ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 20

SIGNAL GENERATOR ASSEMBLY I

RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION OF AMERICA
HOME STUDY SCHOOL
350 West 4th Street, New York 14, N. Y.

Experiment Lesson 20

INTRODUCTION

In this Experiment Lesson and the next, you will build your signal generator. This instrument will provide you with r-f and a-f signals for experimental purposes and for troubleshooting and alignment work. The r-f signals cover a continuous range from 170 kc to 50 mc in 5 bands, as follows:

Band A — 170 kc to 550 kc

Band B — 525 kc to 1650 kc

Band C — 1.65 mc to 6.0 mc

Band D — 5.75 mc to 20.0 mc

Band E — 19.0 mc to 50.0 mc

The internal audio oscillator produces a 400-cycle sine wave, which may be obtained as a separate audio-output signal or may be used to modulate the r-f output signal.

Follow the instructions closely and do your wiring and soldering carefully, so that you will be able to rely on your signal generator as a signal source for your experiments and for your future radio and television servicing work.

MATERIALS NEEDED

One selenium rectifier, 20 ma (SR)

One audio choke (L_1) from Kit 8

Capacitors

One 0.1-μf, 400 volts, paper (C_1) from capacitor board

One 0.05 μf, 400 volts (C_2) from capacitor board

One 0.05 μf, 400 volts (C_3) from capacitor board

Three 0.01 μf, 400 volts (C_4, C_6, C_9) one from capacitor board; two from Kit 10

One 0.02 μf, 400 volts (C_5) from capacitor board

One electrolytic, 20 μf – 20 μf, 250 volts (C_7, C_8)

Two 0.006 μf, 600 volts (C_{13}, C_{14})

Resistors

One 47,000 ohm 1/2-watt (R_1)

One 330-ohm 1/2-watt (R_2)

One 8,200-ohm 1/2-watt (R_4)

One 3,300-ohm 1/2-watt (R_5)

One 33,000-ohm 1/2-watt (R_8)

One 5,000-ohm potentiometer (R_7) with switch

One 500,000-ohm potentiometer (R_3) with switch

Miscellaneous

One grounding lug

One 4-lug terminal strip

Two chassis connectors

One pilot-lamp assembly

One pilot-lamp, No. 47 (from Kit 3)

One signal generator front panel

One subchassis (from Experiment Lesson 19)

One support bracket for signal generator

Five feet hookup wire

Spaghetti

One piece of cardboard or heavy paper, about 8" x 10"

Hardware

One 6-32 x 1-inch screw

Four 6-32 x 1/4-inch screws

Six 6-32 nuts

Five No. 6 lock washers

JOB 20-1

To mount the remaining components on the signal generator subchassis. You began to work on the signal generator subchassis in Experiment Lesson 19, when you installed and partly wired the power transformer and tube socket.

Procedure.

Step 1. Prepare the selenium rectifier (SR) for mounting, as shown in Fig. 20-1. Pass a 6-32 x 1-inch screw through the center hole of the rectifier stack. Make sure the cathode terminal is up, as shown in the figure. The cathode terminal is identified by either a + sign, the letter *K*, or the word CATHODE. Thread a 6-32 hex nut on the screw and tighten it. Pass the screw through the proper hole in the chassis, as in the figure. Place the rectifier so that the terminals face the power transformer. On the other side of the chassis place a lock

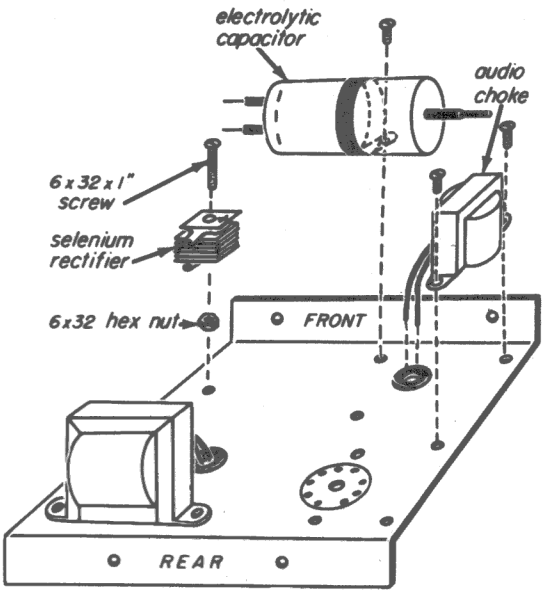


Fig. 20-1

washer and a 6-32 nut on the screw and tighten.

Step 2. Before you mount the audio choke, measure its continuity using the R x 100 range. You should read about 800 ohms. Cut one of the leads of the choke (L_1) so that it is about 3-3/4 inches long and the other lead so that it is about 2-3/4 inches long. Strip off 1/4 inch of insulation from the end of each lead. Place the audio choke on top of the chassis over the proper mounting holes, as shown in Fig. 20-1. Position the choke so that the leads face the 1/4-inch rubber grommet. Pass a 6-32 x 1/4-inch screw through the hole in the choke that is closest to the front edge of the chassis. Fasten, using a lock washer and a 6-32 hex nut. Slip a 6-32 x 1/4-inch screw through the other hole in the choke. On the underside of the chassis, place one side of a 4-lug terminal strip and a grounding lug over this screw as shown in Fig. 20-2. Fasten, using a lock washer and a 6-32 hex nut. Pull the leads of the choke through the 1/4-inch rubber grommet to the underside of the chassis.

Step 3. Fasten the other side of the 4-lug terminal strip to the chassis with a 6-32 x 1/4-inch screw, a hex nut, and a lock washer, as shown in Fig. 20-2. This terminal strip is TS-C.

Step 4. Place the hole in the bracket of the electrolytic filter capacitor (C_7, C_8) so that it is over the proper mounting hole

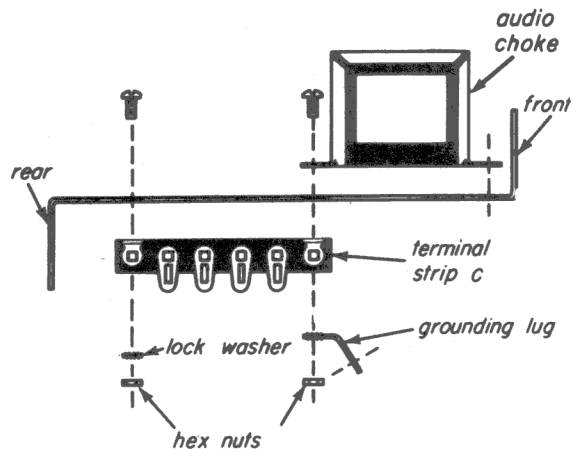


Fig. 20-2

on top of the chassis, as shown in Fig. 20-1. The black (common) lead should face the audio choke. Pass a 6-32 x 1/4-inch screw through the bracket and chassis, and fasten on the underside of the chassis with a lock washer and a 6-32 hex nut. Cut one of the red (positive) leads so that it is 6 inches long and strip 1/4-inch of insulation from the end. Pull the two positive leads of the electrolytic capacitor through the large grommet to the underside of the chassis. Dress the leads so that they are away from the selenium rectifier.

Step 5. Cut the black (common) lead so that it is 3 inches long. Strip 1/4-inch of insulation from the end. Pass it down through the small grommet (next to the choke) to the underside of the chassis.

JOB 20-2

To wire the various component parts on the signal generator subchassis.

Figure 20-3 shows a schematic diagram of the signal generator you will construct. The part of the diagram shown in heavy lines is the portion that will be completed by the end of this lesson. You will wire the half-wave rectifier circuit, the filter circuit, and the audio oscillator. The r.f. oscillator, and its tuning and bandswitching circuits will be wired in Experiment Lesson 21. Figure 20-4 shows a wiring diagram of what you will do in this experiment. Before starting to wire the signal generator, be certain that you have completed the wiring called for in Experiment Lesson 19.

Procedure.

Step 1. Cut the red leads of the power transformer (T_1) so that they are 3 inches long, and remove 1/4-inch of insulation from each end.

Step 2. Looking at the rear of the chassis, connect one of the red leads to the grounding lug at the right side of the transformer on top of the chassis.

Step 3. Connect and solder the other red lead to the *bottom* terminal (plate) of the selenium rectifier.

Step 4. Cut a 6-inch piece of hookup wire. Remove 1/4 inch of insulation from both ends. Connect and solder one end to the *top* (cathode) terminal of the selenium rectifier. Pass the wire down through the large grommet to the underside of the chassis.

Note: Fig. 20-4 does not show existing wiring on the subchassis. Only wiring added in this lesson is shown.

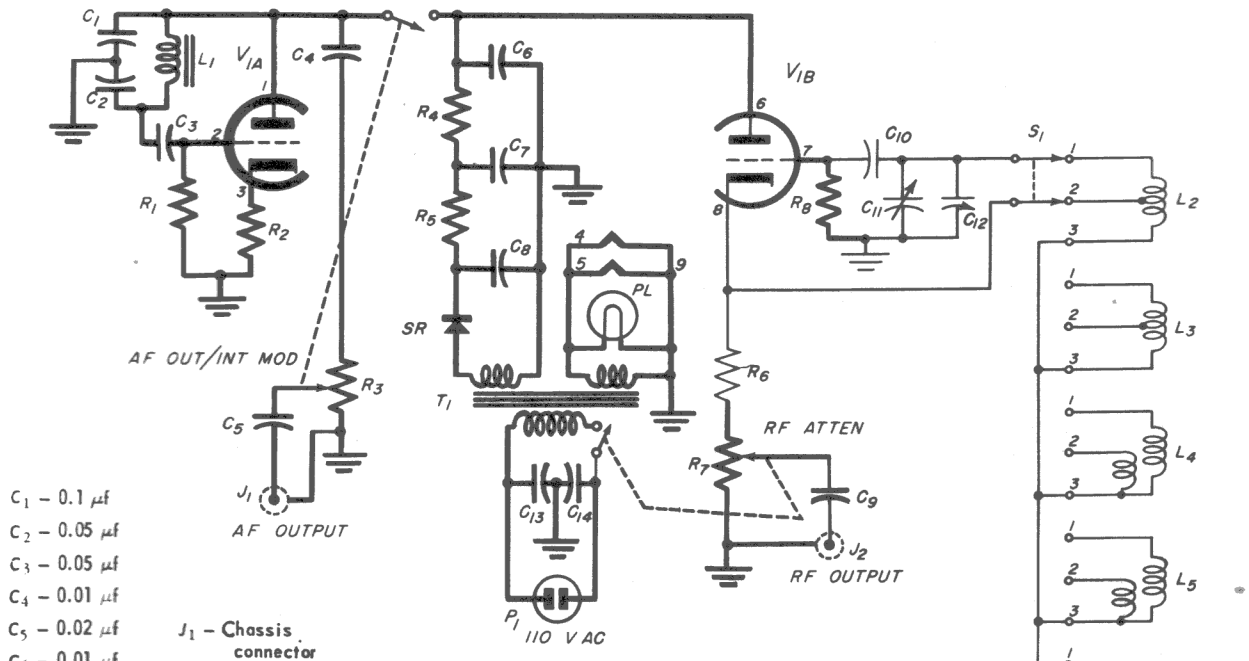
Step 5. Connect (do not solder) the black lead from the electrolytic capacitor to the grounding lug *mounted near lug 1 of TS-C*, on the underside of the chassis, as shown in Fig. 20-4.

Step 6. Twist the leads from the choke together about three times. Connect the long lead to lug 4 of TS-C and the short lead to lug 1 of TS-C. Do not solder.

Step 7. Cut a 11-1/2-inch length of hookup wire. Strip 1/4 inch of insulation from both ends. Connect one end to lug 4 of TS-C. Do not solder. Dress the wire down close to the chassis as shown.

Step 8. Put about 3/4 inch of spaghetti on each lead of a 0.05-μf capacitor, (C_3) and cut the leads so that they are 1/4 inch longer than the spaghetti. Connect (do not solder the capacitor between lugs 1 and 3 of TS-C. Dress the capacitor down close to the chassis and the terminal strip.

Put about 3/4-inch of spaghetti on one lead of a 0.05-μf capacitor, (C_2) and cut this lead so that it is 1/4 inch longer than the spaghetti. Connect this short lead to terminal 1 of TS-C. Solder the three connections at this terminal. Dress the capacitor as shown in the figure. Connect (do not



C_1 – 0.1 μf
C_2 – 0.05 μf
C_3 – 0.05 μf
C_4 – 0.01 μf
C_5 – 0.02 μf
C_6 – 0.01 μf
C_7 – 20 μf
C_8 – 20 μf
C_9 – 0.01 μf
C_{10} – 20 μμf
C_{11} – 360 μμf
C_{12} – 3–12 μμf
C_{13} – 0.006 μf
C_{14} – 0.006 μf

J_1 – Chassis connector
J_2 – Chassis connector
L_1 – Audio choke–12 henries
L_2 – Band A coil
L_3 – Band B coil
L_4 – Band C coil
L_5 – Band D coil
L_6 – Band E coil

P_1 – Male attachment plug
PL – Pilot lamp, No. 47
R_1 – 47 k-Ω
R_2 – 330 Ω
R_3 – 500 k-Ω
R_4 – 8,200 Ω
R_5 – 3,300 Ω
R_6 – 4,700 Ω
R_7 – ɔ k-Ω
R_8 – 33 k-Ω
S_1 – Two-pole six-position switch
SR – Selenium rectifier 20 ma 130 VAC

T_1 – Power transformer– Primary: 117 v, 60 ~ Secondary: 125 v at 15 ma d.c Secondary: 6.3 v at 0.6 amp
V_1 – 12AU7

Fig. 20-3

solder) the other lead of the capacitor to the grounding lug mounted near TS-C.

Step 9. Solder a bare wire to pin 1 of the tube socket. Place 1/2 inch of spaghetti over the wire; cut the wire so that it is 1/4 inch longer than the spaghetti. Connect (do not solder) the other end of the wire to lug 4 of TS-C.

Step 10. Solder a bare wire to pin 2 of the tube socket. Put 1/2 inch of spaghetti over the wire, and cut it 1/4 inch longer than the spaghetti. Connect (do not solder) this end to lug 3 of TS-C.

Step 11. Cut the leads of a 47,000-ohm 1/2 watt resistor (R_1) so that they are 1/2 inch long. Connect and solder one end of the resistor to the ground lug near pin 3 on the tube socket, as shown in Fig. 20-4. Connect the other end of the resistor to lug 3 of TS-C. Solder all the connections at lug 3 of TS-C.

Step 12. Cut the leads of a 0.1-μf capacitor (C_1) so that they are 3/4 inch long. Connect one lead to the grounding lug near TS-C, and solder the three connections at this grounding lug. Connect the other lead of the capacitor to lug 4 of TS-C, and solder the four connections at lug 4 of TS-C.

Step 13. Dress the capacitors connected to TS-C close to the terminal strip, so that they do not hang over the edge of the subchassis. Check all the leads to see that they do not short to other leads or terminals.

Step 14. Cut the leads of a 330-ohm resistor (R_2) so that they are about 5/8 inch long. Connect and solder one end of the resistor to pin 3 of the tube socket. Connect and solder the pin of the resistor to the ground lug near pin 5 of the tube socket.

Step 15. Cut an 8-inch length of hookup wire and strip 1/4 inch of insulation from

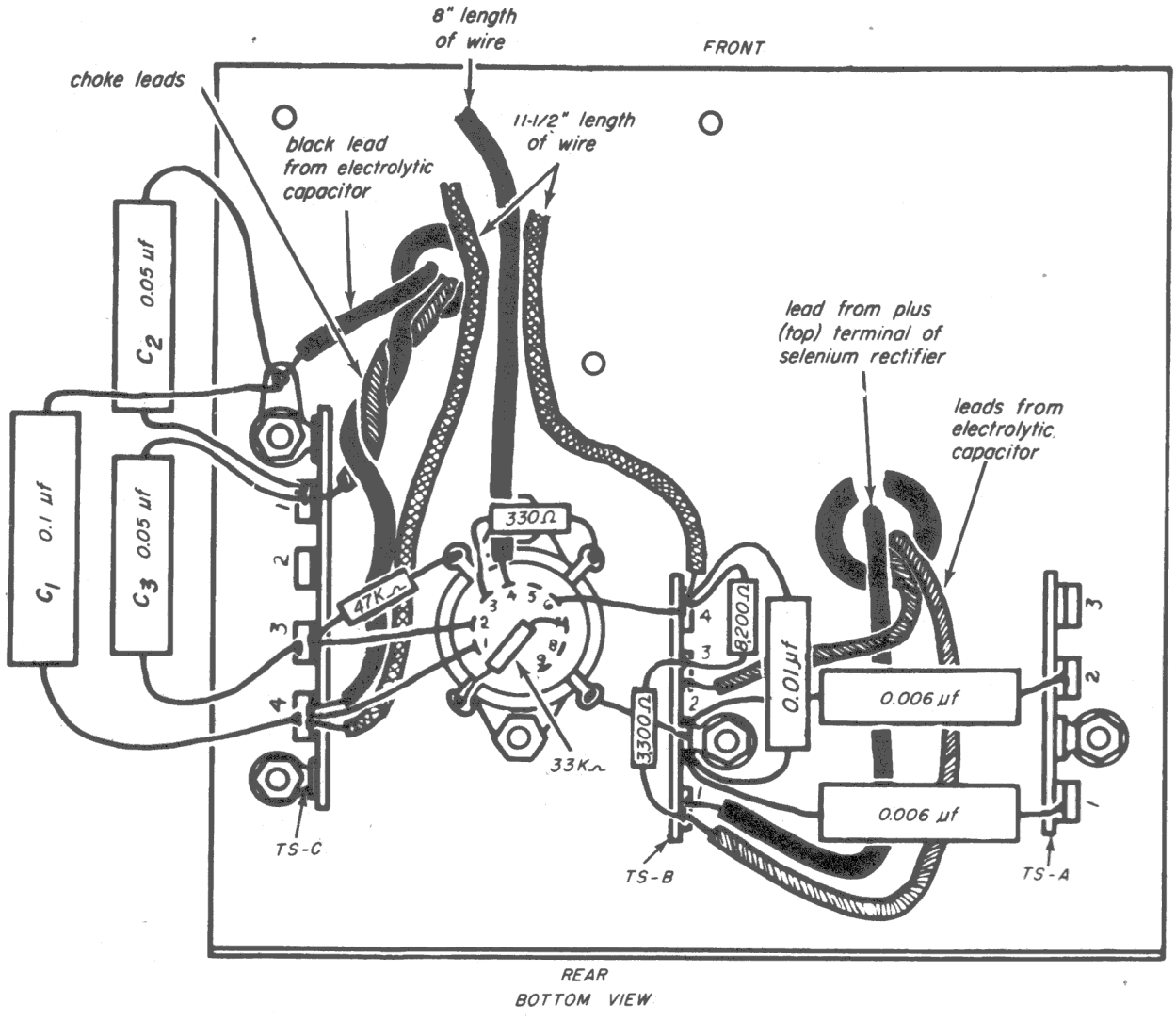


Fig. 20-4

both ends. Connect and solder one end of the wire to pin 4 of the tube socket. Dress the lead down close to the chassis as shown. Do not allow the other (bare) end to touch the chassis.

Step 16. Cut the leads of a 33,000-ohm resistor (R_8) so that they are about 1/2 inch long. Connect (do not solder) one end of the resistor to pin 7 of the tube socket. Dress the resistor directly across the tube socket. Put a 3/8-inch long piece of spaghetti on the other lead. Connect and solder this end of the resistor to the ground lug near pin 1 on the tube socket.

Step 17. Connect a bare wire to lug 4 of TS-B. Place 1/2 inch of spaghetti over the wire, and cut it 1/4 inch longer than the spaghetti. Connect and solder the other end of the wire to pin 6 of the tube socket.

Step 18. Connect (do not solder) a bare wire to lug 2 (grounding terminal) of TS-B. Cut the wire so that it is one inch long. Connect and solder the other end to the ground lug near terminals 8 and 9 of the tube socket. Dress the wire down close to the chassis.

Step 19. Cut the leads of two 0.006-μf capacitors so that they are about 3/4 inch long. Connect one capacitor (C_{13}) between lug 2 of TS-B and lug 1 of TS-A. Connect the other capacitor (C_{14}) between lug 2 of TS-B and lug 2 of TS-A. Solder the connections at lugs 1 and 2 of TS-A. Dress the ground leads of the two capacitors so that they are close to each other and clear of the other terminal lugs on TS-B. Both capacitors are temporarily connected to the same side of the a-c line. Also, the a-c switch is not yet in the circuit. They will be connected as the schematic

diagram shows in the next Experiment Lesson.

Step 20. Connect the lead coming from the top (plus or cathode) terminal of the selenium rectifier to terminal lug 1 of TS-B.

Step 21. Connect the long positive lead from the electrolytic filter capacitor (C_8) to terminal lug 1 of TS-B.

Step 22. Cut the leads of a 3,300-ohm resistor (R_5) so that they are about 1/2 inch long. Connect the resistor between terminal lugs 1 and 3 of TS-B. Solder the three connections at terminal lug 1 of TS-B. Dress the resistor so that it is clear of the grounding terminal of TS-B.

Step 23. Connect the short (2-3/4-inch) positive lead from the electrolytic filter capacitor (C_7) to terminal lug 3 of TS-B.

Step 24. Cut the leads of a 8,200-ohm resistor (R_4) so that they are about 1/2 inch long. Connect one end of this resistor to terminal lug 4 of TS-B. Connect the other end of the resistor to terminal lug 3 of TS-B. Solder all three connections to terminal lug 3 of TS-B.

Step 25. Place about 1/2 inch of spaghetti over each lead of a 0.01-μf capacitor. (C_6). Cut the leads so they are 1/4 inch longer than the spaghetti. Connect the capacitor between terminal lugs 2 and 4 of TS-B. Solder all four connections at terminal lug 2 of TS-B.

Step 26. Cut a 11-1/2-inch lead of hookup wire, and strip 1/4 inch of insulation from each end. Connect one end of the wire to lug 4 of TS-B. Solder all four connections at terminal lug 4 of TS-B.

JOB 20-3.

To test the portion of the signal generator thus far completed.

Information. In this section you will test the completed wiring by making resistance and voltage measurements. If at any time you do not get the measurements called for, ±20%, disconnect the a-c line cord, and recheck your wiring. Do not insert the 12AU7 tube.

Procedure.

Step 1. Tape up the free end of the 11-1/2-inch length of wire connected to terminal lug 4 of TS-B.

Step 2. Measure the resistance from each pin of the tube socket to the chassis, and enter your readings on Table A. Use the ohmmeter range appropriate for the resistance reading you expect to obtain, as given in the table. Your readings should agree with those given within ±20%.

Step 3. Plug the line cord into an a-c outlet.

Step 4. Set up your multimeter as an output meter and to the 300 VAC range. Connect the COMMON lead of the multimeter to the chassis.

Step 5. With red lead in the output jack, measure the a-c voltage at the bottom (plate) terminal of the selenium rectifier. Record your reading here:

136 volts a.c.

The voltage should be about 140 volts a.c.

Step 6. Set up your multimeter to the 500 VDC range.

Step 7. Measure the voltage at the top (positive) terminal of the selenium rectifier. Record your measurements here:

180 volts d.c.

The voltage should be about 200 volts d.c.

Step 8. Measure the d-c voltage at terminal lug 3 of TS-B. Record your reading here:

175 volts d.c.

The voltage should be about 200 volts d.c.

Step 9. Measure the d-c voltage at terminal lug 4 of TS-B. Record your reading here:

175 volts d.c.

The voltage should be about 200 volts d.c.

Step 10. Temporarily solder together the two 11-1/2-inch pieces of hookup wire, and tape up the joint carefully.

Step 11. Insert the 12AU7 tube in the socket and allow 30 seconds for warm up.

Step 12. Measure the voltage at each pin of the tube socket. All voltages are d.c. except as shown. Record the voltages in Table *A* and compare them with the voltages given in the table. Your readings should agree with those given within about ±20%.

TABLE A

RESISTANCE (ohms)			VOLTAGES (volts)	
Pin	Measured	Given	Measured	Given
1	∞	∞	100	100 d.c.
2	43k	47 k	-0.8	-0.7 d.c.[2]
3	350	330	1.8	2.0 d.c.
4	0.9	0.8	6.8	6.3 a.c.
5	0.9	0.8	6.8	6.3 a.c.
6	200 K	500 k[1]	100	100 d.c.
7	32 K	33 k	0	0 d.c.
8			8.5	8.5 d.c.
9	0	0	0	0 d.c.

[1] Variable, depends upon leakage of electrolytic capacitor.

[2] Use 25VDC scale of meter.

Step 13. Set up your multimeter to measure 15 VAC and insert the positive meter lead in the output jack.

Step 14. Measure the a-c voltage at pin 1 of the tube socket. This is the 400-cycle sine wave output of the audio oscillator, and you should measure at least 10 volts. Enter your reading here:

12.7 V

This completes the testing of the first portion of the signal generator.

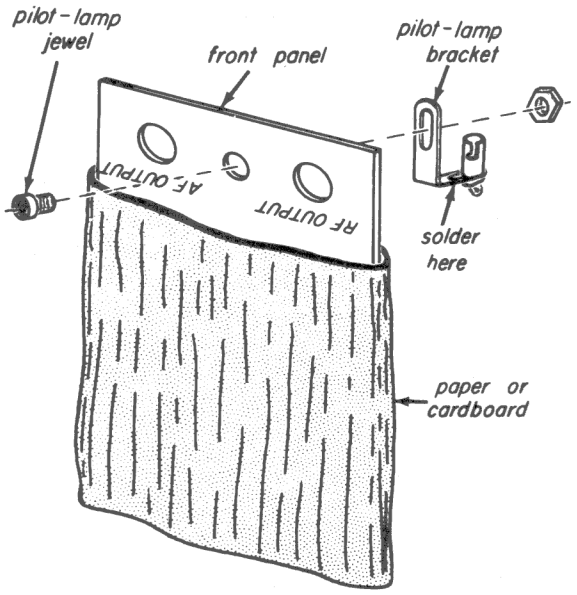


Fig. 20-5

JOB 20-4.

To mount the components of and wire the front panel of the signal generator.

Procedure.

Be very careful not to scratch the front panel when working with it, so that the appearance of your finished instrument will not be spoiled.

Step 1. Wrap the front panel in heavy paper or thin cardboard, leaving the row of holes at the bottom of the front panel exposed, as shown in Fig. 20-5. This will help to prevent the face of the front panel from becoming scratched. Hold the wrapping in place with tape or rubber bands.

Step 2. Using a long-nose pliers, turn the upper terminal lug on the pilot-lamp light socket so that it points into the corner of the bracket, as shown in Fig. 20-5. Squeeze the lug down tight against the bracket with the pliers, and solder the lug to the bracket. Be sure to heat the joint until the solder flows readily; then hold the lug in place until the solder cools. Turn the other lug until it is 1/4 turn from the first, as shown in the figure.

Step 3. Mount the pilot-lamp jewel and bracket assembly as shown in Fig. 20-5. Before tightening the nut, put the lamp in the socket, and adjust the position of the bracket until the lamp filament is opposite the jewel.

Step 4. Disassemble one of the chassis connectors. Install the connector in the hole

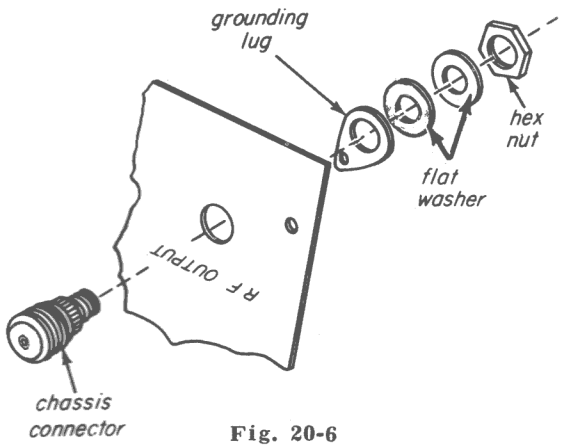


Fig. 20-6

marked RF OUTPUT. On the other side of the front panel, install the grounding lug and both flat washers, as shown in Fig. 20-6. Before tightening the nut, line up the grounding lug so that it points towards the center of the panel as shown in the figure. Note that the figure shows the panel upside down, since it is easier to work with it in this position. Hold the panel upside down as in the illustrations. Using a wrench of proper size, tighten the nut until the burred portion of the connector is pulled through the hole in the front panel and the shoulder of the connector is flush against the front panel. Label the connector on the back of the panel with a crayon so that you can quickly identify it.

Step 5. Disassemble the second chassis connector, and put aside one of the flat washers. Insert this connector in the hole in the front panel marked AF OUTPUT. On the other side of the front panel, mount the small *L*-shaped support bracket on the threaded portion of the connector, followed by a grounding lug, flat washer, and hex nut, as shown in Fig. 20-7. Label this connector on the back of the panel, too.

Step 6. Slide the protective wrapping down to uncover the two holes marked RF ATTEN and AF OUT/INT MOD. Mount the 500 k-ohm potentiometer (R_3), and switch in the hole marked AF OUT/INT MOD. The potentiometer can be identified by the markings on the cover. However, it is a good idea to verify the markings by measuring the resistance of the control with your meter. Use a lock washer next to the control; on the face of the front panel use a flat washer and hex nut, as shown in Fig. 20-8. Before tightening the nut,

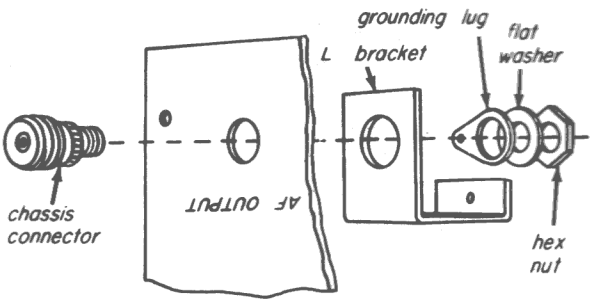


Fig. 20-7

align the terminals on the control so that they point toward the edge of the panel, as shown. Label this control on the back of the panel.

Step 7. Mount the 5,000-ohm potentiometer (R_7) with switch attached in the hole marked RF ATTEN, in the same way that you mounted R_3, except that the terminals of the control are aligned to point toward the pilot-light bracket before the nut is tightened, as in Fig. 20-9. Label this control on the back of the panel.

Step 8. Put 1-1/4 inch of spaghetti over one lead of a 0.01-μf capacitor (C_9), and cut the lead 1/4 inch longer than the spaghetti. Make a right angle bend in the wire at 3/4 inch from the cut end. Insert the lead through the eyelet hole of the RF OUTPUT connector so that it extends out 1/8 inch and bend it over. Place the point of the soldering iron into the eyelet on the connector so that it heats the eyelet and the wire. Then carefully touch the solder to the eyelet and add *just enough* solder to close up the hole in the eyelet. Cut any excess lead off flush with the solder.

Step 9. Put a 1-inch piece of spaghetti over one lead of a 0.02-μf capacitor (C_5), and cut the lead 1/4 inch longer than the spaghetti.

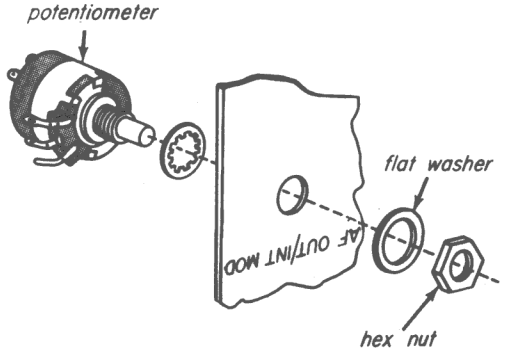


Fig. 20-8

Insert this lead through the eyelet of the AF OUTPUT connector, so that it extends out of the connector 1/8 inch, and bend it over. Solder as described in the previous step.

Step 10. Once again, cover the entire face of the front panel to protect it from being scratched. The wrapping should extend only about 1/2 inch around the other side of the panel so as not to interfere with the wiring to be done.

Step 11. Put a 3/4-inch piece of spaghetti on the other lead of the 0.01-μf capacitor (C_9) connected to the RF OUTPUT connector. Cut the lead so that it is 1/4 inch longer than the spaghetti. Connect and solder this lead to the center terminal of the RF ATTEN control as shown in Fig. 20-9.

Step 12. Connect and solder a bare wire to the grounding lug attached to the AF OUTPUT connector. Cut the wire so that it is 1-3/4 inches long, and connect and solder it to terminal 1 (closest to the connector) of AF OUT/INT MOD control.

Step 13. Put a piece of spaghetti, 1 inch long, on the other lead of the 0.02-μf capacitor (C_5) connected to the AF OUTPUT connector and cut the lead 1/4 inch longer than the spaghetti. Connect and solder this lead to the center terminal of the AF OUT/INT MOD control.

Step 14. Put a piece of spaghetti, 1 inch long, on one lead of a 0.01-μf capacitor (C_4), and cut the lead 1/4-inch longer than the spaghetti. Connect this lead to the switch terminal closest to the pilot-lamp bracket, on the switch attached to the AF OUT/INT MOD control. Cut the other lead of this capacitor 3/4 inch long, and connect and solder it to terminal 3 of the AF OUT/INT MOD control.

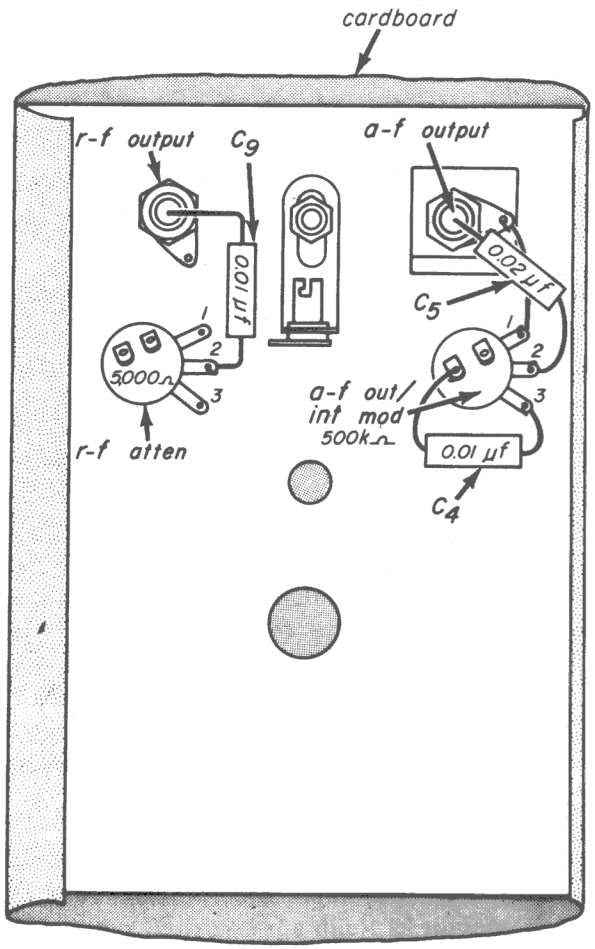


Fig. 20-9

Discussion. At this point, you have completed the wiring of the power-supply and audio-oscillator circuits of your signal generator. In the next Experiment Lesson, you will get directions for the wiring needed to complete your signal generator.