COPY

Sanborn®

DC AMPLIFIER

MODEL 126, 126B, 64-300A
64-300B, 67-300, 67-300B, 67A-300B

SANBORN COMPANY

WALTHAM 54, MASSACHUSETTS

IM-126-2

INSTRUCTION MANUAL

INSTRUCTION MANUAL

Sanborn DC General Purpose Amplifier

Models 126, 126B, 64-300A,
64-300B, 67-300, 67-300B

Sanborn Company

TABLE OF CONTENTS

SECTION I

DESCRIPTION AND DATA

1. FUNCTIONAL DESCRIPTION

The Sanborn DC General Purpose Amplifiers are designed for use in the following Sanborn Recording Systems:

Model no.	System
126, 126B	These models are used with a Sanborn Recorder Model 127, to form a Sanborn Recording System Model 128, or separately, in individual carrying cases.
64–300A, 64–300B	These models are used in the Sanborn Twin–Viso Recording System Model 60, or in the Horizontal Poly–Viso Model 64A.
67–300, 67–300B	These models are used in the Sanborn Poly–Viso Recording System Model 67 or 77. When used in Recording System Model 67A, the instrument is usually identified as DC General Purpose Amplifier Model 67A–300B.

A Sanborn Recording System which uses one of these amplifiers will record voltages from 5 millivolts to 250 volts, at frequencies between zero and 70 cycles. The input voltages may be attenuated in steps by factors between 1 and 1000. The amplifier will operate with either push–pull or single–ended signals. In–phase voltages are rejected by a factor of at least 50.

2. TABULATION OF CHARACTERISTICS
(Including Galvanometer)

SENSITIVITY
50 mv./cm.

SIGNAL RANGES
Reads from 5 millivolts to 250 volts.

FREQUENCY RANGE
Zero to 70 cycles. See fig. 1.

RISE TIME
10 milliseconds (approx.). See fig. 1.

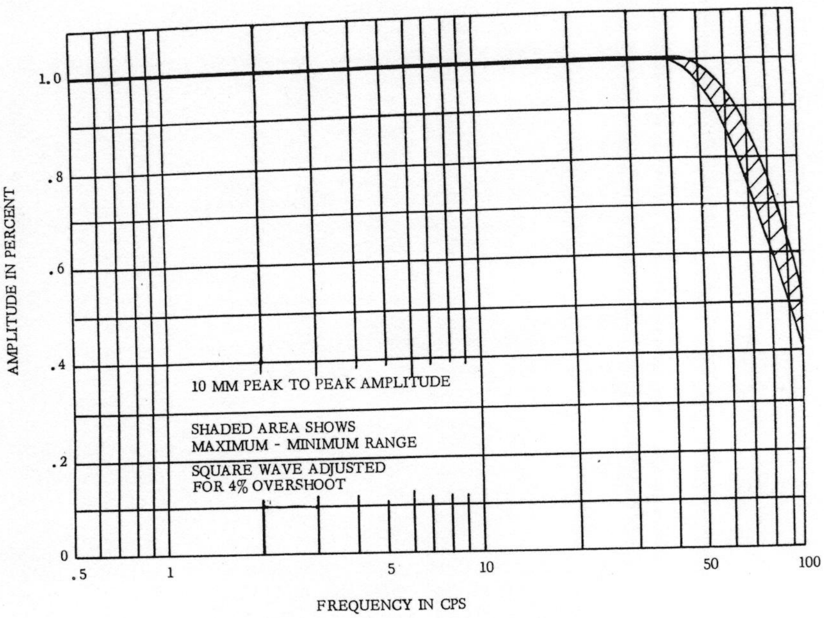
CALIBRATION
50 mv. ±6% from an internal voltage source.

STABILITY
Less than 0.5 mm. drift per hour.

INPUT IMPEDANCE
Resistive, five megohms each input terminal to ground.

INPUT SIGNALS
Push–pull or single–ended.

IN–PHASE REJECTION
Any signal component appearing at the push–pull input terminals with the same amplitude and polarity is an "in–phase component". A small fraction of the in–phase voltage appears on the recording. The table lists the maximum in–phase voltage which the amplifier will tolerate, and the fraction of the in–phase voltage which will appear on the record.



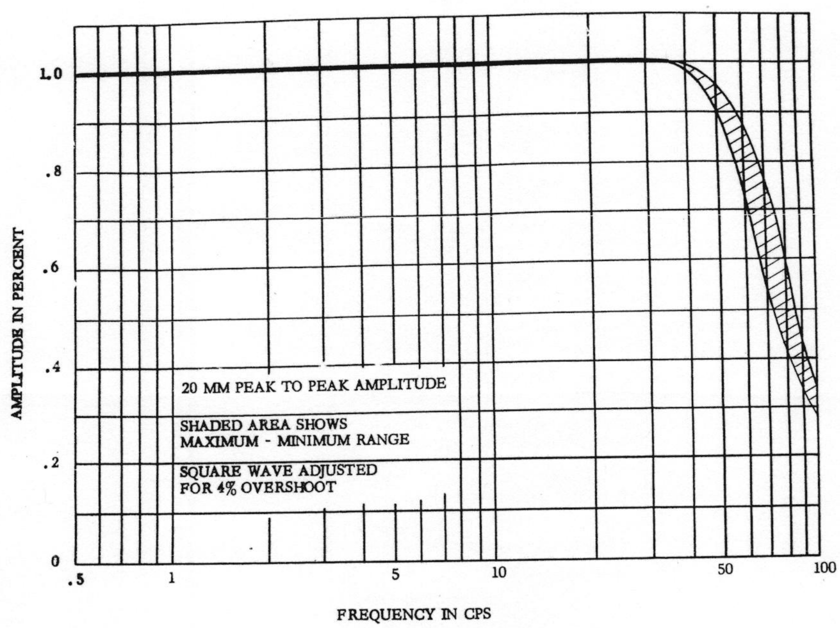
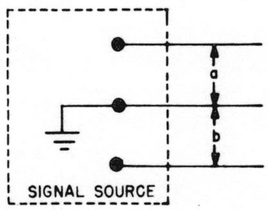


Figure 1. Sanborn DC General Purpose Amplifiers, Combined Response Characteristics of the Sanborn Amplifier and Galvanometer.

ATTENUATOR SETTING	IN-PHASE VOLTAGE LIMIT	FRACTION ON RECORD
X1	1.5 volts	Less than 1/125
X2	3.0 volts	Less than 1/50
X4	6.0 volts	Less than 1/50
X5	7.5 volts	Less than 1/50
X10	15 volts	Less than 1/50
X20	30 volts	Less than 1/50
X50	75 volts	Less than 1/50
X100	150 volts	Less than 1/50
X200	300 volts	Less than 1/50
X400	500 volts	Less than 1/50
X500	500 volts	Less than 1/50
X1000	500 volts	Less than 1/50



The instantaneous voltage "a" exists between one input lead and ground. The instantaneous voltage "b" exists between the other input lead and ground. The amplifier measures the differential voltage, and only a small fraction of the in-phase voltage appears on the recording. The algebraic formulas (with regard to the polarity of "a" and "b" are:)

$$\text{Differential voltage} = a - b$$

$$\text{In-phase voltage} = \frac{a + b}{2}$$

3. FRONT PANEL DATA

SENSITIVITY
This control adjusts the gain of the amplifier. Clockwise rotation increases the gain.

CENTERING
This control sets the no-signal base line of the stylus. Clockwise rotation moves the stylus up-scale.

ATTENUATOR
This switch attenuates the input signal voltage by the factors marked on the panel. There is a CAL position for calibration and an OFF position.

BALANCE
This screwdriver-adjusted control is set to eliminate the residual internal unbalance of the Amplifier. A protective button covers the BALANCE control.

INPUT
Three circuit jack for applying the input signal through a three terminal phone plug.

OSCILLOSCOPE
Three circuit jack for connecting a cathode ray oscilloscope to the DC General Purpose Amplifier.

HUM
This screwdriver-adjusted control is set for minimum hum on the recording. A protective button covers the HUM control.

DAMPING
A protective button covers the DAMPING control. The galvanometer operates near critical damping. The DAMPING control is part of a positive feedback loop in the Amplifier. The feedback loop controls the amplitude and phase characteristics of the Amplifier above approximately 20 cycles. Adjusting the DAMPING control for up to four percent overshoot on the leading edge of a recorded pulse results in a recording which appears as if the Galvanometer were operating near 71% critical damping. 71% is the optimum percentage for a fast rise time and a wide frequency response.

CARDIOSCOPE
This jack is included only on earlier instruments. Use for connecting a Sanborn Cardioscope to monitor the output of the Amplifier.

POWER
(Models 67-300, 67-300B only). Toggle switch for turning on the Amplifier. A neon indicator I301 shows that the Amplifier is receiving power. A fuse protects the amplifier.

SECTION II

OPERATING PROCEDURES

1. BASIC PROCEDURES

There are four basic procedures in operating the Sanborn DC General Purpose Amplifier.

2. CONNECTING THE DC GENERAL PURPOSE AMPLIFIER

Apply power and allow 30 minutes warmup for stability. Connect the signal to the INPUT jack on the panel through a three circuit phone plug as shown in figure 2.

a. With the push–pull (balanced) connection, the recording shows the potential between the two signal terminals. In–phase signals between these two terminals and ground are rejected as tabulated in Section 1.

b. With the single–ended (unbalanced) connections, the recording shows the potential between the live terminal and ground.

c. To record the difference of two single–ended signals, connect one signal between one push–pull terminal and ground, and the other signal between the other input terminal and ground. The instantaneous average of the two signals is present at the two input terminals as an in–phase potential, which is rejected as tabulated in Section 1.

d. To record the sum of two (or more) signals, connect to the Preamplifier through an external mixing circuit. Always correct for the attenuation of the mixing circuit when interpreting the recording.

3. BALANCING THE DC GENERAL PURPOSE AMPLIFIER

Check the balance after extended periods of operation, or after replacing some component. This paragraph applies to:

Model No.	Serial No.
64-300B	915 and above
67-300B	121 and above
67A-300B	279 and above

For older instruments and models 126, 126B, **use words in italics.**

a. After warmup, set the ATTENUATOR to OFF and the SENSITIVITY control fully clock-wise *(counter-clockwise).* Set the stylus to mid-scale with **the** CENTERING **control.**

b. Set the SENSITIVITY **control fully counter-**clockwise *(clockwise).* Remove the protective button and return the stylus to mid-scale with the BALANCE control.

c. Turn the SENSITIVITY **control back and forth between its limits.** There should be no **stylus motion. If a small amount of stylus motion is still present, repeat steps a, b, and c.**

4. CALIBRATING THE DC GENERAL PURPOSE AMPLIFIER

Calibration sets the basic sensitivity to 50 millivolts per centimeter of stylus deflection. The basic

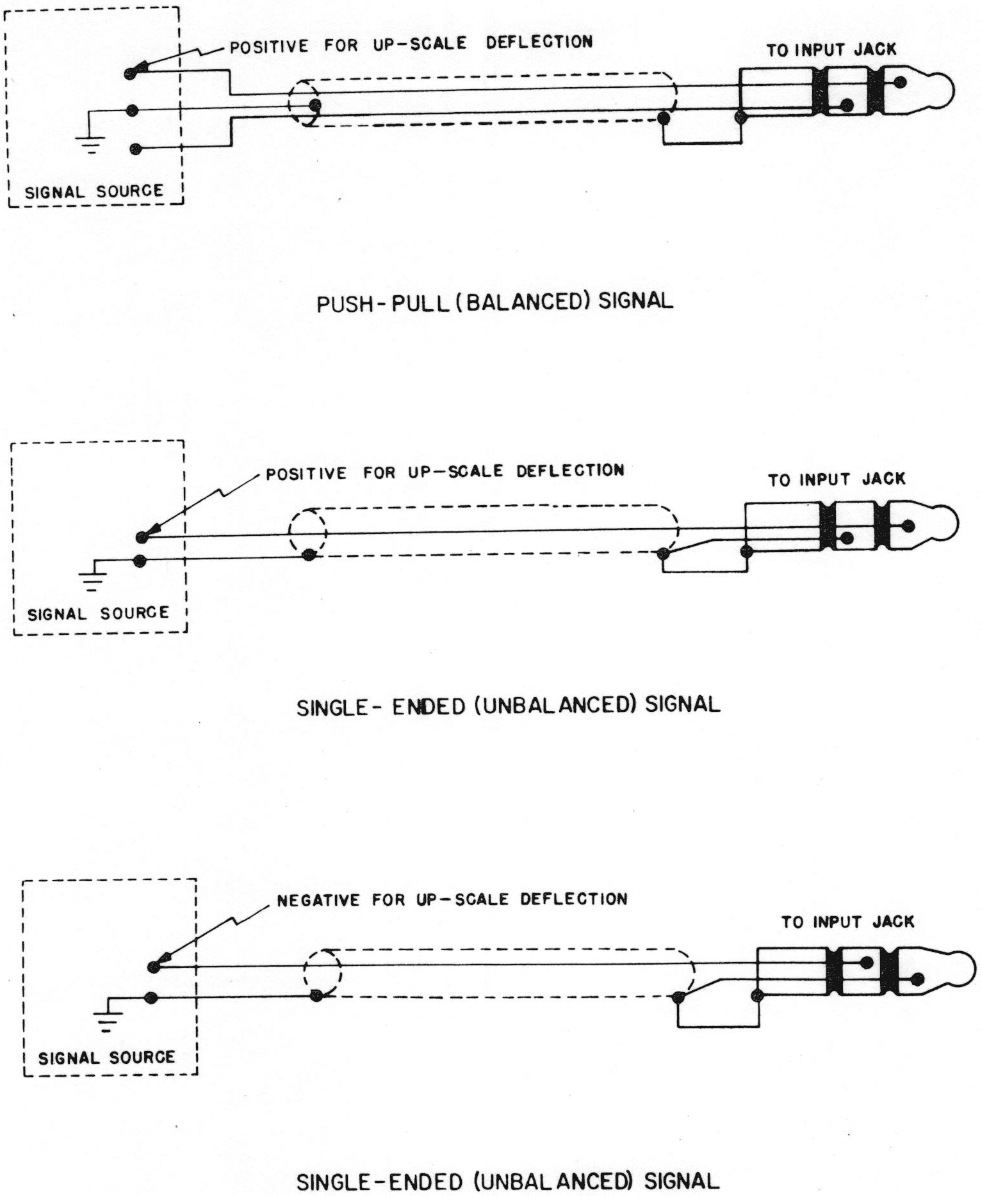


Figure 2. Input Circuit Connections, Sanborn DC General Purpose Amplifier.

sensitivity is the sensitivity of the system when the DC General Purpose Amplifier ATTENUATOR is at X1. The DC General Purpose Amplifier measures the actual potential across the input terminals. When the signal source impedance is negligible with respect to five megohms, the DC General Purpose Amplifier records the equivalent open circuit voltage of the signal source.

a. After warmup (and balancing, if required) set the ATTENUATOR to OFF, and position the stylus at mid-scale with the CENTERING control.

b. Turn the ATTENUATOR between OFF and CAL, and adjust the SENSITIVITY control for a stylus deflection of one centimeter. Return the ATTENUATOR to OFF. The DC General Purpose Amplifier is now calibrated to a basic sensitivity of 50 millivolts per centimeter of stylus deflection.

5. OPERATION

a. After warmup and calibration, turn the ATTENUATOR to OFF and set the base line with the CENTERING control. Run a few inches of record to establish the base line position. Then advance the ATTENUATOR for a convenient deflection and start the recording.

b. Read the input signal in volts by multiplying the factors 0.05 by the ATTENUATOR setting and by the centimeters of stylus deflection, or by using the formula:

Volts = (.05) x (centimeters deflection) x (ATTENUATOR setting)

SECTION III

THE OSCILLOSCOPE JACK

1. INTRODUCTION

The OSCILLOSCOPE jack (not present on all instruments) is used to connect the Sanborn DC General Purpose Amplifier to a cathode ray oscilloscope. The following paragraphs describe circuits used to connect various types of oscilloscopes.

2. THE DIRECT-COUPLED CIRCUIT

An oscilloscope with push-pull "Y" axis input terminals is required, having a direct-coupled "Y" axis amplifier. In this circuit (figure 3), "R" = (220) x (sensitivity), where "R" is in ohms and "sensitivity" is the maximum oscilloscope sensitivity in peak-to-peak millivolts at the "Y" axis input terminals per inch of beam spot deflection. The frequency response of the oscilloscope display will extend to zero cycles.

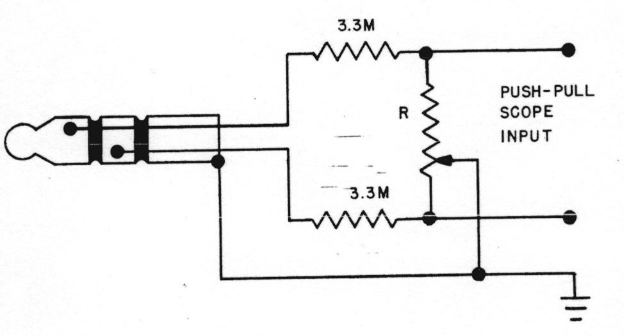


Figure 3. Direct Coupled Oscilloscope Coupling Circuit.

a. Remove the phone plug from the OSCILLOSCOPE jack and turn the ATTENUATOR to OFF. Center the stylus at mid-scale with the CENTERING control of the DC General Purpose Amplifier. Center the oscilloscope beam at its mid-line with the oscilloscope centering control.

b. Insert the phone plug into the OSCILLOSCOPE jack, and center the oscilloscope beam once more, using the potentiometer in the coupling circuit. The oscilloscope is now ready for operation, at a sensitivity of approximately one inch of beam deflection per centimeter of stylus deflection.

3. THE CONDENSER-COUPLED CIRCUIT

An oscilloscope with push-pull "Y" axis input terminals is required, having a direct-coupled or condenser-coupled "Y" axis amplifier. In this circuit (figure 4), "R" = (220) x (sensitivity), where "R" in is ohms and "sensitivity" is the maximum oscilloscope sensitivity in peak-to-peak millivolts at the "Y" axis input terminals per inch of beam spot deflection. The low frequency response of the oscilloscope display is down to 71% of maximum response at the frequency where the reactance of the coupling condenser equals the input resistance of the oscilloscope (unless limited by the oscilloscope response). There will be 45 degrees of phase shift at this frequency (unless affected by the oscilloscope response).

a. Insert the phone plug into the OSCILLOSCOPE jack. Center the stylus at mid-scale with the CENTERING control of the DC General Purpose Amplifier. Center the oscilloscope beam at its mid-line with the oscilloscope centering control.

b. The oscilloscope is now ready for operation, at a sensitivity of approximately one inch of beam spot deflection per centimeter of stylus deflection.

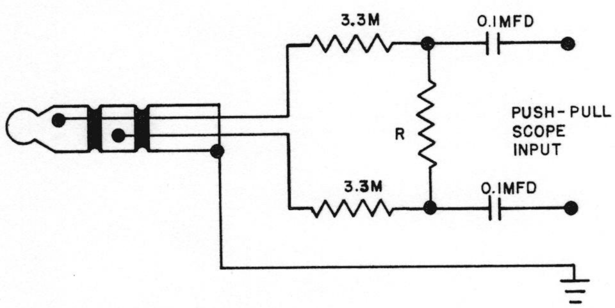


Figure 4. Condenser–Coupled Oscilloscope Coupling Circuit.

4. THE TRANSFORMER–COUPLED CIRCUIT

This circuit uses a conventional oscilloscope with single–ended "Y" axis input terminals. In this circuit (figure 5), "R" is the lowest possible value of resistance which will still give adequate oscilloscope beam deflection; this value is found experimentally. T1 is a medium quality 3:1 step–up interstage audio transformer having a primary inductance of at least 250H, rated to carry d–c. The low frequency response is down 3 db. at the frequency where the transformer primary reactance equals the value of "R". There will be 45 degrees of phase shift at this frequency. This circuit uses the transformer characteristics in an unconventional manner, and because there may be distortion from transformer non–linearity, this circuit must be considered experimental, and cannot be used in all applications where an oscilloscope display is required.

a. Insert the phone plug into the OSCILLOSCOPE jack. Center the stylus at mid–scale with the CENTERING control of the DC General Purpose Amplifier. Center the oscilloscope beam at its mid–line with the oscilloscope centering control.

b. The oscilloscope is now ready for operation.

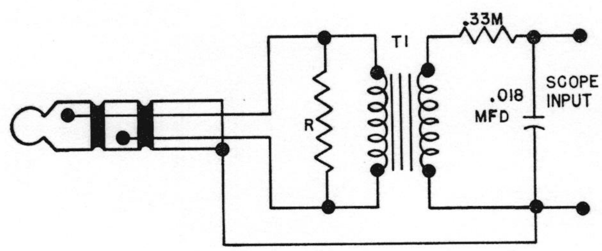


Figure 5. Transformer–Coupled Oscilloscope Coupling Circuit.

5. DIRECT COUPLING TO THE OSCILLOSCOPE DEFLECTION PLATES

This circuit (figure 6), requires no coupling circuit, and gives a response on the oscilloscope display to zero cycles. This method requires minor changes in the oscilloscope, which cannot be specified here because they vary from one make of oscilloscope to another. Refer to your oscilloscope instruction manual for the details of these changes and for warnings on this type of operation. With some oscilloscopes, the manufacturer may not recommend this type of operation, or may specify capacitive coupling to the deflection plates. Follow his instructions.

a. Insert the phone plug into the OSCILLOSCOPE jack. Center the stylus at mid–scale with the CENTERING control of the DC General Purpose Amplifier.

b. The oscilloscope is now ready for operation.

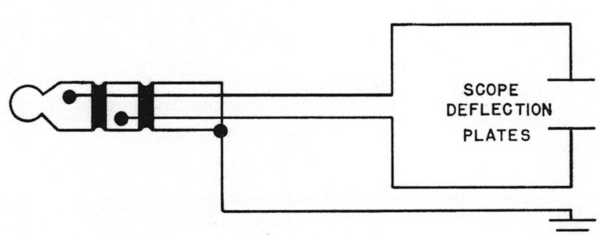


Figure 6. Direct Coupling to Oscilloscope Deflection Plates.

SECTION IV

MAINTENANCE

1. ADJUSTING THE HUM CONTROL

a. Set the ATTENUATOR to X4 (or X2 for models whose number has "B" suffix).

b. Remove the protective button over the HUM control.

c. Open the viewing window of the associated Recorder, to gain access to the wr iting arm.

d. Place one or two fingers at the base of the writing arm. Be careful of the hot stylus and voltages at the galvanometer terminals. Adjust the HUM control for minimum vibration as felt in the fingers.

e. Return the ATTENUATOR to OFF and replace the protective button.

2. ADJUSTING THE DAMPING CONTROL

a. Balance and calibrate the Amplifier for normal operation, as described in Section II.

b. Turn the ATTENUATOR back and forth between OFF and CAL with the Recorder running.

c. Inspect the recorded square wave pulses, and look for the slight overshoot on the leading edge of each pulse. This overshoot should be between zero and four percent, or up to 0.4 mm. with normal Amplifier sensitivity. See figure 1.

d. If the overshoot is outside these limits, remove the protective button and adjust the DAMPING control for four percent overshoot (or 0.4 mm.).

e. The DAMPING control is now properly adjusted. Replace the button.

3. TROUBLE SHOOTING PROCEDURE

In case of faulty or erratic operation, the following steps will help correct the most common causes of trouble.

a. Check that the signal circuit connections are electrically and mechanically tight, and that they ar e properly made.

b. Check that the INPUT plug is inserted to its maximum distance, and that the connections to the plug are mechanically and electrically tight.

c. Check that the in–phase component of signal voltage does not exceed the limits tabulated in Section I.

d. Check with an oscilloscope that the input does not include transient voltages or high frequency components which might overload the instrument. This applies to both the signal and the in–phase component.

e. Repeat the starting, balancing, and calibrating procedures as given in this manual, to check that they have been properly performed.

f. Connect 1.5 a volt dry cell to the three circuit phone plug as a single ended signal. Set the ATTENUATOR to X20. With the SENSITIVITY control fully clockwise, insert and then remove the phone plug from the INPUT jack. The stylus deflection should be a least 1.8 centimeters. This indicates that the system is operating normally.

4. SPECIAL NOTES ON LIMITER CIRCUIT

The DC General Purpose Amplifier includes a limiting circuit and limiter tube, type 12AU7, identified as V307. This limiter was originally included to protect the stylus from damage in case of sudden overload by signals at line frequency. Recent improvement in stylus design has made the limiter unnecessary.

In case this limiter is still in the Amplifier, the operator can improve the linearity of the instrument at low line voltages by removing V307. This also makes the Amplifier less sensitive to variations in tube characteristics.

The limiter is omitted in all instruments Model 126B, 64–300B, and 67–300B.

Model	V307 eliminated after serial no:
126	530
64–300A	2150
67–300	2315

SECTION V

THEORY

1. INTRODUCTION

The Sanborn DC General Purpose Amplifiers are unit instruments designed for use with Sanborn Recorders. The Amplifier and Recorder together comprize a recording vacuum–tube voltmeter capable of recording electrical phenomena down to zerc cycles with no loss.

The amplifier consists of three direct–coupled push–pull stages and a regulated power supply.

2. COMPLETE RECORDING SYSTEM

Figure 7 is a simplified block diagram showing one channel of a Sanborn Recording System using a DC General Purpose Amplifier. The Amplifier is connected to the Recorder through an interconnecting cable. The input signal is amplified and drives the Galvanometer. The writing arm stylus moves across the Permapaper, to make a permanent, instantaneous record of the input signal, in rectangular coordinates.

3. SANBORN DC GENERAL PURPOSE AMPLIFIER: GENERAL DESCRIPTION

Figure 8 is a simplified block diagram of the DC General Purpose Amplifier. The signal (push–pull or single–ended) is fed into the DC General Purpose Amplifier through the INPUT socket J301. When using an AC Preamplifier or DC Preamplifier (with Models 64–300A, 64–300B, 67–300, 67–300B only) the signal from the Preamplifier is fed into the DC General Purpose Amplifier through the interconnecting jack J303.

The ATTENUATOR S302 controls the input signal amplitude by the factors given on the panel. These factors are 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000 on Models 126B, 64–300B, and 67–300B. The factors are 1, 4, 20, 100, 400, and 1000 on Models 126, 64–300A, and 67–300.

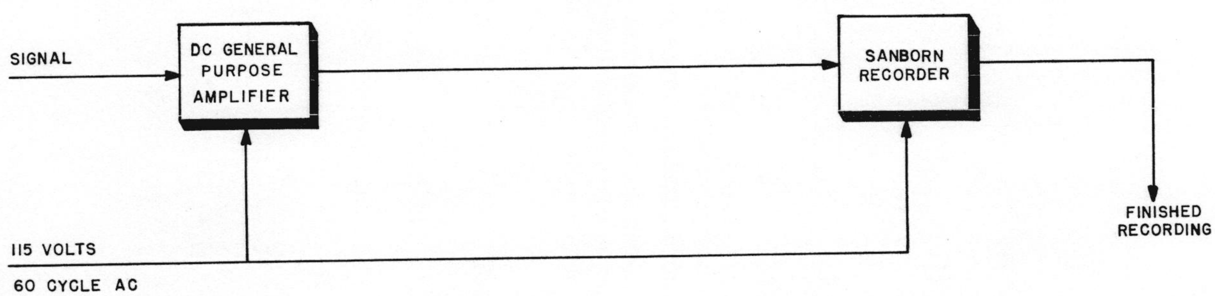


Figure 7. Block Diagram of Recording System Using Sanborn DC General Purpose Amplifier.

The push–pull d–c amplifier V301 amplifies the signal and drives the grids of V302. The SENSITIVITY control R315 in the plate circuit of V301 controls the gain of the system to allow accurate calibration in volts input per centimeter of stylus deflection. The CENTERING control R316 in the grid circuit of V302 selects the position of the Galvanometer writing arm which corresponds to zero input signal to the Amplifier.

The push–pull d–c amplifier V302 amplifies the signal and drives the grids of V303 and V304. The DAMPING control C304 is the controllable element of the positive feedback loop around V302. Adjusting this control varies the positive feedback at the upper frequency range of the Amplifier, so that it will complement the high–frequency response of the Galvanometer. This extends the frequency response of the system, and gives an optimum transient response.

The push–pull direct–coupled cathode follower output stage V303 and V304 supply power to drive the galvanometer. The OSCILLOSCOPE jack J305 couples the signal across the galvanometer to the push–pull input terminals of an oscilloscope. The CARDIOSCOPE jack J204 (Models 64–300A, 67–300 only) couples the signal across the galvanometer to the input terminals of a Sanborn Cardioscope.

Power is supplied to the DC General Purpose Amplifier through the interconnecting jack J303. Power transformer T301 supplies the two 6.3 volt filament circuits, and the center-tapped plate voltage winding. Rectifier V305 supplies rectified pulsating d-c to the RC filter, which furnishes the +360 volt and +280 volt plate voltages. Voltage regulator V306 determines the +103 volt plate voltage and the -5.2 volt bias voltage. HUM control R337 is adjusted to balance out any hum component on the recording.

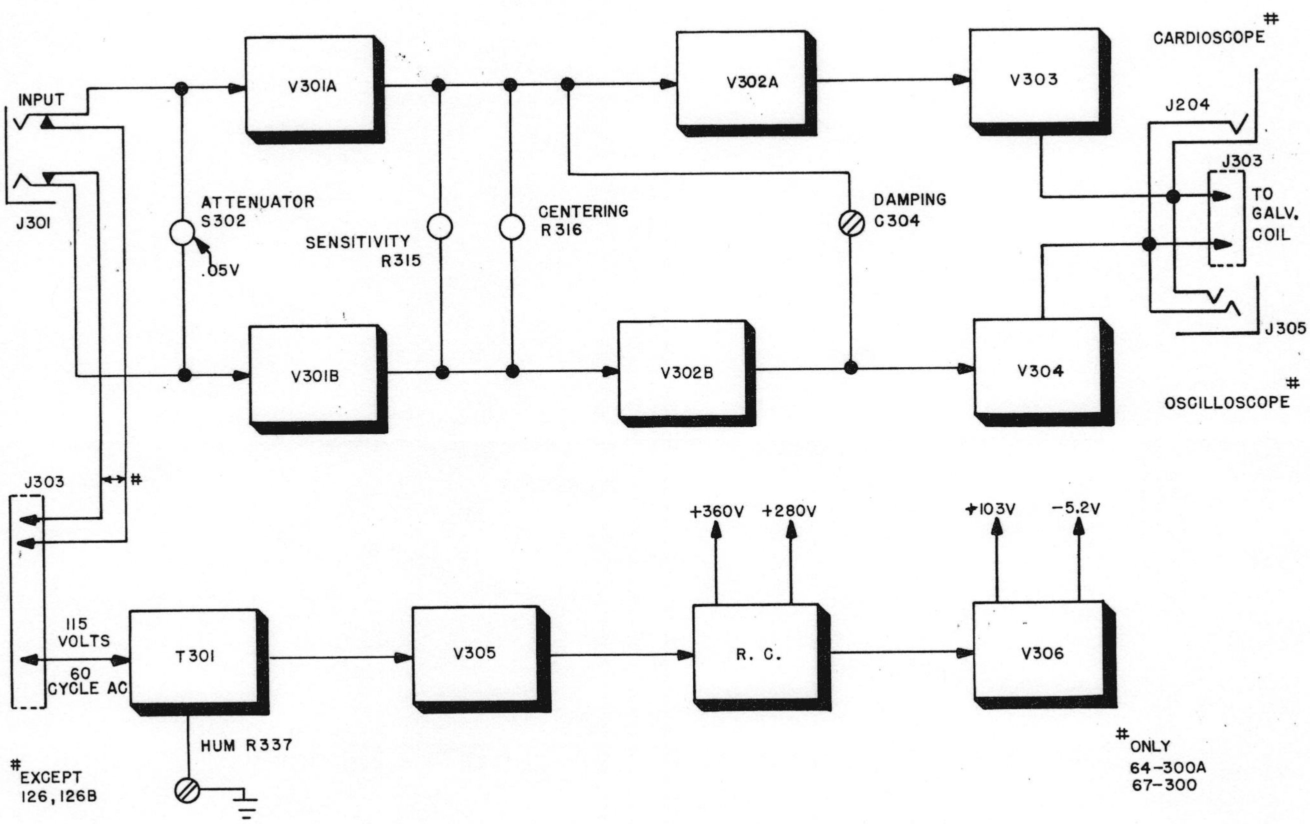


Figure 8. Simplified Block Diagram of Sanborn DC General Purpose Amplifier.

4. INPUT CIRCUIT: THEORY

The input circuit is shown in the simplified schematic diagram, figure 9. The signal is normally fed into the DC General Purpose Amplifier through the INPUT jack J301. When using an AC or DC Preamplifier (with Models 64–300A, 64–300B, 67–300, 67–300B only), the signal from the Preamplifier is fed into the DC General Purpose Amplifier through the interconnecting jack J303.

The ATTENUATOR S302 selects a position on the balanced attenuator resistor network, to attenuate the input signal by the ratio marked on the panel. With Model numbers 126B, 64–300B, and 67–300B, these attenuation ratios are 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000. With Model numbers 126, 64–300A, and 67–300, these attenuation ratios are 1, 4, 20, 100, 400, and 1000.

At the OFF position of the ATTENUATOR switch, the grids of push–pull d–c amplifier V301 are connected to ground. This protects the system from excessive stylus motion during connection and while making adjustments. At the CAL position of the ATTENUATOR switch, the grid of V301B is connected to ground and the grid of V301A is connected to the .05 volt position of the voltage divider R307 and R308, fed from the +103 volt regulated supply. Capacitors C301 and C302 at the grids of V301 have a low reactance at frequencies above the audio range, and short out any radio–frequency components picked up by the wiring, which might otherwise affect the operation of the instrument.

If the two sides of the push–pull d–c amplifier V301 are perfectly balanced, the BALANCE control R354 will be set at the mid–point of its resistance range. If there is unbalance between the two sides of the circuit, the BALANCE control is moved to one side or the other, to a position where the increased degeneration on one side of the circuit and the decreased degeneration on the other side return the two sides of the circuit to balance.

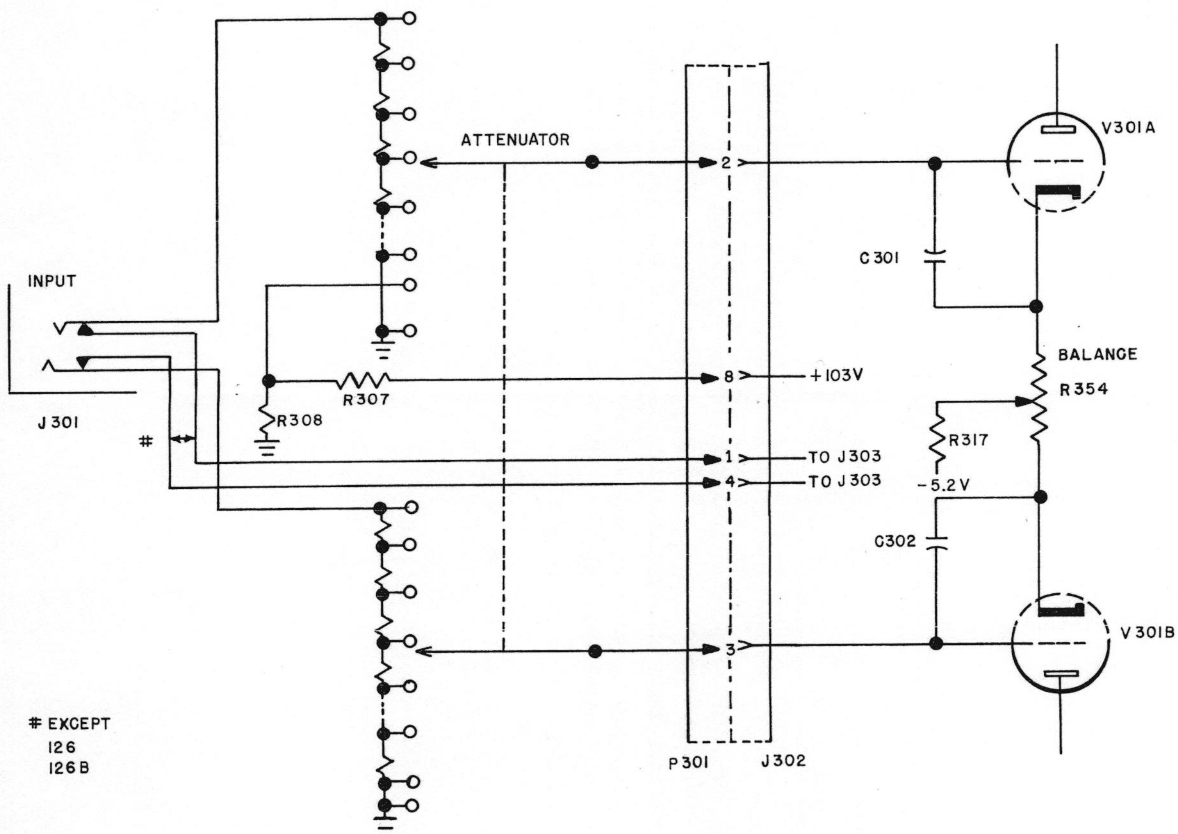


Figure 9. Input Circuit of Sanborn DC General Purpose Amplifier.

The BALANCE control tap is returned to the –5.2 volt supply through an 82K resistor R317. This resistance provides the in–phase rejection characteristics of the Amplifier. Amplifier operation with respect to in–phase rejection is shown by treating the first stage as an elementary push–pull amplifier. See figure 10.

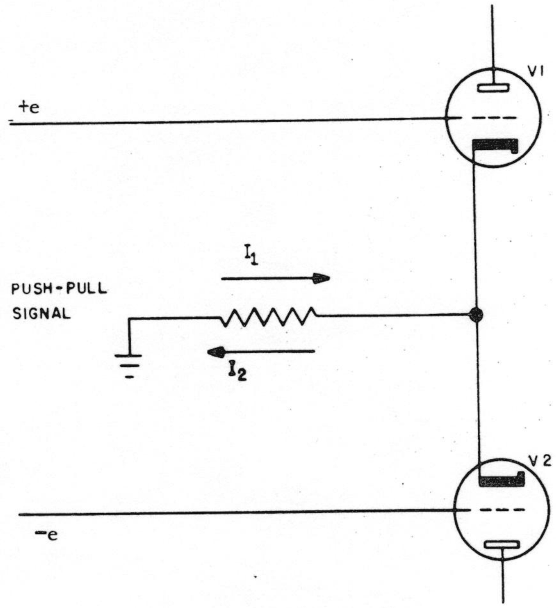


Figure 10. A Push–Pull Signal Impressed On Grids.

The in–phase voltage is the portion of the instantaneous input terminal signal which appears at both input terminals at the same amplitude and polarity with respect to ground. With a push–pull signal the in–phase component equals $\frac{a+b}{2}$, where "a" is the instantaneous voltage between one input terminal and ground. Only a very small fraction of this in–phase voltage will appear on the record because of the inherent in–phase rejection of the Amplifier. The Amplifier ideally responds only to the signal component a – b.

With a true push–pull signal which has no in–phase voltage component, the signal voltage +e at the grid of V1 is exactly equal and opposite to the signal –e at the grid of V2. The signal component of current through V1 is therefore equal and opposite to the signal component of current through V2 (assuming perfect balance). These current components flow through the cathode resistor in opposite directions as shown in figure 10, and cancel out.

The cathode resistance therefore has no effect with push–pull signals because there is no signal component of voltage developed across it, and the stage operates at full gain for push-pull signals.

When a pure In–phase signal is applied (this can be done by connecting the two grids together and applying a signal between the grids and ground) the signal voltage at the grid of V1 is exactly equal and of the same potential as the signal voltage at grid of V2.

The signal component of current through V1 is therefore exactly equal to and in the same direction as the signal component of current through V2 (assuming perfect balance). These current components flow through the cathode resistor in the same direction as shown in figure 11, and develop a voltage drop across this resistor. This voltage introduces a large amount of cathode degeneration for the in–phase component, and thereby introduces the in-phase rejection factor described in Section I.

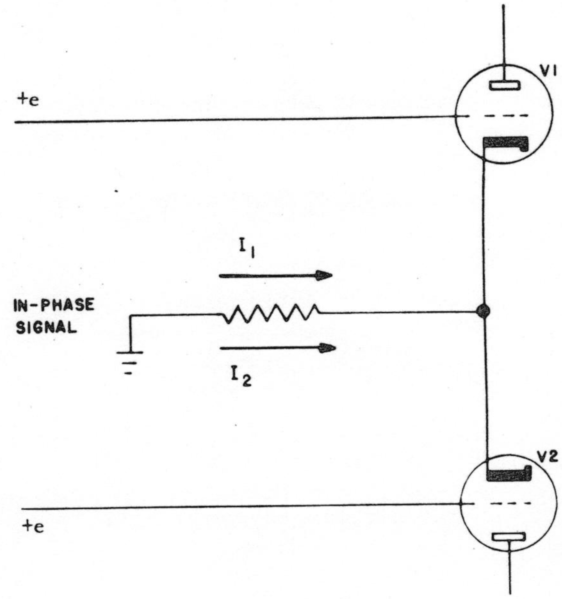


Figure 11. In–Phase Signal Impressed on Grids.

Operation with a single-ended input signal is shown by treating the instrument as an elementary push-pull amplifier shown in figure 12.

With a single-ended signal applied to the grid of V1, there will be a signal component of current through V1. This current component flows through the cathode resistor, and elevates the common cathode potential to a voltage which approaches $+\frac{e}{2}$. As a result, the grid-to-cathode potential of V2 approaches $-\frac{e}{2}$ This is equivalent to a push-pull signal applied to the grids, and the Amplifier therefore operates as if a push-pull signal were applied to the input terminals.

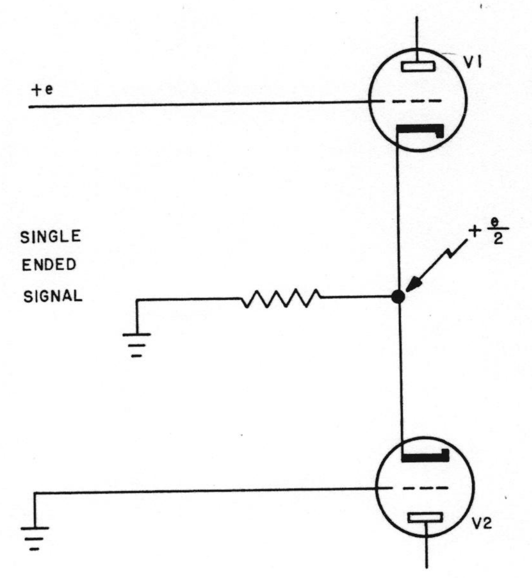


Figure 12. Single-Ended Signals Impressed on Grids.

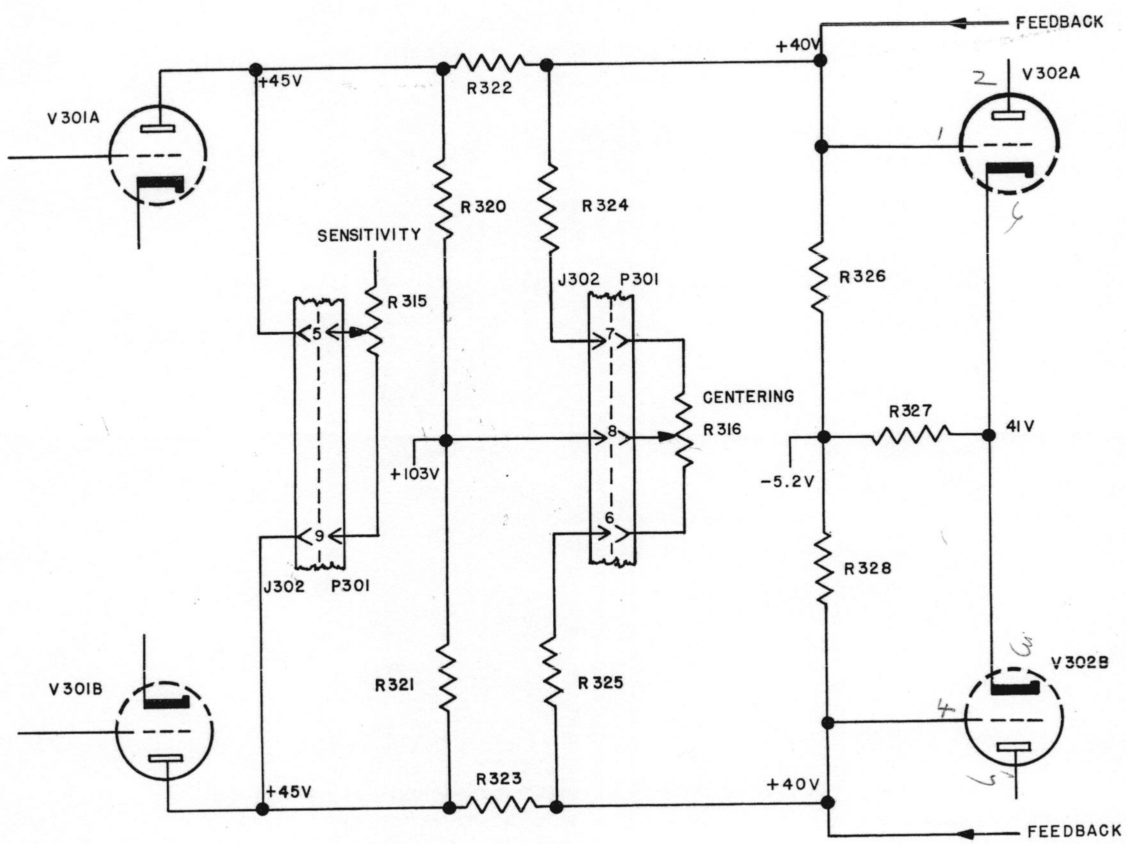


Figure 13. Coupling Circuit Between V301 and V302.

5. COUPLING CIRCUIT BETWEEN V301 AND V302: THEORY

The coupling circuit between V301 and V302 is shown in the simplified schematic diagram, figure 13. The SENSITIVITY control R315 is connected from one plate of the push–pull d–c amplifier V301 to the other plate. As the resistance of this control is increased the gain of the stage is increased. Series resistors R322 and R323 are a part of the coupling network and help maintain the grids of the following stage at the proper bias. Plate load resistors R320 and R321 furnish the plate current path for V301, and present a high impedance across which the amplified signal voltage may be developed.

Series resistors R324 and R325 establish the effect of CENTERING control R316 at a little more than 2.5 centimeters to each side of mid–chart. With the CENTERING control at its mid–position, the voltage at the grid of V302A will equal the voltage at the grid of V302B, at approximately +40 volts. (This assumes that the push–pull circuit is perfectly balanced). When the CENTERING control is moved from its mid–position, the d–c biasing potential at one grid will differ from that at the other grid. This differential signal at the grids moves the galvanometer stylus up or down on the Permapaper depending on the CENTERING control setting, to establish a stylus position corresponding to zero input signal.

The cathode resistor R327 is common to V302A and V302B. This resistor has a high value, and provides an in–phase rejection characteristic for V302. The feedback circuit termination is shown in figure 13. The complete feedback loop is shown in figure 14, and is described in paragraph 6.

6. COUPLING CIRCUIT BETWEEN V302 AND THE OUTPUT STAGE

The coupling circuit between V302 and the output stage is shown in the simplified schematic diagram, figure 14. Resistors R331, R332, R333, and R334 furnish the plate current path for V302 and present a high impedance across which the amplified signal voltage may be developed. One third of the voltage developed across the total plate load resistors is used in a high frequency positive feedback loop.

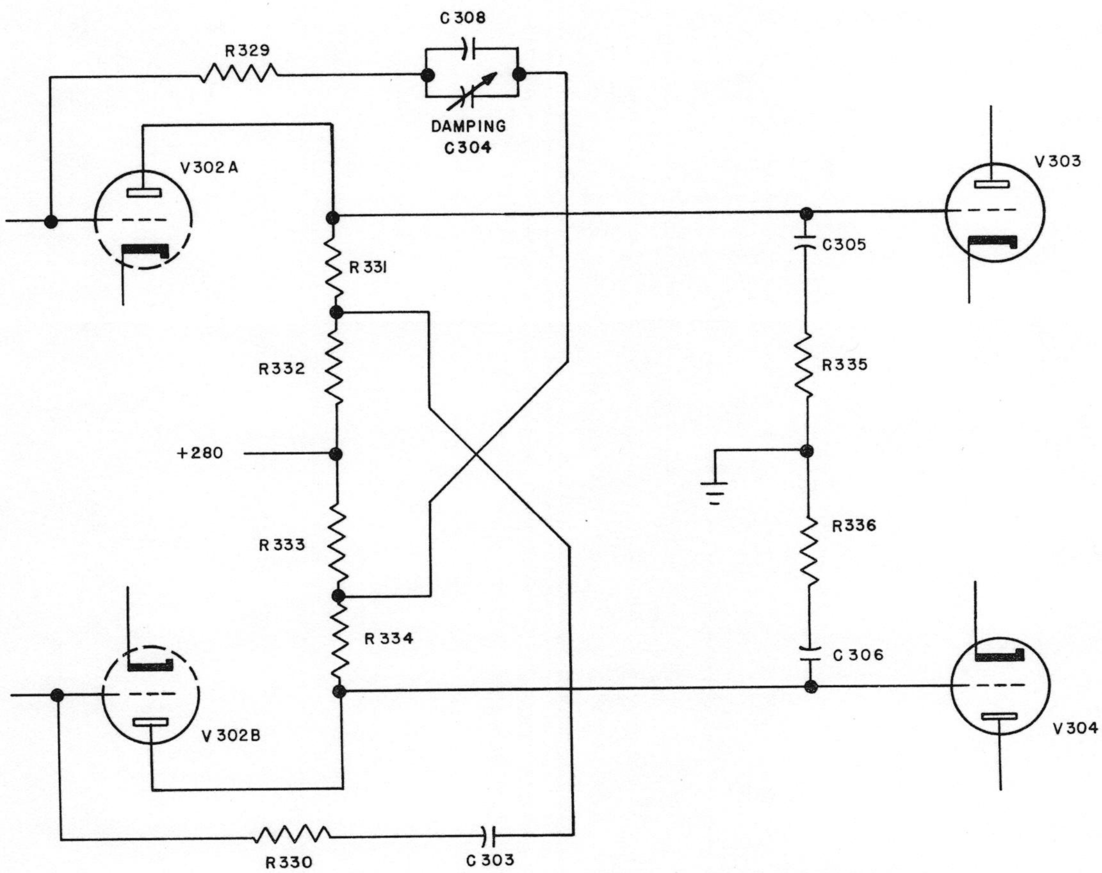


Figure 14. Coupling Circuit Between V302, V303 and V304.

Two feedback paths are required for balanced feedback around the push–pull stage. Each feedback path includes a series resistor (R330 or R329), and a series capacitance (C303 or C304 plus C308). The resistors determine the amount of feedback, and the condenser and resistors combined determine the frequency at which the feedback becomes effective. The DAMPING control C304 is the variable element in the feedback circuit; only one feedback network is made variable because the inherent symmetry of the stage compensates for the slight unbalance resulting from adjusting this control over its range. Adjusting the DAMPING control varies the positive feedback at the upper frequency range of the amplifier, to extend the high frequency response of the galvanometer. This extends the frequency response of the recording, and gives a recording of a square wave unit pulse input which is the same as that of a galvanometer operating at 71% of critical damping. This corresponds to 4% overshoot on the recorded square wave, which is the optimum for a fast rise time with minimum wave form distortion.

With the DAMPING control C304 at maximum capacity, high–frequency equalization is effective at too low a frequency, and the response to a square–wave signal will show an overshoot. With the DAMPING control C304 set for minimum capacity, the high frequency equalization is inadequate, and the response to a square wave signal will show an undershoot. The optimum position is somewhere between these two extremes, depending on the particular DC General Purpose Amplifier and the particular Galvanometer being used. An adjustment for 4% overshoot is the optimum.

In case of overload at any high frequency within the writing range of the system, V302A and V302B will be driven between cutoff and saturation, at a high repetition rate. This can result in excessive stylus vibration, with consequent damage to the writing arm or the stylus. This condition is made worse by the damping characteristic of the output stage under these conditions. At cutoff, an output tube no longer presents a damping impedance to the galvanometer, and an overload voltage records with a violent overshoot, sufficient to damage the stylus or writing arm. This condition is decreased by capacitors C305 and C306. These filter out the high–frequency distortion components generated at the plates of V302 by this type of overload, and make a smoother transition from cutoff to full current, with less possibility of stylus damage. Resistors R335 and R336 prevent parasitic oscillation when the output tube is operating in the positive grid voltage region.

7. OUTPUT CIRCUIT: THEORY

The output circuit is shown in the simplified schematic diagram figure 15. The push–pull cathode follower output stage V303, V304 drives the galvanometer coil, which moves the stylus across the recording Permapaper. The source impedance presented to the galvanometer by the output stage is 500 ohms. At this value, the galvanometer operates near critical damping. Connection to the galvanometer is made through the interconnecting jack J303. Resistors R349A and R349B are cathode–biasing resistors which elevate the cathode potential of the cathode follower output stage to +160 volts. With +145 volts on the grids of this push–pull stage, the tubes are operating with the required 15 volts of negative bias. In DC General Purpose Amplifiers 64–300A and 64–300B, the 1540 ohm resistor R349B is included in the case which holds the Galvanometer and Recorder.

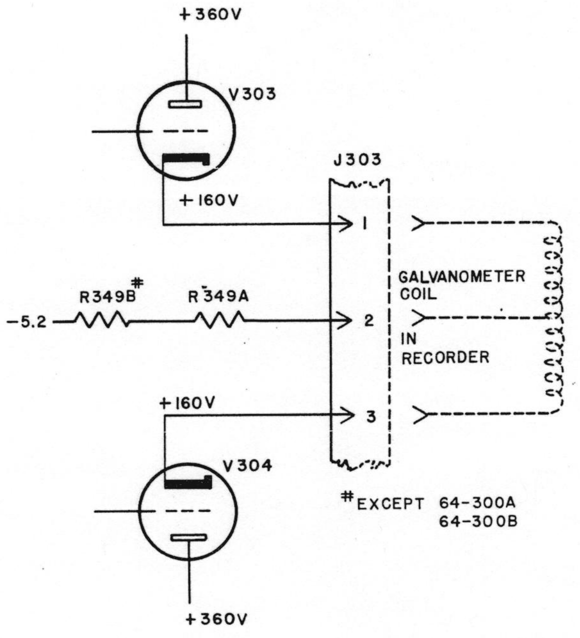


Figure 15. Output Circuit.

8. OSCILLOSCOPE COUPLING CIRCUIT: THEORY

The OSCILLOSCOPE and CARDIOSCOPE jack circuits are shown in figure 16. The series resistors R352 and R353 are connected between the galvanometer terminals and OSCILLOSCOPE jack J305. These isolate the oscilloscope from the galvanometer and furnish the series arm of the RC equalizer circuit. The shunt arm of the equalizer circuit, condensers C313 and C314, is connected between each OSCILLOSCOPE jack terminal and ground. This combination of resistance and capacitance introduce a high-frequency attenuation of the signal to the OSCILLOSCOPE to compensate for the high frequency pre-emphasis introduced by the DAMPING control positive feedback loop. This results in an oscilloscope display which represents the input signal to the Amplifier, with the effects of the high frequency pre-emphasis removed.

The CARDIOSCOPE jack J304 (present on Models 64–300A, 67–300 only) is used to connect a Sanborn Cardioscope to the Amplifier. Resistors R350 and R351 attenuate the signal to the level required by the Cardioscope.

9. POWER CIRCUIT: THEORY

The power circuits are shown in figure 17. The input terminal connections shown are for Models 126 and 126B only. Connections for the other models are shown in figure 18.

Primary power is fed to plate transformer T301 through the interconnecting jack as shown. In Models 67–300, 67–300B only, the input power passes through the 1A Slo–Blo fuse F301 and the series POWER switch S301, and lights the POWER Indicator I301 when the power is applied by closing the switch.

The secondary of T301 includes a center–tapped plate voltage winding, and two 6.3 volt heater windings. The upper 6.3 volt heater winding (identified on the simplified schematic diagram as "Y") lights the heaters of V304 and V303. This winding is connected to the +103 volt supply to reduce the cathode–to–heater potential of this stage. The other 6.3 volt heater winding lights the heaters of the remaining stages, including the rectifier V305, which is designed for this type of operation. The

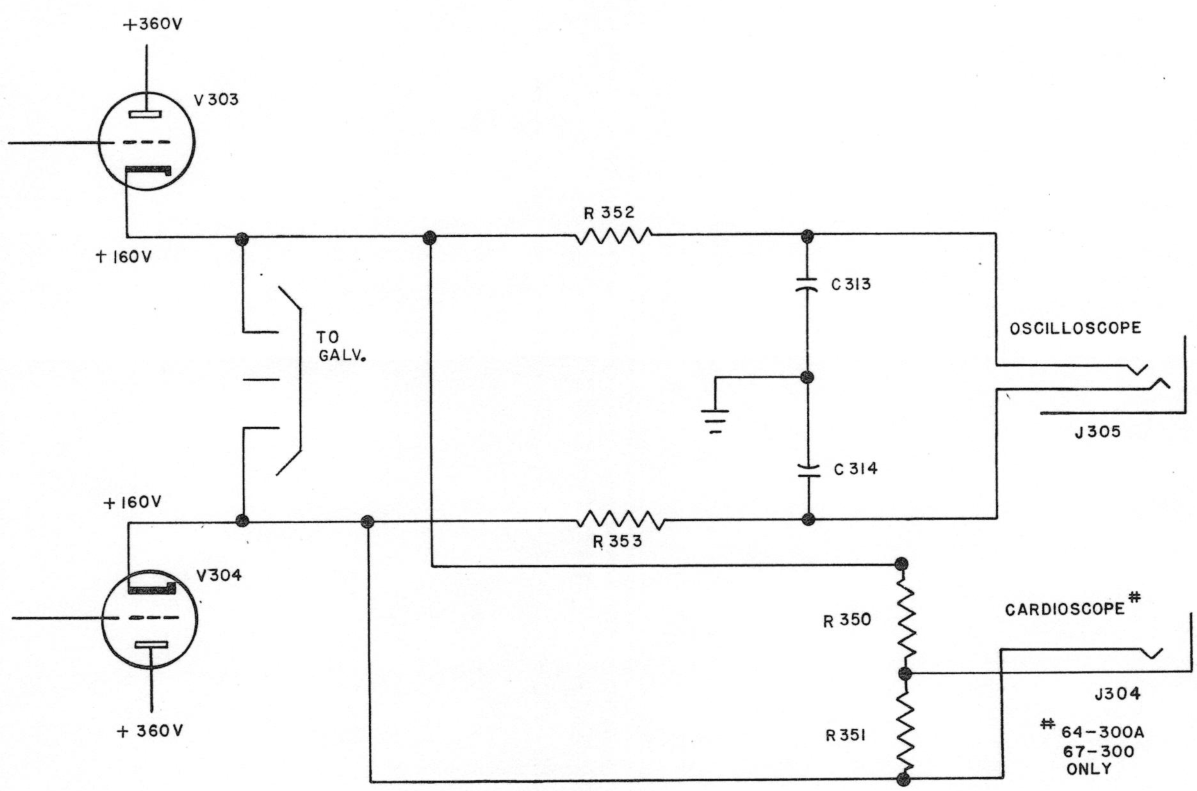


Figure 16. Oscilloscope Coupling Circuit.

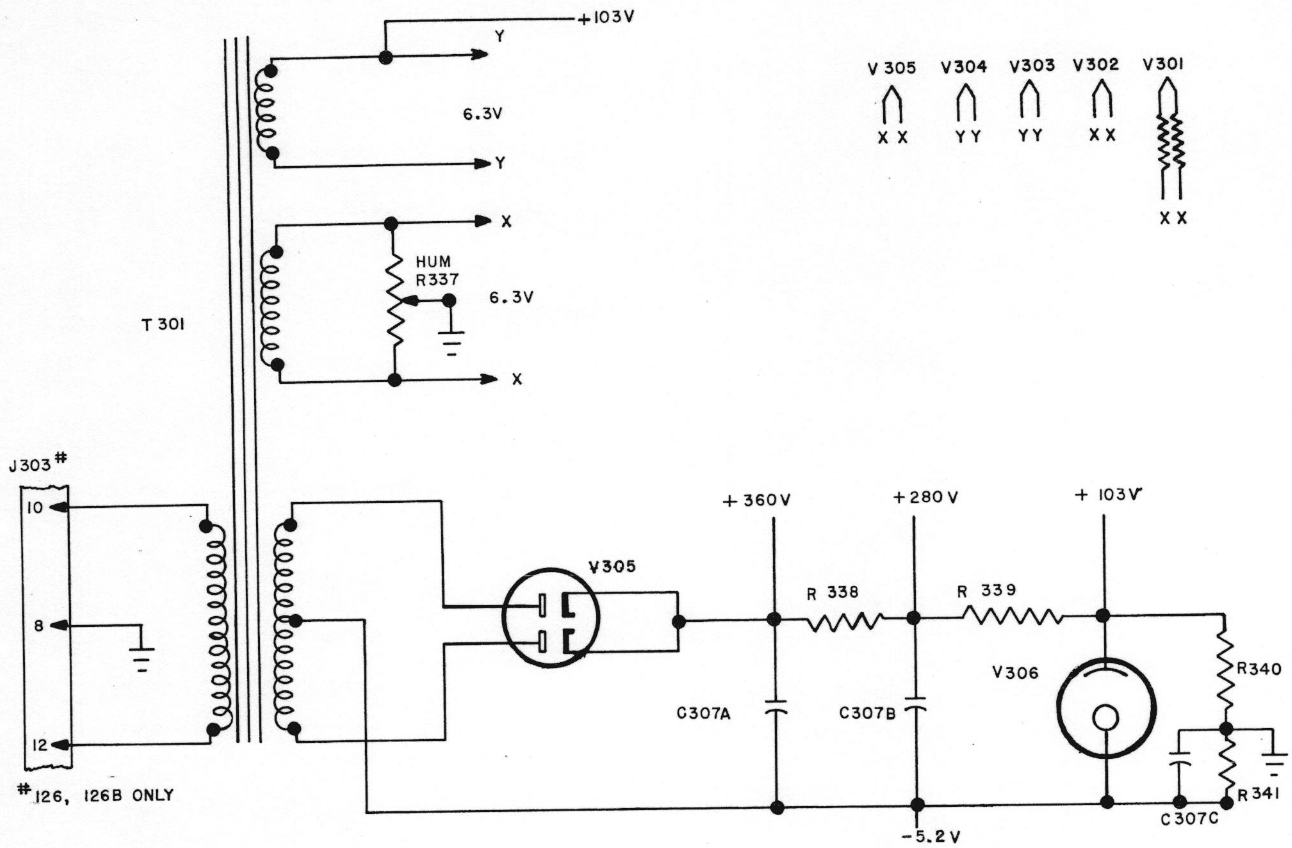


Figure 17. Power Circuit.

HUM control R337 balances the heater winding to ground, at the position which corresponds to zero hum on the recording. Note that the heater winding of V301 is connected through two voltage dropping resistors, R318 and R319. Operating this input stage at reduced heater voltage improves the grid current characteristics of the stage.

Rectifier V305 rectifies the voltage appearing at the center-tapped plate voltage secondary winding of T301. The pulsating d-c output of this rectifier is filtered by C307A, R338, and C307B to fix the +360 and +280 plate supply potentials. Voltage dropping resistor R339 and voltage regulator tube V306 supply a regulated d-c voltage, which is divided into a +103 volt potential and a -5.2 volt potential by grounding the junction of voltage dividers R340 and R341. The filter condenser C307C keeps the -5.2 volt supply at ground potential for a-c components.

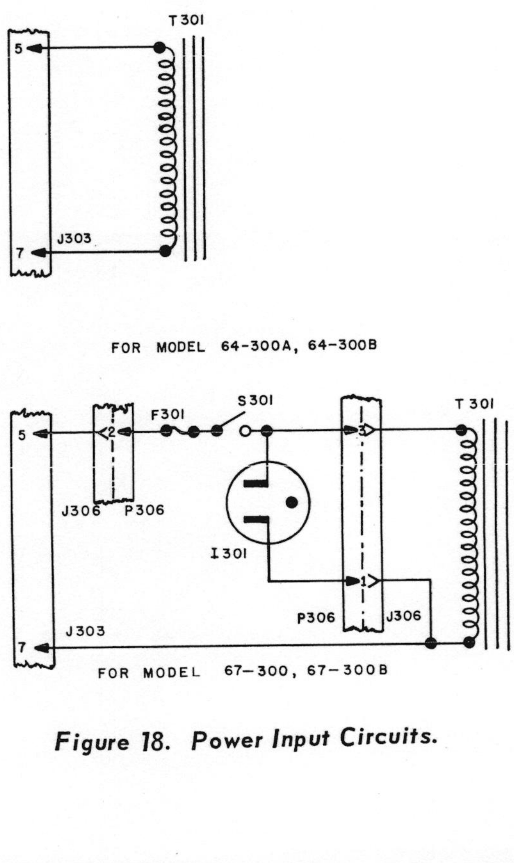


Figure 18. Power Input Circuits.

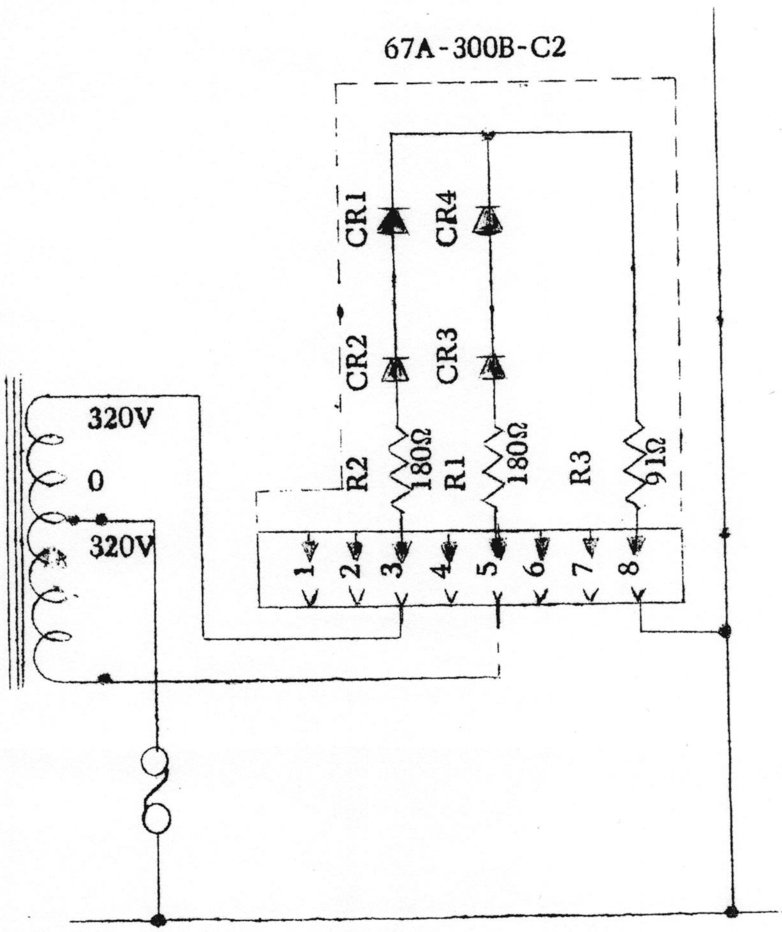
SANBORN COMPANY
175 WYMAN STREET
WALTHAM 54, MASS.
TEL: TW-4-6300
MARCH 19, 1959

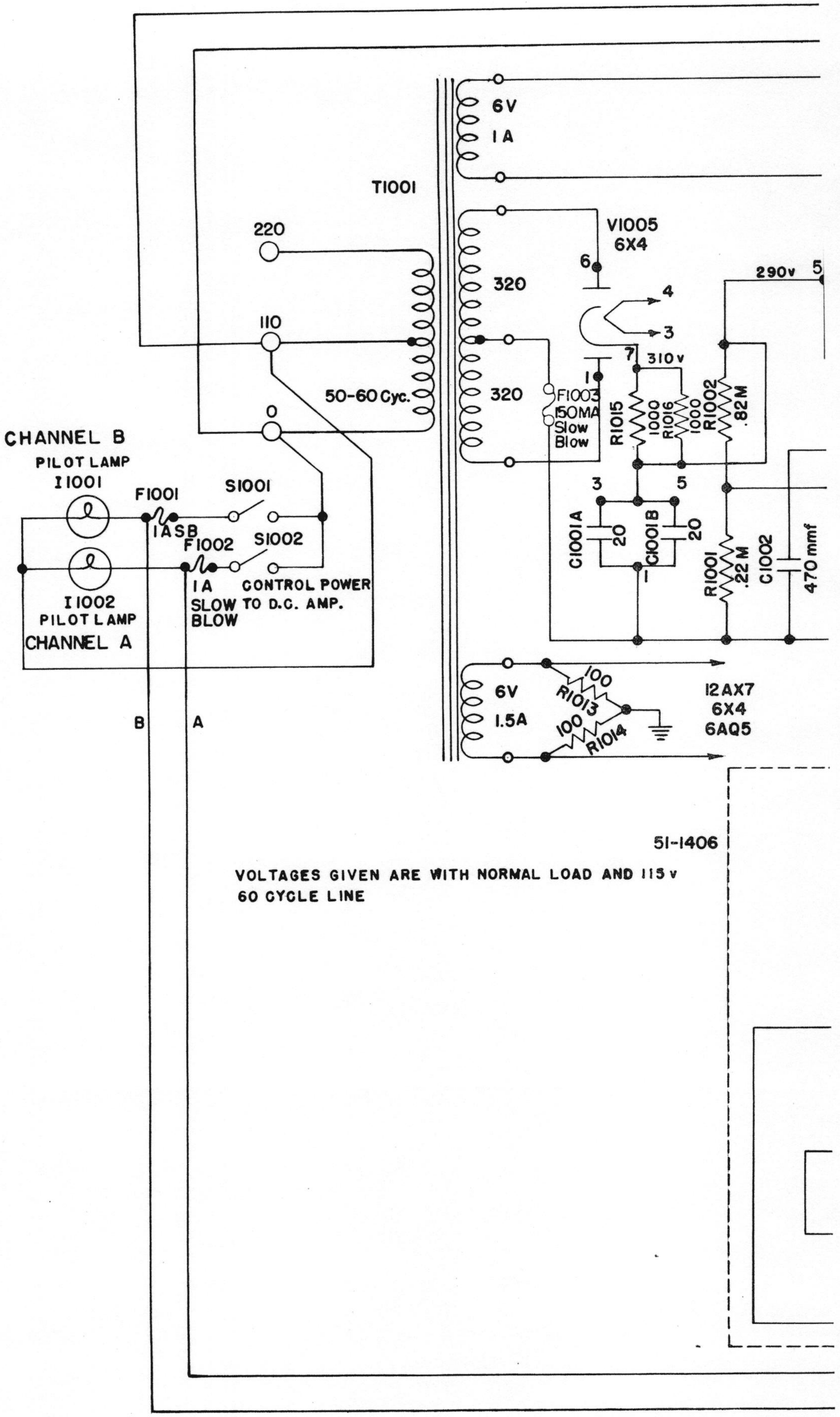
REPLACEMENT PARTS LIST SUPPLEMENT
RPL-64-300B-2A

SANBORN DC GENERAL PURPOSE AMPLIFIER
MODEL 64-300B

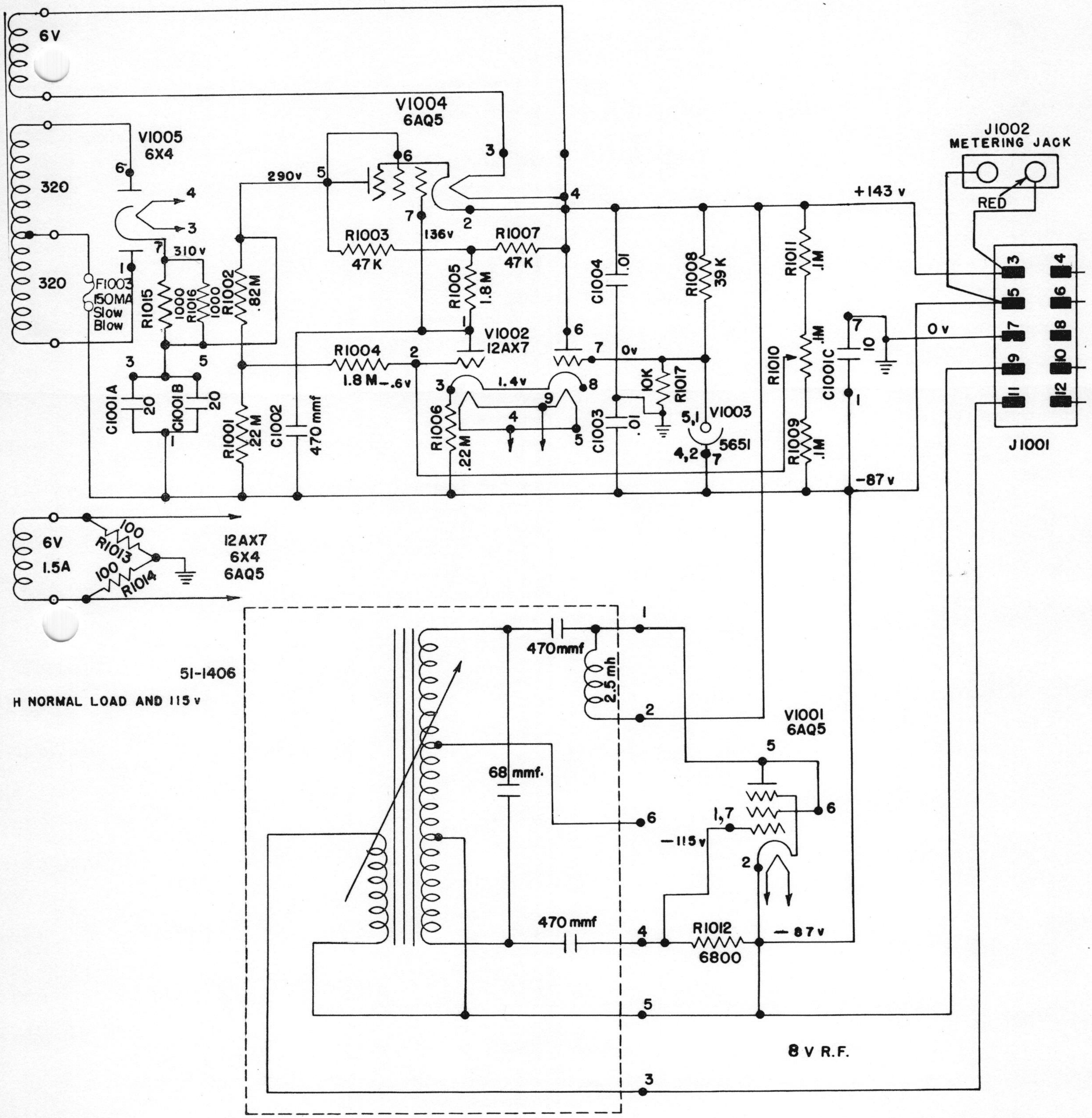
RPL-64-300B-2A
CR 9683 March 4, 1959

Sanborn DC General Purpose Amplifier Model 64-300B stamped with CR 9683 or higher will have V305 a 6X5GT Vacuum Tube changed to a rectifier unit Sanborn Number 67A-300B-C2.



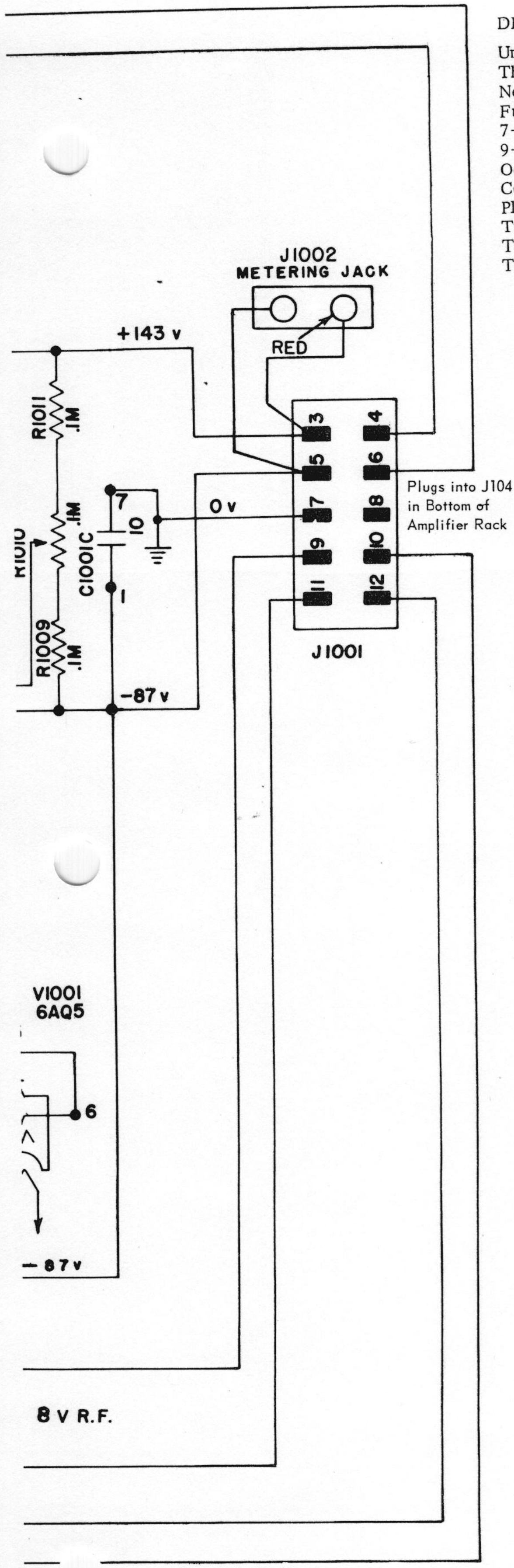


VOLTAGES GIVEN ARE WITH NORMAL LOAD AND 115 v
60 CYCLE LINE



CHANGES

SUB 1. PIN NOS. CORRECTED 9-12-50
SUB 2. R1015 CH. FROM 560 OHMS TO 1000 OHMS. R1016 ADDED 12-7-50
SUB 3. R1017 ADDED, CONNECTIONS CH. 2-9-51
SUB 4. V1001 & V1004 INTERCHANGED 5-14-51
SUB 5. LEADS REVERSED ON T1001 5-21-51
SUB 6. SERVICE INFORMATION ADDED 12-14-51
SUB 7. ADDED F1003 4-12-57



DESCRIPTION	SANBORN NO.
Unit lift handle	64-207
Thumbscrew	85-4
Neon pilot light assembly	60A-11
Fuse holder	26H-2
7-pin miniature socket	10G7-1FX
9-pin miniature socket	10G9-1FX
Octal socket	10H8-2FX
Condenser clamp assembly	651-1002
Plug button	22B-2
Tube guard (V1001, V1004, V1005)	68B-1
Tube guard (V1002)	68B-2
Tube guard (V1003)	68B-6

SYMBOL	DESCRIPTION	SANBORN NO.
CONDENSERS		
C1001 A, B, C	20x20x10 mfd 450 vdcw Elec.	572-217
C1002	.00047 mfd 500 vdcw Ceramic	8E-9
C1003	.01 mfd 500 vdcw Ceramic	8E-6
C1004	.01 mfd 500 vdcw Ceramic	8E-6
FUSES		
F1001	1A Slow Blow	26B-5
F1002	1A Slow Blow	26B-5
F1003	150MA Slow Blow	26B-18
LAMPS		
I1001	Neon Glow (Miniature Bayonet)	30B-1
I1002	Neon Glow (Miniature Bayonet)	30B-1
PLUGS		
J1001	10-Contact Jones	10C10-6MX
J1002	Amphenol Socket	10B2-5FX
RESISTORS		
R1001	220K 5% 1/2W Comp.	50AB-224J
R1002	820K 5% 1/2W Comp.	50A-824J
R1003	47K 5% 1/2W Comp.	50A-473J
R1004	1.8M 5% 1/2W Comp.	50A-185J
R1005	1.8M 5% 1/2W Comp.	50A-185J
R1006	220K 5% 1/2W Comp.	50AB-224J
R1007	47K 5% 1/2W Comp.	50A-473J
R1008	39K 5% 1/2W Comp.	50A-393J
R1009	100K 5% 1/2W Comp.	50A-104J
R1010	100K 20% 2W Pot.	572-350
R1011	100K 5% 1/2W Comp.	50A-104J
R1012	6.8K 5% 1/2W Comp.	50A-682J
R1013	100 Ohms 10% 1/2W Comp.	50A-101K
R1014	100 Ohms 10% 1/2W Comp.	50A-101K
R1015	1K 10% 2W Comp.	52C-102K
R1016	1K 10% 2W Comp.	52C-102K
R1017	10K 5% 1/2W Comp.	50A-103J
SWITCHES		
S1001	SPST toggle	62D-15A
S1002	SPST toggle	62D-15A
TRANSFORMER		
T1001	Power	64-310
	Oscillator Coil Assembly	51-1406
TUBES		
V1001	Type 6AQ5	68A-21
V1002	Type 12AX7 Aged, Tested and Selected	69A-4
V1003	Type 5651	68A-24
V1004	Type 6AQ5	68A-21
V1005	Type 6X4	68A-32

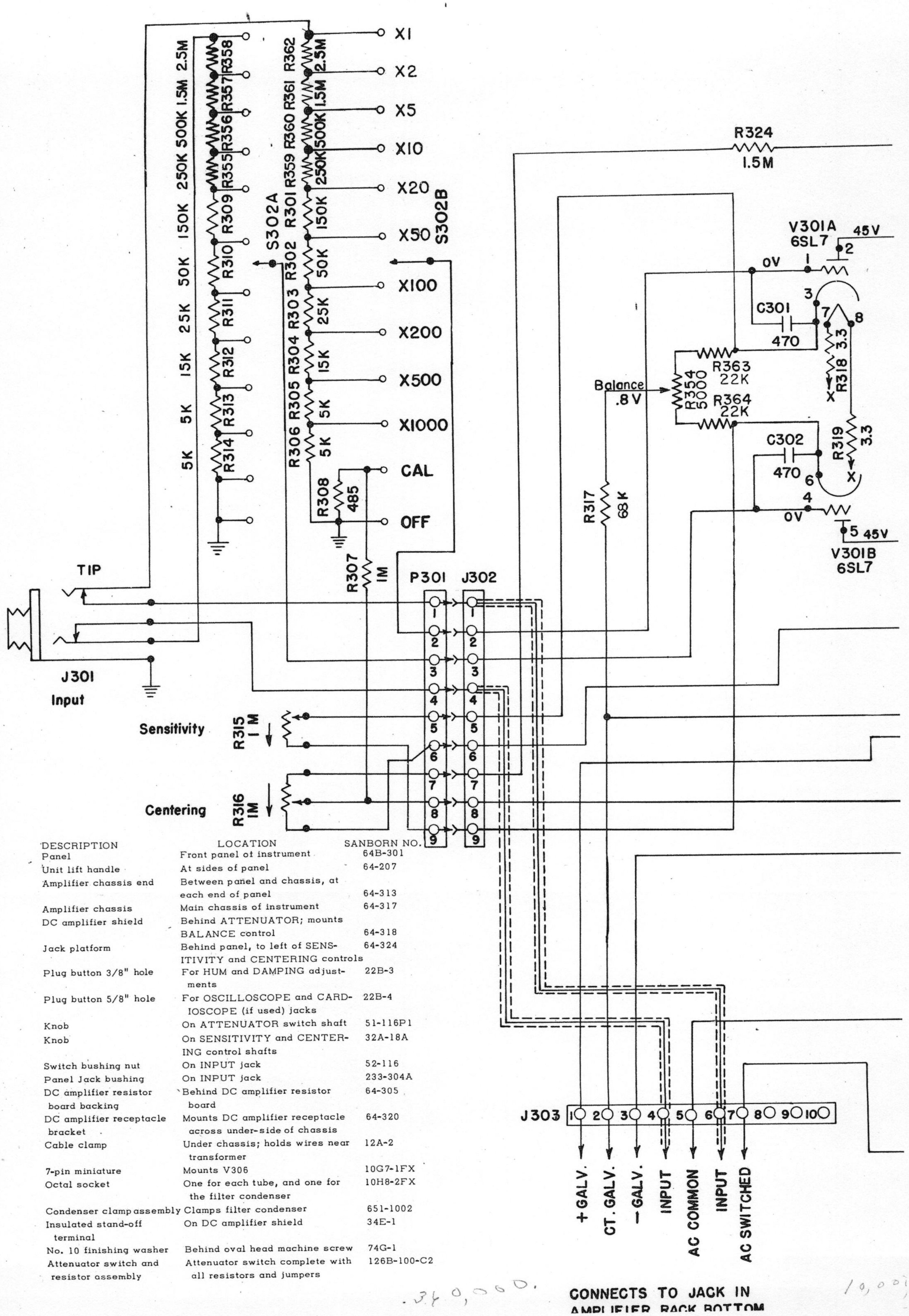
12-50
S
DED 12-7-50
ONS CH. 2-9-51
NGED 5-14-51
01 5-21-51
DDED 12-14-51

SANBORN POWER SUPPLY
MODEL 60-1000
SCHEMATIC: 60-1000-C1 SUB 7

SANBORN COMPANY

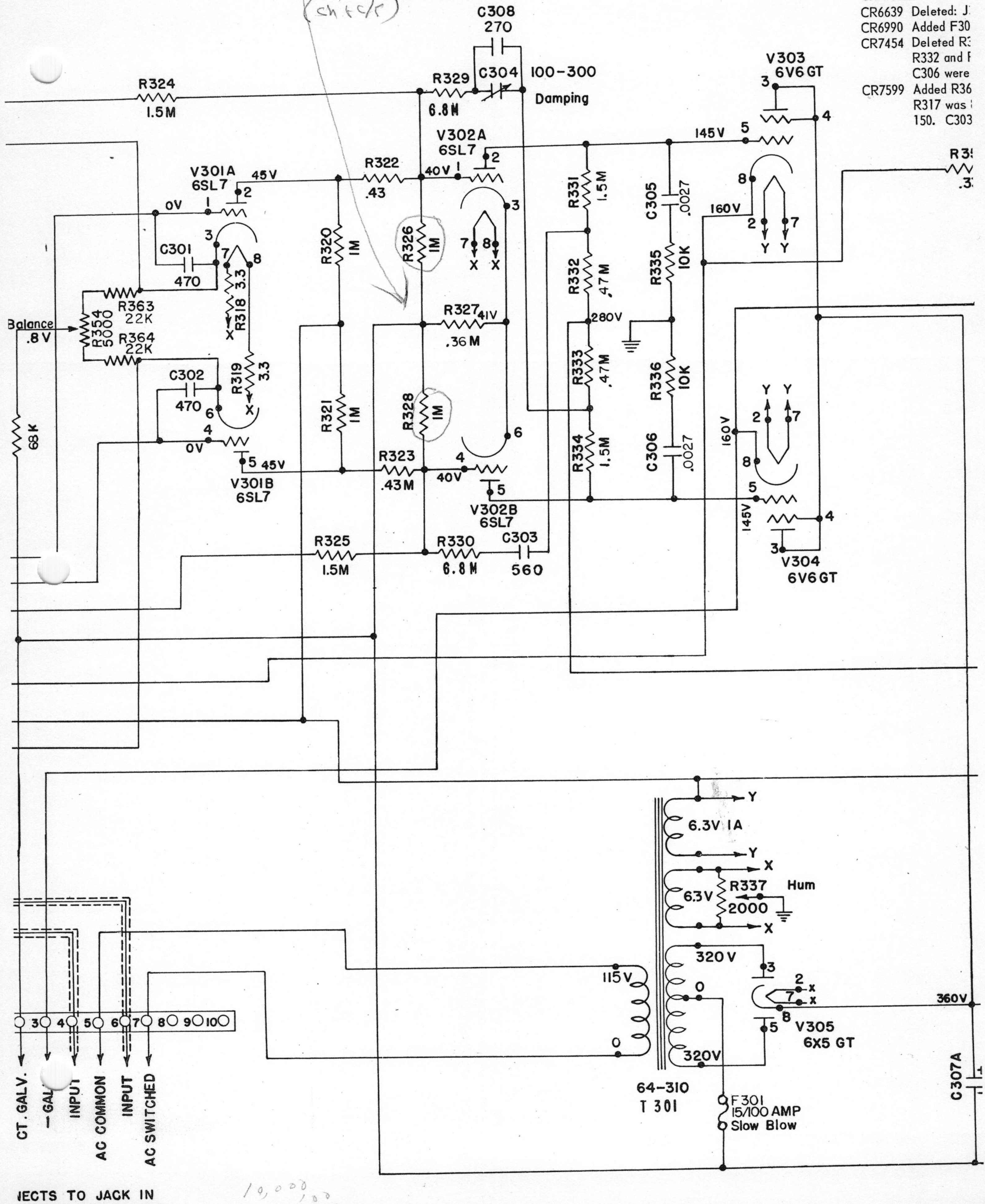
WALTHAM, MASS.
DECEMBER, 1957

CR8038 RPL-60-1000-2

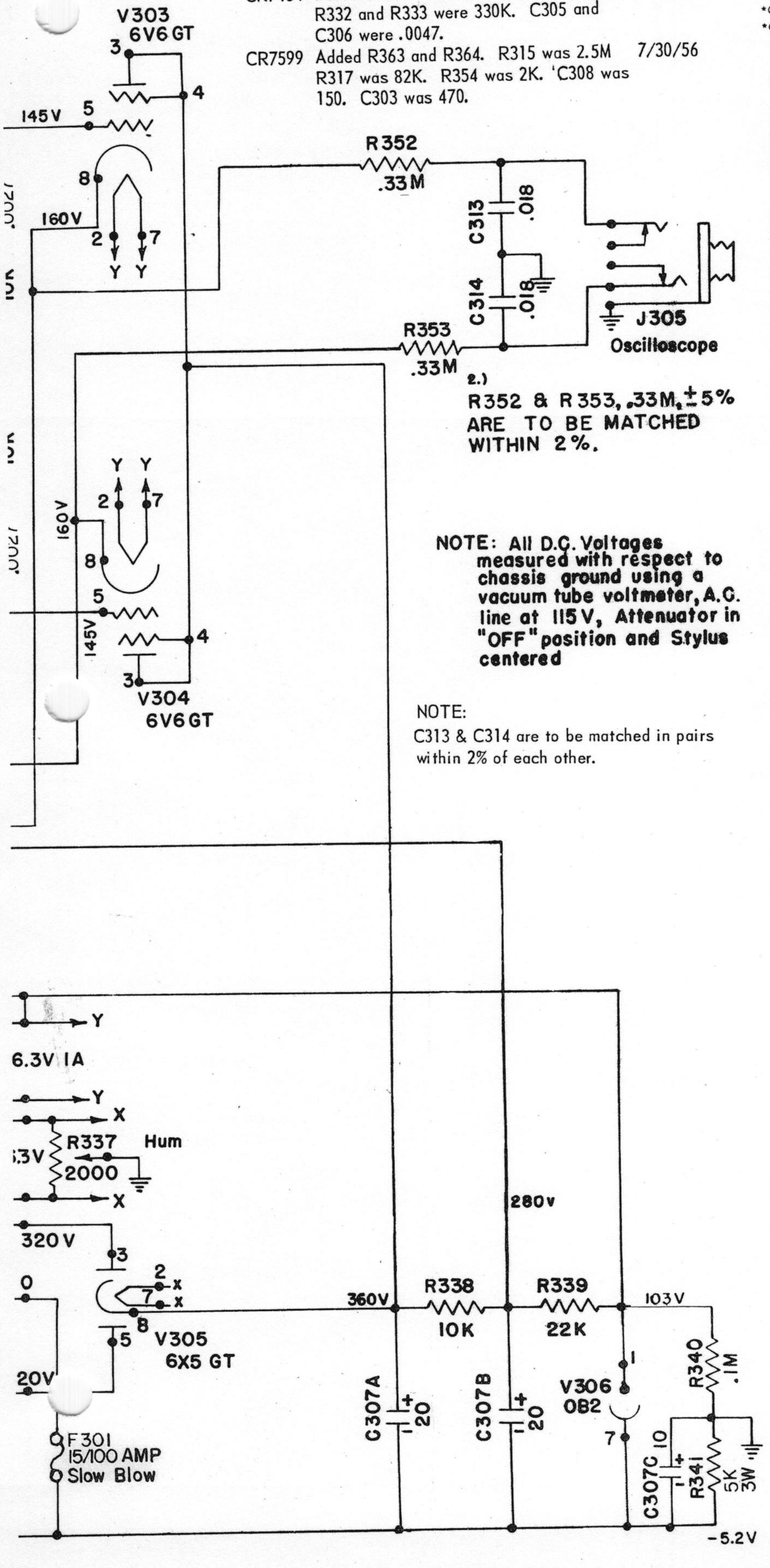


DESCRIPTION	LOCATION	SANBORN NO.
Panel	Front panel of instrument	64B-301
Unit lift handle	At sides of panel	64-207
Amplifier chassis end	Between panel and chassis, at each end of panel	64-313
Amplifier chassis	Main chassis of instrument	64-317
DC amplifier shield	Behind ATTENUATOR; mounts BALANCE control	64-318
Jack platform	Behind panel, to left of SENSITIVITY and CENTERING controls	64-324
Plug button 3/8" hole	For HUM and DAMPING adjustments	22B-3
Plug button 5/8" hole	For OSCILLOSCOPE and CARDIOSCOPE (if used) jacks	22B-4
Knob	On ATTENUATOR switch shaft	51-116P1
Knob	On SENSITIVITY and CENTERING control shafts	32A-18A
Switch bushing nut	On INPUT jack	52-116
Panel Jack bushing	On INPUT jack	233-304A
DC amplifier resistor board backing	Behind DC amplifier resistor board	64-305
DC amplifier receptacle bracket	Mounts DC amplifier receptacle across under-side of chassis	64-320
Cable clamp	Under chassis; holds wires near transformer	12A-2
7-pin miniature	Mounts V306	10G7-1FX
Octal socket	One for each tube, and one for the filter condenser	10H8-2FX
Condenser clamp assembly	Clamps filter condenser	651-1002
Insulated stand-off terminal	On DC amplifier shield	34E-1
No. 10 finishing washer	Behind oval head machine screw	74G-1
Attenuator switch and resistor assembly	Attenuator switch complete with all resistors and jumpers	126B-100-C2

CHANGES
CR6639 Deleted: J
CR6990 Added F30
CR7454 Deleted R3
R332 and F
C306 were
CR7599 Added R36
R317 was
150. C303



NECTS TO JACK IN
IEIER BACK BOTTOM



CHANGES

CR6639 Deleted: J304, R351 and R350. 1/7/54
CR6990 Added F301. R341 was 5.1K. 7/7/55
CR7454 Deleted R349. R331 and R334 were 680K. 4/16/56
R332 and R333 were 330K. C305 and C306 were .0047.
CR7599 Added R363 and R364. R315 was 2.5M 7/30/56
R317 was 82K. R354 was 2K. 'C308 was 150. C303 was 470.

2.) R352 & R353, .33M, ±5% ARE TO BE MATCHED WITHIN 2%.

NOTE: All D.C. Voltages measured with respect to chassis ground using a vacuum tube voltmeter, A.C. line at 115 V, Attenuator in "OFF" position and Stylus centered

NOTE:
C313 & C314 are to be matched in pairs within 2% of each other.

SYMBOL	DESCRIPTION	SANBORN NO.
C301	.00047 mfd 500VDCW ceramic	8E-9
C302	.00047 mfd 500v ceramic	8E-9
C303	560 mmf 500v mica	8A-47
C304	65-340 mmf 175v mica	8D-3
C305	.0027 mfd 500v mica	8A-14
C306	.0027 mfd 500v mica	8A-14
C307	20 x 20 x 10 450v elec.	572-217
C308	270 mmf 500v mica	8A-13
*C313	.018 400v paper	8B-34PG
*C314	.018 400v paper	8B-34PG

* The following condensers are matched within 2%: (C313, C314).

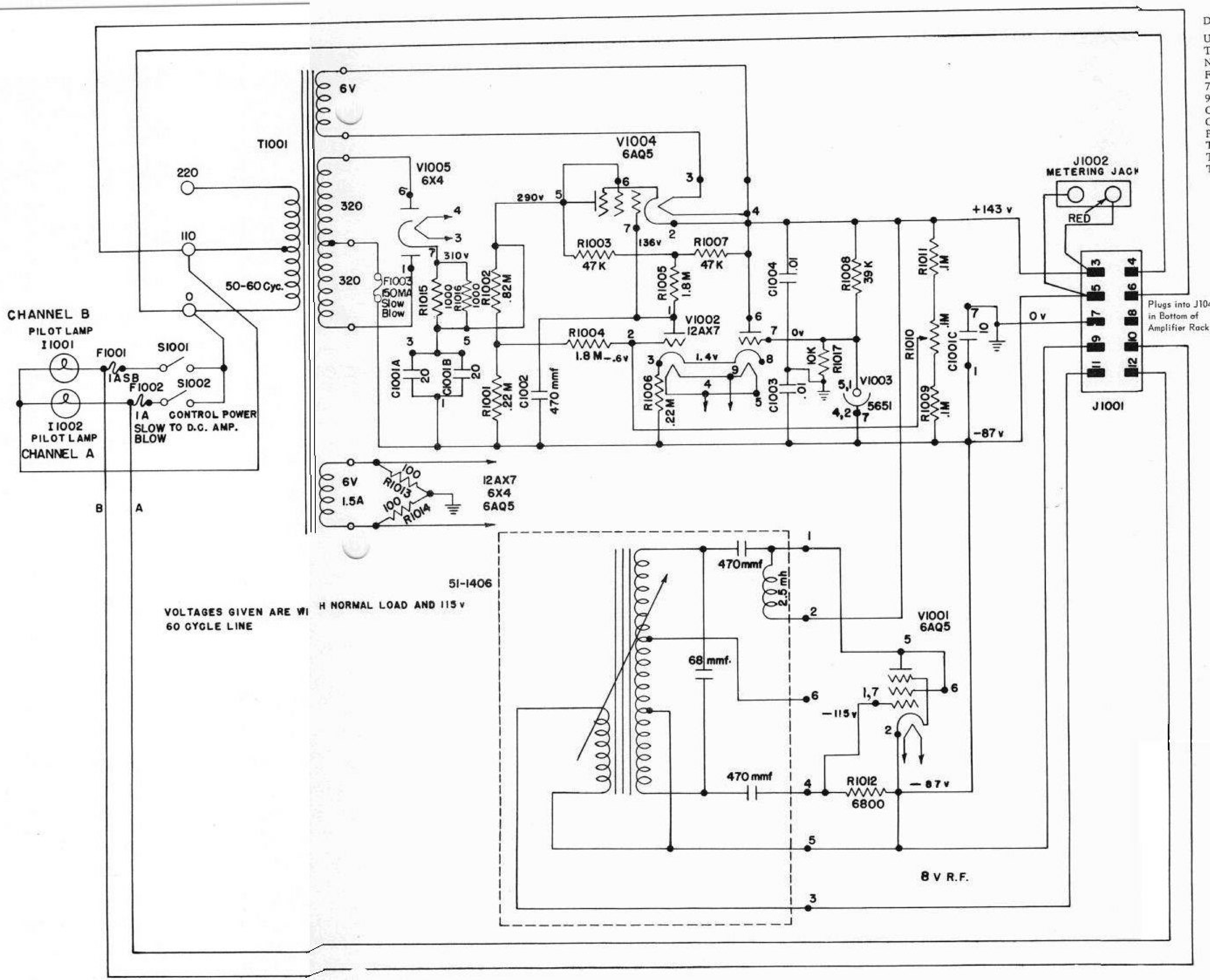
SYMBOL	DESCRIPTION	SANBORN NO.
F301	150 Ma. slo-blo fuse	26B-18
J301	Junior jack	10G2-6FX
J302	Amphenol socket	10B9-1FX
J303	Cannon plug	10F10-1MX
J305	Junior jack	10G2-6FX
P301	Amphenol plug	10B9-2MW
R301	150K 1% ¼w comp.	50H-154G
R302	50K 1% ¼w comp.	50H-503G
R303	25K 1% ¼w comp.	50H-253G
R304	15K 1% ¼w comp.	50H-153G
R305	5K 1% ¼w comp.	50H-502G
R306	5K 1% ¼w comp.	50H-502G
R307	1 Meg 1% ½w comp.	50J-105G
R308	485 ohms 1% ¼w comp.	50H-485-OG
R309	150K 1% ¼w comp.	50H-154G
R310	50K 1% ¼w comp.	50H-503G
R311	25K 1% ¼w comp.	50H-253G
R312	15K 1% ¼w comp.	50H-153G
R313	5K 1% ¼w comp.	50H-502G
R314	5K 1% ¼w comp.	50H-502G
R315	1Meg 20% 2w Pot.	56A-68
R316	1 Meg 20% 2w Linear Taper	572-220
R317	68K 5% ½w comp.	50A-683J
R318	3.3 ohms 10% ½w W.W.	50D-3R3K
R319	3.3 ohms 10% ½w W.W.	50D-3R3K
R320	1 Meg 5% ½w comp.	50AB-105J
R321	1 Meg 5% ½w comp.	50AB-105J
R322	430K 5% ½w comp.	50A-434J
R323	430K 5% ½w comp.	50A-434J
R324	1.5 Meg 5% ½w comp.	50AB-155J
R325	1.5 Meg 5% ½w comp.	50AB-155J
R326	1 Meg 5% ½w comp.	50AB-105J
R327	.36Meg 5% ½w comp.	50A-364J
R328	1 Meg 5% ½w comp.	50AB-105J
R329	6.8 Meg 5% ½w comp.	50A-685J
R330	6.8 Meg 5% ½w comp.	50A-685J
R331	1.5Meg 5% ½w comp.	50AB-155J
R332	.47 Meg 5% ½w comp.	50AB-474J
R333	.47 Meg 5% ½w comp.	50AB-474J
R334	1.5 Meg 5% ½w comp.	50AB-155J
R335	10K 10% ½w comp.	50A-103K
R336	10K 10% ½w comp.	50A-103K
R337	2K 20% ½w Hi-Torque L.T.	56A-26
R338	10K 5% 2w comp.	52C-103J
R339	22K 5% 2w comp.	52C-223J
R340	100K 5% ½w comp.	50A-104J
R341	5K 5% 3w W.W.	53B-502J
*R352	330K 5% ½w comp.	50A-334JPG
*R353	330K 5% ½w comp.	50A-334JPG
R354	5K 20% 2w Hi-Torque L.T.	56A-49
R355	250K 1% ¼w comp.	50H-254G
R356	500K 1% ¼w comp.	50H-504G
R357	1.5 Meg 1% ½w comp.	50J-155G
R358	2.5 Meg 1% ½w comp.	50J-255G
R359	250K 1% ¼w comp.	50H-254G
R360	500K 1% ¼w comp.	50H-504G
R361	1.5 Meg 1% ½w comp.	50J-155G
R362	2.5 Meg 1% ½w comp.	50J-255G
R363	22K 5% ½w	50AB-223J
R364	22K 5% ½w	50AB-223J

* The following resistors are matched within 2%: (R352, R353).

SYMBOL	DESCRIPTION	SANBORN NO.
S302	12 position, 2 deck wafer sw.	62B-25
T301	Power Transformer	64-310
V301	Type 6SL7GT aged, tested and selected	69A-6
V302	Type 6SL7GT	68A-3
V303	Type 6V6GT	68A-4
V304	Type 6V6GT	68A-4
V305	Type 6X5GT	68A-5
V306	Type OB2	68A-18

DC GENERAL PURPOSE AMPLIFIER
MODEL 64-300B
SCHEMATIC: 64-300B-C1 SUB 4

SANBORN COMPANY
WALTHAM, MASS.
DECEMBER, 1957
CR7599 RPL-64-300B-2



DESCRIPTION	SANBORN NO.
Unit lift handle	64-207
Thumbscrew	85-4
Neon pilot light assembly	60A-11
Fuse holder	26H-2
7-pin miniature socket	10G7-1FX
9-pin miniature socket	10G9-1FX
Octal socket	10H8-2FX
Condenser clamp assembly	651-1002
Plug button	22B-2
Tube guard (V1001, V1004, V1005)	68B-1
Tube guard (V1002)	68B-2
Tube guard (V1003)	68B-6

SYMBOL	DESCRIPTION	SANBORN NO.
CONDENSERS		
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C1002	.00047 mfd 500 vdcw Ceramic	8E-9
C1003	.01 mfd 500 vdcw Ceramic	8E-6
C1004	.01 mfd 500 vdcw Ceramic	8E-6
FUSES		
F1001	1A Slow Blow	26B-5
F1002	1A Slow Blow	26B-5
F1003	150MA Slow Blow	26B-18
LAMPS		
I1001	Neon Glow (Miniature Bayonet)	30B-1
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PLUGS		
J1001	10-Contact Jones	10C10-6MX
J1002	Amphenol Socket	10B2-5FX
RESISTORS		
R1001	220K 5% 1/2W Comp.	50AB-224J
R1002	820K 5% 1/2W Comp.	50A-824J
R1003	47K 5% 1/2W Comp.	50A-473J
R1004	1.8M 5% 1/2W Comp.	50A-185J
R1005	1.8M 5% 1/2W Comp.	50A-185J
R1006	220K 5% 1/2W Comp.	50AB-224J
R1007	47K 5% 1/2W Comp.	50A-473J
R1008	39K 5% 1/2W Comp.	50A-393J
R1009	100K 5% 1/2W Comp.	50A-104J
R1010	100K 20% 2W Pot.	572-350
R1011	100K 5% 1/2W Comp.	50A-104J
R1012	6.8K 5% 1/2W Comp.	50A-682J
R1013	100 Ohms 10% 1/2W Comp.	50A-101K
R1014	100 Ohms 10% 1/2W Comp.	50A-101K
R1015	1K 10% 2W Comp.	52C-102K
R1016	1K 10% 2W Comp.	52C-102K
R1017	10K 5% 1/2W Comp.	50A-103J
SWITCHES		
S1001	SPST toggle	62D-15A
S1002	SPST toggle	62D-15A
TRANSFORMER		
T1001	Power	64-310
	Oscillator Coil Assembly	51-1406
TUBES		
V1001	Type 6AQ5	68A-21
V1002	Type 12AX7 Aged, Tested and Selected	69A-4
V1003	Type 5651	68A-24
V1004	Type 6AQ5	68A-21
V1005	Type 6X4	68A-32

CHANGES

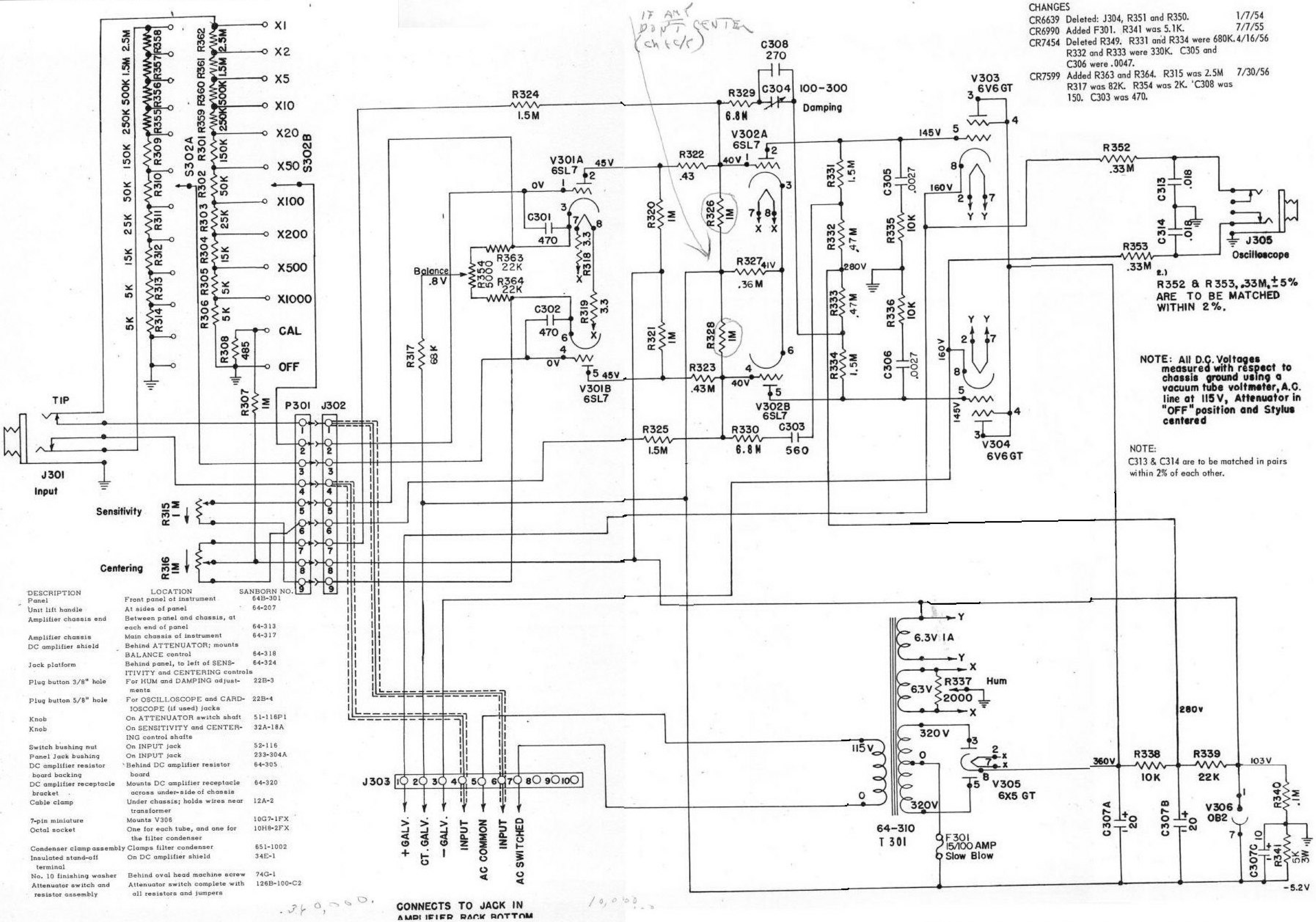
SUB 1. PIN NOS. CORRECTED 9-12-50
SUB 2. R1015 CH. FROM 560 OHMS TO 1000 OHMS. R1016 ADDED 12-7-50
SUB 3. R1017 ADDED, CONNECTIONS CH. 2-9-51
SUB 4. V1001 & V1004 INTERCHANGED 5-14-51
SUB 5. LEADS REVERSED ON T1001 5-21-51
SUB 6. SERVICE INFORMATION ADDED 12-14-51
SUB 7. ADDED F1003 4-12-57

SANBORN POWER SUPPLY
MODEL 60-1000
SCHEMATIC: 60-1000-C1 SUB 7

SANBORN COMPANY

WALTHAM, MASS.
DECEMBER, 1957

CR8038 RPL-60-1000-2



DESCRIPTION	LOCATION	SANBORN NO.
Panel	Front panel of instrument	64B-301
Unit lift handle	At sides of panel	64-207
Amplifier chassis end	Between panel and chassis, at each end of panel	64-313
Amplifier chassis	Main chassis of instrument	64-317
DC amplifier shield	Behind ATTENUATOR; mounts BALANCE control	64-318
Jack platform	Behind panel, to left of SENSITIVITY and CENTERING controls	64-324
Plug button 3/8" hole	For HUM and DAMPING adjustments	22B-3
Plug button 5/8" hole	For OSCILLOSCOPE and CARDIOSCOPE (if used) jacks	22B-4
Knob	On ATTENUATOR switch shaft	51-116P1
Knob	On SENSITIVITY and CENTERING control shafts	32A-18A
Switch bushing nut	On INPUT jack	52-116
Panel Jack bushing	On INPUT jack	233-304A
DC amplifier resistor board backing	Behind DC amplifier resistor board	64-305
DC amplifier receptacle bracket	Mounts DC amplifier receptacle across under-side of chassis	64-320
Cable clamp	Under chassis; holds wires near transformer	12A-2
7-pin miniature	Mounts V306	10G7-1FX
Octal socket	One for each tube, and one for the filter condenser	10H8-2FX
Condenser clamp assembly	Clamps filter condenser	651-1002
Insulated stand-off terminal	On DC amplifier shield	34E-1
No. 10 finishing washer	Behind oval head machine screw	74G-1
Attenuator switch and resistor assembly	Attenuator switch complete with all resistors and jumpers	126B-100-C2

CHANGES

CR6639 Deleted: J304, R351 and R350. 1/7/54
CR6990 Added F301. R341 was 5.1K. 7/7/55
CR7454 Deleted R349. R331 and R334 were 680K. R332 and R333 were 330K. C305 and C306 were .0047. 4/16/56
CR7599 Added R363 and R364. R315 was 2.5M R317 was 82K. R354 was 2K. C308 was 150. C303 was 470. 7/30/56

2.) R352 & R353, .33M, ±5% ARE TO BE MATCHED WITHIN 2%.

NOTE: All D.C. Voltages measured with respect to chassis ground using a vacuum tube voltmeter, A.C. line at 115V, Attenuator in "OFF" position and Stylus centered

NOTE:
C313 & C314 are to be matched in pairs within 2% of each other.

SYMBOL	DESCRIPTION	SANBORN NO.
C301	.00047 mfd 500VDCW ceramic	8E-9
C302	.00047 mfd 500v ceramic	8E-9
C303	560 mmf 500v mica	8A-47
C304	65-340 mmf 175v mica	8D-3
C305	.0027 mfd 500v mica	8A-14
C306	.0027 mfd 500v mica	8A-14
C307	20 x 20 x 10 450v elec.	572-217
C308	270 mmf 500v mica	8A-13
*C313	.018 400v paper	8B-34PG
*C314	.018 400v paper	8B-34PG

* The following condensers are matched within 2%: (C313, C314).

SYMBOL	DESCRIPTION	SANBORN NO.
F301	150 Ma. slo-blo fuse	26B-18
J301	Junior jack	10G2-6FX
J302	Amphenol socket	10B9-1FX
J303	Cannon plug	10F10-1MX
J305	Junior jack	10G2-6FX
P301	Amphenol plug	10B9-2MW
R301	150K 1% ¼w comp.	50H-154G
R302	50K 1% ¼w comp.	50H-503G
R303	25K 1% ¼w comp.	50H-253G
R304	15K 1% ¼w comp.	50H-153G
R305	5K 1% ¼w comp.	50H-502G
R306	5K 1% ¼w comp.	50H-502G
R307	1 Meg 1% ½w comp.	50J-105G
R308	485 ohms 1% ¼w comp.	50H-485-OG
R309	150K 1% ¼w comp.	50H-154G
R310	50K 1% ¼w comp.	50H-503G
R311	25K 1% ¼w comp.	50H-253G
R312	15K 1% ¼w comp.	50H-153G
R313	5K 1% ¼w comp.	50H-502G
R314	5K 1% ¼w comp.	50H-502G
R315	1Meg 20% 2w Pot.	56A-68
R316	1 Meg 20% 2w Linear Taper	572-220
R317	68K 5% ½w comp.	50A-683J
R318	3.3 ohms 10% ½w W.W.	50D-3R3K
R319	3.3 ohms 10% ½w W.W.	50D-3R3K
R320	1 Meg 5% ½w comp.	50AB-105J
R321	1 Meg 5% ½w comp.	50AB-105J
R322	430K 5% ½w comp.	50A-434J
R323	430K 5% ½w comp.	50A-434J
R324	1.5 Meg 5% ½w comp.	50AB-155J
R325	1.5 Meg 5% ½w comp.	50AB-155J
R326	1 Meg 5% ½w comp.	50AB-105J
R327	.36Meg 5% ½w comp.	50A-364J
R328	1 Meg 5% ½w comp.	50AB-105J
R329	6.8 Meg 5% ½w comp.	50A-685J
R330	6.8 Meg 5% ½w comp.	50A-685J
R331	1.5Meg 5% ½w comp.	50AB-155J
R332	.47 Meg 5% ½w comp.	50AB-474J
R333	.47 Meg 5% ½w comp.	50AB-474J
R334	1.5 Meg 5% ½w comp.	50AB-155J
R335	10K 10% ½w comp.	50A-103K
R336	10K 10% ½w comp.	50A-103K
R337	2K 20% ½w Hi-Torque L.T.	56A-26
R338	10K 5% 2w comp.	52C-103J
R339	22K 5% 2w comp.	52C-223J
R340	100K 5% ½w comp.	50A-104J
R341	5K 5% 3w W.W.	53B-502J
*R352	330K 5% ½w comp.	50A-334JPG
*R353	330K 5% ½w comp.	50A-334JPG
R354	5K 20% 2w Hi-Torque L.T.	56A-49
R355	250K 1% ¼w comp.	50H-254G
R356	500K 1% ¼w comp.	50H-504G
R357	1.5 Meg 1% ½w comp.	50J-155G
R358	2.5 Meg 1% ½w comp.	50J-255G
R359	250K 1% ¼w comp.	50H-254G
R360	500K 1% ¼w comp.	50H-504G
R361	1.5 Meg 1% ½w comp.	50J-155G
R362	2.5 Meg 1% ½w comp.	50J-255G
R363	22K 5% ½w	50AB-223J
R364	22K 5% ½w	50AB-223J

* The following resistors are matched within 2%: (R352, R353).

SYMBOL	DESCRIPTION	SANBORN NO.
S302	12 position, 2 deck wafer sw.	62B-25
T301	Power Transformer	64-310
V301	Type 6SL7GT aged, tested and selected	69A-6
V302	Type 6SL7GT	68A-3
V303	Type 6V6GT	68A-4
V304	Type 6V6GT	68A-4
V305	Type 6X5GT	68A-5
V306	Type OB2	68A-18

DC GENERAL PURPOSE AMPLIFIER
MODEL 64-300B
SCHEMATIC: 64-300B-C1 SUB 4

SANBORN COMPANY
WALTHAM, MASS.
DECEMBER, 1957
CR7599
RPL-64-300B-2