, positioning it exactly in the outline previously drawn, and restore the knobs. This time make sure that the indicator dot on each knob agrees with the control position. (15) From the bottom side of the shelf, insert a #8 X 1" screw with a 1/2" flat washer against the head through each of the four left and right side holes. These screws engage the stamped nut over each hole on the chassis flange and when tightened secure the chassis to the shelf.

2. ELECTRICAL CONNECTIONS

a) **SPEAKER CONNECTIONS:** To connect your speaker to the amplifier properly, you must know its rated impedance. This may be read off the speaker nameplate. Connect one speaker lead to the terminal on the rear apron marked "G" and the other speaker lead to the nearby terminal designated by the rated speaker impedance (4, 8, or 16 ohms). Plastic-covered lamp cord may be used for distances up to 50 ft. with little power loss. For shorter distances, TV antenna lead can be used, particularly if it is desired to run the speaker lead under a rug.

If it is desired to use two similar or identical full-range speakers of the same rated impedance (either 8 or 16 ohms only) for better sound distribution, connect one speaker lead of each pair to "G" and the two remaining leads to the terminal with a number equal to half of one of the speaker's rated impedance. (It may be necessary to "phase" the two speakers by reversing both of the leads from one of the speakers.) This may not be done if each of the speakers is designed for reproduction of a different part of the audio spectrum (woofer-tweeter combinations) in which case a cross-over network is required which connects to the amplifier with only one pair of leads.

b) PHONO INPUT: The shielded lead from your phonograph should be provided with a shielded "phono-type" plug. The input jack on the amplifier into which this plug should be inserted depends on the type of cartridge employed. Specific instructions follow

GE Variable Reluctance or Professional, Pickering, Fairchild, Recoton, Electrosonic & transformer: Connect to PHONO INPUT 1.

Weathers FM Capacitance pickup:

Alternative 1—Use Weathers Adaptor Plug Model P-631 and connect PHONO INPUT 2.

Alternative 2—Cut the jumper shorting the 47 mmf capacitor coming off PHONO INPUT 1 jack inside the chassis (identified by red tape in wired units). Connect from the "constant amplitude" output of the Weathers oscillator unit to PHONO INPUT 1.

Audak, Ronette TO-284P; Ferranti & transformer: Connect to PHONO INPUT 2.

Ceramic or crystal cartridges that equalize for RIAA curve. Use Electro-Voice Adaptor Model 504 and connect to PHONO INPUT 2.

If an adaptor such as the Electro-Voice Model 504 is not used, a crystal or ceramic cartridge may be connected to the AUX. INPUT. The equalizer-preamplifier circuit is not effective in this case.

c) HIGH LEVEL INPUTS—Four high level input jacks designated as Tuner, TV, Tape, and Auxiliary are provided for connection of tuners, tv receivers, tape recorder playback, and ordinary or RIAA equalizing crystal or ceramic phono cartridges without adaptor. A shielded cable with a shielded "phono-type" plug should be used to connect each of these sources to the corresponding amplifier input jack. Unless the source has a low-impedance output such as a cathode follower (with which up to 50 ft. of cable can be used), use the shortest possible connection and low capacity shielded cable (cable having as low as 25 mmfd capacitance per foot is available).

If the tuner employed has a volume control to adjust the output, set this control as follows. Turn the amplifier LEVEL control to minimum and the LOUDNESS control to maximum. Play any recording on your phonograph and turn up the level control to obtain an ordinary listening level.

Without touching the LEVEL or LOUDNESS controls, turn the SELECTOR to TUNER and adjust the volume control on the tuner to obtain approximately the same loudness level as was obtained from the recording. In the case where the tuner has no output level control and also in the case of the other high level inputs, the independent LEVEL control on the front panel of the amplifier permits adjustment of the level when changing inputs.

c) TAPE OUTPUT: A shielded cable (up to 30 ft. may be used) with a shielded "phono-type" plug should be used to connect from the TAPE OUTPUT jack to the input of the tape recorder. Any input chosen by the SELECTOR is fed out to the tape recorder through this jack. Phono inputs fed in at PHONO INPUT 1 and PHONO INPUT 2 are of course equalized according to the equalization selected and all inputs are affected by the level and tone controls. The loudness control does not affect the tape output and permits adjustment of the listening level while recording.

d) POWER CONNECTIONS: The power cord of the turntable and tuner may be inserted in the convenience outlets provided on the rear chassis apron. The receptacle marked "PHONO" provides 110 volts AC regardless of whether the power switch of the amplifier is turned on or off in order to protect the turntable mechanism. The receptacle marked "TUNER" is "live" or "dead" depending on whether the amplifier power switch is turned on or off.

3. HUM ADJUSTMENT

a) After checking the amplifier for proper operation, remove all input cables to the amplifier and make the following control settings which hold throughout the process of hum adjustment: SELECTOR at RIAA, LEVEL & LOUDNESS to 10, TREBLE control at -5, BASS control at 0. Next proceed as follows: With your ear held close to the speaker, insert the amplifier power plug into the wall outlet and listen to the hum level. Now pull out the plug and re-insert it with the prongs reversed and listen again. Choose the prong position which gives the least hum. Now connect the tuner input connector to the amplifier TUNER input jack, and with tuner set between stations and the tuner volume control set at minimum, do the same with the power plug of the tuner, using the TUNER convenience outlet on the amplifier if desired. Finally connect the phono input connector to the amplifier PHONO 1 or PHONO 2 input as is required (turntable off and pickup arm at rest position) and do the same with the power plug of the turntable, using the PHONO convenience outlet on the amplifier if desired. When all of this is completed, adjust the hum balance control on top of the amplifier chassis for least hum.

OPERATION

PRELIMINARY: Be sure all tubes are firmly seated in their sockets and that the tube shields are making good contact with their bases. As initial adjustments, set these controls as follows: LEVEL at zero, LOUDNESS at ten, BASS at zero. Turn the amplifier on by turning the TREBLE control clockwise from OFF and set it at zero initially.

LISTENING TO PHONOGRAPH: Set the SELECTOR to one of the record equalization positions on the dial. Doing so automatically selects the phonograph input plugged into PHONO INPUT 1 or PHONO INPUT 2. For help in choosing the recording curve appropriate to any particular record, refer to the chart titled "RECORD EQUALIZATION SELECTION". When in doubt as to which equalization is most appropriate, use RIAA, which is the best compromise for all records. Keep in mind that while the positions offered cover most recording curves likely to be encountered, additional separate and variable bass and treble response adjustments are necessary for fully satisfactory results. These may be necessary to compensate for the over-all characteristics of your audio system (including room acoustics), inexact matching of the actual recording characteristic by any of the equalizations provided, and, above all, the particular tastes of the listener.

LEVEL & LOUDNESS CONTROLS: Simply stated, the purpose of the LOUDNESS control is to provide compensation for the increasing inefficiency of the human ear in hearing bass and treble with decreasing volume level. The LOUDNESS control, as it is turned counter-clockwise from maximum clockwise rotation, not only decreases the volume but increasingly emphasizes the bass and treble according to the Fletcher-Munson curves (curves developed from a statistical study of this effect). An uncompensated LEVEL control is also provided to "set" the LOUDNESS control for proper operation in any system, and also for the purpose of adjusting the listening level when going from quiet program material to loud program material or the reverse without occasioning a change in the loudness compensation. To "set" the LOUDNESS control at any time, perform these operations in the order given to avoid blasting or possible damage to speakers of low power-handling capacity: a) Turn the LEVEL control to zero; b) Turn the LOUDNESS control to ten; c) With high level orchestral program material being fed to the amplifier from your phonograph or tuner, advance the LEVEL control setting until a relatively loud listening level is obtained. d) Turn down the LOUDNESS control until your normal listening level is obtained with the LEVEL control set as just described. Proper loudness compensation should now be obtained at any listening level adjusted to with the LOUDNESS control. The same reference LEVEL control setting will be suitable for both phonograph and tuner listening if the volume control of the tuner has been adjusted as described in the "High Level Inputs" sub-section of the "Electrical Connections" section. When selecting inputs which do not have level adjusts, such as tv or a crystal cartridge connected to the AUX. Input, it may be desirable to set the LEVEL control to zero beforehand and then bring up the LEVEL control to obtain the desired list-

ening level to avoid blasting. Note that the LEVEL controls affects the output to tape recorder available at the TAPE OUT jack but that the LOUDNESS control has no effect on this output.

BASS CONTROL: The plus sign on the right side of the dial indicates that clockwise rotation from the mid-point (0) increases (boosts) bass response; the minus sign on the left side indicate that counter-clockwise rotation from the mid-point decreases (cuts) bass response. There is no interaction with the TREBLE control. Start all adjustments with this control set at the mid-point (0), which is called the "flat" position since bass response is neither cut nor boosted at this setting. This control does affect the output to a tape recorder from the TAPE OUT jack to permit "touching up" of the record equalization or reducing the effect of low frequency disturbances when recording on tape. Set it at zero if no effect during recording is desired.

TREBLE CONTROL: The plus sign on the right side of the dial indicates that clockwise rotation from the mid-point (0) increases (boosts) treble response; the minus sign on the left side indicates that counter-clockwise rotation from the mid-point decreases (cuts) treble response. There is no interaction with the BASS control. Start all adjustments with this control set at the mid-point (0), which is called the "flat" position since treble response is neither cut nor boosted at this position. This control does affect the output to a tape recorder from the TAPE OUT jack to permit "touching up" of the record equalization or reducing the effect of high frequency disturbances when recording to tape. Set it at zero if no effect during recording is desired.

LISTENING TO TUNERS, TV, TAPE RECORDERS: With the SELECTOR switch set at TUNER, TV, TAPE or AUXILIARY, the corresponding high level input from a radio tuner, tv, tape recorder, second tuner or crystal cartridge will feed through the amplifier. Adjustment of the volume control on each source is discussed in the "Electrical Connections" section under "High Level Inputs" and again under "Level & Loudness Control" in this section.

MAKING RECORDINGS: Tape, wire, or disc recordings may be made by connecting the recorder to the TAPE OUTPUT jack. See "TAPE OUTPUT" under ELECTRICAL CONNECTIONS" and the "BASS CONTROL" and "TREBLE CONTROL" operating instructions. With the output of the recorder connected to the "TAPE INPUT" jack, turning the SELECTOR switch to TAPE readies the amplifier for playback of the recording.

RECORD EQUALIZATION SELECTION

Records are made with boosted volume in the treble range to mask surface noise and reduced volume in the bass range to conserve groove space and reduce distortion. As there was no universally accepted standard of treble boost and bass cut in recording before Spring 1954, records of which the masters were made before this date may require any one of several different equalizations

(amounts of bass boost and treble cut) by the amplifier to restore the original balance. The specific equalization required depends upon the brand of the record, and the equalization which should be used for each record brand (for recordings made before 1954) is listed in the first column to the right of the company's name in the chart below. In some cases, additional adjustment is required with the BASS control to match the equalization employed

by the particular company more exactly.

Since Spring 1954, the RIAA (new AES) recording curve has been adopted by almost all record companies and records of which the masters were made after this date will be properly equalized at the RIAA position unless the company involved has not made the change (see second column in chart).

RECORD EQUALIZATION SELECTION

Record Label	Equalization	Since Spring 1954	Record Label	Equalization	Since Spring 1954
Allied	RIAA	RIAA	L'Oiseau-Lyre	LON	RIAA
Angel	RIAA	RIAA	London (ffir)	LON	RIAA
Atlantic	COL, Bass +2*	RIAA	Lyrichord, old	COL or RIAA	RIAA
Amer. Rec. Soc.	RIAA	RIAA	Lyrichord, new	COL, Bass +2	RIAA
Bartok	COL, Bass +2	no change	Mercury	RIAA, Bass +1	RIAA
Blue Note Jazz	RIAA, Bass +1	RIAA	MGM	RIAA	RIAA
Boston	COL	RIAA	Oceanic	COL, Bass +2	RIAA
Caedmon	RIAA	RIAA	Pacific Jazz	RIAA	RIAA
Camden	RIAA	RIAA	Philharmonic	RIAA, Bass +1	RIAA
Canyon	RIAA, Bass +1	RIAA	Polymusic	COL, Bass +2*	RIAA
Capitol	RIAA, Bass +1	RIAA	RCA Victor	RIAA, Bass +2.5	RIAA
Capitol-Cetra	RIAA, Bass +1	no change	Remington	COL, Bass +2	RIAA
Cetra-Soria	COL	no change	Riverside	RIAA	RIAA
Colosseum	COL	RIAA	Romany	RIAA	RIAA
Columbia	COL	RIAA	Savoy	RIAA	RIAA
Concert Hall	RIAA, Bass +1	RIAA	Tempo	RIAA	RIAA
Contemporary	RIAA, Bass +1	RIAA	Urania, most	COL, Bass +2	RIAA
Cook	RIAA *	RIAA	Urania, some	RIAA, Bass +2	RIAA
Decca	COL	RIAA	Vanguard	COL	RIAA
EMS	RIAA, Bass +1	RIAA	Bach Guild	COL	RIAA
Elektra	COL, Bass +2	no change	Vox	COL	RIAA
Epic	COL	RIAA	Walden	RIAA	RIAA
Esoteric	RIAA	RIAA	Westminster	COL, Bass +2	no change
Folkways (most)	COL, Bass +2	no change	European 78's	Eur 78	
Good-Time Jazz	RIAA, Bass +1	RIAA	Older Amer. 78's	AM 78	
Haydn Society	COL	RIAA			

* Except use EUR for binaural, inside band only.

MAINTENANCE

Your amplifier should require little service except for normal tube replacement. If desired, the 6L6GB output tubes may be replaced by the 6L6 GA or the 6L6 metal tubes and also by the premium 5881 tubes without circuit changes. When replacing output tubes, it is desirable to use matched pairs of tubes for the lowest distortion. To facilitate servicing, remedial and trouble-shooting

procedures have been provided in the TROUBLE SHOOTING CHART that follows. VOLTAGE and RESISTANCE CHARTS are also provided as an aid to locating defective components. On the schematic diagram, AC mid-frequency (1 kc) voltage sensitivities are shown at most of the grids for full 20 watt power output in order to permit a careful, stage-by-stage check of the operation.

TROUBLE SHOOTING CHART

SYMPTOM	CAUSE	REMEDY
Amplifier causes power line fuse to blow.	Line cord, J8, J9, primary or high voltage secondary windings of T1, incorrectly wired. Pri./h.v. sec. windings of T1 shorted. (If the amplifier causes the line fuse to blow again when connected to the line with 5U4 GB rectifier V7 removed, one or the other of the above causes must be the reason.) V7 shorted	repair replace replace after checking C26
V7 filament not lit.	Incorrect wiring of fil. leads to V7 socket. 5V fil. winding of T1 open.	repair replace T1
Any or all other tube filament not lit.	Open lead from 6.3V winding of T1. 6.3V winding of T1 open.	repair replace T1
DC voltage at V7 cathode (pin 8) is incorrect as specified below.		
a) No voltage	Defective V7 C26 A shorted internally or externally.	replace replace or repair
b) High Voltage	Connection to C26 A from pin 8 of V7 broken. Connection to center tap of h.v. sec. winding of T1 open. Output tubes V5 & V6 over-biased or not drawing current.	repair repair see trouble-shooting typical stage
c) Low voltage	Excessive current drain in amplifier. Defective V7.	see trouble-shooting typical stage replace

Connect a phonograph and speaker to the amplifier as described in "Electrical Connections" and set controls for phono listening. Play a known high quality LP recording on the phonograph. If there is no output to the speaker or if the output is low or audibly distorted, proceed to the checks for those symptoms. If there is excessive hum in the output, disconnect the phono input cable from the amplifier and short the phono input jack to chassis. If the hum disappears the trouble is not in the amplifier but in the phonograph or in the connection to the amplifier.

The cause of phonograph hum may be a metal pick-up arm not grounded to the cable shield (try a good single ground connection to the cable shield from turntable frame, pick-up arm, and cartridge case), direct hum pick-up by the magnetic cartridge from the record player motor (try using a rubber mat on the turntable to increase the separation of the pick-up from the motor), or pick-up from a power transformer or other magnetic field in the vicinity (try moving phonograph away from suspected source). Check also that the phono input cable shielding is grounded to the amplifier chassis at one point only through the skirt of the input connector where it plugs into the amplifier. Finally, try a good building ground such as a connection from a cold water pipe terminated under speaker terminal "G" on the amplifier. Do not connect such a ground wire to other components in the system.

Excessive hum on other inputs may be checked in a similar manner. Disconnect the input cable in question and short the particular input jack to the chassis. If the hum disappears, the trouble is external to the amplifier. Note that on all inputs, the braid of the input cable should connect to the amplifier only through the skirt of the input connector. The cause and remedies for the following symptoms are then based on the assumption that checks made in the manner described above have eliminated the possibility of the trouble being external to the amplifier.

GENERAL INSTRUCTIONS

Care taken in the construction of this instrument will reward the constructor with many years of satisfactory service and greater confidence in his instrument. We urge you to not rush the construction, but to take all the time necessary for proper assembly and wiring.

Furthermore, we urge strongly that you follow the wire and parts layout shown in the pictorial diagrams as closely as possible. This is essential, because the position of wires and parts is quite critical in this instrument; changes may seriously affect the characteristics of the circuit.

UNPACKING THE KIT: Unpack the kit carefully and check each part against the parts list including those parts that are mounted to the chassis. If you have trouble identifying any parts, refer to the pictorial diagrams or the color code chart.

You may find that the value of a component will vary within the allowable circuit tolerance. As an example, a 470K ohm resistor may have substituted for it a 510K ohm resistor if the circuit is such as to allow this substitution. In general, resistors and controls have a tolerance of $\pm 20\%$ unless otherwise specified. Therefore a 100K resistor may measure anywhere between 80K and 120K ohms. Tolerances on capacitors are even greater, unless specified. Limits of $+100\%$ and -50% are usual for electrolytic capacitors.

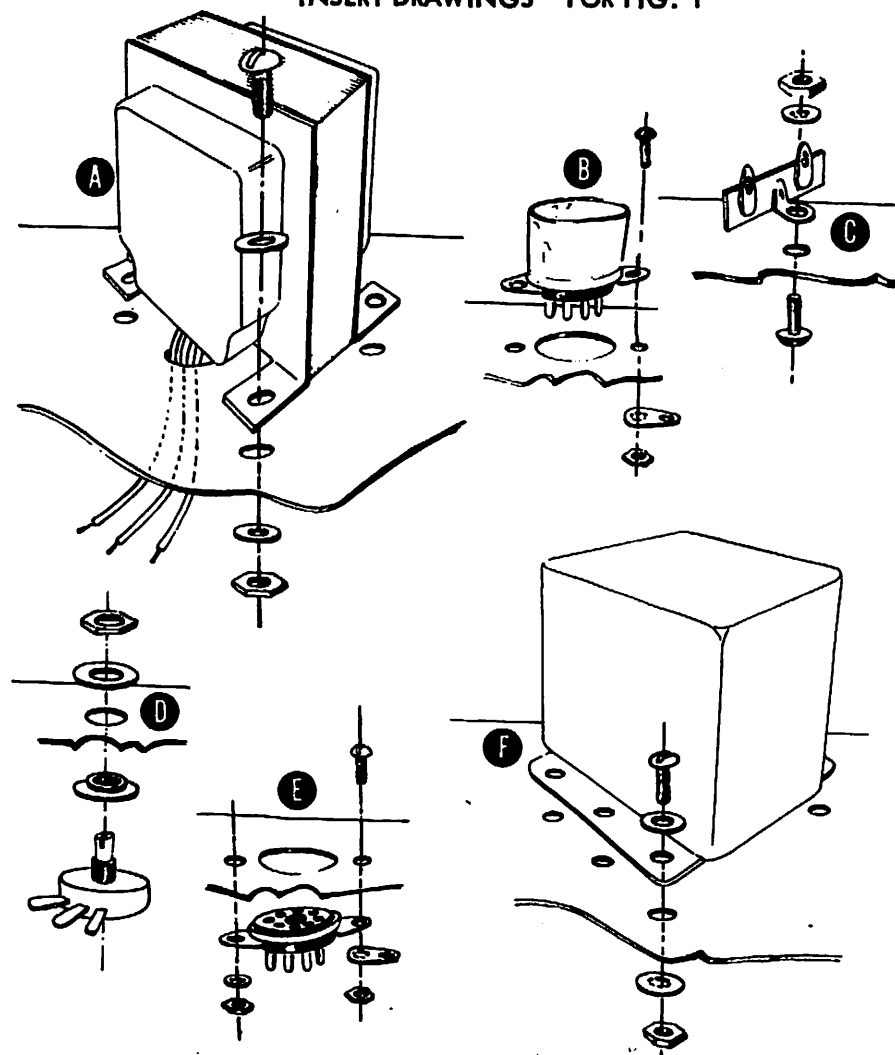
CONSTRUCTION HINTS: USE THE BEST GRADE OF ROSIN CORE SOLDER ONLY, preferably one containing the new activated fluxes such as Kester "Resin-Five", Ersin "Multicore" or similar types. UNDER NO CIRCUMSTANCES USE ACID CORE SOLDER OR ACID FLUX since acid flux can cause serious corrosion. Before soldering make certain of a good mechanical connection. Use a clean, freshly tinned soldering iron, no smaller than 100 watts, and place the solder on the joint (not on the iron) so that the solder is melted by the heat from the joint itself. Do not remove the soldering iron until the solder flows and check to see that the resulting joint is smooth and shiny when the solder has cooled. There are two extremes to be avoided; too little heat and too much heat. If too little heat is applied, the joint will appear pitted and grey, indicating a rosin joint which is unsatisfactory. On the other hand, if too much heat is applied to a joint, the parts connected to it may either change value, lose their protective coating, or break down. If you are soldering close to a part, hold the lead between the part and the joint being soldered with the tip of a pair of longnose pliers. The pliers will conduct the heat away and prevent the component from being unduly overheated. If for any reason it is necessary to resolder a joint, be sure to use new solder.

It should also be noted that the leads on transformers, capacitors, and resistors are very often longer than necessary. These leads should be trimmed to the proper length when wiring.

CONSTRUCTION PROCEDURE: The complete step-by-step mounting and wiring procedure follows. To keep the drawings uncrowded, unnecessary repetition of mounting or wiring details may be omitted. **Note:** The abbreviation (C) means connect but do not solder (until other leads have been connected). The abbreviation (S) means connect and solder.

The drawings below show the method of mounting certain specific components properly. Solder lugs are shown in the socket mounting drawings simply to indicate the correct position of such a lug when it is specified for a particular socket. The mounting drawing for the hum-balancing pot R33, which must be insulated from the chassis, shows the proper position of the insulating shoulder washer. Refer to the relevant drawing as required during the mounting procedure.

INSERT DRAWINGS - FOR FIG. 1



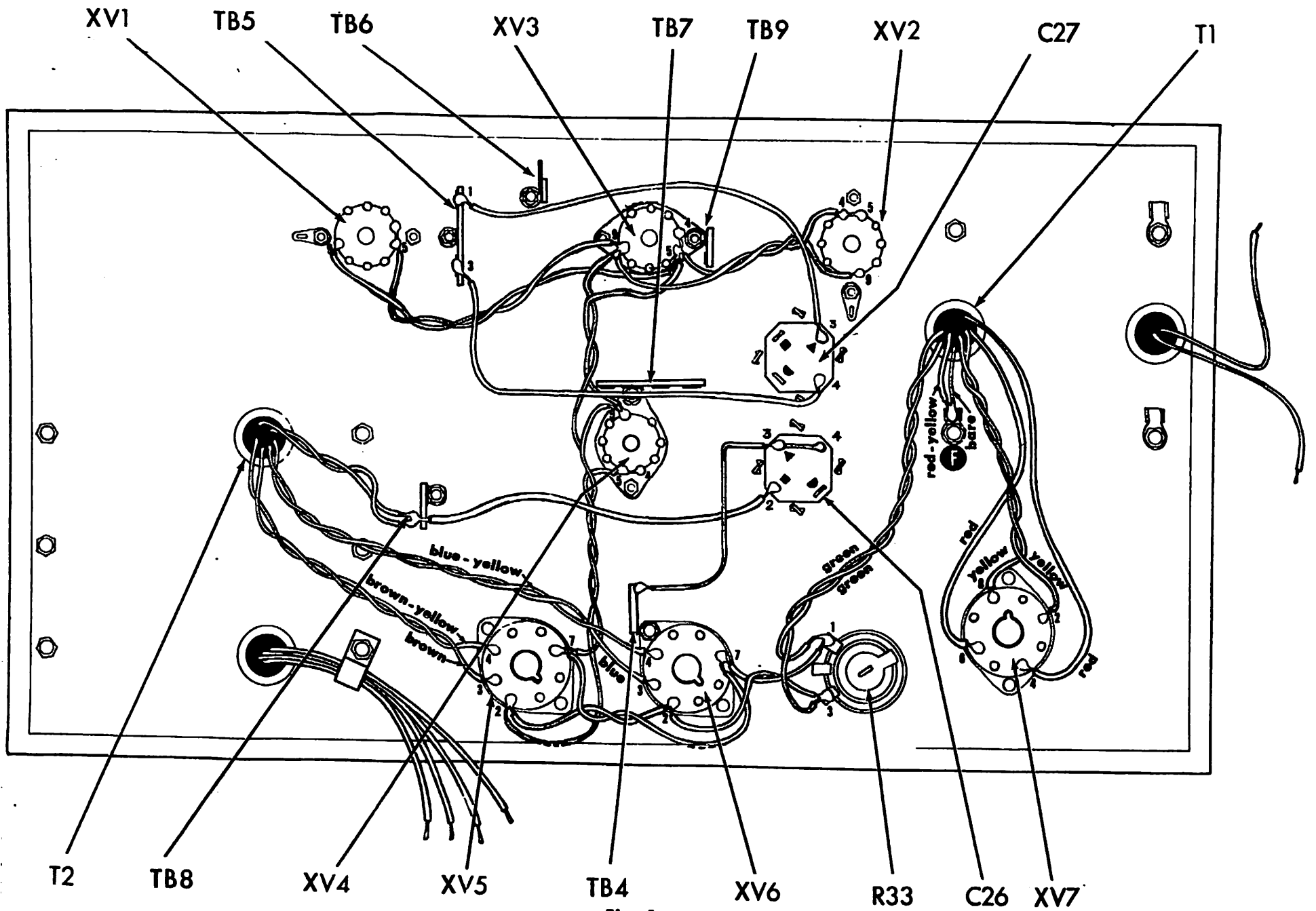


Fig. 1

MAIN CHASSIS ASSEMBLY

- () Fig. 1. Mount sockets with shield supports XV1 & XV2 as shown. Use two #4-40 screws, two #4 hex nuts, one #4 lockwasher and one #4 ground lug per socket. See insert drawing B.
- () Fig. 1. Mount socket, XV3, as shown. Use two #4-40 screws, two #4 hex nuts and two #4 lockwashers. Mount a one post right with ground terminal strip, TB9, under one lockwasher at one end of socket. See insert drawing E.
- () Fig. 1. Mount socket, XV4, as shown. Use two #4-40 screws, two #4 hex nuts and two #4 lockwashers. Mount a three post, two right with ground terminal strip, TB7, under one lockwasher at one end of socket. See insert E.
- () Fig. 1. Mount the 100Ω open pot., R33, as shown. Use one 3/8" hex nut, one fiber flat washer and one fiber shoulder washer. Be careful that the pot does not short against the chassis. See insert drawing D.
- () Fig. 1. Mount the power transformer, T1, as shown. The black leads must come through the hole nearest the side. Use four #10-24 screws, four #10 hex nuts, four #10 flatwashers and four #10 lockwashers. Mount three #10 ground lugs under three of the lockwashers. See insert drawing A.
- () Fig. 1. Mount the output transformer, T2, as shown. The hole with the four leads should be at the rear of the chassis. Use six #10-24 screws, six #10 hex nuts, six #10 flat washers and six #10 lockwashers. Use the cable clamp installed under the mounting nut shown to gather the 4 leads referred to above.
- () Fig. 1. Mount a one post left terminal strip, TB8, a two post with ground terminal strip TB5 and a two post upright terminal strip TB6 as shown. Use one #6-32 screw, one #6 hex nut and one #6 lockwasher per terminal strip.
- () Fig. 1. Mount the electrolytic capacitors, C26 and C27, as shown. Note carefully the position of the three code markers (triangle, semi-circle and square) next to the prongs of the capacitor. Insert the mounting tabs into the slots in the chassis and twist the tabs somewhat less than a quarter turn. DO NOT twist the tabs excessively or they will shear off.
- () Fig. 1. Mount sockets, XV5, XV6, and XV7 as shown. Use two #6-32 X 3/8 screws, two #6 hex nuts and two #6 lockwashers. Mount a one post right terminal strip, TB4, with XV6. See insert drawing E.

PRELIMINARY WIRING

- () Fig. 1. Twist the two green leads from the power transformer, T1, and connect one lead to R33-1 (C) and the other to R33-3 (C).
- () Fig. 1. Connect a yellow lead from R33-1 (S) to XV6-7 (C).
- () Fig. 1. Connect a brown lead from R33-3 (S) to XV6-2 (C).
- () Fig. 1. Cut and strip the ends of one 5" length of yellow wire and one 5" length of brown wire. Connect one end of the yellow lead to XV6-7 (S) and one end of the brown lead to XV6-2 (S). Twist the two leads. Connect the other end of the yellow lead to XV5-7 (C) and the other end of the brown lead to XV5-2 (C).

() Fig. 1. Following the above procedure, cut and strip a 6" length of brown wire and a 5" length of yellow wire. Connect the yellow lead to XV5-7 (S) and the brown lead to XV5-2 (S). Twist the two leads. Connect the yellow lead to XV4-9 (C). Pass the brown lead through XV4-5 (C) to XV4-4 (S).

() Fig. 1. Following the above procedure, cut and strip a 3" length of yellow wire and a 5" length of brown wire. Connect the yellow lead to XV4-9 (S) and the brown lead to XV4-5 (S). Twist the two leads. Connect the yellow lead to XV3-9 (C) and the brown lead through XV3-5 (C) to XV3-4 (S).

() Fig. 1. Following the above procedure, cut and strip a 5" length of yellow wire and a 5" length of brown wire. Connect the yellow lead to XV3-9 (C) and the brown lead to XV3-5 (C). Twist the two leads. Connect the yellow lead to XV2-9 (S) and the brown lead through XV2-4 (S) to XV2-5 (S).

() Fig. 1. Following the above procedure, cut & strip a 7" length of yellow wire and a 7" length of brown wire. Connect the yellow lead to XV3-9 (S) and the brown lead to XV3-5 (S). Twist the two leads. Connect the yellow lead to XV1-9 (S) and the brown lead through XV1-5 (S) to XV1-4 (S).

() Fig. 1. Twist the yellow leads of the power transformer T1 and connect to XV7-2 (S) and XV7-8 (C).

() Fig. 1. Twist the red leads of the power transformer T1 and connect to XV7-4 (S) and XV7-6 (S).

() Fig. 1. Connect the red-yellow lead and the bare lead of the power transformer T1 to ground lug "F" (S).

() Fig. 1. Twist the red and red-yellow leads of the output transformer T2 and connect to TB8 (C).

() Fig. 1. Connect a blue lead from TB8 (C) to C26-2 (C).

() Fig. 1. Twist the blue and blue-yellow leads of the output transformer T2. Connect the blue lead to XV6-3 (S) and the blue-yellow lead to XV6-4 (S).

() Fig. 1. Twist the brown and brown-yellow leads of the output transformer T2. Connect the brown lead to XV5-3 (C) and the brown-yellow lead to XV5-4 (S).

() Fig. 1. Connect a 6" blue lead from TB5-1 (C) to C27-3 (C).

() Fig. 1. Connect an 8" blue lead from TB5-3 (C) to C27-4 (C).

() Fig. 1. Connect one end of a 4" blue lead to TB4 (C). Pass the other end thru C26-3 (C) and connect to C26-4 (C).

SWITCH WIRING

() Fig. 2. Connect an 850mmf capacitor, C19, and a 100K 5% resistor, R34, from 1B (S) to 1C (S).

() Fig. 2. Connect a 500mmf capacitor, C20, and a 100K 5% resistor, R35, from 5C (S) to 5B (S).

() Fig. 2. Connect a 5000mmf 10% capacitor, C18, and a 4.7meg resistor, R36, from 7C (C) to 8A (S).

() Fig. 2. Connect a 2700mmf capacitor, C21, and a 2.2 meg resistor, R38, from 8D (S) to 9B (S).

() Fig. 2. Connect a 3300mmf capacitor, C17, and a 560K resistor, R37, from 11D (S) to 11A (S).

() Fig. 2. Connect a blue lead from 4D (S) to 7C (S).

() Fig. 2. Connect a 2" blue lead to 12C (S). Leave the other end free.

() Fig. 2. Connect one end of a .1mfd 20% capacitor, C25, to 2D (C). This lead should be only 1" long. Leave the other end free.

() Fig. 2. Connect a bare lead from 2D (S) to 3E (S).

() Fig. 2. Connect a 2" blue lead from 10E (C) to 6E (S).

() Fig. 2. Connect a 5" piece of bare wire to 8F (C). Leave the other end free.

() Fig. 2. Cut four 5" length of shielded cable. On one end of each, strip back the braided shield and outer insulation 3/4". Strip back the inner insulation 3/8". (Call this end "A".) On the other end of each (end "B"), the outer insulation is stripped back 1", the braid shield 3/4", and the inner insulation 3/8".

() Fig. 2. Connect the inner leads of the four cables (end "B"), so that one connects to each of the following four switch terminals:

() 1F (S) () 2F (S) () 11F (S) () 12F (S)

() Fig. 2. Cut a 5" piece of bare wire. Wrap this wire one turn around the exposed outer braid on the "B" end of each of the shielded cables now connected to 2F, 1F, 12F, and 11F consecutively and in that order, leaving 3/8" of bare wire between wrappings. Solder the bare to the outer braid on each cable quickly with a hot, clean iron so as to minimize heating of the cable insulation. Connect the free end of the bare wire (coming off the braid of the cable connected to 11F) using spaghetti, to 8F (S).

() Fig. 2. Cut a 6" length of shielded cable. On one end, strip back the braided shield and outer insulation 3/4". Strip back the inner insulation 3/8". (Call this end "A".) On the other end (end "B"), the outer insulation is stripped back 1" the braided shield 3/4" and the inner insulation 3/8". On end "B", wrap one turn of a 2" piece of bare wire around the braided shield and solder with a minimum of heat. Connect the inner lead of end "A" to 10E (S). Leave end "B" and the small piece of bare wire free.

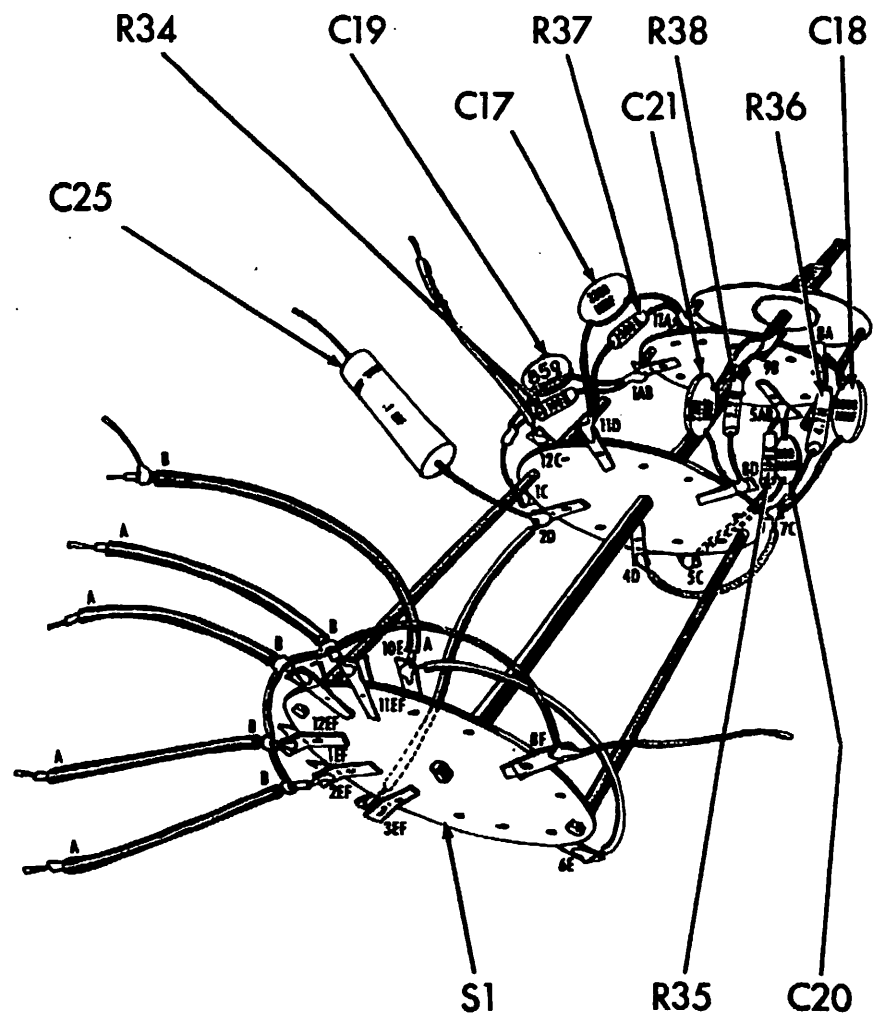


Fig. 2

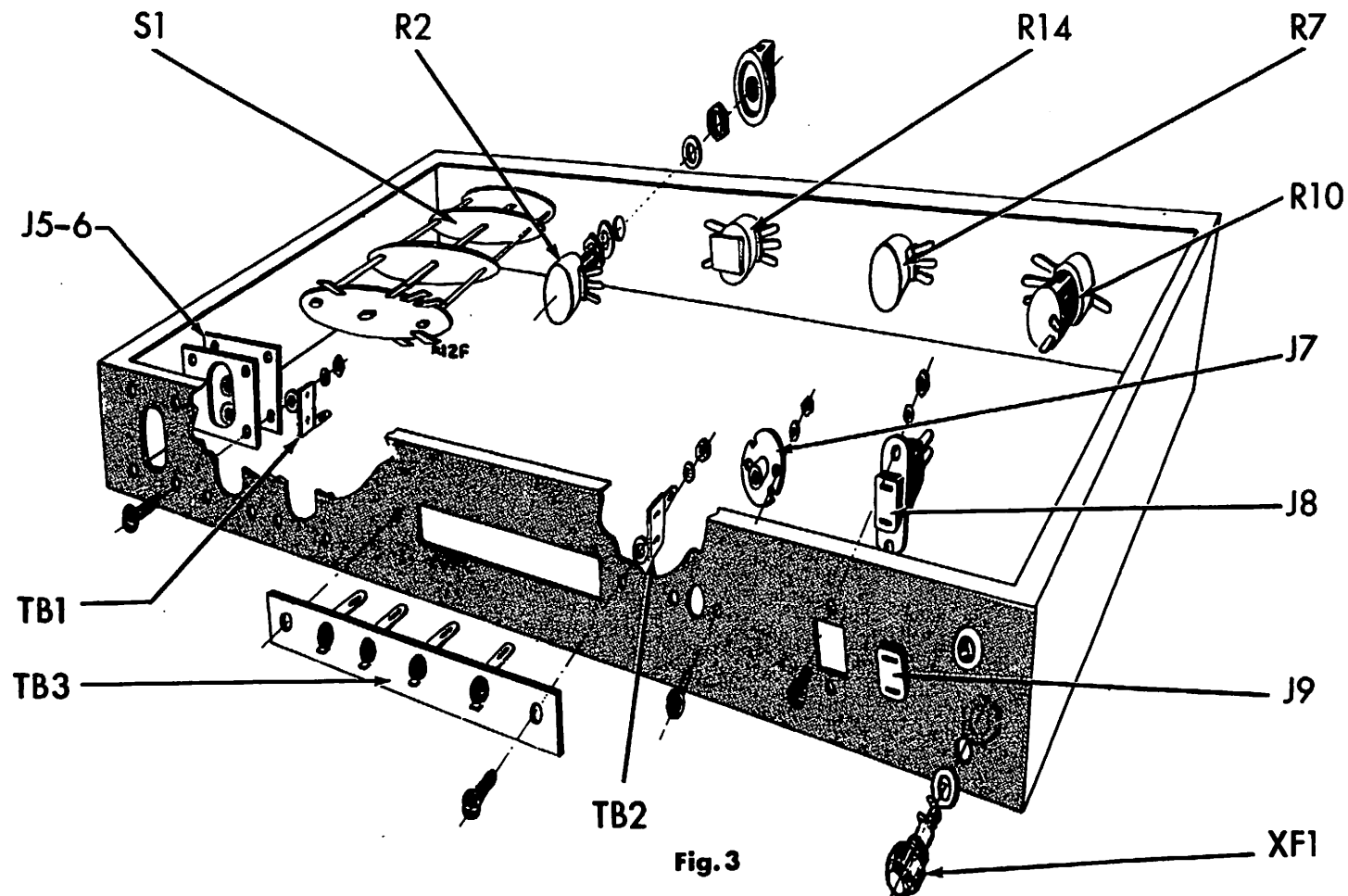


Fig. 3

FRONT AND REAR PANEL ASSEMBLY

() Fig. 3. Mount the 500K pot., R2, the loudness control pot., R14, the 1 meg pot., R7, and the 0.5 meg center-tapped pot with switch, R10. Use two 3/8" hex nuts, one lockwasher and one flat washer on each control.

() Fig. 3. Mount the convenience outlets, J8 and J9, as shown. Use two #6-32 screws, two #6 hex nuts, and two #6 lockwasher on each outlet.

() Fig. 3. Mount the single input jack, J7, as shown. Use two #6-32 screws, two #6 hex nuts, and two #6 lockwashers.

() Fig. 3. Mount the terminal board, TB3, as shown. Use two #6-32 screws, two #6 hex nuts, and two #6 lockwashers. Mount a one post right terminal

strip, TB2, under one lockwasher as shown.

() Fig. 3. Mount the dual input jack, J5-6, as shown. Use four #6-32 screws, four #6 hex nuts, and four #6 lockwashers. Use an insulating bakelite between the dual jack and the chassis. Mount a one post left terminal strip, TB1, under one lockwasher as shown.

() Fig. 3. Mount two dual input jacks, J1-2, and J3-4. Use four #6-32 screws, four #6 hex nuts and four #6 lockwashers with each. Do not use any insulating bakelite or terminal strips (Fig. 4).

() Fig. 3. Mount the fuseholder, XF1, as shown.

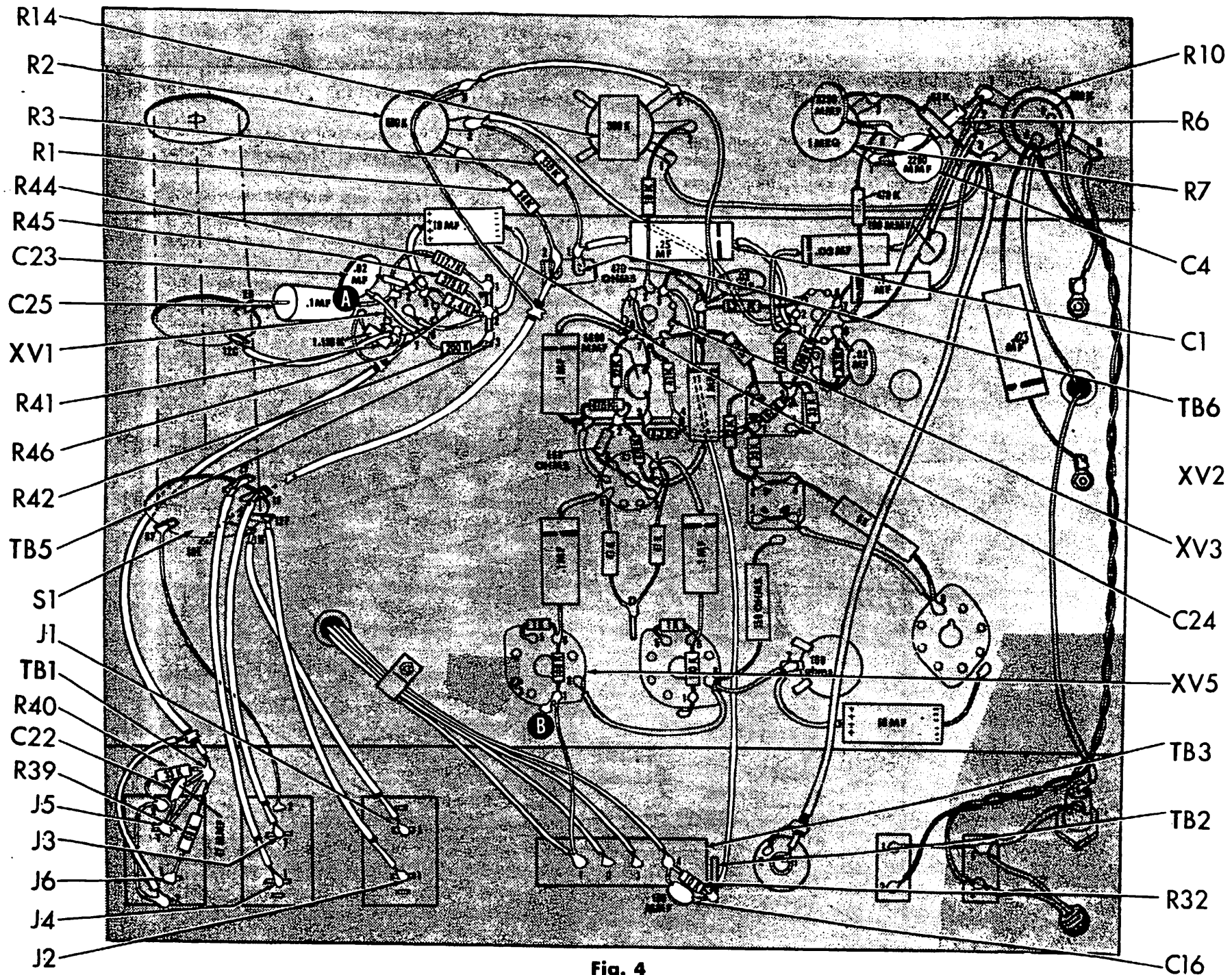


Fig. 4

REAR PANEL WIRING

- () Fig. 4. Connect a 33K 20% resistor, R40, from J5-2 (C) to TB1 (C).
- () Fig. 4. Connect a 2" black lead from J5-2 (S) to J6-2 (C).
- () Fig. 4. Connect a 47mmf capacitor, C22, from J5-1 (C) to TB1 (C).
- () Fig. 4. Connect a piece of bare wire from J5-1 (S) to TB1 (C).
- () Fig. 4. Connect a 68K 20% resistor, R39, from J6-1 (S) to TB1 (C).
- () Fig. 4. Cut a 7" piece of shielded cable. On both ends, the outer insulation is stripped back 1", the braided shield is stripped back 3/4" and the inner insulation is stripped back 3/8". Wrap one turn of a 3" piece of bare wire around each end of the braided shield and solder. Connect the inner lead of one end to TB1 (S), and the inner lead of the other end to XV1-7 (S). Connect the bare wire at one end (covered with spaghetti) to J6-2 (S), and the other bare wire to ground lug "A" (C).
- () Fig. 4. Mount the switch, S1, as shown. Use two 3/8" nuts, one 3/8" lockwasher and one 3/8" flatwasher (Fig. 3).
- () Fig. 4. Connect the bare wire from S1-8F to J3-2 (S).
- () Fig. 4. Connect the four ends "A" of the shielded cables from S1 as follows:

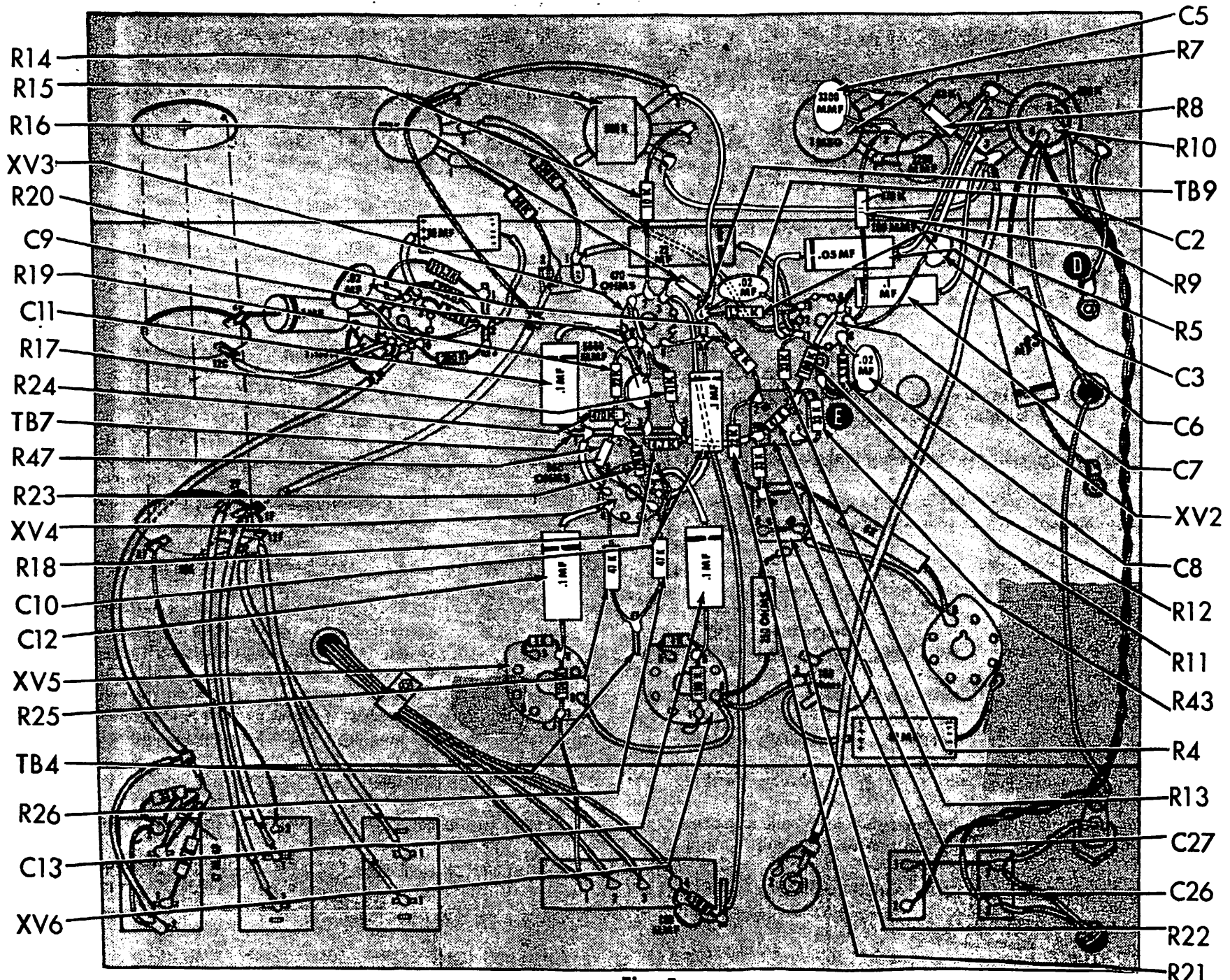
1F to J3-1 (S)	11F to J1-1 (S)
2F to J4-1 (S)	12F to J2-1 (S).
- () Fig. 4. Connect the black lead from the output transformer, T2, to TB3-1 (C).
- () Fig. 4. Connect the slate lead from T2 to TB3-2 (S).
- () Fig. 4. Connect the green lead from T2 to TB3-3 (S).
- () Fig. 4. Connect the yellow lead from T2 to TB3-4 (C).
- () Fig. 4. Connect one end of a bare wire to TB3-1 (S). Pass the other end thru XV5-1 (C) and connect to ground lug "B" (S) on XV5.
- () Fig. 4. Connect a 10K resistor, R32 and a 100mmf capacitor, C16, from TB3-4 (S) to TB2 (C).
- () Fig. 4. Connect an 10" black lead from TB2 (S) to XV8-3 (C). Run the lead along the chassis as shown.

PRE-AMPLIFIER WIRING

- () Fig. 4. Connect a 1.138K resistor, R41, from XV1-8 (C) to ground lug "A" (S).
- () Fig. 4. Connect the blue lead from S1-12C to XV1-8 (S).
- () Fig. 4. Run the free end of C25 under R41 and connect to XV1-1 (C). The capacitor should be perpendicular to the chassis. Use spaghetti.
- () Fig. 4. Connect a 117.7K resistor, R44, from XV1-1 (S) to TB5-1 (S).
- () Fig. 4. Connect a 375K resistor, R45, from XV1-2 (C) to TB5-2 (C).
- () Fig. 4. Connect a 200K resistor, R42, from XV1-6 (C) to TB5-3 (S).
- () Fig. 4. Connect a .02mfd GMV capacitor, C23, from XV1-6 (S) to XV1-2 (S). Use spaghetti.
- () Fig. 4. Connect a 2.4K resistor, R46, and a 10mfd capacitor, C24, from XV1-3 (S) to TB5-2 (C). Note that the negative lead goes to ground (TB5-2).
- () Fig. 4. Connect a short piece of bare wire covered with spaghetti from the center shield post of XV1 (S) to TB5-2 (S).
- () Fig. 4. Connect a 56K resistor, R1, from R2-1 (S) to TB6-2 (C).
- () Fig. 4. Connect the free end of the inner wire of the shielded cable on S1-10E to TB6-2 (S). Cover the bare wire soldered to the braided shield with spaghetti and connect to R2-3 (C). Run lead away from chassis.

TONE CONTROL CIRCUIT

- () Fig. 4. Connect a 330K resistor, R3, from TB6-1 (C) to R2-2 (C).
- () Fig. 4. Connect a .25mfd capacitor, C1, from TB6-1 (S) to XV2-1 (C). Use spaghetti on both ends.
- () Fig. 4. Connect a 8" green lead from R2-2 (S) to XV2-2 (S). Run wire in the bend of the chassis.
- () Fig. 4. Connect a 4" black lead from R2-3 (S) to R14-3 (C).
- () Fig. 4. Connect a 2200mmf capacitor, C4, from R7-1 (C) to R7-2 (C).
- () Fig. 4. Connect a 68K 5% resistor, R6, from R7-1 (S) to R10-1 (C). Use spaghetti on both ends.



- R14
- R15
- R16
- XV3
- R20
- C9
- R19
- C11
- R17
- R24
- TB7
- R47
- R23
- XV4
- R18
- C10
- C12
- XV5
- R25
- TB4
- R26
- C13
- XV6

- C5
- R7
- R8
- R10
- TB9
- C2
- R9
- R5
- C3
- C6
- C7
- XV2
- C8
- R12
- R11
- R43
- R4
- R13
- C27
- C26
- R22
- R21

Fig. 5

() Fig. 5. Connect a 68K 5% resistor, R8, from R7-3 (C) to R10-3 (C). Use spaghetti on both ends.

() Fig. 5. Connect a 3300mmf capacitor, C5, from R7-2 (C) to R7-3 (S).

() Fig. 5. Connect an 8" blue lead from R10-3 (C) to R14-1 (S). Run the lead in the bend of the chassis.

() Fig. 5. Connect a .1 mfd 20% capacitor, C7, from R10-3 (C) to XV2-6 (C). The capacitor should be dressed into the bend of the chassis. Use spaghetti on both ends.

() Fig. 5. Connect a .05 mfd capacitor, C3, from R10-1 (S) to XV2-1 (C). The capacitor should be placed above C7 at the front of the chassis. Use spaghetti on both ends.

() Fig. 5. Connect a 470K 5% resistor, R9, from XV2-7 (C) to R7-2 (S).

() Fig. 5. Connect a 100mmf capacitor, C6, from R10-2 (S) to XV2-7 (S).

() Fig. 5. Connect a piece of bare wire from R10-6 (S) to ground lug "D" (S).

() Fig. 5. Connect a .02 mfd GMV capacitor, C8, and a 3.3K resistor, R12, from XV2-8 (S) to ground lug "E" (S).

() Fig. 5. Connect a 100K 10% resistor, R11, from C27-3 (C) to XV2-6 (S).

() Fig. 5. Connect a 33K 1/2W 10% resistor, R4, from C27-3 (C) to XV2-1 (S). Solder mounting lugs of C27 and C26 to chassis.

() Fig. 5. Connect a 1.2K resistor, R5, and a .02 mfd 20% capacitor, C2, from XV2-3 (S) to TB9-1 (C).

() Fig. 5. Connect a 3" black lead from R14-3 (S) to TB9-1 (C).

PHASE INVERTER WIRING

() Fig. 5. Connect a 10K resistor, R15, from R14-2 (S) to XV3-2 (S).

() Fig. 5. Connect a 470Ω resistor, R16, from XV3-3 (S) to TB9-1 (S).

() Fig. 5. Connect one of the two matched 22K resistors, R20, from TB9-2 (C) to C27-2 (C). Connect the other 22K resistor of the matched pair, R19, from XV3-8 (C) to TB7-2 (C).

() Fig. 5. Connect a bare wire from XV3-6 (S) to TB9-2 (C).

() Fig. 5. Connect one end of a 47K resistor, R17, to TB7-4 (C). Pass the other end through XV3-7 (C) and connect to XV3-1 (S).

() Fig. 5. Connect a 4.7K resistor, R18, from TB7-4 (C) to TB7-3 (C).

() Fig. 5. Connect a 5000mmf 20% capacitor, C9, from TB7-3 (S) to XV3-7 (S).

() Fig. 5. Connect a 2" blue lead from C27-1 (C) to TB7-4 (S).

() Fig. 5. Connect a 33K 1/2W resistor, R43, from C27-4 (S) to C27-3 (C).

() Fig. 5. Connect a 47K resistor, R13, from C27-1 (C) to C27-3 (S).

() Fig. 5. Connect a 22K resistor, R21, from C26-3 (C) to C27-2 (S).

() Fig. 5. Connect a 33K 1W resistor, R22, from C26-3 (S) to C27-1 (S).

() Fig. 5. Connect a .1 mfd 10% capacitor, C10, from TB9-2 (S) to XV4-2 (C).

() Fig. 5. Connect a .1 mfd 10% capacitor, C11, from XV3-8 (S) to TB7-1 (C).

() Fig. 5. Connect a bare lead with spaghetti from TB7-1 (C) to XV4-7 (S).

DRIVER AMPLIFIER

() Fig. 5. Connect a 470K resistor, R24, from TB7-1 (S) to TB7-2 (C).

() Fig. 5. Connect one end of a 560Ω resistor, R47, to TB7-2 (C). Pass the other end thru XV4-8 (S) and connect to XV4-3 (S).

() Fig. 5. Connect a 47K 2W resistor, R26, from XV4-1 (C) to TB4 (C). Connect the other 47K 2W resistor, R25, from XV4-6 (C) to TB4 (S).

() Fig. 5. Connect a 470K resistor, R23, from XV4-2 (S) to TB7-2 (S).

() Fig. 5. Connect a .1 mfd 10% capacitor, C13, from XV4-1 (S) to XV6-6 (C).

() Fig. 5. Connect a .1 mfd 10% capacitor, C12, from XV4-6 (S) to XV5-6 (C).

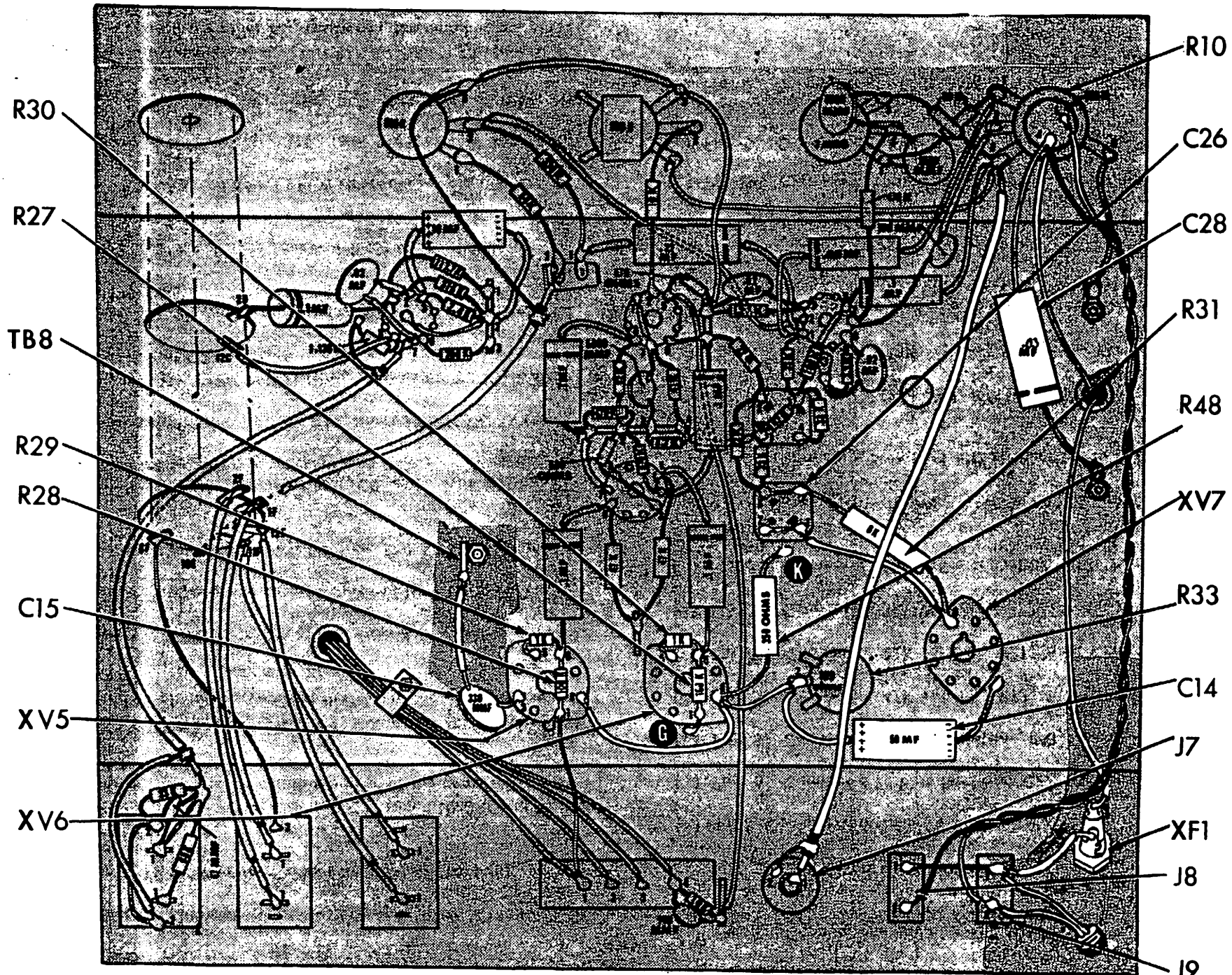


Fig. 6

OUTPUT STAGE

- () Fig. 6. Connect a 1K resistor, R29, from XV5-6 (C) to XV5-5 (S).
- () Fig. 6. Connect a 1K resistor, R30, from XV6-6 (C) to XV6-5 (S).
- () Fig. 6. Connect a 100K, 5% resistor, R28, from XV5-6 (S) to XV5-1 (S).
- () Fig. 6. Connect a 100K, 5% resistor, R27, from XV6-6 (S) through XV6-1 (S) to ground "G" (S) on XV6.
- () Fig. 6. Connect the 330mfd capacitor, C15, from XV5-3 (S) to TB8 (S). Be sure to use spaghetti on both pigtailed.
- () Fig. 6. Connect a 4" yellow lead from XV5-8 (S) to XV6-8 (C).
- () Fig. 6. Connect a 2" yellow lead from XV6-8 (C) to R33-2 (C).
- () Fig. 6. Connect a 50mfd capacitor, C14, from R33-2 (S) to ground "J" on XV7 (S). Note that the negative lead goes to ground "J". Use spaghetti.
- () Fig. 6. Connect a 350Ω 7W resistor, R48, from XV6-8 (S) to ground "K" (S) on C26. Dress resistor against chassis. Use spaghetti. Dress adjacent leads away from resistor to avoid damage by heat generated in operation.

FINAL WIRING

- () Fig. 6. Connect a 6K 10W resistor, R31, from C26-4 (S) to XV7-8 (C).
- () Fig. 6. Connect a 4" blue lead from XV7-8 (S) thru C26-1 (S) to C26-2 (S).
- () Fig. 6. Connect a .03mfd 20% capacitor, C28, from R10-4 (C) to ground lug "C".
- () Fig. 6. Connect one black lead from the power transformer T1 to R10-4 (C). Connect the other black lead to the fuseholder XF1-1 (S).
- () Fig. 6. Connect a black lead from XF1-2 (S) to convenience outlet J9-1 (C).
- () Fig. 6. Connect a 1 1/2" piece of bare wire from convenience outlet J8-1 (S) to convenience outlet J9-1 (C).
- () Fig. 6. Connect a 15" black lead from convenience outlet J8-2 (S) to R10-4 (S).
- () Fig. 6. Connect a 14" blue lead from convenience outlet J9-2 (C) to R10-5 (S).

() Fig. 6. Cut an 8" length of shielded cable. On one end (end "A"), strip the outer insulation back 1", the braided shield 3/4", and the inner insulation 3/8". On the other end (end "B"), strip the outer insulation and braid back 3/4", and the inner insulation 3/8". Wrap one turn of a 2" length of bare wire around the exposed shield at end "A" and solder. Connect the inner lead of end "A" to J7-1 (S) and the bare wire to J7-2 (S). Connect the inner lead of end "B" to R10-3 (S).

() Fig. 6. Insert a 3/8" grommet into the hole at the rear of the chassis. Pass the line cord through this grommet. Knot the line cord inside the chassis 3" from the end. Connect one lead to J9-1 (S) and the other lead to J9-2 (S).

FINAL STEPS

You have now completed the assembly and wiring of your amplifier. When you have completed the following steps your amplifier will be ready for use.

- 1) To catch any wiring errors, it is suggested that the entire wiring be checked point-by-point against the wiring instructions (and preferably also against the schematic wiring diagram in order to become more familiar with the component layout and circuitry). While doing so, check for rosin joints, loose lumps of solder, poor lead dress, and accidental shorts or leakage paths arising from the flow of rosin between contacts (remove with a stiff brush dipped in carbon tetrachloride, being careful not to spring contacts when cleaning switches).
- 2) Clean socket XV1 with carbon tetrachloride using a stiff brush. It is also advisable to remove the tube and shield from XV1, and clean the socket and pins on top of the chassis.
- 3) Insert V1 through V7 in their correct sockets. Place shields over V1 and V2.
- 4) If the amplifier is not to be installed in a console, mount the control plate by slipping it over the control shafts and using two #4-40 X 1/8 B.H. screws to fasten it to the front chassis apron (see Fig. 7). If the amplifier is to be installed in a console, the mounting of the control plate is taken care of in INSTALLATION in the instruction section.
- 5) Mount the knobs on the front panel. All controls should be set at their most counter-clockwise position. The knobs are pushed onto the shafts with the dot pointing to the following markings.

CONTROL

SELECTOR
LEVEL
LOUDNESS
BASS
TREBLE

MARKING

TAPE
0
0
-5
OFF

Use the knobs with the short shanks if the amplifier is not to be installed in a console. The knobs with the long shanks are to be used if the amplifier is installed in a console. In the latter case, the knobs are finally placed on the shafts only after console installation is completed. See INSTALLATION in the instruction section.

6) **IMPORTANT: BE SURE TO MAKE THE FOLLOWING RESISTANCE CHECKS BEFORE CONNECTING TO THE AC LINE:** Check for a cold dc resistance of 3 ohms across the AC plug with the AC power switch turned on; check for a resistance of at least 70 ohms between ground and pins 4 and 6 of XV7; check for a resistance of at least 70K ohms between the positive terminal of each section of the multi-section electrolytic capacitors, C26 and C27 to ground. Allow sufficient time for the electrolytic capacitors to be charged by the ohmmeter battery when they are involved in the measurements. These measurements constitute a reasonable check of the power supply components and wiring before applying power. If you fail to obtain these resistance values, do not connect the instrument to the ac line until the cause is discovered and the condition remedied.

7) **OPERATIONAL CHECKS ON COMPLETED KITS:** In the instruction part of this manual, you will find a sub-section in the installation section titled "Electrical Connections". Read this carefully and connect your speaker, phonograph, and tuner to the amplifier in accordance with the instructions given. Then read the section titled "Operating Instructions" and operate all the controls, checking aurally for the results described. If the amplifier does not operate at all or operates incorrectly, use the trouble shooting chart and the Voltage and Resistance chart to discover and remedy the difficulty. As the Trouble Shooting chart presumes a properly wired amplifier, which may not be the case, recheck the wiring for errors or reversed connections and continuity.

8) Press a speed nut in place over each hole on the bottom flange of the chassis (see Fig. 8).

9) If the amplifier is not to be installed in a console, insert the rubber feet in the openings provided in the bottom plate. Whether the amplifier is to be installed in a console or not, mount the bottom plate on the chassis, using 4 #8-32 X 3/8" on the front and rear flanges and 4 #8-32 X 1" on the side flanges. (It is essential that the bottom plate be mounted on the amplifier at the start and during the process of console installation described in the instruction section, until that point in the installation procedure where it is instructed to remove the bottom plate temporarily for use as a template.)

10) Installation, electrical connections, and operation will be found in the instruction section of this manual. Proceed to the instruction section at this point.

SERVICE

If you are still having difficulty, write to our service department listing all possible indications that might be helpful. If desired, you may return the instrument to our factory where it will be placed in operating condition for \$9.50 plus the cost of parts replaced due to their being damaged in the course of construction. This service policy applies only to completed instruments constructed in accordance with the instructions as stated in the manual. Instruments that are not completed or instruments that are modified will not be accepted for repair. Instruments that show evidence of acid core solder or paste fluxes will be returned not repaired. **NOTE:** Before returning this unit, be sure all parts are securely mounted. Attach a tag to the instrument, giving your home address and the trouble with the unit. Pack very carefully in a rugged container, using sufficient packing material (cotton, shredded newspaper, or excelsior), to make the unit completely immovable within the container. The original shipping carton is satisfactory, providing the original inserts are used or sufficient packing material is inserted to keep the instrument immovable. Ship by prepaid Railway Express, if possible, to the Electronic Instrument Co., Inc., 33-00 Northern Blvd., L.I.C. 1, New York. Return shipment will be made by express collect. Note that the carrier cannot be held liable for damages in transit if packing, IN HIS OPINION, is insufficient.

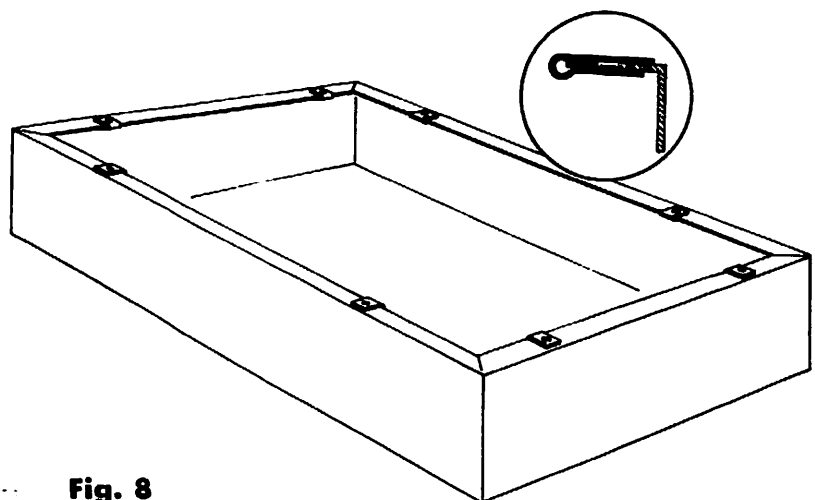


Fig. 8

SYMPTOM	CAUSE	REMEDY
Excessive phono hum	12AX7 (V1) defective Fil. leads dressed too close to grid lead. C27 defective Tube shield not making electrical contact to base or base not making electrical contact to chassis. Outer braid connection on phono 1 or phono 2 input jacks accidentally shorting to chassis at the jack. Outer braid of shielded lead going from phono 1 and 2 jacks to switch not grounded at switch as required. Shielded lead contacting chassis ground at other than required point.	Replace Dress fil. leads away from grid lead. replace C27. Check and correct clear short at Input jack repair repair
Excessive phono noise	V1 socket and contacts dirty.	clean thoroughly with carbon tetrachloride.
Sustained oscillations	Poor dress of output transformer T2 leads.	Dress all input leads and T2 leads away from each other. Keep T2 leads away from input jacks.
Sustained phono microphonics	12AX7 (V1) defective	replace 12AX7 (V1) with selected new 12AX7 or with premium 12AD7.
Hum on all inputs	12AX7 (V2) defective, not properly shielded, or dirty socket and contacts. Dress of power transformer T1 leads.	see below correct

If the trouble is no output or low output, check ac signal voltages starting at the input and working step-by-step toward the output. Set LEVEL & LOUDNESS controls to maximum (10) and BASS and TREBLE controls to their mid-points (0). Use a 1000 cycle sine-wave signal, such as supplied by the EICO 377 Sine & Square wave Audio Generator. In addition, use a precision 100:1 attenuator to permit obtaining a level of 0.004 volt fed into PHONO Input 1 from an audio generator output of 0.4 volts, which can easily be measured on the lowest AC volts range of your VTVM (also improves signal to hum from generator). Use a high input impedance VTVM for all AC signal voltage measurements (such as the EICO 232, 249, 221, or 214). This procedure should suffice to localize the defective stage.

If the trouble is an excessively distorted output, try tube replacement, signal tracing, or proceed directly to voltage and resistance measurements. If desired, premium 5881 tubes may be used as direct replacements for the 6L6 GB tubes without any circuit change.

When the defective stage is localized, proceed to a resistance and voltage check of the stage, using the data in the resistance and Voltage chart. Disconnect the amplifier from the power line and discharge capacitors prior to making any resistance check and prior to removing either or both of the 6L6 GB output tubes V3 and V4. Do not turn the amplifier on with either of the output tubes removed.

TROUBLE - SHOOTING TYPICAL TUBE STAGE

1. Check tube
2. Check plate and cathode resistors.
3. Check coupling capacitors for leakage or short.
4. For output stage, check dc resistance of transformer windings.
5. Check grid leak resistor for open.
6. Check cathode by-pass capacitors for short.

7. If no or low B+ voltage on tube, check decoupling path for open or defective R13, R21, R22, R31, R43, and filter capacitor C26B, C27A-B-C-D for short.
8. If wiring and circuit components including the tube check O.K. and B+ voltage is excessive, check the decoupling path for short or defective R13, R21, R22, R31, R43.

Suspected trouble in the equalization, tone, loudness, and level controls and networks should lead to specific resistance and capacitance checks to localize the trouble. In general, if the user suspects poor frequency response, defective equalization, or defective operation of the tone or loudness controls, the amplifier should be tested thoroughly with audio generator, vtvm, and scope.

VOLTAGE CHART

TUBE	V1 12AX7	V2 12AX7	V3 12AU7A	V4 12AU7A	V5 6L6GB	V6 6L6GB	V7 5U4GB
PIN [#]							
1	72	84	60	135	0	0	-
2	0	0	0	0	35	35	410 HR
3	0.65	0.75	1.4	4.8	400	400	-
4	H	H	H	H	405	405	370VAC
5	H	H	H	H	0	0	-
6	37	75	210	140	-	-	370VAC
7	-0.2	0	60	0	H	H	-
8	0.35	0.85	65	4.8	H	H	410 HR
9	H	H	H	H	-	-	-

REFERENCES FOR VOLTAGE & RESISTANCE CHARTS

H - Heater pin; all biased 35 volts dc above chassis ground to prevent heater-cathode current.
Heater AC voltages as follows: a) V1, V2, V3, V4 : 6.3VAC from pin 9 to pins 4 & 5; b) V5, V6 : 6.3VAC between pins 2 & 8.

HR - Heater pin of Rectifier V7 : 5VAC between pins 2 & 8; check only with V7 socket empty.

— Not connection to tube element or not contact on socket.

UNLESS OTHERWISE INDICATED, ALL VOLTAGES ARE DC, POSITIVE AND MEASURED TO CHASSIS.

Line Voltage: 115volts, 60cps

All measurements are made with VTVM of approximately 11 meg Input Impedance.

AC mid-frequency (1 kc) voltage sensitivities for 20W output are shown on the schematic diagram. Set LEVEL & LOUDNESS controls at max. (10) and BASS TREBLE controls at flat (0) for these checks.

CONTROL SETTINGS FOR CHARTS

SELECTOR - RIAA
LEVEL & LOUDNESS - Min. (0)
BASS & TREBLE - Flat (0)

TRANSFORMER DC WINDING RESISTANCES (COLD)

T1 primary (black leads) -2.3Ω
T1 secondary (red leads) -166Ω
T2 plate-to-plate (blue to brown) -315Ω
T2 screen-to-screen (blue-yel. to brown-yel.) -135Ω
T2 common (black) to 4Ω tap (white) -0.5Ω
T2 common (black) to 8Ω tap (green) -0.8Ω
T2 common (black) to 16Ω tap (yellow) -1.1Ω

ALL VOLTAGE AND RESISTANCE VALUES MAY NORMALLY VARY BY ±15%.

RESISTANCE CHART

TUBE	V1 12AX7	V2 12AX7	V3 12AU7A	V4 12AU7A	V5 6L6GB	V6 6L6GB	V7 5U4GB
PIN#							
1	430K	250K	260K	240K	-	-	-
2	350K	0	12K	470K	350	350	170K
3	2.2K	1.2K	470	560	170K	170K	-
4	350	350	350	350	170K	170K	83
5	350	350	350	350	120K	120K	-
6	500K	330K	230K	230K	120K	120K	83
7	33K	660K	260K	470K	350	350	-
8	1.2K	3.3K	22K	560	350	350	170K
9	350	350	350	350	-	-	-

TERMINALS OF SELECTOR SWITCH S1 CONNECTED AT EACH SETTING (AID TO READING SCHEMATIC DIAGRAM)

SELECTOR SWITCH S2	SECTION	TAPE	TV	TUNER	AUX	COL	LON	RIAA	AM-78	EUR-78
	A	NC	1-8	8-11	NC	1-11	5-11	NC	NC	5-8
B	NC	NC	5-9	1-5	NC	NC	1-9	5-9	NC	
C	NC	1-12	NC	1-12	1-12	5-12	1-12	5-12	5-12	
D	2-8	2-8	2-4-11	2-4-11	2-11	2-11	2-8	2-8	2-4	
E	6-10-11	6-10-12	1-6-10	2-6-10	3-6-10	3-6-10	3-6-10	3-6-10	3-6-10	
F	1-2-3-8-12	1-2-3-8-11	2-3-8-11-12	1-3-8-11-12	1-2-8-11-12	1-2-8-11-12	1-2-8-11-12	1-2-8-11-12	1-2-8-11-12	

Entries are numbers of those switch contacts which are connected together by the rotors at the particular position.

NC means no connection.

SERVICE

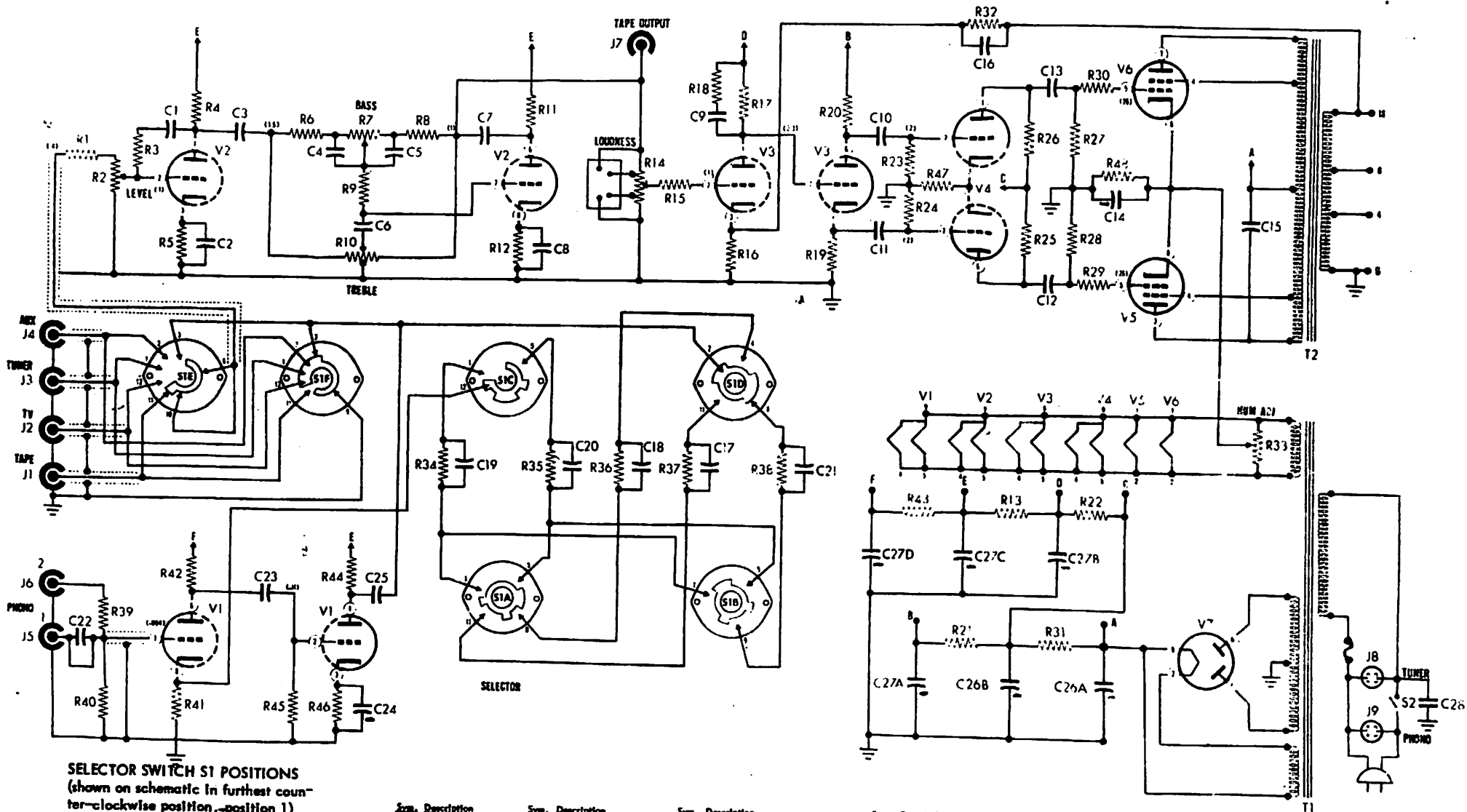
If trouble develops in your instrument which you can not remedy yourself, write to our service department listing all possible indications that might be helpful. If desired, you may return the instrument to our factory where it will be placed in operating condition for \$9.50 plus the cost of parts replaced due to their being damaged in the course of construction. NOTE: Before returning this unit, be sure all parts are securely mounted. Attach a tag to the instrument, giving your home address and the trouble with the unit. Pack very carefully in a rugged container, us-

ing sufficient packing material (cotton, shredded newspaper, or excelsior), to make the unit completely immovable within the container. The original shipping carton is satisfactory, providing the original inserts are used or sufficient packing material is inserted to keep the instrument immovable. Ship by prepaid Railway Express, if possible, to Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N.Y. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damages in transit if packing IN HIS OPINION, is insufficient.

REPLACEMENT PARTS LIST

Stk. #	Symbol	Description	Am't.	Stk. #	Symbol	Description	Am't.
20038	C1	cap., molded, 25 mfd	1	11512	R46	res., 2.4K Ω , 1/2W, 5% CD	1
22506	C2	cap., disc, .02 mfd	1	10433	R47	res., 560 Ω , 1/2W, 10% (G-BI-Br)	1
20042	C3	cap., molded, .05 mfd	1	14700	R48	res., 350 Ω , 7W, 10%	1
22507	C4	cap., disc, 2200 mmf	1	60038	S1	switch, 6P-9 Posn. (sel.)	1
22508	C5,17	cap., disc, 3300 mmf	2	30016	T1	power transformer	1
22509	C6,16	cap., disc, 100 mmf	2	32004	T2	output transformer	1
20039	C7,25	cap., molded, .1 mf - 10%	6	54000	TB1,8	term. strip 1P left	2
	10-13			54001	TB2,4	term. strip 1P right	2
22510	C8,23	cap., disc, .02 mf	2	54500	TB3	term. board 4 screw	1
22511	C9	cap., disc, 5000 mmf - 20%	1	54004	TB5	term. strip 2P w/ground	1
23011	C14	cap., elec., 50 mf - 50V	1	54010	TB6	term. strip 2P upright	1
22512	C15	cap., disc, 330 mmf - 800V	1	54007	TB7	term. strip 3P 2 right w/ground	1
22513	C18	cap., disc, 5000 mmf - 10%	1	54002	TB9	term. strip 1P right w/ground	1
22514	C19	cap., disc, 850 mmf	1	90034	V1,2	tube, 12AX7	2
22515	C20	cap., disc, 500 mmf	1	90033	V3,4	tube, 12AU7A	2
22518	C21	cap., disc, 2700 mmf	1	90031	V5,6	tube, 6L6 GB	2
22516	C22	cap., disc, 47 mmf	1	90032	V7	tube, 5U4	1
23014	C24	cap., elec., 10 mf - 6V	1	97800	XF1	fuseholder	1
24003	C26,27	cap., elec., 2 X 20 mfd - 450 V & 2 X 10 mfd - 350V	2	97027	XV1,2	socket, 9 pin min. w/shield	2
20043	C28	cap., molded, .03 mf	1	97025	XV3,4	socket, 9 pin min.	2
91000	F1	fuse, 2A	1	97032	XV5,6,7	socket, octal	3
50011	J1-2,	phono-input, dual	1	40000		nut, hex, 6-32	28
	3-4,5-6			40001		nut, hex, 3/8-32	10
50013	J7	phono-input, single	1	40005		nut, hex, 10-24	10
50016	J8,9	ac receptacle	2	40007		nut, hex, 4-40	8
10425	R1	res., 56K Ω , 1/2W, 10% (G-BI-O)	1	40017		nut, tinnerman, 8-32	8
18019	R2	pot., 500K Ω , (level)	1	41003		screw, 8-32 X 3/8	4
1042	R3	res., 330K Ω , 1/2W, 10% (O-O-Y)	1	41006		screw, 10-24 X 3/8	10
10426	R4,43	res., 33K Ω , 1/2W, 10% (O-O-O)	2	41014		screw, 6-32 X 3/8	28
10427	R5	res., 1.2K Ω , 1/2W, 10% (Br-R-R)	1	41016		screw, 4-40 X 1/4	8
11523	R6,8	res., 68K Ω , 1/2W, 5% CD	2	41026		screw, 4-40 X 1/4	2
18020	R7	pot., 1M Ω , (bass)	1	41027		screw, wood, #4 X 3/8	2
11531	R9	res., 470K Ω , 1/2W, 5% CD	1	41028		screw, 8-32 X 1	4
18008	R10	pot., 500K Ω , CT w/switch (treble)	1	42000		washer, lock, 3/8	5
10410	R11	res., 100K Ω , 1/2W, 10% (Br-B-Y)	1	42001		washer, flat, 3/8	5
10420	R12	res., 3.3K Ω , 1/2W, 10% (O-O-R)	1	42002		washer, lock, #6	28
10428	R13,17	res., 47K Ω , 1/2W, 10% (Y-V-O)	2	42004		washer, lock, #10	12
18021	R14	pot., compentrol, 500K Ω (loudness)	1	42007		washer, lock #4	10
10400	R15,32	res., 10K Ω , 1/2W, 10% (B-B-O)	2	42011		washer, flat, #10	10
10429	R16	res., 470 Ω , 1/2W, 10% (Y-V-Br)	1	42030		washer, fibre, flat, 3/8	1
10430	R18	res., 4.7K Ω , 1/2W, 10% (Y-V-R)	1	42031		washer, fibre, shoulder, 3/8	1
10424	R19,20	res., 22K Ω , 1/2W, 10% (matched)	2	42032		washer, flat, #8	4
10424	R21	res., 22K Ω , 1/2W, 10% (R-R-O)	1	43002		lug, #10	3
10850	R22	res., 33K Ω , 1W, 10% (O-O-O)	1	43006		lug, #4	2
10431	R23,24	res., 470K Ω , 1/2W, 10% (Y-V-Y)	2	46000		grommet, rubber, 3/8	1
10955	R25,26	res., 47K Ω , 2W, 10% (matched)	2	46006		bumper, rubber	4
11527	R27,28	res., 100K Ω , 1/2W, 5% CD	4	50012		bakelite for dual phono input	1
	34,35			51006		phono plug	6
10432	R29,30	res., 1K Ω , 1/2W, 10% (Br-B-R)	2	53007		knob, round	5
14301	R31	res., 6K Ω , 10W, 10%	1	53008		knob, round w/1/2" shank	5
19009	R33	pot., 100 Ω , W.W. (hum bucking)	1	57000		line cord	1
11536	R36	res., 4.7M Ω , 1/2W, 5% CD	1	58000		hook-up wire	length
11511	R37	res., 560K Ω , 1/2W, 5% CD	1	58300		spaghetti	length
11518	R38	res., 2.2M Ω , 1/2W, 5% CD	1	58408		cable, coax	length
10023	R39	res., 68K Ω , 1/2W, 20% (BI-G-O)	1	58501		wire, bare	length
10020	R40	res., 33K Ω , 1/2W, 20% (O-O-O)	1	80043		panel	1
11510	R41	res., 1.138K Ω , 1/2W, 5% CD	1	81077		chassis	1
11526	R42	res., 200K Ω , 1/2W, 5% CD	1	81078		bottom plate	1
11524	R44	res., 117.7K Ω , 1/2W, 5% CD	1	81903		cable clamp	1
11528	R45	res., 375K Ω , 1/2W, 5% CD	1	97300		tube shield	2
				66297		manual of instructions (kit only)	
				66041		manual of instructions (wired only)	

Note: CD means "deposited carbon" type



SELECTOR SWITCH S1 POSITIONS
(shown on schematic in furthest counter-clockwise position, position 1)

POSITION	SETTING
1	TAPE
2	TV
3	TUNER
4	AUX.
5	COL.
6	LON.
7	RIAA
8	AM-78
9	EUR-78

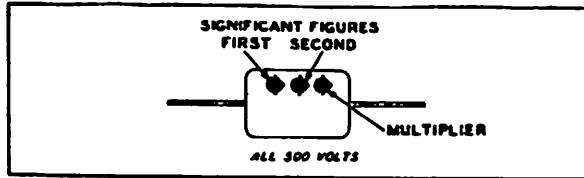
Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description		
C1	cap., .22 mfd	C16	cap., 100 mfd	R1	res., 54KΩ, 1/2W, 10%	R15	res., 10KΩ, 1/2W, 10%	R29	res., 1KΩ, 1/2W, 10%	R43	res., 33KΩ, 1/2W, 10%
C2	cap., .02 mfd	C17	cap., 3300 mfd	R2	pot., 500KΩ, (level)	R16	res., 470Ω, 1/2W, 10%	R30	res., 1KΩ, 1/2W, 10%	R44	res., 117.7KΩ, 1/2W, 5% CD
C3	cap., .05 mfd	C18	cap., 5000 mfd	R3	res., 330KΩ, 1/2W, 10%	R17	res., 47KΩ, 1/2W, 10%	R31	res., 6KΩ, 10W, 10%	R45	res., 375KΩ, 1/2W, 5% CD
C4	cap., 2200 mfd	C19	cap., 850 mfd	R4	res., 33KΩ, 1/2W, 10%	R18	res., 4.7KΩ, 1/2W, 10%	R32	res., 10KΩ, 1/2W, 10%	R46	res., 2.4KΩ, 1/2W, 5% CD
C5	cap., 3300 mfd	C20	cap., 900 mfd	R5	res., 1.2KΩ, 1/2W, 10%	R19	res., 22KΩ, 1/2W, 10% (matched)	R33	pot., 100Ω, W.W. (sum bucking)	R47	res., 560Ω, 1/2W, 10%
C6	cap., 100 mfd	C21	cap., 2700 mfd	R6	res., 68KΩ, 1/2W, 5%	R20	res., 22KΩ, 1/2W, 10% (matched)	R34	res., 100KΩ, W.W. (sum bucking)	R48	res., 350Ω, 7W, 10%
C7	cap., .1 mfd, 10%	C22	cap., 47 mfd	R7	pot., 1MΩ, (boom)	R21	res., 22KΩ, 1/2W, 10%	R35	res., 100KΩ, 1/2W, 5% CD	S1	switch, 6P-9Posn. (selector)
C8	cap., .02 mfd, 10%	C23	cap., .02 mfd	R8	res., 68KΩ, 1/2W, 5% CD	R22	res., 33KΩ, 1W, 10%	R36	res., 4.7KΩ, 1/2W, 5% CD	S2	switch, SPST, (off) on R10
C9	cap., 5000 mfd	C24	cap., 10 mfd - 6V	R9	res., 470KΩ, 1/2W, 5% CD	R23	res., 470KΩ, 1/2W, 10%	R37	res., 560KΩ, 1/2W, 5% CD	T1	power transformer
C10	cap., .1 mfd, 10%	C25	cap., .1 mfd, 10%	R10	pot., 500KΩ, C.T., switch (treble)	R24	res., 470KΩ, 1/2W, 10%	R38	res., 2.2KΩ, 1/2W, 5% CD	T2	output transformer
C11	cap., .1 mfd, 10%	C26	cap., 2 X 20 mfd - 450V & 2 X 10 mfd - 350V	R11	res., 100KΩ, 1/2W, 10%	R25	res., 47KΩ, 2W, 10% (matched)	R39	res., 68KΩ, 1/2W, 5% CD	V1-2	tube, 12AX7
C12	cap., .1 mfd, 10%	C27	cap., 2 X 20 mfd - 450V & 2 X 10 mfd - 350V	R12	res., 3.3KΩ, 1/2W, 10%	R26	res., 47KΩ, 2W, 10% (matched)	R40	res., 33KΩ, 1/2W, 5% CD	V3-4	tube, 12AU6A
C13	cap., .1 mfd, 10%	C28	cap., .03 mfd, 20%	R13	res., 47KΩ, 1/2W, 10%	R27	res., 100KΩ, 1/2W, 5% CD	R41	res., 1.138KΩ, 1/2W, 5% CD	V5-6	tube, 6L6GB
C14	cap., 30 mfd - 50V			R14	pot., compentrol, 500KΩ (loudness)	R28	res., 100KΩ, 1/2W, 5% CD	R42	res., 200KΩ, 1/2W, 5% CD	V7	tube, 6U4
C15	cap., 330 mfd - 800V										



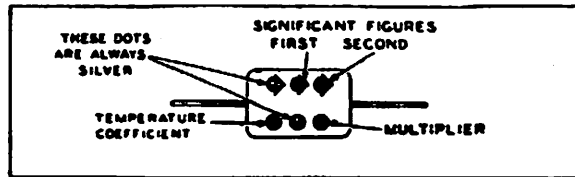
MODEL HF20 HIGH FIDELITY AMPLIFIER

CAPACITOR COLOR CODES

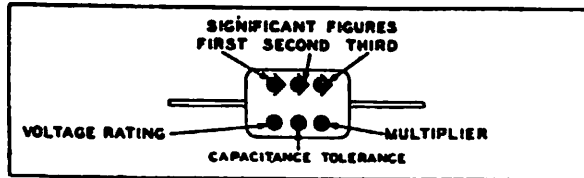
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



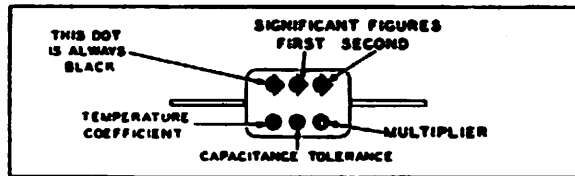
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



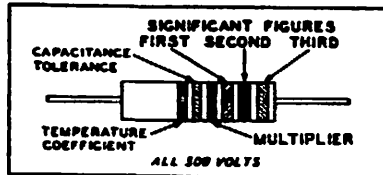
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



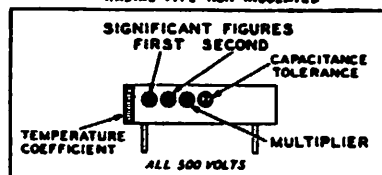
JAN 8-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



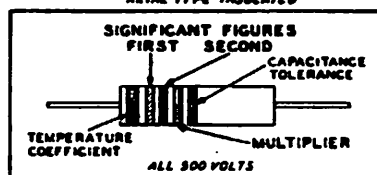
RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS



AXIAL TYPE INSULATED

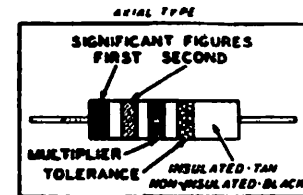


RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

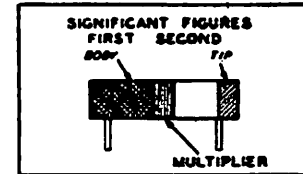
RESISTORS			CAPACITORS					
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	MULTIPLIER			VOLTAGE RATING	TEMPERATURE COEFFICIENT
				RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC		
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1000	3	ORANGE	1000	1000	1000	300	D
	10000	4	YELLOW	10000			400	E
	100000	5	GREEN	100000			500	F
	1000000	6	BLUE	1000000			600	G
	10000000	7	VIOLET	10000000			700	
	100000000	8	GRAY	100000000		0.01	800	
	1000000000	9	WHITE	1000000000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

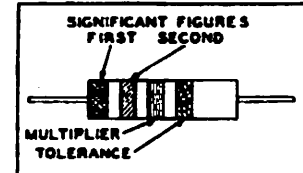


RADIAL TYPE

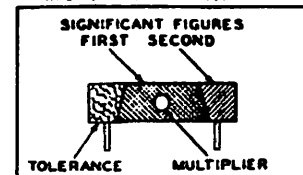


JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED



MODEL HF - 20 SUPPLEMENTARY CONSTRUCTION INFORMATION

To aid in the rapid and correct identification of resistors and capacitors, we have prepared a list of these components with the exact color coding of each part indicated (where the part may be color coded) or with the equivalent numerical values in the various units of resistance and capacitance (where the part value is normally printed as a number). Please note that many of the parts for which color coding is given may not be color coded, but have their values and ratings printed. It is also useful to know that 5%, 10% and 20% resistors are color coded, whereas 1% resistors have their value printed; also, that molded tubular capacitors may or may not be color coded, whereas disc capacitors and electrolytics will always have their values printed (rarely, some disc capacitors may be color coded). The letter K following the value on a resistor or capacitor is a multiplier (X1000), indicating that the printed numerical value must be multiplied by 1000 to obtain the value in ohms or micro-micro farads respectively (if the K does not follow the value, it may signify a $\pm 10\%$ tolerance). Finally, please note the following relationship between the units used to express resistance or capacity.

$$1,000,000 \text{ ohms } (\Omega) = 1000 \text{ kilohms } (K\Omega) = 1 \text{ megohm } (M\Omega)$$

$$1,000,000 \text{ micro-micro farads } (mmf) = 1 \text{ micro farad } (mf)$$

PARTS IDENTIFICATION LIST

<u>Sym.</u>	<u>Description</u>
C1	.22 mf (red-red-yellow-black-yellow)
C2	.02 mf = 20,000 mmf = 20K
C3	.05 mf (green-black-orange-black-yellow)
C4	2200 mmf = .0022 mf = 2.2K
C5,17	3300 mmf = .0033 mf = 3.3K
C7,25,28	.1 mf, 20% (brown-black-yellow-black-yellow)
C8,23	.02 mf = 20,000 mmf = 20K
C9	5000 mmf = .005 mf = 5K
C10,11 12,13	.1 mf, 10% (brown-black-yellow-white-yellow)
C15	330 mmf = .00033 mf
C18	5000 mmf = .005 mf = 5K
C19	850 mmf = .00085 mf
C20	500 mmf = .0005 mf
C21	2700 mmf = .0027 mf = 2.7K
C22	47 mmf = .000047 mf
R1	56K, 10% (green-blue-orange-silver)
R3	330K, 10% (orange-orange-yellow-silver)
* { R4,43	33K, 10%, 1/2W (orange-orange-orange-silver)
* { R22	33K, 10%, 1W, (orange-orange-orange-silver)
R5	1.2K, 10% (brown-red-red-silver)
R6,8	68K, 5% (blue-grey-orange-gold)
R9	470K, 5% (yellow-violet-yellow-gold)
R11	100K, 10% (brown-black-yellow-silver)
R12	3.3K, 10% (orange-orange-red-silver)
* { R13,17	47K, 10%, 1/2W (yellow-violet-orange-silver)
* { R25,26	47K, 10% (matched), 2W, (yellow-violet-orange-silver)
R15,32	10K, 10% (brown-black-orange-silver)
R16	470 Ω , 10% (yellow-violet-brown-silver)
R18	4.7K, 10% (yellow-violet-red-silver)
* { R19,20	22K, 10% (matched) (red-red-orange-silver)
* { R22	22K, 10% (red-red-orange-silver)
R23,24	470K, 10% (yellow-violet-yellow-silver)
R27,28	100K, 5% (brown-black-yellow-gold)
34,35	
R29,30	1K, 10% (brown-black-red-silver)
R36	4.7M, 5% (yellow-violet-green-gold)
R37	560K, 5% (green-blue-yellow-gold)
R38	2.2M, 5% (red-red-green-gold)

* Identical value resistors bracketed together can be distinguished from one another by the larger physical size of the resistors of larger power rating. Also, all matched pairs of resistors have been placed in a separate bag.

HF20 CONSTRUCTION BOOK ADDENDA

Page 9

Left hand column, Step 2: Change value of C5 to 2700mmf $\pm 10\%$.

Left hand column, Step 5: Change value of C3 to .1 mfd 400V.

Left hand column, Step 8: For "a piece of bare wire", substitute "a 47K Ω , 1/2W, 10% resistor (from R10-6 (S) to ground lug "D" (S).

Left hand column, Step 12: Change value of C2 to 2200mmf, 10%.

Right hand column, Step 3: Change value of R18 to 1.5K Ω , 1/2W, 10%.

Right hand column, Step 4: Change value of C9 to 850mmf, $\pm 10\%$.

Please correct Fig. 5 on page 8 in accordance with the above listed changes.

Page 1. (last step in Output Stage wiring): Resistor R48 is 350 Ω , 10W, not 350 Ω , 7W.

Please also make the following changes in your instruction book (white pages).

Parts list of opposite schematic: the third item in the second column reads:

14700 R48 res., 350 Ω , 7W, 10% 1

It should read:

14302 R48 res., 350 Ω , 10W, 10% 1

The parts list under the schematic reads:

R48 res., 350 Ω , 7W, 10%

It should read:

R48 res., 350 Ω , 10W, 10%

The Replacement Parts List

Stk. # 10400 should read: 10400 R15 res., 10K Ω , 1/2W, 10% (B-B-O) 1

ADD to the Parts List: 11500 R32 res., 10K Ω , 1/2W, 5% CD 1

Also make the change on the parts list under the schematic.

ADDENDA MODEL HF 20

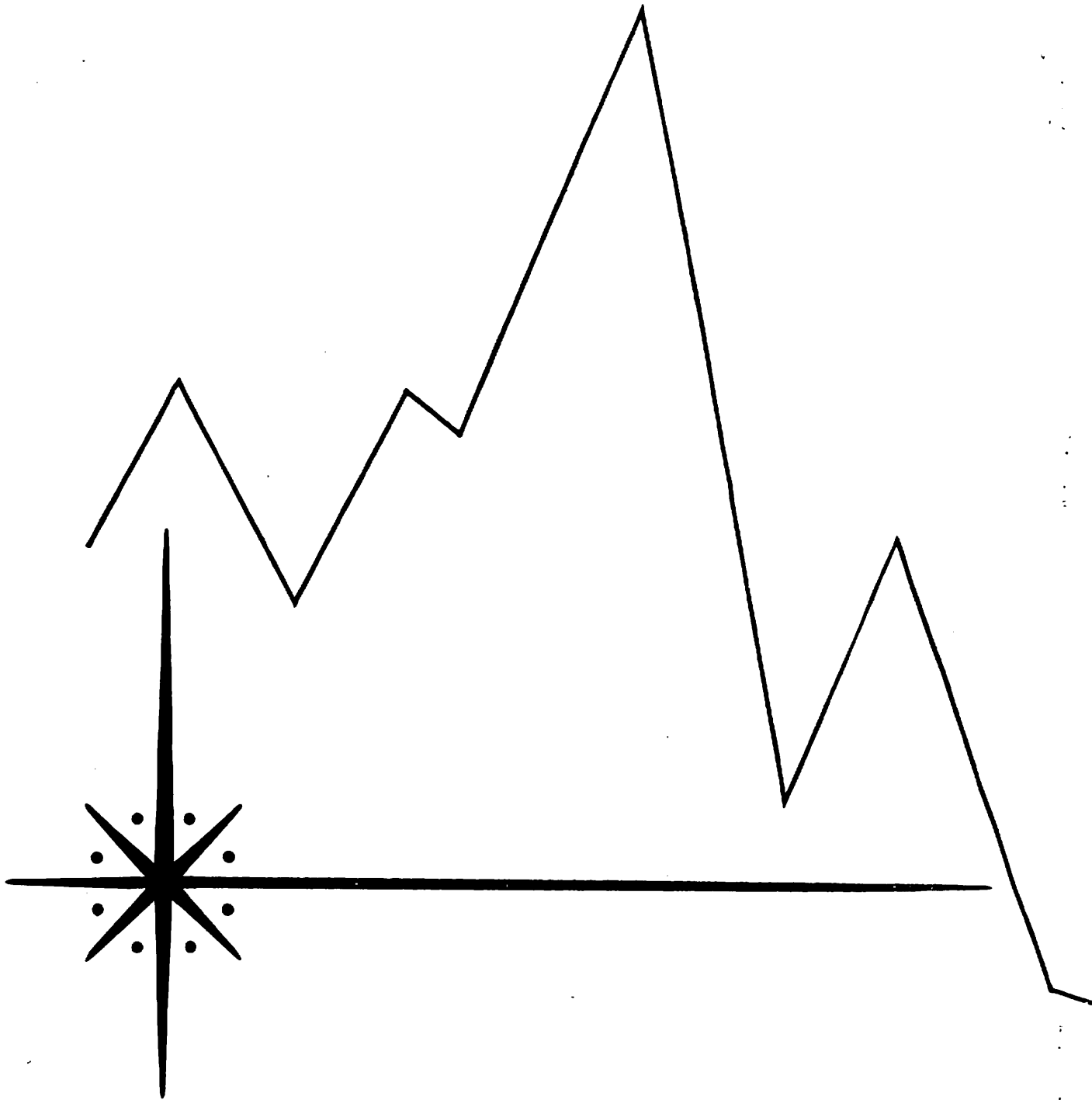
To improve the performance possible from the HF20, certain parts values have been changed from the values given in your book. A part has been added also for this reason. Please correct your book as follows before beginning the construction.

REPLACEMENT PARTS LIST & SYMBOL IDENTIFICATION LIST BELOW SCHEMATIC DIAGRAM

OLD		NEW		
SYM.	STOCK#	DESCRIPTION	STOCK#	DESCRIPTION
C2	22506	cap., disc., .02 mfd, 20%	22507	cap., disc., 2200 mmf, ±10%
C3	20042	cap., disc., .05 mfd	20039	cap., .1 mfd, 400 V
*C5	22508	cap., 3300 mmf	22518	cap., 2700 mmf, ±10%
C9	22511	cap., disc., 5000 mmf, 20%	22514	cap., disc., 850 mmf, ±10%
R18	10430	res., 4.7KΩ, 1/2W, 10%	10442	res., 1.5KΩ, 1/2W, 10%(Br, G, R)
ADD				
**R49	new component		10428	res., 47KΩ, 1/2W, 10%(Y, V, O)

* In row beginning 22508, strike out C5 and change quantity from 2 to 1. Add new C5 as a separate line.

** R49 should be connected between the tap on pot R10 and ground instead of the jumper previously used. Connect schematic diagram accordingly.



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