INSTRUCTION BOOK

for

MODEL 317
WIDE-BAND ELECTRONIC
VOLTMETER

THE SINGER COMPANY
INSTRUMENTATION DIVISION
BALLANTINE OPERATION
BOONTON, NEW JERSEY

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INSTRUCTION BOOK CONTENTS

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ILLUSTRATIONS AND DIAGRAMS

Figure 1. Ballantine Model 317 Wide-Band Voltmeter with Model 2317A Cathode Follower Probe

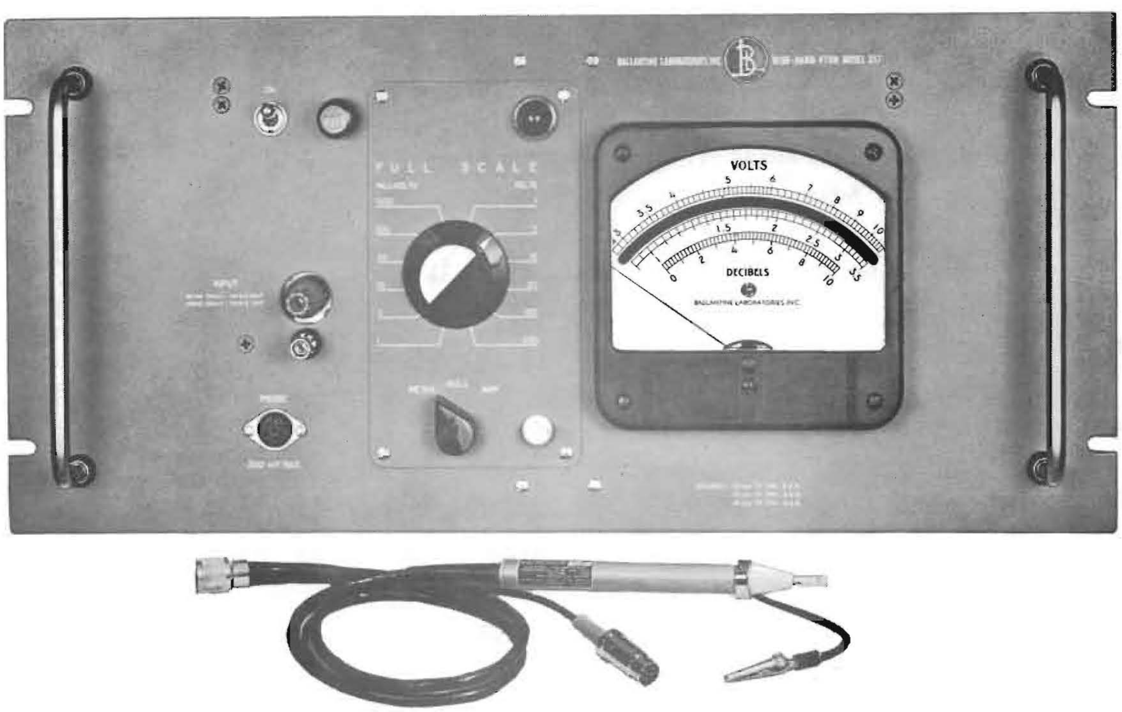

Figure 1A. Rack Panel Mounted Ballantine Model 317 Wide-Band Voltmeter with Model 2317A Cathode Follower Probe

1. GENERAL INFORMATION

1.1 Purpose and Use

The Ballantine Model 317 is a sensitive wide-band voltmeter which measures over the frequency range of 10 cps to 11 Mc and voltage range of 300 μV to 300 V. Its high basic accuracy of $\pm 2\%$ of indication, 5″ long logarithmic mirror-backed scale, excellent stability, and freedom from line transient disturbances, make this voltmeter invaluable for accurate and reliable measurements over audio and video frequency ranges.

In the design of this voltmeter, consideration has been given to the reduction of several side effects usually encountered in low level voltage measurements, especially in the megacycle range. A voltage drop produced by the ground current in the ground impedance, electromagnetic pickup in the leads, and the loading of the source by the impedance of the connecting leads may introduce severe errors and make accurate measurements difficult. In the Model 317 the input attenuator is coaxial which reduces the ground impedance and minimizes the ground current effects. Also, a Type UHF connector is used as input terminal. This allows coaxial connections and complete shielding of the input, and provides a low impedance ground path. For low frequency measurements the Model 617 binding post adapter is supplied as a standard accessory, which converts the input to standard ¾″ spacing binding posts.

For accurate high frequency measurements, directly in the circuit, a Model 2317A cathode follower probe is available. Through the probe, the point of measurement is brought to the circuit without the deteriorating effects of long connecting leads. The probe is usable over the entire frequency range. Its input impedance, 10 MΩ shunted by 7pF, is higher than the impedance of the basic instrument. The probe introduces no loss of sensitivity and only a slight decrease in accuracy.

The frequency response of the voltmeter extends above its specified limit up to 30 Mc. Over that bandwidth the instrument is usable as a wide-band amplifier or sensitive null detector.

Special emphasis is given to the high reliability, long life, and easy serviceability of the instrument. The amplifier's modern instrument type, frame grid tubes, ample feedback in a multi-loop feedback circuit, and the conservative rating of all components assure long life and stability. The electronically regulated power supply, with hermetically sealed silicon rectifiers, has extended life and guarantees freedom from line transient effects. Plug-in printed circuit boards of translucent glass laminate and component marking ease the serviceability. The rugged chassis is designed for best ventilation and accessibility to all parts of the circuit. Front frame protects the indicator from accidental damage.

Over a three-prong power cord the instrument can be connected to any 115 V or 230 V, 50 to 400 cps line.

1.2 Technical Characteristics

1.2.1 Voltmeter (Without Probe)

Voltage Range

300 microvolts to 300 volts — as a null detector, 100 microvolts to 300 microvolts

Frequency Range

10 cps to 11 Mc
As a null detector, useful 5 cps to 30 Mc

Decibel Range

−70 db to +50 db, referred to 1 volt

Accuracy

AT ANY POINT ON SCALE, ANY VOLTAGE:

Error does not exceed

2%, 20 cps to 2 Mc
3%,[1] 10 cps to 6 Mc
5%,[2] 10 cps to 11 Mc

Scales

Two logarithmic voltage scales, 1 to 3 and 3 to 10, each with 10% overlap on both ends. A mirror is located between the two voltage scales for precise readings.
One linear db scale, 0 to 10

Input Impedance

WITHOUT PROBE
2 MΩ shunted by 24 pF on all ranges up to 300 mV
2 MΩ shunted by 11 pF on all ranges above 300 mV
WITH PROBE (Usable to 300 mV)
10 MΩ shunted by 7 pF

Characteristics of Amplifier

Maximum gain:	60 db
Maximum output voltage:	2.5 volts
Minimum load resistance:	0 ohms
Source impedance:	450 ohms, approximately
Frequency response:	±1 db, from 6 cps to 11 Mc
Equivalent input noise for 60 db gain:	Input open, below 45 μV Input shorted, below 35 μV

Vacuum Tubes and Diodes

Four 6EJ7[3], three 5654/6AK5, one 6GW6, one 0A2, and ten[4] semiconductor diodes are used.

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(1) 4% in serial #1 thru 200
(2) 6% in serial #1 thru 200
(3) 6688 in serial #1 thru 200
(4) Twelve in serial #1 thru 200

Signal Rectification

Average-responding. Instrument calibrated in rms of a sine wave.

Stability

For line voltage change of 105 to 130 or 210 to 260, the variation is less than 1/10 of stated accuracy.

Warmup Time

Usable after 20 seconds under normal laboratory conditions. Reading is within 0.5% of its final value after 2 minutes.

Power Supply

70 watts, 115/230 volts, 50 to 400 cps

Color

Portable: Gray panel with black case
Rack: Gray or special to customer's specification

Size (inches)

Portable, 13 high x 7½ wide x 9½ deep
Rack, 8½ high x 19 wide x 8½ deep

Weight (pounds)

Portable or rack, instrument alone, 17 lbs.
Shipping weight: Portable 23, rack 32.

1.2.2 Cathode Follower Probe

Voltage Range

300 μV to 300 mV

Frequency Range

5 cps to 11 Mc

Accuracy

Gain is 1 ±0.5%, 10 cps to 2 Mc
1 ±5%, 5 cps to 11 Mc

Input Impedance

10 MΩ shunted by 7 pF

Vacuum Tubes

One 7586 Nuvistor

Stability

For line voltage change of 10% (on the Model 317) the variation is less than 1/5 of the stated accuracy

2. OPERATION

2.1 Power Connection

The voltmeter is supplied ready to operate at 105 - 125 V, 50 cps to 400 cps, or 210 - 250 V, 50 cps to 400 cps power line, as indicated on the decal on the back of the case adjacent to the power cord.

2.1.1 Line Voltage Conversion from 115 to 230 V or vice versa is possible. Instructions are given on the schematic diagram at the end of the instruction book. For conversion to 230 V:

Remove jumper between terminals 3 and 4. Disconnect black-red wire from terminal 1 and black-yellow wire from terminal 4. Connect both together to terminal 3.

Replace fuse F1, ¾ ampere, Slo-Blo, by 0.4 ampere, Slo-Blo.

2.2 Starting Procedures

Insert the three-prong plug into the proper AC power outlet. Where two-prong outlets are available, use a conversion unit. Move the power switch to ON position. The pilot light should glow. The instrument is ready for use after a short warmup period.

2.2.1 Warmup Period

The instrument is usable after approximately 20 seconds. After 2 minutes the reading will be within ±0.5% of the final value.

For measurements of the highest accuracy or when the instrument has not been used for months or has been stored in high humidity, allow the instrument to warm up for an hour.

PERMIT AIR TO CIRCULATE FREELY AROUND THE INSTRUMENT TO AVOID EXCESSIVE TEMPERATURE RISE. IF THE CATHODE FOLLOWER PROBE IS CONNECTED, DO NOT PLACE THE PROBE ON TOP OF THE INSTRUMENT.

The voltmeter is calibrated in the vertical position. For convenience in reading, a tilting device is provided on the bottom of the case.

2.3 Function of Controls

The front panel controls shown in figure 1 are:

Power Switch	ON	Turns the instrument on
Function Switch		Selects the operating mode of the instrument
	METER	The instrument operates as a voltmeter
	NULL	The instrument operates as an approximate indicator. The gain in increased 10 db or 3.16 times.
	AMP	The instrument operates as a wide-band amplifier with indicator disconnected

Range Selector		Selects the voltage range in METER and NULL mode Changes amplifier gain in 10 db step in AMP mode
Connector	PROBE 300 mV max.	Connector for supply voltages for Model 2317A Cathode Follower Probe.

Accessible from the rear is a screwdriver adjustment.

Down Scale Adjustment	With the Function Switch in METER position, this control affects the down scale indication.

2.4 Voltage Measurement

NOTE: This is a wide-band voltmeter. Extreme care has to be given to the connecting leads, especially when low level and high frequency measurements are being made. Use coaxial connections whenever possible.

To measure a voltage, set the Function Switch to METER, Range Selector to 300 V, and connect the unknown voltage to the input of the voltmeter. Turn Range Selector counterclockwise, toward the most sensitive range, until an indication appears on the meter. For most accurate measurement the indicator should indicate within the red db scale. If the indication is below or above that scale select the next lower or higher range. The voltage reading must be taken from the scale indicated by the range selector.

2.4.1 Down Scale Adjustment

For highest accuracy, the down scale adjustment of the instrument should be checked. This adjustment is equivalent to the zero setting of a linear indicator and it should be corrected periodically. For down scale adjustment:

2.4.1.1 Set the Range Selector to the 1 volt range; Function Switch in METER position.

2.4.1.2 Apply a signal of approximately 1 volt and a frequency between 500 cps and 500 kc.

2.4.1.3 Vary the signal until the pointer lines up with the 10* on the upper scale.

2.4.1.4 Switch the range selector to the 3 volt range and adjust the lower (or left) control in the rear of the instrument so that the pointer lines up with the 1 on the lower scale.

2.4.1.5 Repeat steps 1 to 4 until the ranges agree.

2.5 Possible Error Sources

The Model 317 is a sensitive wide-band voltmeter. To utilize its high accuracy, certain precautions should be taken, especially when measurements at millivolt levels and high frequencies are to be made. The most common error sources are:

—

* 1.0 on meters having dbm scale

2.5.1 Loading Error, caused by the input impedance of the voltmeter or the capacitance of the connecting leads. Loading causes the terminal voltage to be different from the source voltage. It also may detune and damp the circuit measured.

The error can be minimized by using low capacitance cables or by using Model 2317A or Model 1311 probe.

2.5.2 Ground Current Error is often caused by ground current of power, or high frequency which flows through the ground connections. This current causes a voltage drop in the ground lead which adds to the signal. To reduce this effect, the circuit should be checked for ground current and the currents reduced as much as possible. Also the ground lead should have as low an impedance as possible. A substantial improvement is usually possible only through the use of coaxial connections and an isolation transformer.

2.5.3 Transmission Line Error. Mismatch in the connecting leads which act as the transmission line causes the voltage at the end of the leads, or cable, to be different from the voltage at the voltmeter input. To avoid this, use as short leads as possible or use the Model 2317A probe.

2.5.4 Magnetic or Electrostatic Pickup. Connecting leads, when unshielded and forming a loop, are liable to pick up magnetic fields, producing an erroneous voltage measured on the input terminals of the voltmeter. To avoid these errors coaxial, twisted or closely spaced and shielded leads should be used.

2.5.5 Distortion of the Signal produces waveform error. The Model 317 is average responding but calibrated in rms of the sine wave. If the source has distortion exceeding 5% a noticeable difference (over 1.5%) between average and rms value can exist which will cause a measuring error.

The nature of these errors is described in the paper TECHNIQUES AND ERRORS IN HIGH FREQUENCY VOLTAGE CALIBRATION by Dr. Endel Uiga and Wallace F. White, a copy of which can be obtained from Ballantine Laboratories upon request.

2.6 AC Overload Considerations

The instrument is designed to withstand severe overload without damage to any components. The maximum AC voltage which may be applied to the instrument in the millivolt ranges is limited by the maximum allowable voltage at the grid of the first tube. For an extended time, this voltage should not exceed 35 V. However, the input tube will not be damaged by higher voltages applied for a short time, and tests made showed no change in instrument performance after 8 hours of overloading the 1 mV range with 300 V.

2.7 DC Component of the Input Signal

The voltmeter does not measure the dc component of the signal. The maximum dc voltage which can be safely applied is 600 V. If the dc component of the signal is higher, a capacitor of at least 0.1 μF, together with a 10 megohm resistor, should be connected to the input as shown in figure 2.

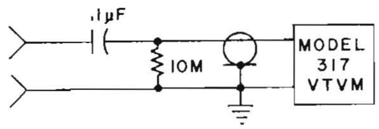


Figure 2. Blocking a High DC Voltage

2.8 Input Impedance

The input impedance of the instrument depends on the setting of the range switch and on the frequency of the signal measured. At low frequencies, for ranges 1 mV to 300 mV, the input impedance is represented by 2 MΩ shunted by 24 pF; for all other ranges, 2 MΩ shunted by 11 pF.

The capacitive component of the input impedance changes only very little with frequency. The change of the resistive impedance with frequency is shown in figure 3.

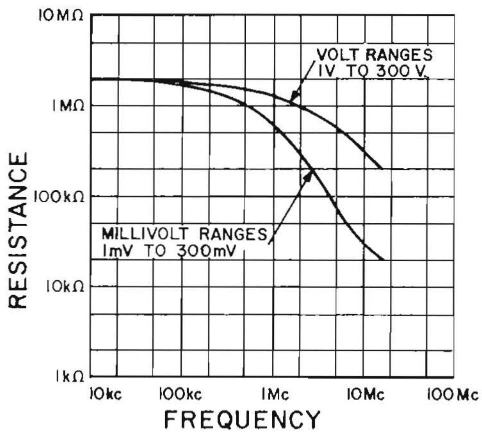


Figure 3. Model 317 Input Resistance vs. Frequency

2.9 Measuring Voltages Above 300 V

Using the Ballantine Series 1300 Voltage Multiplier, the voltage range of the instrument can be extended. Model 1311 10000x multiplier allows voltage measurements up to 10 kV RMS at frequencies to 1 Mc.

2.10 Measuring Sources Connected to the Power Line

When measuring sources which have a connection to the power line, the third prong of the line cord has to be considered. It is connected to the chassis and the input ground terminals. In case the low terminal of the source has any potential against the ground, a ground current may flow through the chassis if it is grounded. This can disturb the measurement or — in extreme cases — cause short circuits. This condition of measurement should be avoided. The two power prongs of the line cord are insulated from the chassis by the insulation of the power transformer. The impedance from chassis to power line is several hundred megohms in parallel with a few hundred picofarads.

2.11 Influence of the Line Voltage

The instrument is operative from approximately 105 V to 130 V or from 210 to 260 V. Line voltage variations from the specified operating voltage (115 V or 230 V) affect the accuracy of the instrument in midband by approximately 0.15% per 10% line voltage change.

If the line voltage drops below the 105 V, a large amount of jitter may be noticeable and low frequency oscillation of the amplifiers can occur. The instrument should not be used under these conditions.

2.12 Use as Amplifier

When the function switch is set to AMP position, the Model 317 can be used as a wide-band amplifier. The amplifier output is available from the BNC connector on the front of the instrument. The gain of the amplifier is determined by the setting of the range selector and the load impedance. If the range selector is in 1 mV FS position, the max gain into the unloaded output is 1000 or 60 db. Switching to higher voltage ranges will decrease the gain in 10 db steps. The voltage on the amplifier output is 1 V if the input signal would produce a full scale deflection in voltmeter mode. If the voltmeter would read above scale, to avoid overloading the amplifier, the next higher voltage range should be selected. The lowest output voltage is limited by the noise output, which is on the order of 20 mV in the 1 mV and 1 V range and lower in the other ranges.

The source impedance of the output is approximately 450 ohms. The output can be short-circuited, in which case 2.2 mA can be obtained from the amplifier. A 50 ohm termination will allow approximately matching the output to a 50 ohm transmission line. In this case the maximum gain is 100 or 40 db.

The frequency response depends on the loading impedance and is shown in figure 4. For open circuit conditions, the capacitive loading should be below 5 pF. This may be correspondingly increased if lower termination resistors are used.

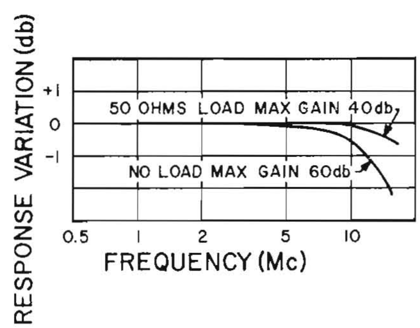


Figure 4. Model 317 Amplifier Response

2.13 Use as Null Detector

By setting the Function Switch to NULL position, the meter can be used as a null detector. In this position the amount of feedback is reduced and the sensitivity increased approximately three times or 10 db. With reduced accuracy approximately ±1 db, the instrument can be used as a sensitive voltmeter down to 100 µV.

In the 1 mV and 1 V range, if the instrument is set to NULL position, the noise of the amplifiers can be checked. It will cause the pointer to jitter slightly. This jitter should not exceed ±0.5 db. (See 4.6.3)

The frequency response of the instrument above 11 Mc depends on the voltage range selected, and varies from instrument to instrument. It tends to rise up to 20 Mc and is approximately 10 db down at 30 Mc.

2.14 Current Measurements

Using the Ballantine Series 600 Precision Shunt Resistors, currents from 1 μA to 10 A can be accurately measured. These and other accessories can be found in the general catalog of Ballantine Laboratories, Inc.

2.15 Measurements Using the Model 2317A Cathode Follower Probe

2.15.1 Purpose of the Cathode Follower Probe

The Model 2317A probe is designed for sensitive high frequency measurements directly in the circuit. The probe has a higher input impedance than the basic instrument and therefore reduces the loading error.

Also, the point of measurement is at the tip of the probe, eliminating the connecting leads and their errors. The small size of the probe with its unique tip design allows easy reach to a point in a circuit. The protective sleeve of the tip avoids shorts between neighboring points. The hook arrangement holds the probe to any wire up to #16 AWG.

The probe is usable over the entire frequency range of the instrument. As with the basic instrument, its frequency range extends above the 11 Mc, up to 20 Mc. It introduces no loss to the instrument's sensitivity.

The small loss in the cathode follower's gain is compensated in the main instrument when the probe power connector is connected to it. The maximum voltage measureable with the probe is 300 mV. It can be extended to 350 V by using the Model 3317 60 db attenuator designed to fit on the front of the probe. The use of this attenuator also increases the input impedance of the probe ($C < 4$ pF, $R > 1000$ MΩ).

2.15.2 Connecting the Probe to the Model 317

The cathode follower probe Model 2317A is connected to the Model 317 over approximately 3 feet of cable, which is terminated in two separate connectors. The UHF connector is used to connect the signal and the ground. The multiple contact connector provides the dc supply voltages for the tube and switches the gain correction on.

When connecting the probe to the instrument always connect the UHF connector first. When disconnecting, unplug the multiple contact connector first.

Failure to do so may damage the Nuvistor tube in the probe if the signal conductor of the UHF connector touches ground. Also, electric shock is possible since the center conductor carries a 75 V dc potential against the ground.

2.15.3 Voltage Measurements with Probe

To measure a voltage, connect the probe to the source and turn the range selector until an indication appears on the scale. This is the voltage which exists at the probe tip.

The maximum voltage which can be measured with the probe is 300 mV. The use of the probe above the 300 mV range of the voltmeter will introduce excessive errors and is not recommended.

The precautions described under 2.5 should be taken when making measurements with the probe. Special care should be given to short and low impedance ground connections. For higher frequencies the ground lead supplied with the probe may have too much inductance. Coaxial arrangements, using 6314 BNC adapter, very short leads, or ground clamps should be used for accurate measurements.

2.15.4 Input Impedance of the Probe is represented by 10 MΩ parallelled with 7 pF; it does not depend on the voltage range on which the voltmeter is used. The capacitive component of the input stays practically constant over the frequency range, but the resistive component changes as indicated in figure 5.

As seen from the graph, the input impedance of the probe becomes negative at frequencies beyond 1 Mc. This may cause an undamped resonant circuit tuned to 5 - 15 Mc to oscillate if the probe is connected across it. If that occurs connect a parallel resistor with value equal to the negative resistance of the input impedance across the input of the probe or add a small resistance (approximately 350 Ω) in series with the probe.

If resistive or capacitive loading is a problem the use of Model 3317 (60 db attenuator for Model 2317A) or the high voltage probe Model 1311 is recommended.

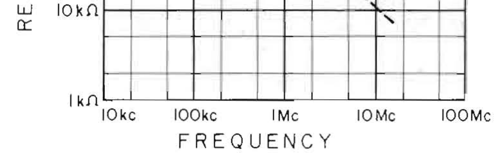


Figure 5. Model 2317A Cathode Follower Probe — Input Resistance vs. Frequency

2.15.5 Maximum Input Voltages

Without the 60 db attenuator Model 3317, the probe is usable for measurements of max 300 mV. For a short time a voltage up to 300 V AC may be applied to the probe without damage.

600 V dc can be safely applied to the probe input. If the source carries a higher dc component an external blocking capacitor with the proper dc rating and a minimum value of 0.02 μF should be used as described under 2.7.

3. CIRCUIT DESCRIPTION

The block diagram, schematic, and replacement parts list are included at the end of this instruction book.

3.1 Input Attenuator

The signal to be measured is fed from the uhf connector over dc blocking capacitor C1 to the input attenuator. At low frequencies, below 40 cps, the attentuation is determined by the resistors R1 and R2, above 40 cps by the capacitors C2 and C3. The attenuation ratio is 1 ÷ 1000 ±0.25%. R3 moves the crossover frequency of C2 and R1 from 40 kc to 40 cps.

The attenuation is distributed between the input attenuator and midsection attenuator as follows:

Pos.	Range	Input Attenuator		Midsection Attenuator		Total	
		Ratio	Attentuation db	Ratio	Attentuation db	Ratio	Attenuation db
1	1 mV	1	0	1	0	1	0
2	3 mV	1	0	3.162	10	3.162	10
3	10 mV	1	0	10	20	10	20
4	30 mV	1	0	31.62	30	31.62	30
5	100 mV	1	0	100	40	100	40
6	300 mV	1	0	316.2	50	316.2	50
7	1 V	1000	60	1	0	1000	60
8	3 V	1000	60	3.162	10	3162	70
9	10 V	1000	60	10.0	20	10000	80
10	30 V	1000	60	31.62	30	31620	90
11	100 V	1000	60	100	40	100000	100
12	300 V	1000	60	316.2	50	316200	110

3.2 Input Amplifier is a three-stage feedback amplifier with tubes V1, V2 and V3. The feedback loop is closed over the feedback network R4, R5 and R6. R6 is used to adjust the sensitivity of the voltmeter. When the cathode follower probe is used, R11 is connected to ground, which increases the gain of the amplifier approximately 4% and compensates for the loss in the cathode follower.

The first two stages V1 and V2 are direct coupled. Z1 limits the maximum grid current of V2 and avoids damage to the tube under extreme overload, or when V1 is removed.* The large cathode bypass on V2 is split into C61 and C62 and connected between +B and ground to prevent heavy surge current through the tube when the instrument is switched on. A second feedback path is formed from the cathode of V2 to the screen of V1.

The filaments of tubes V1 - V3 are series connected. They are fed from a dc source. L1-C11 and L2-C16 are gain forming networks effective at 11 and 28 Mc. The high frequency response is adjustable in position 1 by L3, in position 2 by C20 and in positions 3 to 6 with C31.

V3 has a positive grid bias of approximately 9 V from divider R24 - R25 to stabilize its operating point. The plate load of V3 is the midsection attenuator.

3.3 Midsection Attenuator consists of precision matched resistors R41 - R47 and compensating capacitors C30 and C31, C32. It provides 50 db attenuation in 10 db steps. Position 1 has no attenuation. In position 2 the gain of the input amplifier is reduced 10 db by shunting the plate load R40 with R44. In position 3 to 6 it is further shunted by the input impedance of the ladder network which starts with R45 and provides additional 10 db attenuation for positions 4, 5 and 6.

3.4 Output Amplifier, similar to the input amplifier, is a three-stage amplifier with tubes V4 - V6. The feedback loop is closed over the feedback resistors R52 and R56. R56 is used for coarse adjustment of the voltmeter sensitivity. R49 and C33 are used for the correction of the frequency response above 3 Mc.

Z2 is a protection network similar to Z1. A second feedback path is formed from the cathode of V5 to the screen of V4 through R57. L4-C37 and L5-C40 are gain shaping networks effective at 11 and 28 Mc. CR3 on the cathode of V5 is a protection diode for the signal rectifier circuit. Its function is explained below:

*Serial #1 thru 200, instead of Z1 and Z2, protection diodes CR1 and CR2 were used between grid and cathode of V2 and V5. Also the filaments of both amplifiers were biased to +75 V through a connection to a center-tap of the cathode resistors of V2 and V5.

3.5 Signal Rectifier Circuit consists of the dc blocking capacitors C57A and B, and the signal rectifier diodes CR5 and CR6 which are connected to the plate of V6 through the function switch S2A. The circuit is average responding.

CR4 is a protection diode limiting the dc voltage across the moving coil meter and holding the reverse voltage on the signal rectifiers to acceptable values. CR3 limits the maximum discharge current of C57, protecting the signal rectifier diodes from burnout. CR3 is biased by the cathode current of V6. When the discharge current exceeds the bias current, the diode cuts off and limits the current.

R83 is the down-scale adjustment for the logarithmic indicator M1. Its function is similar to that of the zero adjustment on a linear indicator. It is used to adjust the scale linearity so that a full-scale indication (10) corresponds exactly to the down-scale indication (1) of the next higher range. The setting of R83 adjusts a small current of either direction to flow through the indicator. This affects the indication, especially at down-scale.

In AMP position, the amplifier output is connected to the output jack and R80 is switched in parallel with the plate load of V6 to provide a flat frequency response.

3.6 The Power Supply is electronically regulated, and consists of 3 tubes — V8, V10 and V11. V11 is the reference tube; V10 the dc amplifier; and V8 the series regulator. V9 is an NE-2 glow discharge tube to limit the grid-to-cathode voltage of V8 during its warmup period. With R107 the +B voltage may be adjusted. R101 adjusts the suppression of fast line transients. CR9 to CR12 form a rectifier bridge for +B. CR7 and CR8 are rectifiers for the dc filament supply.

3.7 The Cathode Follower Probe, Model 2317A is a standard grounded plate amplifier. R6 and C3 filter the supply voltage of 150 V at high frequencies. The divider R2, R4 provides a fixed, positive bias voltage to the grid of the Nuvistor tube. The amount of current flowing through the tube is governed by the value of the cathode resistor. The dc filament is carefully bypassed by C4 and C5.

An increase in the sensitivity of the voltmeter makes up for the losses in the cathode follower. This increase is adjustable by means of R11, located inside the probe connector P4, and is effective only if the probe connecter P4 is plugged into the Model 317. The connector also makes correction for the added load on the dc filament.

4. MAINTENANCE

4.1 General

The Model 317 is designed for extended, troublefree service. Long-life, instrument-type tubes are used where the circuit is critical. All components are operated well below ratings. Continuous operation for more than 4000 hours is expected without the need for component or tube change.

The purpose of the maintenance procedure is to check the condition of the instrument and detect and correct deteriorated tubes or components before they have an appreciable effect on the instrument's performance.

4.2 Recommended Maintenance consists of two types of periodic checks.

4.2.1 A 1000 hour check after every 1000 hours or 1 year of operation.

4.2.2 A 2000 hour check after every 2000 hours or 2 years of operation.

4.3 Necessary Maintenance Equipment

4.3.1 A DC Voltmeter
Range 0 to 300 V; accuracy ±3%; input resistance 10 MΩ or higher.

4.3.2 A Stable, Calibrated AC Voltage Source
Frequency between 1 kc and 50 kc; voltage adjustable 1 mV to 10 V; voltage calibration accuracy ±0.25% or better. Ballantine Model 420 or 421 precision voltage calibrator is recommended.

4.3.3 Accurate Attenuator (Ratio Transformer)
Frequency 1 to 50 kc; attenuation 60 db, 1 ÷ 1000; attenuation accuracy ±0.1%. Not needed if Ballantine Model 420 is used.

4.3.4 Variable Frequency RF Generator
Frequency range 10 cps to 11 Mc; wave form distortion less than 5%; able to deliver 5 mA into 50 Ω.

4.3.5 RF Voltage Standard
Frequency 1 to 50 kc; attenuation 60 db, 1 ÷ 1000; 1.5 and 15 mV; voltage accuracy ±1% or better.

Ballantine Model 440 Micropotentiometer with part #2951 housing and part #2950-0.33 and #2950-3.3 resistors are recommended. Used together with a DC Microammeter 0 to 200 μA, 25 Ω.

4.3.6 Variable, Metered AC Power Supply 75 W

4.4 Removing the Case

Place the instrument with front panel down on a table.

Remove the power cord and unscrew the two #10 binder head screws on the back of the case.

Lift off the case.

To replace the case, proceed in reverse order.

WARNING . . . When the instrument is operated without the case, danger of electric shock exists. USE EXTREME CARE. The highest voltages are: 350 V AC; 500 V DC.

4.5 1000 Hour Check

The purpose of the 1000 hour check is to test the performance of the instrument as a whole to detect unexpected failure of any tube or component.

4.5.1 Tests Comprising the 1000 Hour Check

4.5.1.1 Measuring the supply voltage.

4.5.1.2 Testing the accuracy of the input attenuator.

4.5.1.3 Testing the accuracy of the voltmeter.

4.5.1.4 Testing the accuracy of the cathode follower probe.

4.5.2 Measuring the Supply Voltage

Remove the case according to 4.4. Allow 10 minutes warmup, measure the dc voltage on pin 8 of tube V8 on power supply board.

The voltage should be between 290 and 300 V.

If the voltage is out of these limits, adjust R107 to bring the voltage within them.

Replace the case.

4.5.3 Testing the Accuracy of the Input Attenuator

The attenuation ratio of the input attenuator is 1 ÷ 1000 ±0.25%. To test the ratio:

4.5.3.1 Allow 15 minutes warmup. Connect a stable 10 V, 1 kc to 50 kc source to the voltmeter over an ±0.1% or more accurate 1 ÷ 1000 attenuator. A ratio transformer may be used for this purpose.

4.5.3.2

Set	To
Attenuator	0 attenuation
Voltmeter	10 V range

Adjust source voltage to produce exact indication of 10 on the voltmeter. Tap meter slightly before taking reading.

4.5.3.3 Do not change the source voltage.

Set	To
Attenuator	1 ÷ 1000 attenuation
Voltmeter	10 mV range

Tap the indicator and take an accurate reading.

The voltmeter should indicate from 9.975 to 10.025 (10 V ±0.25%)

Using the Ballantine Model 420 voltage calibrator the same test may be accomplished with greater precision. For the test:

4.5.3.4 Connect the Model 420 to voltmeter:

Set	To
Model 420	1 V range
Voltmeter	10 V range

Adjust the Model 420 to produce a reading 9.80 on the voltmeter. Record the setting of the Model 420.

4.5.3.5

Set	To
Model 420	10 mV range
Voltmeter	10 mV range

Adjust the setting of the Model 420 to produce exactly the same indication of 9.8. Compare the setting with previous setting. The difference should be ±0.25% or less.

If the attenuator ratio differs from 1 ÷ 1000 more than 0.25% readjust the attenuator according to 5.7.

4.5.4 Testing the Accuracy of the Voltmeter

Allow at least 1 hour warmup and check the scale adjustment according to 2.4.1. Connect a 1 kc to 50 kc signal 10 mV ±0.25% to the voltmeter. Set voltmeter to 10 mV range, measure the signal. The indication should be 9.90 mV to 10.1 mV (10 mV ±1%). If the error is larger, readjust the sensitivity according to 5.6.

4.5.5 Testing the Accuracy of the Cathode Follower Probe

Allow instrument and probe to warm up for approximately 10 minutes.

Measure a signal of 50 to 100 mV, 500 cps to 50 kc once with and once without probe. Note the difference in indication. If it exceeds 0.5% the Nuvistor tube should be checked and replaced if necessary.

Tube replacement may make a readjustment of the gain correction for the cathode follower necessary (See 5.10.5).

4.6 2000 Hour Check

The purpose of the 2000 hour check is, in addition to the performance check, to check the condition of the tubes and subassemblies. This is done by checking the performance under changed line voltage at high frequencies. Under these conditions the weakness of any deteriorated tube or component can easily be detected.

4.6.1 Tests Comprising the 2000 Hour Check

4.6.1.1 Measuring the supply voltage (same as 4.5.2).

4.6.1.2 Measuring the indication change at 10 Mc.

4.6.1.3 Testing for noise and flutter.

4.6.1.4 Testing the accuracy of the input attenuator (same as 4.5.3).

4.6.1.5 Testing the accuracy of the voltmeter (same as 4.5.4).

4.6.1.6 Testing the accuracy of the cathode follower probe (same as 4.5.5).

4.6.1.7 Measuring the frequency response of the voltmeter.

4.6.1.8 Measuring the frequency response of the probe.

4.6.2 Measuring the Indication Change at 10 Mc

4.6.2.1 For the test connect the voltmeter to a variable power supply. After 1 hour warmup raise the line voltage to 130 V ±2%, feed a 10 Mc, stable signal, of any amplitude to the Model 317. Measure the signal accurately, note the result.

4.6.2.2 Lower the line voltage to 110 V ±2%.

After 1 minute, note the indication for the same signal.

The change in indication should not exceed ±2%. If it does, check the tubes V1 to V6 for transconductance and emission drop under reduced filament voltage. Replace the tubes having low transconductance or poor emissivity.

4.6.3 Testing for Noise and Flutter

Set	To
Function Switch	NULL
Range Selector	1 V

Apply a steady signal of approximately 100 mV of any frequency. Adjust the signal so that the meter reads just on scale. Observe the fluctuation of the pointer which should not exceed ±0.5 db.

If the fluctuation exceeds ±0.5 db, check the amplifier tubes, especially V1. Check the dc leakage of C21 by measuring the dc potential at the negative terminal of C21. This can be reached on the standoff terminal marked "To S1" on the input amplifier board.

The potential at this terminal should not exceed +80 mV above ground.

4.6.4 Measuring the Frequency Response of the Voltmeter

Set the function switch to METER position and check the frequency response at the following three ranges:

1 mV range at approximately 600 μV
3 mV range at approximately 1.5 mV
30 mV range at approximately 15 mV

For the test:

4.6.4.1 Connect a stable variable frequency rf generator and Model 440 Micropotentiometer as shown in figure 6 below.

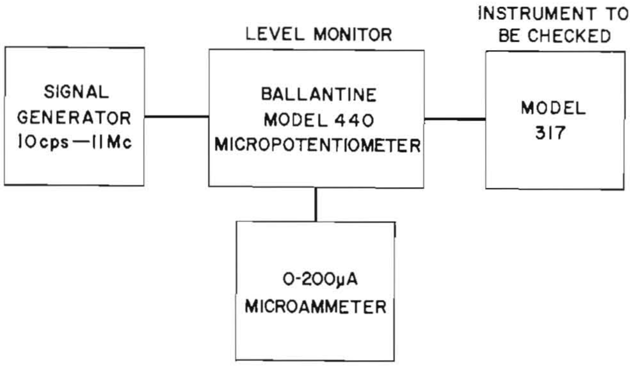


Figure 6. Setup for Measurement of the Frequency Response

Use Part #2950 — 0.33 Ω Micropotentiometer resistor for 600 μV and 1.5 mV output and Part #2950 — 3.3 Ω resistor for 15 mV output.

4.6.4.2 Set rf generator to 10 kc, adjust its output voltage until an indication exactly at the 6 or 1.5 mark is produced. Note the indication of the dc microammeter on the micropotentiometer output.

4.6.4.3 Set the generator frequency to the following frequencies:

10 cps, 20 cps, 100 kc, 2 Mc, 7Mc, 11 Mc.

Adjust the generator amplitude to produce exactly the same microammeter reading as noted on 4.6.4.2. Observe and note the indication of the voltmeter.

4.6.4.4 The maximum deviations from the indication at 10 kc are:

10 cps to 2 Mc ±1.5%
2 Mc to 6 Mc ±3%
6 Mc to 11 Mc ±5%

If the deviation exceeds these limits, the voltmeter should be readjusted according to 5.8.

4.6.5 Measuring the Frequency Response of the Probe

The frequency response of the voltmeter should be checked according to 4.6.4, once with, and once without the probe, preferably in the 30 mV range at 10 cps, 2 Mc and 11 Mc. The change in frequency response introduced by the probe should not exceed:

10 cps to 2 Mc ±0.3%
10 cps to 11 Mc ±4%

If the change in response is larger, the Nuvistor tube should be checked. There are no provisions made for adjustment of the frequency response of the probe; excessive frequency response error should be traced down to defective components.

5. SERVICE AND TROUBLE SHOOTING

5.1 General

In case of voltmeter malfunction, servicing by the user is feasible provided skilled personnel and recommended equipment are available and the procedures outlined below are followed.

However, it should be pointed out that the described procedures are only simplified outlines of service and calibration. Refined service and comprehensive calibration requires accurate and special equipment normally not available to the user. Therefore, if trouble develops which cannot be corrected by the simplified methods outlined here, or when accurate recalibration of the instrument is needed, it is recommended that the voltmeter be returned to Ballantine Laboratories for service and/or recalibration. A letter describing the trouble or desired service will help our Service Department greatly and insure a fast return. If it should be necessary to return the instrument, make certain that at least 4 inches of padding material surrounds the instrument.

Ship via REA Express, motor truck, or air freight.

5.2 Necessary Equipment

For successful servicing and trouble shooting, the following equipment is needed:

5.2.1 A DC Voltmeter

Range 0 to 300 V; accuracy ±3%; input resistance 10 MΩ or higher.

5.2.2 A Stable, Calibrated AC Voltage Source

Frequency between 1 kc and 50 kc; voltage adjustable 1 mV to 10 V; voltage calibration accuracy ±0.25% or better.

Ballantine Model 420 or 421 precision voltage calibrator is recommended.

5.2.3 Accurate Attenuator (Ratio Transformer)

Frequency 1 to 10 kc; attenuation 60 db, 1 ÷ 1000; attenuation accuracy ±0.1%.

Not needed if Ballantine Model 420 is used.

5.2.4 Variable Frequency RF Generator

Frequency range 10 cps to 11 Mc; wave form distortion less than 5%; able to deliver 5 mA into 50 Ω.

5.2.5 RF Voltage Standard

Frequency range 10 cps — 11 Mc; voltage range 0.5, 1.5 and 15 mV; voltage accuracy ±1% or better.

Ballantine Model 440 Micropotentiometer with part #2951 housing and part #2950 — 0.33 Ω and #2950 — 3.3 Ω resistors are recommended. Also required with these units is a dc microammeter 0-200 μA, 25 Ω.

5.2.6 A Sensitive AC Voltmeter

Frequency range 10 cps to 100 kc; voltage range 1 mV-300 V; input impedance 2 MΩ or higher; accuracy 3% or better.

Recommended — Ballantine Model 300H.

5.2.7 Variable Metered AC Power Supply 75 W

5.3 Simple Service Problems

5.3.1 Removing the Case is required for several tests. In doing so:

Place the instrument with front panel down on a table.

Remove the power cord and unscrew the two #10 binder head screws on the back of the case.
Lift up the case.

To replace the case proceed in reverse order.

WARNING . . . When the instrument is operated without the case, the danger of electric shock exists. USE EXTREME CARE. The highest voltages are: 350 V AC; 500 V DC.

5.3.2 Line Voltage Conversion from 115 V to 230 V or vice versa is possible. Instructions are also given on the schematic diagram at the end of this instruction book.

For conversion to 230 V:

Remove jumper between terminals 3 and 4; disconnect black-red wire from terminal 1 and black-yellow wire from terminal 4. Connect both together to terminal 3.

Replace fuse F1, ¾ ampere, Slo-Blo, by 0.4 ampere Slo-Blo.

5.3.3 The Tubes Can Be Replaced with any tubes which meet the tube manufacturer's specifications. No selection is needed. When several tubes are changed, and the transconductance of all changed tubes happen to be abnormally high or low, the voltmeter sensitivity may change slightly (up to 0.5%). This change may be corrected by setting the sensitivity adjustment according to 5.6.

5.3.4 For Fuse Replacement unscrew the fuseholder cap on the front panel and pull out the fuse. For replacement, use:

For 115 V operation, ¾ A Slo-Blo ¼" x 1¼" fuse.
For 230 V operation, 0.4 A Slo-Blo ¼" x 1¼" fuse.

Before replacement, the reason for fuse failure should be investigated and corrected. On 115 V, the voltmeter normally draws approximately 650 mA current.

5.3.5 Removal of the Escutcheon Plate is required when sensitivity or attenuator adjustments have to be made.

5.3.5.1 Remove the range selector and the function switch knob by unscrewing the two set screws on each knob.

5.3.5.2 Remove the four #4 nickel plated binder head screws on the covers on the escutcheon plate and take the plate off. The location of the controls underneath the escutcheon plate are shown on the photograph figure 9 at the end of this instruction book.

5.3.6 Removing the Printed Boards may be necessary when components have to be repaired or replaced.

For the removal, take the instrument out of the case (see 5.3.1) and.

5.3.6.1 Power Supply Board

Pull out all three tubes from the board; unscrew the two #6 round head screws which hold the board; unplug the board from the edge connector.

5.3.6.2 Output Amplifier Board

Unclip the two diode leads and the signal lead close to V6; unsolder the feedback lead from the terminal marked "To S1", close to R52, on the lower left corner of the board; unsolder the green grid wire leading to the midsection attenuator.

Unscrew the two #6 round head screws holding the board, and unplug the board from the edge connector.

To replace the board, proceed in reverse order. Make sure that the ground lug of the shielding of the feedback connection is correctly placed between post and board, and that the binder head screws are securely tightened.

5.3.6.3 Input Amplifier

Unsolder the green wire from the terminal "To S1" and the white wire from the terminal "To R4/R5". Unsolder the lead connecting to J4 and S2 from their terminals. Remove the two #6 round head screws holding the board. Unsolder the grid lead and remove the board. Carefully pull the board out from the edge connector.* For replacement, proceed in reverse order.

5.4 A DC Voltage Check should be undertaken when the voltmeter shows malfunctioning which cannot be corrected by replacing defective tubes or burned-out components.

5.4.1 For dc measurement remove the case, allow 5 minutes warmup, then:

Set	To
Function Switch	AMP
Range Selector	1 mV

Short the input terminals.

5.4.2 Measure the tube pin voltages with 10 MΩ input resistance voltmeter (see 5.2.1).

Compare the result with the pin voltages table on this page.

5.4.3 The voltages should be within ±25% of the table values. If a voltage deviates more than ±25% of the normal value, check the associated tube, measure the components, or inspect the connections until the reason for the voltage deviation is found and corrected.

5.5 Signal Tracing is recommended when the voltmeter malfunction cannot be found by dc voltage measurements.

Set	To
Function Switch	AMP
Range Selector	1 mV

Apply 1 mV 1 kc to 50 kc signal to the input. Measure the ac voltages at the points indicated in the schematic. The values should be within ±10% of those shown in the schematic.

5.6 Sensitivity Adjustment (Cal. Adjust R6) is required when the voltmeter has an error of the same sign and magnitude at all ranges at mid-frequencies 0.4 kc to 1 Mc.

The sensitivity adjustment changes the amplifier gain and affects the indication in all ranges and at all frequencies.

To adjust R6 proceed as follows:

5.6.1 Allow 1 hour warmup and check the downscale adjustment according to 2.4.1. Set the range selector to 10 mV range, remove the escutcheon plate (see 5.3.5), apply a 10 mV ±0.25% signal (Ballantine Model 420) to the input.

5.6.2 Through the hole in the panel (see photograph figure 9 at the end of this instruction book) adjust the sensitivity adjustment (Cal. Adjust R6) until the indicator shows 10 mV ±0.1% (9.99 mV to 10.01 mV).

MODEL 317 PIN VOLTAGES (in Volts against ground)

TUBE \ PIN	1	2	3	4	5	6	7	8	9
V1	<10 mV	2.4	−6.3	0	155	125	2.4	—	—
V2	156	155	156	0	+6.3	+156	290	300	156
V3	9.8	8.8	9.8	6.3	12.6	9.0	150	130	9.8
V4	<10 mV	204	0	4.3VAC	149	115	2.0	—	—
V5	150	149	150	6.3VAC	0	159	290	300	150
V6	5.7	4.4	5.7	0	6.3VAC	5.7	160	110	5.7
V8	—	300	—	430	290	—	300	300	CAP435
V10	148	150	6.3VAC	0	290	225	150	—	—
V11	150	0	—	0	150	—	0	—	—

*Serial #1 thru 200, the connection to the grid of V1 is beneath the board.

5.7 Adjustment of the Input Attenuator is required when the voltmeter has an error of the same sign and magnitude in the ranges from 1 V to 300 V. The adjustment is done by setting the trimmer capacitor C2, which affects the sensitivity of the 1 V to 300 V ranges at all frequencies above 100 cps. When using the Ballantine Model 420 Calibrator as a standard, the input attenuator is adjusted as follows:

5.7.1 Remove the Case (see 5.3.1), allow 15 minute warmup. Connect Model 420 to the input of the voltmeter.

Set	To
Range Selector	10 mV range
Model 420	10 mV range

Adjust the Model 420 output to produce a reading at 9.80 on the voltmeter.

5.7.2

Set	To
Range Selector	10 V range
Model 420	10 V range

Adjust the trimmer C2 until the indicator indicates 9.80 $\pm 0.1\%$. The trimmer C2 is located at the rear of the attenuator assembly, as shown on the photograph figure 8 at the end of the instruction book.

5.7.3 A stable voltage source and an accurate 1 ÷ 1000 attenuator (ratio transformer) may be used to adjust the input attenuator. Follow instruction 4.5.3.1 to 4.5.3.3 for attenuator and voltmeter settings. Make adjustment through trimmer C2.

5.8 Alignment of the Frequency Response

5.8.1 Low Frequency Response is determined by the design and initial component values of the instrument and has no adjustment or alignment.

5.8.1.1 If an excessive error appears at low frequencies on all ranges, a defective coupling or decoupling capacitor may be found. Check the tubes for grid current, the coupling condenser for value and leakage, and the screen bypasses for value.

5.8.1.2 If only the ranges from 1 V to 300 V are affected, tube V1 may be defective and exhibit grid current, or excessive leakage in C2 may be the reason. The capacitor C2 is a small polystyrene trimmer which may develop surface leakage when exposed to a humid and dirty atmosphere over extended periods. The effect of the leakage is a rising low frequency response.

This condition may be corrected by disassembling the input attenuator and washing the trimmer C2 with clean alcohol. The need for cleaning C2, however, is a service problem which may occur very infrequently. Before undertaking this procedure, the components described under 5.8.1.1 should be checked to make sure that the fault is not caused by other sources.

5.8.1.3 For the removal of C2 - C3 assembly, remove the attenuator shield and L bracket. Loosen the holding screws of C64 and lift the electrolytic capacitor up, without unsoldering the leads.

Remove the 4 screws holding the rear plate of the attenuator block. Unsolder the two connections to the C2 - C3 assembly (one through the side hole of the attenuator block), being careful not to overheat the solder joints.

Pull out C2 - C3 assembly. To assemble the attenuator, proceed in reverse order.

5.8.2 High Frequency Response needs alignment when the voltmeter shows excessive error at high frequencies above 3 Mc. The high frequency adjustment L3, C30 and C31 affects the following voltage ranges:

L3	1 mV and 1 V range (also all other ranges, but to lesser extent)
C30	3 mV and 3 V range
C31	10 - 300 mV and 10 - 300 V ranges

To align the high frequency response proceed as follows:

Remove the escutcheon plate (see 5.3.5).

Allow 30 minutes warmup.

5.8.2.1 L3 Adjustment

Connect a stable, high frequency generator to the voltmeter over the Model 440 Micropotentiometer as shown in figure 6.

Set	To
Range Selector	1 mV range (fully counterclockwise)
Function Switch	METER
HF Generator	1 kc - 50 kc

Adjust the generator output to produce an indication of 0.6 mV. Note the indication on dc microammeter connected to the micropotentiometer.

5.8.2.2 Change the hf generator frequency to 11 Mc. Adjust the level to produce exactly the same indication on the dc microammeter. Adjust C30 through the hole in the front panel (see the photograph figure 9 at the end of the instruction book) until the voltmeter indicates 0.6 mV $\pm 0.5\%$.

5.8.3 C30 Adjustment

5.8.3.1

Set	To
Range Selector	3 mV range
Function Switch	METER
HF Generator	1 kc - 50 kc

Adjust the generator output to produce an indication of 1.5 mV. Note the indication on the dc microammeter of the micropotentiometer.

5.8.3.2 Change the frequency of the hf generator to 11 Mc. Adjust its level to produce exactly the same indication on the dc microammeter. Adjust C30 through the hole in the front panel (see the photograph figure 9 at the end of the instruction book) until the voltmeter indicates 1.5 mV ±0.5%

5.8.4 C31 Adjustment

5.8.4.1 Set	To
Range Selector	30 mV range
Function Switch	METER
HF Generator	1 kc - 50 kc

Adjust the generator output to produce an indication of 15 mV. Note the indication on the dc microammeter in the micropotentiometer setup.

5.8.4.2 Change the frequency of the hf generator to 11 Mc. Adjust its level to produce exactly the same indication on the dc microammeter. Adjust C31 through the hole in the front panel (see the photograph figure 9 at the end of the instruction book) until the voltmeter indicates 1.5 mV ±0.5%.

5.9 Power Supply Adjustment is needed if the +B Voltage is not within 290 to 300 V or when the power supply shows poor regulation for line transients. Adjustments can be made through R101 or R107 (see figure 7).

5.9.1 +B Voltage Adjustment (R107)

Check the voltage on pin 8 of tube V8 on power supply board. If the voltage is outside of the 290-300 V limits check the tubes V8 and V10 for transconductance and replace if necessary. Adjust the R107 to bring the +B voltage to 295 V.

5.9.2 Adjustment of R101

For the adjustment of R101 connect the voltmeter to a variable voltage power supply.

Set	To
Range Selector	1 V range
Function Switch	NULL

Apply a signal of approximately 100 mV to bring indication on 0 db (see 2.13). Vary the line voltage to the voltmeter periodically (approximately 2 times a second) ±5 V. Observe the fluctuation in meter indication. Adjust R101 to give minimum pointer deflection.

5.10 Servicing the Cathode Follower Probe

5.10.1 Removing the Probe Housing

Remove the #2 screw which holds the spade lug of the ground wire. Unscrew both #2 screws holding the Teflon head. Slowly pull the head ¼ out of the housing. Unsolder the wire of R1 which is located in the probe head. Pull the probe head out completely. Unscrew the #4 screw, which holds the housing to the end piece and remove the housing. To assemble the probe proceed in reverse order.

5.10.2 Changing the Nuvistor Tube

After the housing of the probe is removed (5.10.1), the 7586 tube can be pulled out of the socket. The tube can be replaced with any tube meeting the tube manufacturer's specifications. The tube, however, should only be replaced after several thousand hours of operation and, if the probe is proven to be operating improperly (see 4.5.5). In case the replacement tube deviates largely in plate resistance from the original tube, the accuracy test according to 4.5.5 may show that an adjustment of the gain correction is necessary.

5.10.3 Checking the DC Operating Point of the Tube

Carefully, so as not to touch or ground the center conductor of the UHF connector, plug in the probe supply, measure the voltage from the center conductor to ground. If the tube is operating properly, and no interruption exists in the coaxial cable, the voltage measured should be 75 V ±10%.

5.10.4 DC Voltage Check should be undertaken when the probe shows malfunction, which cannot be corrected by replacing a defective tube. The dc operating point alone can also be checked without removal of the housing (see 5.10.3).

For complete dc measurement, remove the housing (5.10.1) and measure the dc voltages indicated in the schematic with a 10 MΩ or higher input resistance voltmeter.

5.10.5 Probe Gain Correction

Open the probe connector P4. With screwdriver or similar instrument depress the locking tap accessible through the side hole. Holding wire and strain relief, pull the metal sleeving off. Unsolder resistor R11. Put the connector together temporarily.

Measure a stable signal of 50 to 100 mV, 400 cps to 50 kc once with, and once without, the probe.

The reading with probe will be lower. To correct the probe loss, select the right value for R11 according to the chart below. Use a ¼ W carbon composition resistor.

Reading with Probe is Low	Approximate Value of R11
5.5%	82 Ω
5.2%	100 Ω
5.0%	120 Ω
4.8%	150 Ω
4.6%	160 Ω
4.4%	180 Ω
4.2%	200 Ω
4.0%	220 Ω
3.8%	270 Ω
3.5%	330 Ω

Solder the selected resistor to the connector pin 4 and ground. Use a small soldering iron, being careful not to short any pins or burn any insulation.

5.11 TROUBLE SHOOTING CHART

SYMPTOM	POSSIBLE CAUSE	PERTINENT SECTION
Instrument inoperative; pilot light does not light up.	No power; fuse blown; defect in power supply.	5.3.4 5.4
Incorrect indication in all ranges, but correct gain in amplifier position.	Incorrect downscale adjustment; signal rectifiers defective.	2.4.1 5.5
Incorrect indication in all ranges and amplifier gain incorrect.	Gain change in input or output amplifier; defect in feedback network.	5.5 5.4 5.6
Incorrect indication, mainly downscale, all frequencies and voltage ranges.	Downscale adjustment misadjusted; excessive noise in output amplifier.	2.4.1 4.6.3
Error when measuring 60 cps, all ranges.	Hum in output amplifier; V4 defective.	5.3.3
Error when measuring 120 cps, all ranges.	Defective tube or filter capacitor in power supply or output amplifier.	5.3.3 5.9
Error when measuring 120 cps, mainly 1 mV and 1 V range.	Defective first amplifier, especially V1, or DC filament filtering.	5.3.3
Excessive low frequency noise or flutter, mainly 1 mV and 1 V range.	Defective tube in the first amplifier, especially V1, V11, leakage current of C21 too high.	4.6.3
Excessive low frequency noise or flutter, in all ranges.	Defective V3/V11 or power supply.	5.9
Instrument gives reading without signal, also with shorted input.	Function switch in null position; low line voltage.	5.4
Low frequency oscillation.	Low line voltage; B+ adjusted too high; failure in power supply.	5.9 3.6
Error when reading in ranges 1 V to 300 V only.	Defective input attenuator; misadjusted C2.	4.5.3 5.7
Insufficient downscale adjustment.	Defective signal rectifiers CR5 or CR6; defective meter; operating point of V6 changed.	5.5 5.4 3.5
Excessive effect of line voltage change.	Weak tubes in power supply or amplifiers.	5.9 4.6.2
Error in all ranges when measuring high frequencies.	Incorrect amplifier frequency response. Function switch in null position.	5.8.2
Error when measuring high frequencies, for some ranges only.	Misaligned midsection attenuator.	5.8.2
Error when measuring low frequencies, volt ranges only.	R1 or R2 defective, C2 has leakage.	3.1 5.8.1

TROUBLES DEVELOPING ONLY WHEN USING MODEL 2317A CATHODE FOLLOWER PROBE.

SYMBOLS REFER TO PROBE SCHEMATIC

No indication.	DC supply interrupted; broken signal lead; connection to R1 broken.	5.10.3
Indication low at all frequencies.	No gain correction; defective Nuvistor tube V1; connection to R1 interrupted.	5.10.5
Indication low at low frequencies.	Nuvistor exhibits grid current; connection to R1 interrupted.	5.10.2
Indication low at high frequencies.	Defective Nuvistor V1; broken outer conductor. L1 shorted.	5.10
Error when reading, high or low frequencies.	Input signal exceeds 300 mV; Nuvistor V1 has low transconductance.	4.5.5 5.10
Indication without signal, input shorted.	Short in supply leads; low line voltage; Model 317 B+ too low.	5.10.3 5.9
Indication without signal, input open.	Normal 60 or 120 cps pickup; shorted dc supply.	5.10.3
Excessive low frequency noise and flutter.	Nuvistor V1 or C1 defective.	5.10.2

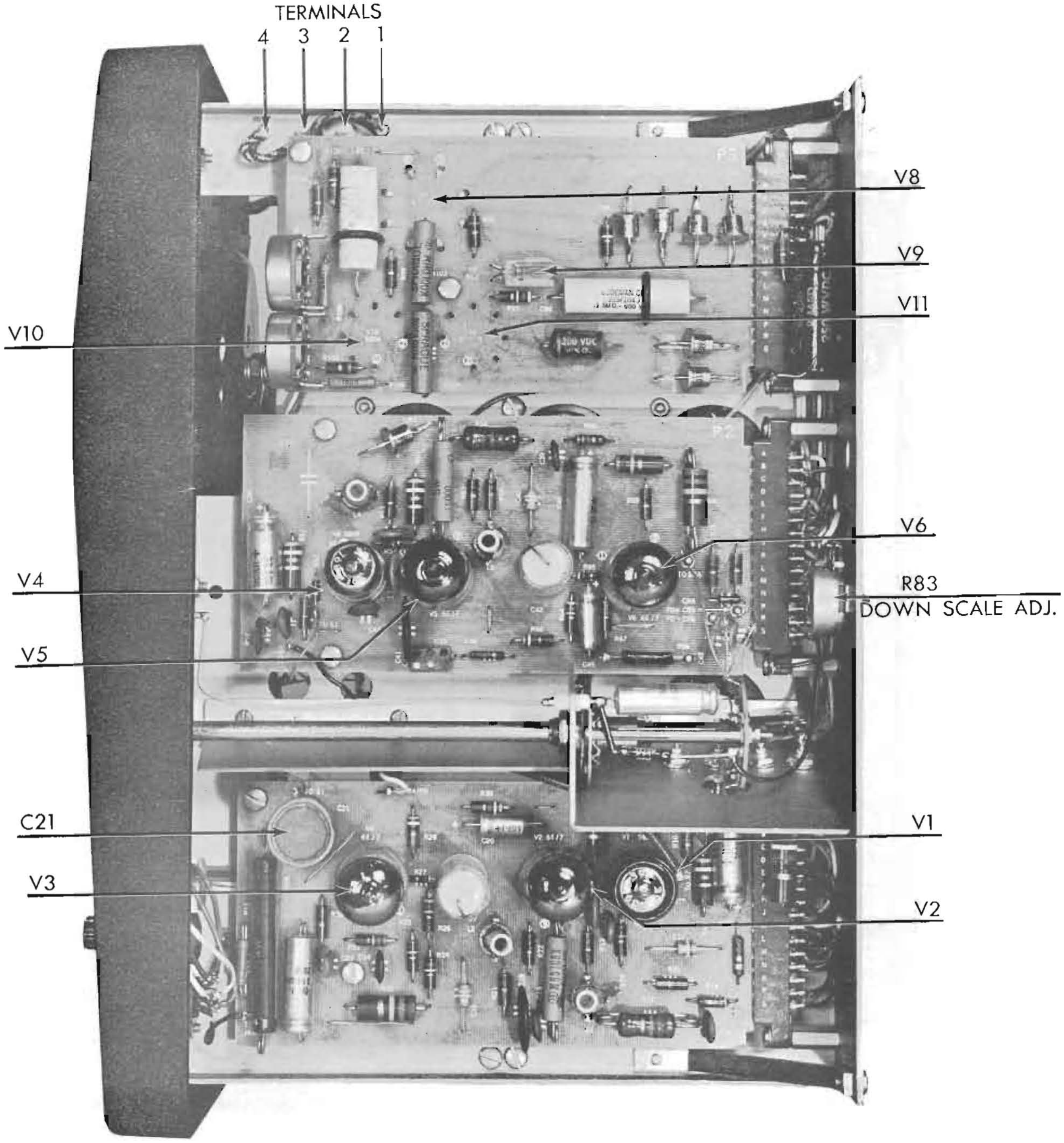


Figure 7. Side View of Model 317 (right) Location of Tubes and Adjustments

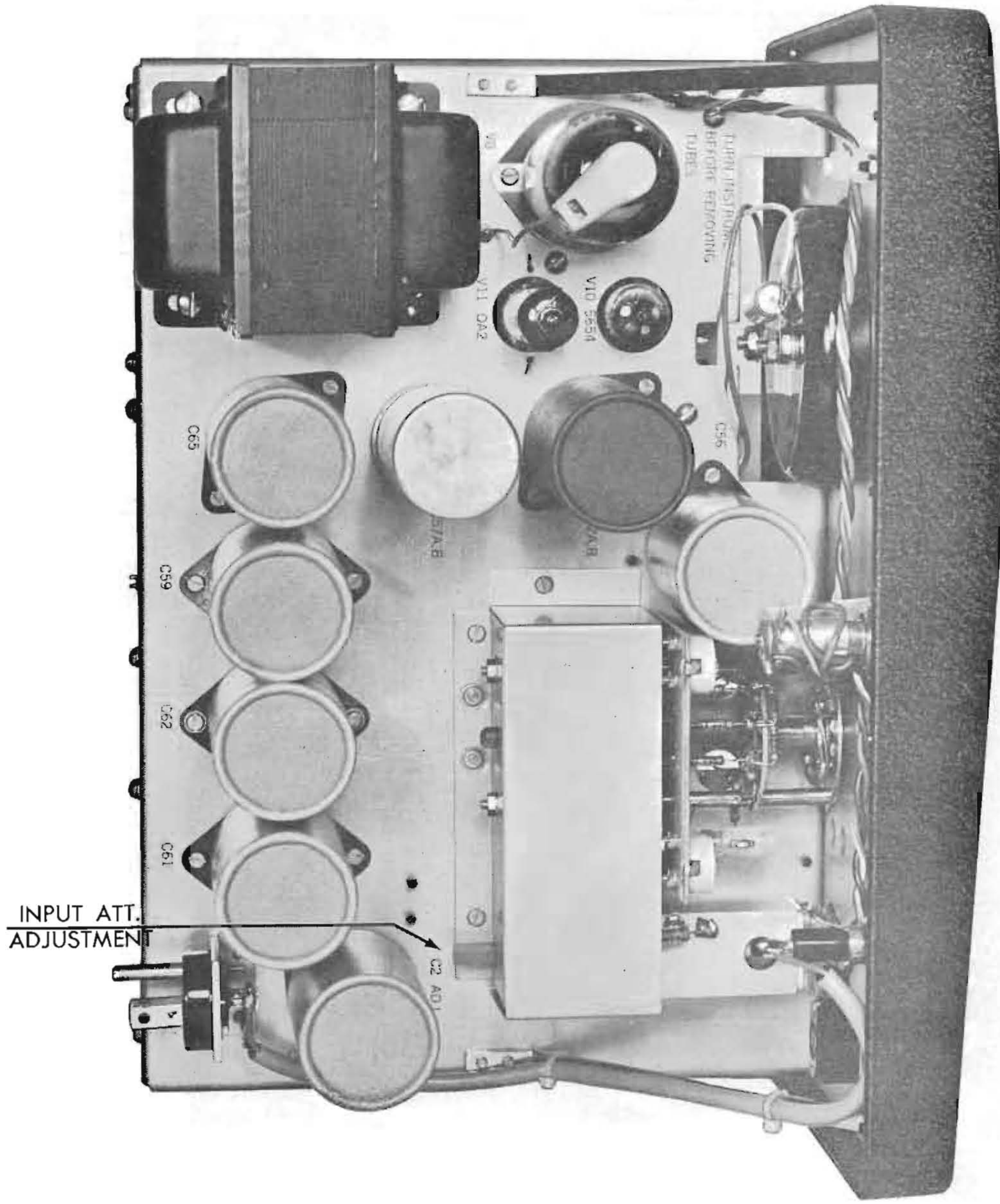
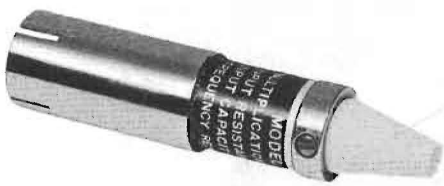


Figure 8. Side View of Model 317 (left) Location of the Input Attenuator Adjustment

Figure 9. Front View of the Model 317 (escutcheon plate removed) **Location of Adjustments**

Model 1311
High Voltage Probe for use to 10,000 Volts



Model 3317
60 db Attenuator Adapter
to extend voltage range of
Model 2317A Probe from
300 mV to 350 V

Model 6314
BNC Adapter to connect
Model 2317 and Model 3317
to coaxial inputs

Series 600
Precision Shunt Resistors
for measuring current when
attached to binding post input
of Model 317

Figure 10. Additional Accessories for Model 317 which may be purchased separately

6. REPLACEMENT PARTS LIST — VOLTMETER

REFER TO MODEL 317 SCHEMATIC DIAGRAM, DWG. MD-1556N

B. L. Part No.	*Circuit Symbol*	*Capacitors*	*Manufacturer*
2380	C1	.068 μF, Type 620S-683-0-600, 600 V	Goodall
2580	C2	0.7-3 pF, Special	Ballantine
2539	C3	2,000 pF, Type 470BH, 10%	Erie
2540	C10	5,000 pF, Type EGP-Z5U, 20%, 500 V	Erie
2508	C11	6.2 pF, Type QC5, 5%	Quality Components
2085	C12	150 μF, Type 30D136A1, 6 V	Sprague
2540	C14	5,000 pF, Type EGP-Z5U, 20%, 500 V	Erie
2540	C15	5,000 pF, Type EGP-Z5U, 20%, 500 V	Erie
2511	C16	3.9 pF, Type QC5, 10%	Quality Components
2370	C17	.22 μF, Type 355-E224K, 10%, 400 V	Gudeman
2536	C18	.02 μF, Type 841 Y5V 203M, 20%, 500 V	Erie
2540	C19	5,000 pF, Type EGP-Z5U, 20%, 500 V	Erie
2087	C20	10 μF, Type 30D147A1, 12 V	Sprague
2093	C21	12 μF, 350 V, special	Ballantine
2541	C22	.01 μF, Type 19C241, 500 V	Sprague
2083	C23	3 μF, Type TT-TS-15085, 300 V	Mallory
2541	C24	.01 μF, Type 19C241, 500 V	Sprague
2222	C25	10 pF, Type CM-15-C-100-J, 5%	El Menco
2556	C26	75 pF, Type 831 X5R 750J, 5%	Erie
2429	C30	7-45 pF, Type 822-BN	Centralab
2429	C31	7-45 pF, Type 822-BN	Centralab
2235	*C32	33 pF, Type CM-15-E-330-J, 5%	El Menco
2224	*C33	100 pF, Type CM-15-E-101-J, 5%	El Menco
2508	*C37	6.2 pF, Type QC5, 5%	Quality Components
2540	C38	5,000 pF, Type EGP-25U, 20%, 500 V	Erie
2540	C39	5,000 pF, Type EGP-25U, 20%, 500 V	Erie
2511	C40	3.9 pF, Type QC5, 10%	Quality Components
2536	C41	.02 μF, Type 841 Y5V 203M, 20%, 500 V	Erie
2370	C42	.22 μF, Type 355-E224K, 10%, 400 V	Gudeman
2540	C43	5,000 pF, Type EGP-25U, 20%, 500 V	Erie
2086	C45	25 μF, Type 30D150A1, 12 V	Sprague
2083	C46	3 μF, Type TT-TS-15085, 300 V	Mallory
2541	C47	.01 μF, Type 19C241, 500 V	Sprague
2541	C48	.01 μF, Type 19C241, 20%, 500 V	Sprague
2541	C49	.01 μF, Type 19C241, 20%, 500 V	Sprague
2083	C55	3 μF, Type TT-TS-15085, 300 V	Mallory
2760	C56	150 μF, Type TVL-1540, 250 V	Sprague
2181	C57A	2 μF, Type 8323, 10%, 300 V	Gudeman
	C57B	2 μF, Type 8323, 10%, 300 V	Gudeman
2084	C58	300 μF, Type 30D118A1	
2760	C59	150 μF, Type TVL-1540, 250 V	Sprague
2582	C60	1,000 pF, Type FB2B, 500 V	Allen-Bradley
2760	C61	150 μF, Type TVL-1540, 250 V	Sprague

* Calibration Item — In some instruments the component listed may not be used at all or its value may differ from the value shown.

REPLACEMENT PARTS LIST *Continued*

REFER TO MODEL 317 SCHEMATIC DIAGRAM, DWG. MD-1556N

B. L. Part No.	*Circuit Symbol*	*Capacitors*	*Manufacturer*
2760	C62	150 μF, Type TVL-1540, 250 V	Sprague
2582	C63	1,000 pF, Type FB25, 500 V	Allen-Bradley
2020	C64	3,000 μF, Type FP, 10 V	Mallory
2757	C65	1,000 μF, Type FP, 25 V	Mallory
2582	C66	1,000 pF, Type FB25, 500 V	Allen-Bradley
2761	C72A	40 μF, Type TVL-2940, 500 V	Sprague
	C72B	40 μF, Type TVL-2940, 500 V	Sprague
2582	C73	1,000 pF, Type FB2B, 500 V	Allen-Bradley
2050	C74	8 μF, Type BBR, 250 V	Cornell-Dubilier
2363	C80	0.1 μF, Type 355C104J, 5%, 600 V	Gudeman
2301	C81	0.1 μF, Type ML-2-1, 20%, 200 V	Cornell-Dubilier
2352	C82	.47 μF, Type BAL-2, 200 V, 10%	Goodall
		Resistors	
2709	R1(1)	2,000,000 ohms, Type PT-60, 0.2%	Pyrofilm
2710	R2(1)	2,002 ohms, Type PT-60, 0.2%	Pyrofilm
1007	R3	2,000,000 ohms, Type EB, 5%	Allen-Bradley
2722	R4	39.1 ohms, Type PT-60, 1%	Pyrofilm
2721	R5	195 ohms, Type PT-60, 2%	Pyrofilm
6857	R6	100 ohms, Type G	Allen-Bradley
1240	R7	470 ohms, Type CB, 10%	Allen-Bradley
1108	R10	180 ohms, Type EB, 5%	Allen-Bradley
2724	R11	540 ohms, Type N5, 1%	Constanta
1677	R12	15,000 ohms, Type C42S, 5%	Corning Glass
1086	R13	1,500 ohms, Type EB, 5%	Allen-Bradley
1678	R14	4,700 ohms, Type C20, 5%	Corning Glass
1265	R15	3.9 ohms, Type GB, 10%	Allen-Bradley
1042	R16	15,000 ohms, Type EB, 5%	Allen-Bradley
1725	R17	15,000 ohms, Type 452E1535	Sprague
1265	R18	3.9 ohms, Type GB, 10%	Allen-Bradley
1076	R20	22 ohms, Type EB, 5%	Allen-Bradley
1057	R21	1,000 ohms, Type EB, 5%	Allen-Bradley
1076	R22	22 ohms, Type EB, 5%	Allen-Bradley
1865	R23	1.2 ohms, Type WM-10, 10%	Continental-Wirt
1014	R24	510,000 ohms, Type EB, 5%	Allen-Bradley
1042	R25	15,000 ohms, Type EB, 5%	Allen-Bradley
1015	R26	470,000 ohms, Type EB, 5%	Allen-Bradley
1236	R27	47 ohms, Type CB, 10%	Allen-Bradley
1664	R28	10,000 ohms, Type S30, 1%	Corning Glass
1072	R29	39 ohms, Type EB, 5%	Allen-Bradley
1062	R30	390 ohms, Type EB, 5%	Allen-Bradley
1028	R31	68,000 ohms, Type EB, 5%	Allen-Bradley
1076	R32	22 ohms, Type EB, 5%	Allen-Bradley
1201	R33	20,000 ohms, Type HB, 5%	Allen-Bradley

NOTE

(1) Resistors R1 and R2 are part of a matched set, and must be purchased as Set No. 1594.

REPLACEMENT PARTS LIST *Continued*

REFER TO MODEL 317 SCHEMATIC DIAGRAM, DWG. MD-1556N

B. L. Part No.	*Circuit Symbol*	*Resistors*	*Manufacturer*
2723	R34	15.1 ohms, Type N5, 1%	Constanta
2741	R40(2)	1,514 ohms, Type PT-60, 1%	Pyrofilm
2714	R41(2)	67.69 ohms, Type PT-60, 1%	Pyrofilm
2714	R42(2)	67.69 ohms, Type PT-60, 1%	Pyrofilm
2715	R43(2)	46.29 ohms, Type PT-60, 1%	Pyrofilm
2712	R44(2)	609.2 ohms, Type PT-60, 1%	Pyrofilm
2713	R45(2)	100.1 ohms, Type PT-60, 1%	Pyrofilm
2713	R46(2)	100.1 ohms, Type PT-60, 1%	Pyrofilm
2713	R47(2)	100.1 ohms, Type PT-60, 1%	Pyrofilm
1053	*R49	2,200 ohms, Type EB, 5%	Allen-Bradley
1246	R50	220 ohms, Type CB, 10%	Allen-Bradley
1873	R52	17 ohms, Special	Ballantine
1086	R53	1,500 ohms, Type EB, 5%	Allen-Bradley
1677	R54	15,000 ohms, Type C42S, 5%	Corning Glass
1108	R55	180 ohms, Type EB, 5%	Allen-Bradley
1667	*R56	200 ohms, Type N20, 5%	Corning Glass
1042	R57	15,000 ohms, Type EB, 5%	Allen-Bradley
1678	R58	4,700 ohms, Type C20, 5%	Corning Glass
1057	R59	1,000 ohms, Type EB, 5%	Allen-Bradley
1265	R60	3.9 ohms, Type GB, 10%	Allen-Bradley
1725	R61	15,000 ohms, Type 452E1535	Sprague
1076	R63	22 ohms, Type EB, 5%	Allen-Bradley
1015	R64	470,000 ohms, Type EB, 5%	Allen-Bradley
1236	R65	47 ohms, Type CB, 10%	Allen-Bradley
6161	R66	18,000 ohms, Type 452E1835, 5%	Sprague
1098	R67	120 ohms, Type EB, 5%	Allen-Bradley
1062	R68	390 ohms, Type EB, 5%	Allen-Bradley
1076	R69	22 ohms, Type EB, 5%	Allen-Bradley
1252	R70	62,000 ohms, Type GB, 5%	Allen-Bradley
1101	R71	15 ohms, Type EB, 5%	Allen-Bradley
1101	R72	15 ohms, Type EB, 5%	Allen-Bradley
1665	R80	457 ohms, Type N20, 1%	Corning Glass
1005	R81	3,000,000 ohms, Type EB, 5%	Allen-Bradley
1927	R83	500,000 ohms, Type PM-45	Chicago Telephone
	R85	51 ohms, Type HB, 5%	Allen-Bradley
1217	R86	91 ohms, Type HB, 5%	Allen-Bradley
1032	R90	47,000 ohms, Type EB, 5%	Allen-Bradley
1272	R91	1,000 ohms, Type GB, 5%	Allen-Bradley
1098	R92	120 ohms, Type EB, 5%	Allen-Bradley
1026	R96	100,000 ohms, Type EB, 5%	Allen-Bradley

NOTE

(2) Resistors R40, R41, R42, R43, R44, R45, R46, R47 are part of a matched set and must be purchased as Set No. 1591.

* Calibration Item — In some instruments the component listed may not be used at all or its value may differ from the value shown.

REPLACEMENT PARTS LIST *Continued*

REFER TO MODEL 317 SCHEMATIC DIAGRAM, DWG. MD-1556N

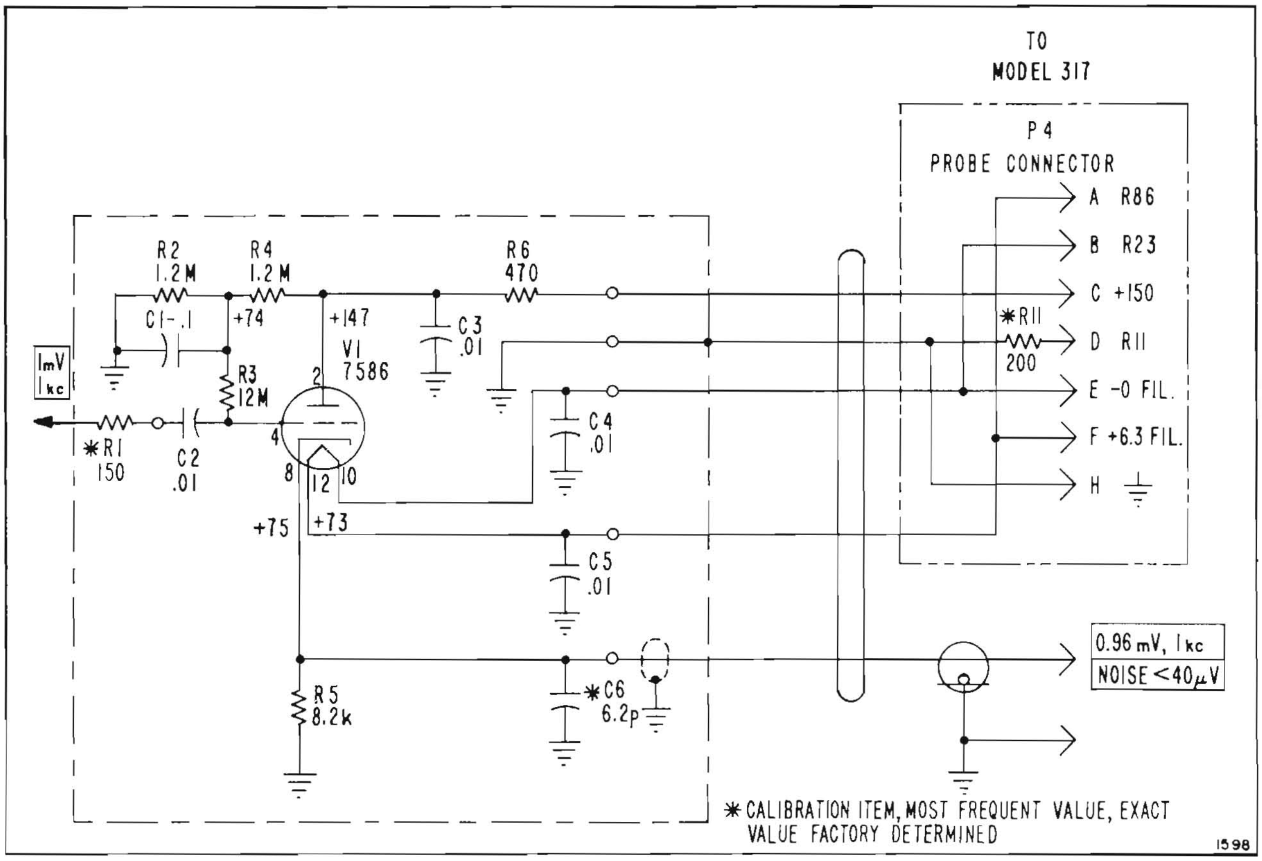
B. L. Part No.	*Circuit Symbol*	*Resistors*	*Manufacturer*
1015	R97	470,000 ohms, Type EB, 5%	Allen-Bradley
1069	R98	56 ohms, Type EB, 5%	Allen-Bradley
1057	R99	1,000 ohms, Type EB, 5%	Allen-Bradley
1009	R100	1,500,000 ohms, Type EB, 5%	Allen-Bradley
1926	R101	2,000,000 ohms, Type XPM-45	Chicago Telephone
1740	R102	4,000 ohms, Type 452E, 5%	Sprague
1069	R103	56 ohms, Type EB, 5%	Allen-Bradley
1740	R104	4,000 ohms, Type 452E, 5%	Sprague
1040	R105	20,000 ohms, Type EB, 5%	Allen-Bradley
2678	R106	150,000 ohms, Type N5, 5%	Constanta
1928	R107	50,000 ohms, Type XPM-45	Chicago Telephone
2678	R108	150,000 ohms, Type N5, 5%	Constanta
		Other Components	
7921	CR3, 7, 8	Rectifier, Type 36591	RCA
5588	CR4	Diode, Type 1N816	Sperry
5580	CR5, 6	Rectifier, Type HPS1670, PIV20	Hughes
5586	CR9, 10, 11, 12	Rectifier, Type 1N1764, PIV500	RCA
3407	F1	Fuse, 1 amp, Type MDL Slo-Blo	Bussmann
3018	L1	Coil, Special	Ballantine
3017	L2, 5	Coil, Special	Ballantine
3074	L3	Coil, 5-12 μH, Type 4204	Miller
3015	L6, 7	Coil, 39 μH, Type 4628	Miller
3024	L10	Coil, Special	Ballantine
3196	M1	Meter, Indicating, Special	Ballantine
3278	S1	Switch, Attenuator, Special	Ballantine
3279	S2	Switch, Function, Special	Ballantine
3268	S3	Switch, Toggle, ON-OFF, #80994H	Arrow
3056	T1	Transformer, Power	Ballantine
3126	V1, 4, 10	Tube, Type 5654	G.E.
5593	V2, 3, 5, 6	Tube, Type 6EJ7/EF184	Amperex
3479	V7	Tube, Neon, Type NE-51H	General Electric
5590	V8	Tube, Type 6GW6	RCA
3138	V9	Tube, Neon, Type NE-2	General Electric
3106	V11	Tube, Type OA2	RCA
617	----	UHF Binding Post Adapter	Ballantine
3322	----	Connector, Input, Type 50239A, Series UHF	Dage
3420	----	Connector, Probe Supply, Miniature Socket, Type Mab-6	Hirschmann
2567	Z1	Resistor-Capacitor Network, 1,000 pF, GMV, Type 129C81, parallel to 470,000 ohms, ±10%	Sprague
2567	Z2	Resistor-Capacitor Network, 1,000 pF, GMV, Type 129C81, parallel to 470,000 ohms, ±20%	Sprague

7. REPLACEMENT PARTS LIST — PROBE

REFER TO MODEL 2317A SCHEMATIC DIAGRAM, DWG. MB-1598E

B. L. Part No.	Circuit Symbol	Capacitors	Manufacturer
2385	C1	0.1 μF, Type 338Y104M, 20%, 150 V	Gudeman
2541	C2	.01 μF, Type 19C241, 500 V	Sprague
2541	C3	.01 μF, Type 19C241, 500 V	Sprague
2541	C4	.01 μF, Type 19C241, 500 V	Sprague
2541	C5	.01 μF, Type 19C241, 500 V	Sprague
2508	*C6	6.2 pF, Type QC5, 5%	Quality Components
		Resistors	
1249	*R1	150 ohms, Type CB, 10%	Allen-Bradley
1239	R2	1,200,000 ohms, Type CB, 10%	Allen-Bradley
1230	R3	12,000,000 ohms, Type CB, 10%	Allen-Bradley
1239	R4	1,200,000 ohms, Type CB, 10%	Allen-Bradley
1275	R5	8,200 ohms, Type GB, 5%	Allen-Bradley
1240	R6	470 ohms, Type CB, 10%	Allen-Bradley
1231	*R11	200 ohms, Type CB, 10%	Allen-Bradley
		Other Components	
5587	V1	Tube, Nuvistor Type 7586	RCA
3427	---	Connector, Type UHF-UG-203/U	Amphenol
3354	---	Connector, Probe Supply, Shielded Multi-pole Connector, Type Mas-6	Hirschmann
4134	---	AC Power Cord	Ballantine

*Calibration Item — In some instruments the component listed may not be used at all or its value may differ from the value shown.

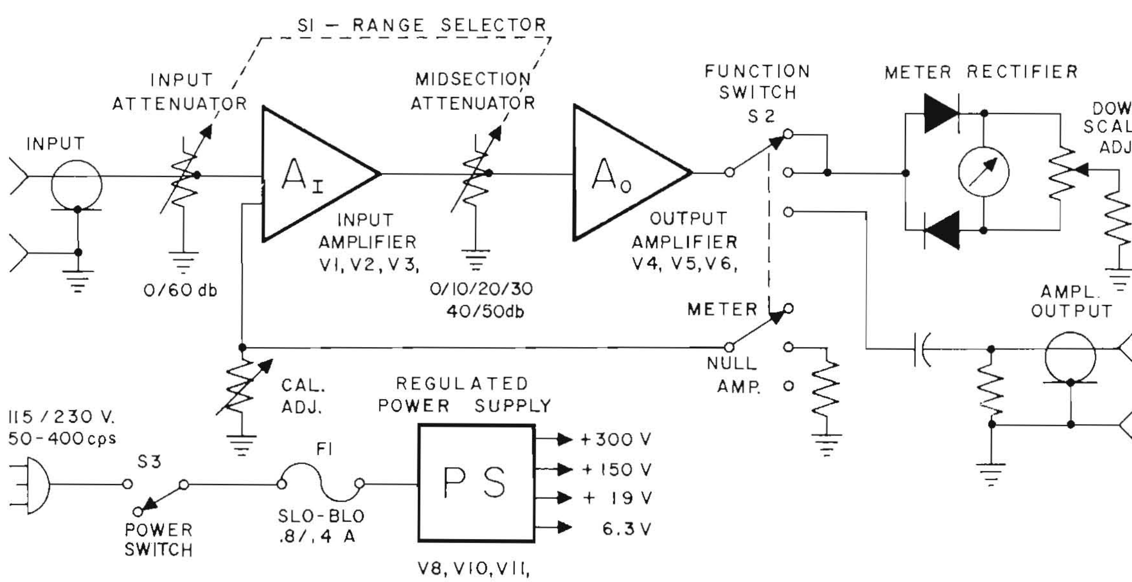


CAPACITORS: NOT MARKED – MICROFARADS (10^{-6}F).
P ——— PICOFARADS (10^{-12} F).
RESISTORS: NOT MARKED – OHMS (Ω)
K ——— KILOHMS (10^3 Ω)
M ——— MEGOHMS (10^6 Ω)
VOLTAGES: NOT MARKED — VOLTS (V)
mV ——— MILLIVOLTS (10^{-3} V)

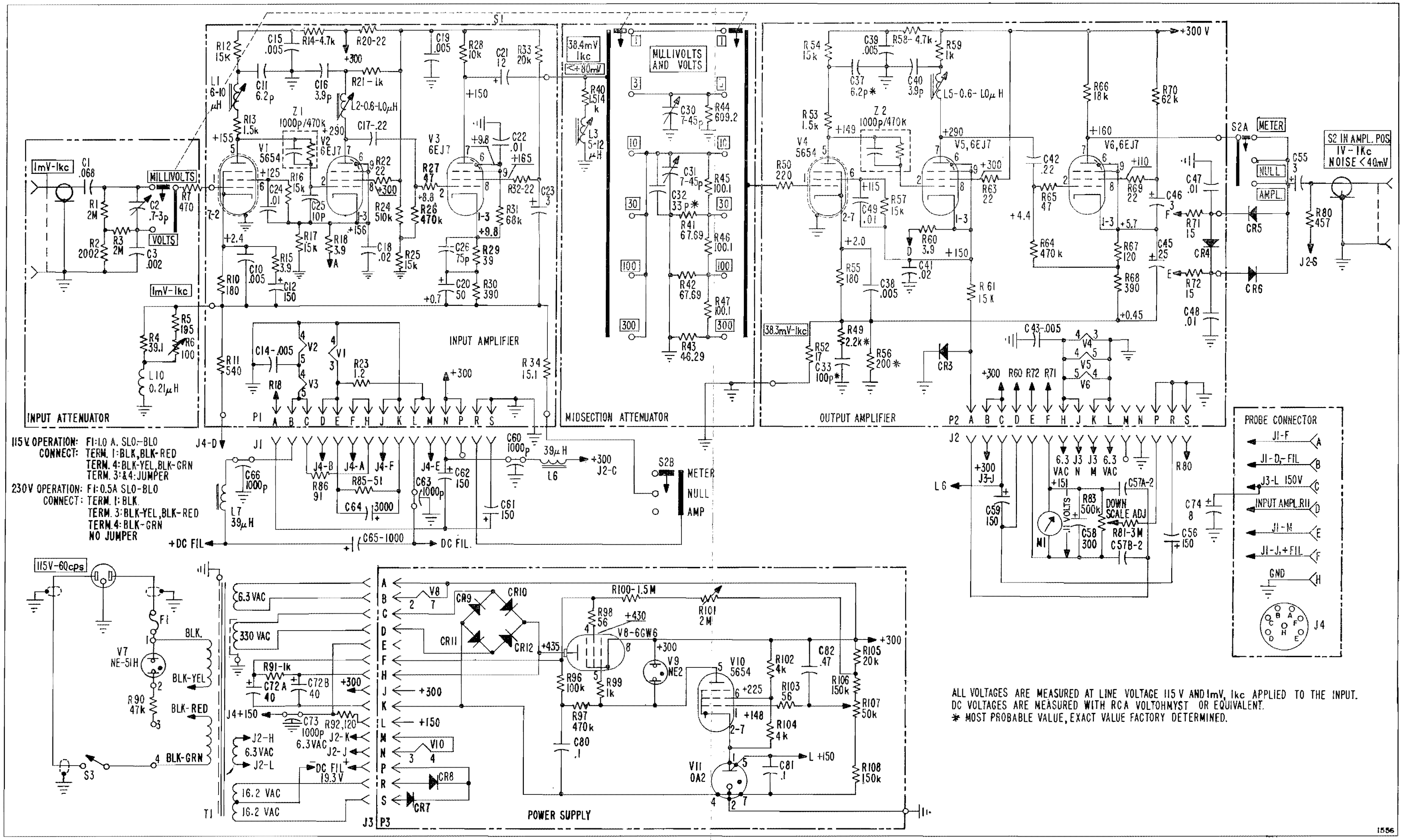
P4
PROBE CONNECTOR
CROSS REFERENCE FOR NUMERAL MARKING

A	B	C	D	E	F	H
1	2	3	4	5	6	GND. TO CONNECTOR SHELL

Schematic of Model 2317A Cathode Follower Probe
Ballantine Drawing No. MB-1598E



Block Diagram



CAPACITORS: NOT MARKED — MICROFARADS (10^{-6}F)
P — PICOFARADS (10^{-12}F)
RESISTORS: NOT MARKED — OHMS (Ω)
K — KILOHMS (10^{3} Ω)
M — MEGOHMS (10^{6} Ω)
VOLTAGES: NOT MARKED — VOLTS (V)
mV — MILLIVOLTS (10^{-3}V)

J4 & P4
PROBE CONNECTOR
CROSS REFERENCE FOR NUMERAL MARKING

A	B	C	D	E	F	H
1	2	3	4	5	6	GND. TO CONNECTOR SHELL

Schematic of Model 317 Wide-Band Voltmeter

Ballantine Drawing MD-1556N

THE SINGER COMPANY
BALLANTINE OPERATION
BOONTON, NEW JERSEY