TM 11-2657
C 1

TECHNICAL MANUAL

SIGNAL GENERATORS TS-155/UP AND TS-155A/UP

CHANGES No. 1

WAR DEPARTMENT
Washington 25, D. C.,
10 August 1945

TM 11-2657, 8 February 1945, is changed as follows:

4. TECHNICAL CHARACTERISTICS OF SIGNAL GENERATOR TS-155/UP

* * * * *

Externally synchronized.

External trigger requirements.

Trigger frequency____120 to 2,000 cycles.

* * * * *

Polarity____Either positive or negative.

Amplitude_____**15** to 100 volts.

Negative pulses work * * * than 470,000 ohms.

Rise time____Less than 0.2 microsecond rise time to 20 volts.

* * * * *

5. LIST OF COMPONENTS.

* * * * *

e. Tube Complement.

Tube Number	Type	Function
*	*	* * *
V5 A and B	6SN7 GT	Blocking oscillator, cathode follower.
V6	OD3/VR-150	Voltage * * * multivibrator.
V7	OC3/VR-105	Voltage regulator for thermistor bridge.
*	*	* * *

* * * * *

6. DIFFERENCES IN MODELS.

Signal Generator TS-155/UP * * * used on the TS-155 UP. **The R. F. TUNING dial is calibrated for increasing wavelength with increasing reading on the TS-155 UP and for increasing frequency with increasing reading on the TS-155A UP.** The other differences * * * are listed below.

* * * * *

Figure 7. Coarse PULSE DELAY settings with fine PULSE DELAY set at midpoint

13. STARTING PROCEDURE.

* * * * *

f. Turn the METER * * * meter reads zero.

CAUTION: (Added.) Always set meter to zero before turning R. F. OSC switch to ON.

* * * * *

14. SYNCHRONIZATION.

* * * * *

b. Internal Synchronization.

* * * * *

(*3*) (Added.) Turn the INPUT TRIGGER switch to +.

15. TESTING OVER-ALL PERFORMANCE OF RADAR SYSTEM.

* * * * *

c. Interpretation of Tests.

* * * * *

(*3*) *Explanation of Table II.*

* * * * *

TABLE II

RADAR RANGE VS. RADAR PERFORMANCE

Performance down in db	Percent of total effective range
0	100%
−1.5	92%
−3	84%
* * *	* * *

(4) *Explanation of Table III.* This table shows * * * of 1 milliwatt. This may also be expressed as −20 dbm, and this, as the table indicates, corresponds to an output power of 10 x 10^{-6} watts, or 10 microwatts, or 0.01 milliwatt.

* * * * *

In figure 23, on waveform No. 1, change "S_2 IN TRIG. IN. POSITION" to read: **"S_2 IN INT TRIG POSITION."**

In figure 24, indicate that the waveforms apply to the input and output sides of C6.

In figure 29, change the value of R46 (grid leak of V9) to read: **"22,000."**

42. TEST ANALYSIS DATA.

* * * * *

b. Voltage Chart. The following voltages * * * switch was off.

VOLTAGE CHART

Tube	PIN 1	2	3	4	5	6	7	8	Selector switch
*		*		*		*			*
V_2	0 −36 0	140	11. 7 11. 7 3.3 to 13[c]	2. 3 to −6. 8[c] 0. 9 to 5. 3[c] −70. 7 to 7.5[b]	145	11. 7 11. 7 3.3 to 13[c]	0	6 ac	EXT CALIB INT
*		*		*		*			*

* * * * *

43. MECHANICAL REPAIRS.

* * * * *

d. ATTENUATOR.

* * * * *

(2) The piston may * * * is fully compressed.

CAUTION: Unless a means * * * not be removed. The adjusting screw on the attenuator is set at the factory so that when 200 milliwatts is fed into the **R. F.** jack and the attenuator piston is completely compressed, the monitoring meter gives a full-scale reading. The attenuator loop * * * may be destroyed.

44. ADJUSTMENTS.

a. Adjustment of Electrical Constants of the Cavity for Optimum Operation with a Type 446B or 2C40 Tube.

* * * * *

(3) To check for * * * cylinder sleeve assembly.

* * * * *

(*h*) Turn the R. F. TUNING dial to read 45 (**turn to read 55 for TS–155A/UP**).

* * * * *

(*j*) Measure the frequency, or the wavelength, of the oscillator with the tuning dial set at 45 (**55 for TS–155A/UP**) (subpar. **b,** below). If the frequency, * * * directly to step *n*.

TABLE IV (Superseded)

CAVITY ADJUSTMENT DATA FOR OPTIMUM OPERATION

	Normal limits with tuning dial reading of 45 (55 for TS–155A/UP)
Frequency in megacycles	2,812 to 2,785
Wavelength in centimeters	10.66 to 10.77
Length of grid cylinder	1¾″ ± 3/16″

* * * * *

Figure 32. Calibration of Signal Generator TS–155/UP *with Wavemeter Test Set TS–117/GP.*

* * * * *

c. Frequency Adjustment with Other Test Equipment. (Added.)

(*1*) If the test instrument being used to determine the r-f output does not contain a crystal rectifier, an adapter assembly or group of fittings is required for making the tests. The component parts of this assembly are listed in the following table.

Quantity	Name of unit	Dimensions (in.)			Weight (lb)	Stock No.
		Height	Width	Depth		
1	Radio Frequency Adapter UG–57/U	¾	¾	2	⅛	2Z7390–57
1	Crystal Adapter UG–119/UP	¾	¾	2	⅛	2Z308–119
1	Radio Frequency Adapter UG–28/U	⅝	1¾	2¾	3/16	2Z7390–28
1	Tube (crystal) 1N21B (in Crystal Adapter UG–119/UP).	⅞				2J1N21B

The components of the adapter assembly can be requisitioned through channels if they are not supplied with the test equipment.

(*2*) The frequency of the signal generator may be adjusted using any calibrated resonant-frequency device which is tunable in the frequency range of the signal generator. The adapter assembly is used with an echo box, a wavemeter, an oscilloscope, or other sensitive indicator. The wavemeter may be any absorption type covering the frequencies required. The oscilloscope should have an amplifier gain of 200 and a minimum bandwidth of 500,000 cycles. These values will give good results, although it may be possible to achieve some results with less gain and smaller bandwidth. It is possible to use a sensitive amplifier (giving a useful indication with a minimum input of 0.1 volt) as an indicator in place of the oscilloscope.

(*3*) Typical test instruments which may be used are: Echo Boxes TS–207/UP, TS–217/MPN–1, TS–238/GP, TS–270/UP, and TS–270A/UP; Frequency Meters I–140–A and I–183–A; Wavemeter TS–192/CPM–4; Test Set TS–3/AP; Wavemeter Test Set TS–117/GP; and Oscilloscopes BC–1060–A, BC–1060–B and I–134–B (DuMont model 224).

d. Installation of Adapter Assembly. (Added.) Connect the adapter assembly as indicated in figures 33 and 34.

(*1*) Connect the free end of Cord CG–71/MPM (trigger cable) to the input signal terminals of the test oscilloscope (or other indicator).

(*2*) Connect the free end of Cord CG–70/MPM (antenna cable) to the frequency-measuring device being used. For example:

(*a*) If Test Set TS–3/AP is used, connect the r-f cord to the FREQ METER IN receptacle and connect the FREQ METER OUT cord to the CRYS IN receptacle.

(*b*) If Wavemeter Test Set TS–117/GP is used, connect the r-f cord to the TUNE TO PEAK receptacle.

(*c*) If Frequency Meter I–183–A is used, connect the r-f cord to the TRACK connector and turn the SEARCH-TRACK switch to TRACK. If any other instrument is used, connect the r-f cord to the r-f input connector.

(*3*) If an oscilloscope is used as an indicator, connect Cord CX–145/MPM (trigger

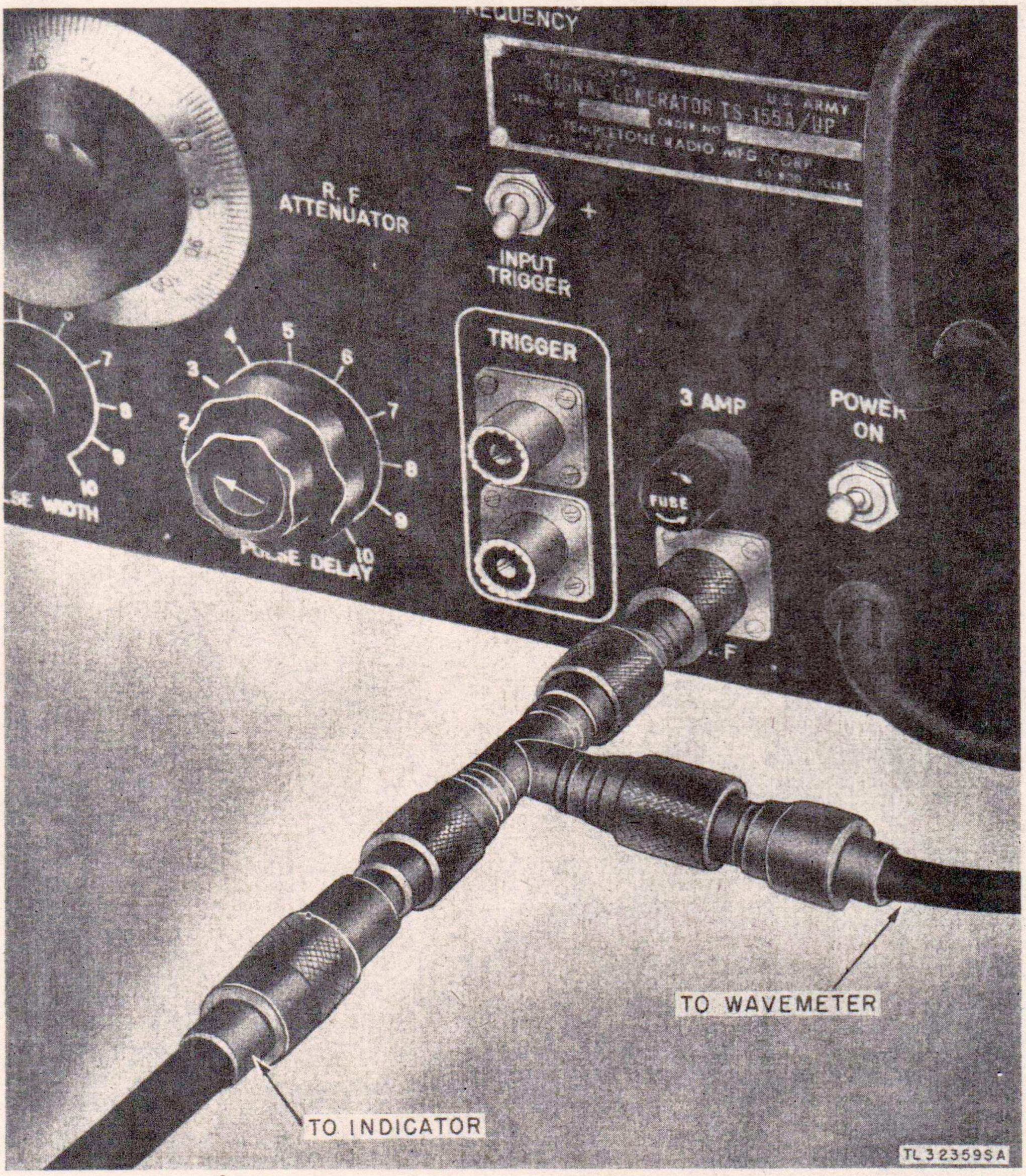

Figure 33. Adapter assembly connected to signal generator.

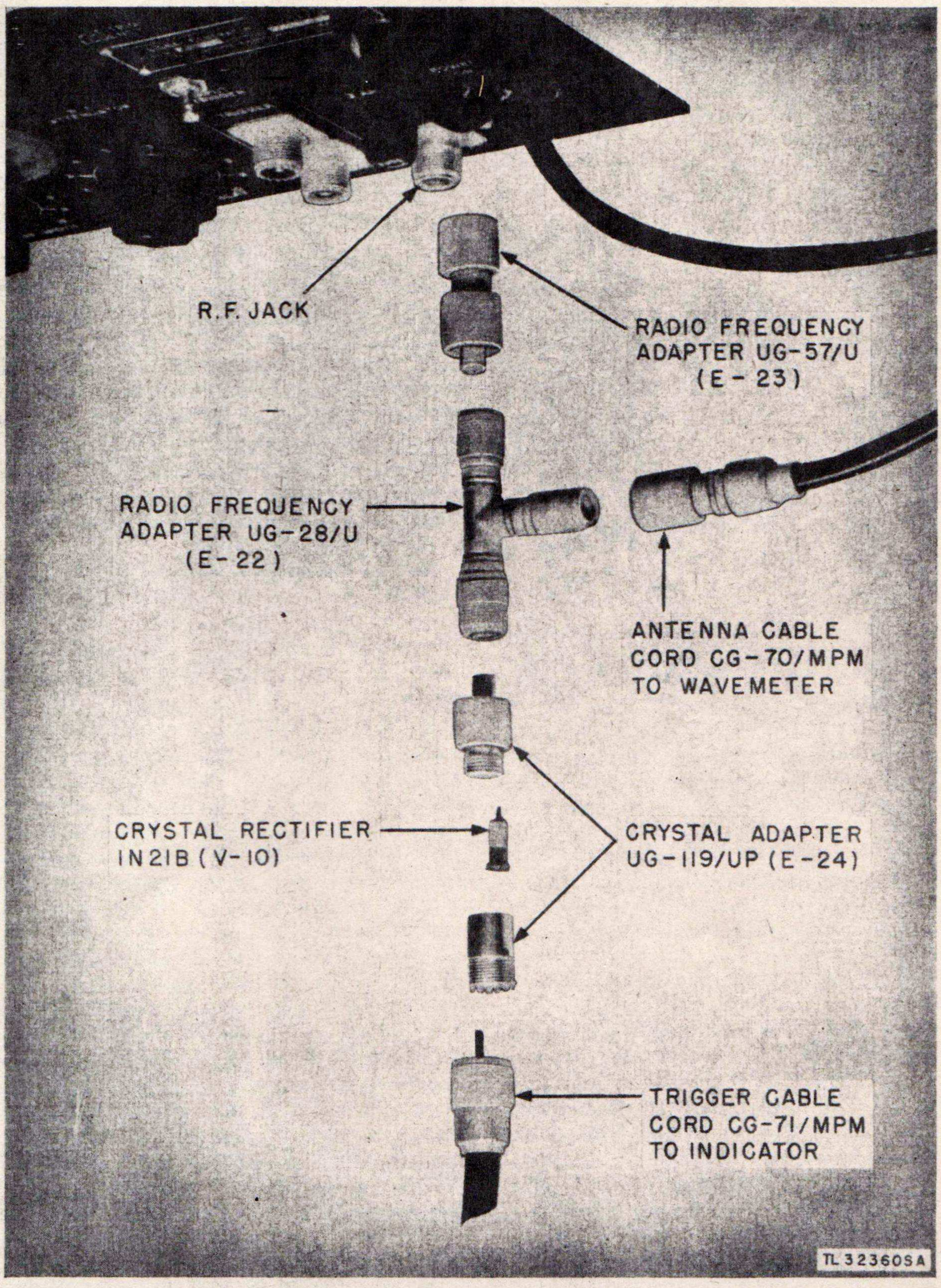

Figure 34. Adapter assembly, exploded view.

cable) between a TRIGGER jack of the signal generator and the synchronizing input terminal of the oscilloscope (fig. 35).

(*4*) The use of adapter assembly is covered in paragraph 44.1.

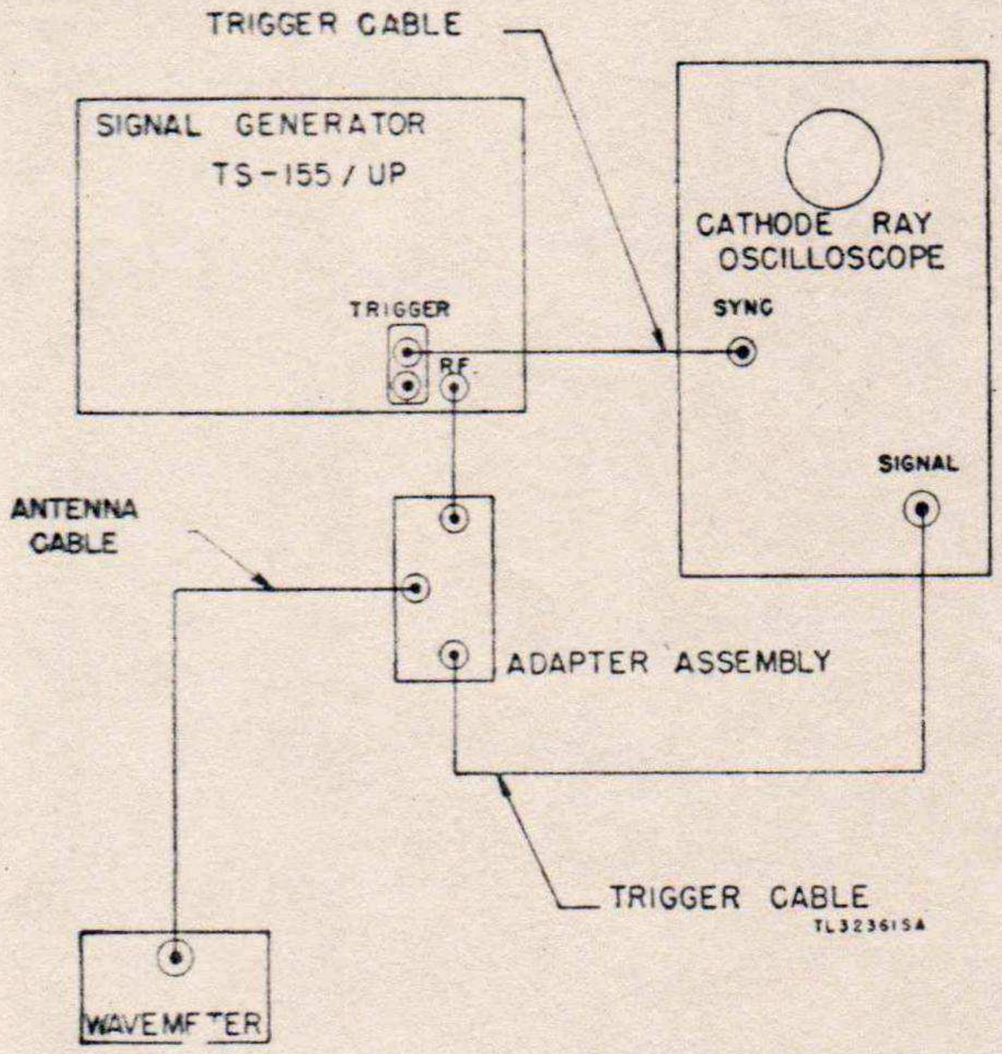

Figure 35. Adapter assembly connections, block diagram.

44.1. FREQUENCY CALIBRATION OF SIGNAL GENERATOR USING ADAPTER ASSEMBLY. (Added.)

a. Assemble and connect the adapter assembly as described in paragraph 44d.

b. Put the signal generator into operation as follows:

(*1*) Set selector switch to CALIB.

(*2*) Turn OUTPUT TRIG FREQUENCY control to 2,000 on Signal Generator TS–155A/UP or to 10 on Signal Generator TS–155/UP.

(*3*) Turn R. F. OSC OUTPUT control to midposition.

(*4*) Turn METER ZERO SET control fully clockwise.

(*5*) Turn R. F. TUNING control to the setting for which frequency is to be measured.

(*6*) Turn R. F. ATTENUATOR control clockwise to red reference mark.

(*7*) Set INPUT TRIGGER switch to +.

(*8*) Set PULSE DELAY controls to minimum delay (fully counterclockwise). Set fine PULSE DELAY (small knob) to 3.

(*9*) Set PULSE WIDTH control to maximum (fully clockwise).

(*10*) Turn POWER switch to ON and R. F. OSC switch off. Wait 3 minutes for the signal generator to warm up.

(*11*) Turn METER ZERO SET control until power monitor meter reads zero.

(*12*) Turn R. F. OSC switch to ON. With R. F. OSC OUTPUT control, set power monitor meter to read 200.

(*13*) Turn selector switch to INT TRIG.

c. Connect Cord CG–71/MPM (trigger cable) between Crystal Adapter UG–119/UP and the signal input terminals of the test oscilloscope (fig. 35).

d. Start the oscilloscope according to the information contained in the technical manual supplied with it. Set the oscilloscope with its sweep externally synchronized by the trigger from the signal generator and with maximum gain for the input signal. A small pulse should appear at the beginning of the trace on the screen of the oscilloscope.

e. Connect Cord CG–70/MPM (antenna cable) to the tee adapter jack at right angles to the two jacks in line (fig. 35). Connect the free end of the cable to the input of the wavemeter, echo box, or other frequency-measuring device.

f. Turn the wavemeter or echo box frequency control slowly through the range of frequencies believed to include the frequency of the signal generator. When the frequency measured by the wavemeter is the same as the frequency of the r-f output of the signal generator, the amplitude of the pulse on the oscilloscope screen will dip or rise sharply. When the dip or rise is located, tune the wavemeter or echo box about this point carefully to get the maximum dip or rise of the pulse on the oscilloscope screen. The wavemeter or echo box reading will indicate the frequency of the r-f output of the signal generator.

g. A calibration curve for the R. F. TUNING dial may be made by using the wavemeter or echo box to determine the frequency at different settings of the R. F. TUNING dial on the signal generator. The curve obtained by plotting the dial settings against the frequency will give a calibration of the signal generator. Replacement of the oscillator tube or changes in the variables of the cavity will necessitate recalibration of the unit.

44.2. THEORY OF OPERATION OF ADAPTER ASSEMBLY. (Added.)

The adapter assembly is made up of standard type–N fittings, a crystal rectifier, and an ultra-high-frequency (u-h-f) jack. The assembly is essentially a T-section of coaxial line, one leg of which contains a crystal rectifier. Figure 36 shows the equivalent circuit of this arrangement of adapters.

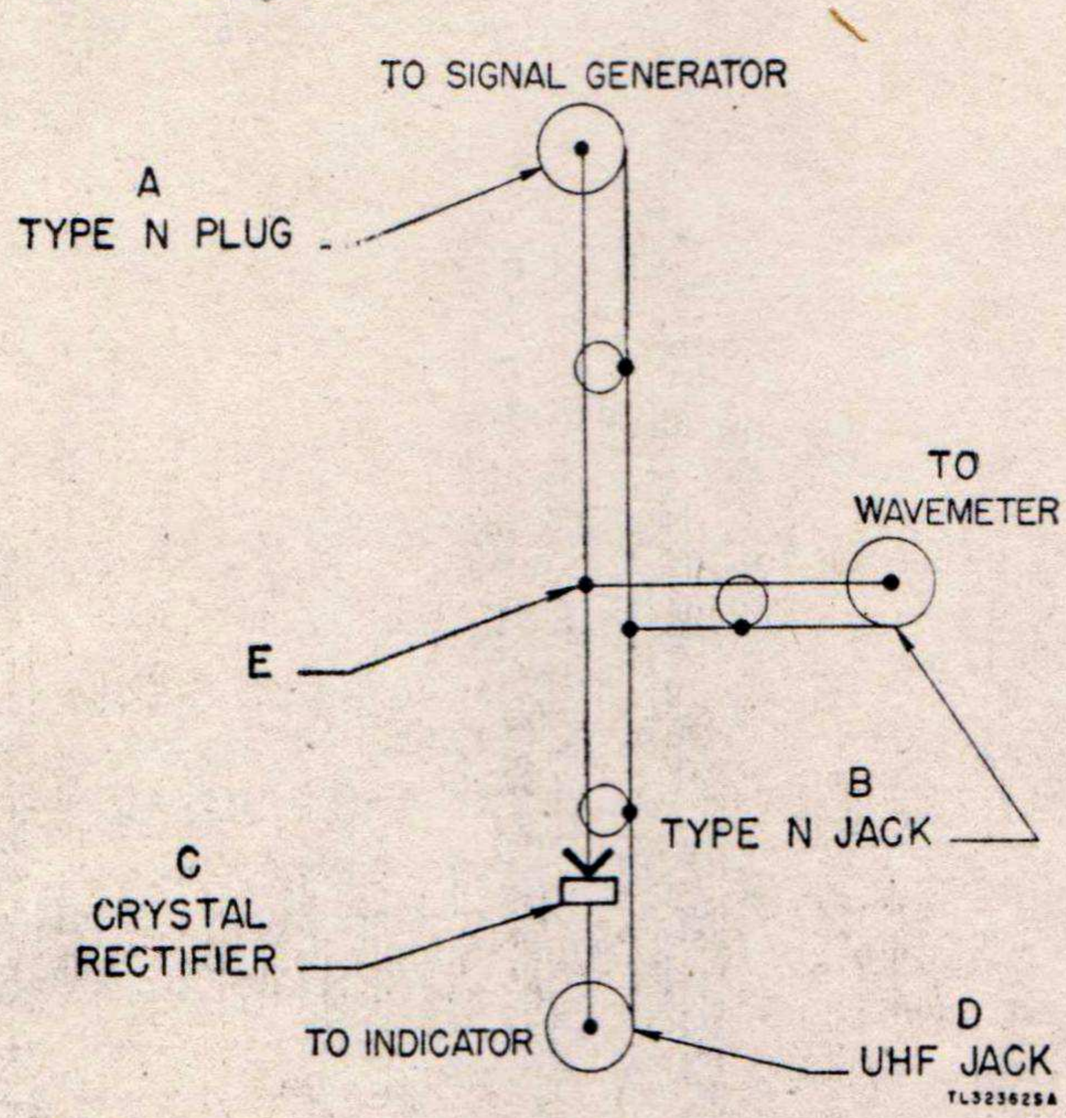

Figure 36. Adapter assembly, schematic diagram.

a. When the signal generator is placed in operation with the adapter assembly connected (par. 44d), a fixed amount of power is fed into the type-N plug, A, (fig. 36) of the adapter assembly at the R. F. jack. This power is fed through the coaxial line to the type-N jack, B, and through the coaxial line and crystal rectifier, C, to the u-h-f jack, D. The crystal rectifier converts the r-f pulses into video pulses which can be seen on the test oscilloscope.

b. The distribution of energy (at point E) to the two output lines is determined mainly by the ratios of the impedances of the two output lines. In operation, the line with the crystal rectifier and the oscilloscope (or other indicator) will maintain a constant impedance. The line which is loaded by the wavemeter has a variable impedance. This impedance will remain fairly constant until the wavemeter is set so that its resonant frequency is the same as the input frequency (from the signal generator). The impedance will then undergo a marked change. This affects the impedance ratio between the two output lines and causes a change in the distribution of power to these two lines (at point E). The change in power distribution changes the power input to the oscilloscope and will be indicated by a rise or dip in the amplitude of the pulse on the oscilloscope screen.

NOTE: It is possible that the combination of the adapter assembly, cables, and wavemeter may be such that no pulse dip or rise occurs at a critical frequency. It is much more probable, when no dip or rise is seen, that the range covered is wrong or that the range was covered too quickly and the dip or rise not noticed. To eliminate the possibility of no dip or rise appearing because of the combination of parts, check the apparatus at a different frequency setting.

44.3. PREVENTIVE MAINTENANCE RFO ADAPTER ASSEMBLY. (Added.)

Remove all dirt and dust from the adapter assembly with a clean cloth. Crystal rectifiers 1N21B, when not installed in the crystal adapter, should be kept in the lead shielding jackets.

44.4. TROUBLE SHOOTING ADAPTER ASSEMBLY. (Added.)

The two troubles which may occur in the adapter assembly, aside from breakage, are a burned-out crystal or an adapter failing to make contact. Loose contacts may be tightened easily and a burned-out crystal replaced.

a. Check for Burned-out Crystal. The simplest test for a faulty crystal is substitution of a spare crystal which is known to be in good condition. The crystal may be checked also with an ohmmeter. The resistance measured in the two directions through the crystal will be nearly equal in a burned-out crystal and in approximately 5-to-1 ratio or higher for a good crystal.

b. Replacement of Crystal. To install a new crystal rectifier in Crystal Adapter UG–119/UP, unscrew the two parts of the crystal adapter. Remove the spare crystal rectifier from its container and insert it, small diameter end first, in the inner portion of the half of Crystal Adapter UG–119/UP containing the type-N plug. The crystal rectifier will fit firmly into the fingers in the adapter. Screw

down the other part of the crystal adapter until a positive contact is made.

44.5. DISASSEMBLY OF CAVITY (figs. 37 to 41). (Added.)

a. General.

(*1*) The cavity should not be disassembled except for replacement of the r-f oscillator tube (8) or the thermistors (42, 43). Instructions for these replacement procedures are contained in paragraphs 43b and 43c. By looking into the cavity when the tailpiece (2) is removed, it is possible to observe the condition of the plate cap fingers (17) and of that portion of the plate tuning shaft on which the inner ring of fingers of the plunger slides.

CAUTION: If the tailpiece (2) is to be removed and replaced, the grid leak housing (14) must first be unthreaded and removed; otherwise, the grid leak sleeve assembly will be damaged.

(*2*) If the cavity is defective, it should be returned to the factory. Emergency conditions, however, may necessitate repairs at a repair base. The following instructions are therefore supplied. These instructions apply to the "PR" type cavity. Refer to paragraph 43a for the structural differences between the "PR" and the "AO" type cavities.

(*3*) Read paragraphs 31 and 32 for a description of the cavity and associated parts. Refer to figures 37 through 41 for removal of the oscillator cavity and associated assemblies.

(*4*) The following is a key to figures 37 to 41, inclusive:

1. Adjusting screw.
2. Tailpiece.
3. R-f chokes.
4. Heater.
5. Cathode.
6. Tailpiece clamp.
7. Tailpiece clamp screw.
8. Oscillator tube (type 446B or 2C40).
9. Cathode ring.
10. Cathode fingers.
11. Grid ring.
12. Grid fingers.
13. Grid cylinder sleeve assembly.
14. Grid leak and housing.
15. Plate cap.
16. Split cylinder, outer ring contact fingers.
17. Plate cap fingers.
18. Plunger rack.
19. Plunger.
20. Plunger gear.
21. Plunger gear housing.
22. Plunger gear locking screw.
23. Cap nut.
24. Slot for screwdriver adjustment.
25. Worm.
26. Front clamp screw.
27. Front clamp.
28. Plate tuning shaft assembly.
29. Sliding drive yoke.
30. Collector ring.
31. Lockscrew.
32. Stop.
33. Shaft to tuning dial.
34. Brush.
35. Brush mounting block.
36. Thermistor coupling loop.
37. Attenuator mounting screws.
38. Thermistor connecting link.
39. Soldered connection.
40. Thermistor assembly mounting screws.
41. Thermistor housing.
42. Disk thermistor.
43. Bead thermistor.
44. Brass disk.
45. Securing nut.
46. Tapered brass rod.
47. Brass rod.
48. Terminal post.
49. Limit screw.
50. Guide rod.
51. Rack.
52. Attenuator loop.
53. Spring fingers.
54. Attenuator tube.
55. Support block.
56. Clamping screw.
57. Coupling to attenuator dial shaft.
58. Gear.
59. Attenuator piston.
60. Insulated brass rod.
61. Attenuator jack.
62. Adjusting screw.
63. Allen setscrew wrenches.
64. Oscillator cavity.

65. Tuning shaft setscrews.
66. Plate lead.
67. Coupling setscrews.
68. Attenuator dial shaft.
69. Attenuator dial shaft setscrews.
70. Attenuator cable connection.
71. Attenuator cable.
72. R-f jack.
73. Support block mounting screws.
74. Tailpiece clamp mounting screws.
75. Front clamp mounting screws.

reassembled in the cavity. This procedure is necessary to prevent damage to the grid cylinder sleeve assembly (13) and to the grid lead.

(*3*) Turn the tuning dial fully counterclockwise. This moves the plate cap fingers (17) to a position close to the end of the plate cap (15) of the tube and minimizes the possibility of breaking the tube when it is removed.

(*4*) Loosen the tailpiece adjusting screw (1). (In the "AO" type cavity it is necessary

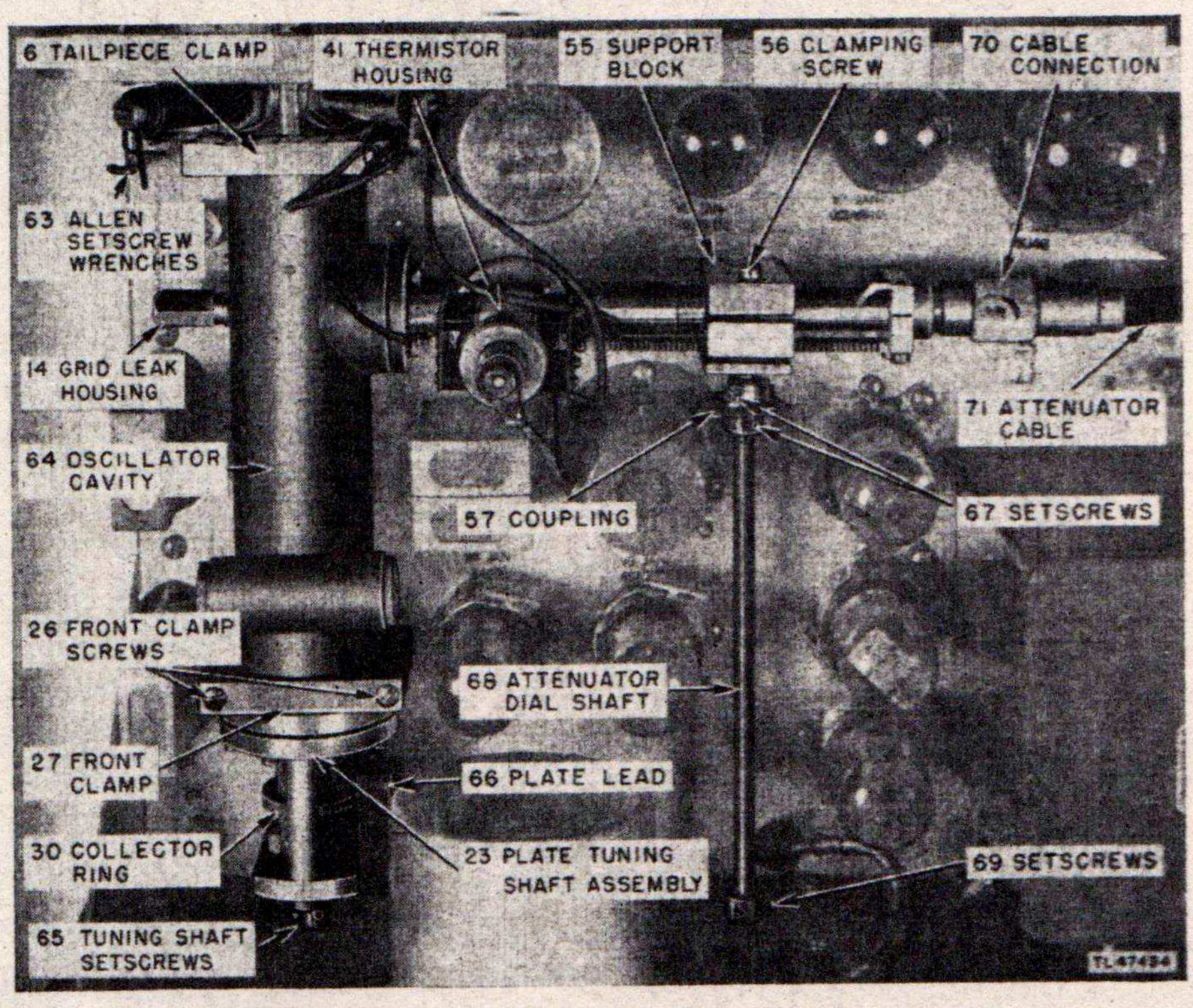

Figure 37.—Oscillator assembly mounted on signal generator chassis.

b. Removal of Tailpiece and Type 446B or 2C40 Oscillator Tube. Access to the oscillator tube (8) and to the filament cathode chokes (3) is gained by removal of the tailpiece (2):

(*1*) Turn the POWER switch and the R. F. OSC switch off and disconnect the power cord from the main source.

(*2*) Remove the grid leak housing (14) from the cavity.

CAUTION: Remove the grid leak housing (14) before removing the tailpiece. Do not replace the grid leak housing and grid leak until the tailpiece has been permanently

to remove the six screws that hold the tailpiece in the cavity.)

(*5*) Disconnect the cathode and heater leads from the tailpiece and tag them.

(*6*) Loosen the tailpiece clamp screw (7).

(*7*) Withdraw the tailpiece by rotating it slightly and pulling backwards.

c. Removal of Oscillator and Attenuator Assemblies from Chassis of Signal Generator. Before proceeding further with the disassembly of the cavity it is necessary to remove the entire assembly from the signal generator.

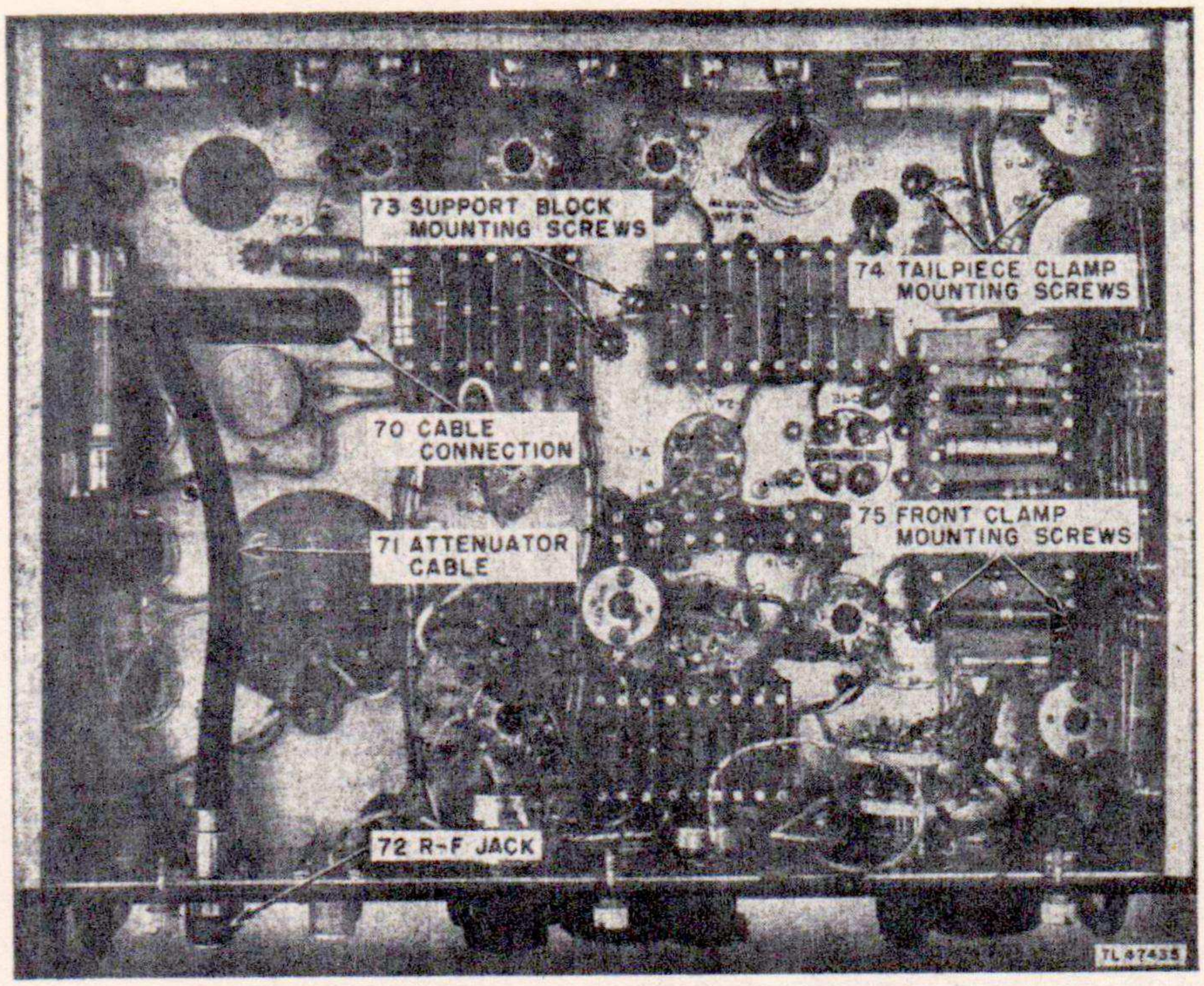

Figure 38. Bottom of chassis, oscillator assembly mountring scews.

(*1*) Disconnect the attenuator cable connection (70).

(*2*) Unsolder and remove all thermistor terminal connections. Tag all leads to facilitate location during reassembly.

(*3*) Disconnect the plate lead (66) on the brush mounting block (35).

(*4*) Loosen the r-f tuning shaft setscrews (65) and setscrews (67) at the coupling to the attenuator dial shaft (68).

(*5*) While supporting the cavity assembly, remove the support block mounting screws (73) on the bottom of the chassis.

(*6*) Support the cavity assembly. Remove the tailpiece clamp mounting screws (74) and front clamp mounting screws (75) on the bottom of the chassis.

(*7*) Free the oscillator cavity and associated assemblies and remove from the signal generator chassis.

d. Disassembly of Attenuator (fig. 39). Remove the four attenuator mounting screws (37) that fasten the attenuator to the oscillator cavity. Separate the attenuator from the cavity.

(*1*) Remove the limit screw (49) and withdraw the attenuator piston (59) from the attenuator tube (54) by turning the coupling to the attenuator dial shaft (57) counterclockwise.

(*2*) The support block (55) may be removed from the attenuator tube (54) by loosening the clamping screw (56).

CAUTION:

1. Do not change the setting of the adjusting screw (62), or the calibration of the unit may be destroyed.

2. The lead from the thermistor coupling loop (36) is soldered (39) to the lead from the bead thermistor. This connection will be broken if the thermistor assembly mounting screws (40) are removed and the thermistor assembly separated from the attenuator assembly.

e. Disassembly of Thermistor Unit. Removal and replacement of the bead and disk thermistors is described in paragraph 43c.

f. Removal of Plate Tuning Shaft Assembly from Oscillator Cavity (figs. 39 and 40). To remove the plate tuning shaft assembly (28) from the oscillator cavity proceed as follows:

(*1*) Remove the two screws holding the brush mounting block (35) in place.

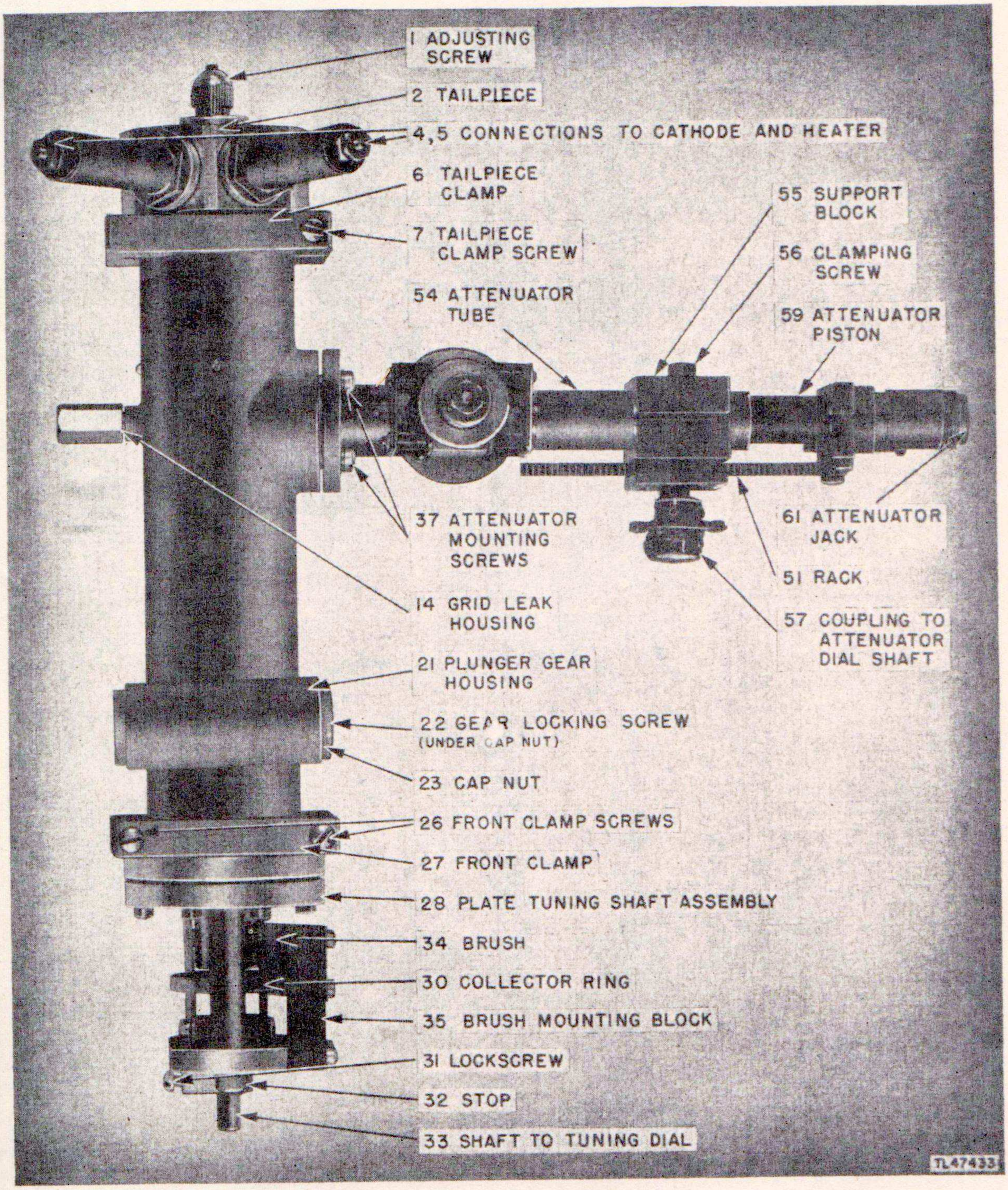

Figure 39. Oscillator assembly removed from signal generator chassis.

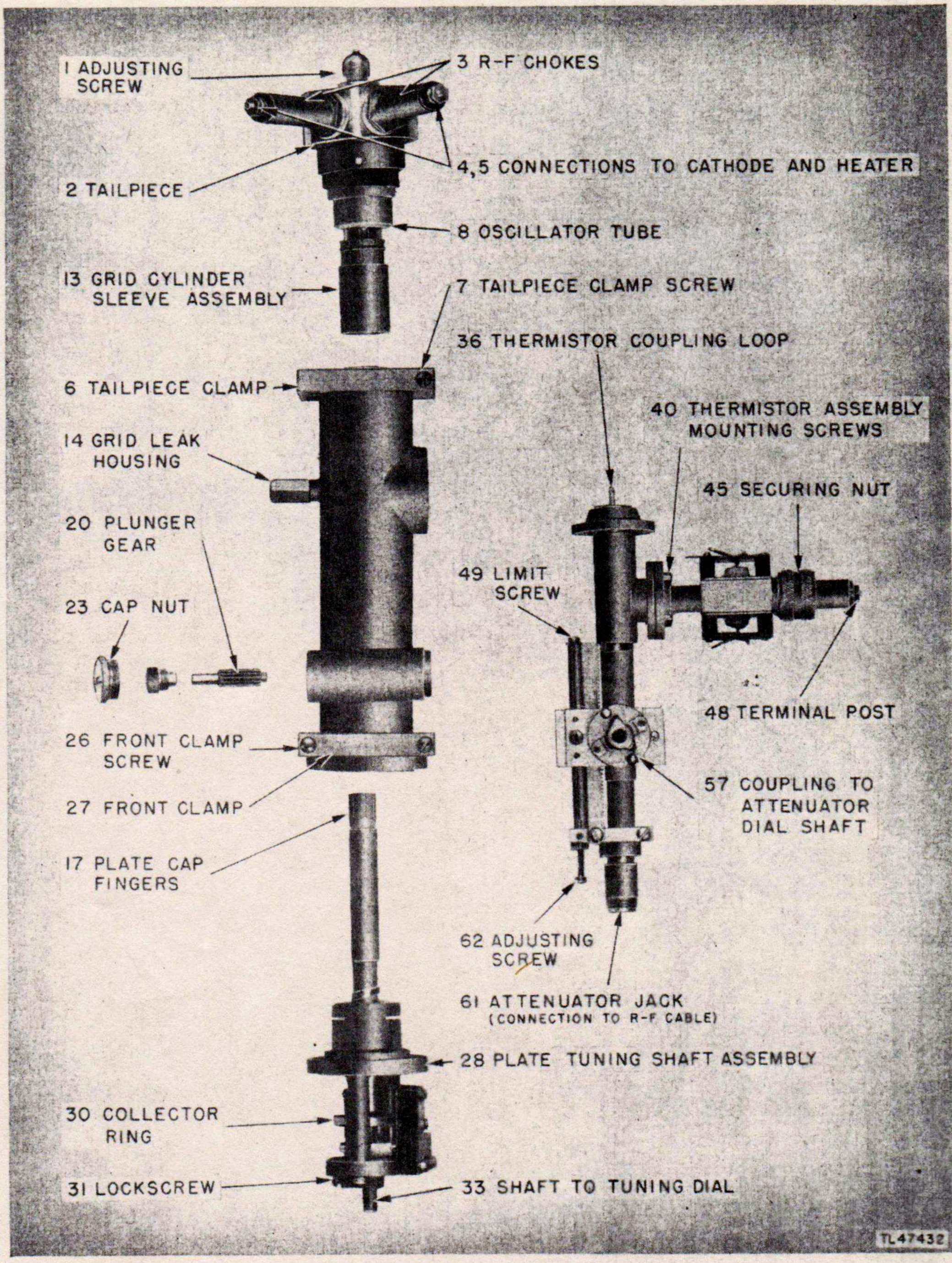

Figure 40 —Oscillator assembly, exploded view.

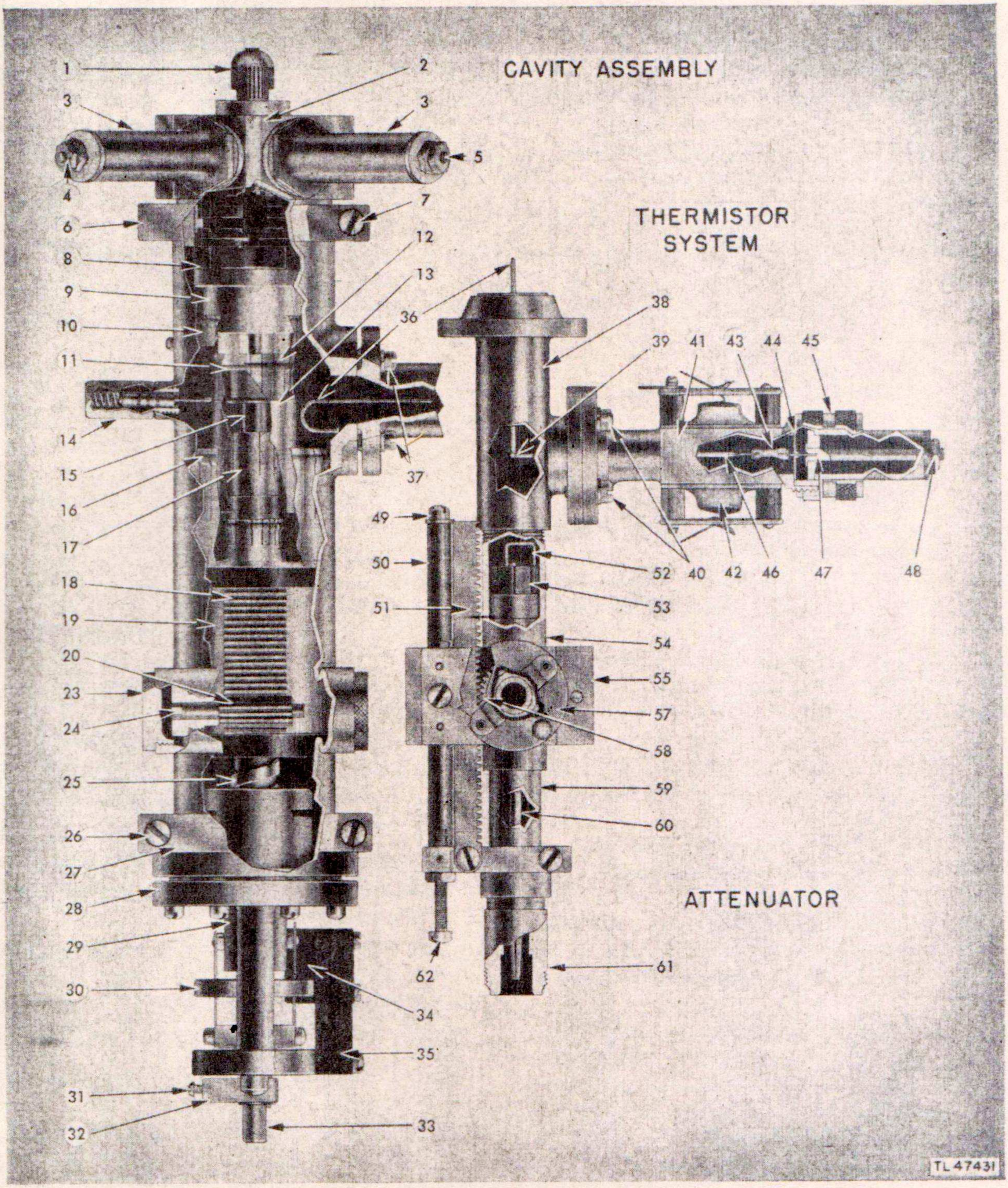

Figure 41.—Oscillator assembly, cut-away view.

(*2*) Remove the eight screws holding the plate tuning shaft assembly (28) in the cavity.

(*3*) Carefully withdraw the tuning assembly from the cavity.

CAUTION:

1. Do not loosen the lockscrew (31) on the tuning shaft stop (32), or the calibration of the unit will be destroyed.

2. Removal of the plunger gear (20) from the housing may also destroy the calibration.

44.6. REASSEMBLY OF CAVITY. (Added.)

The steps in reassembly are in each case the reverse of the disassembly. Care must be exercised to avoid damage to any of the parts during reassembly operations.

a. Replacement of Plate Tuning Shaft Assembly.

(*1*) Insert the plate tuning shaft assembly (28) into the oscillator cavity.

(*2*) Replace the eight holding screws.

(*3*) Replace the brush mounting block (35).

b. Reassembly of Attenuator.

(*1*) Insert the attenuator piston (59) into the attenuator tube (54) and mesh the rack (51) with the pinion gear (58).

(*2*) Turn the coupling (57) clockwise until the adjusting screw (62) makes contact with the support block (55).

(*3*) Replace the limit screw (49).

(*4*) Fasten the attenuator assembly to the oscillator cavity by means of the four mounting screws (37).

c. Mounting Oscillator and Attenuator Assemblies on Signal Generator Chassis.

(*1*) Place the oscillator and attenuator assemblies on the chassis; insert the plate tuning shaft (33) into the R. F. TUNING dial, and the attenuator dial shaft (68) into the coupling (57).

(*2*) While supporting the cavity assemblies, replace the support block mounting screws (73), the tailpiece clamp mounting screws (74), and the front clamp mounting screws (75).

d. Setting R. F. ATTENUATOR Dial.

(*1*) Turn coupling (57) clockwise until the adjusting screw (62) contacts the support block (55).

(*2*) Set the R. F. ATTENUATOR dial to the red reference line.

(*3*) Tighten the coupling setscrews (67).

(*4*) If the R. F. ATTENUATOR dial is turned counterclockwise to the limit defined by the limit screw (49), the setting of the dial should be at the red reference line again. Agreement on this check will indicate that the attenuator calibration is unchanged.

e. Setting R. F. TUNING Dial.

(*1*) Turn the r-f tuning shaft (33) to the extreme clockwise position.

CAUTION: Do not loosen the lockscrew (31) on the tuning shaft stop (32), or the calibration of the unit will be destroyed.

(*2*) Set the R. F. TUNING dial to 100.

(*3*) Tighten the tuning shaft setscrews (65).

(*4*) If the R. F. TUNING dial is turned counterclockwise to its limit position, the dial should be at zero. Agreement on this check will indicate that the oscillator calibration is unchanged.

f. Replacement of Tailpiece and Oscillator Tube. Refer to paragraph 43b for the tailpiece and oscillator replacement procedure and the precautions to be observed.

g. Replacement of Leads.

(*1*) Reconnect the plate lead (66) on the brush mounting block (35).

(*2*) Reconnect all thermistor terminal connections.

(*3*) Reconnect the attenuator cable (70).

NOTE: Position cable under chassis so that it clears the protruding screwdriver adjustment fitting.

45. MAINTENANCE PARTS LIST FOR SIGNAL GENERATORS TS–155/UP AND TS–155A/UP.

The following information was compiled on 23 May 1945. The appropriate pamphlets of the ASF Signal Supply Catalog for Signal Generators TS–155/UP and TS–155A/UP are:

SIG 7–TS–155/UP, Organizational Spare Parts.

SIG 8–TS–155/UP, Higher Echelon Spare Parts.

For an index of available catalog pamphlets, see the latest issue of ASF Signal Supply Catalog SIG 2.

* * * * *

[AG 300.7 (6 Jul 45)]

By order of the Secretary of War:

Official:
EDWARD F. WITSELL
Major General
Acting The Adjutant General

G. C. MARSHALL
Chief of Staff

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