

INSTRUCTION MANUAL

MODEL 603

ELECTROMETER AMPLIFIER

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof (except tubes and batteries) which, within a year after shipment, proves defective upon examination. We will pay domestic surface freight costs.

To exercise this warranty, call your local field representative or the factory, DDD 216-795-2666. You will be given assistance and shipping instructions.

REPAIRS AND RECALIBRATION

Keithley Instruments maintains a complete repair service and standards laboratory in Cleveland, and has an authorized field repair facility in Los Angeles.

To insure prompt repair or recalibration service, please contact your local field representative or the plant directly before returning the instrument.

Estimates for repairs, normal recalibrations, and calibrations traceable to the National Bureau of Standards are available upon request.

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SECTION I INTRODUCTION

The model 603 Electrometer Amplifier is a high gain amplifier and voltmeter for the frequency range of dc to 50 kilocycles. Its outstanding characteristics are an input impedance of greater than 10^{14} ohms shunted by 10 micromicrofarads, a grid current of less than 5×10^{-14} amperes, a maximum full scale sensitivity of 2.5 millivolts, differential input, low drift and a remote probe containing the first stage electrometer tubes. The remote probe allows the input grids to be located as far as 24 feet from the main amplifier. By employing this feature the input capacitance may be kept to a minimum so that it is possible to achieve fast voltage and current measurements in high impedance circuits. Current measurements, either differential or single-ended are made by inserting high megohm resistors in the place provided in the remote probe.

The output capability of the Model 603 is 10 volts single ended or 20 volts pushpull at a maximum current of 10 milliamperes. The output is therefore suitable for driving milliamperere recorders as well as pen amplifiers and oscilloscopes.

SECTION II SPECIFICATIONS

AS A VOLTMETER:

RANGE: Differential input from .0025 volt full scale to 1 volt in nine 1x, 2.5x and 5x ranges.

ACCURACY: $\pm 2\%$ of full scale on all ranges exclusive of drift.

ZERO DRIFT: Less than 2 millivolts per hour after 1-hour warm-up.

INPUT IMPEDANCE: Greater than 10^{14} ohms shunted by 10 picofarads each input to ground.

AS AN AMMETER (WITH MODEL 6033 SHUNT RESISTORS):

GRID CURRENT: Less than 5×10^{-14} ampere.

TYPICAL RISE TIMES: 10% to 90% for selected current ranges.

Current Range, amperes	Voltage Range, millivolts	Shunt Resistance, ohms	Rise Time with No External Capacitance, milliseconds	Rise time with 20 pf Across Input, milliseconds
2.5×10^{-12}	2.5	10^9	60	125
2.5×10^{-12}	25.0	10^{10}	500	1000
2.5×10^{-10}	2.5	10^7	0.6	1.0
2.5×10^{-10}	25.0	10^8	6.0	12.0
2.5×10^{-8}	2.5	10^5	0.03	0.04
2.5×10^{-8}	25.0	10^6	0.05	0.1

AS AN AMPLIFIER:

GAIN: With single-ended input and output, 4000, 2000, 1000, 400, 200, 100, 40, 20, and 10 for meter ranges of .0025 to 1 volt full scale.

FREQUENCY RESPONSE (Within 3 db): From 1-kilohm source resistance or less, dc to 10 kc on the .0025-volt range, rising to 50 kc on the 1-volt range.

NOISE: Less than 25 microvolts rms referred to the input on the .0025-volt range, increasing to 2 millivolts rms on the 1-volt range.

COMMON MODE REJECTION: More than 100:1 at dc. Input grids must be within one volt of ground for minimum grid current; can be run at maximum of ± 3 volts.

INPUT IMPEDANCE: Greater than 10^{14} ohms shunted by 10 picofarads each input to ground.

OUTPUT: ± 20 volts differential or ± 10 volts single ended at up to 10 milliamperes for full-scale input.

GENERAL:

INPUT HEAD: Contains input section of amplifier and may be connected directly to front panel or operated remotely through cabling at distances of up to 24 feet from the amplifier.

INPUT SWITCH: Located on remote head and shorts each side of the input through 1 megohm to ground.

ZERO SUPPRESSION: Up to one volt.

POLARITY: Zero-center scale.

CONNECTORS: Input: BNC type; Output; Amphenol 91-PC3F; binding posts on front panel.

POWER: 105-125 or 210-250 volts, 50-60 cps., 120 watts.

DIMENSIONS, WEIGHT: Amplifier: 5-1/4 inches high x 19 inches wide x 10-1/2 inches deep. Input Head: 2-1/4 inches high x 3-1/2 inches wide x 3-1/2 inches deep. Net weight, 21 pounds.

ACCESSORIES SUPPLIED: Mating input and output connectors; binding post adapter; Model 6031 Connecting Cable, 12 feet long.

SECTION III - OPERATION

A. OPERATING CONTROLS

The operating controls for the Model 603 are all located on the front panel. Their location and functions are as follows:

ON - OFF switch is located below and to the left of the panel meter.

COARSE BALANCE is the first of three large knobs starting from the left of the panel. This control is a 19 position switch. Moving the switch by one position changes the meter zero by approximately 100 millivolts.

FINE BALANCE is the knob following the coarse balance control. It is a ten-turn potentiometer and each turn shifts the zero by approximately 10 millivolts.

MILLIVOLTS is the third knob in the row. This control selects the full scale sensitivity or the amplifier gain as stated in the specifications.

OUTPUT LEVEL is a screw driver adjustment located below the meter and to the right of the output. Its function is to adjust the output dc so that the output terminals are at ground potential when the panel meter reads zero.

B. INPUT AND OUTPUT CONNECTIONS

Input connections are made via either BNC input connector in the remote probe. If the cover is removed and the interior exposed as shown in Figure I, it is seen that a place is provided for two input resistors between the input grids and ground. If it is desired to use the instrument only as a single ended device, the other grid is shorted to ground by placing a length of wire between the diode clips furnished to hold the resistor. The remaining grid may be left open or shunted with the appropriate resistor as desired. The cover is then replaced and either a BNC connector is used to mate with the BNC receptacle on the probe or the binding post adapters furnished may be used. If particularly low capacity is desired, it is possible to force a pin into the central portion of the connector, employing the binding post for the ground connection.

The input head is either plugged directly into the panel of the main amplifier or plugged in at the end of a cable not to exceed 24 feet in length. The instrument should be turned on only if the input head is connected to the amplifier.

Output connections are furnished either on the panel with binding posts or at the rear of the instrument with a three pin connector. The two red binding posts are connected to the balanced output cathode followers and output is exactly 180 degrees out of phase between the two signal outputs. AT NO TIME SHOULD EITHER OUTPUT BE GROUNDED TO THE CHASSIS.

C. PRELIMINARY SET-UP

1. Plug in input head either directly at the panel or at the end of the cable.
2. Observe the instructions about input connections in section III-B.
3. Connect the instrument to the power line. Unless otherwise marked the unit may be used on 117 volt 50 to 60 cps power only. To convert to 220 operation refer to the schematic DR 12669-D at the rear of this manual. A three wire cord is furnished which grounds the cabinet. If a three wire receptacle is not available, use the two pin adapter furnished and ground the third lead to an external ground.
4. Set the controls as follows:
 - a. Coarse and Fine Balance: To center of their range.
 - b. Range: 1000 millivolts.
 - c. Input: Short Inputs to ground.
5. Turn on instrument and wait approximately 60 seconds. The instrument should now indicate on scale. Bring the meter to zero by adjusting the Balance Controls as necessary. To increase the sensitivity, turn the Millivolt switch to the desired range and rebalance as necessary. It should be realized that on the more sensitive ranges (about 25 millivolts and below) that the warm-up drift will be apparent. It is therefore recommended that on the most sensitive ranges about one hour warm-up be allowed before use.
6. Driving of Recorders: The model 603 furnishes an output of 10 volts single ended (one output terminal to ground) or 20 volts push-pull (across both output terminals) for full scale meter deflection at a maximum current of 10 milliamperes. This output may be used directly with oscilloscopes and pen amplifiers. Milliampere recorders and galvanometers must be connected to the output in series with the appropriate resistance to limit the output current.

D. Use of the Model 603 as a Differential Amplifier:

The basic circuit of the Model 603 incorporates a differential amplifier with an in-phase rejection of 100:1. Differently stated this means that a signal applied to one input grid with the other grounded will produce an output signal which is 100 times greater than the output signal produced if the input is applied to both grids in parallel. However in the Model 603 there is a basic

restriction that the DC potential between the grids and ground must not exceed one volt plus or minus with respect to ground if the grid current specifications are to be met.

Nevertheless, where the balanced input can be used, it will give considerable improvement in spurious signal rejection if it can be arranged that the desired signal appears across the input grids while any spurious signal is picked up equally and in phase at the two grids. In this way the spurious signal will be discriminated against and the desired signal will be amplified.

If the balanced input is used, it should be remembered that each input grid must have a DC return to ground and it is not sufficient to connect between the two input terminals. Very often the resistance of the surroundings will provide the return path to ground. However if a sufficient return path does not exist it can be provided by shunting resistors to ground in the place provided in the input head. (See section IIIB.) If this precaution is not observed the input will rapidly charge up due to grid current flow and the amplifier will be inoperative until a return path is provided. The value of resistance to ground will best be determined by considering the impedance that, in the first place, is necessary and the permissible voltage that can be allowed to build up at the grids due to grid current.

E. GENERAL PRECAUTIONS:

1. Input wires should be as short as possible and well shielded in order to reduce power line pickup as well as the pick-up of stray electrostatic fields. When the Model 603 is used at its maximum input impedance, electrostatic pick-up must be carefully eliminated. In some cases it may be necessary to shield the entire test object.

2. If the high input resistance of the Model 603 is to be realized in practice, careful attention should be paid to the quality of insulation used in the input circuit. Ordinary rubber and plastic insulation should be avoided in favor of teflon or polystyrene. Insulation for switches, standoffs and bushings in contact with the signal lead should be made of polystyrene, polyethylene, ceramic, teflon or other high quality insulation material. If cables are necessary, most types of polyethylene or teflon insulated cable will be satisfactory. However if critical work at low levels is contemplated, a very substantial reduction in cable noise will be obtained with a coaxial cable using a graphite-coated dielectric. One satisfactory type is Amphenol 21-537.

3. Avoid leaving the input grids floating and unshielded. Large signals can be induced at the input of the amplifier. Although no permanent damage will occur, some temporary loss of DC stability may be experienced.

4. If the power line is especially unstable some improvement in stability can be obtained with a line regulating transformer.

5. Some attention should be given to providing adequate ventilation for the amplifier since the power dissipation is about 120 watts. If it is used with end-frames in the open air no precautions are necessary. However, if the instrument is used with rack mounting, it will pay dividends in longer instrument life if forced air ventilation is provided. Several blowers for rack mounting are available such as Bud Radio Type B25.

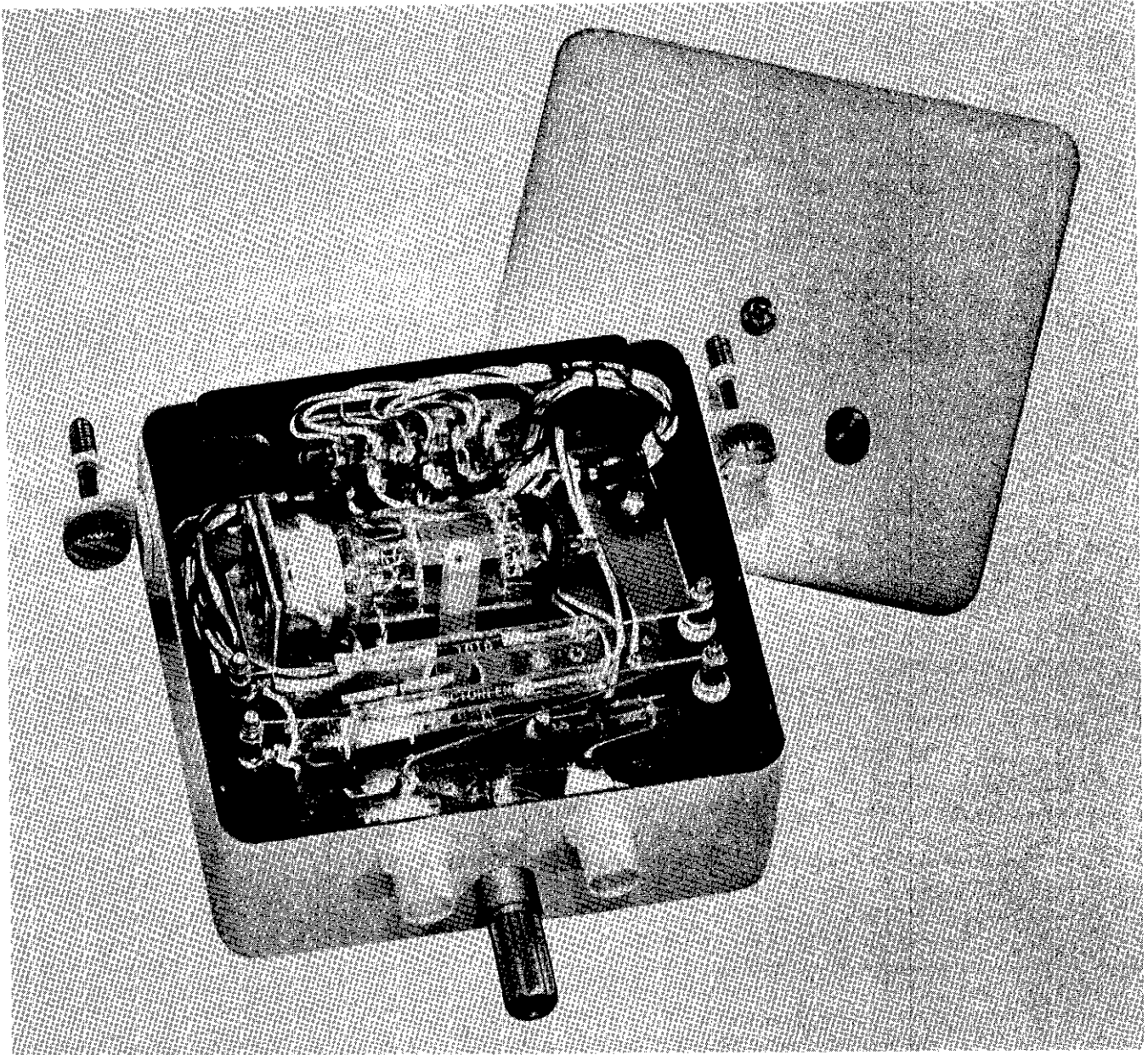


FIG. 1

SECTION IV -- CIRCUIT DESCRIPTION

The Model 603 is a direct-coupled DC amplifier with a balanced electrometer input followed by three stages of balanced pentode amplification and two output cathode-followers which drive the output stage and the balanced feedback loops.

The amplifier derives a high degree of DC stability by the use of balanced circuitry and close regulation of all critical plate and filament supplies.

A. Detailed description of the Amplifier (refer to DR 12669-D the circuit schematic):

The input tubes, V1, V2 and V3 are contained in the remote input head. V1 and V2 are type 5886 electrometer tubes and V3 is a cathode follower used to transmit the signal at a relatively low impedance to the main amplifier. The filaments of V1 and V2 are supplied from the regulated B⁺ supply via R105 and R106. The filament current then flows through R103 and R104. The drop across these resistors furnishes the bias for the electrometer tubes. A bias voltage of five volts is used to allow some measure of input voltage variation around ground when operating the amplifier with a balanced input. Resistors R103 and R104 also serve as the return point for the negative feedback voltage from the cathodes of V10 and V11, the output cathode-followers. This feedback voltage is attenuated by R159, R160, R161, R162 and resistors R176 through R193. Resistors R176 to R193 are chosen to set the gain of the amplifier.

Due to the fact that the input tubes are filamentary types, it is not convenient to float the filaments above ground. Therefore in order that some measure of in-phase rejection is obtained, local feedback from the cathodes of V4 and V5 to the screens of V1 and V2 is used to provide rejection against common mode signals.

The principle of operation is as follows: If a signal of the same magnitude and phase is received at each input grid simultaneously, equal signals are transmitted to each grid of V4 and V5 via cathode followers V3a and V3b. Since V4 and V5 form a differential amplifier, an equal in-phase signal received at each input grid will cause the cathode of the stage to move nearly as far as the grids. This cathode signal is fed back to the screens of V1 and V2 via R107 through R128. It will be found that the direction of the feedback signal is such as to cancel the input signal. On the other hand if the signal to the two input grids is equal but the signal each input grid receives is 180° out of phase with respect to the other, then when the signal arrives at the grids of V4 and V5, the plate current in one tube will increase and the plate current in the other tube will decrease in such a manner as to cause no change in potential at the cathodes of these tubes. In this way no signal is fed back and the full forward gain of the first two stages is utilized.

Resistors R107 through R128 vary the DC potential on the electrometer tube screens for the purpose of balancing the output voltage of the amplifier. These controls have small effect on the local feedback circuit described in the above paragraph. R133 is adjusted for the maximum in-phase rejection and does not need further attention unless the tubes are changed.

From V4 and V5, the signal is transmitted via R136, R137, R138 and R139 to V6 and V7. The cathodes of V6 and V7 are separately returned to B- via R142 and R143. The purpose of this connection is to provide a means of varying the loop gain of the amplifier as the feedback is varied to change the overall sensitivity. This is necessary to prevent oscillation. To this end it can be appreciated that if now Resistors R170 to R175 are shunted across the cathodes of V6 and V7 the gain of the stage can be varied according to the size of the resistor from about 1 to approximately 200. The loop gain is thus varied as the sensitivity is changed by S-3 so that the feedback factor will not be too large for the amplifier to be stabilized against oscillation by stabilizing networks provided by C103, C104, R140 and C107, R141 and C108, R144 and C109, R151, and C112. The resistors R170 through R175 which adjust the loop gain are adjustable so that in the initial line-up of the amplifier they may be adjusted for the maximum bandwidth possible on each range with an absence of ringing and peaking. In general this adjustment will remain fixed for an indefinite period after once adjusted. However as the instrument ages or if a tube is replaced in the amplifier readjustment of these controls as outlined in the maintenance section may be desirable.

The remainder of the amplifier is relatively conventional. Resistance coupling is again used between V6, V7 and V8. V9. Between V8, V9 and V10, V11, however, coupling is through DS2 and DS3, neon lamps. These were used to prevent attenuation of the signal into the output tubes so that a larger dynamic range could be obtained from the output stage than otherwise possible. The output cathode followers are "pentode" connected. That is, the screens are supplied from the well regulated B+ supply while the plates derive their supply from the unregulated supply. The advantage of this connection is that line transients and ripple present in the unregulated plate supply will hardly affect the tube output, although very little power is required from the well regulated supply to which the screen is returned.

B. Power Supply Voltages:

The following unregulated potentials are obtained from the transformer secondaries by means of silicon rectifiers and electrolytic filter sections:

- (1) Plus 210 volts from D102 and D104 to the input of the electronic regulator (The plates of V12 to V15) and the plates of V10 and V11. The current drain is approximately 210 milliamperes.

(2) Minus 210 volts from D101 and D103 to the cathode load resistors of V10 and V11, R163 and R164. The current drain is 40 milliamperes.

(3) Minus 370 volts from D105 and D106 through R202, R218 and R219 to the negative voltage regulator tube V18. The current drain is about 25 milliamperes. This tube then supplies a second voltage regulator V19.

The following regulated voltages are obtained for operation of the amplifier:

(1) Plus 100 volts from the electronic regulator consisting of V12 through V17. This potential supplies the B+ voltage for all amplifier tubes with the exception of the output stage; the filaments for the electrometer tubes by means of dropping resistors R105 and R106; and the filament voltages for tubes V3, V4, V5, V6, V7, V8, V9, and V17 which are in series across the plus 100 volt supply. The drain is about 180 ma.

(2) Minus 150 volts: This potential is obtained from the cathode of V18, a type OA2 voltage regulator tube. This tube supplies bias voltage for several amplifier stages and pre-regulates the supply to V19.

(3) Minus 85 volts. This is the reference potential for the electronic regulator and the negative supply for the first three amplifier stages.

C. Electronic Regulator:

The electronic regulator consists of a comparator tube, V17, an amplifier tube, V16, and a series regulator, V12 through V15.

Resistors R212 and R217 are so chosen that, with a regulated output of 100 volts, the junction will be at ground potential. Since one grid of V17 is connected to this junction and the other is grounded, any difference or error signal is amplified by V17. The output of V17 is further amplified by V16, the output of which controls the grids of the series regulators, V12 through V15, in such a way as to minimize the change in the output voltage. The filament of the comparator tube, V17, is connected in the series string across the regulated output for greater stability. A 10% line voltage change will cause the output to change by 0.02%.

SECTION V -- MAINTENANCE AND TROUBLE SHOOTING

A. Maintenance:

No periodic maintenance is required. Tubes V₁, V₂, V₄ and V₅ are selected and should only be replaced by the proper Keithley replacement part. When replacing a tube realign frequency response as outlined in Section V-B 2 b for all ranges.

B. Trouble Shooting:

1. A thorough understanding of Section IV, Circuit Description will be of considerable aid in tracing any circuit troubles.

2. Specific Faults: Listed below are several of the common service difficulties that may be encountered with this instrument. If the fault is not covered in the listing below, refer to section 3 below where a general check-out procedure is outlined.

a. Instrument will not balance: In general, this will be the most common symptom of malfunction. Unfortunately, since this instrument is a direct-coupled amplifier, it will seldom be possible to localize the fault simply, since the failure to balance can be caused by either faults in the power supplies, or in any stage of the amplifier. First check all power supply voltages as given in section IV B, if not correct refer to section V-B3b for detailed instruction. If the voltages are correct, refer to section V-B3a which gives a detailed plan of action for trouble shooting the amplifier.

b. Noise or erratic output or meter indication on the more sensitive ranges: This can be caused by either a defective amplifier tube (usually V₁, V₂, V₃, V₄, or V₅) or a defect in the power supplies. To trace the cause, first place the instrument on a variable source of line power such as a Variac or powerstat transformer. Vary the line voltage fairly rapidly from 105 to 130 volts. If there is only a meter division or two change in indication with this variation of line voltage, the power supplies are working properly and the erraticness is in the amplifier. If it is determined that the power supply is at fault consult section V-B3b for instructions on the power supply. On the other hand if the power supply is operating correctly, change first the input tubes V₁ and V₂ and if this does not cure the trouble, proceed in order to change the tubes in the later stages. If available, a spare input head may be plugged into the amplifier to check the performance.

There is also a chance that noise or erratic output can be caused by a defective resistor or a defective solder joint. If it is not possible to cure the trouble by changing tubes or trouble-shooting the power supply, the procedure in section V-B3a for a systematic inspection of the amplifier should be followed.

c. Excessive Drift: The trouble shooting procedure is exactly the same as indicated in 2b above for the localization of noise. In brief drift can be caused by defective input tubes, a power supply not regulating properly or a defective component.

d. Oscillation on any range or poor high frequency response: As pointed out in Section IV, Circuit Description, potentiometers R170 through R175 are used to set up the frequency response from range to range. If one of these are improperly set or if tubes have been changed in the amplifier it is possible that one of these potentiometers may have to be adjusted. To adjust the response or stop oscillation, locate the potentiometer involved as shown on the schematic. (These potentiometers are located, accessible by removing the bottom plate, on the front transverse channel of the chassis.) Then with an external oscillator with a range of approximately 20 cps to 1 mc., apply a signal to one input, with the other grounded, of less than the full scale signal for that range. On the more sensitive ranges a divider following the oscillator will usually be necessary. Sweep the oscillator through a frequency range of about 1kc to 500kc. The frequency response should be adjusted so that the instrument does not peak more than 3 db through the range. It is not possible to adjust the three lowest ranges but this usually will not be necessary. With the remote head plugged into the panel, the upper three db point should be adjusted to only 50 kc even if it is possible to achieve a higher frequency response on some ranges if it is contemplated that the head will then be used on the end of a cable, since the cable will cause instability if the adjustment is made for a wider bandwidth. With a 50 kc adjustment, the frequency response will be satisfactory with the cable attached. Finally if the constancy of frequency response near the high-frequency roll-off is of importance, it is of advantage to check the frequency response of the amplifier with the length of cable being used and adjust it to suit.

If oscillation cannot be stopped by the above means, check the following components which are employed in stabilizing loops: C103, C104, R140, R141, C107, C108, R144, R151, C109, C112, C118, C119.

Replace any defective component.

If the frequency response is less than specifications this is usually due to tubes with low transconductance and the remedy is to replace tubes until the frequency response is normal.

If no success is experienced in stopping oscillation with the procedures outlined above, check the power supply B-plus output. In rare cases it may happen that the power supply will oscillate. For a cure see Section V-B3b.

3. General Procedures for Trouble-Shooting.

a. The Amplifier:

If the amplifier cannot be zeroed with the front panel controls, the first step is to disable the negative feedback loops. This may be done in most cases by removing the output tubes from their socket and shorting both outputs to ground. After this is done, the feedback loops are broken and it is possible to study the operation of each stage without the possibility of the operating point being disturbed by large feedback voltages introduced by the feedback connections.

Now short both input grids to ground and proceed to measure the plate potentials of the first stage. These plate potentials should be adjustable by means of the front panel zero controls to 15 volts. If manipulation of the front panel zero controls allows the first stage tubes to pass through the correct operating voltage, it can be assumed that the stage is operating correctly. If not, check the other electrode potentials, per the voltage-resistance diagram at the rear of the manual. Lead 3 of the electrometer tubes, (F - plus) should be at approximately 5.5 volts. If it is found to be at plus 100 volts, the electrometer tube filament has opened and V1 and V2 should be replaced with a new matched pair of electrometer tubes (Keithley part number EV 5886-9).

If, however, the correct potentials are obtained at the plates of V1 and V2, proceed to pins 6 and 7 of V3 and repeat the procedure. The voltage again should swing through the value indicated on the voltage-resistance diagram. As before, if it does not, check other voltages at that stage and if necessary the various resistances to ground. If the trouble is not at V3, proceed in a similar manner step by step through the amplifier until finally the fault is found. Note that the filaments of V3 through V9 and V17 are in series. If these tubes do not light one has a burnt out filament and both the amplifier and power supply will be disabled.

b. Power Supply:

The negative voltage regulator consists of V18 and V19 which are gas-filled diodes operating from the unregulated minus 325 volt supply. If either the minus 150 or minus 85 volt potentials are incorrect check to see if V18 or V19 are lit. If they are not measure the voltage between R202 and R215. If it is not approximately 380 volts, either the rectifier or filter capacitor has failed or else there is a short to ground. Check and replace components if necessary. It should be pointed out that it is rare for a voltage-regulator tube to fail and replacement should be avoided in uncertain situations.

There is also available a minus 200 volt potential which is not regulated and is used for the negative return of the output cathode-followers. This potential may be measured at the junction of R222 and C203c. If this potential is not correct check the corresponding rectifiers and filter capacitors.

The positive power supplies consist of an unregulated 200 volt supply and a regulated 100 volt supply. The 200 volt supply is used to supply the plates of the output cathode followers. Any defect in the 200 volt supply can be easily found since the supply is a conventional rectifier-filter system. The regulated 100 volt supply is somewhat more involved.

If the trouble has been traced to the 100 volt regulated supply and it has been determined that the unregulated 200 volt supply is correct, check to see that V17, the 12AX7 has filament voltage. As seen from the schematic it is in series with several of the amplifier tubes and a break in any one of these filaments will disable the power supply as well as the amplifier. If it is correct, check the voltage at the junction of R216 and R217. It should be minus 85 volts. If it is incorrect the trouble is in the negative supply. If the trouble still persists, check to see if V12 through V17 are defective and replace if necessary. Check the output with an oscilloscope for oscillation. If oscillation is found probably C204 is defective. If the trouble still remains check each resistor for a changed value.

SECTION 6. REPLACEABLE PARTS

6-1. REPLACEABLE PARTS LIST. The Replaceable Parts List describes the components of the Model 603 and its accessories. The List gives the circuit designation, the part description, a suggested manufacturer, manufacturer's part number and the Keithley Part Number. The name and address of the manufacturers listed in the "Mfg. Code" column are contained in Table 2.

6-2. HOW TO ORDER PARTS.

a. For parts orders, include the instrument's model and serial number, the Keithley Part Number, the circuit designation and a description of the part. All structural parts and those parts coded for Keithley manufacture (80164) must be ordered from Keithley Instruments, Inc. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through your nearest Keithley distributor or the Sales Service Department, Keithley Instruments, Inc.

amp	ampere	Mil. No.	Military Type Number
CbVar	Carbon Variable		
GerD	Ceramic, Disc	Ω	ohm
Coml	Commercial		
Comp	Composition	Poly	Polystyrene
CompV	Composition Variable	p	pico (10^{-12})
DCb	Deposited Carbon	μ	micro (10^{-6})
ETB	Electrolytic, tubular	v	volt
f	farad	Var	Variable
k	kilo (10^3)	w	watt
M or meg	mega (10^6) or megohms	WW	Wirewound
m	milli (10^{-3})	WWVar	Wirewound Variable
Mfg.	Manufacturer		

TABLE 1. Abbreviations and Symbols.

MODEL 603 REPLACEABLE PARTS LIST

(Refer to Schematic Diagram 12669D for circuit designations.)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C101	Not Used					
C102	Not Used					
C103 (i)	510 pf	500 v	Poly	71590	CPR-510J	C138-510P
C104 (i)	510 pf	500 v	Poly	71590	CPR-510J	C138-510P
C105	33 pf	1000 v	CerD	72982	831U2M330K	C22-33P
C106	33 pf	1000 v	CerD	72982	831U2M330K	C22-33P
C107	.0015 μ f	1000 v	CerD	72982	801Z5V152P	C22-.0015M
C108	.0015 μ f	1000 v	CerD	72982	801Z5V152P	C22-.0015M
C109	.0001 μ f	1000 v	CerD	72982	831X5R101K	C22-100P
C110	33 pf	1000 v	CerD	72982	831U2M330K	C22-33P
C111	33 pf	1000 v	CerD	72982	831U2M330K	C22-33P
C112	.0001 μ f	1000 v	CerD	72982	831X5R101K	C22-100P
C113	.02 μ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C114	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C115	470 pf	1000 v	CerD	72982	831Z5V471P	C22-470P
C116	*.0015 μ f	1000 v	CerD	72982	801Z5V152P	C22-.0015M
C117	*.0015 μ f	1000 v	CerD	72982	801Z5V152P	C22-.0015M
C118	.0047 μ f	1000 v	CerD	72982	811Z5V472P	C22-.0047M
C119	.0047 μ f	1000 v	CerD	72982	811Z5V472P	C22-.0047M
C120 (i)	.001 μ f	500 v	Poly	71590	CPR-1000J	C138-.001M
C121 (i)	.001 μ f	500 v	Poly	71590	CPR-1000J	C138-.001M
C122	*.001 μ f	1000 v	CerD	72982	801Z5V102P	C22-.001M
C123	*.001 μ f	1000 v	CerD	72982	801Z5V102P	C22-.001M
C201	150 μ f	300 v	ETB	00656	FP131	C46-150M
C202	20 μ f	600 v	ETB	14655	BR20-600	C35-20M
C203	3x30 μ f	350 v	ETB	12674	ME50039	C52-3x30M
C204	40 μ f	250 v	ETB	56289	TVA1511	C27-40M
C205	.02 μ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C206	.02 μ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C207	.02 μ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C208	470 pf	1000 v	CerD	71590	DD471	C64-470P
C209	470 pf	1000 v	CerD	71590	DD471	C64-470P

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.
D101	Silicon	1N3255	02735	RF-17
D102	Silicon	1N3255	02735	RF-17

*Nominal value, factory set.

(i) Located in Input Head.

DIODES (Cont'd)

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.
D103	Silicon	1N3255	02735	RF-17
D104	Silicon	1N3255	02735	RF-17
D105	Silicon	1N3255	02735	RF-17
D106	Silicon	1N3255	02735	RF-17

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
DS1	Lamp (Mfg. No. 51)	08804	PL-8
---	Pilot Light Assembly (Mfg. No. 755-621)	72619	PL-9
DS2	Neon Lamp (Mfg. No. NE-81)	08804	PL-6
DS3	Neon Lamp (Mfg. No. NE-81)	08804	PL-6
F1(117v)	Fuse, 2 amp, 3 AG (Mfg. No. 312002)	75915	FU-13
F1(234v)	Fuse, 1 amp, 3 AG (Mfg. No. 312001)	75915	FU-7
---	Fuse Holder (Mfg. No. 342012)	75915	FH-3
J1 (i)	Receptacle, bnc, Input, Mil No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
J2 (i)	Receptacle, bnc, Input, Mil. No. UG-1094/U (Mfg. No. 31-221)	02660	CS-15
---	Plug, bnc, Mate of J1 and J2, Mil. No. UG-88/U (Mfg. No. 31-002)	02660	CS-44
---(i)	Binding Post (Mfg. No. 938-A)	24655	BP-1
---	Binding Post Adapter furnished for J1 and J2, Mil. No. UG-1090/U (Mfg. No. 1090)	91737	BP-12
J3	Socket (Mfg. No. 126-150)	02660	CS-53
---	See P2 for mate of J3		
J4	Receptacle, Microphone, Output (Mfg. No. 91-PC3F)	02660	CS-58
---	Plug, Microphone, Mate of J4 (Mfg. No. 91-MC3M)	02660	CS-59
---	Binding Posts, OUTPUT (Mfg. No. DF31BC)	58474	BP-8
---	Binding Post, G (Mfg. No. DF31BC)	58474	BP-8
M1	Meter	80164	ME-18
P1	Power Cord Set, 6 feet (Mfg. No. 4638-13)	82879	CO-2
---	Cable Clamp (Mfg. No. SR-6P-1)	28520	CC-7
P2 (i)	Plug, Mate of J3 (Mfg. No. 126-151)	02660	CS-52
S1	Toggle Switch, DPDT, ON (Mfg. No. 20905-FR)	04009	SW-14
S2	Rotary Switch less components, BALANCE COARSE	80164	SW-65
---	Knob Assembly, Balance Coarse Switch	80164	15459A

(i) Located in Input Head.

MISCELLANEOUS PARTS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
---	Knob Assembly, Balance Fine Potentiometer	80164	15459A
S3	Rotary Switch less components, MILLIVOLTS	80164	SW-66
---	Knob Assembly, Millivolts Switch	80164	15459A
S4 (i)	Push Button, Zero Check	80164	13783A
T1	Transformer	80164	TR-31

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R101	Not Used					
R102	Not Used					
R103 (i)	500 Ω	1/4%, 1 w	WW	91637	RS-1A	R46-500
R104 (i)	500 Ω	1/4%, 1 w	WW	91637	RS-1A	R46-500
R105 (i)	10 k Ω	1%, 5 w	WW	44655	4654	R4A-10K
R106 (i)	10 k Ω	1%, 5 w	WW	44655	4654	R4A-10K
R107 to R124	1 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1K
R125	20 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-20K
R126	3.9 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-3.9K
R127	10 k Ω	3%, 5 w	WWVar	73138	A	RP4-10K
R128	20 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-20K
R129 (i)	10 M Ω	1%, 1 w	DCb	91637	DC-1	R13-10M
R130 (i)	10 M Ω	1%, 1 w	DCb	91637	DC-1	R13-10M
R131 (i)	50 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-50K
R132 (i)	50 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-50K
R133	50 k Ω	10%, 2 w	CompV	01121	J	RP5-50K
R134	200 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-200K
R135	200 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-200K
R136	500 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-500K
R137	1.5 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1.5M
R138	1.5 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1.5M
R139	500 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-500K
R140	22 k Ω	10%, 1/2 w	Comp	01121	EB	R1-22K
R141	22 k Ω	10%, 1/2 w	Comp	01121	EB	R1-22K
R142	220 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-220K
R143	220 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-220K
R144	22 k Ω	10%, 1/2 w	Comp	01121	EB	R1-22K
R145	100 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-100K

(i) Located in Input Head

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R146	100 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-100K
R147	700 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-700K
R148	1.5 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1.5M
R149	1.5 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1.5M
R150	700 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-700K
R151	22 k Ω	10%, 1/2 w	Comp	01121	EB	R1-22K
R152	70 k Ω	10%, 4 w	WWVar	37942	M70MPK	RP1-70K
R153	62 k Ω	1%, 1 w	DCb	91637	DC-1	R13-62K
R154	50 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-50K
R155	100 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-100K
R156	100 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-100K
R157	1 M Ω	1%, 1/2 w	Comp	01121	EB	R1-1M
R158	1 M Ω	1%, 1/2 w	Comp	01121	EB	R1-1M
R159	4 k Ω	1/4%, 5 w	WW	91637	RS-5	R39-4K
R160	*3.75 k Ω	1/4%, 5 w	WW	91637	RS-5	R39-3.75K
R161	4 k Ω	1/4%, 5 w	WW	91637	RS-5	R39-4K
R162	*3.75 k Ω	1/4%, 5 w	WW	91637	RS-5	R39-3.75K
R163	11 k Ω	5%, 10 w	WW	63743	10F	R5-11K
R164	11 k Ω	5%, 10 w	WW	63743	10F	R5-11K
R165	Not Used					
R166	Not Used					
R167	180 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-180K
R168	70 k Ω	10%, 4 w	WWVar	37942	M70MPK	RP1-70K
R169	220 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-220K
R170	200 k Ω	20%, 1/2 w	CbVar	75042	RQ11-129	RP2-200K
R171	200 k Ω	20%, 1/2 w	CbVar	75042	RQ11-129	RP2-200K
R172	200 k Ω	20%, 1/2 w	CbVar	75042	RQ11-129	RP2-200K
R173	10 k Ω	20%, 1/2 w	CbVar	75042	RQ11-116	RP2-10K
R174	10 k Ω	20%, 1/2 w	CbVar	75042	RQ11-116	RP2-10K
R175	1 k Ω	20%, 1/2 w	CbVar	75042	RQ11-108	RP2-1K
R176	2.54 k Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-2.54K
R177	780 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-780
R178	327 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-327
R179	120 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-120
R180	58 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-58
R181	28.5 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-28.5
R182	11.2 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-11.2
R183	*5.6 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-5.6
R184	*2.8 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-2.8
R185	2.54 k Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-2.54K

* Nominal value, factory set.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R186	780 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-780
R187	327 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-327
R188	120 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-120
R189	58 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-58
R190	28.5 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-28.5
R191	11.2 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-11.2
R192	*5.6 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-5.6
R193	*2.8 Ω	1/4%, 0.4 w	WW	77764	CAB	R18-22-2.8
R194 (i)	1 M Ω	1%, 1/2 w	Comp	01121	EB	R1-1M
R195 (i)	1 M Ω	1%, 1/2 w	Comp	01121	EB	R1-1M
R201	25 Ω	1%, 5 w	WW	91637	RS-5	R4A-25
R202	47 Ω	1%, 5 w	WW	91637	RS-5	R4A-47
R203	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10
R204	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10
R205	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10
R206	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10
R207	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100
R208	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100
R209	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100
R210	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100
R211	470 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-470K
R212	1 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-1M
R213	100 k Ω	10%, 1/2 w	Comp	01121	EB	R1-100K
R214	10 M Ω	1%, 1 w	DCb	91637	DC-1	R13-10M
R215	3.3 M Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-3.3M
R216	450 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-450K
R217	750 k Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-750K
R218	4 k Ω	3%, 7 w	WW	91637	RLS-7	R7-4K
R219	4 k Ω	3%, 7 w	WW	91637	RLS-7	R7-4K
R220	8.2 k Ω	10%, 2 w	Comp	01121	HB	R3-8.2K
R221	47 Ω	10%, 2 w	Comp	01121	HB	R3-47
R222	2 k Ω	1%, 5 w	WW	91637	RS-5	R4A-2K

VACUUM TUBES

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
V1 (i)	5886	80164	**EV-5886-9
V2 (i)	5886	80164	**EV-5886-9
V3 (i)	12AT7	80164	**EV-12AT7
V4	12AU6	94154	EV-12AU6
V5	12AU6	94154	EV-12AU6

*Nominal value, factory selected.

**V1, V2 and V3 must be matched to each other; order only as complete set.

(i) Located in Input Head.

VACUUM TUBES (Cont'd)

Circuit Desig.	Number	Mfg. Code	Keithley Part No.
V6	12AU6	94154	EV-12AU6
V7	12AU6	94154	EV-12AU6
V8	12AU6	94154	EV-12AU6
V9	12AU6	94154	EV-12AU6
V10	6AS5	00011	EV-6AS5
V11	6AS5	00011	EV-6AS5
V12	12B4A	85599	EV-12B4A
V13	12B4A	85599	EV-12B4A
V14	12B4A	85599	EV-12B4A
V15	12B4A	85599	EV-12B4A
V16	6AU6	94154	EV-6AU6
V17	12AX7	73445	EV-12AX7
V18	0A2	86684	EV-0A2
V19	0G3	80164	EV-0G3-240

MODEL 6032 REPLACEABLE PARTS LIST

Description	No. Required Per Model	Mfg. Code	Keithley Part No.
End Frames	2		
Fastener, Thumbscrew	4	80164	FA-9
Feet, Rubber	4	80164	FE-2

Attaching Parts

Machine Screw, No. 6-32UNC-2x1/2, Rd Hd, Phillips	4	Coml	---
Hex Nut, No. 6-32UNC-2	4	Coml	---

Machine Screw, No. 8-32UNC-2x5/16, Rd Hd, Phillips	4	Coml	---
---	---	------	-----

MODEL 6033 MATCHED RESISTOR PAIRS

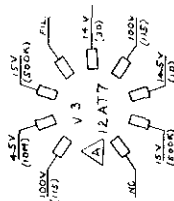
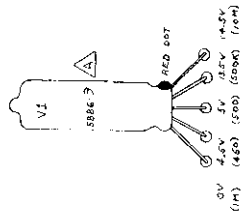
Model No.	Resistance Value
6033-6	10 ⁶ Ω
6033-7	10 ⁷ Ω
6033-8	10 ⁸ Ω
6033-9	10 ⁹ Ω
6033-10	10 ¹⁰ Ω
6033-11	10 ¹¹ Ω

00011	Sylvania Electric Products, Inc. Buffalo Operations of Sylvania Electronic Systems Buffalo, N. Y.	63743	Ward Leonard Electric Co. Mount Vernon, N. Y.
		71450	CTS Corp. Elkhart, Ind.
00656	Aerovox Corp. New Bedford, Mass.	71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.
01121	Allen-Bradley Corp. Milwaukee, Wis.	72619	Dialight Corp. Brooklyn, N. Y.
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Illinois	72982	Gudeman Co. Chicago, Ill.
02735	RCA Semiconductor and Materials Division of Radio Corp. of America Somerville, N. J.	73138	Helipot Division of Beckman Instruments, Inc. Fullerton, Calif.
04009	Arrow-Hart and Hegeman Electric Co. Hartford, Conn.	73445	Amperex Electronic Co. Division of North American Philips Co., Inc. Hicksville, N. Y.
08804	Lamp Metals and Components Department G. E. Co. Cleveland, Ohio	75042	International Resistance Co. Philadelphia, Pa.
12674	Syncro Corp. Hicksville, Ohio	75915	Littelfuse, Inc. Des Plaines, Ill.
14167	Efcon, Inc. Garden City, L.I., N. Y.	77764	Resistance Products Co. Harrisburg, Pa.
14655	Cornell-Dubilier Electric Corp. Newark, N. J.	79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
24655	General Radio Co. West Concord, Mass.	80164	Keithley Instruments, Inc. Cleveland, Ohio
28520	Heyman Mfg. Co. Kenilworth, N. J.	82879	Royal Electric Corp. Pawtucket, R. I.
37942	Mallory, P. R., and Co., Inc. Indianapolis, Ind.	83330	Smith, Herman H., Inc. Brooklyn, N. Y.
44655	Ohmite Mfg. Co. Skokie, Ill.	85599	Tube Department G. E. Co. Schenectady, N. Y.
56289	Sprague Electric Co. North Adams, Mass.	86684	RCA Electron Tube Division of Radio Corp. of America Harrison, N. J.
58474	Superior Electric Co., The Bristol, Conn.		

TABLE 2 (Sheet 1). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

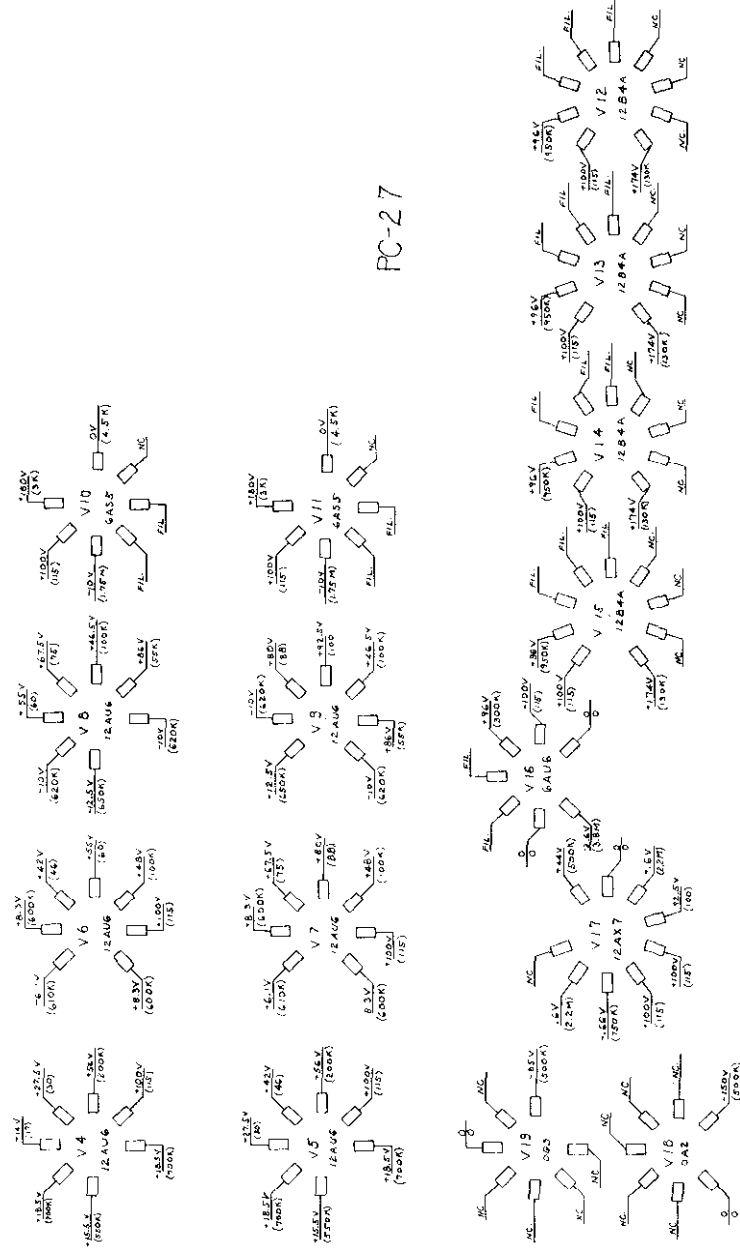
91637	Dale Electronics, Inc. Columbus, Nebr.	94154	Tung-Sol Electric, Inc. Newark, N. J.
91737	Gremer Mfg. Co., Inc. Wakefield, Mass.		

TABLE 2 (Sheet 2). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)



PC-28

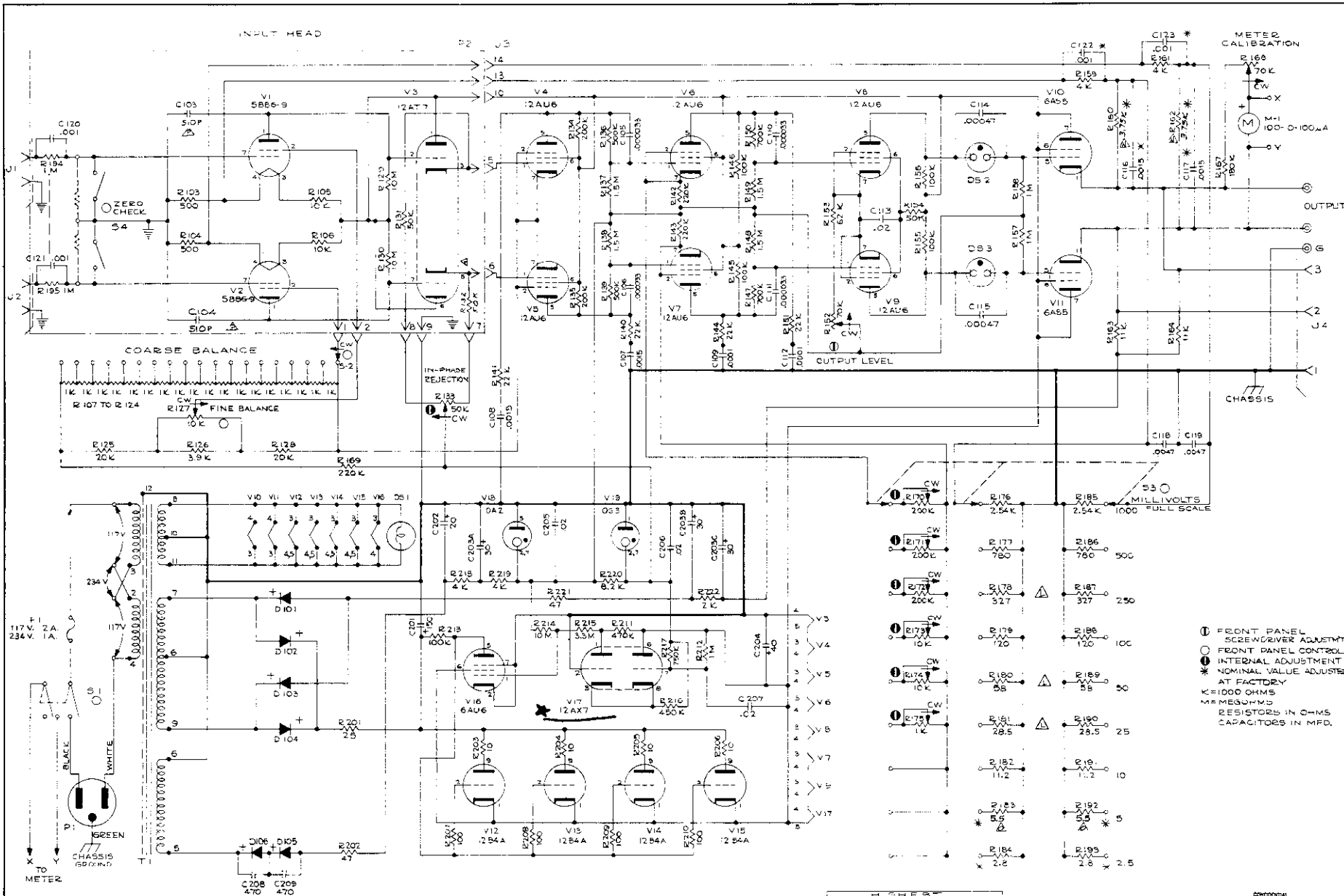
PC-27



MEASUREMENTS FROM TUBE PIN TO GROUND USING VTVM WITH 10 MEGOHM INPUT RESISTANCE. INPUTS SHORTED TO GROUND

ALL READINGS ARE APPROXIMATE. RESISTANCES ARE GIVEN IN OHMS; K = 1,000, M = MEGOHMS

A	EEO	149	CO.	12-5-67
MODEL 603 VOLTAGE AND RESISTANCE CHART				
REPALEBY INSTRUMENTS COMPANY				
CITY OF NEW YORK				
NEW YORK				
12852 D				



- ① FRONT PANEL ADJUSTMENT
- ② SCREW DRIVER ADJUSTMENT
- ③ FRONT PANEL CONTROL
- ④ INTERNAL ADJUSTMENT
- * NOMINAL VALUE ADJUSTED AT FACTORY
- K=1000 OHMS
- M=MEG OHMS
- R=RESISTORS IN OHMS
- C=CAPACITORS IN MFD.

REF. NO.	DESCRIPTION	DESIGNATION	VALUES	UNIT	TOLERANCE	DATE
C123	RESISTOR	R123	100K	Ω	±1%	12-15-52
C124	RESISTOR	R124	100K	Ω	±1%	12-15-52
C125	RESISTOR	R125	100K	Ω	±1%	12-15-52
C126	RESISTOR	R126	100K	Ω	±1%	12-15-52
C127	RESISTOR	R127	100K	Ω	±1%	12-15-52
C128	RESISTOR	R128	100K	Ω	±1%	12-15-52
C129	RESISTOR	R129	100K	Ω	±1%	12-15-52
C130	RESISTOR	R130	100K	Ω	±1%	12-15-52
C131	RESISTOR	R131	100K	Ω	±1%	12-15-52
C132	RESISTOR	R132	100K	Ω	±1%	12-15-52
C133	RESISTOR	R133	100K	Ω	±1%	12-15-52
C134	RESISTOR	R134	100K	Ω	±1%	12-15-52
C135	RESISTOR	R135	100K	Ω	±1%	12-15-52
C136	RESISTOR	R136	100K	Ω	±1%	12-15-52
C137	RESISTOR	R137	100K	Ω	±1%	12-15-52
C138	RESISTOR	R138	100K	Ω	±1%	12-15-52
C139	RESISTOR	R139	100K	Ω	±1%	12-15-52
C140	RESISTOR	R140	100K	Ω	±1%	12-15-52
C141	RESISTOR	R141	100K	Ω	±1%	12-15-52
C142	RESISTOR	R142	100K	Ω	±1%	12-15-52
C143	RESISTOR	R143	100K	Ω	±1%	12-15-52
C144	RESISTOR	R144	100K	Ω	±1%	12-15-52
C145	RESISTOR	R145	100K	Ω	±1%	12-15-52
C146	RESISTOR	R146	100K	Ω	±1%	12-15-52
C147	RESISTOR	R147	100K	Ω	±1%	12-15-52
C148	RESISTOR	R148	100K	Ω	±1%	12-15-52
C149	RESISTOR	R149	100K	Ω	±1%	12-15-52
C150	RESISTOR	R150	100K	Ω	±1%	12-15-52
C151	RESISTOR	R151	100K	Ω	±1%	12-15-52
C152	RESISTOR	R152	100K	Ω	±1%	12-15-52
C153	RESISTOR	R153	100K	Ω	±1%	12-15-52
C154	RESISTOR	R154	100K	Ω	±1%	12-15-52
C155	RESISTOR	R155	100K	Ω	±1%	12-15-52
C156	RESISTOR	R156	100K	Ω	±1%	12-15-52
C157	RESISTOR	R157	100K	Ω	±1%	12-15-52
C158	RESISTOR	R158	100K	Ω	±1%	12-15-52
C159	RESISTOR	R159	100K	Ω	±1%	12-15-52
C160	RESISTOR	R160	100K	Ω	±1%	12-15-52
C161	RESISTOR	R161	100K	Ω	±1%	12-15-52
C162	RESISTOR	R162	100K	Ω	±1%	12-15-52
C163	RESISTOR	R163	100K	Ω	±1%	12-15-52
C164	RESISTOR	R164	100K	Ω	±1%	12-15-52
C165	RESISTOR	R165	100K	Ω	±1%	12-15-52
C166	RESISTOR	R166	100K	Ω	±1%	12-15-52
C167	RESISTOR	R167	100K	Ω	±1%	12-15-52
C168	RESISTOR	R168	100K	Ω	±1%	12-15-52
C169	RESISTOR	R169	100K	Ω	±1%	12-15-52
C170	RESISTOR	R170	100K	Ω	±1%	12-15-52
C171	RESISTOR	R171	100K	Ω	±1%	12-15-52
C172	RESISTOR	R172	100K	Ω	±1%	12-15-52
C173	RESISTOR	R173	100K	Ω	±1%	12-15-52
C174	RESISTOR	R174	100K	Ω	±1%	12-15-52
C175	RESISTOR	R175	100K	Ω	±1%	12-15-52
C176	RESISTOR	R176	100K	Ω	±1%	12-15-52
C177	RESISTOR	R177	100K	Ω	±1%	12-15-52
C178	RESISTOR	R178	100K	Ω	±1%	12-15-52
C179	RESISTOR	R179	100K	Ω	±1%	12-15-52
C180	RESISTOR	R180	100K	Ω	±1%	12-15-52
C181	RESISTOR	R181	100K	Ω	±1%	12-15-52
C182	RESISTOR	R182	100K	Ω	±1%	12-15-52
C183	RESISTOR	R183	100K	Ω	±1%	12-15-52
C184	RESISTOR	R184	100K	Ω	±1%	12-15-52
C185	RESISTOR	R185	100K	Ω	±1%	12-15-52
C186	RESISTOR	R186	100K	Ω	±1%	12-15-52
C187	RESISTOR	R187	100K	Ω	±1%	12-15-52
C188	RESISTOR	R188	100K	Ω	±1%	12-15-52
C189	RESISTOR	R189	100K	Ω	±1%	12-15-52
C190	RESISTOR	R190	100K	Ω	±1%	12-15-52
C191	RESISTOR	R191	100K	Ω	±1%	12-15-52
C192	RESISTOR	R192	100K	Ω	±1%	12-15-52
C193	RESISTOR	R193	100K	Ω	±1%	12-15-52
C194	RESISTOR	R194	100K	Ω	±1%	12-15-52
C195	RESISTOR	R195	100K	Ω	±1%	12-15-52
C196	RESISTOR	R196	100K	Ω	±1%	12-15-52
C197	RESISTOR	R197	100K	Ω	±1%	12-15-52
C198	RESISTOR	R198	100K	Ω	±1%	12-15-52
C199	RESISTOR	R199	100K	Ω	±1%	12-15-52
C200	RESISTOR	R200	100K	Ω	±1%	12-15-52
C201	RESISTOR	R201	100K	Ω	±1%	12-15-52
C202	RESISTOR	R202	100K	Ω	±1%	12-15-52
C203	RESISTOR	R203	100K	Ω	±1%	12-15-52
C204	RESISTOR	R204	100K	Ω	±1%	12-15-52
C205	RESISTOR	R205	100K	Ω	±1%	12-15-52
C206	RESISTOR	R206	100K	Ω	±1%	12-15-52
C207	RESISTOR	R207	100K	Ω	±1%	12-15-52
C208	RESISTOR	R208	100K	Ω	±1%	12-15-52
C209	RESISTOR	R209	100K	Ω	±1%	12-15-52

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1015 28TH STREET, CLEVELAND, OHIO 44115
MADE IN THE U.S.A.

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

FILE NO. 12669D
SCHEMATIC DIAGRAM

PART NUMBER
12669D

CHANGE NOTICE

January 16, 1967

MODEL 603 ELECTROMETER AMPLIFIER

Page 6-6. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R214	10 MΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-10M
R217	*	1%, 1/2 w	DCb	79727	CFE-15	R12-*

* Nominal value, factory selected.