

SIGNAL TRACER

MODEL
145 A



ELECTRONIC INSTRUMENT CO. INC.
3300 NORTHERN BLVD., L. I. CITY 1, N. Y.



general description

GENERAL DESCRIPTION

The Model 145A Signal Tracer provides remarkably complete facilities in very compact form. Any type of substitution testing may be performed and a valuable noise locator circuit has been included. Very important also is the careful attention that has been given to the basic requirements of good audio quality and high sensitivity. The Model 145A is essentially the Model 147A Signal Tracer with eye tube indicator and wattmeter omitted.

FEATURES

1. Two input channels: high-gain RF and low-gain audio. RF channel gain more than adequate for tracing up to receiver input.
2. Shielded RF crystal demodulator and direct probes provided. Individual panel receptacles provided for easy change-over from RF to audio tracing or visa versa.
3. Valuable noise locator circuit ferrets out noisy controls, resistors, capacitors, coils, transformers, cold solder joints, etc.
4. May be connected as substitute speaker, amplifier, or output transformer.
5. Output for VTVM or oscilloscope.
6. Transformer operated for isolation and safety.

SPECIFICATIONS

Tube & Diode Complement: 1- 12AX7 dual triode as voltage amplifiers, 1- 6AQ5 as beam power amplifier, 1- 6X4 as full-wave rectifier.

Power Requirements: 105-125 volts ac 50/60 cycles.

Size: 7 13/16" high, 5 9/16" wide, 5 1/16" deep.

Shipping Weight: 7lbs.

CIRCUIT DESCRIPTION

The Model 145A Signal Tracer is basically a transformer-operated three-stage, high gain audio amplifier. A speaker is coupled to the output for aural monitoring. The first stage is intended primarily to preamplify the audio stripped from the a-m broadcast or test oscillator signal by the RF crystal demodulator probe. The last two stages form a low-gain audio amplifier provided with a separate input and a direct audio probe. In this way, normal audio circuit

exploration can be carried on with the possibility of amplitude or rectification distortion minimized and the lowest possible hum and noise level. As the gain control is in the grid circuit of the second stage, it is effective when either channel is used. Additional test facilities provided are a noise locator circuit, and substitute test speaker, amplifier, and output transformer.

One triode section of the 12AX7 tube (V1A) is the pre-amplifier or first stage; the other triode section of the 12AX7 tube (V1B) is the second amplifier and is coupled conventionally to the 6AQ5 beam power output tube V2, which is the third amplifier. The primary of the output transformer connected to the last stage is tapped so that substitution may be made for the output transformer in either a single-ended or push-pull amplifier.

A panel switch (INPUT SELECTOR S1) in the grid circuit of the V1B tube section permits this grid to be connected in the following ways: a) to the plate of the V1A triode preamplifier for RF signal tracing; b) to the AUDIO panel connector via blocking capacitor C2 for low-gain audio signal tracing; c) same as (b) but approximately 130 VDC placed on AUDIO panel connector for application to suspected components in NOISE testing.

Another panel switch, OUTPUT SELECTOR S2, connects the instrument for either tracing or the various substitution tests, as well as switching AC supply power on and off. As the power must be off when the instrument is used as a substitution output transformer, AC OFF and TEST OUT. XFMR are the same position of the switch. At the TRACE and TEST AMP-TEST SPKR. positions, the power is on as is obviously required for the TRACE and TEST AMPLIFIER functions (although not for the TEST SPKR. function).

The transformer-operated, full wave rectifier power supply utilizes a quadruple electrolytic filter capacitor to provide maximum filtering for hum-free operation. The hum level is further reduced by a hum-balancing control. As a result of these important measures toward hum reduction, inherent hum is extremely low and the hum heard while using the high gain (RF) input can be classified as grid hum. As the RF probe circuit actually constitutes an extension of the V1A triode grid circuit, this is understandable.

It is only natural that there be some hum when the high gain input channel is used with the gain control set at maximum. While a triode is used as the input stage, which is desirable, a certain amount of sporadic microphonic operation is normal and to be expected. Almost any tube used in this application would exhibit this condition to some extent. However, it should be possible to use maximum gain without meeting a continuous microphonic condition.

operation

GENERAL

Signal tracing a receiver consists of following or tracing a broadcast signal or the radio-modulated output of an r-f signal generator through the various stages of a receiver by connecting an indicating device, such as signal tracer, first to the input and then to the output of each succeeding stage. The trouble is thereby located in the stage between the point at which the desired signal disappears or is not of proper strength, or an undesired signal (such as hum, noise, or oscillation) appears, and the last previous point at which no trouble was encountered. Once the defective stage is located, control and operating voltage checks are made, which, if necessary, are followed by d-c resistance checks and special components tests such as tube tests, value and leakage checks of capacitors, and noise locator tests. These tests allow the final determination of the defect in the stage which signal tracing has localized as the source of the trouble.

A good r-f signal generator is highly desirable for signal tracing (especially in weak signal areas) since it provides a steady signal of controlled strength and frequency as well as constant audio-frequency modulation. This is particularly important in estimating signal level and gain-per-stage with an external VTVM or scope. For detecting distortion, however, it is preferable to employ a broadcast signal, since distortion in music or speech can be detected much more readily by ear than distortion in a single-frequency tone. Of course, if distortion is to be detected visually with a scope, the single-frequency modulated output of a signal generator must be used, as distortion would be impossible to detect visually in the varying complex tone of music or speech.

In checking f-m sets or the sound section of a tv receiver, it is not necessary to use a frequency-modulated signal except in the a-f section. An a-m carrier can be traced using the RF channel as far as the ratio detector; or if a phase discriminator is used, it can be detected as a d-c voltage in the output circuit of the discriminator. To determine proper operation of the a-f stage, an a-m signal can be fed to the receiver at the antenna input terminals. Sufficient audio signal will get through to provide a quality check. As with a-m receivers, distortion is checked by listening to broadcast music or speech.

Obviously, all-wave receivers can be checked on the broadcast band as well as an ordinary a-m receiver. If the defect is encountered on all bands, it will be revealed by signal tracing on the broadcast band. If the defect is encountered on one band and not on the others, then the trouble is in the r-f, mixer, or oscillator sections since the rest of the receiver is the same on all bands. If the oscillator and mixer sections check properly, then the trouble is localized to the r-f section. It is recommended that the r-f signal generator be set at 600 kc for testing

standard a-m broadcast and all-wave receivers since the capacity of the ganged tuning capacitor in the receiver is high when set to tune in this frequency. As a result, the additional shunt capacity introduced by connecting the test probe to the circuit will not cause appreciable detuning.

RF SIGNAL TRACING

Connect the RF probe to the panel connector marked RF INPUT. Set the INPUT SELECTOR at RF. Set the OUTPUT SELECTOR at TRACE if the aural (speaker) monitor is desired, or at TEST SPKR-TEST AMPL if it is more convenient to work with the speaker off and a VTVM or scope is connected to the VTVM-SCOPE jack.

The loudness of the signal from the signal tracer speaker is the indication of signal level. Note that the loudness of the signal depends both upon the strength of the signal at the point to which the probe is touched and the setting of the GAIN control. To maintain constant any desired loudness that you may choose as a reference level, normally you must reduce the GAIN control setting (turn it counter-clockwise) progressively as you trace the signal thru the receiver point-by-point starting from the antenna input terminals. With practice, you will get to know whether the gain of a particular stage is approximately normal by how much the GAIN control must be turned down to maintain the same loudness as you move the test probe from the input to the output of the stage. For an actual numerical check of gain-per-stage, a scope or vtvm should be connected to the panel terminals provided. The GAIN control can be used to establish any desired reference level. The signal tracer will provide more than enough gain to permit easily observable differences in readings or deflections.

Let us take the case of the weak receiver as a typical servicing problem, and outline the signal tracing method of locating the cause of the trouble. It is assumed that routine checks of tubes, of voltages on tube elements, of line voltage, and of adequacy of antenna for receiver and location have not revealed the reason for weak signals, and that therefore signal tracing is indicated. As the receiver is operative, either tune the receiver to a local station, preferably around 600 kc, or connect a signal generator between the antenna and ground terminals and feed a 600 kc audio-modulated signal to the operating receiver. Turn down the volume control of the receiver, as it is the sound emanating from the signal tracer speaker which is of interest during the tests, not the sound from the receiver speaker. Connect the ground lead of the RF probe to B minus or ground of the receiver under test and apply the test probe directly to the antenna terminal or to the antenna loop. Turn up the signal tracer gain control until sufficient indication of the signal level is obtained. The test probe can then be moved along the

normal signal path point-by-point: to the grid and then the plate of the RF stage, if one is present; to the grid and then the plate of the mixer or converter tube; to the grid and then the plate of the first IF tube; and then to the grid and plate of any other IF tubes, in order, and on into the detector stage. As was discussed previously, the operator will with experience come to know whether or not normal stage gain is being obtained in each particular stage.

It should be noted that the input capacity of the RF probe may in some cases be sufficiently large to cause a slight detuning effect when touched to tuned circuits and may induce oscillation. If this should occur, it would generally be wiser to pass on to the next test point rather than to conclude that the receiver is defective in this respect. If the receiver gives good signal indication at the next test point, in all likelihood the effect just described is responsible and the receiver is operating properly.

AUDIO SIGNAL TRACING

To trace the signal through the audio stages following the detector in the receiver circuit, neither the RF probe nor high gain is required. To provide the best fidelity of reproduction and the lowest possible hum and noise level, a shielded direct probe and the low gain audio channel are used. The audio probe is plugged into the AUDIO INPUT pin jacks, and the INPUT SELECTOR set at AUDIO to connect to the low gain amplifier. Here again, the OUTPUT SELECTOR is set to TRACE or TEST SPKR-TEST AMPL (no aural indication). Note that all output transformers in receivers are of the step-down type to match the relatively high impedance of the output tube plate circuit to the low impedance of the speaker. Naturally, therefore, a sharp drop in signal voltage will be observed when the probe is moved from the primary winding of the output transformer to the secondary winding. Elsewhere in the a-f section, of course, the gain increases as the probe is moved from the detector toward the speaker.

It is important to realize that the presence of signal at a particular point may indicate improper operation just as much as the absence of signal at some other point. For example, it is common practice to employ a large capacitor to bypass the bias resistor in the cathode circuit of the output stage. If signal voltage is picked up at the cathode, obviously the bypass capacitor is not performing its function and is probably open.

NOISE LOCATOR

The noise locator circuit is used to locate noisy and intermittent components. A filtered dc voltage taken from the power supply is applied via the audio probe to the suspected component and the effect amplified so that it is heard through the speaker. The ground clip of the audio probe of course provides the necessary ground return circuit. The applied voltage at no load is about 130 vdc ($\pm 20\%$), but there is no danger of damaging receiver components since

the short circuit current is about 1 ma. Some care should be taken in handling the probe, although the shock that can result from careless handling is relatively harmless.

Noise locator tests are made only when the receiver under test is completely disconnected from the a-c line. The instrument is set up for noise testing by setting the INPUT SELECTOR at NOISE, the GAIN control at near maximum clockwise rotation, and the OUTPUT SELECTOR at TRACE. The following is a typical example of noise location procedure, taking the plate circuit of the IF stage as an example: Connect the audio probe ground clip to the B plus supply point and apply the audio probe to the plate of the IF tube. If a sharp clean click is heard at the instant of contact, with no frying, crackling, or buzzing sound afterwards as the probe is held at the test point, it indicates that there are no noisy or intermittent components in the path from the plate of the IF tube to the B plus point to which the ground clip is connected. If frying, crackling, or buzzing is heard, then there is a noisy or intermittent component in the path. In the latter case, the obvious procedure is to move the test probe down toward the B plus point, checking at each junction between two components in the path. In all likelihood, the noise indication will disappear at some point along the path. When this occurs, return the test probe to the last point at which the noise indication appeared, and check the component between this point and the point at which the noise indication disappeared for a possible defect.

The noise locator test will show up noisy and intermittent resistors, volume and tone controls, capacitors and cold solder joints. The part under test should be jiggled or prodded in order to determine whether or not an intermittent or noisy condition exists.

PANEL CONNECTIONS

For the utmost flexibility and convenience, seven pin jacks are provided on the panel for connection of the instrument as a substitute amplifier, substitute speaker, substitute output transformer, and for connection of the signal tracer output to a vtvm or scope. Specific instructions follow for setting up and connecting to the instrument for each function.

SUBSTITUTE SPEAKER: With the OUTPUT SELECTOR set at TEST SPKR-TEST AMPL, the voice coil terminals of the internal speaker are available at the TEST SPKR and GND pin jacks.

SUBSTITUTE AMPLIFIER: With the OUTPUT SELECTOR set at TEST SPKR-TEST AMPL, connections to the output transformer secondary of the tracer amplifier are available at the TEST AMPL and GND pin jacks.

SUBSTITUTE OUTPUT TRANSFORMER (PLUS SPEAKER): With the OUTPUT SELECTOR set at AC OFF-TEST OUT, XFMR, connect the plate lead of single-ended power amplifiers to either P pin jack and the B+ lead to the B+ pin

jack. For push-pull amplifiers, connect one power amplifier plate lead to one P pin jack and the other plate lead to the other P pin jack; connect the B+ lead to the B+ pin jack. The OUTPUT SELECTOR should be turned to AC OFF-TEST OUT, XFMR before connections to the output transformer pin jacks are made (there is a dangerously high B+ voltage on the B+ pin jack when the instrument is on). The OUTPUT SELECTOR should not be moved from the AC OFF position during the test or before unmaking the pin jack connections at the conclusion of the test.

SERVICE

If at any time trouble develops in the operation of your instrument, consult the circuit diagram and the circuit description for aid localizing the defective circuit. A chart of normal operating voltages and also of resistances measured with the unit off is provided for aid in identifying the defective component. 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 \$3.50 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, 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 Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, New York. 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.

VOLTAGE AND RESISTANCE CHART

TUBE	PIN#	VOLTS	OHMS (UNIT OFF)
ECC83/12AX7 V1	1	85 VDC	330K Ω
	2	-1 VDC (approx.)	10 Meg Ω
	3	0	0
	4 & 5	6.3 VAC	0
	6	105 VDC	270K Ω
	7	0	0
	8	0.9 VDC	2.2K Ω
	9	0	0
	6AQ5 V2	1	0
2		13 VDC	330 Ω
3		0	0
4		6.3 VAC	0
5		260 VDC	1.15K Ω
6		265 VDC	1K Ω
7		0	470K Ω
6X4 V3	1	270 VAC	250 Ω
	2	-	-
	3	0	0
	4	6.3 VAC	0
	5	-	-
	6	270 VAC	250 Ω
	7	310 VDC	100K Ω or greater

Voltages given are operating voltages measured to ground with no signal. Resistances are measured to ground with unit off. Cathode of rectifier (pin 7 of V3) shorted to ground during all resistance measurements except when measuring resistance from pin 7 of V3 to ground. CONTROL SETTINGS: GAIN at minimum, INPUT SEL. to RF, OUTPUT SEL. to TEST SPKR. Voltage measurements are made with a VTVM or 20,000 Ω /V VOM. Operating line voltage at which voltage measurements are made is 117 VAC, 60 cps. NOTE: ALL VOLTAGE & RESISTANCE VALUES MAY VARY NORMALLY BY $\pm 15\%$.

PARTS LIST

Stock#	Sym.	Description	Am't.	Stock#	Sym.	Description	Am't.
22513	C1	cap., disc., .005mfd (5K or 5000mmf) 10%	1	41016		screw, #4-40 x 1/4 Bd.H.	6
22517	C2,3,4	cap., disc., .025mfd (25K or 25000mmf) 10%	3	41035		screw, #6 P. K.	2
24003	C5	cap., elec., 2x 20/450V - 2x 10/350V	1	42000		washer, lock, #3/8	5
95000	CR1	rectifier, 1N48	1	42001		washer, flat, #3/8	3
92000	I1	pilot light, #47	1	42002		washer, lock, #6	7
50001	J2,7,8	jack, pin, black	5	42007		washer, lock, #4	6
	9,10			42012		washer, star (for pin jacks)	9
50000	J2,4,5,6	jack, pin, red	4	42019		washer, rubber	1
50002	J3	mic. connector, male	1	43000		lug, ground, #6	2
10402	R1	res., 10MΩ (black,brown,blue,silver) 1/2W, ±10%	1	43001		pot ground lug	1
10431	R2,8,14	res., 470KΩ (yellow,violet,yellow,silver) 1/2W, ±10%	3	45000		eyelet, brass	2
10410	R3	res., 100KΩ (black,brown,yellow,silver) 1/2W, ±10%	1	46000		grommet, 3/8 rubber	1
10417	R4,7	res., 220KΩ (red,red,yellow,silver) 1/2W, ±10%	2	46005		feet, rubber	4
18043	R5	pot., 500KΩ, audio taper	1	47001		spring	1
10423	R6	res., 2.2KΩ (red,red,red,silver) 1/2W, ±10%	1	51000		connector, female	1
10862	R9	res., 330Ω (orange,orange,brown,silver) 1W, ±10%	1	51004		tip, pin	2
10422	R10	res., 68KΩ (blue,greys,orange,silver) 1/2W, ±10%	1	51502		clip, crocodile	2
10436	R11	res., 47Ω (yellow,violet,black,silver) 1/2W, ±10%	1	53006		knob, round bar	3
14501	R12	res., 1KΩ, 5W, ±10%	1	54507		board, probe	1
10428	R13	res., 47KΩ (yellow,violet,orange,silver) 1/2W, ±10%	1	55302		grill, speaker	1
60053	S1	switch, input selector	1	55500		probe, red	1
60058	S2	switch, output selector	1	57000		line cord	1
55005	SP1	speaker	1	58004		wire, hook-up	length
32009	T1	transformer, output	1	58300		spaghetti	length
30023	T2	transformer, power	1	58401		cable, mic.	length
54007	TB1,2	terminal strip, 3 post, 2right w/ground	2	58403		cable, grey	length
90034	V1	tube, 12AX7	1	58501		wire, bore #22	length
90047	V2	tube, 6AQ5	1	58502		braid, flat	1
90036	V3	tube, 6X4	1	80055		panel	1
97712	X11	socket, pilot lamp	1	81123		chassis	1
97025	XV1	socket, 9 pin min. bottom mount	1	87003		handle, leather	1
97024	XV2,3	socket, 7 pin min. bottom mount	2	88034		cabinet	1
40000		nut, hex, #6-32	9	89511		probe, nosepiece	1
40001		nut, hex, #3/8	3	89512		probe, tip	1
40005		nut, hex, #10-24	2	89524		probe, shell	1
40007		nut, hex, #4-40	2	97710		pilot light jewel	1
41000		screw, #6-32 x 1/4 Bd.H	9	66061		instruction manual (wired)	1
41012		screw, #10-24 x 3/8	2	66310		instruction manual (kit)	1

NOTE: When ordering replacement parts, please include all of the following information: 1) stock number and description given in parts list; 2) quantity; 3) model number of instrument; 4) serial number of instrument (on panel). This information will expedite the processing of your order and insure your receiving the correct replacement parts.

GENERAL INSTRUCTIONS

The section of the manual beginning with this page is the CONSTRUCTION section. All pages in this section have page numbers followed by "C" (1C, 2C, etc.). The INSTRUCTION section resumes on the pages following the CONSTRUCTION section. Note that the CONSTRUCTION section is located centrally in the book and may be removed without disrupting the INSTRUCTION section that both precedes it and follows it.

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. Very often wires are placed as shown for a good reason, and certainly the appearance of the completed instrument will be improved and the difficulty of finding a wiring error will be reduced by the following the wire and parts layout shown.

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 will find that the value of a component will vary within the allowable circuit tolerance. For example, the $4.7\text{K}\Omega$, $\pm 10\%$ resistor may measure anywhere between $4.2\text{K}\Omega$ and $5.2\text{K}\Omega$. Tolerances on paper capacitors are substantially greater, and the tolerance for electrolytics is usually $+100\%$ and -50% .

CONSTRUCTION HINTS: USE THE BEST GRADE OF ROSIN CORE SOLDER ONLY, preferably one containing the new activated fluxes such as Kester "Resin-Flux", Ersa "Multicore" or similar types. UNDER NO CIRCUMSTANCES USE ACID CORE SOLDER OR ACID FLUX since acid flux can cause serious corrosion. Before soldering make a 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 supplied, 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 sol-

dered 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 resistors, capacitors, and transformers are often longer than required. These leads should be trimmed to the proper length when necessary. Do not cut any lead until you have determined the required length when the lead is routed as shown in the diagrams.

BASIC TOOLS REQUIRED: These basic tools are required for the construction of the amplifier.

1. Screwdriver - $3/16"$ to $1/4"$ blade
2. Screwdriver - $1/8"$ blade
3. Longnose pliers - 5 or 6"
4. Diagonal cutters
5. Soldering iron (100 watts), or soldergun, or pencil iron (35 watts)
6. Gas pliers
7. High quality rosin or equivalent synthetic flux core solder. Do not use acid or paste flux under any circumstances.

A set of spintites and a wire stripper are also very useful supplementary tools.

PARTS IDENTIFICATION: Please note that very many of the parts for which color coding is given may not be color coded, but have their values and ratings printed. The letter K is a multiplier ($\times 1000$) and on resistors or capacitors indicates that the printed numerical value must be multiplied by one thousand to obtain the value in ohms or micro-micro farads respectively. Note also that one microfarad (mf) is equal to one millimicrofarad (mmf). To aid in rapid identification, keep in mind that 5%, 10%, and 20% resistors are color coded whereas 1% resistors have their values printed; also that molded tubular capacitors may or may not be color coded, whereas disc capacitors and electrolytics will always have their values printed. Please note the following relationships between the units used to express resistance or capacity.

$$1,000,000 \text{ ohms } (\Omega) = 1000 \text{ kilohms } (\text{K}\Omega) = 1 \text{ megohm } (\text{M}\Omega)$$
$$1,000,000 \text{ micro-micro farads } (\text{mmf}) = 1 \text{ micro farad } (\text{mf})$$

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. Bend the ground lug tabs on the sockets toward the chassis to prevent accidental shorting to the socket pins.

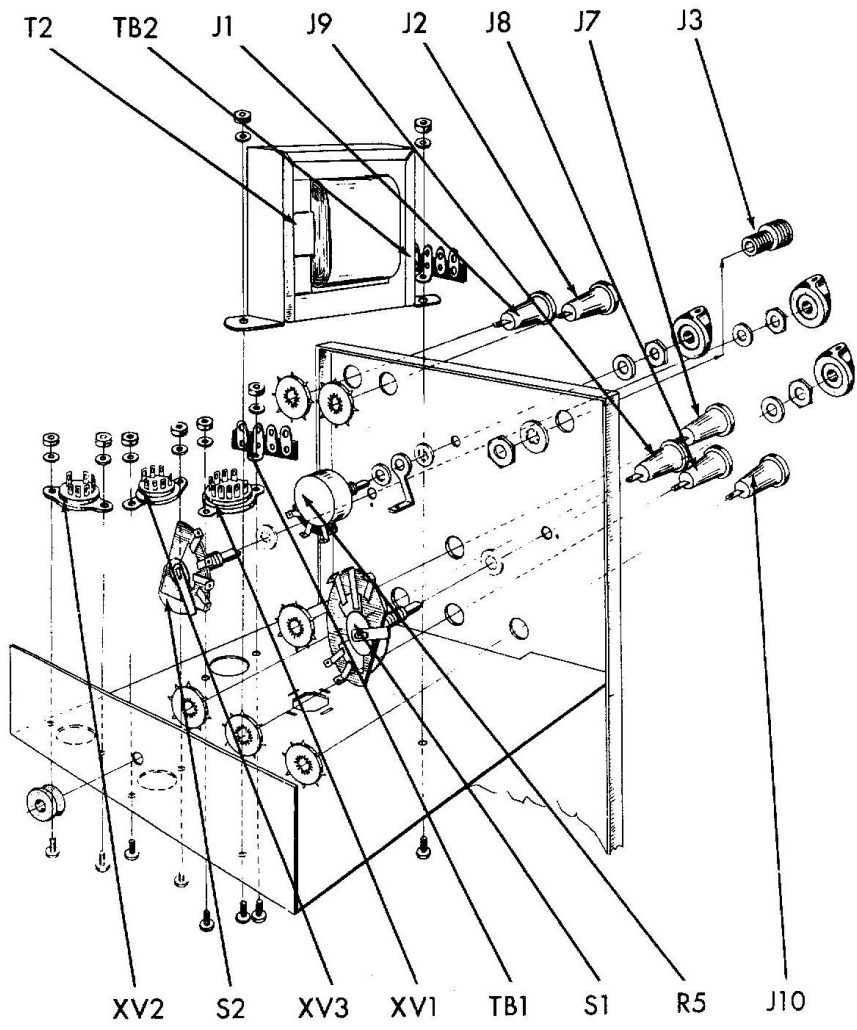


Fig. 1

BELOW CHASSIS MOUNTING - PANEL

1. () Fig. 1. Mount the red pin jack J1, in the lower left hand corner of the panel at the AF IN. Use a star washer. With the smooth or convex rounded side of the star washer facing away from the panel, press the star washer firmly against the panel over the pin jack until the pin jack is held securely.
2. () Fig. 1. In a similar manner, mount black pin jack J2 at the ground of the AF IN, black pin jack J9 at TEST AMP, black pin jack J8 at GND, black pin jack J10 at VTVM SCOPE and black pin jack J7 at TEST SPKR. Use one star washer on each to secure jacks as above.
3. () Fig. 1. Mount the male amphenol connector J3, at hole marked RF IN. Use two lockwashers and a hex nut to secure to panel.
4. () Fig. 1. Mount the 500K Ω gain potentiometer, R5, as shown. Use two 3/8 flat washer, one 3/8 lock washer, one pot grounding lug and one 3/8 hex nut. When tightening nut, let the grounding lug be opposite pin 1 on the pot to facilitate wiring.

BELOW CHASSIS MOUNTING - CHASSIS

5. () Fig. 1. Mount 9 pin miniature tube socket XV1 as shown. Use two #4-40 x 1/4 screws, two #4 lockwashers and two #4-40 hex nuts. Mount a 3 post 2 right with ground terminal strip, TB1, under one of the lockwashers (Fig. 4).
6. () Fig. 1. Mount 7 pin tube sockets XV2 and XV3 as shown. Use two #4-40 x 1/4 screws, two #4 lockwashers and two #4-40 hex nuts (Fig. 4).
7. () Fig. 1. Push the rubber grommet into the 3/8 hole at the rear of the chassis.
8. () Fig. 1. Mount power transformer T2, 30023, as shown. Use two #6-32 x 1/4 screws, two #6 lockwashers and two #6-32 hex nuts. Mount a 3 post 2 right with ground terminal strip, TB2, as shown under one of the lockwashers. The twin black leads should face the outside edge of the chassis.
9. () Fig. 1. The chassis is held to the panel with the two switches. Mount the half wafer output selector switch, S1, and the quarter wafer input selector switch S2, through the chassis and associated panel holes as shown. The key hole adjacent to the mounting hole on the chassis, determines the direction for mounting the switches, by pushing the key on each switch through this hole. Use a 3/8 lockwasher, a 3/8 flat washer, and a 3/8 hex nut on each switch as shown to secure the chassis, panel and switches.

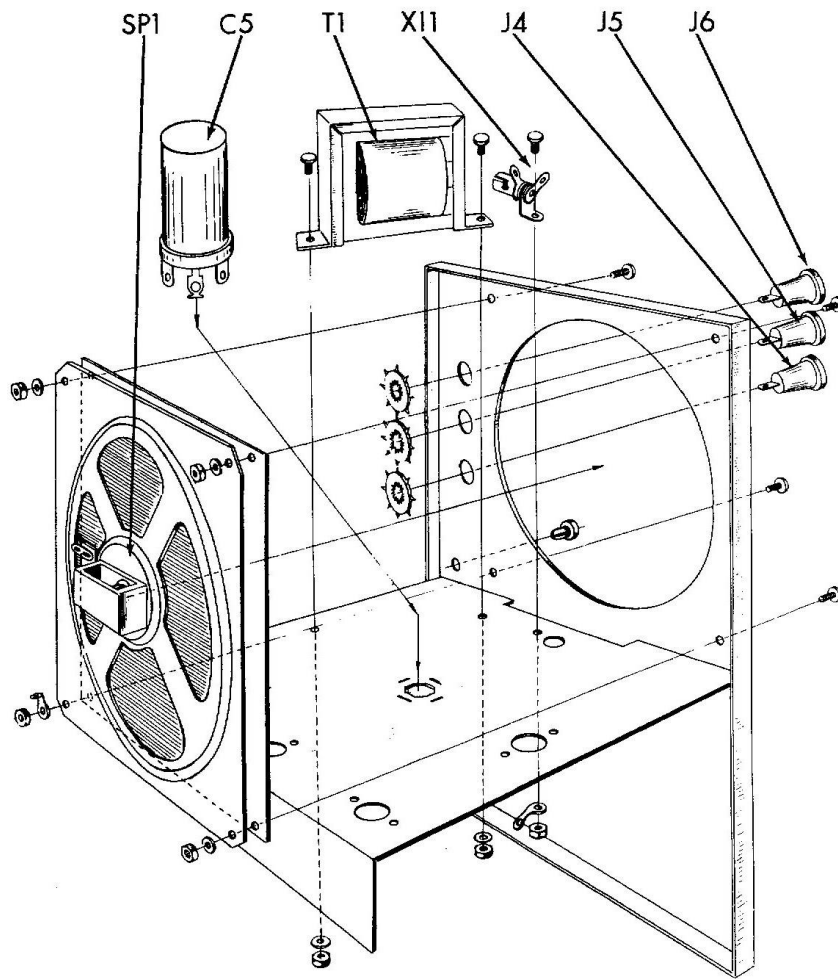


Fig. 2

TOP CHASSIS MOUNTING - PANEL

1. () Fig. 2. Mount the three red pin jacks, J4, J5 and J6 through the three holes marked P, B+ and P as shown. Similar to the above, use one star washer to secure each pin jack to the panel.
2. () Fig. 2. Mount the speaker, SP1 as shown. Place the flocked screen between the speaker and the panel. Use four #6-32 x 1/4 screws, one #6 ground lug, three #6 lockwashers and four #6-32 hex nuts. Note direction of solder lug.
3. () Fig. 2. Press the pilot light jewel firmly into the hole at the front of the panel.
4. () Fig. 3. Connect a 2" piece of bare wire covered with a 1 1/2" piece of spaghetti from SP1-2(C) to ground lug "A" (S).

TOP CHASSIS MOUNTING - CHASSIS

5. () Fig. 2. Mount the pilot light bracket X11, as shown. Use one #6-32 x 1/4 screw, one #6 ground lug and one #6-32 hex nut. Do not tighten as yet.
6. () Fig. 2. Mount the output transformer T1, 32009, as shown. Use two #6-32 x 1/4 screws, two #6 lockwashers and two #6-32 hex nuts. All leads facing the outside edge of chassis.
7. () Fig. 2. Tighten the nut on the pilot light bracket, X11. Turn the bracket so that it does not short against the output transformer, while at the same time permitting the insertion of a pilot light.
8. () Fig. 2. Mount the electrolytic capacitor C2, as shown. Note the position of the three code markers (triangle, semi-circle and square) next to the prongs on 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. See Fig. 4. Solder the tab without a hole to the chassis at its slot.

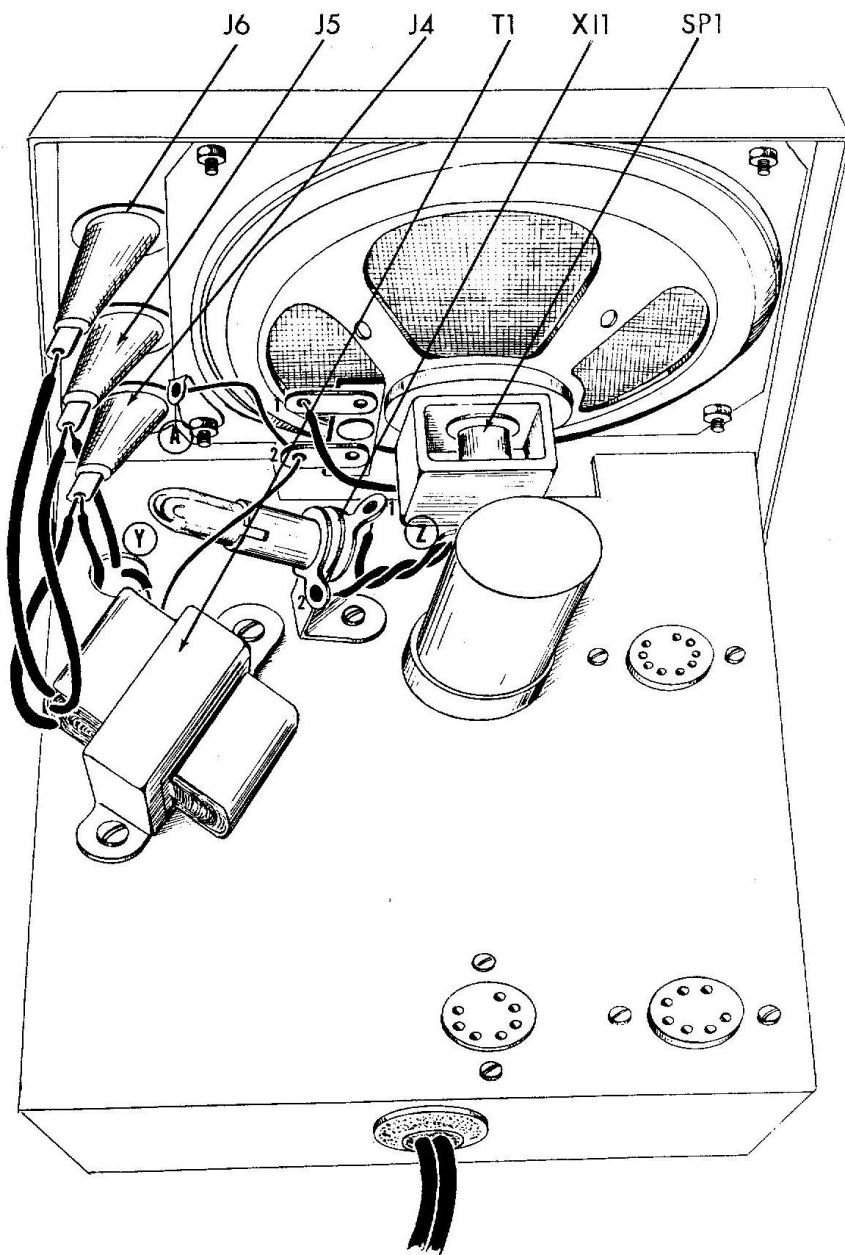


Fig. 3

TOP OF CHASSIS WIRING

1. () Fig. 3. Cut the upper enameled lead from the output transformer, T1, to 2". Scrape off about 1/4" of the enamel insulation from the end of the wire and tin with some solder. Connect to SP1-2 (S).
2. () Fig. 3. Connect one end of a 5" piece of yellow wire to X11-1 (S) and one end of a 5" piece of brown wire to X11-2 (S). Twist the leads together and push through hole "Z".
3. () Fig. 3. Cut the lower enameled lead from the output transformer, T1, to 3" and cover with a 2 3/4" piece of spaghetti. Scrape off about 1/4" of the enamel insulation from the end of the wire and tin with some solder. Push this lead through hole "Y".
4. () Fig. 3. On output transformer, T1, cut the brown lead to 3 1/2", the red lead to 2" and the blue lead to 1 3/4". Connect the blue lead to J4 (C), the red lead to J5 (C) and the brown lead to J6 (S).
5. () Fig. 3. Connect one end of an 8" piece of blue wire to J4 (S). Push the other end through hole "Y".
6. () Fig. 3. Connect one end of a 5" piece of red wire to J5 (S). Push the other end through hole "Y".
7. () Fig. 3. Connect one end of a 5" piece of blue wire to SP1-1 (S). Push the other end through hole "Z".

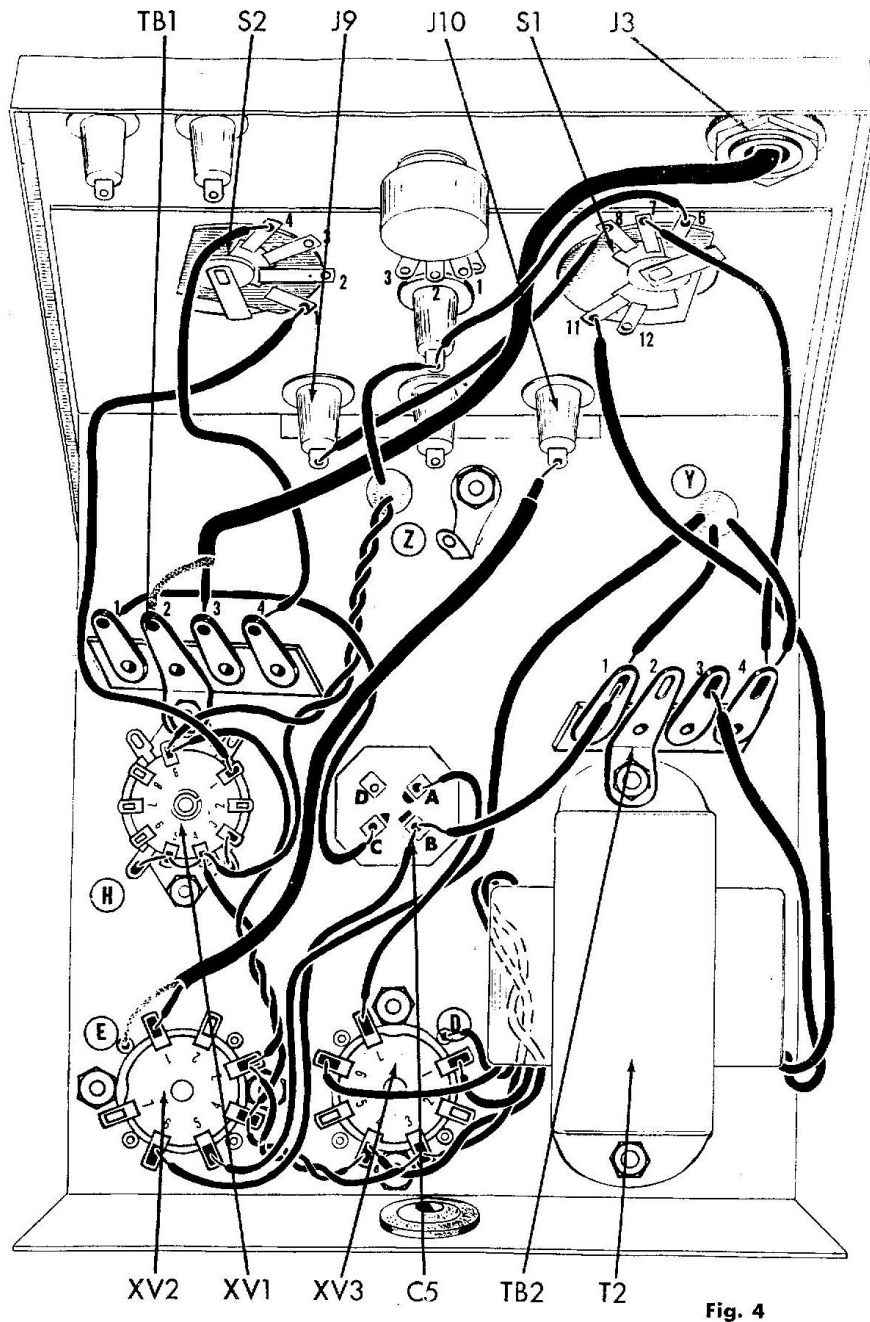
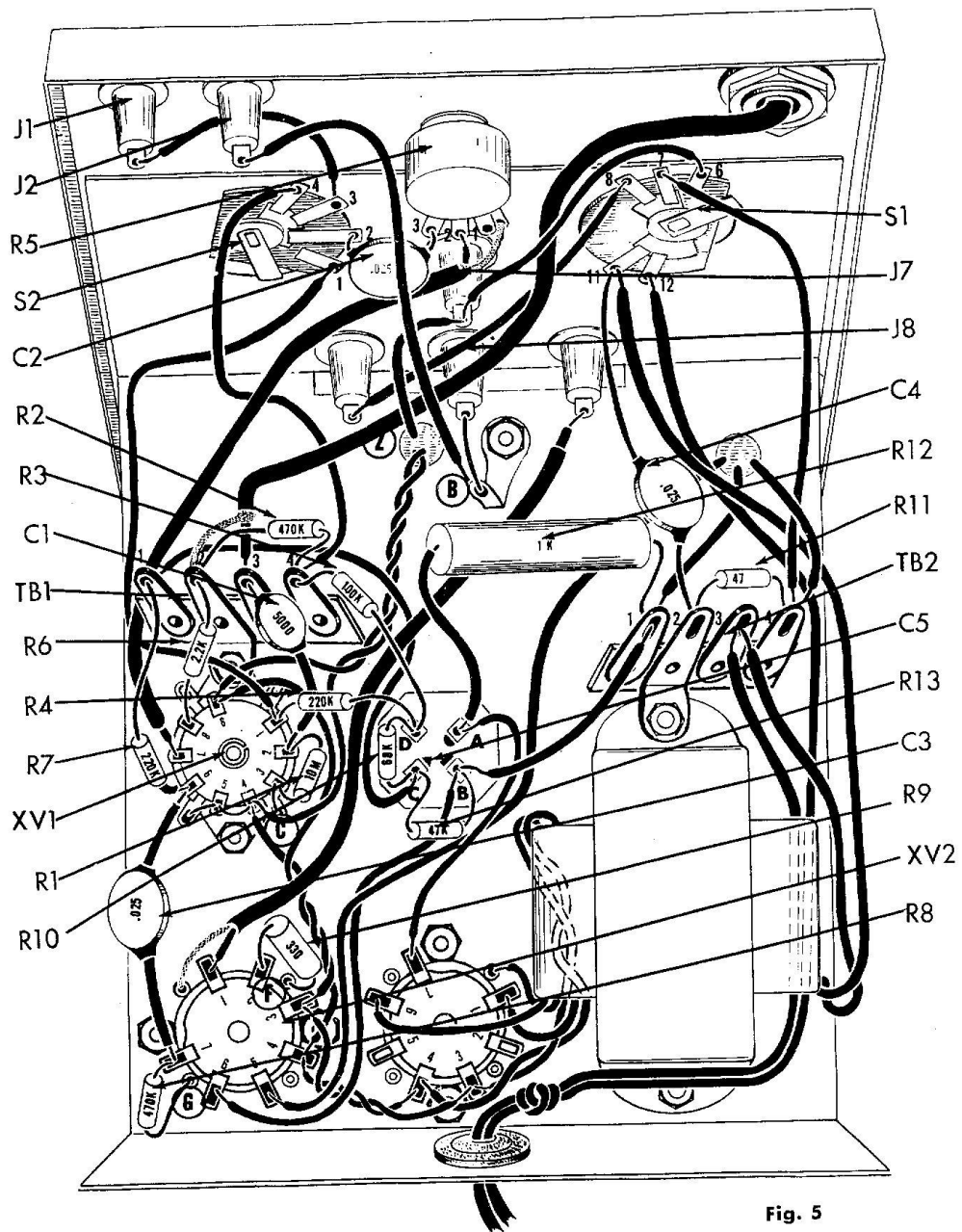


Fig. 4

BOTTOM OF CHASSIS WIRING

1. () Fig. 4. Connect the yellow wire from the twisted pair of wires going through hole "Z" to XV1-4 (C) and the brown wire from the same twisted pair to XV1-9 (C).
2. () Fig. 4. Connect one end of a 4 1/2" piece of brown wire to XV1-9 (S) and one end of a 3 1/2" piece of yellow wire to XV1-4 (C). Twist the two leads together. Connect the other end of the brown lead to XV2-3 (C) and the yellow lead to XV2-4 (C).
3. () Fig. 4. Connect one end of a 2 1/2" piece of brown wire to XV2-3 (S) and one end of a 2 1/2" piece of yellow wire to XV2-4 (S). Connect the other end of the brown wire to XV3-4 (C) and the other end of the yellow wire to XV3-3 (C).
4. () Fig. 4. On power transformer, T2, cut the green lead to 3 1/2" and the green-yellow lead to 4 1/2". Twist the leads and run along the chassis as shown. Connect the green lead to XV3-3 (S) and the green-yellow lead to XV3-4 (S). Cut the brown lead flush with the transformer winding so that no free end hangs loose.
5. () Fig. 4. Cut the red-yellow lead on power transformer T2, to 2". Connect to ground lug "D" (S) at XV3.
6. () Fig. 4. Cut the lower red lead on power transformer to 1 1/2" and connect to XV3-1 (S).
7. () Fig. 4. Cut the upper red lead on power transformer to 2 1/2" and connect to XV3-6 (S). Note: It is immaterial if the connections to XV3-1 and XV3-6 are reversed.
8. () Fig. 4. Connect a 1/2" piece of bare wire from XV1-4 (S) to XV1-5 (C).
9. () Fig. 4. Connect a 3/4" piece of bare wire from XV1-5 (S) to ground lug "H" (S) at XV1.
10. () Fig. 4. Connect the red lead from hole "Y" to TB2-1 (C).
11. () Fig. 4. Connect a 4" piece of red wire from C5B (C) to XV2-6 (S).
12. () Fig. 4. Connect the blue lead from hole "Y" to XV2-5 (S).
13. () Fig. 4. Connect a 3" piece of red wire from C5A (C) to XV3-7 (S).
14. () Fig. 4. Connect a 2" piece of red wire from TB2-1 (C) to C5B (C).
15. () Fig. 4. Cut one black lead on the power transformer, T2, to 7" and the other black lead to 5". Run along the chassis as shown. Connect the longer lead to S1-11 (C) and the shorter one to TB2-3 (C).
16. () Fig. 4. Connect a 4" piece of blue wire from TB2-4 (C) to S1-7 (S).
17. () Fig. 4. Connect the lead covered with spaghetti from hole "Y" to TB2-4 (C).
18. () Fig. 4. Connect a 3 1/2" piece of red wire from C5C (C) to TB1-1 (C).
19. () Fig. 4. Connect a 5" piece of blue wire from S2-1 (S) to XV1-1 (C).
20. () Fig. 4. Connect a 4" piece of red wire from TB1-4 (C) to S2-4 (S).
21. () Fig. 4. Connect a 4 1/2" piece of brown wire from J9 (S) to S1-8 (S).
22. () Fig. 4. Strip back 3/4" the outer insulation from both ends of a 7" piece of shielded cable. Twist the shielded strands together. Cut off these shield strands on one end of the cable. Strip the inner insulation of the inner conductor back 1/4" on both ends. Connect the twisted shield strands to TB1-2 (C) and the inner conductor on the same end to TB1-3 (C). Run the lead along the chassis and panel as shown. Connect the inner conductor on the remaining end to the center of J3 (S), bypassing the lead through the hole in J3. Be careful that excess solder or inner conductor strands do not short this input to ground either on the outside of the connector or internally.
23. () Fig. 4. Strip back 3/4" the outer insulation from both ends of a 5" piece of shielded cable. Twist the shield strands together. Cut off these shield strands on one end of the cable. Strip the inner insulation of the inner conductor back 1/4" on both ends. Connect the twisted shield strands to ground lug "E" (S) at XV2, and the inner conductor on the same end to XV2-1 (S). Run the cable along the chassis as shown, and connect the other end to J10 (S).



1. () Fig. 5. Connect the blue wire from hole "Z" to J7 (C).
2. () Fig. 5. Connect a 3" piece of blue wire from J7 (S) to S1-6 (S).
3. () Fig. 5. Connect a 1" piece of bare wire from J8 (S) to ground lug "B" (C).
4. () Fig. 5. Strip back 3/4" the outer insulation from both ends of a 6" piece of shielded cable. Twist the shield strands together. Cut off these shield strands on one end of the cable. Strip the inner insulation of the inner conductor back 1/4" on both ends. Connect the twisted shield strands to R5-1 (C) and the inner conductor on the same end to R5-2 (S). Run the cable along the chassis as shown and connect the other end to XV1-7 (S).
5. () Fig. 5. Bend the pot grounding lug over R5-1 (S).
6. () Fig. 5. Cut both leads on .025mfd (25K or 25,000mmf) capacitor, C2, to 1/2". Connect from R5-3 (S) to S2-2 (S).
7. () Fig. 5. Connect a 4" piece of brown wire from J2 (S) to ground lug "B" (S).
- 7A. () Fig. 5. Connect a 2" piece of blue wire from J1 (S) to S2-3 (S).
8. () Fig. 5. Cut both leads on a 470K Ω (yellow, violet, yellow, silver) resistor, R2, to 3/4". Connect from TB1-2 (C) to TB1-4 (C).
9. () Fig. 5. Cut both leads on a 2.2K Ω (red, red, red, silver) resistor, R6, to 3/4". Connect from TB1-2 (S) to XV1-8 (S).
10. () Fig. 5. Cut both leads on a 220K Ω (red, red, yellow, silver) resistor, R7, to 3/4". Cover one lead with a 1/2" piece of spaghetti and connect to XV1-6 (C). Connect the other lead to TB1-1 (S).
11. () Fig. 5. Connect a 3/4" piece of bare wire from XV1-3 (C) to ground lug "C" (S) on XV1.
12. () Fig. 5. Cut both leads on a 10M Ω (brown, black, blue, silver) resistor, R1, to 1/2" and connect from XV1-2 (C) to XV1-3 (S).
13. () Fig. 5. Cut both leads on a 220K Ω (red, red, yellow, silver) resistor, R4, to 3/4" and connect from XV1-1 (S) to C5D (C).
14. () Fig. 5. Cut both leads on a 5000mmf (5Kmmf or .005mfd) disc capacitor, C1, to 3/4". Cover one lead with a 1/2" piece of spaghetti and connect to XV1-2 (S). Connect the other lead to TB1-3 (S).
15. () Fig. 5. Cut both leads on a 100K Ω (brown, black, yellow, silver) resistor, R3, to 3/4". Connect from TB1-4 (S) to C5D (C).
16. () Fig. 5. Cut both leads on a 47K Ω (yellow, violet, orange, silver) resistor, R13, to 3/4". Connect from C5B (S) to C5C (C).
17. () Fig. 5. Cut both leads on a 68K Ω (blue, grey, orange, silver) resistor, R10, to 3/4". Connect from C5C (S) to C5D (S).
18. () Fig. 5. Cut both leads on a .025mfd (25K or 25,000mmf) disc capacitor, C4, to 1 1/4". Connect from S1-11 (S) to TB2-2 (C).
19. () Fig. 5. Cut both leads on a 47 Ω (yellow, violet, black, silver) resistor, R11, to 3/4". Connect from TB2-2 (S) to TB2-4 (S).
20. () Fig. 5. Cut one lead on the 1K Ω (1000 ohm) 5 watt resistor, R12, to 1/2" and the other lead to 1 1/2". Cover the longer lead with a 1 1/4" piece of spaghetti and connect to C5A (S). Connect the other lead to TB2-1 (S). Dress resistor away from the other leads.
21. () Fig. 5. Cut both leads on a 330 Ω (orange, orange, brown, silver) 1 watt resistor, R9, to 3/4". Connect from XV2-2 (S) to ground lug "F" (S) on XV2.
22. () Fig. 5. Cut both leads on a 470K Ω (yellow, violet, yellow, silver) resistor, R8, to 1/2". Connect from XV2-7 (C) to ground lug "G" (S).
23. () Fig. 5. Cut both leads on a .025mfd (25K or 25,000mmf) capacitor, C3, to 1 1/4" and cover each lead with a 1" piece of spaghetti. Connect from XV1-6 (S) to XV2-7 (S).
24. () Fig. 5. Push the line cord through the grommet at the rear of the chassis and make a knot 7" from the end of the cord with the tinned leads, inside the chassis. "Zip" the two leads apart from the tinned end for 3" and cut one of the leads 2" from the end. Connect the longer lead to S1-12 (S) and the shorter lead to TB2-3 (S).

RF PROBE CONSTRUCTION

First, press fit the probe tip into the rectangular notch at one end of the board as shown in Fig. 6. Then install the 1N48 crystal diode, CR1, on the same side of the board the solder lug is on (Fig. 7) between the probe tip and eyelet 1, cathode to eyelet 1, (cathode side of crystal indicated by band or by direction of rectifier symbol — cathode K anode). To do this, pass the cathode lead of the crystal through eyelet 1 and bend back this lead on the other side of the board when the crystal is positioned properly. Solder the anode lead of the crystal to the flat shank of the probe tip and trim off excess. On the same side of the board, install the 470KΩ resistor, (yellow, violet, yellow, silver) R14, one lead in eyelet 1 and the other lead through eyelet 2. Bend back the leads on the other side of the board to lock the resistor in place, and then trim off excess. Solder eyelet 1 (see Fig. 8). To avoid overheating the crystal diode, hold each crystal diode lead with pliers when soldering the terminal to which the lead is connected. When soldering is completed, lay the terminal board aside.

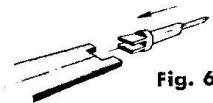


Fig. 6



Fig. 8

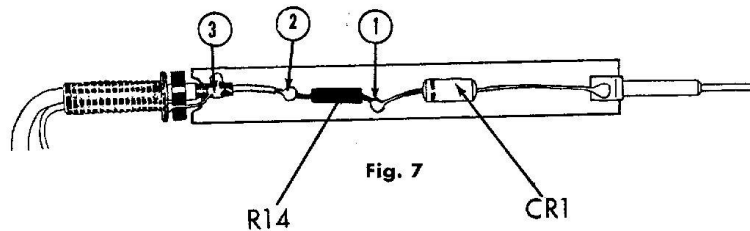


Fig. 7

Strip the grey co-axial cable and the ground lead (stranded wire) as shown in Fig. 9. Position the ground lead in the spring as shown in Fig. 10, and solder it to the spring, as shown, at the point indicated in the drawing. Then insert the co-axial cable in the spring as shown in Fig. 10. Push the rubber washer over the stripped end of the co-axial cable on to the outside insulation and position it as shown in Fig. 7. Next position the stripped end of the co-axial cable so that the end of the outside insulation rests inside the semi-circular notch in the end of the terminal board and the outside braid lays across the solder lug. (Check to see that the inner co-axial conductor reaches eyelet 2.) Then bend the solder lug over to grip the cable braid (Fig. 11 is a profile view) and solder the connection, keeping in mind that overheating will soften the inner co-axial insulation with the consequent danger of a short. Bring the stripped end of the ground lead (extending from the solder point on the spring) around the outside of the rubber washer and insert it in eyelet 3 (Fig. 7, after which solder eyelet 3. Insert the inner conductor of the co-axial cable in eyelet 2 (Fig. 7), after which solder eyelet 2.

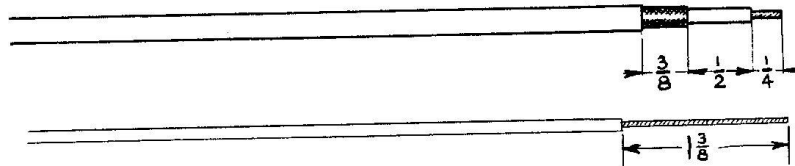


Fig. 9

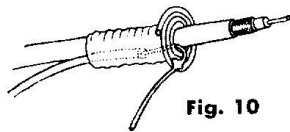


Fig. 10



Fig. 11

Pass the free ends of the co-axial cable and the ground lead through the probe shell from the threaded end. Then grasp the probe tip with one hand and with the other hand move the shell down over the probe body with a rocking motion and without forcing. When the large end of the spring is flush against the rolled over end of the shell, pass the plastic nose-piece over the probe tip and screw it into the shell (see Fig. 12). Complete the ground lead by connecting and soldering and alligator clip to the free end (crimp U-shaped groove in clip over the insulation to make a firm mechanical connection).

Connect the female co-axial connector to the other end of the probe cable as follows (Fig. 13): Strip the cable end exactly as shown. Disassemble the connector. Slip the stripped cable end into the large diameter end of the spring and then solder the small diameter end of the spring to the very edge of the metal braid. Slip the connector ring over the cable end past the spring, unthreaded end first. Pass the cable end thru the tapered end of the connector (threading the inner conductor thru the eyelet in the bakelite disc) until passage is stopped by the large spring diameter. Tighten the set screw in the connector body so that the cable and spring will be secured mechanically. Solder the inner conductor of the cable to the eyelet in the bakelite disc and trim off excess lead. A section of the internally threaded part of the connector ring should extend past the connector body to enable coupling to the male connector on the panel.

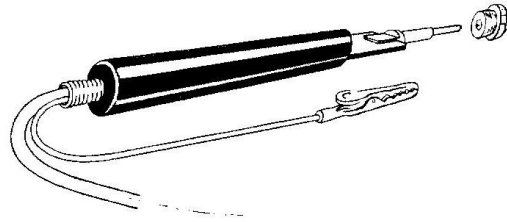


Fig. 12



Fig. 13

AUDIO PROBE CONSTRUCTION

1. () Fig. 14, end A. Strip one end of the 4 ft. length of black shielded test lead as follows: Remove $1\frac{3}{4}$ " of the black outside insulation. From the same end, remove $1\frac{1}{2}$ " of braid. Next, expose $\frac{3}{4}$ " of inner conductor.

Next, solder a 1 ft. length of flat wire braid to the $\frac{1}{4}$ " of exposed shielding at end A. Wrap the end of the flat braid a few turns around the shielding before soldering to ensure a lasting connection. Also be careful not to overheat the shielding while soldering, as this will soften the inner co-axial insulation with the consequent danger of a short.

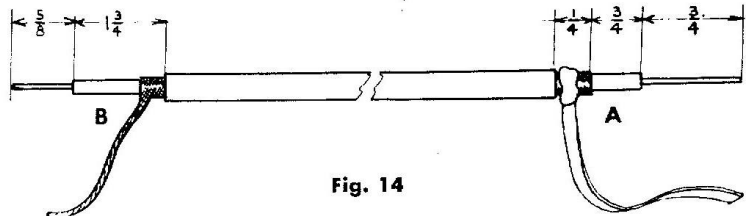


Fig. 14

2. () Fig. 15. Adjust the flat wire braid to a position parallel to the shielded lead and flat against it, the free end of the braid pointing toward the remaining long length of lead. Unscrew the collar from the tip of the red audio probe housing, and slide end A of the shielded lead through the housing until the inner conductor protrudes from the small hole in the tip. Wind the exposed inner conductor around the tip in the clockwise direction and then screw on the collar tightly to secure it. Finally, solder an alligator clip to the free end of the flat wire braid.

3. () Fig. 14, end B. Strip the opposite end of the shielded test lead as follows: Remove $2\frac{3}{8}$ " of black outside insulation. From the same end, remove $2\frac{1}{8}$ " of braid. Next, expose $\frac{5}{8}$ " of inner conductor.

Next, solder a 3 1/2" length of flat wire braid to the 1/4" of exposed shielding at end B. Use the same method described above.

4. () Fig. 16. Complete end B of the shielded lead by soldering pin tips to the inner conductor and to the flat wire braid.

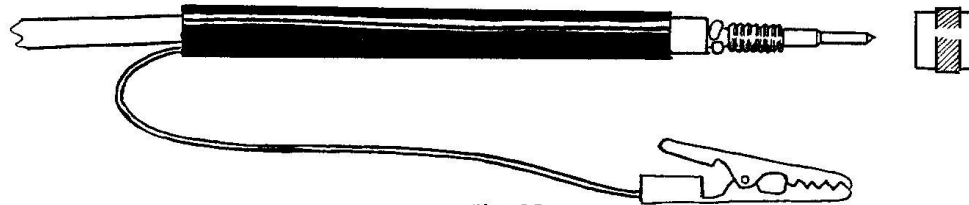


Fig. 15

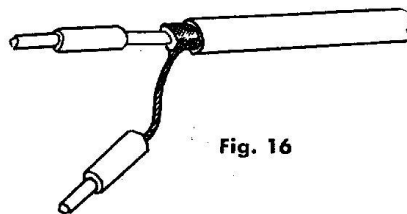


Fig. 16

FINAL STEPS

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

- 1) Make a careful examination of the unit to determine whether all joints are soldered properly. Check for loose lumps of solder and straighten out the wiring and components so that there are no accidental shorts.
- 2) The flowing of rosin between switch contacts causes leakage. If examination reveals the presence of rosin, remove it by briskly cleaning the area between the contacts with a stiff brush saturated with carbon tetrachloride. Be very careful not to spring the contacts when cleaning switches.
- 3) Insert the ECC83/12AX7 tube (V1), the 6AQ5 tube (V2), and the 6X4 tube (V3) in their respective sockets on the chassis as shown in Fig. 17.
- 4) Attach the control knobs as follows:
 - a) Turn the shafts of the INPUT SEL. and OUTPUT SEL. switches and the GAIN control shaft to their furthest counter-clockwise positions.
 - b) Place a knob on the INPUT SEL. switch shaft so that it points at the RF position and tighten the set screw.
 - c) Place a knob on the OUTPUT SEL. switchshaft so that it points at the AC OFF position and tighten the set screw.
 - d) Place a knob on the GAIN control shaft so that it indicates just to the left of the word GAIN on the panel and tighten the set screw.
- 5) Before connecting the instrument to the a-c line, connect an ohmmeter from B plus (V3, pin 7) to ground; the resistance should not be less than 50,000 ohms. (NOTE: Wait until the ohmmeter reading reaches the final value.) If the resistance is under 50,000 ohms, do not connect to the a-c line before you have checked the rectifier circuit and remedied the trouble.

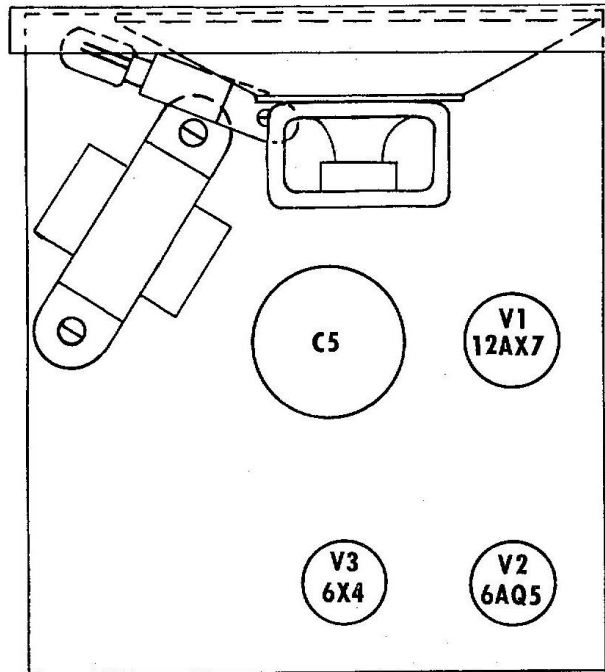


Fig. 17

6) Insert the rubber feet in the openings provided in the bottom of the cabinet as shown. The method is to work the rounded portion of each foot into the interior of the cabinet from the outside, using a small screw driver. The flat portion should be the actual resting or contact surface. See insert drawing of Fig. 18.

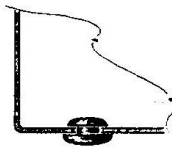


Fig. 18

7) Mount the leather handle on the cabinet using two brass eyelets, two #10-24 screws, and two #10-24 nuts. See Fig. 19 for a detailed drawing of the assembly.

8) Run the ac line cord through the rear cabinet opening and insert the completed unit in the cabinet, fitting the cabinet edges inside the lip around the panel. Use the line cord to position the chassis so that the two #6 holes in the rear chassis apron line up with the corresponding holes in the cabinet rear and insert two #6 P.K. screw. After the screws are tightened, chassis installation is completed.

9) Insert the line cord plug into a 117VAC, 60 cps outlet. Set the OUTPUT SEL. at TRACE and the GAIN control clockwise to near maximum. Connect both the RF and Audio probes to the proper panel connectors. Allow one minute for the instrument to warm up. Now, with the INPUT SEL. set at RF, touching the tip of the RF probe should result in a loud humming sound from the signal tracer speaker. With the INPUT SEL. set at AUDIO, touching the tip of the audio probe should produce a much lower output buzzing or humming sound. If these results are not obtained, the instrument is not functioning properly and should be checked for the cause. Otherwise, the instrument is now ready for use.

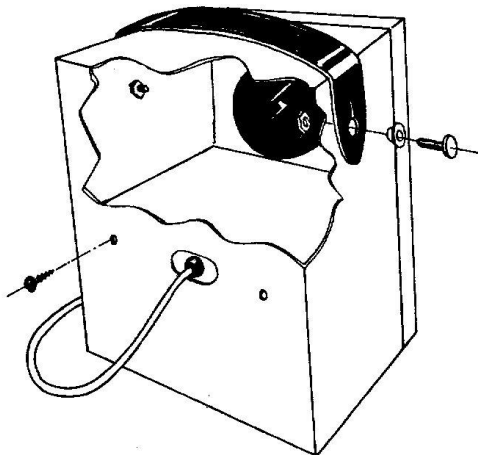


Fig. 19

NOTE

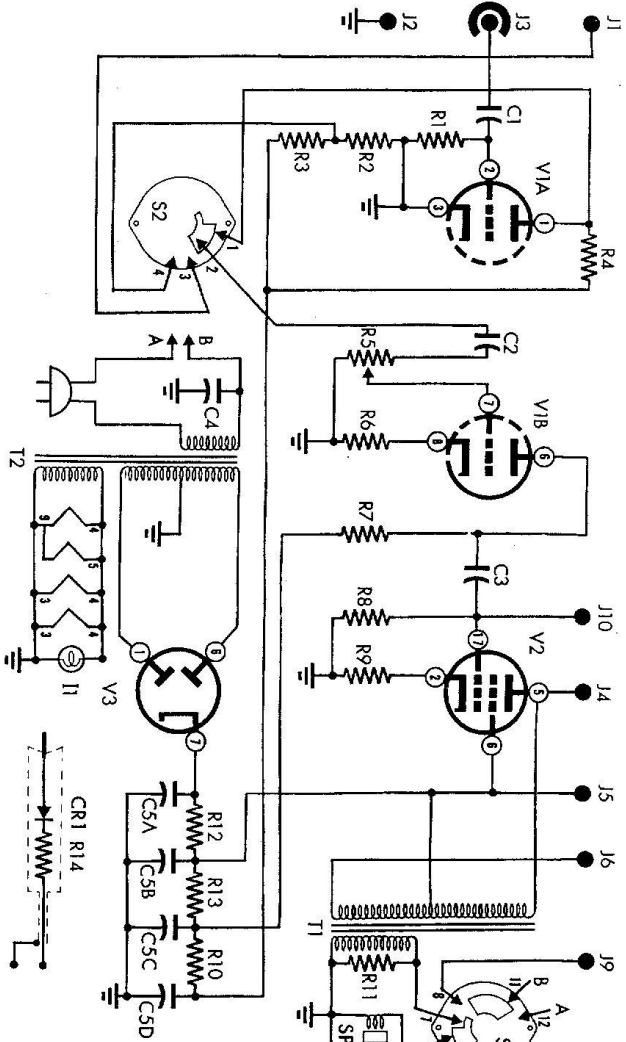
If the instrument fails to operate properly, recheck the wiring for errors or reversed connections, test for continuity, and check individual components for breakdown. Check all dc and ac operating voltages, keeping in mind that all voltages may vary from the values shown by as much as 20% due to component tolerance, line voltage variations, and the type of measuring instrument used (schematic voltages were measured with VTVM).

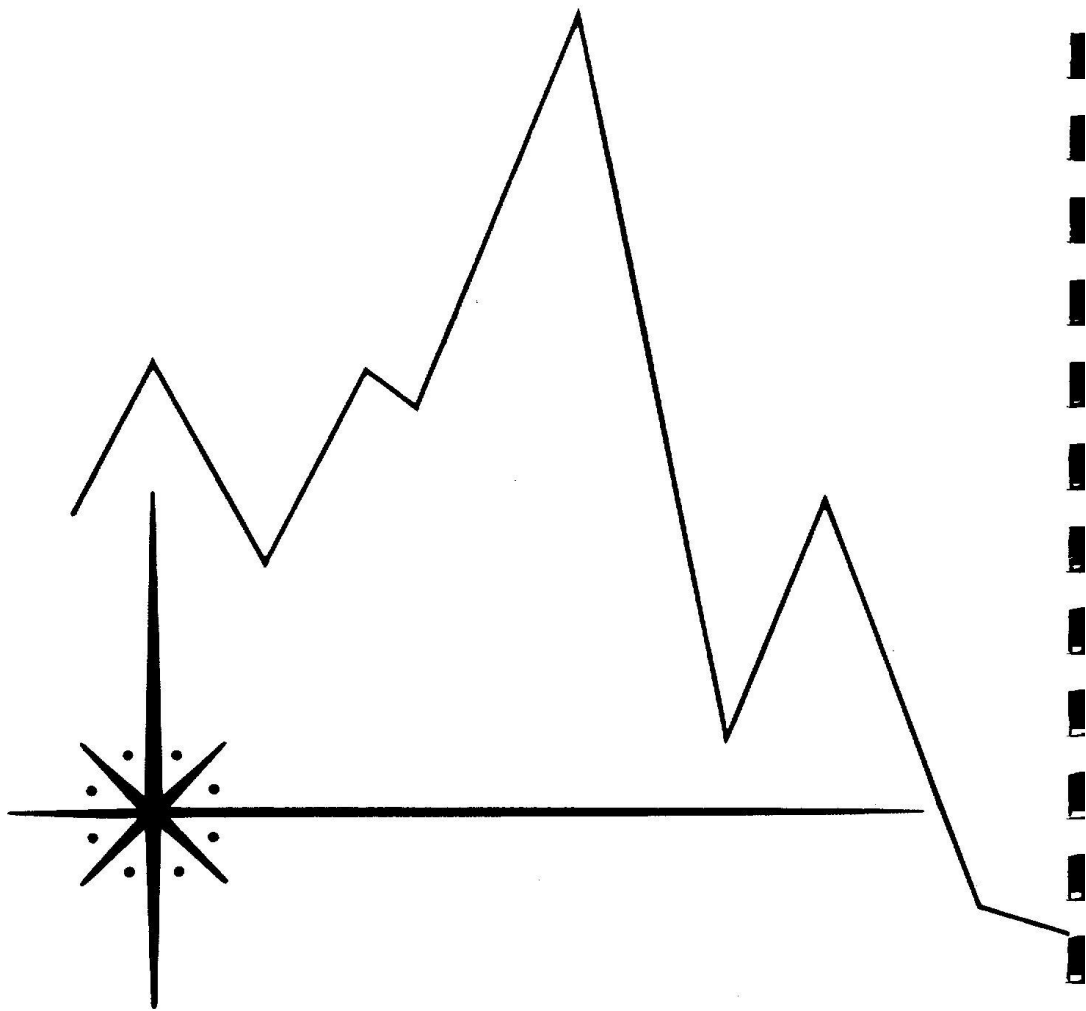
SERVICE

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 \$3.50 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, preferably wood, 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., Long Island City 1, New York. 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.

MODEL 145 A SIGNAL TRACER

Sym.	Description	Sym.	Description	Sym.	Description	Sym.	Description
C1	cap., disc., .005 mfd, 10%	I1	pilot light, 447	J7	Test Speaker	R4	res., 220K Ω , 1/2W, \pm 10%
C2	cap., disc., .025 mfd, 10%	J1	AF Input	J8	Ground	R5	pot., 500K Ω , audio taper
C3	cap., disc., .025 mfd, 10%	J2	Ground	J9	Test Ampl.	R6	res., 2.2K Ω , 1/2W, \pm 10%
C4	cap., disc., .025 mfd, 10%	J3	RF Input	J10	VTVW Scope	R7	res., 220K Ω , 1/2W, \pm 10%
C5	cap., elec., 2 x 20/450V -	J4	Plate (output transformer)	R1	res., 10M Ω , 1/2W, \pm 10%	R8	res., 470K Ω , 1/2W, \pm 10%
CRI	rectifier, 1N48	J5	Bt (output transformer)	R2	res., 470K Ω , 1/2W, \pm 10%	R9	res., 330 Ω , 1W, \pm 10%
		J6	Plate (output transformer)	R3	res., 100K Ω , 1/2W, \pm 10%	S1	Input Selector
						S2	Output Selector
						SP1	speaker
						T1	output transformer
						T2	power transformer
						V1	tube, 12AX7
						V2	tube, 6AG5
						V3	tube, 6X4





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