94D AMPLIFIER — DESCRIPTION

1. GENERAL

1.01 This issue replaces issue 1, dated February, 1940.

1.02 The 94D is an a-c operated, two-stage, audio-frequency amplifier which, because of its convenient form and characteristics is used in a number of message and program applications: As a line amplifier on wire line extensions of radiotelephone circuits, monitoring amplifier on program facilities, power amplifier in loud speaker systems or bridging amplifier in one-way speech networks. While differing slightly from the 94D in some mechanical features, the 94C, 103B and 109B amplifiers which are similarly applied may, in general, be tested in the same manner.

2. CIRCUIT DESCRIPTION

2.01 The simplified schematic of the 94D amplifier is shown in Fig. 1. More complete drawings are shown in the instruction bulletin supplied with the amplifier. Speech enters the amplifier through terminals 3 and 4 where a 25,000-ohm unbalanced potentiometer P1, operated by a knob on the front of the amplifier panel, serves as a gain control. There are two push-pull stages of amplification and the output from terminals 6 and 8 is designed to work into a 500-ohm load impedance or from terminals 7 and 8 into an 8-ohm load impedance.

2.02 The voltage supplies for the amplifier tubes are provided by the 352AA transformer T3 and the full-wave rectifier tube V5. The input to the transformer is provided with an external 1.25-amp Fusetron or Fustat and is controlled by the toggle switch D1 mounted on the front of the amplifier panel. Secondary terminals 4 and 6 furnish the 6.3-amp a-c filament supply; 10 and 12 supply the plate circuits of the rectifier tube; and 7 and 8 furnish the 5-volt a-c heater supply of the rectifier tube. The d-c output of the rectifier is passed through a filter L1-C11-C12 and supplies 260 volts to the plate

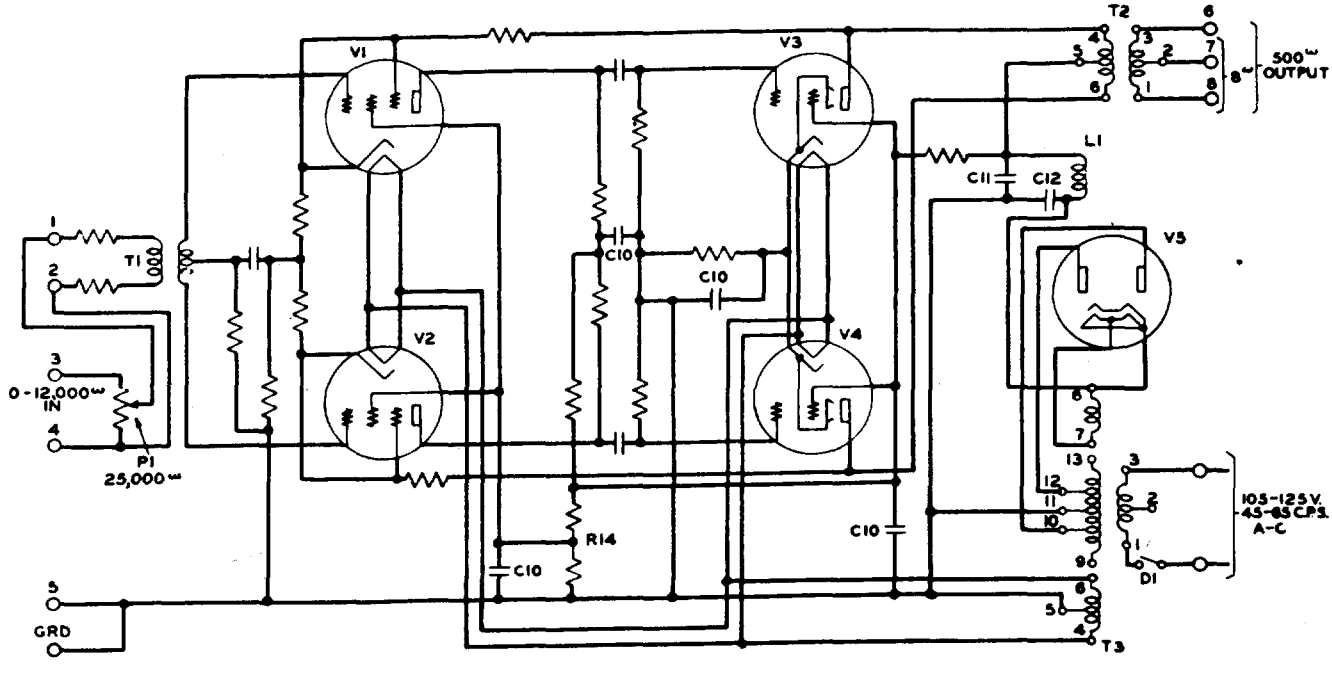

Fig. 1 — 94D Amplifier Schematic

circuits of tubes V1 and V2 and 380 volts to the plate circuits of tubes V3 and V4. The screen grids of the tubes V1 and V2 are supplied with 60-volt d-c from the tap on the R14 resistance.

3. EQUIPMENT FEATURES

3.01 The 94D amplifier is shown in Fig. 2. It is arranged for standard 19-inch mounting, is 7 inches high and weighs approximately 20 lbs. Its wiring diagram is shown in the instruction bulletin.

3.02 The metal panel or mat on which are mounted the potentiometer knob and toggle switch is available in three finishes as follows:

AMPLIFIER CODE	FINISH ON MAT
94D-3	Rubber finish black japan
94D-15	Aluminum gray
94D-24	Aluminum lacquer

3.03 The tube type designations are stenciled near the sockets.

3.04 The ***electron tubes*** used in the 94D amplifier may be either of the glass or metal types as shown below. While the glass tubes do not become so hot and so are not as liable to cause burns when handled, the metal tubes (particularly in the first stage and with shielded grid caps) provide better shielding and will prevent singing.

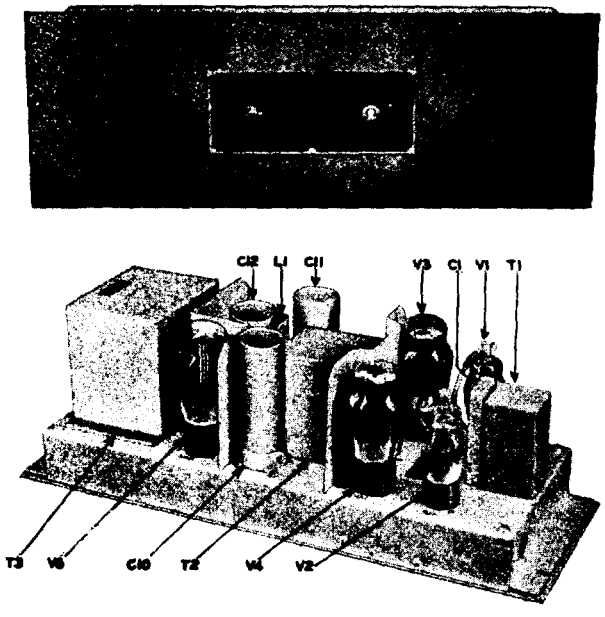

Fig. 2 – 94D Amplifier

TYPE	QUANTITY	DESIGNATION
5T4 or 5U4-G	1	V5
6J7 or 6J7-G	2	V1, V2
6L6 or 6L6-G	2	V3, V4

3.05 The ***power consumption*** of the 94D amplifier is approximately 100 watts; and the a-c supply to the amplifier should be fused with a 1.25-amp Fusetron or Fustat external to the amplifier.

3.06 The ***ventilation*** of this type of amplifier is important since it generates considerable heat, and it is essential to provide for it as much ventilation as is practicable. The permissible temperature rise (as measured on the case of the C11 condenser) above the ambient temperature is 40°F. If a single amplifier is to be rack-mounted in a cabinet, at least 2 inches of air space should be provided at the top and 2-1/2 inches at the two ends. An open back is satisfactory only when the construction of the cabinet makes it impossible to bring an obstruction within 3 inches of the open back. If the cabinet is 50 per cent perforated on top and has an equal opening area on sides and back with access to open air, the space, above the amplifier may be reduced to 1-1/2 inches.

3.07 When two or more amplifiers are mounted on the same bay, there should be 7 inches from the top of one to the bottom of the one above. If the bay is enclosed, its top should have approximately 140 square inches of opening and an equal amount should be provided near the bottom of the bay. As many as 5 amplifiers or any combination of amplifiers and apparatus with a total heat dissipation of 550 watts may be mounted in such a single enclosed bay.

3.08 The location of the a-c operated 94D with respect to other amplifiers is not limited since its power input transformer has been found to cause negligible interference in the speech input transformers of adjacent 12, 14 or similar type amplifiers.

3.09 Experience in the operation of 94C and D amplifiers of the early period of manufacture (serial numbers below 1000) indicated a condition which in some cases has resulted in short life of their electrolytic condensers C4 and C5. Improved condensers and heat shields, which are included in amplifiers having serial numbers above 1000, may be applied to existing amplifiers in service as authorized by the engineers.

3.10 ***Apparatus:***

3 Condensers C10, C11 and C12 (see Apparatus List)

1 Soldering lug W.E. Piece Part 91308 or equivalent

2 Heat Shields per ES-675552 Det. 1 and 2

3.11 ***Procedure:***

(1) Remove the mat, disconnect and remove the 5-terminal condenser C5 and mount the 4-terminal condenser C10 in its place. Provide the common cathode connection of the 4-section condenser by mounting a soldering lug on the under side of the chassis by means of the same screw that holds the condenser clamp to the chassis.

(2) Punch out the knockout hole between transformers T2 and T3 and file smooth the edges of this hole.

(3) Mount the heat shields.

(4) Disconnect and remove the 3-terminal condenser C4 and mount the 2-terminal condenser C11 in its place.

(5) Remove the hexagonal nut, lockwasher and collar terminal from condenser C12 and mount it in the new knockout hole, with the collar terminal adjacent to and on the under side of the chassis.

(6) Wire the three new condensers in accordance with the wiring diagram shown on ES-675551.

(7) Check the d-c voltage and the output noise in accordance with part 5 of this practice.

(8) Replace the mat.

4. TRANSMISSION CHARACTERISTICS

4.01 The maximum ***gain*** of the 94D amplifier when operating between a 600-ohm source impedance and a 500-ohm load impedance is from 47 to 49 db. For other values of source impedance, the maximum gain is approximately as follows:

SOURCE IMPEDANCE OHMS	MAX. GAIN DB
2	20
20	30
50	35
200	40
500	45
1700	50
5000	55
10000	58

4.02 The ***gain control potentiometer*** has a total loss of from 45 to 50 db in 50 segments of approximately 1 db each. Its dial is marked OFF, 1 to 9 and MAX, giving 10 divisions of approximately 5 db per division. The common side of the potentiometer (terminal 4 on terminal strip 1) should always be grounded.

4.03 The ***response-frequency characteristic*** is essentially flat from 40 to 10,000 cps, the maximum difference between any two frequencies not exceeding 2 db.

4.04 The ***power output*** is 12 watts, with less than 5 per cent harmonic distortion on a single frequency, to either an 8 or 500-ohm load. This output can be increased to 20 watts by modifying the amplifier per D-151095 as authorized by engineers.

4.05 The output noise (a-c hum) is less than 28 db (message weighting), 38 db (program weighting) or 58 db (flat weighting)above reference noise.

4.06 The amplifier works from impedance inputs over the range of zero to 12,000 ohms and into load impedances of either 8 or 500

ohms. Either load impedance may vary from one-half to twice normal value with only slight reduction in the output power.

5. DESCRIPTION OF TESTS AND ADJUSTMENTS

(A) Power Transformer Voltages

5.01 The 352AA power transformer T3 on the amplifier panel is designed for operation from a 105-125-volt, 45-60-cps power supply. If the available service is at a higher or lower voltage, an external transformer must be installed.

5.02 ***Apparatus:***

Weston Model 697 Volt-Ohm Milliammeter with test leads or

Weston Model 772 Type 2 Analyzer with test leads

Screwdriver

5.03 ***Procedure:***

Caution: Take proper precautions in measuring these voltages. Connect meter before turning on power; and avoid personal contact with terminals.

(1) Take off the potentiometer knob and remove the front mat of the amplifier panel by taking out the four screws at the corners of the chassis.

(2) Measure the commercial supply voltage across terminals 1 and 2 or 1 and 3 of transformer T3.

Requirement: If the a-c commercial supply voltage is between 105 and 115, it shall be connected to terminals "A" and 2; if between 115-25, to terminals "A" and 3.

Note: Terminal "A" which is not designated is mounted on the inside of the shield enclosing terminals 1, 2, and 3 of the transformer.

(3) Measure the d-c voltage supplies within the amplifier.

Requirements: With an a-c commercial supply of 105-115 or 115-125 volts, the d-c voltages measured from the following points to the GND terminal on the output terminal strip TS2 shall be within the following ranges:

Terminal 5 of transformer T2 to GND	350-410 V
Yellow lead terminal of resistance R15 to GND	250-290 V
Red lead terminal of resistance	210-250 V
Black-red lead terminal of resistance R14 to GND	50-60 V
Green lead terminal of resistance R15 to GND	17-25 V

(4) Replace front mat and potentiometer knob.

(B) Electron Tubes

5.04 ***Apparatus:***

Hickok Model 530B Tube Tester or equivalent

5.05 ***Procedure:***

(1) Test each tube in accordance with the information given in the practice covering the tube tester.

Requirements: The tubes shall meet the requirements as given in the practice covering the tube tester.

5.06 ***Test Interval:***

Three months

(C) Step-Gain Characteristic

5.07 The input circuit of the 94D amplifier is unbalanced by reason of the potentiometer; and when it is tested separately the amplifier must be properly grounded.

5.08 If the amplifier is at a remote location to which testing power can be supplied from a remote 13A oscillator, a 13A transmission

measuring set may be used in conjunction with a 45-db pad at the amplifier input. The testing power may be supplied locally from a 19-type oscillator.

5.09 ***Apparatus:***

40B or 13A Transmission Measuring Set or equivalent

13A or 19-type Oscillator or equivalent

45-db 600-ohm Pad (for use with 13A Transmission Measuring Set)

Note: The pad may be made up of two 19SJ resistances for the four series elements of 296.65 ohms each and two 18JT resistances in parallel for the shunt element of 6.75 ohms.

5.10 ***Procedure:***

Caution: The test power at the output of the amplifier must not exceed 20 db above 1 MW.

(1) Connect the 40B transmission measuring system to the amplifier and measure its gain at 1000 cps for each potentiometer dial position from 1 to MAX.

Requirement: The maximum overall gain shall be from 47 to 49 db; and the gain between successive steps shall be from 3.5 to 7.5 db.

(2) If the amplifier is being tested at a remote location, connect either the wire line from the distant test power source or the 19-type oscillator, adjusted for 1 milliwatt of 1000 cps tone, through the 45-db pad to the amplifier input.

(3) Connect the 13A transmission measuring set to the amplifier output and measure as in (1).

(D) Gain-Frequency Characteristic

5.11 ***Apparatus:***

40B or 13A Transmission Measuring Set

13A or 19-type Oscillator

5.12 ***Procedure:***

(1) Connect the measuring equipment as in Paragraph 5.10(1) or (2).

(2) Set the amplifier potentiometer as required.

(3) With the input limited to 10 db below 1 milliwatt, measure the amplifier gain at the required frequencies.

Requirements: The gain at 200, 300, 500, 2000, 3000 and 5000 cps shall be within 1 db of the 1000 cps gain.

Note: In program applications, include additional measurements at 50, 100 and 8000 cps in the above test.

(E) Output Noise

5.13 ***Apparatus:***

2B Noise Measuring Set or equivalent

600-Ohm Termination

5.14 ***Procedure:***

(1) Disconnect the normal input to the amplifier, terminate the amplifier input in 600 ohms and adjust the potentiometer to MAX.

(2) Connect the 600-ohm amplifier output to the noise measuring set, insert its plug in its LINE jacks and, after calibrating, measure noise (a-c hum).

Requirement: The noise at the output of the amplifier with ***message weighting*** shall not exceed 28 db above reference noise.

(3) Change the noise measuring set plug to its PROG jacks and measure noise (a-c hum).

Requirement: The noise at the output of the amplifier with ***program weighting*** shall not exceed 38 db above reference noise.

(4) Change the noise measuring set plug to its SOUND jacks, operate the SOUND WTG key to FLAT and measure noise (a-c hum).

Requirement: The noise at the output of the amplifier with ***flat weighting*** shall not exceed 58 db above reference noise.

(5) If these requirements are not met, check ground connections, voltages, tubes and condensers.

(F) Electrolytic Condensers

5.15 The dielectric film of the electrolytic condensers will slowly deteriorate if there is no voltage across the condensers. If the amplifier is not in continuous operation, it will be necessary to reform the condenser films every 3 months by applying power to the amplifier for a period of 4 hours.

5.16 ***Apparatus:***

2B Noise Measuring Set

40B or 13A Transmission Measuring Set

13A or 19-type Oscillator

5.17 ***Procedure:***

(1) Operate the toggle switch to ON and turn potentiometer to MAX.

(2) At the end of 4 hours, check the maximum gain and output noise as in Paragraphs 5.10 and 5.14.

(3) If the output noise (a-c hum) exceeds the permissible value with rated maximum gain, substitute new electron tubes. If this does not bring the noise below the limit, substitute new electrolytic condensers.

(4) If gain is below rated maximum, measure voltages as in Paragraph 5.03.

(5) If gain is still below rated maximum, check the vacuum tubes.

(6) If voltages are approximately normal and electron tubes are satisfactory, check the other units (external to the amplifier) in the transmission circuit under test.

5.18 ***Test Interval:***

One year

6. REFERENCE AND APPARATUS LISTS

(A) Reference

W.E.Co. Instruction Bulletin No. 881 "94D Amplifier"

(B) Apparatus List

APPARATUS DESIGNATION	DESCRIPTION
C1	W.E.Co. D-96818 Condenser 0.8 mf.
C2, C3	Aerovox Condensers Type 1455 0.02 mf.
C10	Sprague Specialty Co. 4-section dry Electrolytic Condenser 20 mf. 350 v., 10 mf. 350 v., 12 mf. 100 v., and 50 mf. 25 v. Class 1 can and DX2 section per sample 7842.
C11	Sprague Specialty Co. 1-section dry Electrolytic Condenser 50 mf. 450 v. Class 2 can and DX2 section per sample 7841.
C12	Cornell Dubilier Type TLA-6040 "Dykanol" oil condenser 4 mf. 600 v.
D1	Hart and Hegeman 20992 Tumbler Switch
L1	W.E.Co. 221-G Retardation Coil
P1	Allen-Bradley 733-A Potentiometer 25,000 ohms
(Resistances R—R13 incl. have No. 1 terminals)	
R1, R13	I.R.C. BT-1 Resistance 0.3 megohm
R2, R5, R12	I.R.C. BT-1/2 Resistance 0.5 megohm
R3, R11	Resistance 0.25 megohm
R4, R9	Resistance 800 ohms
R6, R8	Resistance 5,000 ohms

APPARATUS DESIGNATION	DESCRIPTION
R7	Resistance 400 ohms
R10	Resistance 50,000 ohms
R14	I.R.C. MW-5 Resistance 31,800 ohms tapped at 25,000 ohms with No. 2 terminals
R15	I.R.C. MW-5 Resistance; two separate sections of 250 ohms and 10,000 ohms with No. 2 terminals
T1	W.E.Co. 285-K Input Transformer
T2	W.E.Co. 171-B Output Transformer
T3	W.E.Co. 352-AA Transformer
V1, V2	R.C.A. 6J7 or 6J7-G Electron Tubes
V3, V4	R.C.A. 6L6 or 6L6-G Electron Tubes
V5	R.C.A. 5T4 or 5U4-G Electron Tube