STABILIZED DC PREAMPLIFIER
MODEL 150-1800

IM-150-1800-1

INSTRUCTION MANUAL

HEWLETT PACKARD

SANBORN DIVISION

SANBORN COMPANY
175 WYMAN STREET
WALTHAM 54, MASS.
TEL: TW 4-6300
FEBRUARY 12, 1958

INSTRUCTION MANUAL SUPPLEMENTS
IM-150-1800-1A(Rev)
IM-150-1800-1D
SANBORN STABILIZED DC PREAMPLIFIER
MODEL 150-1800, A

IM-150-1800-1A December 18, 1956

This Sanborn Instrument uses a specially-manufactured calibration cell. This cell has not only been carefully selected and processed for constant voltage output over long periods of time, but is also of extra-heavy construction, as a guard against deterioration. Do not use a common hearing aid battery as a replacement - this invites incorrect voltage readings and damage from corrosion. Use only the replacement calibration cell identified as Sanborn No. 2C-4, available from your nearest Sanborn Company representative, or directly from Sanborn Company, Waltham, Mass.

Figure 1 in the Instruction Manual shows a shielding on the cabling between the signal source and the Preamplifier. This shielding is shown grounded at both ends. In some cases, this can introduce a ground loop in the wiring between the signal source and the Preamplifier. If a ground loop is suspected (when there is interference on the recording, for example), try operation with this shield grounded at one end only.

IM-150-1800-1D December, 1957

The Driver Amplifier used with this Preamplifier should have its +80 ADJ control re-set after replacing the glow tube voltage regulator (V209 in 150-200, V208 in 150-200A, 150-200B). To adjust, apply positive test voltage from 1.019 volt standard cell to input terminal through 19,000 ohm ±0.5% resistance. (This applies a +1.000 volt signal to input terminals). Set ATTENUATOR to X500, turn function switch back and forth between USE and OFF, and note stylus deflection. Now set ATTENUATOR to X1 and turn function switch back and forth between CAL and OFF. Stylus deflection should be the same as that obtained from standard cell; if not, adjust +80 ADJ control to make the deflection the same.

SANBORN COMPANY
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DECEMBER 24, 1958

INSTRUCTION MANUAL SUPPLEMENT
IM-150-1800-1E
IM-150-1800-1F
SANBORN STABILIZED DC PREAMPLIFIER
MODEL 150-1800

The Instruction Manual IM-150-1800-1 for the Stabilized DC Preamplifier should be corrected as follows:

Page 3..... Figure 1 shows a shielded cable between the signal and the Preamplifier. The shield is shown grounded at both ends. In some cases, this forms a ground loop between the signal and the Preamplifier, which can cause interference on the recording. If this happens, try operation with the shield grounded at one end only.

Page 3..... Paragraph 7 BALANCING THE PREAMPLIFIER

Add step:

6. After once balanced "...to the center of the chart", re-balancing will usually not be needed. When you want to check: go through the balancing procedure, and note the deflection in step 3. If this deflection does not take the stylus beyond the edge of the recording channel, re-balancing is not required. The stabilizing amplifier stage will correct it.

Maintenance notes .....

The Driver Amplifier used with this Preamplifier should have its +80 ADJ control re-set after replacing its glow tube voltage regulator (V209 in 150-200, V208 in 150-200A, 150-200B). To adjust, apply positive test voltage from 1.019 volt standard cell to input terminal of Preamplifier through 19,000 ohm ±0.5% resistance. (This applies a +1.000 volt signal to input terminals). Set ATTENUATOR to X500, turn function switch back and forth between USE and OFF, and note stylus deflection. Now set ATTENUATOR to X1 and turn function switch back and forth between CAL and OFF. Stylus deflection should be the same as that obtained from standard cell; if not, adjust +80 ADJ control to make the deflection the same.

IM-150-1800-1F

COMMENTS ON PARAGRAPH 13 PAGE 6

When recording near line frequency, there is a small possibility of a beat note showing in the recording. An improperly set Stabilized Gain control R1822 can cause this beat note. If such a beat note is visible, the Stabilize Gain control R1822 may be re-set by adjusting for minimum beat note.

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NOVEMBER 24, 1961

INSTRUCTION MANUAL SUPPLEMENT
IM-150-1800-1G

SANBORN STABILIZED DC PREAMPLIFIER
MODEL 150-1800, 150-1800A

IM-150-1800-1G

SUBJECT: BALANCING THE PREAMPLIFIER

Page 3, paragraph 7 of the standard instruction manual.

ADDITIONAL INFORMATION: The stabilized DC preamplifier employs a 3-stage resistance coupled amplifier circuit, whose output is stabilized by a correction signal applied at its input from a 2-stage stabilizing chopper amplifier circuit.

BALANCING THE PREAMPLIFIER as described in page 3, paragraph 7 of the standard instruction manual is performed to avoid overloading the stabilizing amplifier circuit. Once this step has been initially performed, it need not be repeated for each successive operational use of preamplifier.

The balancing procedure must be performed only when a component has been replaced within the preamplifier, or when it is suspected that the preamplifier is not operating within its specified accuracy.

In the performance of the step, an output drift will be noticed when the USE-OFF-CAL-ZERO-BAL switch is turned to the BAL position. This drift is not an indication of poor preamplifier performance, it is however an indication that the stabilizing signal has been removed, which is exactly what happens.

A study of the preamplifier schematic will show that when the USE-OFF-CAL-ZERO-BAL switch is turned to the BAL position, the output from the stabilizing network is disconnected from the DC amplifier circuit input.

TABLE OF CONTENTS

Paragraph		Page
1	Introduction	1
2	Table of Characteristics	1
3	Front Panel Controls	1
4	Basic Procedures	3
5	Connecting the Input	3
6	Starting the Preamplifier	3
7	Balancing the Preamplifier	3
8	Calibrating the Preamplifier	4
9	Using the Preamplifier	4
10	Zero Suppression	4
11	Checking Stabilizing Amplifier Operation	6
12	Adjusting the Sensitivity Balance	6
13	Adjusting the Gain Stabilizer	6
14	Adjusting the Attenuator Trimmers	7
15	Adjusting the Internal Balance	7
16	Removing and Replacing Preamplifiers	7
17	Checking and Replacing Zero Suppression Cells	8
18	Theory of Operation	8
19	Functional Description	9

INSTRUCTION MANUAL

SANBORN STABILIZED DC PREAMPLIFIER MODEL 150–1800

1. INTRODUCTION

Sanborn Stabilized DC Preamplifier, Model 150–1800, is a direct-coupled preamplifier having high gain, broad frequency response, and a high degree of stability against baseline drift. The preamplifier output is stabilized against drift by a chopper amplifier which provides a correction voltage. The preamplifier gain is stabilized by a conventional negative feedback loop.

This preamplifier may be plugged into either Sanborn Driver Amplifier and Power Supply Model 150–200B / 400, or Sanborn Wide Band Driver Amplifier and Power Supply Model 150–300 / 700. The frequency response of the system is modified by the characteristic of the Driver Amplifier with which the preamplifier is used; an output voltage not modified by the Driver Amplifier is available at the OUTPUT jack of the preamplifier, however.

2. TABLE OF CHARACTERISTICS

The following characteristics are those of the Model 150–1800 Preamplifier, Model 150–200B Driver Amplifier, and Sanborn "150" Series Recorder combined, except where otherwise indicated.

SENSITIVITY	1 mv./cm. to 2 volts/cm.
DRIFT	Approximately 0.1 mm./hr.
GAIN OF PREAMPLIFIER	1000. This gain is measured from preamplifier INPUT to preamplifier OUTPUT jack.
DRIFT OF PREAMPLIFIER OUTPUT	Mean drift is 5 mv./hr.
INPUT	Single-ended only, one megohm input resistance.
FREQUENCY RESPONSE	DC to 3 db. down at 10,000 cycles, measured from preamplifier INPUT to OUTPUT jack. (The OUTPUT jack is intended for loads of one megohm or greater, such as oscilloscope and vacuum-tube voltmeters.)
NOISE	Noise plus 60 cycle component: 46 db. below full scale deflection.
ZERO SUPPRESSION	Positive or negative, up to twenty times full scale deflection.

3. FRONT PANEL CONTROLS

POSITION	This control provides independent adjustment of stylus position or other indicator. Clockwise rotation moves the stylus upscale.

3. FRONT PANEL CONTROLS (Cont.)

USE–OFF–CAL–ZERO–BAL	This switch determines the function of the Preamplifier. USE position: the input terminals are connected to the Preamplifier input, and the stabilizing amplifier is operative. OFF position: the input terminals are disconnected, the Preamplifier input circuit is grounded, power remains connected to the Preamplifier, and the stabilizing amplifier is operative. CAL position: the preamplifier input circuit is connected to the 2 mv. calibration voltage circuit, and the stabilizing amplifier is operative. ZERO position: the input of the phase-inverter amplifier (which couples the dc preamplifier to the driver amplifier) is grounded to provide a reference for balancing the Preamplifier. BAL position: the stabilizing amplifier is inoperative to permit independent adjustment of the dc preamplifier.
BALANCE	This control determines the operating conditions which demand least output from the stabilizing amplifier. This ensures the stabilizer's working well within the overload limiting circuit operating point.
SENSITIVITY	This control determines the amount of Preamplifier output which is applied to the input of the Driver Amplifier.
CAL 2MV	This button applies a two millivolt calibration signal to the input circuit of the instrument.
ATTENUATOR	This switch attenuates the input signal by the following accurately fixed factors: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 and 2000.
DC ZERO SUPPRESSION	This switch inserts a voltage of the correct polarity to offset the zero line for recording small voltages in a circuit which may be at a high voltage level. A method of checking the two zero suppression cells by comparing their output voltages is provided.
SUPPRESSION VOLTAGE	This control determines the amount of input voltage suppressed.
INPUT	This connector is used to connect the input signal to the instrument.
OUTPUT	This jack is used to connect a load of not less than one megohm to the instrument. This output circuit is not affected by the SENSITIVITY control.

4. BASIC PROCEDURES

There are four basic procedures to be followed in preparing the Preamplifier for operation: connecting the input and starting the Preamplifier, balancing, calibrating, and using the Preamplifier.

Connecting the input and starting the Preamplifier: involves making the input connections and turning on the Preamplifier for warm-up.

Balancing the Preamplifier: avoids overloading the stabilizing amplifier.

Calibrating the Preamplifier: adjusts the overall basic sensitivity to exactly one centimeter deflection per millivolt input.

Using the Preamplifier: includes interpreting the record, and making use of such optional features as zero suppression and the OUTPUT jack.

5. CONNECTING THE INPUT

Apply power and allow 30 minutes warmup for maximum stability. Connect the signal to the INPUT socket on the panel or the connector J204 or J304 at the Driver Amplifier rear, as shown in figure 1. A positive potential at terminal A with respect to terminal B (or of pin 1 with respect to pin 3) gives a negative potential at the OUTPUT jack and an up-scale deflection of the galvanometer or other indicator connected to the Driver Amplifier.

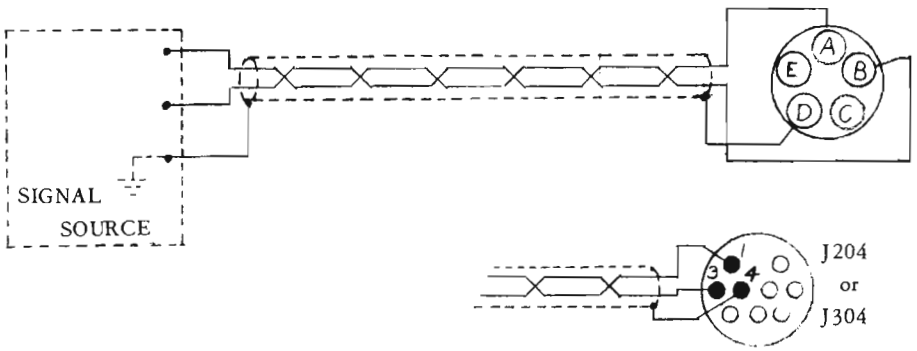

Figure 1. Input Circuit Connections to Stabilized DC Preamplifier.

6. STARTING THE PREAMPLIFIER

The Preamplifier derives its operating power from the associated Driver Amplifier/Power Supply, and is turned on with these units. Turn the ATTENUATOR, ZERO SUPPRESSION and USE-OFF-CAL-ZERO-BAL switches to OFF, and allow the Preamplifier to warm up thirty minutes before making adjustments or taking records.

7. BALANCING THE PREAMPLIFIER

Balance the Preamplifier only after it has warmed up at least thirty minutes. This is usually not required as an operational step.

1. Turn the USE-OFF-CAL-ZERO-BAL switch to ZERO.

2. Adjust the POSITION control to place the stylus in the center of the recording chart.

3. Turn the USE-OFF-CAL-ZERO-BAL switch to BAL. Unless the instrument is already balanced, the stylus will deflect.

7. BALANCING THE PREAMPLIFIER (Cont.)

4. Adjust the BALANCE control to return the stylus to the center of the chart. This is a sensitive adjustment, but it is not critical because a slight residual unbalance is automatically corrected by the stabilizing amplifier.

5. Turn USE-OFF-CAL-ZERO-BAL switch to CAL.

8. CALIBRATING THE PREAMPLIFIER

1. Turn the ATTENUATOR to X1.

2. Turn the USE-OFF-CAL-ZERO-BAL switch to CAL.

3. Press the CAL 2MV button intermittently and adjust the SENSITIVITY control for a stylus deflection of exactly two centimeters. The basic sensitivity of the system is now one millivolt per centimeter.

9. USING THE PREAMPLIFIER

To operate the preamplifier:

1. Turn the ATTENUATOR to OFF.

2. Turn the USE-OFF-CAL-ZERO-BAL switch to USE.

3. Set the stylus to a convenient baseline by adjusting the POSITION control.

4. Turn the ATTENUATOR clockwise for a convenient stylus deflection, or set it to the appropriate attenuation factor for the expected signal level.

5. Turn on the paper drive motor to start the recording.

6. Read voltage input in millivolts from the record by multiplying the deflection in centimeters by the attenuation factor.

10. ZERO SUPPRESSION

A problem which arises occasionally is the measurement and recording of a small variation of a high voltage level. SENSITIVITY and ATTENUATOR settings which would provide adequate deflection for the small variation would block the stylus off-scale because of the high voltage level. Conversely, ATTENUATOR and SENSITIVITY settings which permit registration of the high voltage level limit the deflection caused by the small variation. The Zero Suppression circuit provides the solution by subtracting the high voltage and leaving only the smaller variation. Effectively, it suppresses the zero line by removing it from the recording scale.

The amount of input voltage which may be suppressed is twenty times the voltage which produces full scale deflection. This is true at all ATTENUATOR settings because the zero suppression circuit is independent of the attenuator circuit. The ATTENUATOR is normally set to reduce the input signal voltage to the 1 mv./cm. level, thereby affording a basis for electrical comparison. The amount of voltage suppressed may be read directly from the zero suppression dial.

10. ZERO SUPPRESSION (Cont.)

Refer to the following table for guidance in calibrating the system, setting the controls and interpreting the recording:

ATTENUATOR SETTING	1 CM. DEFLECTION	FULL SCALE DEFLECTION	MAXIMUM VOLTAGE WHICH MAY BE SUPPRESSED	VALUE OF EACH Z.S. DIAL DEGREE
X1	1 MV.	5 MV.	100 MV.	0.1 MV.
X2	2 MV.	10 MV.	200 MV.	0.2 MV.
X5	5 MV.	25 MV.	500 MV.	0.5 MV.
X10	10 MV.	50 MV.	1 Volt	1.0 MV.
X20	20 MV.	100 MV.	2 Volts	2.0 MV.
X50	50 MV.	250 MV.	5 Volts	5.0 MV.
X100	100 MV.	500 MV.	10 Volts	10.0 MV.
X200	200 MV.	1 Volt	20 Volts	20.0 MV.
X500	500 MV.	2.5 Volts	50 Volts	50.0 MV.
X1000	1 Volt	5 Volts	100 Volts	100 MV.
X2000	2 Volts	10 Volts	200 Volts	200 MV.

There are two practical ways of setting the ZERO SUPPRESSION controls:

a. When the level of the voltage to be suppressed and the amplitude of the voltage waveform to be recorded are known, turn the DC ZERO SUPPRESSION switch to + if a positive potential is to be suppressed, or to − if a negative voltage base is to be suppressed, and turn the SUPPRESSION VOLTAGE control to the value of the dc voltage level to be suppressed.

b. When the level of voltage to be suppressed and the amplitude of the voltage waveform to be recorded are not known, turn the DC ZERO SUPPRESSION switch to the polarity of the base voltage to be suppressed, and advance the ATTENUATOR and SUPPRESSION VOLTAGE controls from zero simultaneously until a convenient deflection is obtained.

To interpret the final recording, read the total input voltage as the algebraic sum of two components: the recorded component and the suppressed component.

The recorded component in millivolts is equal to the product of the deflection in centimeters and the ATTENUATOR setting.

The suppressed component in millivolts is the product of the SUPPRESSION VOLTAGE dial reading and the value of each dial unit given in the preceding table.

NOTE: There is a noticeable delay in the response of the recording system to the ZERO SUPPRESSION control. Accordingly, the ZERO SUPPRESSION dial should be turned slowly.

11. CHECKING STABILIZING AMPLIFIER OPERATION

This check should be performed only as a routine maintenance step, or if the system shows a tendency to drift.

1. Balance the Preamplifier as described in Paragraph 7.
2. Turn the USE-OFF-CAL-ZERO-BAL switch to OFF or CAL.
3. Turn the BALANCE control about forty-five degrees. The stylus should deflect, but after rotation of the control ceases, the stylus should return to its previous position if the stabilizing amplifier is functioning properly.
4. Rebalance the Preamplifier as described in Paragraph 7, upon completion of the checking procedure.

12. ADJUSTING THE SENSITIVITY BALANCE

This adjustment affects the phase inverter stage only. It should be performed only if rotation of the SENSITIVITY control causes the stylus to move under no-signal conditions.

1. Open the rear door of the "150" system cabinet and remove the screw which secures the Driver Amplifier and Power Supply to the rear mounting brace. Then remove the four screws which hold the front of the channel in place. Slide the entire channel out far enough to adjust the Sensitivity Balance control R1849, which is located behind the panel near the OUTPUT jack.
2. Turn the SENSITIVITY control fully counterclockwise.
3. Set the stylus on the center line of the recording chart with the POSITION control.
4. Turn the SENSITIVITY control fully clockwise.
5. Adjust the Sensitivity Balance control R1849 to return the stylus to its original position.
6. The adjustment is now complete, but a slight amount of baseline shift may still be experienced. To correct this condition, rotate the SENSITIVITY control continuously and adjust the Sensitivity Balance control until no baseline shift occurs.
7. Replace the channel on completion of this adjustment.

13. ADJUSTING THE GAIN STABILIZER

This adjustment controls the amount of negative feedback which stabilizes the gain of the dc preamplifier. It should be performed if the response to the calibration signal is not a perfect square but instead has a leading edge which is either rounded or peaked.

1. Open the rear door of the "150" system cabinet, and slide the entire channel out as described in paragraph 12, far enough to adjust the Stabilized Gain control R1822, accessible through the top of the attenuator shield housing.
2. Press the 2 MV CAL button intermittently and adjust the Stabilized Gain control R1822 for the most rectangular leading edge obtainable.
3. Replace the channel on completion of this adjustment.

14. ADJUSTING THE ATTENUATOR TRIMMERS

This adjustment should rarely need attention. The attenuator trimmers affect high frequency response only on the X2, X5, and X10 attenuator positions, and need readjustment only if the response of the preamplifier near 10,000 cycles is adversely affected at these attenuator positions.

1. Open the rear door of the "150" system cabinet, and slide the entire channel out as described in paragraph 12, far enough to adjust the Attenuator Trimmers C1801, C1802, and C1803, accessible through the top of the attenuator shield housing.

2. Connect a variable frequency audio signal generator to the INPUT jack, and an AC VTVM to the OUTPUT jack of the preamplifier.

3. Adjust the Attenuator Trimmers C1801, C1802, and C1803 when the ATTENUATOR is at X2, X5, and X10 respectively, for less than 3 db. loss at 10 KC.

15. ADJUSTING THE INTERNAL BALANCE

This adjustment is needed only to correct non-linear operation of the preamplifier.

1. Open the rear door of the "150" system cabinet and slide the entire channel out as described in paragraph 12, far enough to permit adjustment of S1804 and R1871 behind the OUTPUT jack.

2. Turn the USE-OFF-CAL-ZERO-BAL switch to ZERO, and center the stylus with the POSITION control.

3. Turn the USE-OFF-CAL-ZERO-BAL switch to BAL; adjust the BALANCE R1833 control to recenter the stylus.

4. Adjust the SENSITIVITY BALANCE control R1849 to eliminate stylus deflection while opening and closing S1804. Ignore switching transients.

5. Adjust R1871, the −100 volt control, to recenter the stylus after the previous adjustment is completed.

6. Repeat steps 2 and 3 to ensure adequate balance.

NOTE: The stylus will tend to wander somewhat during this adjustment because the stabilizing amplifier is disabled; this should not be too annoying if at least thirty minutes warm-up has been allowed. Adjustments are not critical; discrepancies of the order of two millimeters will be corrected by the stabilizing amplifier in normal operation.

16. REMOVING AND REPLACING PREAMPLIFIERS

1. To remove a Preamplifier, turn off the POWER switch on the associated Power Supply. Loosen the thumbnuts behind the chrome handles on the Preamplifier and pull the Preamplifier from its recess.

2. To replace a Preamplifier, check that the POWER switch on the associated Power Supply is turned off. Insert the new Preamplifier into the vacant space, taking care that the multi-circuit connector at the Preamplifier chassis rear becomes properly engaged with the mating connector on the Driver Amplifier Align the two small dowels at the top corners of the Preamplifier with the corresponding holes in the framework. Then press the Preamplifier in firmly and tighten the thumbnuts.

17. CHECKING AND REPLACING ZERO SUPPRESSION CELLS

Separate cells supply voltages for each polarity of zero suppression. Their output voltages may be checked by switching both cells into a sampling resistance network for comparison; this is accomplished when the ZERO SUPPRESSION switch is in the CHK position. If one cell is defective, a voltage proportional to the difference between the output voltages appears in the zero suppression circuit causing the stylus to deflect. The direction of this deflection indicates which cell is defective. (This assumes that both cells do not deteriorate at the same rate; experience indicates that this is a safe assumption.) The test procedure is as follows:

1. Turn the ATTENUATOR to OFF.

2. Turn the USE-OFF-CAL-ZERO-BAL switch to OFF.

3. Turn the ZERO SUPPRESSION switch to CHK.

4. Advance the SUPPRESSION VOLTAGE to 1000, and note the direction and amount of stylus deflection. If the deflection is more than three millimeters, one of the cells must be replaced; if the deflection is upward, replace BT1802; if downward, replace BT1801. These cells are located inside the preamplifier behind the DC ZERO SUPPRESSION switch. Sanborn replacement number is 2C–4.

5. Repeat the check after the defective cell is replaced. If a deflection of three millimeters or more is obtained either the wrong cell was replaced or the remaining cell is also defective. If the deflection is in the same direction as in the first check, the wrong cell was replaced; if the deflection is in the opposite direction, the remaining cell is defective. These cells normally last one year.

18. THEORY OF OPERATION

Figure 2 shows the Stabilized DC Preamplifier in relation to the other components which make up one Channel of a Sanborn "150" Series System. The input signal to the system is applied to the input of the Preamplifier, which amplifies this signal and feeds it to the Driver Amplifier. Driver Amplifier Model 150–200 (or 150–200A, 150–200B) usually feeds a Sanborn direct-writing galvanometer; Driver Amplifier Model 150–300 may feed a panel meter, an oscilloscope (or other high-impedance load), or a galvanometer (or other low-impedance load). The Power Supply provides all the plate, bias, and heater voltages for the Driver Amplifier and the Preamplifier. The Preamplifier interconnects with the Driver Amplifier through a multi-circuit connector.

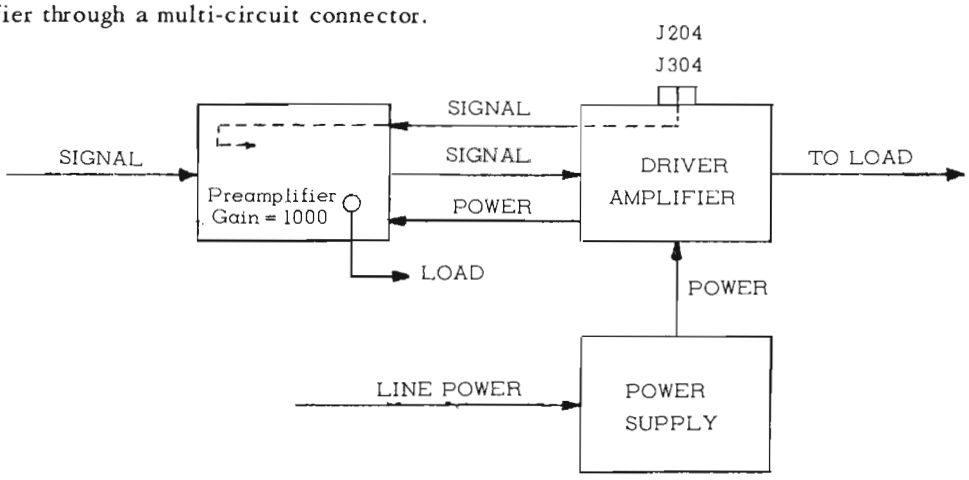

Figure 2. Block Diagram of Stabilized DC Preamplifier in a "150" System.

19. FUNCTIONAL DESCRIPTION OF CIRCUITS

Figure 3 is a block diagram which shows the basic circuits in the Stabilized DC Preamplifier. The instrument includes two amplifier circuits: the signal amplifier circuit, across the top of figure 3, and the stabilizing amplifier circuit, across the bottom of the figure.

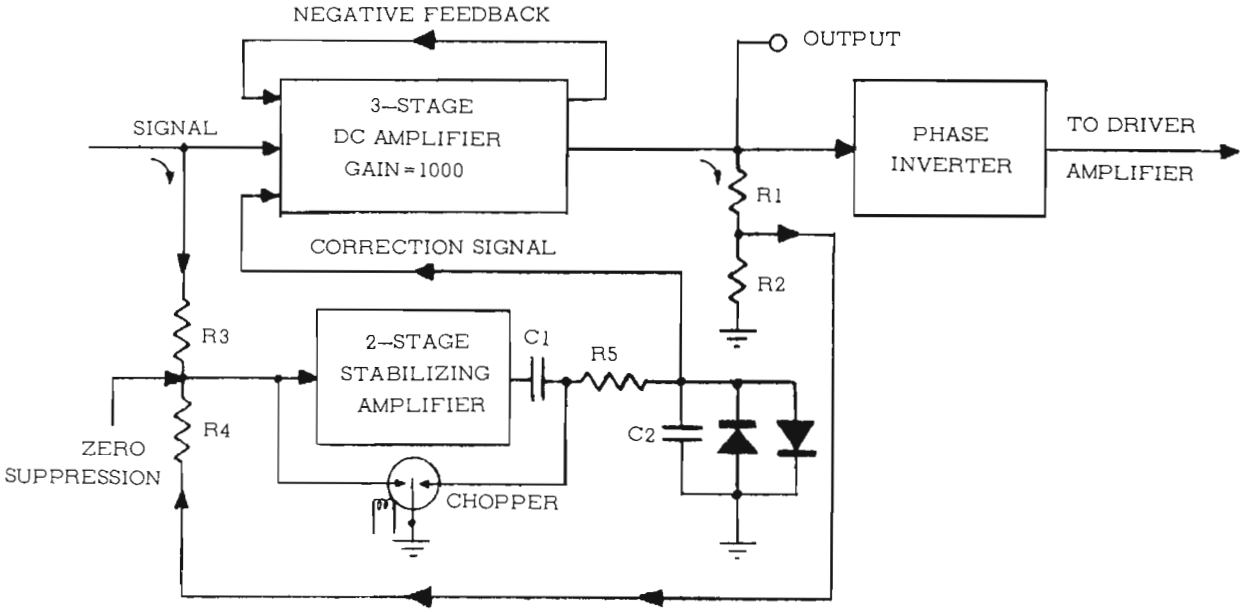

Figure 3. Basic Circuits of the Stabilized DC Preamplifier.

The three-stage d-c amplifier uses a push-pull resistance coupled circuit. The gain is 1000, stabilized by a balanced negative feedback loop. The input signal is fed into one grid of the push-pull input stage. After being amplified by a factor of 1000, the signal is not only fed to the Driver Amplifier through a phase inverter, but is also available to the OUTPUT jack as a single-ended signal for feeding an oscilloscope or other high-impedance load.

Even with careful design of a push-pull d-c amplifier, there is still a small amount of d-c drift remaining. In this Preamplifier, the drift is corrected by a low frequency stabilizing amplifier, which inserts a drift correction voltage into the signal amplifier.

At the output of the three-stage d-c amplifier (in the signal amplifier circuit) there is a voltage dividing circuit of two resistors having a ratio of one thousand to one. When there is zero drift, the voltage from the divider is of exactly the same magnitude as the signal into the instrument, and of the opposite polarity. When drift is present, this voltage is the same as the input signal plus a drift component.

At the input to the stabilizing amplifier there are two equal resistors. One resistor is connected to the preamplifier input, and the other is connected to the voltage divider. When there is zero drift, the input signal to the Preamplifier is the same as the voltage from the divider, there is no signal into the stabilizing amplifier, and there is no drift correction voltage inserted into the signal amplifier. When drift is present, there is a drift component present in the voltage from the divider, there is a signal inserted into the stabilizing amplifier, and a correction signal is inserted into the signal amplifier.

The stabilizing amplifier is a condenser-coupled amplifier, with a single-pole double throw chopper operating on both the stabilizing amplifier input and its output. The chopper intermittently grounds

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NOVEMBER 20, 1962

REPLACEMENT PARTS LIST SUPPLEMENTS
RPL-150-1800-3A, 3B, 3C, 3D

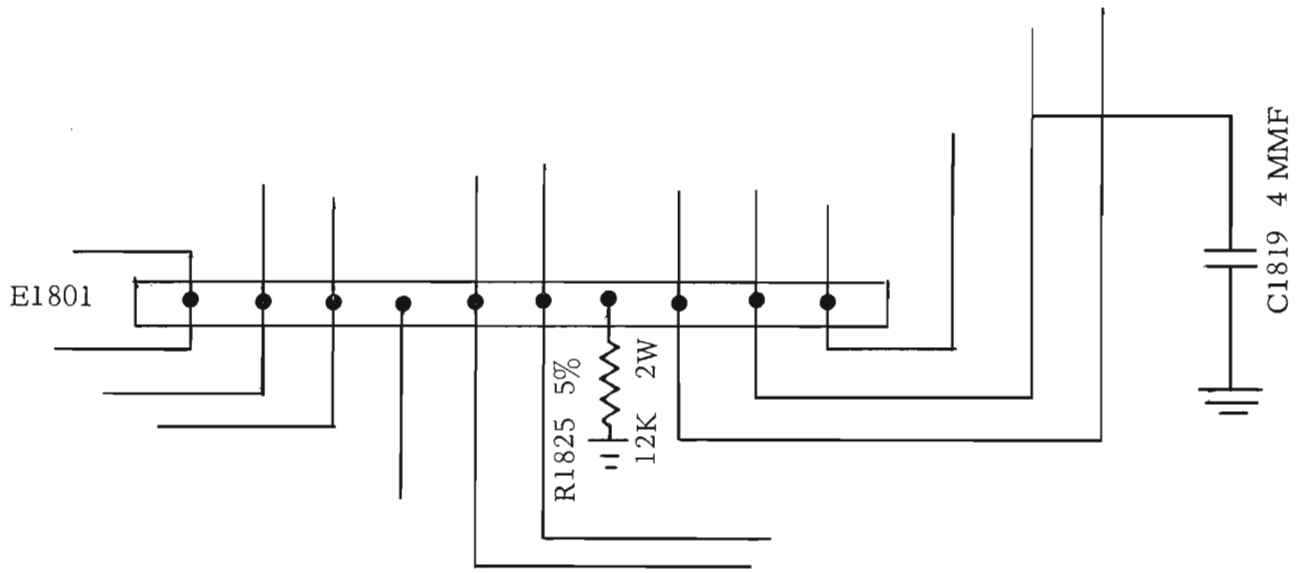
SANBORN STABILIZED DC PREAMPLIFIER
MODELS 150-1800, 150-1800A

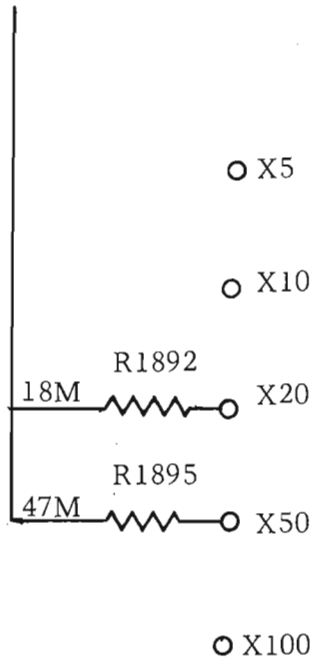
RPL-150-1800-3A
CR8917 5/29/58 STANDARD CHANGE

The following resistor and capacitor were added to prevent high frequencies from overloading the Driver and feeding back to the Preamplifier.

Capacitor C1819 4 mfd. 450V Electrolytic Sanborn No. 8C-22.

Resistor R1895 47 meg. 5% 1/2 W Sanborn No. 50AB-476J.





CR10731 4/14/60

Capacitors C1805, C1808 have Sanborn Number 8B-120.

SANBORN COMPANY
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APRIL 1, 1965

REPLACEMENT PARTS LIST SUPPLEMENT
RPL-150-1800-3E

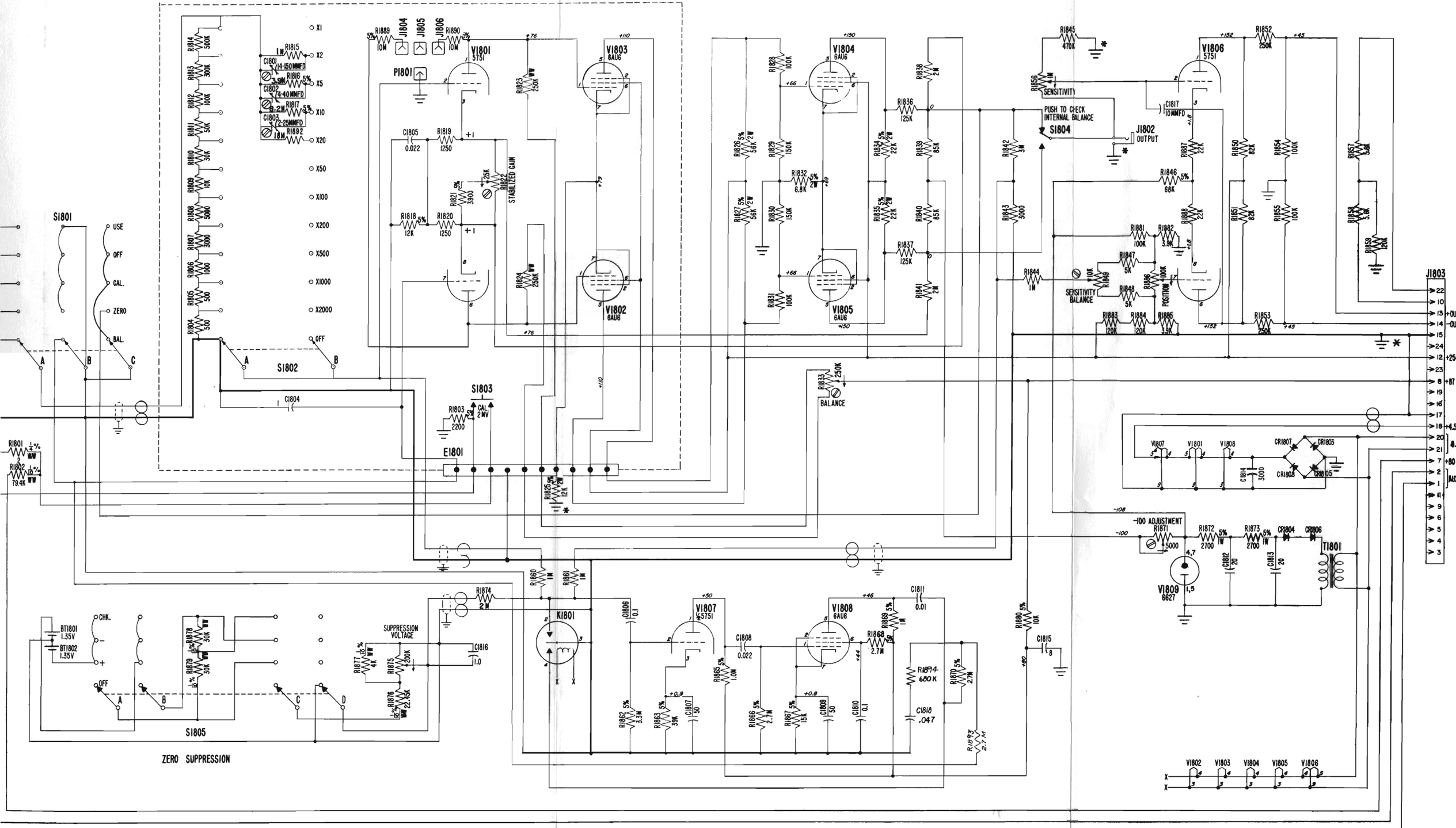
SANBORN STABILIZED DC PREAMPLIFIER
MODEL 150-1800

CHANGES TO INSTRUMENT AND SCHEMATIC
from 3/6/62 to 3/29/65 Schematic: 150-1800-C1 Sub 14

DATE	CHANGE RELEASE	SYMBOL	CHANGED TO	SANBORN NUMBER	VENDOR CODE
3/29/65	CR14877	R1898	Resistor: 47M ±5% 1/2W added across R1874.	50AB-476J	EB (AB)
3/24/65	CR14880	BT1801 BT1802	Mercury Cell: 1.35V	2C-4A	(SAN)

VENDOR ABBREVIATIONS

AB Allen Bradley
SAN Sanborn Company



NOTES

1. All Resistors 1% unless noted
2. R1875 - 10 turns, 1/10% Linearity & 5% resistance tolerance.
3. Connections indicated by Ground Symbol ⏚ tie to a Common Ground Point. Ground Symbols marked * go to Chassis.

RESISTORS – MATCHED WITHIN 2%

R1826	R1827
R1834	R1835
R1887	R1888
R1850	R1851

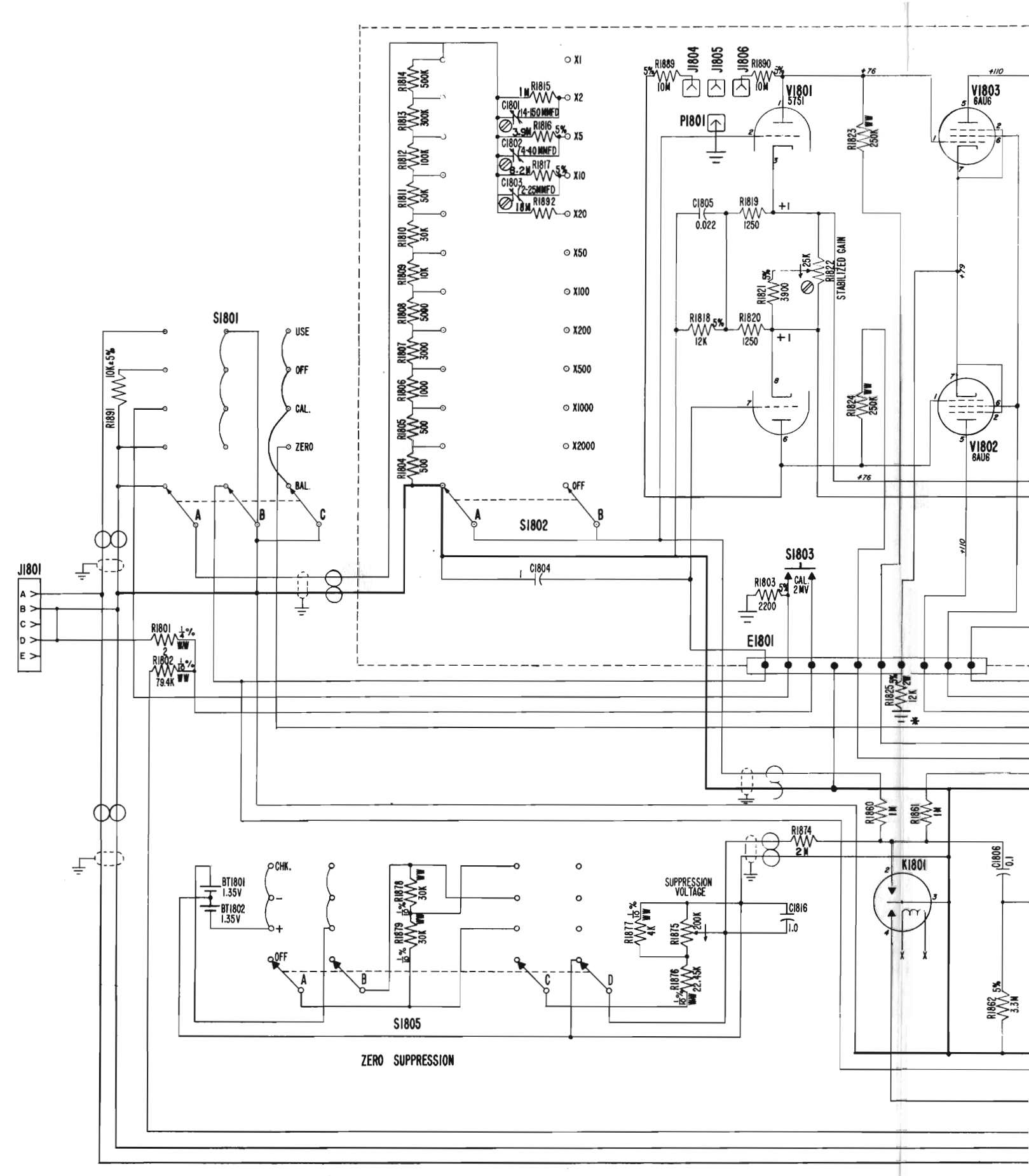
CHANGES

(1) (CR7442) added matched resistors within 2% R1887 R1888, R1850 - R1851 4/10/56
(2) (CR7540) added R1891 6/15/56
(3) (CR7605) added note 3 and shields 8/1/56
(4) (CR7680) changed values of R1815, R1816, R1817, R1860, R1861, and R1874 9/27/56
(5) (CR7717) added R1892 10/19/56
(6) (CR7745) R1833 was 100K 11/2/56
(7) (CR8024) removed CR1801 & CR1802 added R1880, R1881, and C1818, R1870 was 6.8M 4/16/56
(8) (CR8482) removed CR1803 and R1805: added CR1803, CR1805, CR1807, CR1808 in place of CR1803: added C1814 & Fil. of V1801 in parallel with Fil. of V1807 & V1808. 11/4/57

STABILIZED DC PREAMPLIFIER
MODEL 150-1800
SCHEMATIC: 150-1800-C1 SUB 8

SANBORN COMPANY
WALTHAM, MASS.
NOVEMBER, 1957

CR8482 RPL-150-1800-3



NOTES

1. All Resistors 1% unless noted
2. R1875 - 10 turns, 1/10% Linearity & 5% resistance tolerance.
3. Connections indicated by Ground Symbol ⏚ tie to a Common Ground Point. Ground Symbols marked * go to Chassis.

REPLACEMENT PARTS LIST

SYMBOL	DESCRIPTION	SANBORN NO.
BT1801	1.35 volt Mercury Cell	2C-4
BT1802	1.35 volt Mercury Cell	2C-4
C1801	14-150 mmf variable	8D-9
C1802	4-40 mmf variable	8D-10
C1803	2-25 mmf variable	8D-11
C1804	1 mfd 200V Paper	8B-73
C1805	.022 mfd 200V Paper	8B-67
C1806	.1 mfd 200V Paper	8B-66
C1807	50 mfd 6V Elect.	8C-15
C1808	.022 mfd 200V Paper	8B-67
C1809	50 mfd 6V Elect.	8C-15
C1810	.1 mfd 200V Paper	8B-66
C1811	.01 mfd 200V Paper	8B-68
C1812	20 mfd 250V Elect.	8C-24
C1813	20 mfd 250V Elect.	8C-24
C1814	3000 mfd 10V Elect.	8C-19
C1815	8 mfd 150V Elect.	8C-10
C1816	1 mfd 200V Paper	8B-73
C1817	10 mmf Ceramic	8E-16
C1818	.047 mfd 200V Paper	8B-65
CR1803	Silicon rectifier	16A-22
CR1804	Rectifier	16A-15
CR1805	Silicon rectifier	16A-22
CR1806	Rectifier	16A-15
CR1807	Silicon rectifier	16A-22
CR1808	Silicon rectifier	16A-22
J1801	5 contact AN socket	10A5-1FX
J1802	2 conductor jack	10G2-10FX
J1803	24 contact connector	10B24-1MX
K1801	SPDT chopper	62S-2
P1801	Tapper Pin	10J1-2MW
R1801	2 ohm ¼% w.w.	54A-74C
R1802	79.4K 1/10% w.w.	54A-78T
R1803	2.2K 5% ½w Comp.	50AB-222J
R1804	500 ohm 1% ¼w Comp.	50H-501G
R1805	500 ohm 1% ¼w Comp.	50H-501G
R1806	1K 1% ¼w Comp.	50H-102G
R1807	3K 1% ¼w Comp.	50H-302G
R1808	5K 1% ¼w Comp.	50H-502G
R1809	10K 1% ¼w Comp.	50H-103G
R1810	30K 1% ¼w Comp.	50H-303G
R1811	50K 1% ¼w Comp.	50H-503G
R1812	.1 Meg 1% ¼w Comp.	50H-104G
R1813	.3 Meg 1% ¼w Comp.	50H-304G
R1814	.5 Meg 1% ¼w Comp.	50H-504G
R1815	1 Meg 1% ½w Comp.	50J-105G
R1816	3.9 Meg 5% ½w Comp.	50AB-395J
R1817	8.2 Meg 5% ½w Comp.	50A-825J
R1818	12K 5% ½w Comp.	50AB-123J
R1819	1.25K 1% ¼w Comp.	50H-125-1G
R1820	1.25K 1% ¼w Comp.	50H-125-1G
R1821	3.9K 5% ½w Comp.	50AB-392J
R1822	25K variable	56A-41
R1823	.25 Meg 1% w.w.	54A-75F
R1824	.25 Meg 1% w.w.	54A-75F
R1825	12K 5% 2W Comp.	52C-123J
*R1826	56K 5% 2w Comp.	52C-563JPG
*R1827	56K 5% 2w Comp.	52C-563JPG
R1828	.1 Meg 1% ¼w Comp.	50H-104G
R1829	.15 Meg 1% ¼w Comp.	50H-154G
R1830	.15 Meg 1% ¼w Comp.	50H-154G
R1831	.1 Meg 1% ¼w Comp.	50H-104G
R1832	6.8K 5% 2w Comp.	52C-682J
R1833	.25 Meg Hi-torque Linear	56A-39
*R1834	22K 5% 2w Comp.	52C-223JPG
*R1835	22K 5% 2w Comp.	52C-223JPG
R1836	.125 Meg 1% ¼w Comp.	50H-125-3G
R1837	.125 Meg 1% ¼w Comp.	50H-125-3G
R1838	2 Meg 1% ½w Comp.	50J-205G
R1839	85K 1% ¼w Comp.	50H-853J
R1840	85K 1% ¼w Comp.	50H-853J
R1841	2 Meg 1% ½w Comp.	50J-205G
R1842	3 Meg 1% ½w Comp.	50J-305G
R1843	3K 1% ¼w Comp.	50H-302G
R1844	1 Meg 1% ½w Comp.	50J-105G
R1845	.47 Meg 5% ½w Comp.	50AB-474J
R1846	68K 5% ½w Comp.	50AB-683J
R1847	5K 1% ¼w Comp.	50H-502G
R1848	5K 1% ¼w Comp.	50H-502G
R1849	10K w.w. Pot.	56A-22
*R1850	82K5% ½w Comp.	50AB-823JPG
*R1851	82K 5% ½w Comp.	50AB-823JPG
R1852	.25 Meg 1% ¼w Comp.	50H-254G
R1853	.25 Meg 1% ¼w Comp.	50H-254G
R1854	.1 Meg 1% ¼w Comp.	50H-104G
R1855	.1 Meg 1% ¼w Comp.	50H-104G
R1856	1 Meg variable	572-220
R1857	5.6K 5% ½w Comp.	50AB-562J
R1858	5.6K 5% ½w Comp.	50AB-562J
R1859	120K 5% ½w Comp.	50A-124J
R1860	1 Meg 1% ½w Comp.	50J-105G
R1861	1 Meg 1% ½w Comp.	50J-105G
R1862	3.3 Meg 5% ½w Comp.	50AB-335J
R1863	39K 5% ½w Comp.	50AB-393J
R1865	1 Meg 5% ½w Comp.	50AB-105J
R1866	2.7 Meg 5% ½w Comp.	50AB-275J
R1867	15K 5% ½w Comp.	50AB-153J
R1868	2.7 Meg 5% ½w Comp.	50AB-275J
R1869	1 Meg 5% ½w Comp.	50AB-105J
R1870	2.7 Meg 5% ½w Comp.	50AB-275J
R1871	5K variable w.w.	56A-72
R1872	2.7K 10% 1w Comp.	51D-272K
R1873	2.7K 10% 1w Comp.	51D-272K
R1874	2 Meg 1% ½w Comp.	50J-205G
R1875	200K variable	56C-7
R1876	22.45K 1/10% w.w.	54A-77T
R1877	4K 1/10% w.w.	54A-79T
R1878	30K 1/10% w.w.	54A-76T
R1879	30K 1/10% w.w.	54A-76T
R1880	10K 5% ½w Comp.	50AB-103J
R1881	.1 Meg 1% ½w w.w.	54A-88F
R1882	3.9K 1% ½w w.w.	54A-82F
R1883	.12 Meg 1% w.w.	54A-83F
R1884	.12 Meg 1% w.w.	54A-83F
R1885	3.9K 1% w.w.	54A-82F
R1886	100K Potentiometer	56A-46
*R1887	22K 5% ½w Comp.	50AB-223JPG
*R1888	22K 5% ½w Comp.	50AB-223JPG
R1889	10 Meg 5% ½w Comp.	50AB-106J
R1890	10 Meg 5% ½w Comp.	50AB-106J
R1891	10K 5% ½w Comp.	50AB-103J
R1892	18 Meg 5% ½w Comp.	50AB-186J
R1893	2.7 Meg 5% ½w	50AB-275J
R1894	.68 Meg 5% ½w	50AB-684J

* The following resistors are matched within 2%: (R1826, R1827), (R1834, R1835), (R1850, R1851) (R1887, R1888).

S1801	5 position 3 deck	62B-32
S1802	12 Position 2 deck wafer switch	62B-8
S1803	Min. SPST snap action normally open	62C-3
S1804	SPDT coin switch	62C-6
S1805	4 position 2 deck	62B-33
T1801	Power transformer	66B-40
V1801	Type 5751	68A-37
V1802	Type 6AU6	68A-19
V1803	Type 6AU6	68A-19
V1804	Type 6AU6	68A-19
V1805	Type 6AU6	68A-19
V1806	Type 5751	68A-37
V1807	Type 5751	68A-37
V1808	Type 6AU6	68A-19
V1809	Type 6627	68A-48

PANEL AND CHASSIS LIST

DESCRIPTION	LOCATION	SANBORN NO.
Preamplifier panel	Front panel of instrument	150-1801
Bushing	On panel; associated with tie rod and knob assembly	150-1008
Locating pin	Upper corners of front panel	150-1030
Lift handle	At sides of front panel	150-1005
Tie rod and knob	Knob visible behind each list handle; rod alongside chassis brackets	150-1100-C13
Chassis	Main chassis of instrument	150-1802
Bottom plate	Shield plate which covers bottom of chassis	150-1017
Bracket, right	Right side of chassis	150-1032
Bracket, left	Left side of chassis	150-1031

KNOBS, DIALS, ETC., LIST

Shaft lock knob	One each on SENSITIVITY and POSITION control shafts.	150-1120
Shaft lock bushing	One each on SENSITIVITY and POSITION control shafts	150-1121
Shaft lock nut	One each on SENSITIVITY and POSITION control shafts.	150-1122
MV switch plunger	Part of CAL switch assembly	51-108
Switch threaded bushing	Part of CAL switch assembly	51-132P2
MV switch threaded bushing	Part of CAL switch assembly	51-213P1
Plug button	On panel	22B-3
Knob	One each on ATTENUATOR and USE-OFF-CAL-ZERO-BAL switches	32A-16
Knob	On DC ZERO SUPPRESSION switch	32A-27
Duo-dial	On SUPPRESSION VOLTAGE control	37F-4

SOCKETS, RESISTOR BOARDS, ETC., LIST

7-pin miniature socket	3 on chassis, 2 on attenuator	10G7-1FX
7-pin miniature socket with shock shield	On shock mounted chassis	10G7-3FX
9-pin miniature socket	1 on chassis, 1 on attenuator	10G9-2FX
9-pin miniature socket with shock shield	On shock mounted chassis	10G9-3FX
Octal socket	On shock mounted chassis	10H8-2FX
Noval tube shield	On 9-pin socket	68B-3
Tube shield	On 8-pin socket	68B-8
Fuse clip	Holds mercury cells	12A-17
Standard cell mounting board	Part of standard cell assembly	52-202
Standard cell contact	Part of standard cell assembly	60-218
Attenuator shield cover top	Top part of attenuator shield	150-1813
Attenuator shield cover end	End of attenuator shield	150-1814
Attenuator shield base	Bottom part of attenuator shield	150-1804
Shock mounted chassis	Centrally located on main chassis	150-1803
Mounting bracket	Holds dual potentiometers	150-1808
Bracket	Holds zero suppression components	150-1811
Trimmer capacitor mounting board	Inside attenuator shield	150-1810
Terminal board assembly	Under chassis, mounts six	150-1800-C7
Component board assembly	Mounts trimmer condensers	150-1800-C8

MAINTENANCE MANUAL
FOR
SANBORN STABILIZED DC PREAMPLIFIER

MODELS 150-1800, 150-1800A

TABLE OF CONTENTS

	Page
Theory (Sanborn Stabilized DC Preamplifier)	1
System Trouble Check	4
STABILIZED DC PREAMPLIFIER	
Trouble Shooting Chart	5
Periodic Maintenance	8
Check Chart	9
Repair and Adjustment of Chopper Vibrator	11
Component Location on Resistor Boards	14
Voltage and Resistance Chart	15

SANBORN COMPANY
175 WYMAN STREET
WALTHAM, MASS.
MAY, 1959
MM-150-1800-3

THEORY

SANBORN STABILIZED DC AMPLIFIER

MODEL 150-1800

1. INTRODUCTION

This information supplements the information given in the Instruction Manual. This Preamplifier is a DC-to-10KC instrument (assuming adequate frequency response in the indicator used) when (1) used with an external oscilloscope, (2) used with any other high-impedance load (one megohm or more), or (3) when plugged into a 150-300 Sanborn Driver Amplifier.

This Preamplifier is a DC-to-100 cps. instrument when plugged into a 150-200, A, B Sanborn Driver Amplifier (limited to 100 cycles by the frequency limitations of direct-writing galvanometer and stylus). The Preamplifier includes two amplifier circuits. The first circuit is the signal amplifier: a four-stage direct-coupled push-pull d-c amplifier, which amplifies the input signal and delivers it to the Driver Amplifier. The second circuit is the stabilizing amplifier: a two-stage chopper-type single-ended amplifier, which amplifies the drift component at the output of V1804, and feeds it back into the input of the signal amplifier with such a polarity as to reduce the drift toward zero.

2. INPUT STAGE OF SIGNAL AMPLIFIER

V1801 is the input amplifier, a push-pull triode d-c amplifier. Input to this amplifier is from terminal A of the INPUT jack J1801 (or from the Driver Amplifier rear) through USE/OFF/CAL/ZERO/BAL switch S1801, then through the ATTENUATOR switch S1802, and into the grid of one side of the push-pull input amplifier. The other side of this input amplifier is fed a stabilizing signal from the stabilizing amplifier; this will be described further on. In the USE position of S1801 the input signal follows the described path, and the stabilizing amplifier feeds back into the input stage as described. In the OFF position, the Preamplifier input circuit is grounded, so that the input signal will have no effect. In the CAL position V1801 is connected to the 2 mv. calibration signal developed by pressing CAL switch S1803. In the ZERO position, one side of the signal-amplifier V1804 output is grounded, for balancing the signal amplifier. In the BAL position, the stabilizing amplifier is inoperative, for adjusting the signal amplifier without the stabilizing signal.

The ATTENUATOR S1802 includes frequency correction capacitors C1801 - 2 - 3 to maintain the Preamplifier frequency range at the high ATTENUATOR switch settings. The zero suppression voltage is inserted into the circuit through the stabilizing amplifier, which will be described in a later paragraph. Note that the V1801 cathode circuit includes a Gain control R1822. This control is connected cathode-to-cathode. When at its maximum resistance setting, the cathode-to-cathode feedback voltage of the stage is at its maximum, and the stage gain is at its minimum. When this resistor is set to its minimum resistance, the cathode-to-cathode feedback voltage is at its minimum, and the stage gain is at its maximum. This feedback voltage is taken from the plate circuit of V1804, and includes V1801, V1802, and V1803 in the overall feedback loop. This is the internal feedback loop of the signal amplifier alone; do not confuse it with the overall feedback loop of the Preamplifier which includes both the signal amplifier and the stabilizing amplifier so as to stabilize against drift.

2. INPUT STAGE OF SIGNAL AMPLIFIER (Continued)

The plate circuit includes BALANCE control R1833, which is adjusted with the stabilizing amplifier inoperative, so as to set the d-c output component of the signal amplifier to zero, with no input signal. If this adjustment were not made, the stabilizing amplifier would bring about the same stabilizing effect, but possibly upsetting the required d-c potentials of the circuit, with resulting non-linearity. Note also in the plate circuit the jacks J1804-5-6 and plug P1801. This is a "cheater" circuit, which shunts ten megohms across one triode, or the other, or neither, as an aid toward the initial balance of V1801, so that the BALANCE control R1833 is not required to have a wide range of control, for easier balancing of the instrument.

3. OUTPUT STAGES OF SIGNAL AMPLIFIER

The second signal amplifier stage (V1802-V1803) is a conventional direct-coupled push-pull pentode amplifier, having a sufficiently high common cathode resistor so that its grids may be connected directly to the plates of V1801 for d-c amplification. The output stage of the signal amplifier is V1804-V1805 (do not confuse with V1806, which is the output stage of the entire Preamplifier). The grids of V1804-V1805 are connected directly to the plates of V1803 through a 6:10 attenuator circuit which brings the signal level at its grids down to a level required by the characteristics of the stage. The output circuit of this stage includes a balancing network returned to the -100 volt line, which gives a pair of output signal terminals which are both at ground potential when there is no signal. Adjustment is made by S1804, with the USE/OFF/CAL/ZERO/BAL switch S1801 set at ZERO. With this switch at ZERO, one of the output signal terminals is connected to ground; pressing S1804 then disconnects the input to V1806 from one signal line to the other, for a signal comparison and adjustment of R1833 so that both terminals are at the same potential.

4. STABILIZING AMPLIFIER

The stabilizing amplifier consists of a conventional single-ended condenser-coupled a-c amplifier V1807, V1808, together with chopper vibrator K1801. This amplifier is connected in a degenerative feedback loop around the signal amplifier, so as to reduce the drift component of the signal amplifier toward zero. Note first that the gain of the signal amplifier is 1,000, and then note that the divider circuit R1842 - R1843 at the signal amplifier output selects one-one thousandth of the output voltage, for comparison with the input voltage. As a result, the signal from the divider circuit should be exactly equal to the input signal (and also, for purposes of the circuit, will also be of opposite polarity). Under this condition, the voltage at the junction of comparison resistors R1860-R1861 will be zero. However, if a drift component arises within the signal amplifier this drift component will be present at the junction of the divider circuit R1842-R1843, but will not be present at the input signal. Accordingly, the junction of comparison resistors R1860-R1861 will no longer be at zero, but will change to a voltage proportional to the drift arising within the signal amplifier. This drift component is amplified by the stabilizing amplifier, and fed back into the grid of the input amplifier V1801 with such a polarity as to reduce the signal amplifier drift toward zero. Note that the drift which is corrected is the drift arising in the signal amplifier only; any drift occurring external to the Preamplifier cannot be distinguished from any other d-c signal, and is amplified as a signal.

4. STABILIZING AMPLIFIER (Continued)

The stabilizing amplifier has a single-pole double-throw chopper vibrator operating on both the stabilizing amplifier input and its output. The chopper intermittently grounds the stabilizing amplifier input circuit, to change the stabilizing amplifier input signal into a line-frequency square wave. During the interval where the stabilizing amplifier input is not grounded, one side of the stabilizing amplifier output capacitor C1811 is kept at ground potential by the chopper, so that this condenser can quickly charge to a value which represents the full amount of voltage present at the input of the stabilizing amplifier, at the junction of the comparison resistors R1860-R1861. Then during the next half-wave of line frequency which drives the chopper vibrator, the input to the stabilizing amplifier is connected to ground, and the stabilizing amplifier output capacitor C1811 discharges slowly through the associated RC filter R1870-C1804. This output voltage from the RC filter is fed back into the signal amplifier input, so as to reduce the signal amplifier drift toward zero. Earlier models of this instrument include a pair of rectifiers CR1801-CR1802 across the output of the RC filter, to reduce the discharge time in case of signal overload which could block the system. Later models perform a similar function by using a more complex RC filter which reduces the time constant of the stabilizing amplifier.

The zero suppression voltage for this instrument is developed across R1875. Since the stabilizing amplifier can control the baseline position, the zero suppression voltage is fed into the stabilizing amplifier. This isolates the zero suppression circuits from the signal circuit, and uses the stabilizing amplifier for the dual purposes of stabilization and zero suppression. (Model 150-1800 only.)

5. OUTPUT AMPLIFIER

The output amplifier V1806 is a phase-inverter stage designed to amplify the signal amplifier output, and deliver it to the Driver Amplifier. Note that the signal amplifier is push-pull, yet the output from the signal amplifier is taken from one side of the signal amplifier and then passed through this phase inverter for a push-pull output to the Driver Amplifier. This is done because the stabilizing amplifier operates so as to stabilize one side only of the signal amplifier output; it is this stabilized side of the signal circuit which furnishes the signal to the phase inverter output. This stage (V1806) is a gain-of-unity amplifier, having a balancing and stylus positioning circuit in the grid not used for signal.

SYSTEM TROUBLE CHECK

SANBORN 150 SYSTEM

RECORDER

DRIVER AMPLIFIER AND POWER SUPPLY

STABILIZED DC AMPLIFIER

Save time by first finding out where the fault is, by following these steps in sequence:

1. IS THERE ACTUALLY A FAULT?

   Check the operator's technique - try the measurements again - see that the operator isn't trying something the system is not built for - check line voltage and frequency.

2. IS THE FAULT IN THE GALVANOMETER?

   Power OFF: Check that there is NO roughness when moving writing arm with finger.

   Power OFF: Measure resistance at pins 1 and 2 of OUTPUT socket on 150-400 Power Supply, or directly at rear pins of padding resistor terminal boards on galvanometer cap. Resistance should be 3150-3250 ohms.

   Power ON: Measure voltage at pins 1 and 2 of OUTPUT socket on 150-400 Power Supply, or directly at rear pins of padding resistor terminal boards on galvanometer cap. Each 32 volts change should give 10 millimeters of stylus deflection (12.5 divisions on narrow Permapaper).

   Final check: Exchange the connections of the suspected galvanometer and its neighbor (in multi-channel system). If symptom moves over to next channel, the galvanometers are normal.

3. IS THE FAULT IN THE PREAMPLIFIER OR THE DRIVER AMPLIFIER/POWER SUPPLY?

   Replace Preamplifier by one known to be good, or by dummy Preamplifier. If the fault remains, the trouble is probably in the Driver Amplifier/Power Supply. If the fault disappears, the trouble was probably in the Preamplifier.

4. DID THESE STEPS POINT OUT THE TROUBLE?

   By now, you should have found the unit at fault. If not, the trouble may be system-wide, or may be impossible to track down by this method. What to do: use the Trouble Shooting Charts and Check Charts.

TROUBLE SHOOTING CHART

SANBORN STABILIZED DC AMPLIFIER

MODEL 150-1800

This chart assumes that the fault has been traced to the Preamplifier.

SYMPTOM	POSSIBLE CAUSE	CHECK
Preamplifier will not work at all	Loose Preamplifier	Check that Preamplifier is plugged in firmly
	Defective tube	Check tubes
	Defective chopper vibrator	Check K1801
	Defective d-c heater voltage rectifier in Preamplifier or Driver Amplifier	Check Preamplifier rectifiers. See Driver Amplifier Trouble Shooting Chart, also note at end of this Trouble Shooting Chart.
Erratic stylus motion, microphonics, or noise, with or without signal	Defective tube	Check tubes
	Defective chopper vibrator	Check K1801
	Defective component	Check for leaky, noisy, or intermittent component or contact
	Loose tube, Preamplifier, or other plug-in unit	Plug in firmly
	Defective circuit element	Check for noisy element with oscilloscope and meter
	Defective soldering of input cable to input connectors	Make electrical connections with high-quality rosin-core solder only. If rosin leakage suspected, clean connectors with carbon tetrachloride (including connector to J204 or J304 at Driver Amplifier rear). Avoid spattering solder.
	Erratic signal	Check signal with oscilloscope
	Defective signal cable	Replace cable
	Vibration of signal cable	Move cable to check for intermittent short or open
	Spurious signal pickup	Check cable grounding and shielding connections. Avoid ground loops. Try omitting shield ground connection to signal source and/or to Preamplifier, shown in Instruction Manual figure 1.

SYMPTOM	POSSIBLE CAUSE	CHECK
	Routing of wires	Check inside Preamplifier that wires from V1802 - 5 and V1803 - 5 are routed past the pin 7 side of V1801, not the pin 2 side.
Drift, with or without signal	Inoperative stabilizing amplifier V1807-V1808-K1801	Check as described in paragraph 11 of Instruction Manual
	Defective tube	Check V1807 and V1808, then all tubes
	Defective chopper vibrator	Check K1801
	Line voltage drifting widely, or drifting outside limits	Check with meter
	BALANCE control requires resetting	Check setting. If cannot adjust, see later in this chart
	Defective d-c heater voltage rectifier in Preamplifier	Check Preamplifier rectifiers.
	Inadequate warmup	Warm up at least 30 minutes
Drift, with signal only	Signal drift	Check signal with oscilloscope or meter
	Non-linear signal circuit element which rectifies stray a-c signals	Avoid non-linear elements and stray a-c fields
Low sensitivity	Defective tube	Check tubes
	Defective resistor	Check R1842, R1843, R1860, R1861
	Defective tube	Check V1806, then all tubes
	Improper calibration	Check calibration technique
	Low-impedance load connected to OUTPUT jack on Preamplifier	Load resistance should be above one megohm
Non-linear	Defective tube	Check V1806, V1809, then all tubes
	Preamplifier unbalanced	Adjust BALANCE control; see paragraph 15 in Instruction Manual
	Excessive high-frequency component, or sharp spikes in signal	Cannot be seen on recording with direct-writing galvanometer. Check with oscilloscope
	Defective bias supply	Check that V1809 glows, to show bias voltage is present

SYMPTOM	POSSIBLE CAUSE	CHECK
Stylus stays at one side of recording channel while instrument on	Zero suppression left on (150-1800 only).	Turn zero suppression off
	Improper use of zero suppression	Check operating technique
	Defective tubes	Check tubes
	Defective chopper vibrator	Check K1801
	Defective stabilizing amplifier	Check V1807, V1808 circuit, including C1811
POSITION control will not cover range	Defective tube	Check V1806, V1809, then all tubes
	Preamplifier unbalanced	Check BALANCE control; see paragraph 15 in Instruction Manual
	Defective output stage	Check output stage components associated with V1806
	Defective bias supply	Check that V1809 glows, to show bias voltage is present

NOTE: This Preamplifier uses a d-c heater supply for V1801, V1807, and V1808. This requires a parallel rectifier circuit, where rectifier CR1803 has its four terminals in parallel with the d-c heater voltage rectifier in the Driver Amplifier, and where the rectifier CR1805 has its input (a-c) terminals in parallel with the input terminals of the other two d-c heater voltage rectifiers. It is possible that if one section of one of these rectifiers should become defective, this would place an additional load on the parallel rectifier, and possibly damage these other rectifiers or other components in the d-c heater voltage circuits. Therefore, when replacing a d-c heater voltage rectifier or condenser in either the Preamplifier or the Driver Amplifier, always check over all the d-c heater voltage circuits, both in the Preamplifier and in the Driver Amplifier. Include the rectifiers and the filter condensers in this check.

NOTE: Beginning Dec. 1957, CR1803 replaced by bridge identified as CR1803, CR1805, CR1807, CR1808. Original CR1805 eliminated. Above damage warnings hold for these instruments. Chassis of these Preamplifiers bear stamp CR8482 or higher.

PERIODIC MAINTENANCE

SANBORN STABILIZED DC AMPLIFIER

MODEL 150-1800

This is recommended every 500 hours of operation or every 3 to 6 months, as determined by experience.

1. Remove the Preamplifier, inspect above-chassis on the Preamplifier for loose tubes, controls, and plug-in components.

2. Inspect under the chassis for loose resistors, condensers, terminals boards, etc.

3. Look for evidence of overheated components - check visually and by smell for burned insulation, transformers, resistors, condensers, etc.

4. Look for frayed or burned-away insulation.

5. Replace the two mercury voltage cells, using Sanborn n. 2C-4 (Model 150-1800 only). These have a rated life of a little over one year, whether the Preamplifier has been used or not. (Model 150-1800 only.)

6. Check for dents, panel scratches, corrosion, and other mechanical abuse. See that all locking controls will lock firmly, and that all plug buttons are in place. Controls, connections, meters, indicators, etc., must be firmly fastened to the panel. See that all knobs are fastened firmly.

7. Blow out dust and dirt with an air hose.

8. Check that the blue-ribbon connector will mate properly with Driver Amplifier.

9. Insert the Preamplifier back into the Driver Amplifier.

10. Go through the steps of the Check Chart.

CHECK CHART

SANBORN STABILIZED DC AMPLIFIER

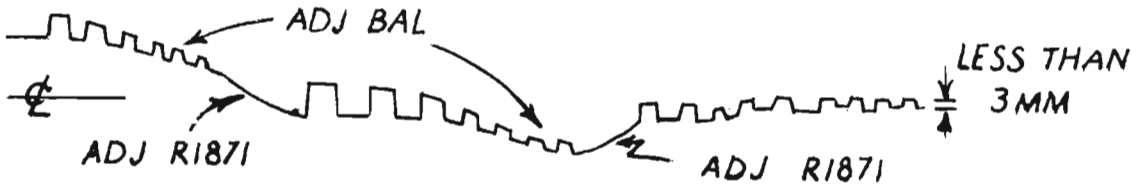
MODEL 150-1800

Perform these checks with the Preamplifier plugged into a Sanborn Driver Amplifier Models 150-200A or 150-200B.

1. Set USE/OFF/CAL/ZERO/BAL to ZERO. Check that POSITION control will move stylus over entire chart, and then set stylus to mid-scale.

2. ADJUST BALANCE CONTROL (part 1). Set USE/OFF/CAL/ZERO/BAL to BAL. Set SENSITIVITY full counterclockwise. Turn the front-panel BALANCE control through its full range, and watch for stylus motion over its entire channel. If this is not possible, remove ATTENUATOR shield top and shift the moveable lead in the compartment to either of its other two positions and repeat this test. If still cannot adjust, replace V1801 and repeat.

3. ADJUST BALANCE CONTROL (part 2). Intermittently press the back-of-panel switch S1804 and adjust the BALANCE control for minimum stylus deflection which must be less than 3 divisions peak-to-peak at the middle of the chart. The baseline will probably drift; keep it at mid-scale with the -100V ADJ control R1871. The record will be approximately:

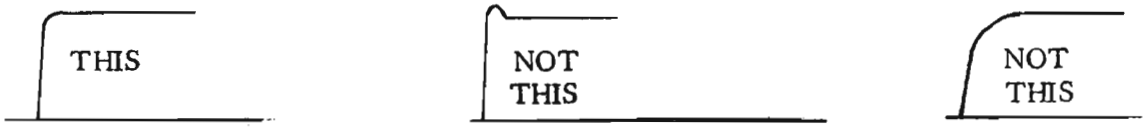


4. ADJUST SENSITIVITY BALANCE. Set USE/OFF/CAL/ZERO/BAL to ZERO. Set SENSITIVITY full counterclockwise. Center stylus on chart with POSITION control. Set USE/OFF/CAL/ZERO/BAL to OFF. Set SENSITIVITY control full clockwise. Return stylus to mid-scale with SENSITIVITY BALANCE control R1849 behind panel. Now turn SENSITIVITY control back and forth over its range; there should be no stylus movement.

5. CHECK STABILIZING AMPLIFIER. Set USE/OFF/CAL/ZERO/BAL to CAL. Set ATTENUATOR to X1. Intermittently press CAL button and adjust SENSITIVITY control for 20 divisions of stylus deflection. Recorded trace should show negligible a-c interference. Now turn front-panel BALANCE control slightly; stylus will deflect and return if operation is normal. Now turn the BALANCE control over its range; any sustaining baseline shift should be less than 3 divisions.

6. REBALANCE. Set USE/OFF/CAL/ZERO/BAL to ZERO. Set stylus to mid-scale with POSITION control. Turn USE/OFF/CAL/ZERO/BAL to BAL. Set stylus to mid-scale with BALANCE control.

7. ADJUST THE STABILIZED GAIN. Set USE/OFF/CAL/ZERO/BAL to CAL. Set ATTENUATOR to X2. Intermittently press CAL button and adjust SENSITIVITY control for 10 divisions stylus deflection. Now intermittently press CAL button and adjust STABILIZED GAIN control R1822 for best looking square wave leading edge. See Examples:



8. ADJUST THE SENSITIVITY. Set USE/OFF/CAL/ZERO/BAL to CAL. Set ATTENUATOR to X1. Set SENSITIVITY control full counterclockwise and press CAL button; stylus deflection should be less than 9 millimeters (11 divisions with narrow-channel Permapaper). Now turn SENSITIVITY control full clockwise and press CAL button; stylus deflection should be more than 27 millimeters (34 divisions with narrow-channel Permapaper).

9. CHECK THE HUM. Set USE/OFF/CAL/ZERO/BAL to CAL. Set ATTENUATOR to X1. Intermittently press CAL button and adjust SENSITIVITY control for 20 divisions stylus deflection. Hum and noise content on recording should be less than 1/4 division peak-to-peak. (At this point in checking out a newly-manufactured instrument, the transformer underneath the chassis is rotated to the position giving least hum and noise.)

10. CHECK THE LINEARITY. This step checks the linearity of Preamplifier, Driver Amplifier, and Galvanometer combined. Calibrate with stylus at bottom of channel. Record a series of accurately-measured d-c input signals at 0, +1, +2, +3, +4, and +5 volts. Then set stylus at top of channel and repeat for negative voltages. Recording should be a step-series pattern, each step within one-half division of the heavy ten-division lines on the chart.

11. ADJUST THE ATTENUATOR TRIMMERS. Insert square-wave signal at 2,000 cycles from audio oscillator. Use a fixed external attenuator circuit, having resistance values selected for easy control of signal levels for a 1 - 10 millivolt input into Preamplifier. Adjust trimmers as per table:

ATTENUATOR at	X2,	adjust C1801
ATTENUATOR at	X5,	adjust C1802
ATTENUATOR at	X10,	adjust C1803

Make these adjustments by watching Preamplifier output on oscilloscope, with the input tube of Driver Amplifier removed to protect later circuits. Proper oscilloscope patterns are:

DESIRED SETTING

WRONG SETTING-OVERSHOOT

WRONG SETTING - RINGING (BAD LEAD PLACEMENT)
Plate leads of V1803 should be run past pin 7 side of V1801

11. (Continued)

Now check with sine-wave signals that frequency response is not more than 3 db. down (71%) at 10K when ATTENUATOR is at X2, X5, and X10.

12. INTERNAL BALANCE AND DRIFT CHECK. After 30-minutes warmup, turn USE/OFF/CAL to ZERO and center stylus with POSITION control. Now turn switch to BAL and adjust BALANCE control to center stylus. Make fine adjustment of BALANCE control to eliminate stylus motion while opening and closing S1804 (ignore switching transients). Now adjust R1871 to recenter the stylus. Repeat entire series of adjustments until BALANCE control no longer needs readjustment. Now turn USE/OFF/CAL to BAL and record stylus motion for two minutes at paper speed of 5 mm./sec. Drift must remain within $\pm$ 10 mm. of mid-scale during some 30 mm. interval of the 2-minute recording. (Limit is 12.5 mm. with narrow-channel Permapaper.) If outside limits, see Trouble Shooting Chart under Drift.

REPAIR AND ADJUSTMENT OF CHOPPER VIBRATOR

The following adjustment should be performed only by a qualified instrument repair technician:

CLEANING PROCEDURE

1. Assemble the following:

(A)	1 oz. carbon tetrachloride	(C)	glass rod
(B)	1 oz. pure alcohol (not denatured). Isopropyl alcohol 99% pure is satisfactory.	(D)	ear-syringe
		(E)	jeweler's loupe or a 10-20 power microscope.

2. Remove cover in a dust free room. Don't handle parts or touch contacts. Do not use compressed air.

3. Using the glass rod, place a drop of carbon tetrachloride on each set of contacts. Gently blow dry with ear-syringe. Examine with microscope or loupe for dryness and cleanliness.

4. Repeat step 3 with alcohol.

ADJUSTMENT PROCEDURE

1. Connect the Chopper as shown in Figure 1. Use an oscilloscope having push-pull "Y" axis input terminals.

2. Apply rated voltage and frequency to the Chopper vibrator coil.

3. Set the oscilloscope horizontal sweep at 30 cycles (or 1/2 any other rated frequency) and sync internal. When the Chopper is operating normally, the display shown in Figure 2 will appear. The pattern may be inverted, depending upon polarity.

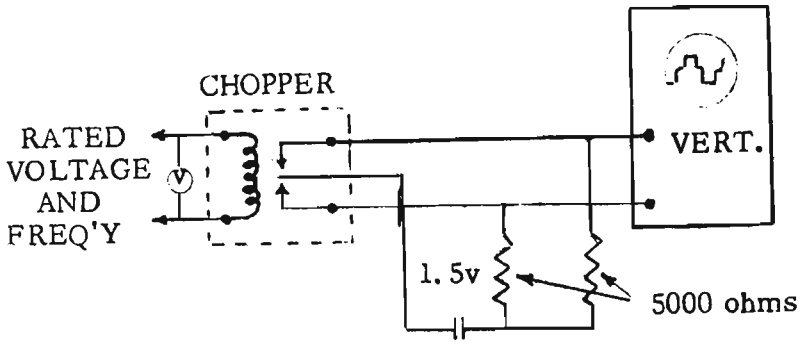


FIGURE 1

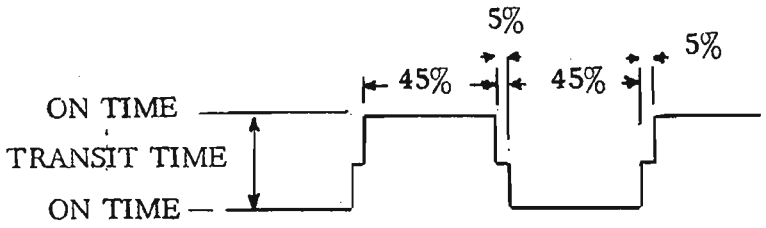
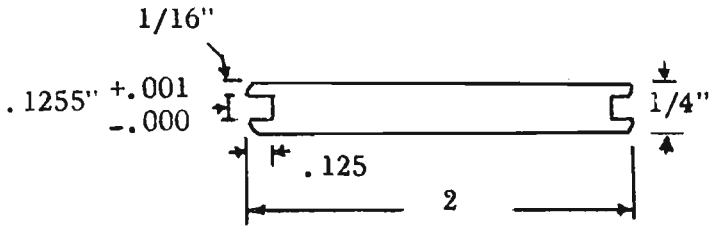


FIGURE 2



MATERIAL - 3/32" PAPER BAKELITE

FIGURE 3

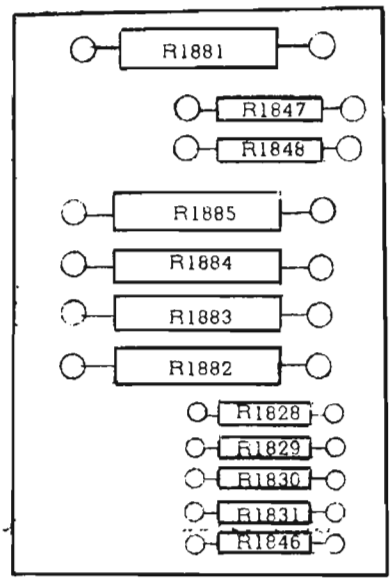
ADJUSTMENT PROCEDURE (Continued)

4. If adjustment is indicated, turn the adjusting screws carefully, one at a time, watching effect on the oscilloscope pattern. Turn the screw counter-clockwise to increase ON-time, clockwise to decrease.

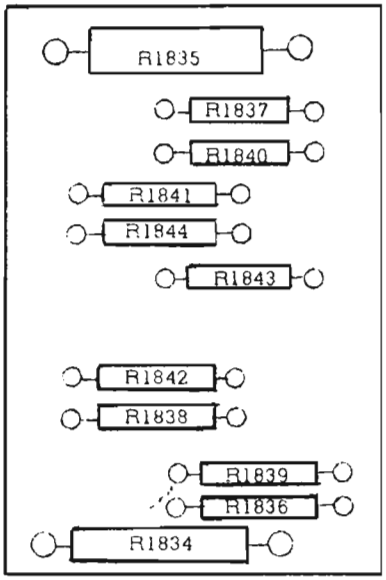
5. Replace cover immediately.

ADJUSTMENT TOOL

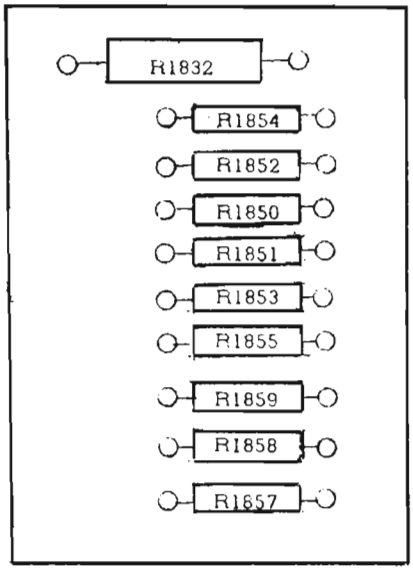
The preferred tool for making these adjustments is the bakelite wrench shown in Figure 3. This may be constructed from the drawing or it may be ordered from Stevens-Arnold, Inc., 22 Elkins Street, South Boston, Mass. as Adjustment Tool 368-8, price 50 cents each net. It is possible to substitute a small metallic wrench, but closer adjustments are obtained when the insulated tool is used.



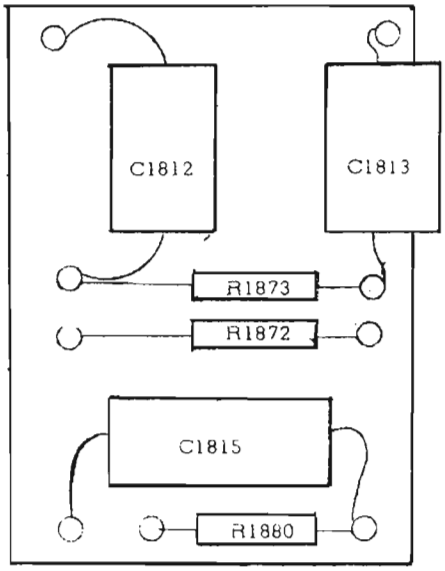
E1802



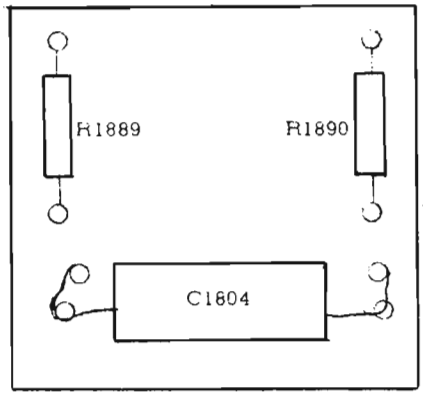
E1803



E1804

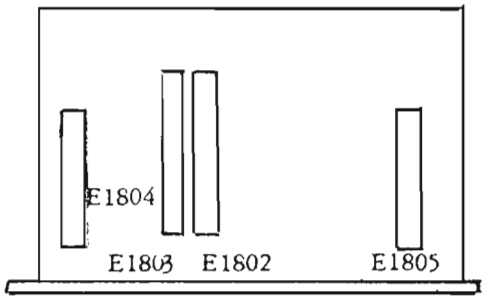


E1805



E1806

LOCATED BEHIND ATTENUATOR



BOTTOM VIEW OF CHASSIS

COMPONENT LOCATION ON RESISTOR BOARDS

VOLTAGE AND RESISTANCE CHART

SANBORN STABILIZED DC PREAMPLIFIER

MODEL 150-1800

TUBES	1	2	3	4	5	6	7	8	9
V1801	68V 260K*	-.2V	1.15V 10.4K	FIL	FIL	68V 300K	0 5.5M*	1.15V 10.35K	FIL
V1802	68V 260K*				108V 60K*	255V 20K*	70V 10.5K		
V1803	68V 260K*				108V 60K*	255V 20K*	70V 10.5K		
V1804	67V 80K	70V 7K			135V 36K*	248V 30K*	70V 7K		
V1805	67V 80K	70V 7K			130V 36K*	248V 30K*	70V 7K		
V1806	150V 80K*	0V 330K	1.85V 100K			150V 80K	.39V 28K	2.1V 100K	
V1807	60V 1M	0V 3.5M	.82V 40K*	FIL					FIL
V1808	0V 2.7M	1.0V 15K			36V 1M	34V 2.7M	1.0V 15K		
V1809				-105V 24K*					

NO SIGNAL

USE OFF CAL TO OFF
ATTENUATOR TO OFF
ZERO SUPPRESSION TO OFF
SENSITIVITY COUNTERCLOCKWISE
POSITION CENTER

*CHARGING CAPACITOR