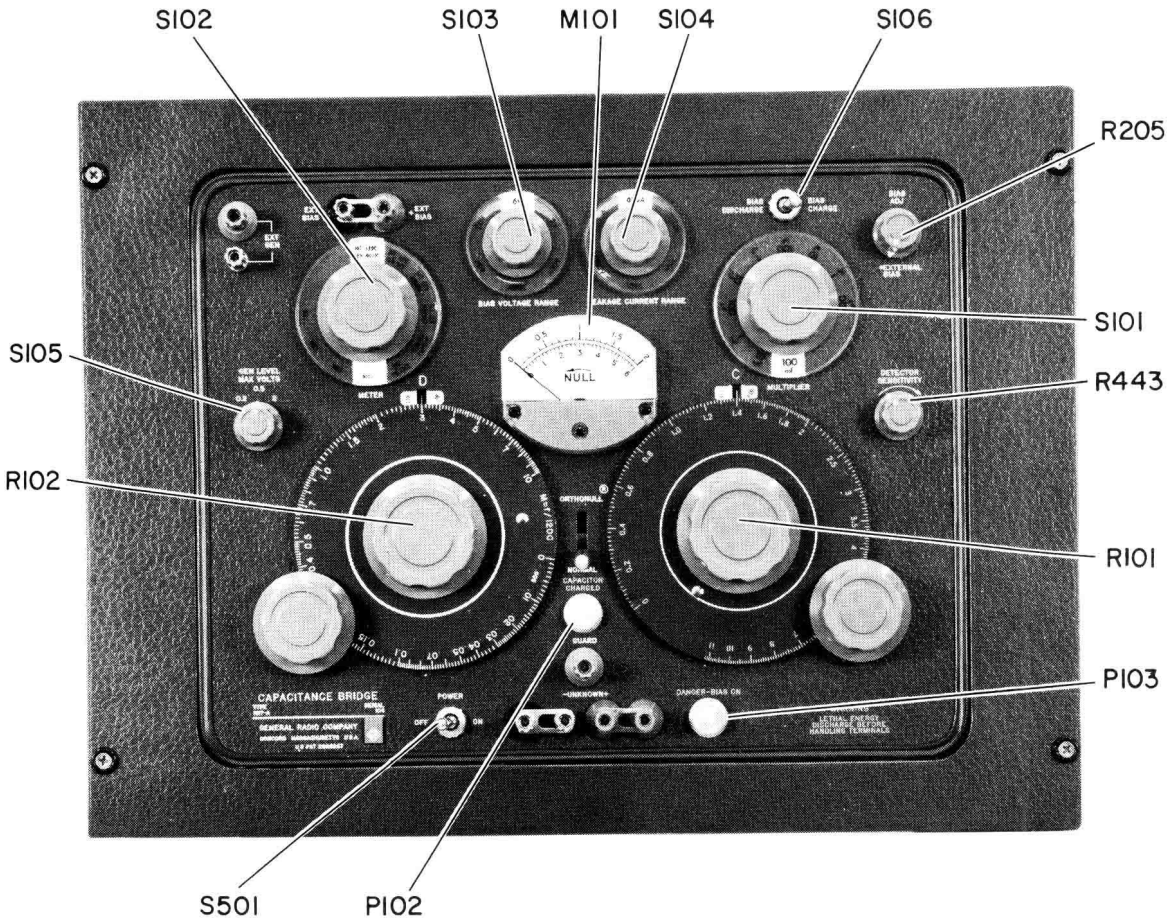
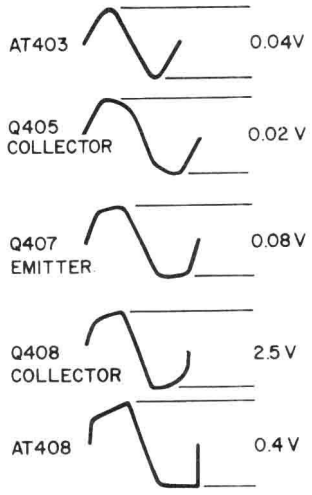


Figure 6-1. Front view of the Type 1617 Capacitance Bridge.

Table 6-2

Waveforms in the Detector Circuit (Figure 6-2)

AT403	~0.04 V
Coll., Q405	~0.02 V
Emitt., Q407	~0.8 V
Coll., Q408	~2.5 V
AT408	~0.4 V



6.4.3 INTERNAL BIAS SUPPLY.

To check the internal bias supply:

a. If the measured voltage is correct on all ranges but the indication of the Type 1617 meter differs from the measured value –

Adjust R183 (VOLTAGE RANGE switch on 2V).

Check the meter-range resistors (R158 through R163) for proper value (on second deck of S103).

b. If the measured voltage is wrong on only some ranges, check the values of the resistors of the first deck of S103 and the switch contacts associated with these resistors.

c. The highest voltage in each range is not equal to the value indicated on the switch legend – adjust R208. If not sufficient, check all dc levels as in Table 6-6.

d. If the dc bias voltage varies with line voltage, check the 7239 tube and the transistors of the circuit (Table 6-6).

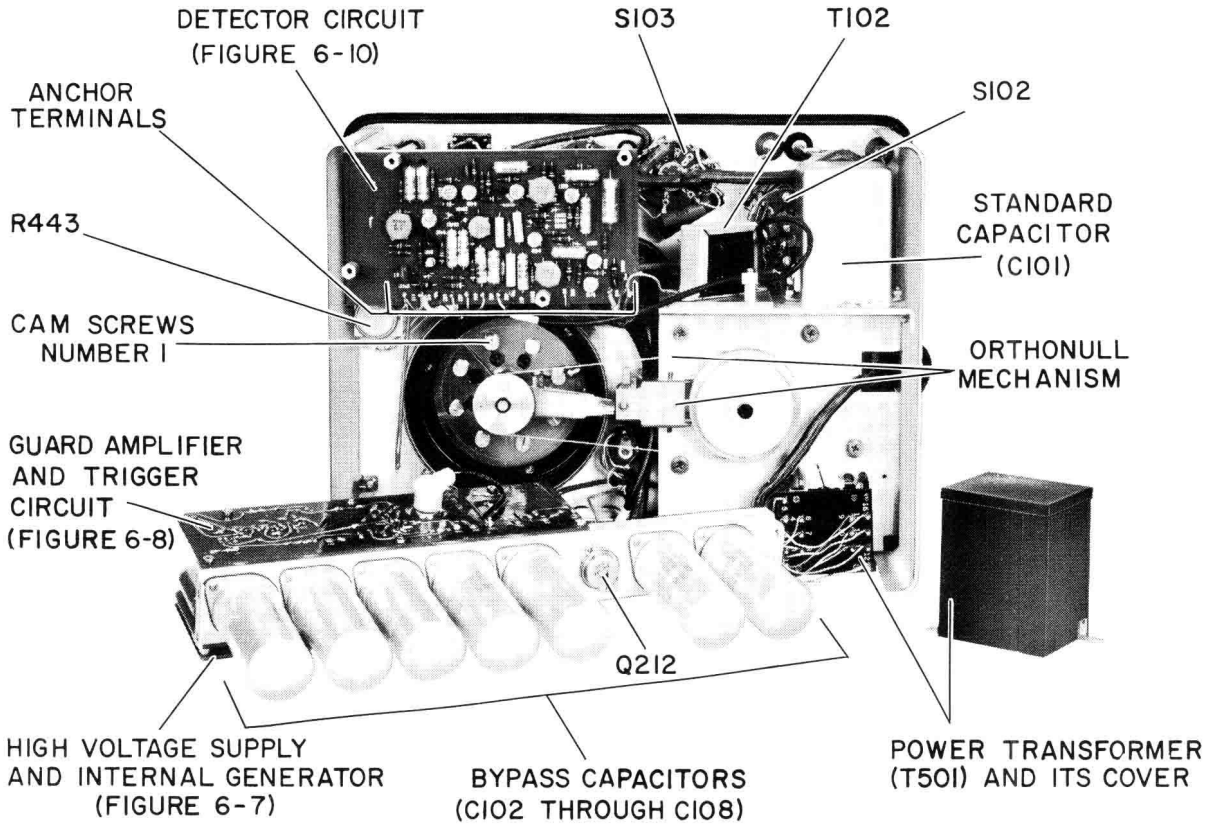


Figure 6-2. Rear interior view of the Type 1617 Capacitance Bridge.

6.4.4 GUARD CIRCUIT.

Observe that:

a. The shield around the positive UNKNOWN terminals, and all the shielded cables from UNKNOWN and GUARD terminals are properly guarded.

b. The lead connecting the unknown to the positive terminal is properly shielded.

c. The guard-circuit amplifier is functioning. To do this, set the function switch to INT 120C, the MULTIPLIER switch to 1 μF, the C dial to 0, and switch the bias off. Then the ac voltage measured between the GUARD terminal and ground should be the same as that measured from the positive unknown terminal to ground.

A negative check is caused by a faulty amplifier or some shorted guard point. To find out if the amplifier is operating, check the guard output at AT307, with the white-yellow-brown lead disconnected. If the amplifier is not functioning properly check the dc voltages in Table 6-6.

6.4.5 TRIGGER.

The trigger circuit should operate so that it fires the CAPACITOR CHARGED lamp when a bias of 0.5 to 1.0 volt is applied to the UNKNOWN TERMINALS. Check the dc voltages if it does not (Table 6-6).

6.4.6 BRIDGE.

For an unknown $(R_x + \frac{1}{\omega C_x})$, the balance equations of the bridge are:

$$R_x = \frac{R_A}{R_N} R_s \text{ and } C_x = \frac{R_N}{R_A} C_S$$

where R_A and C_S are fixed components.

R_N and R_S are rheostats (C and D dials) and all four components have to be within tolerance.

Check the calibration of the bridge by making the measurements of Table 6-3. Six standard capacitors are shown although any range can be checked using any capacitor of known value which falls within that range. Suitable capacitors include the Type 1409 Standard Capacitor, Type 1423-A Precision Decade Capacitor, and Type 1424-A and 1425-A Standard Decade Capacitors.

If large standard capacitors are not available, the higher capacitance ranges may be checked by direct measurement of the ratio-arm resistors, for these are the only components in the bridge that change with the range. These resistors (R103 through R112) may be measured with a dc bridge. A Kelvin, four-terminal bridge is necessary for the two highest ranges, and preferable for the next two lower ones, to avoid errors due to lead resistance.

Table 6-3

Bridge Calibration Check

Measurement	*Standard Value*	*Connection No Terminals*	*MULTIPLIER setting*	*C setting ±1%*	*Faulty R_A*
a	100 pF	3*	100 pF	1	R112
b	10 MF	3	1 nF	10	R111
c	10 nF	3	10 nF	1	R110
d	1 μF	3	100 nF	10	R109
e	1 μF	3	1 μF	1	R108
f	100 μF	4**	10 μF	10	R107
g	100 μF	4	100 μF	1	R106
h	100 μF	4	1 mF	0.1	R105
i	10 mF	4	1 mF	10	R105
j	10 mF	4	10 mF	1	R104
k	100 mF	4	100 mF	1	R103

*three-terminal measurement (two-lead cable)
**four-terminal measurement (three-lead cable).

The main circuit diagram, Figure 6-13, indicates the terminals on S101 that should be used for connection. (The highest capacitance range uses the lowest-valued resistors e.g., R103.) The four highest ranges use a four-terminal connection in the bridge. Each resistor should be within 0.25% of its nominal value. The range switch should be set to a range other than that being measured to avoid error. The side pan of the instrument will have to be removed for access to the higher-value units.

The results of the measurements in Table 6-3 indicate:

1. When only one measurement is in error the corresponding faulty component is listed in Table 6-3.

2. When all measurements at either 1 or 10 on the C dial are in error, the C rheostat is in error at 1 or 10.

3. When all measurements are in error by the same percentage (value), the standard capacitor (C101) is faulty.

4. When measurements are in error by the same arc of displacement, whether at 0.1 or 10 on the C dial (measurement f and h), the dial has slipped and is easily realigned.

5. When all measurements and all fixed components of the bridge are within tolerance, if the C rheostat is correct on the 1 and 10 setting, it may still be incorrect between 1 and 10 (refer to paragraph 6.5.2).

6.5 CALIBRATION PROCEDURE.

The few internal adjustments are factory set and normally do not require readjustment. Procedures for recalibration are included here but should be used only when the operator is reasonably certain that it is necessary.

6.5.1 GENERAL.

An impedance bridge with an accuracy of 0.25% or better is necessary; the Types 1608 and 1656 Impedance Bridges can be used.

If the trouble is narrowed to the ratio arm resistors (R_A) or the standard capacitor, ascertain that they are within tolerances (±0.25% for R_A, ±0.25% for C_S); change any defective unit.

The C rheostat can be recalibrated (paragraph 6.5.3); the D rheostat is fixed and only slipping of the dial can be corrected (paragraph 6.5.3); finally the orthonull operation can be checked (paragraph 6.5.4).

6.5.2 C CALIBRATION.

If it has been found that the C rheostat is faulty, it can be readjusted by means of its justifying mechanism. Two methods can be used to do so.

Direct Resistance Measurement. The C rheostat mechanical justifying mechanism consists of eight cam screws located on the rear of the C rheostat (see Figure 6-2), numbered from 1 to 8 in a clockwise direction from the slit on the cam plate. They can be adjusted by setting them for the proper resistances as indicated in Table 6-4. To reach the rheostat, remove two screws on each side of the inner plates, unsolder the connecting wire, and swing down the battery of capacitors.

NOTE

If these cam screws seem to be completely out of adjustment, preset cam screw 1 four turns from fully clockwise and preset the remaining screws two turns from fully clockwise, before attempting the adjustment procedure.

Table 6-4

C Dial Calibration Adjustments (Figure 6-2)

Dial Reading	Resistance* Ohms	Tolerance	Adjust Cam Screw
0.1	200	190 to 210 ±1/4 division	1
0.6	1,200	1190 to 1210 ±1/4 division	2
1.3	2,600	2574 to 2626 (±1/2%)	3
2.2	4,400	4356 to 4444 (±1/2%)	4
3.6	7,200	7128 to 7272 (±1/2%)	5
5.5	11,000	10,890 to 11,110 (±1/2%)	6
8.0	16,000	15,840 to 16,160 (±1/2%)	7
11.0	22,000	21,780 to 22,220 (±1/2%)	8

If, after adjustment, the cam plate is too high or too low, reposition the C dial on its shaft and repeat the cam-screw adjustment procedure.

Adjustment From A Measurement. A somewhat easier method (because it does not require a resistance bridge) consists in connecting a variable capacitor (like the GR 1423 or 1413 Precision Capacitors) to the bridge, and making the balance setting of the C dial and the known value of C, agree by adjustment of the proper cam screw.

Proceed as follows:

a. Connect the variable standard of value S to the bridge UNKNOWN TERMINALS.

b. Set the MULTIPLIER on (M) and the C Dial on (C), so as to have S =(M) x (C)

c. Balance the bridge with the D dial and the cam screw (s) closest to the rheostat arm.

d. Change S and C and repeat the procedure until all cam screws are adjusted.

NOTE

It is advantageous to choose the settings of the C dial given in Table 6-4, because the cam screw to be adjusted is then directly under the rheostat arm.

6.5.3 D DIAL CHECK.

To check the calibration of the D dial proceed as follows:

a. Set the MULTIPLIER switch to 100 nF.

b. Set the C dial on 5.

c. Connect to the bridge a 1.0 μF Standard Capacitor*, such as GR 1409 in series with a decade resistance box, such as a GR 1433 (Figure 6-3).

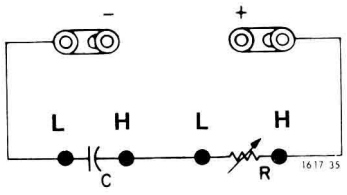


Figure 6-3. Connections for R and C in the D-dial check.

d. Set the resistance according to Table 6-5 and observe that the bridge balances for the corresponding D setting.

If the first and last measurements are in error by the same arc or displacement of the dial, then the dial has slipped. If the errors are random, the rheostat is faulty (it cannot be adjusted and has to be changed).

Table 6-5

Resistance Settings for D Check When C=1μF

D* Setting	Resistance Setting 100 Hz	120 Hz
0.1	159 Ω	133 Ω
1	1.592 kΩ	1.326 kΩ
3	4.775 kΩ	3.979 kΩ
5	7.958 kΩ	6.631 kΩ
10	15.92 kΩ	13.26 kΩ

*Specified accuracy ± .001 ± 2%

6.5.4 ORTHONULL OPERATION.

With the lever in the NORMAL position, the C and D dials must operate independently of each other.

With the lever in the ORTHONULL position, the C dial must move the D dial but the D dial must not move the C dial; if performance is different and ——

1. D dial moves C dial:

ORTHONULL lever-spring tension is excessive. Turn the nut on the spade-lug counterclockwise to reduce tension.

2. C dial doesn't move D dial:

a. ORTHONULL lever-spring tension is insufficient. Turn the nut on the spade-lug clockwise to increase tension.

b. Lever spring is broken or otherwise defective.

c. Drive cable between C dial and D dial is broken or off the pulley.

*Actually any combination of C and R can be used. D = ωRC has to check with the D setting (within specifications).

Replace the ORTHONULL drive cable as follows (see Figure 6-4):

a. Insert the cable ends through slots 1 and 2 of the D pulley and attach the eyelets to the springs.

NOTE

The cable is attached only to the D pulley at this time.

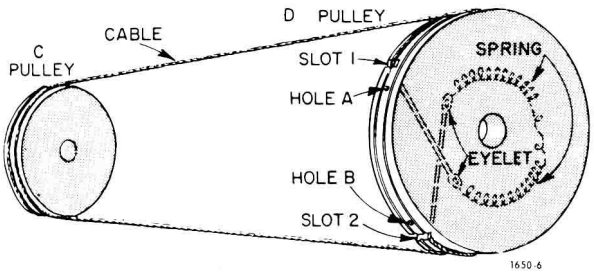


Figure 6-4. Replacement of the Orthonull drive cable.

b. Pull the cable until the eyelets are visible through holes A and B. Insert a pin or small nail through the holes into the respective cable eyelet and release the cable. The pins hold the springs expanded to allow the cable to be threaded around the C pulley.

c. Set the C dial to 1.8. Thread the cable from slot 1, around the D pully in the groove nearest the panel and then around the C dial in the second groove from the panel.

d. Continue the cable around the C pulley until it emerges from the third groove from the panel and return it to the D dial.

e. The cable is now completely threaded and the pins can be removed from holes A and B.

6.6 FLIP-TILT CABINET.

Figure 6-5 shows the operation of the flip-tilt cabinet and Figure 6-6 shows details of the pivoting part of the flip-tilt.

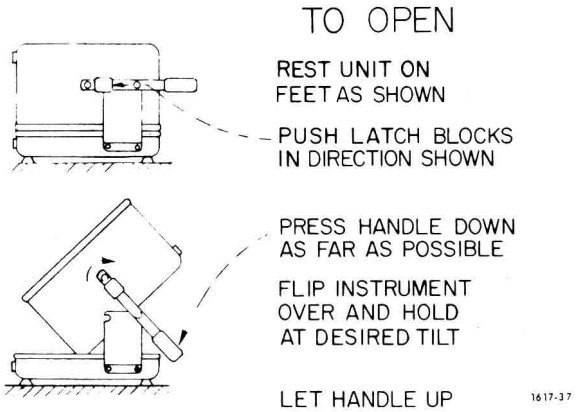


Figure 6-5. Operation of the flip-tilt cabinet.

6.7 REPAIR AND REPLACEMENT.

Defective parts indicated by the trouble-analysis procedures should be repaired or replaced. As an aid in the location of detail parts on the bridge, the etched-circuit boards used are shown in Figures 6-7, 6-8 and 6-10. Figures 6-9, 6-11 and 6-13 contain the complete wiring schematic drawings for the instrument. Figure 6-12 is a switch wiring diagram for front-panel controls.

Reference designators used in all the figures are the same as those used in the parts list that follows.

6.8 MINIMUM PERFORMANCE STANDARDS

The following procedures for checking capacitance and dissipation-factor measurement accuracy of the GR 1617 are recommended for acceptance and periodic tests. There are four basic tests:

1. Capacitance Dial Calibration (see 6.8.2).
2. Capacitance-Range Accuracy (see 6.8.3).
3. Dissipation-Factor Dial Calibration (see 6.8.4).
4. Dissipation-Factor Accuracy On All Ranges (see 6.8.5).

6.8.1 EQUIPMENT REQUIRED

To make the recommended tests the following equipment is necessary:

1. A capacitance decade with range of 1 μF in steps of .01 μF and accuracy of 0.1% or better.

2. A resistance decade with a range of 100 kΩ, steps of 1 Ω, and accuracy of 0.1% or better.

3. Capacitance standards or decades with values from 100 pF to 1 F with accuracy of 1/4% or better.

Table 6-7 lists recommended equipment which is fully specified in the appendix.

6.8.2 CAPACITANCE-DIAL CALIBRATION

Set the 1617 MULTIPLIER switch to the x100 nF range and connect the decade capacitor. If the GR 1413 is used, the shield of the high terminal should be connected to the 1617 GUARD terminal. A GR 1423 can be used

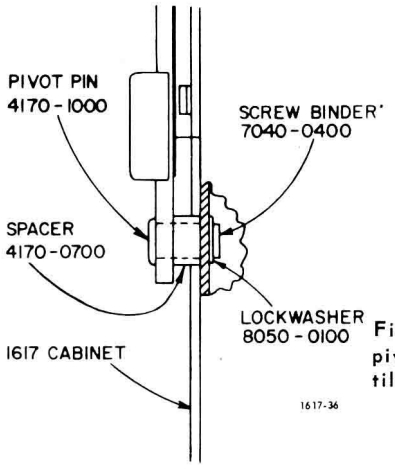


Figure 6-6. Details of the pivot assembly of the flip-tilt cabinet.

Table 6-6

DC Voltages

Test Conditions:

GEN LEVEL MAX VOLTS = 0.5
INT. 120 C GEN NORM
BIAS VOLTAGE RANGE = 2 V
LEAKAGE CURRENT RANGE = 60 μA
BIAS CHARGE switch on
BIAS ADJ control fully CW
DETECTOR SENS control fully CCW
MULTIPLIER = 1 μF
C DIAL = 0
D DIAL = 0
J101 tied to J102, J103 tied to J104

All voltages to chassis ground unless otherwise stated.

High Voltage Supply (Figures 6-7 and 6-9)

V201
Pin #1 -5.80 V
Pin #2 2.35 V
Pin #6 92.0 V
AT205 2V
AT205 to AT206 2V on all ranges

	Emitter	*Collector*
Q201	-11.0 V	-5.80 V
Q202	0.645 V	-11.0 V
Q203	0.645 V	-10.5 V

AT207	0.007 V	AT211	-18.2
AT208	0.007 V	AT301	142 V
AT209	-15.5	AT303	142 V
AT210	-15.5	AT304	300 V

Generator (Figures 6-7 and 6-9)

	Emitter	*Collector*
Q204	1.20 V	8.35 V
Q205	8.50 V	0.910 V
Q212	8.70 V	0.910 V

AT201	4.5 V	AT203	0.62 V
AT202	4.5 V	AT204	-0.003

Guard Amplifier (Figures 6-8 and 6-9)

	Emitter	*Collector*
Q301	8.75 V	12.7 V
Q302	12.7 V	17.8 V
Q303	18.2 V	8.95 V

Positive side of C307 18.2
AT310 2 V
AT305 0 V

Trigger (Figures 6-8 and 6-9)

	Emitter	*Collector*
Q304	0 V	0.025 V
Q305	0.480 V	0 V
Q306	0.830 V	0 V

AT306 -1.9 V
AT307 -0.25 V
AT308 -0.007 V

Detector (Figures 6-10 and 6-11)

All transistor voltages are to detector low (AT402)

	Emitter	*Collector*
Q401	0.250 V	3.60 V
Q402	3.00 V	7.80 V
Q403	7.60 V	13.3 V
Q404	5.85 V	13.2 V
Q405	13.3 V	10.0 V
Q406	10.1 V	6.40 V
Q407	5.70 V	12.6 V
Q408	12.7 V	6.10 V
Q409	19.0 V	15.7 V
Q410	9.35 V	18.8 V

AT401 through AT405	1.9 V
AT407	1.9 V
AT408	2 V
AT409	1.9 V
AT410	1.4 V
AT411, 412	-0.28 V
positive side of C407	15.9 V

two-terminal (LOW terminal tied to case). Measure various values between .01 and 1 μF and all should be within ± 1% or ± 1000 pF.

If any measurements are out of tolerance, refer to para 6.5.1 and 6.5.2.

6.8.3 CAPACITANCE-RANGE ACCURACY

To check all ranges of the 1617, capacitance standards from 1000 pF to 100 mF are required. Suggested standards are given in Table 6-7.

A decade box is suggested for values up to 1 μF. If a GR 1413 is used, the shield of the HIGH terminal should be connected to the 1617 GUARD terminal. A GR 1423 can be used with a two-terminal connection (LOW tied to case). The shielded lead set (P/N 1617-2200) should be used for low values.

To check the lowest range of the 1617, first measure the "zero" capacitance of the bridge, standard, and lead arrangement. For the GR 1413 this can be done by setting the 1413 to zero value and making a measurement obtain-

Table 6-7

Equipment for Minimum Performance Test

Equipment	Recommended
Decade Capacitor	GR 1423 or GR 1413
Decade Resistor	GR 1433-M (or X, B, F, G or H) GR 1434-M (or B, X or G)
Standard 100 pF to 1 μF	GR 1423 or GR 1413 Capacitance Decade
Standard 1 μF to 1 F	GR 1417 or GR 1426

See Appendix for full specifications

ing C_0. For the GR 1423, disconnect the high lead, support it at least an inch away from the 1423 panel, and make a measurement of C_0. Then set the decade box to a value of 1000 pF and make a second measurement, C_1. The value of C_1-C_0 should be within 1000 pF ± 1%.

The same zero connection should be used if the next range is checked at 1/10 Ω full scale (1000 pF) but has almost negligible effect at full scale (10 μF).

The higher ranges of the 1617 require high-valued standards such as the GR 1426 or GR 1417. The four-terminal lead set (P/N 1617-2210) should be used (and the shorting links on the 1617 terminals disconnected). For very high values, it is preferable to tightly twist together the two inner leads to reduce mutual inductance (see para 3.1.5).

The connections to the 1426 are between corresponding terminals. The connection to the 1417 depends on the 1617 range as shown in Table 6-9. The two connections, A and B, are given in Table 6-8.

Table 6-8

Test Connections

	1417 Connections	
1617 Terminal	"A"	"B"
− UNKNOWN (outside)	+ POTENTIAL	− CURRENT
− UNKNOWN (inside)	+ CURRENT	− POTENTIAL
+ UNKNOWN (inside)	− CURRENT	+ POTENTIAL
+ UNKNOWN (outside)	− POTENTIAL	+ CURRENT

The accuracy of both the 1426 or the 1417 can be checked by determining the value at the 1 μF setting. This can be done, using the 1617, by first measuring the 1426 or 1417 and then, leaving the 1617 C dial untouched, rebalance the 1617 with a precision decade capacitor connected, using only the decade's adjustment and the 1617 D dial. The indicated value of the decade capacitor should be 1 μF, within 1/4%.

The accuracy of the 1617 calibration can be improved by using the value of the 1426 or 1417 at 1 μF, as determined above, as the nominal value at higher settings (when multiplied by the appropriate factor of 10).

6.8.4 DISSIPATION-FACTOR DIAL.

The D dial of the 1617 can be checked by connecting a series combination of a decade resistor and a 1 μF capacitor to the 1617 and making bridge balances at various

Table 6-9

CALIBRATION WITH 1417

1417 Setting	1617 Multiplier	Connection	Gen Level(V)	Nom C Read.	C Tol.	D Nominal	D Tol.
1 μF	100 nF	A or B	2.0	10	± 1%	.01	±.001
1 μF	1 μF	A or B	2.0	1	± 1%	.01	±.001
10 μF	1 μF	A	2.0	10	± 1%	.008	±.001
10 μF	10 μF	A	0.5	1	± 1%	.008	±.001
100 μF	10 μF	A	0.5	10	± 1%	.009	±.001
100 μF	100 μF	A	0.2	1	± 1%	.009	±.001
1 mF	100 μF	B	0.2	10	± 1%	.01	±.001
1 mF	.1 mF	B	0.2	1	± 1%	—	
10 mF	1 mF	B	0.2	10	± 1%	.01	±.0011
10 mF	10 mF	B	0.2	1	± 1%	—	
100 mF	10 mF	B	0.2	10	± 1%	.01	±.002
100 mF	100 mF	B	0.2	1	± 2%	—	
1 F	100 mF	B	0.5	10	± 2%	.01	±.011

NOTES (1) Use 1417 frequency setting corresponding to test frequency.
(2) Make two measurements with 1617 input reversed and take average.
(3) Twist leads at high C values (See para 3.1.5.)

resistance settings. The D dial should read 2 πfRC, to within the D-accuracy specification where R is the resistance of the decade resistor, C is 1 μF, and f is the test frequency in Hz. Suggested resistance settings and the resulting D readings are given in Table 6-5.

6.8.5 DISSIPATION-FACTOR ACCURACY.

The dissipation factor can be checked on various ranges by using series R-C combinations as described above. Only one check for each range is required to ensure that the bridge range resistor (ratio-arm) is not introducing phase shift and hence D error. This check should be made at a low D value for greatest resolution.

Some care must be used when checking the lowest capacitance range, for stray capacitance can cause an appreciable D error. It is preferable to the fixed resistors of known value.

The D accuracy of the higher capacitance ranges can be checked with the GR 1417 four-terminal capacitance standard. The D value that should be read on the 1617 at balance (within the 1617 tolerance) is given in Table 6-9 as the nominal D value. At higher capacitance values, this check should be made only when the capacitance dial is balanced near full scale, because the lead resistance of the 1417 causes excessive D errors at lower settings. Use precautions noted at the bottom of Table 6-9.

6.9 KNOB REMOVAL.

If it should be necessary to remove the knob on a front-panel control, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knob firmly with the fingers and pull the knob straight away from the panel.

CAUTION

Do not pull on the dial to remove a dial/knob assembly. Always remove the knob first.

b. Observe the position of the set screw in the bushing, with respect to any panel marking (or at the full ccw position of a continuous control).

c. Release the set screw and pull the bushing off the shaft.

d. Remove and retain the black Nylon thrust washer, behind the dial/knob assembly, as appropriate.

NOTE

To separate the bushing from the knob, if for any reason they should be combined off the instrument, drive a machine tap a turn or two into the bushing for a sufficient grip for easy separation.

6.10 KNOB INSTALLATION.

To install a knob assembly on the control shaft:

a. Place the black Nylon thrust washer over the control shaft, if appropriate.

b. Mount the bushing on the shaft, using a small slotted piece of wrapping paper as a shim for adequate panel clearance.

c. Orient the set screw on the bushing with respect to the panel-marking index and lock the set screw.

NOTE

Make sure that the end of the shaft does not protrude through the bushing or the knob won't set properly.

d. Place the knob on the bushing with the retention spring opposite the set screw.

e. Push the knob in until it bottoms and pull it slightly to check that the retention spring is seated in in the groove in the bushing.

NOTE

If the retention spring in the knob comes loose, reinstall it in the interior notch with the small slit in the outer wall.

6.11 METER WINDOW CARE

The clear acrylic meter window can become susceptible to electrostatic-charge buildup and can be scratched, if improperly cleaned.

It is treated inside and out in manufacturing with a special non-abrasive anti-static solution, Statnul , which normally should preclude any interference in meter operation caused by electrostatic effects. The problem is evidenced by the inability of the meter movement to return promptly to a zero reading, once it is deenergized. As supplied by General Radio, the meter should return to zero reading within 30 seconds, immediately following the placement of a static charge, as by rubbing the outside surface. This meets the requirements of ANSI standard C39.1-1972.

If static-charge problems occur, possibly as the result of frequent cleaning, the window should be carefully polished with a soft dry cloth, such as cheesecloth or nylon chiffon. Then, a coating of Statnul should be applied with the polishing cloth.

CAUTION

Do not use any kind of solvent. Kleenex or paper towels can scratch the window surface.

If it should be necessary to place limit marks on the meter window, paper-based masking tape is recommended, rather than any kind of marking pen, which could be abrasive or react chemically with the acrylic.

HIGH VOLTAGE SUPPLY & GENERATOR PRINTED CIRCUIT BOARD (60 HZ) P/N 1617-2720

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 201	CAP ALUM 16 UF 150V	4450-0200	56289	30D166G150DF4
C 202	CAP CER SQ .10UF 80/20PCT 100V	4403-4100	72982	8131M100651104Z
C 203	CAP CER DISC 1000PF 80/20PCT 500	4404-2105	72982	0831082Z5U00102Z
C 204	CAP MYLAR .1UF 2 PCT 100V	4860-8251	56289	410P 0.1 UF 2PCT
C 205	CAP MYLAR .1UF 2 PCT 100V	4860-8251	56289	410P 0.1 UF 2PCT
C 206	CAP ALUM 40 UF 6V	4450-3600	56289	30D406G006
C 207	CAP ALUM 100 UF 25V	4450-2300	56289	30D107G025
C 208	CAP ALUM 100 UF 25V	4450-2300	56289	30D107G025
CR 201	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 202	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 203	ZENER 1N976B 43V 5PCT .4W	6083-1020	07910	1N976B
CR 204	ZENER 1N967B 18V 5PCT .4W	6083-1016	14433	1N967B
CR 205	ZENER 1N957B 6.8V 5PCT .4W	6083-1009	07910	1N957B
CR 206	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 207	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 208	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 209	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 210	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 211	ZENER 1N976B 43V 5PCT .4W	6083-1020	07910	1N976B
Q 201	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q 202	TRANSISTOR 2N3702	8210-1106	01295	2N3702
Q 203	TRANSISTOR 2N3702	8210-1106	01295	2N3702
Q 204	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 205	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 212	TRANSISTOR 2N1544	8210-1014	04713	2N1544
R 201	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 202	RES COMP 470 K 5PCT 1/2W	6100-4475	81349	RCR20G474J
R 203	RES COMP 150 OHM 5PCT 1/2W	6100-1155	81349	RCR20G151J
R 204	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 205	POT COMP KNOB 5K OHM 10PCT SW U	6045-2510	24655	6045-2510
R 206	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 207	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 208	POT WW TRM 5K OHM 10 PCT 20T	6051-2509	80294	3005P-1-502
R 209	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 210	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 211	RES COMP 120 K 5PCT 1/2W	6100-4125	81349	RCR20G124J
R 212	RES COMP 20 K OHM 5PCT 1/2W D	6100-3205	81349	RCR20G203J
R 213	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 214	RES FLM 2K 1 PCT 1/8W	6250-1200	81349	RN55D2001F
R 216	RES FLM 13.0K 1 PCT 1/8W	6250-2130	81349	RN55D1302F
R 217	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 218	RES FLM 15.8K 1 PCT 1/8W	6250-2158	81349	RN55D1582F
R 219	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 220	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 221	RES COMP 2.0 K OHM 5PCT 1/2W D	6100-2205	81349	RCR20G202J
R 222	POT WW TRM 1K OHM 10 PCT 20T	6051-2109	80294	3005P-1-102
R 223	RES COMP 3.0 K OHM 5PCT 1/2W D	6100-2305	81349	RCR20G302J
R 224	RES COMP 470 OHM 5PCT 1/2W	6100-1475	81349	RCR20G471J
R 225	RES WW MOLDED .47 OHM 10 PCT 2W	6760-8479	75042	BWH 0.47 OHM 10PCT
V 201	TUBE VACUUM 7239	8380-7239	02639	7239

HIGH VOLTAGE SUPPLY & GENERATOR PRINTED CIRCUIT BOARD (50 HZ) P/N 1617-2780

COMPONENTS ARE IDENTICAL TO THE 1617-2720 COMPONENTS EXCEPT FOR THE FOLLOWING

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 204	CAP MYLAR .121UF 2 PCT 100V	4860-7908	56289	410P 0.121 UF 2PCT
C 205	CAP MYLAR .121UF 2 PCT 100V	4860-7908	56289	410P 0.121 UF 2PCT

ELECTRICAL PARTS LIST

GUARD AMPLIFIER & TRIGGER PRINTED CIRCUIT BOARD P/N 1617-2730

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 301	CAP ALUM 10UF 475V	4450-6175	56289	30D405G475
C 302	CAP ALUM 10UF 475V	4450-6175	56289	30D405G475
C 303	CAP MYLAR 0.22UF 10 PCT 400V	4860-9501	24655	4860-9501
C 304	CAP ALUM 40 UF 6V	4450-3600	56289	30D406G006
C 305	CAP ALUM 15 UF 15V	4450-3700	56289	30D156G015
C 306	CAP CER DISC.0047UF80/20PCT500V	4405-2479	72982	0801082Z5U00472Z
C 307	CAP ALUM 40 UF 6V	4450-3600	56289	30D406G006
C 308	CAP ALUM 60 UF 25V	4450-2900	56289	30D606G025
C 309	CAP ALUM 60 UF 25V	4450-2900	56289	30D606G025
C 310	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 312	CAP CER DISC.047UF80/20PCT 500V	4409-3479	72982	3851087Z5V00473Z
CR 301	RECT 1N4006 800PIV .5A SI A50A	6081-1004	14433	1N4006
CR 302	RECT 1N4006 800PIV .5A SI A50A	6081-1004	14433	1N4006
CR 303	RECT 1N4006 800PIV .5A SI A50A	6081-1004	14433	1N4006
CR 304	RECT 1N4006 800PIV .5A SI A50A	6081-1004	14433	1N4006
CR 305	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 306	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 307	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 308	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 309	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
Q 301	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q 302	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q 303	TRANSISTOR 2N3702	8210-1106	01295	2N3702
Q 304	TRANSISTOR 2N910	8210-1037	04713	2N910
Q 305	TRANSISTOR 2N3702	8210-1106	01295	2N3702
Q 306	TRANSISTOR 2N3702	8210-1106	01295	2N3702
R 301	RES COMP 220 K 5PCT 1/2W	6100-4225	81349	RCR20G224J
R 302	RES COMP 150 K 5PCT 1/2W	6100-4155	81349	RCR20G154J
R 303	RES COMP 47 K 5PCT 1/2W	6100-3475	81349	RCR20G473J
R 304	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 305	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 306	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 307	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 308	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 309	RES COMP 1.0 M 5PCT 1/2W	6100-5105	81349	RCR20G105J
R 310	RES COMP 330 K 5PCT 1/2W	6100-4335	81349	RCR20G334J
R 311	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 312	RES WW MOLDED 1 OHM 10 PCT 2W	6760-9109	75042	BWH 1 OHM 10PCT
R 313	RES WW AX LEAD 100 OHM 5 PCT 5W	6660-1105	75042	AS-5 100 OHM 5PCT
R 314	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 315	RES COMP 1.0 M 10PCT 1W	6110-5109	81349	RCR32G105K
R 316	RES COMP 1.0 M 10PCT 1W	6110-5109	81349	RCR32G105K
R 317	RES COMP 100 OHM 5PCT 1/2W	6100-1105	81349	RCR20G101J
R 318	RES COMP 2.0 K OHM 5PCT 1/2W	6100-2205	81349	RCR20G202J

REFERENCE DESIGNATOR ABBREVIATONS

B	= Motor	P	= Plug
BT	= Battery	Q	= Transistor
C	= Capacitor	R	= Resistor
CR	= Diode	S	= Switch
DS	= Lamp	T	= Transformer
F	= Fuse	U	= Integrated Circuit
J	= Jack	VR	= Diode, Zener
K	= Relay	X	= Socket for Plug-In
KL	= Relay Coil	Y	= Crystal
KS	= Relay Switch	Z	= Network
L	= Inductor		
M	= Meter	References	
MK	= Microphone	ASA Y32.16 and MIL-STD-16C	

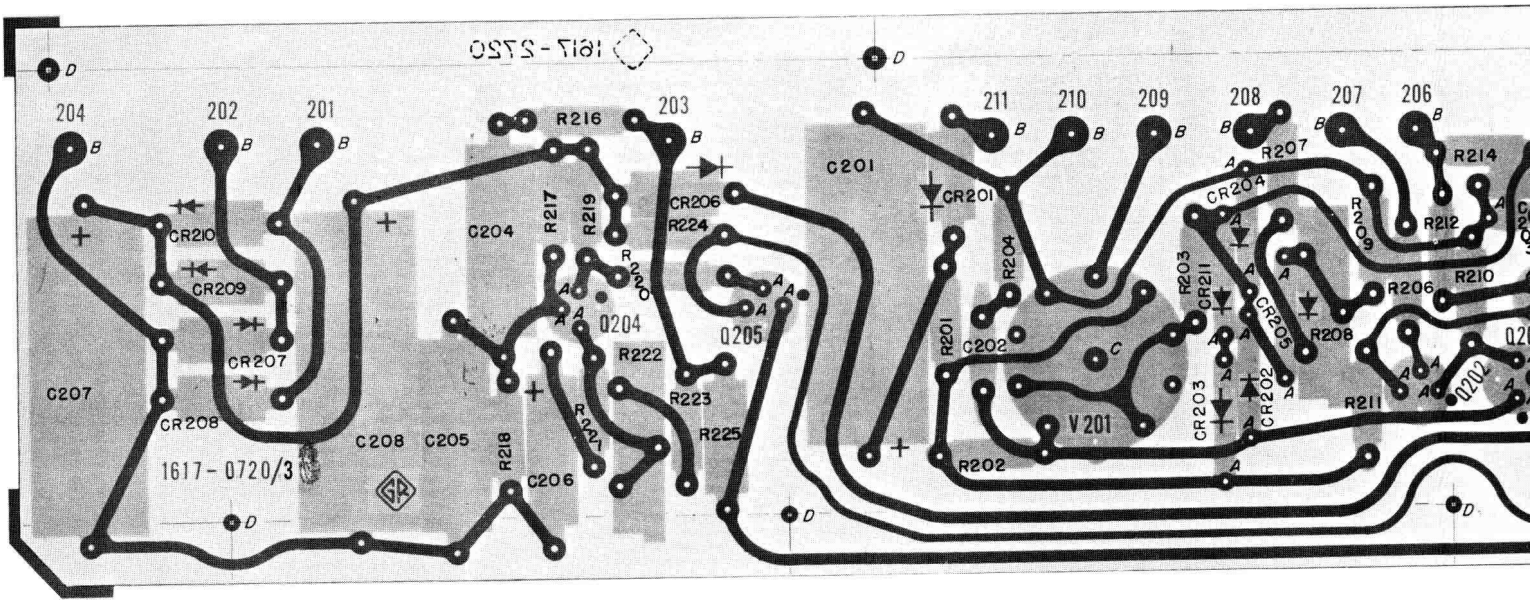


Figure 6-7. The high-voltage supply and the generator etched board (P/N 1617-2780) for 50-Hz units, or (P/N 1617-2720) for 60-Hz units.

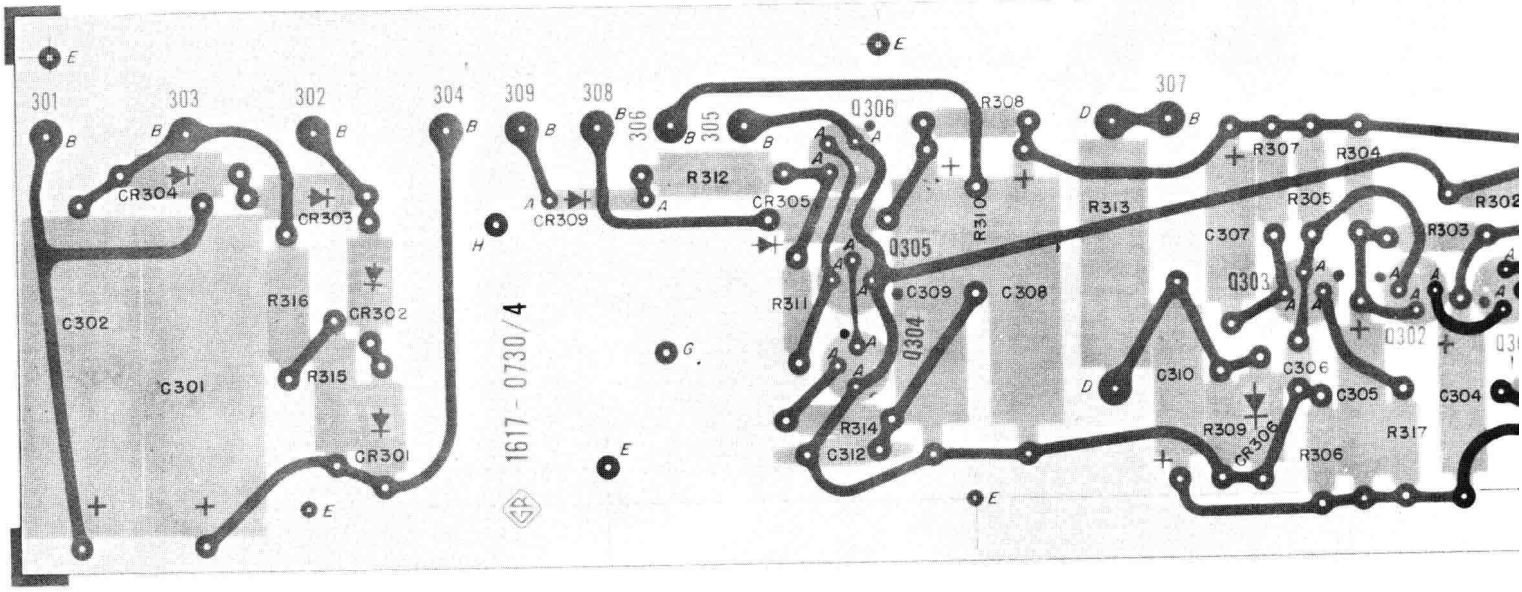
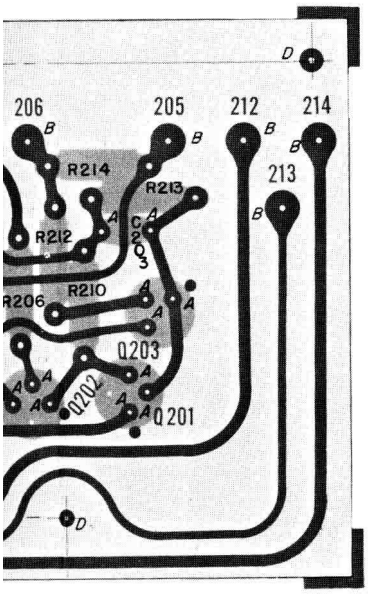
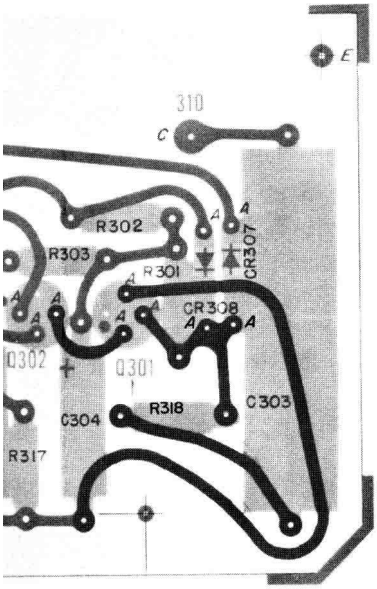


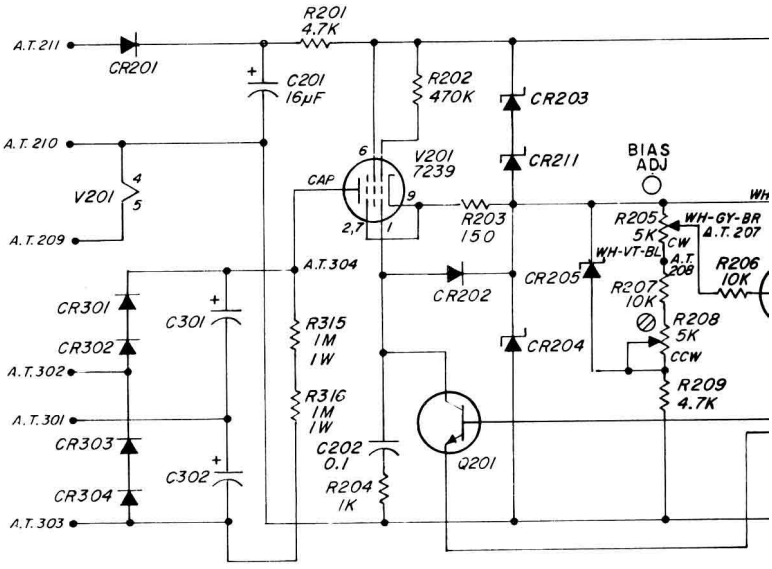
Figure 6-8. The guard amplifier and trigger etched board (P/N 1617-2730).

NOTE: The number on the foil side is not the part number for the complete assembly. The dot on the foil at the transistor socket indicates the collector lead.

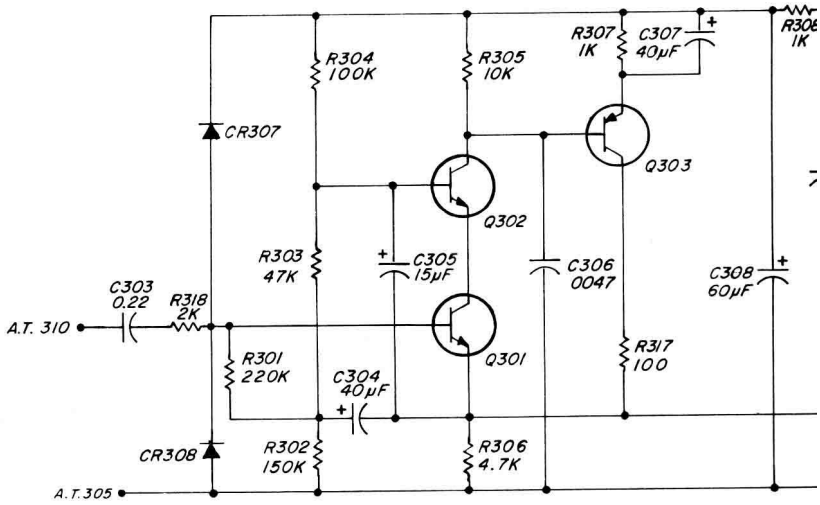


for 60-Hz units.

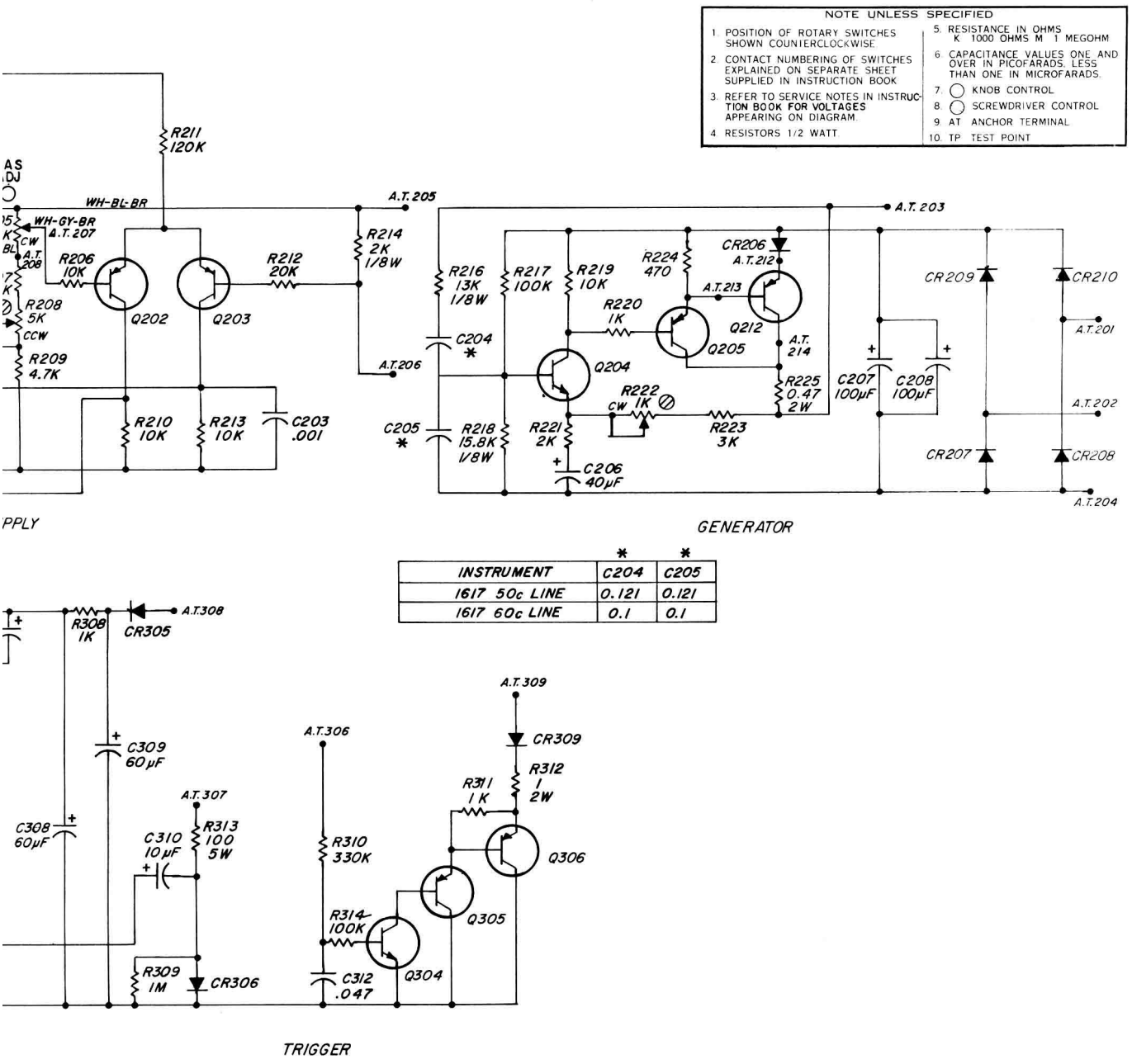




HIGH VOLTAGE SUPPLY



GUARD AMP



INSTRUMENT	C204 *	C205 *
1617 50c LINE	0.121	0.121
1617 60c LINE	0.1	0.1

Figure 6-9. Schematic diagram of the high-voltage supply, guard, trigger and generator circuits.

ELECTRICAL PARTS LIST

DETECTOR PRINTED CIRCUIT BOARD (60 HZ) P/N 1617-2700

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 401	CAP CER DISC.01UF 80/20PCT 500V	4406-3109	72982	0811082Z5U00103Z
C 402	CAP CER SQ .10UF 80/20PCT 100V	4403-4100	72982	8131M100651104Z
C 403	CAP CER DISC 470PF 10PCT 500V	4404-1475	72982	0831082Z5D00471K
C 404	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 405	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 406	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 407	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 408	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 409	CAP CER DISK 0.22UF 80/20PCT 12V	4432-4229	72982	5615-000-Y5F-224Z
C 410	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 411	CAP MYLAR .02UF 1 PCT 100V	4860-7853	56289	410P .02 UF 1PCT
C 412	CAP MYLAR .02UF 1 PCT 100V	4860-7853	56289	410P .02 UF 1PCT
C 413	CAP MYLAR .04UF 1 PCT 100V	4860-7836	56289	410P .04 UF 1PCT
C 414	CAP CER DISC .01UF 80/20PCT 100V	4401-3100	72982	0805540Z5U00103Z
C 415	CAP CER DISC 470PF 10PCT 500V	4404-1475	72982	0831082Z5D00471K
C 416	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 417	CAP CER SQ .10UF 80/20PCT 100V	4403-4100	72982	8131M100651104Z
C 418	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 419	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 420	CAP ALUM 10 UF 25V	4450-3800	56289	30D106G025
C 421	CAP ALUM 5 UF 50V	4450-3900	56289	30D505G050
C 422	CAP CER SQ .10UF 80/20PCT 100V	4403-4100	72982	8131M100651104Z
C 423	CAP ALUM 60 UF 25V	4450-2900	56289	30D606G025
CR 401	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 402	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 403	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 404	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 405	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 406	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 407	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 408	DIODE RECTIFIER 1N645	6082-1016	14433	1N645
CR 409	DIODE 1N191 90PIV IR 125UA GE	6082-1008	14433	1N191
CR 410	DIODE RECTIFIER 1N4003	6081-1001	14433	1N4003
CR 411	ZENER 1N957B 6.8V 5PCT .4W	6083-1009	07910	IN957B
Q 401	TRANSISTOR 2N930	8210-1002	01295	2N930
Q 402	TRANSISTOR 2N3414	8210-1290	56289	2N3414
Q 403	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 404	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 405	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 406	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 407	TRANSISTOR 2N1304	8210-1304	01295	2N1304
Q 408	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 409	TRANSISTOR 2N1305	8210-1305	01295	2N1305
Q 410	TRANSISTOR 2N1304	8210-1304	01295	2N1304
R 403	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 404	RES COMP 1.0 M 5PCT 1/2W	6100-5105	81349	RCR20G105J
R 405	RES COMP 22 M 5PCT 1/2W	6100-6225	81349	RCR20G226J
R 406	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 407	RES COMP 62 K OHM 5PCT 1/2W	6100-3625	81349	RCR20G623J

DETECTOR PRINTED CIRCUIT BOARD (60 HZ) P/N 1617-2700

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
R 408	RES COMP 30 K OHM 5PCT 1/2W	6100-3305	81349	RCR20G303J
R 409	RES COMP 3.0 K OHM 5PCT 1/2W	6100-2305	81349	RCR20G302J
R 410	RES COMP 470 OHM 5PCT 1/2W	6100-1475	81349	RCR20G471J
R 411	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 412	RES COMP 470 OHM 5PCT 1/2W	6100-1475	81349	RCR20G471J
R 413	RES COMP 2.0 K OHM 5PCT 1/2W	6100-2205	81349	RCR20G202J
R 414	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 415	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 416	RES COMP 4.3 K OHM 5PCT 1/2W	6100-2435	81349	RCR20G432J
R 417	RES COMP 16 K OHM 5PCT 1/2W	6100-3165	81349	RCR20G163J
R 418	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 419	RES COMP 22 K 5PCT 1/2W	6100-3225	81349	RCR20G223J
R 420	RES COMP 5.1 K OHM 5PCT 1/2W	6100-2515	81349	RCR20G512J
R 421	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 422	RES FLM 66.5K 1 PCT 1/8W	6250-2665	81349	RN55D6652F
R 423	RES FLM 66.5K 1 PCT 1/8W	6250-2665	81349	RN55D6652F
R 424	RES FLM 33.2K 1 PCT 1/8W	6250-2332	81349	RN55D3322F
R 425	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 426	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 427	RES COMP 160 K OHM 5PCT 1/2W	6100-4165	81349	RCR20G164J
R 428	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 429	RES COMP 15 K 5PCT 1/2W	6100-3155	81349	RCR20G153J
R 430	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 431	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 432	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 433	RES COMP 100 K 5PCT 1/2W	6100-4105	81349	RCR20G104J
R 434	RES COMP 3.9 K 5PCT 1/2W	6100-2395	81349	RCR20G392J
R 435	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 436	RES COMP 6.8 K 5PCT 1/2W	6100-2685	81349	RCR20G682J
R 437	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 438	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 439	RES COMP 4.7 K 5PCT 1/2W	6100-2475	81349	RCR20G472J
R 440	RES COMP 1.0 K 5PCT 1/2W	6100-2105	81349	RCR20G102J
R 441	RES COMP 47 K 5PCT 1/2W	6100-3475	81349	RCR20G473J
R 442	RES COMP 10 K 5PCT 1/2W	6100-3105	81349	RCR20G103J
R 443	POT COMP KNOB 50K OHM 10PCT LOG	6020-0600	01121	JA1N056S503AZ

DETECTOR PRINTED CIRCUIT BOARD (50 HZ) P/N 1617-2770

COMPONENTS ARE IDENTICAL TO THE 1617-2700 COMPONENTS EXCEPT FOR THE FOLLOWING

REFDES	DESCRIPTION	PART NO.	FMC	MFGR PART NUMBER
C 411	CAP MYLAR .0243UF 1 PCT 100V	4860-7833	56289	410P .0243 UF 1PCT
C 412	CAP MYLAR .0243UF 1 PCT 100V	4860-7833	56289	410P .0243 UF 1PCT
C 413	CAP MYLAR .0475UF 1 PCT 100V	4860-8204	56289	410P .0475 UF 1PCT