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HEWLETT-PACKARD

460AR

WIDE BAND AMPLIFIER

SERIALS PREFIXED: 046-

OPERATING AND SERVICING MANUAL



OPERATING AND SERVICING MANUAL



MODEL 460AR
WIDE BAND AMPLIFIER

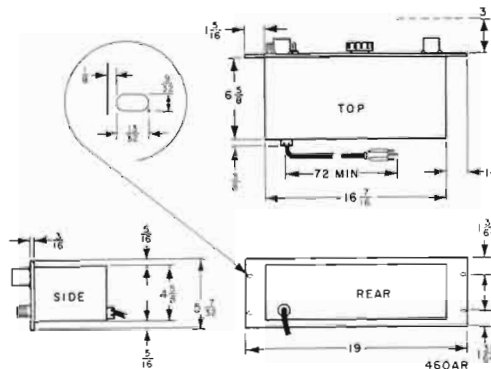
SERIALS PREFIXED: 046 -



*NORTH SHORE LTD.
1074 Cheltenham Rd.
Santa Barbara, Calif. 93105*

SPECIFICATIONS

FREQUENCY RESPONSE:	<u>High Frequency</u> - closely matches Gaussian curve when operating into a 200-ohm resistive load. 3 db point is 120 mc. <u>Low Frequency</u> - off approximately 3 db at 20 kc when operating into a matched load. Off approximately 3 db at 3 kc when operating into an open circuit (i.e., CRT plates). With \textcircled{P} 410B VTVM - when used with \textcircled{P} 46A-95D Adapter, response ± 1 db, 200 kc to 200 mc.
GAIN:	Nominally 20db into 200 ohm load. Gain control has range of 6db. Five amplifiers may be cascaded.
SINUSOIDAL OUTPUT:	Approximately 8 volts peak open circuit, less than 5% distortion.
PULSE OUTPUT:	Positive Pulse Input: +8 V open circuit: +3.2 V into rated load Negative Pulse Input: -20 V open circuit: -8 V into rated load
INPUT IMPEDANCE:	200 ohms
OUTPUT IMPEDANCE:	300 ohms
NOISE FIGURE:	Less than 10 db
DELAY CHARACTERISTICS:	Approximately 0.014 μ sec.
RISE TIME:	Nominally 0.003 μ sec (10% to 90% amplitude). No appreciable overshoot.
POWER SUPPLY:	115/230 volts $\pm 10\%$, 50/1000 cps, 50 watts

DIMENSIONS:
(Rack Mount)



WEIGHT:	Net 12 lbs. Shipping weight 18 lbs.
ACCESSORIES AVAILABLE:	<ul style="list-style-type: none"> \textcircled{P} 46A-16A Patch Cord; 200 ohms, 2 feet long \textcircled{P} 46A-16B Patch Cord; 200 ohms, 6 feet long \textcircled{P} 46A-95A Panel Jack; for 200-ohm cables, low capacitance \textcircled{P} 46A-95B Cable Plug; for 200-ohm systems \textcircled{P} 812-52 Cable; 200 ohm cable in length to specification \textcircled{P} 46A-95C 50-ohm Adapter; Type N to \textcircled{P} 460, 50 ohm termination \textcircled{P} 46A-95D Adapter; \textcircled{P} 410B VTVM to \textcircled{P} 460, no termination \textcircled{P} 46A-95E Connector Sleeve; Joins two 46A-95B Cable Plugs \textcircled{P} 46A-95F Adapter; For connecting to 5XP CRT \textcircled{P} 46A-95G Adapter; Connect \textcircled{P} 460 to Tektronic 511 Oscilloscope \textcircled{P} 46A-95H Adapter; Type N to \textcircled{P} 460, 200 ohm termination \textcircled{P} 46A-95J Adapter; Type N to \textcircled{P} 460, no termination \textcircled{P} 46A-95K Adapter; \textcircled{P} 410 VTVM to \textcircled{P} 460, 200 ohm termination \textcircled{P} 460B-95A Adapter; For connecting to \textcircled{P} Model 150A Oscilloscope plates.

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SECTION I
GENERAL DESCRIPTION

1-1 GENERAL

The  Model 460AR is a wide band distributed amplifier especially designed to amplify high speed pulses to high voltage levels with negligible overshoot. In order to retain the fast rise time and shape of high speed pulses, it is necessary that the amplifier have a wide, reasonably flat frequency response. The frequency response of the  model 460AR closely approximates the gaussian response and hence retains the characteristics of short fast pulses.

A gain of 20 db may be obtained with this amplifier. Up to five amplifiers may be cascaded for additional amplification.

The Model 460AR is useful as a general laboratory amplifier, to increase voltmeter and oscilloscope sensitivity, and in television work.

1-2 ACCESSORIES AVAILABLE

A complete line of accessories, for use with the Model 460AR, is available from the Hewlett-Packard Company. These accessories are listed on the Specification page and at the end of the Table of Replaceable Parts in this manual.

1-3 230 VOLT OPERATION

This instrument can be easily converted for operation from a 230 volt power source. This conversion is covered in the maintenance section of this manual.

SECTION II
OPERATING INSTRUCTIONS

2-1 INSPECTION

After the instrument is unpacked, it should be carefully inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in the "Claim for Damage in Shipment" page at the back of this instruction book.

2-2 CONTROLS AND TERMINALS

ON

This toggle switch controls all the power supplied to the instrument from the power line.

GAIN

This variable resistor controls the gain of the amplifier.

FUSE

The fuseholder, located on the panel, contains the power line fuse. Replacement fuses should be of the type specified in the Table of Replaceable Parts.

POWER CABLE

The three-conductor power cable supplied with this instrument is terminated in a polarized three-prong male connector. The third contact is an offset, round pin added to a standard two-bladed a-c plug which grounds the instrument chassis when used with an appropriate receptacle. An adapter may be used to connect this plug to a standard two contact system. When the adapter is used, the ground connection is brought out on a short wire. This ground lead should then be connected to a suitable ground for the protection of operating personnel.

INPUT AND OUTPUT

The input and output jacks on the control panel, require special 200-ohm connectors and cables.

2-3 INSTALLATION

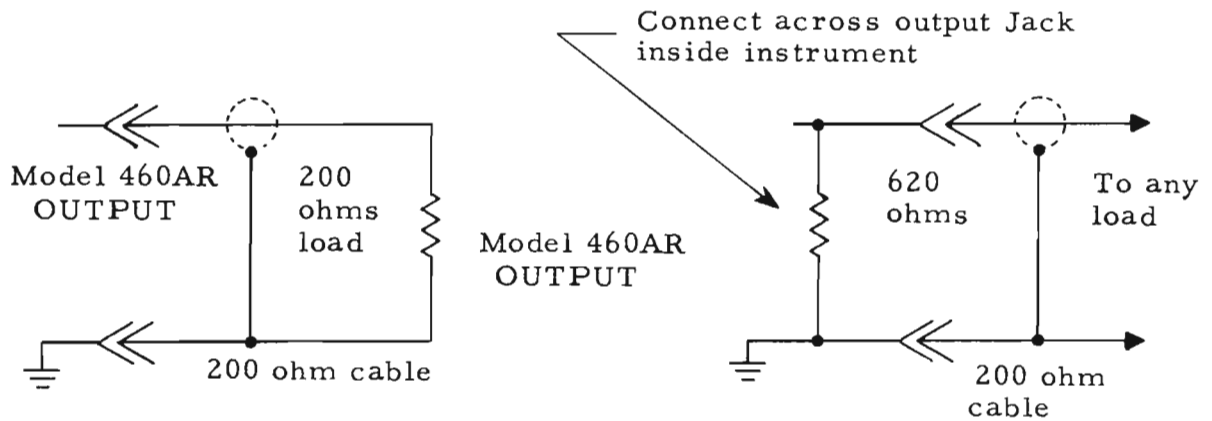
No special precautions are necessary except, when several 460 Amplifiers are to be used in cascade, they must have a good common ground, i. e. : mounted in a relay rack, and the high-voltage

output must be kept away from the input to avoid the possibility of feedback.

2-4 OPERATION

The input circuit of the Model 460AR is a terminated transmission line with a characteristic impedance of 200 ohms.

The output circuit has an impedance of 280 ohms (resistive). The load impedance determines the gain of the amplifier. Therefore, it is not necessary to match the load to the output of the amplifier unless the gain is adversely affected. Shown below are two diagrams for connecting a matched or unmatched load to the Model 460AR using a 200 ohm cable.



The GAIN control will vary the gain of the amplifier over a range of approximately 6 db. This control is provided so that the gain of the amplifier can be set to a known value if necessary. There is no feedback in the amplifier, so the gain is directly proportional to the Gm of the tubes. The gain is also determined by the output load and will vary with output load in accordance with the relation

$$\frac{280 \times Z_L}{280 + Z_L}$$

The Wide Band Amplifier can be used with the ^{hp} Model 410 Vacuum Tube Voltmeter to provide additional sensitivity in measuring high frequencies. A special adaptor is available to connect the probe of the Model 410 to the output terminal of the amplifier. The overall frequency response of the Model 460AR, in combination with the Model 410, is within 1 db out to 190 mc. This combination will give a full scale meter reading on the Model 410 with 1/10 volt applied to the input of the Model 460AR.

Several amplifiers can be cascaded when more than 20 db gain is desired. The maximum gain which can be used will be limited by the effective noise generated in the input circuit of the amplifier. The noise figure is approximately 10 db.

When amplifiers are cascaded, the rise time will be greater than that of a single unit in accordance with the relation:

$$T = t (n)^{1/2}$$

where: T is total rise time
t is the rise time of a single unit (3 X 10⁻⁹ sec.)
n is the number of 460 units.

The total rise time of any number of 460 Amplifiers in conjunction with any load may be found approximately by the following relation:

$$T = [nt^2 + (440C)^2]^{1/2}$$

where: n = number of 460 Amplifiers
t = rise time of one 460 =
2.6 X 10⁻⁹ sec.

C = total shunt capacitance on the output of the 460 in farads.
T = total rise time.

2-5 CIRCUIT DESCRIPTION

The Model 460AR is an amplifier which has a very wide transmission band. It has two stages with five tubes in the first stage and seven tubes in the second stage. The grids of these tubes are connected along one transmission line for the input circuit and the plates of the tubes are connected along a second transmission line for the output circuit. A wave traveling down the input line excites the grids in succession and half of the corresponding wave generated in the plate circuit travels down the plate line toward the output and is reinforced at each successive plate. The part of the wave in the plate line which travels in the reverse direction is absorbed by a termination of the other end of that line. By the time the wave in the plate line reaches the output, it has been amplified by about 10 db. The second stage adds another 10 db to make a total of 20 db gain for the unit.

The Model 460AR will amplify pulses with an extremely short rise time and with virtually no overshoot. The time of rise of the amplifier itself is approximately 3 millimicroseconds. The amplifier has an amplitude response closely matching the Gaussian Curve, which is the ideal transmission for pulse amplifications when ring- or overshoot cannot be tolerated.

SECTION III
MAINTENANCE

3-1 COVER REMOVAL

You will be able to slide the one-piece cover off of the instrument after removing the four screws in the rear of the cover.

3-2 TUBE REPLACEMENTS

In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before making any internal adjustment or component replacement, check the tubes. Adjustments made in an attempt to compensate for a defective tube will often complicate the repair problem.

It is good practice to check tubes by substitution rather than by the use of a "tube checker". The results obtained from the "tube checker" can be misleading. Mark original tubes to insure return to the same socket. Replace only tubes proved to be weak or defective.

Any tube with corresponding standard EIA (JEDEC) characteristics can be used as a replacement.

3-3 POWER SUPPLY

Rectifier CR1 is connected in a half-wave circuit. The dc output voltage between ground and the junction of C96 and L25 should be 110 ± 10 volts with the line voltage set to 115 volts. The GAIN control should be set fully clockwise to maximum. Ripple voltage can be quite high without affecting instrument performance.

Low power supply voltages are generally due to a weak selenium rectifier, leaky filter capacitors, shorted tubes or off value plate line, grid line, or screen resistors.

3-4 230 VOLT OPERATION

The hp Model 460AR can be quickly and easily converted to operate from a nominal 230 volt 50/1000 cps power source. The instrument is normally supplied with the dual primary windings of the power transformer connected in parallel for 115 volt operation. To convert for 230 volt operation, reconnect the primary windings in series as shown on the schematic diagram. The line fuse F1 must also be changed from 0.6 amp. slow-blow to 0.4 amp. slow-blow.

3-5 TROUBLE SHOOTING

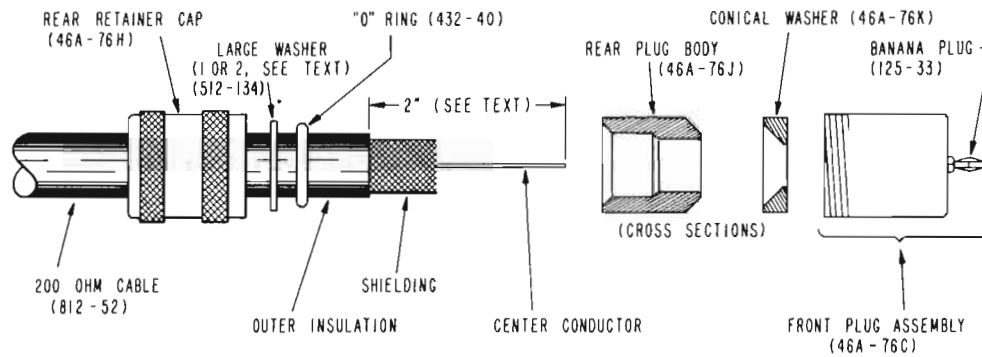
Low gain, low output, and impaired frequency response are all directly related to tube mutual conductance and power supply output voltage. Consequently, should any of the above symptoms appear, the power supply output voltages should be checked (Paragraph 3-3) and the tubes should be checked (Paragraph 3-2).

Impaired frequency response, low gain, and/or excessive hum can also be caused by open or shorted coils and by defective terminating resistors or screen resistors.

The can of electrolytic capacitor C9 is insulated from the chassis. If this capacitor is shorted to the chassis the bias voltage will also be shorted. The bias voltage is normally not more than about 1.8 volts and is not dangerous to personnel but tube damage can result if this voltage is removed.

3-6 REPLACEMENT OF 200 OHM CABLE CONNECTOR

1. Connect 200 ohm cable to length desired. Trim end of cable to a point where shielding and outer insulation are even with the end of a center conductor support bead. After assembly, cable length to tip of banana plug will be approximately 1/4" shorter than trimmed cable length.



LD-M-52

Figure 3-1. Exploded View of the 46A-95B Assembly



2. Remove outer cable insulation for a distance of 2" from cable end.
3. Remove three support beads from center conductor. To do this, upset shielding just enough to release beads.



4. Slide the following parts over the cable shielding in order given: rear retainer cap, large washer(s), rubber "O" ring. Either one or two washers are included with the connector parts at the factory. Use all of the large 512-134 washers supplied. Purpose of additional washer is given in step 9.
5. Slide rear plug body over shielding. Hold rear plug body against end of outer insulation and cut off shielding 3/16" from beveled end of rear plug body.
6. Fan shielding out and bend back over rear plug body. Trim off any shield wire protruding beyond beveled edge.
7. Place conical washer over shielding with flat side toward end of plug.
8. Insert center conductor through hole in center of front plug assembly, slide assembly back over conical washer. Thread rear retainer cap on front plug assembly. Plug must be firmly tightened so that it cannot be rotated on end of cable. The use of strap wrenches is recommended.
9. Measure distance between front edge of rear retainer cap and front edge of front plug assembly. This distance must not be less than 31/32". Additional washers installed as in step 4 will increase this distance.
10. Wrap and solder the center conductor to the base of the banana plug. Do not pull center conductor excessively tight when connecting to banana plug.
11. Resistance between outer connectors must be less than one ohm. Resistance between center connectors must be less than one ohm. Resistance between outer connectors and center connectors must be greater than 500 megohms.

3-7 TEST PROCEDURE

Testing of the 460AR is a long tedious procedure and is not often needed. However, anyone with the necessary equipment for making the several somewhat complex test set-ups can complete the procedure. The following Φ instruments or their equivalent will be required.

- Signal Sources - Models 212A, 608C, and 650A.
- Voltmeters - - - - Models 410B and 400D/H/L.
- Oscilloscope - - - - - Model 150A.
- Attenuators - - - - - Models 355A and 355B.
- Miscellaneous - - - - - Cable Adapters.

The complete Test Procedure is available from the  Factory as a Service Note. Perhaps your most convenient source for these Service Notes is your local  Representative who will be pleased to supply you with copies on request.

Your  Representative also maintains complete facilities and specially trained personnel to assist you with any engineering, application, test, or repair problems you may have with  instruments.

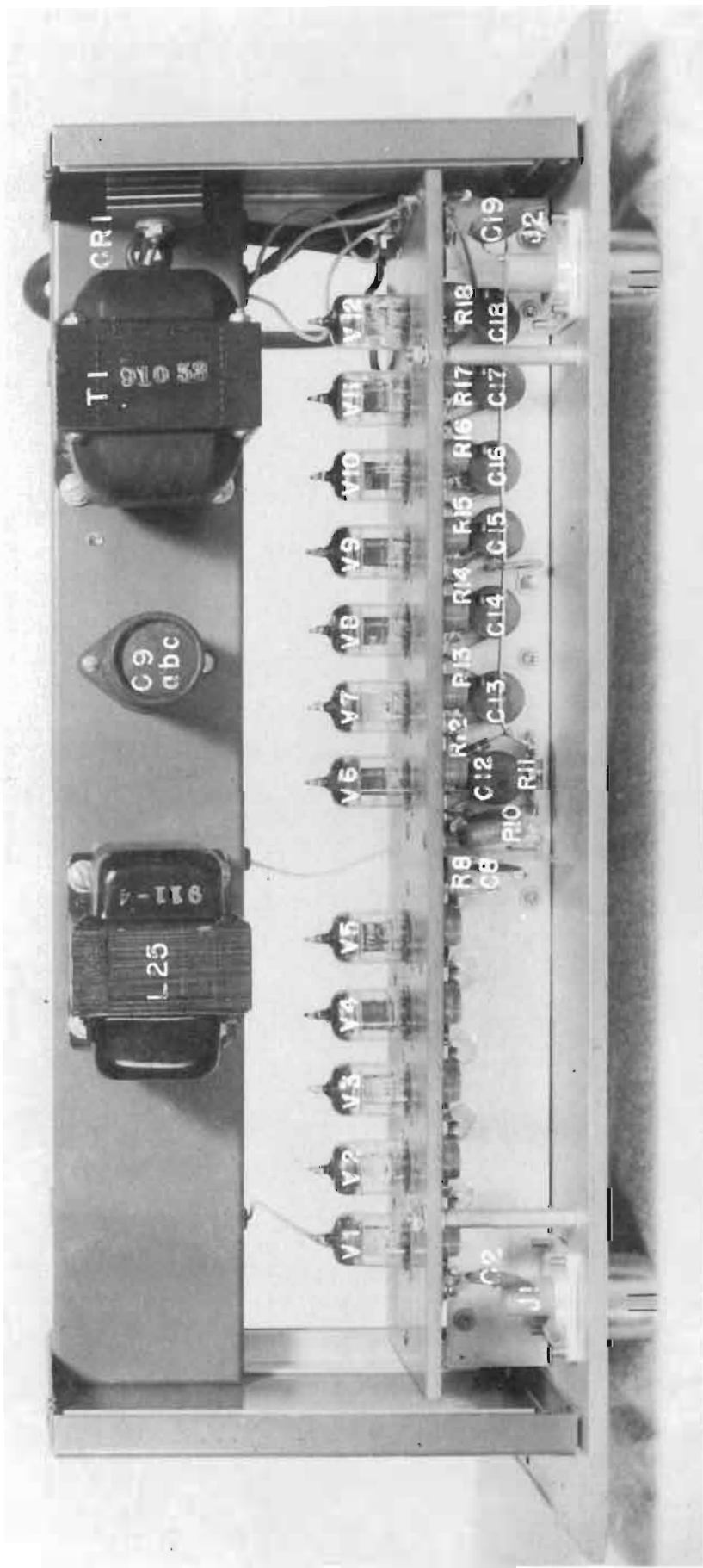


Figure 3-2. Model 460A Top View

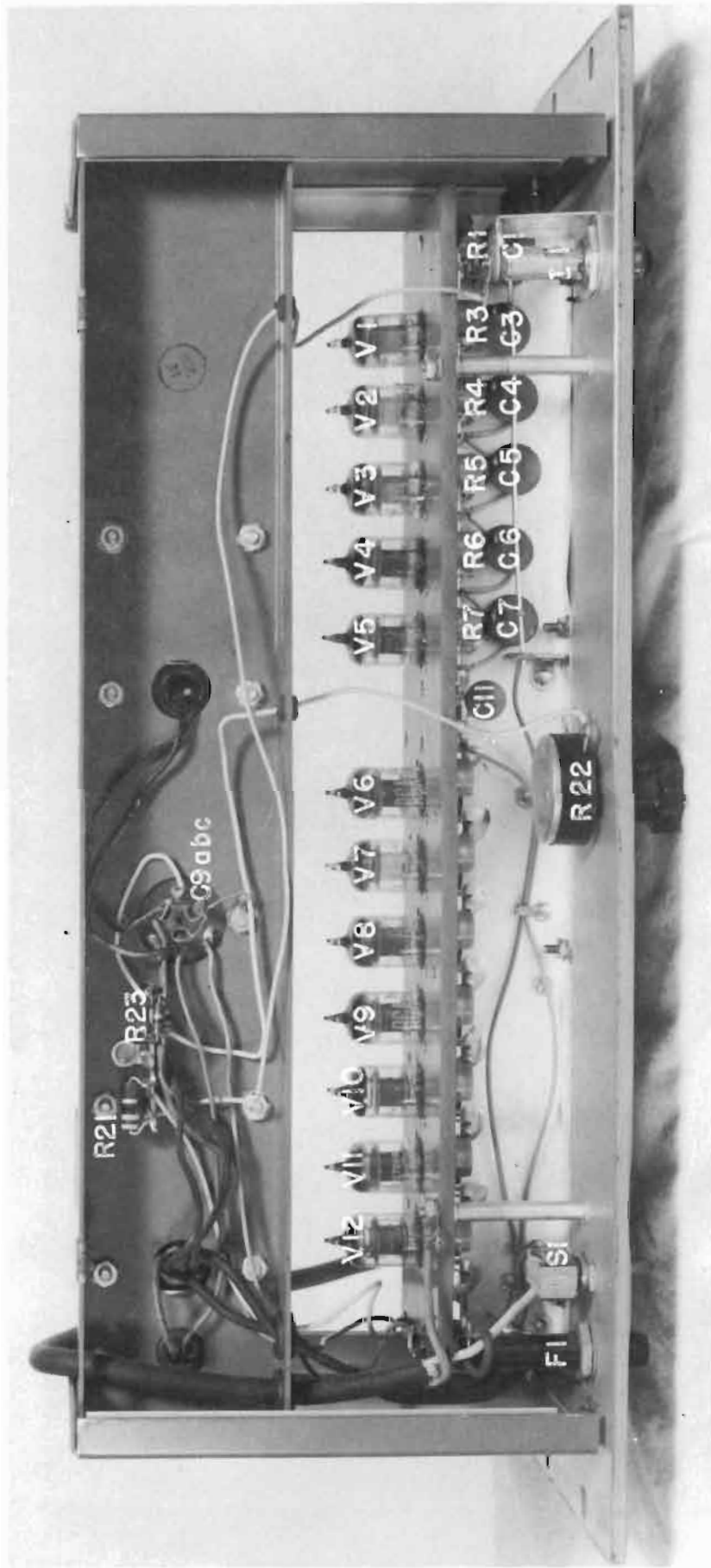


Figure 3-3. Model 460A Bottom View

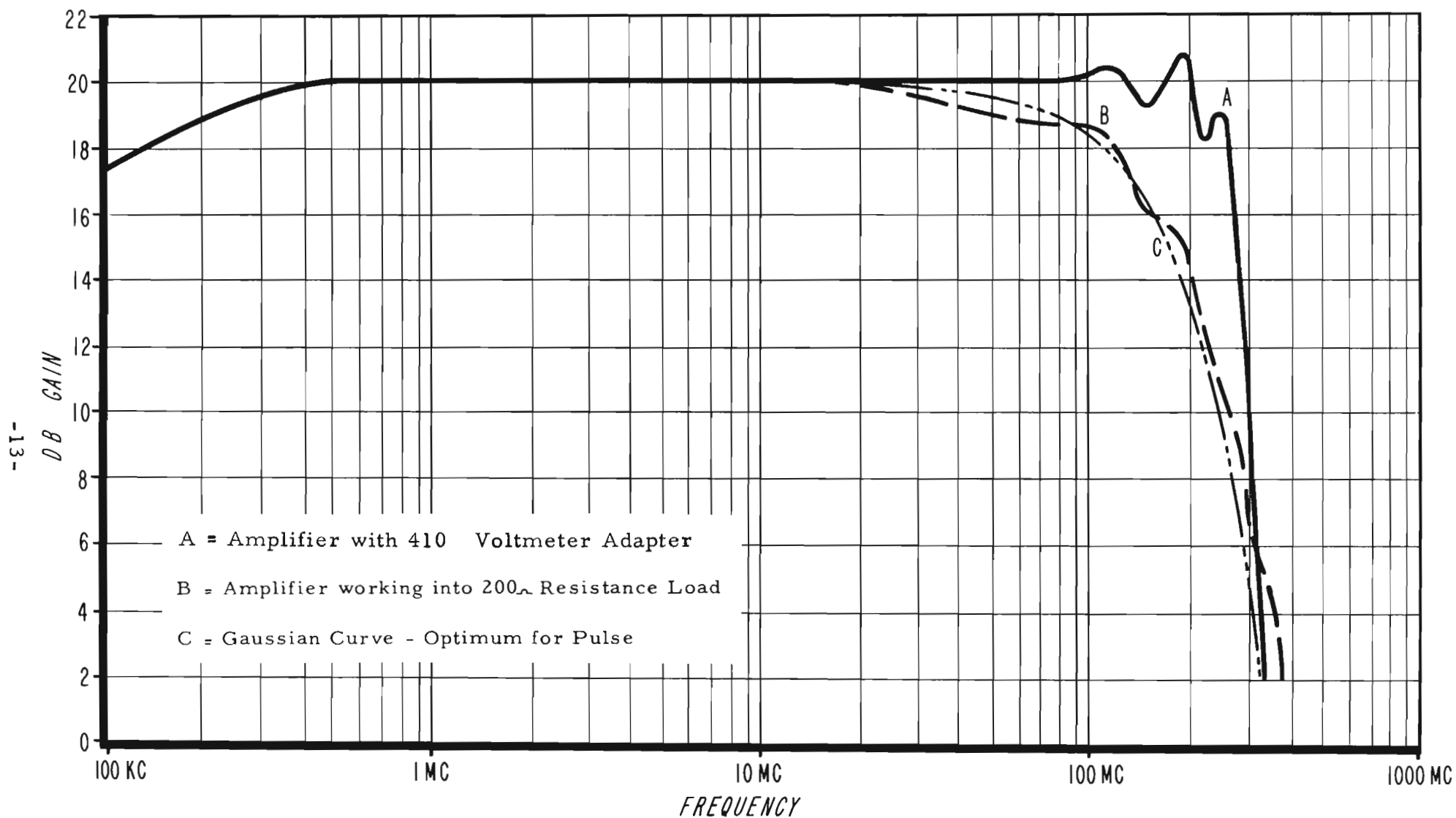


Figure 3-4. Typical Response Curves Model 460A Wide Band Amplifier

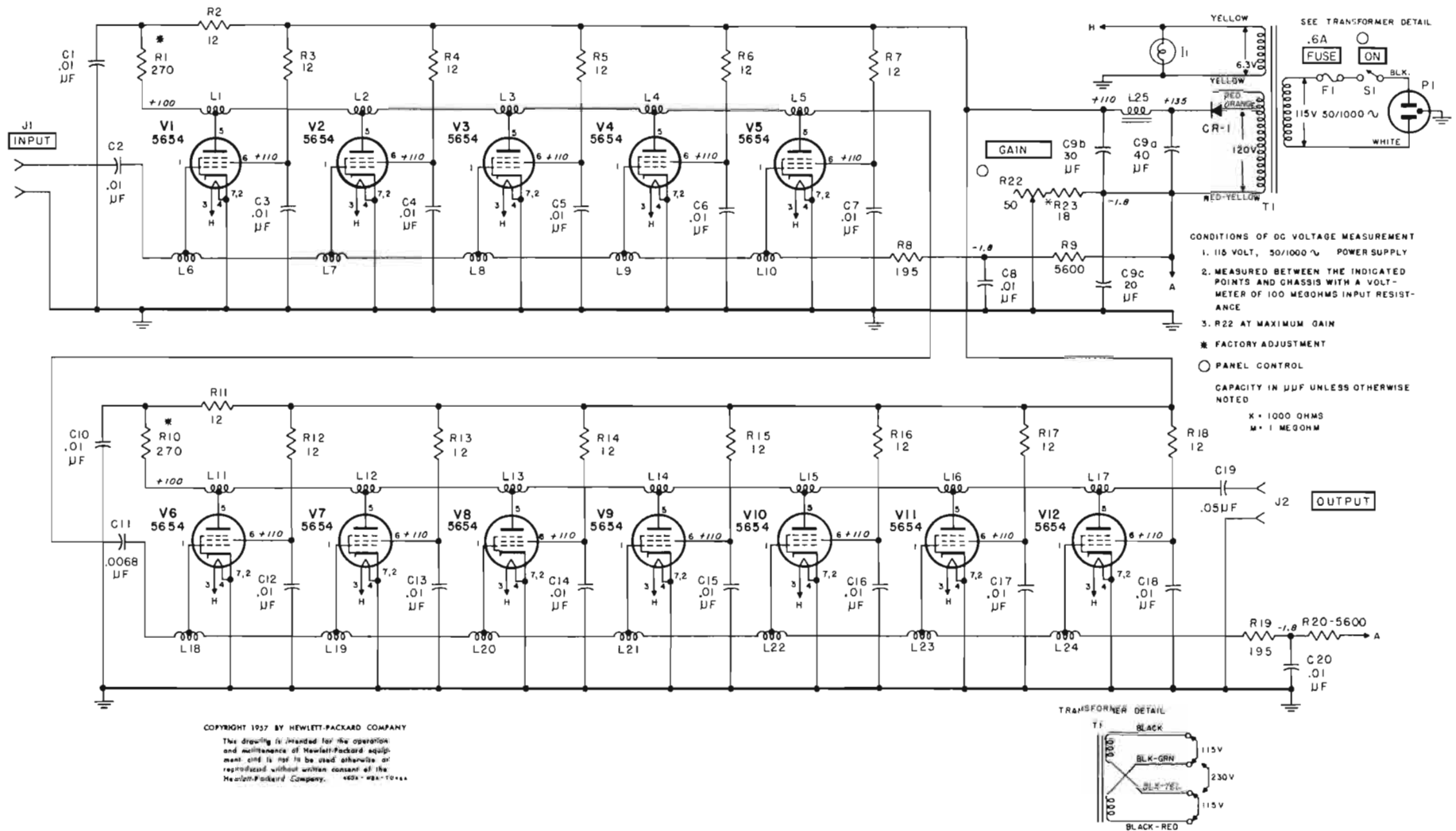



Figure 3-5. Model 460AR Wide Band Amplifier

SECTION V TABLE OF REPLACEABLE PARTS

NOTE

Standard components have been used in this instrument, whenever possible. Special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1.  Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed, give complete description, function and location of part.

Corrections to the Table of Replaceable Parts are listed on an Instruction Manual Change sheet at the front of this manual.

RECOMMENDED SPARE PARTS LIST

Column RS in the Table lists the recommended spare parts quantities to maintain one instrument for one year of isolated service. Order complete spare parts kits from the Factory Parts Sales Department. ALWAYS MENTION THE MODEL AND SERIAL NUMBERS OF INSTRUMENTS INVOLVED.

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	Mfr. *	[Ⓟ] Stock No.	TQ	RS		
C1	Capacitor: fixed, ceramic, .01 μ f \pm 20%, 1000 vdcw	56289	0150-0012	1	1		
C2	Capacitor: fixed, ceramic, .01 μ f \pm 20%, 100 vdcw	91418	0150-0098	3	1		
C3 thru C7	Capacitor: fixed, ceramic, .01 μ f \pm 20%, 1000 vdcw	56289	0150-0012	13	3		
C8	Same as C2						
C9A,B,C	Capacitor: fixed, electrolytic, 3 sections, 40 x 30 x 20 μ f, 150 vdcw	56289	0180-0053	1	1		
C10	Same as C3						
C11	Capacitor: fixed, ceramic, .0068 μ f \pm 20%, 1000 vdcw	91418	0150-0097	1	1		
C12 thru C18	Same as C3						
C19	Capacitor: fixed, ceramic, .05 μ f \pm 10%, 400 vdcw	19701	0150-0052	1	1		
C20	Same as C2						
CR1	Rectifier, metallic	21964	1880-0001	1	1		
F1	Fuse, cartridge: .6 amp, slow-blow (for 115 volt operation)	75915	2110-0016	1	10		
	Fuse, cartridge: .4 amp, slow-blow (for 230 volt operation)	75915	2110-0019	1	0		
I1	Lamp, incandescent: 6-8V, 2 pin base, #12	24455	2140-0012	1	1		
J1, 2	Jack, panel	28480	46A-76	2	0		
	Knob: GAIN	28480	G-74K	1	0		
L1 thru L5	Coil Assembly	28480	46A-95L	1	1		
L6 thru L10	Coil Assembly	28480	46A-95N	1	1		
L11 thru L17	Coil Assembly	28480	46A-95M	1	1		
L18 thru L24	Coil Assembly	28480	46A-95P	1	1		

* Refer to "List of Manufacturers' Codes".

TQ Total Quantity used in the instrument.

RS Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	Mfr. *	^{hp} Stock No.	TQ	RS		
L25	Reactor: 6h	28480	9110-0017	1	1		
P1	Cord, power	70903	8120-0050	1	1		
R1	Resistor: fixed, deposited carbon, 277 ohms $\pm 1\%$, 1 W Optimum value selected at factory Average value shown	19701	0730-0008	11	3		
R2 thru R7	Resistor: fixed, composition, 12 ohms $\pm 10\%$, 1/2 W	01121	0687-1201	14	3		
R8	Resistor: fixed, deposited carbon, 195 ohms $\pm 1\%$, 1/8 W	19701	0721-0008	2	1		
R9	Resistor: fixed, composition, 5,600 ohms $\pm 10\%$, 1/2 W	01121	0687-5621	2	1		
R10	Same as R1						
R11 thru R18	Same as R2						
R19	Same as R8						
R20	Same as R9						
R21	Not assigned						
R22	Resistor: variable, wirewound, 50 ohms $\pm 10\%$, 3 W	71590	2100-0002	1	1		
R23	Resistor: fixed, composition 18 ohms $\pm 10\%$, 1 W Optimum value selected at factory Average value shown	01121	0690-1801	1	1		
S1	Switch, toggle: SPST	04009	3101-0001	1	1		
T1	Transformer, power	28480	9100-0065	1	1		
V1 thru V12	Tube, electron: 5654	86684	1923-0001	12	12		
	<u>MISCELLANEOUS</u>						
	Jewel, pilot lamp	72765	1450-0020	1	1		
	Lampholder: for 2 pin base	72765	1450-0022	1	0		

* Refer to "List of Manufacturers' Codes".

TQ Total Quantity used in the instrument.

RS Recommended spares for one year isolated service for one instrument.

LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
00334	Humidial Co.	Colton, Calif.	19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.	72619	Dialight Corp.	Brooklyn, N.Y.
00335	Westrex Corp.	New York, N.Y.				72656	General Ceramics Corp.	Keasbey, N.J.
00656	Aerovox Corp.	New Bedford, Mass.	19701	Electra Manufacturing Co.	Kansas City, Mo.	72758	Girard-Hopkins	Oakland, Calif.
00781	Aircraft Radio Corp.	Boonton, N.J.	20183	Electronic Tube Corp.	Philadelphia, Pa.	72765	Drake Mfg. Co.	Chicago, Ill.
00853	Sangamo Electric Co., Cap. Div.	Marion, Ill.	21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	21335	The Fafnir Bearing Co.	New Britain, Conn.	72928	Gudeman Co.	Chicago, Ill.
01121	Allen Bradley Co.	Milwaukee, Wis.	21964	Fed. Telephone and Radio Corp.	Clifton, N.J.	72982	Erie Resistor Corp.	Erie, Pa.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	24446	General Electric Co.	Schenectady, N.Y.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
01281	Pacific Semiconductors, Inc.	Culver City, Calif.	24455	G. E., Lamp Division	Nela Park, Cleveland, Ohio	73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
01295	Texas Instruments, Inc. Semiconductor Components Div.	Dallas, Texas	24655	General Radio Co.	West Concord, Mass.	73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
01349	The Alliance Mfg. Co.	Alliance, Ohio	26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.	73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.	26992	Hamilton Watch Co.	Lancaster, Pa.	73506	Bradley Semiconductor Corp.	New Haven, Conn.
02286	Cole Mfg. Co.	Palo Alto, Calif.	28480	Hewlett-Packard Co.	Palo Alto, Calif.	73559	Carling Electric, Inc.	Hartford, Conn.
02660	Amphenol Electronics Corp.	Chicago, Ill.	33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
02735	Radio Corp. of America Semiconductor and Materials Div.	Somerville, N.J.	35434	Lectrohm Inc.	Chicago, Ill.	73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
02777	Hopkins Engineering Co.	San Francisco, Calif.	37942	P. R. Mallory & Co., Inc.	Indianapolis, Ind.	73793	The General Industries Co.	Elyria, Ohio
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.	39543	Mechanical Industries Prod. Co.	Akron, Ohio	73905	Jennings Radio Mfg. Co.	San Jose, Calif.
03705	Apex Machine & Tool Co.	Dayton, Ohio	40920	Miniature Precision Bearings, Inc.	Keene, N.H.	74455	J. H. Winns, and Sons	Winchester, Mass.
03797	Eldema Corp.	El Monte, Calif.	42190	Muter Co.	Chicago, Ill.	74861	Industrial Condenser Corp.	Chicago, Ill.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	44655	Ohmite Mfg. Co.	Skokie, Ill.	74868	Industrial Products Co.	Danbury, Conn.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.	48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.	74970	E. F. Johnson Co.	Waseca, Minn.
04404	Dymec Inc.	Palo Alto, Calif.	54294	Shallcross Mfg. Co.	Selma, N.C.	75042	International Resistance Co.	Philadelphia, Pa.
04651	Special Tube Operations of Sylvania Electronic Systems	Mountain View, Calif.	55933	Sonotone Corp.	Elmsford, N.Y.	75378	James Knights Co.	Sandwich, Ill.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	55938	Sorenson & Co., Inc.	So. Norwalk, Conn.	75382	Kulka Electric Mfg. Co., Inc.	Mt. Vernon, N.Y.
04777	Automatic Electric Sales Corp.	Northlake, Ill.	56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.	75818	Lenz Electric Mfg. Co.	Chicago, Ill.
05624	Barber Colman Co.	Rockford, Ill.	56289	Sprague Electric Co.	North Adams, Mass.	75915	Littlefuse Inc.	Des Plaines, Ill.
05783	Stewart Engineering Co.	Soquel, Calif.	61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.	76005	Lord Mfg. Co.	Erie, Pa.
06004	The Bassick Co.	Bridgeport, Conn.	62119	Universal Electric Co.	Owosso, Mich.	76210	C. W. Marwedel	San Francisco, Calif.
06812	Torrington Mfg. Co., West. Div.	Van Nuys, Calif.	64959	Western Electric Co., Inc.	New York, N.Y.	76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.	65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.
07261	Avnet Corp.	Los Angeles, Calif.	70119	Advance Electric and Relay Co.	Burbank, Calif.	76530	Monadnock Mills	San Leandro, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.	70276	Allen Mfg. Co.	Hartford, Conn.	76545	Mueller Electric Co.	Cleveland, Ohio
07933	Rheem Semiconductor Corp.	Mountain View, Calif.	70309	Allied Control Co., Inc.	New York, N.Y.	76854	Oak Manufacturing Co.	Chicago, Ill.
07980	Boonton Radio Corp.	Boonton, N.J.	70563	Amperite Co., Inc.	New York, N.Y.	77068	Bendix Corp., Bendix Pacific Div.	No. Hollywood, Calif.
08718	Cannon Electric Co. Phoenix Div.	Phoenix, Ariz.	70903	Belden Mfg. Co.	Chicago, Ill.	77221	Phaotron Instrument and Electronic Co.	South Pasadena, Calif.
08733	Camloc Fastener Corp.	Los Angeles, Calif.	70998	Bird Electronic Corp.	Cleveland, Ohio	77342	Potter and Brumfield, Inc.	Princeton, Ind.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S. Inc.	Lowell, Mass.	71002	Birnbach Radio Co.	New York, N.Y.	77630	Radio Condenser Co.	Camden, N.J.
09134	Texas Capacitor Co.	Houston, Texas	71218	Bud Radio Inc.	Cleveland, Ohio	77634	Radio Essentials Inc.	Mt. Vernon, N.Y.
09250	Electro Assemblies, Inc.	Chicago, Ill.	71286	Camloc Fastener Corp.	Paramus, N.J.	77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
10646	Carborundum Co.	Niagara Falls, N.Y.	71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.	77764	Resistance Products Co.	Harrisburg, Pa.
12697	Clarostat Mfg. Co.	Dover, N.H.	71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.	78283	Signal Indicator Corp.	New York, N.Y.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.	71450	Chicago Telephone Supply Co.	Elkhart, Ind.	78471	Tilley Mfg. Co.	San Francisco, Calif.
15909	The Daven Co.	Livingston, N.J.	71468	Cannon Electric Co.	Los Angeles, Calif.	78488	Stackpole Carbon Co.	St. Marys, Pa.
16758	Delco Radio Div. of G. M. Corp.	Kokomo, Ind.	71471	Cinema Engineering Co.	Burbank, Calif.	79142	Veeder Root, Inc.	Hartford, Conn.
18873	E. I. DuPont and Co., Inc.	Wilmington, Del.	71482	C. P. Clare & Co.	Chicago, Ill.	79251	Wenco Mfg. Co.	Chicago, Ill.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.	71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.	79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
			71700	The Cornish Wire Co.	New York, N.Y.	80130	Times Facsimile Corp.	New York, N.Y.
			71744	Chicago Miniature Lamp Works	Chicago, Ill.	80248	Oxford Electric Corp.	Chicago, Ill.
			71753	A. O. Smith Corp., Crowley Div.	West Orange, N.J.	80411	Acro Manufacturing Co.	Columbus, Ohio
			71785	Cinch Mfg. Corp.	Chicago, Ill.	80486	All Star Products Inc.	Defiance, Ohio
			71984	Dow Corning Corp.	Midland, Mich.	80583	Hammerlund Co., Inc.	New York, N.Y.
			72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.	80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
						81030	International Instruments, Inc.	New Haven, Conn.
						81415	Wilkor Products, Inc.	Cleveland, Ohio
						81453	Raytheon Mfg. Co., Industrial Tube Division	Quincy, Mass.

LIST OF MANUFACTURERS

CONTINUED

CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS	CODE NO.	MANUFACTURER	ADDRESS
81483	International Rectifier Corp.	El Segundo, Calif.	91506	Augat Brothers, Inc.	Attleboro, Mass.	98734	Palo Alto Engineering Co., Inc.	Palo Alto, Calif.
82042	Carter Parts Co.	Skokie, Ill.	91637	Dale Products, Inc.	Columbus, Neb.	98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
82170	Allen B. DuMont Labs., Inc.	Clifton, N.J.	91662	Elco Corp.	Philadelphia, Pa.	99313	Varian Associates	Palo Alto, Calif.
82209	Maguire Industries, Inc.	Greenwich, Conn.	91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.	99800	Delevan Electronics Corp.	East Aurora, N.Y.
82219	Sylvania Electric Prod. Inc., Electronic Tube Div.	Emporium, Pa.	91929	Micro-Switch Div. of Minneapolis Honeywell Regulator Co.	Freeport, Ill.	99848	Wilco Corporation	Indianapolis, Ind.
82376	Astron Co.	East Newark, N.J.	93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.	99934	Renbrandt, Inc.	Boston, Mass.
82389	Switchcraft, Inc.	Chicago, Ill.	93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio	99957	Technology Instruments Corp. of Calif.	No. Hollywood, Calif.
82647	Spencer Thermostat, Div. of Texas Instruments, Inc.	Attleboro, Mass.	93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.			
82866	Research Products Corp.	Madison, Wis.	94144	Raytheon Mfg. Co., Receiving Tube Div.	Quincy, Mass.			
82893	Vector Electronic Co.	Glendale, Calif.	94145	Raytheon Mfg. Co., Semi- conductor Div.	Newton, Mass.			
83148	Electro Cords Co.	Los Angeles, Calif.	94154	Tung-Sol Electric, Inc.	Newark, N.J.			
83186	Victory Engineering Corp.	Union, N.J.	94197	Curtiss-Wright Corp., Electronics Div.	Carlstadt, N.J.			
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.	94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.			
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.	95236	Allies Products Corp.	Miami, Fla.			
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.	95238	Continental Connector Corp.	Woodside, N.Y.			
83821	Loyd Scruggs Co.	Festus, Mo.	95263	Leecraft Mfg. Co., Inc.	New York, N.Y.			
84171	Arco Electronics, Inc.	New York, N.Y.	95265	National Coil Co.	Sheridan, Wyo.			
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.	95987	Weckesser Co.	Chicago, Ill.			
84411	Good All Electric Mfg. Co.	Ogallala, Neb.	96067	Huggins Laboratories	Sunnyvale, Calif.			
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.	96095	Hj-Q Division of Aerovox	Olean, N.Y.			
85474	R. M. Bracamonte & Co.	San Francisco, Calif.	96296	Solar Manufacturing Co.	Los Angeles, Calif.			
85660	Koiled Kords, Inc.	New Haven, Conn.	96341	Microwave Associates, Inc.	Burlington, Mass.			
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.	96501	Excel Transformer Co.	Oakland, Calif.			
88140	Cutler-Hammer, Inc.	Lincoln, Ill.	97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.			
89473	General Electric Distributing Corp.	Schenectady, N.Y.	97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.			
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.	98141	Axel Brothers Inc.	Jamaica, N.Y.			
90970	Bearing Engineering Co.	San Francisco, Calif.	98220	Francis L. Mosley	Pasadena, Calif.			
91418	Radio Materials Co.	Chicago, Ill.	98291	Seaelectro Corp.	New Rochelle, N.Y.			
			98405	Carad Corp.	Redwood City, Calif.			

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000A	Amp, Inc.	Hawthorne, Calif.
0000B	Chicago Telephone of Calif.	S. Pasadena, Calif.
0000C	Connor Spring Mfg. Co.	San Francisco, Calif.
0000D	Connex Corp.	Oakland, Calif.
0000E	Fisher Switches, Inc.	San Francisco, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000G	Microwave Engineering Co.	Palo Alto, Calif.
0000H	Philco Corp. (Lansdale Tube Division)	Lansdale, Pa.
0000I	Telefunken (c/o American Elite)	New York, N.Y.
0000J	Ti Tal, Inc.	Berkeley, Calif.
0000K	Transitron Electronic Sales Corp.	Wakefield, Mass.
0000L	Winchester Electronics, Inc.	Santa Monica, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.
2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY
Laboratory Instruments for Speed and Accuracy
1501 Page Mill Road  Palo Alto, California
CABLE "HEWPACK"

