INSTRUCTION MANUAL

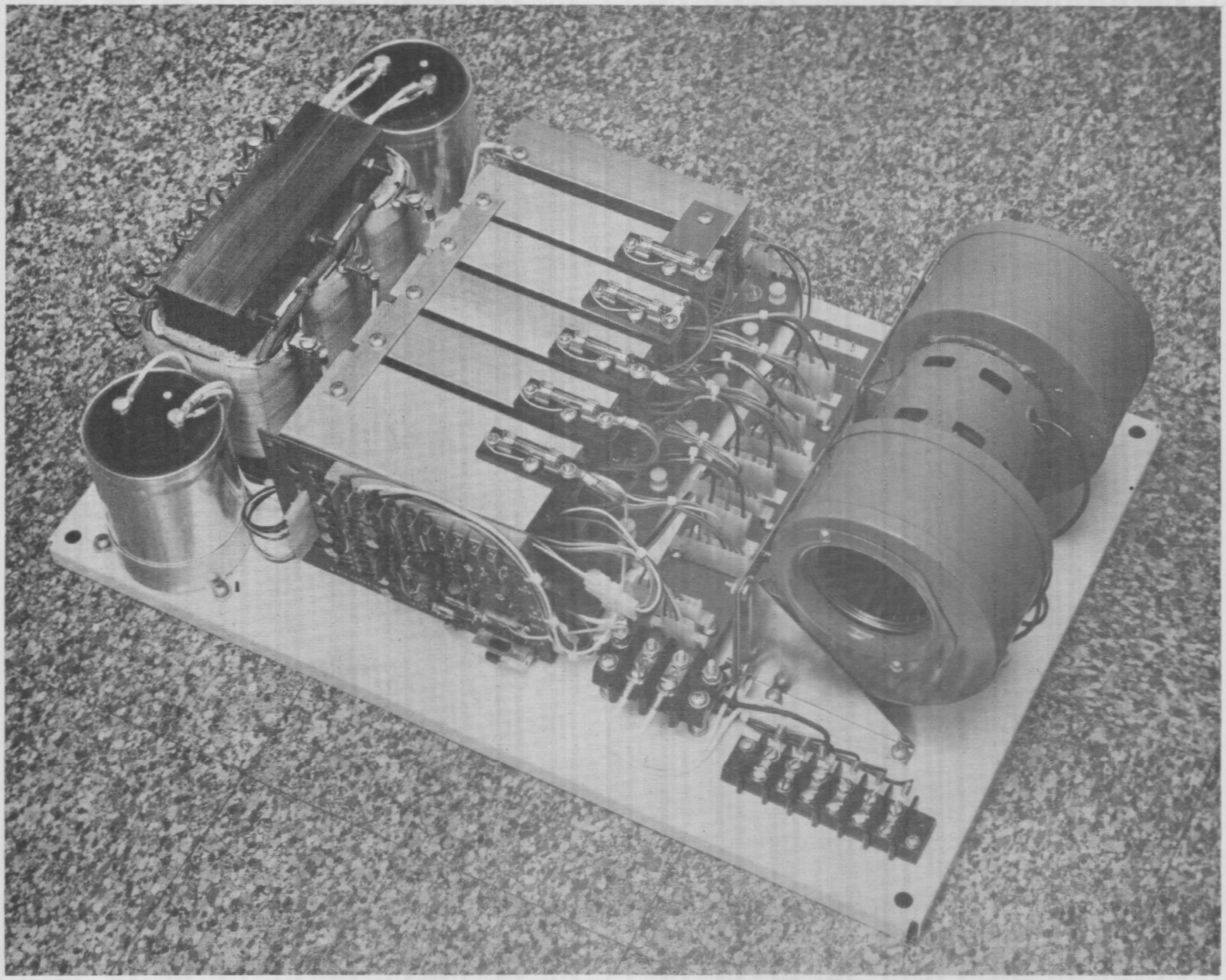
WESTAMP A524 & A528 SERIES

This is a general manual describing a series of amplifiers and may be used in conjunction with drawings pertaining to various specific models.

CAUTION

The maintenance procedure described herein should be attempted only by highly skilled technicians using proper test equipment. Read your warranty provisions before starting, to avoid voiding your warranty.

WESTAMP



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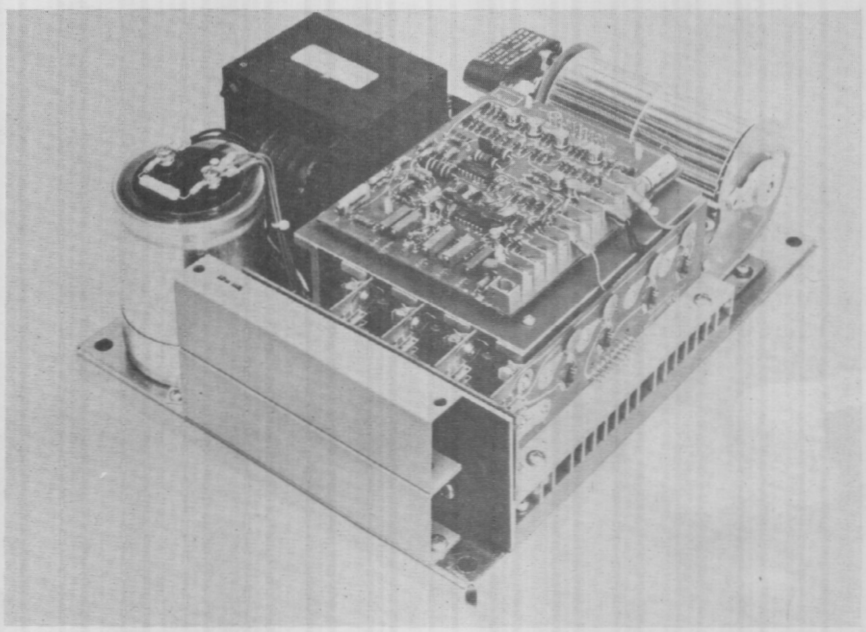

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FOREWORD:

This manual is a general purpose manual, covering the installation, application, adjustment, theory, and trouble-shooting of these Linear D. C. Transistor Amplifiers. The manual does not necessarily specifically apply to any one individual amplifier. However, the information is presented in a general way, so that it may be applied to any specific amplifier in conjunction with its associated drawings and parts lists.

DESCRIPTION

The amplifiers covered by this manual have a linear bi-polar D.C. type of output. All of the amplifiers have easy access for adjustments and easily removable sub-assemblies for maintenance. The amplifiers contain many adjustments to facilitate first time application in new equipment. For production applications most of these adjustments can be fixed to simplify the application.

SPECIFICATIONS:

GAIN No. 2 and 3	1000
GAIN No. 1	40
D. C. DRIFT PER INPUT	10 μ V per $^{\circ}$C
INPUT VOLTAGE MAX	± 50 V
INPUT IMPEDANCE	10 K Ohms
OUTPUT IMPEDANCE	.01 Ohms

ADJUSTMENTS

- Gain (3)
- Time Constant
- Balance
- Current Limit
- Current Limit Balance

BAND WIDTH [2]	2 KHz
POWER INPUT	110/220V 50/60 Hz
AMBIENT TEMPERATURE	0° to + 50°C

HUMIDITY AND DIRT PROTECTION

NOTES:

1. The amplifier is normally supplied with voltage feedback. The current feedback is obtained by connecting Terminal 9 of TB1 to Terminal 3. This uses up one of the three available signal inputs.

2. The bandwidth is 2 KHz at 2/3 max. output, when the speed-up capacitor in the current limit circuit is removed. When the speed-up capacitor is used to eliminate current overshoots for alnico magnet torque motors, the frequency response at 2/3 max. output is 750 Hz.

OUTPUT-CURRENT and VOLTAGE: Refer to the specific Model. This is a general specification covering current ratings from 2 Amperes to 50 Amperes and voltage from 30 Volts D.C. to 50 Volts D.C.

INSTALLATION:

GENERAL: Your Westamp Servo Amplifier is a precision piece of equipment. When handling and installing the amplifier, it should be treated with Tender Loving Care. The following general provisions should be observed when installing the equipment:

1. The amplifier should be oriented so that air flow through the heatsinks will be up for normal convection cooling.
2. Leave space around the amplifier for access to adjustments and test points.
3. Provide adequate clearance around high voltage circuits.
4. Allow space for routing of heavy conductors. Avoid routing high level power and output circuits adjacent to sensitive signal circuits.
5. Use shielded twisted pairs of Signal and Tachometer Circuits.
6. Check the tabs on any dual voltage transformers to be sure they are set for the actual voltage to be applied.
7. Mount the amplifier in a location which will be as free of oil, dirt and moisture as possible.

WIRING: Connect the amplifier as shown in Fig. 1, General Installation Drawing and in accordance with the detail installation drawing provided with the amplifier.

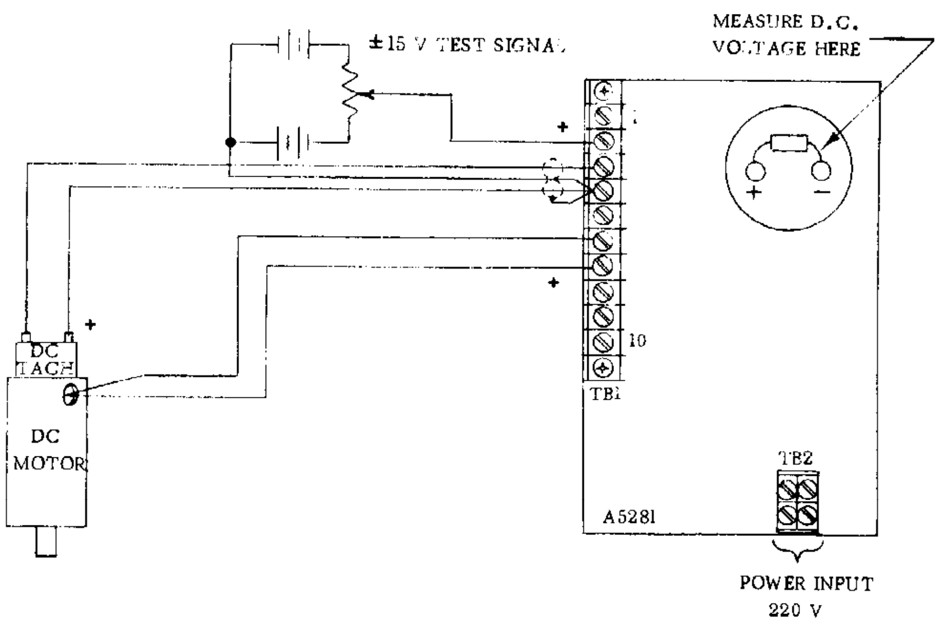


Fig. 1
Typical Installation

ADJUSTMENTS:

LOCATION: See Fig. 2

FUNCTION:

Gain 1, adjustable zero to max. at the maximum setting, sets the amplifier gain to 40. Gain 2 and 3, adjustable zero to max. At the maximum setting, sets the amplifier gain to 1000.

BAL A, adjusts the amplifier D.C. balance. The BAL A part should not be used to cancel out any offsets from external signals coming into the amplifier.

LIMIT: Adjust the maximum value of D.C. output current.

BAL C: Adjust the current limit amplifier D.C. balance.

COMPENSATION BOARD ADJUSTMENTS:

Tach R102 adjusts the amplitude of the Tach Signal on the Compensation Board.

TC R109 adjusts the Time Constant of the lag function around Pre-Amplifier A1A.
SIG (R110) adjusts the amplitude of the Signal Input on the Compensation Board.

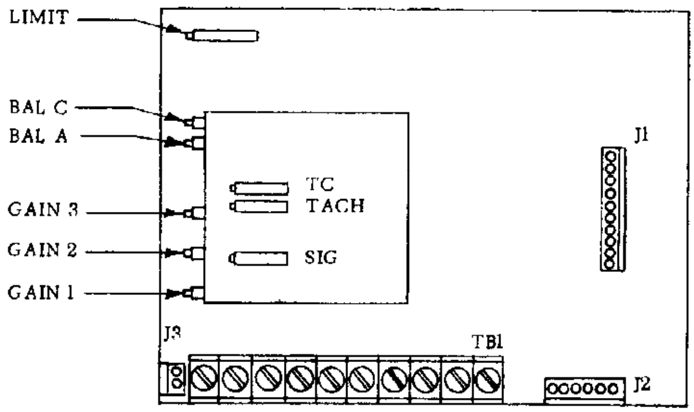


Fig. 2

PRODUCTION START-UP

Amplifiers designed for series production may have some of the adjustments described in the "First Time Start-up" either fixed or eliminated from the amplifier. This will result in a great simplification of the start-up procedure when the same amplifier is used repeatedly for the same application. In this situation there will be a special simplified start-up procedure written for the specific application.

OPERATION - FIRST TIME START-UP

Follow this step by step procedure carefully for first time start-up to eliminate potential catastrophes. The procedure tells exactly how to arrive at a good working system the first time. After you have gained experience, you may find that you can minimize some of these steps. Also, production amplifiers can be constructed with many of the adjustments "fixed" after the parameters required have been determined initially. There is provision within the amplifier for the highly skilled Servo Engineer to make fine adjustments beyond the scope of this procedure.

DETAIL PROCEDURE:

1. Connect the amplifier in accordance with Fig. 1 and the specific Installation Drawing.
2. Check all dual voltage transformers for correct primary tap connections.
3. Connect a D.C. signal simulator (source of D.C. test voltage typical 0 Volts to 15 Volts) to TB1-2 with respect to TB1-4. Connect the Tachometer to TB1-3 with respect to TB1-4. Use shielded wires.
4. Set all signal gain pots fully counter-clockwise and R4 on the Compensation Board fully counter-clockwise.
5. Connect the Oscilloscope probe to TB1-3 with respect to TB1-4. Set the vertical sensitivity to 0.5 Volts per cm. Set the horizontal sweep to 100 milliseconds per cm. Apply power to the amplifier.
6. With a zero input signal the motor shaft should remain stationary. If not, adjust BAL A such that the motor shaft does not rotate. Apply a small positive signal from the signal simulator and adjust the signal input potentiometer - in this case gain 2 slightly clockwise. The motor shaft should now rotate. Observe the oscilloscope and the tachometer voltage TB1-3 with respect to TB1-4 should be negative. If it is, adjust the tachometer input potentiometer - in this case gain 3 slightly clockwise, so as to cause the motor speed to be reduced by the negative tach feedback.

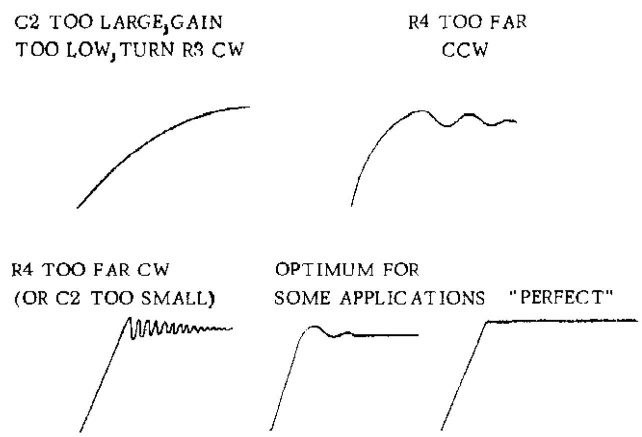


Fig. 3

While applying step inputs, rotate gain 3 slowly clockwise until a desired response curve is obtained. Note Fig. 3.
CAUTION: Always observe the response frequently, when making adjustments to avoid system oscillation. If the system does oscillate, immediately turn off power and start over with reduced tach.
NOTE: If after adjusting tach gain to maximum, the desired response curve is not obtained, this is probably because the bandwidth of the Servo Loop is not high enough. In this case turn R4 on the Compensation Board slowly clockwise. This should sharpen the response to a step input. But be cautious not to adjust R4 too far clockwise, as you may cause a high frequency oscillation.
The procedure above should make it

possible for technicians with little or no previous servo experience to get a working system or to give the more experienced engineer a "feel" for the location of the adjustments. However, this procedure does not account for all the anomalies of servo systems and it may be necessary to refer to the abundance of literature on the subject.

BLOCK DIAGRAM

Figure 4 is a block diagram of the complete servo amplifier, showing the general direction of flow of signals and power through the amplifier. The flow of signals starts at the three signal inputs and proceeds through the pre-amplifier A1-A working in conjunction with the Compensation Board. The output of the pre-amplifier A1-A proceeds to the second voltage amplifier A1-B. The output of the second voltage amplifier A1-B is summed with the output of the current limit amplifier A2 and proceeds to the Differential Amplifier input at Q2 base. The output of the Differential Amplifier at Q2 and Q3 collector proceeds to the Pre-Driver transistors Q7 through Q10, providing current gain for the driver transistors. The driver transistors provide additional current gain to drive the power output bridges. The power output bridge or bridges driven out of balance by the driver transistors provide the bi-polar voltage source for the load. The load current flowing through the output bridge is sampled differentially in the output bridge and tied to the current limit amplifier A2. The output of the current limit amplifier A2 proceeds to the summing junction at the output of the second voltage amplifier A1-B.

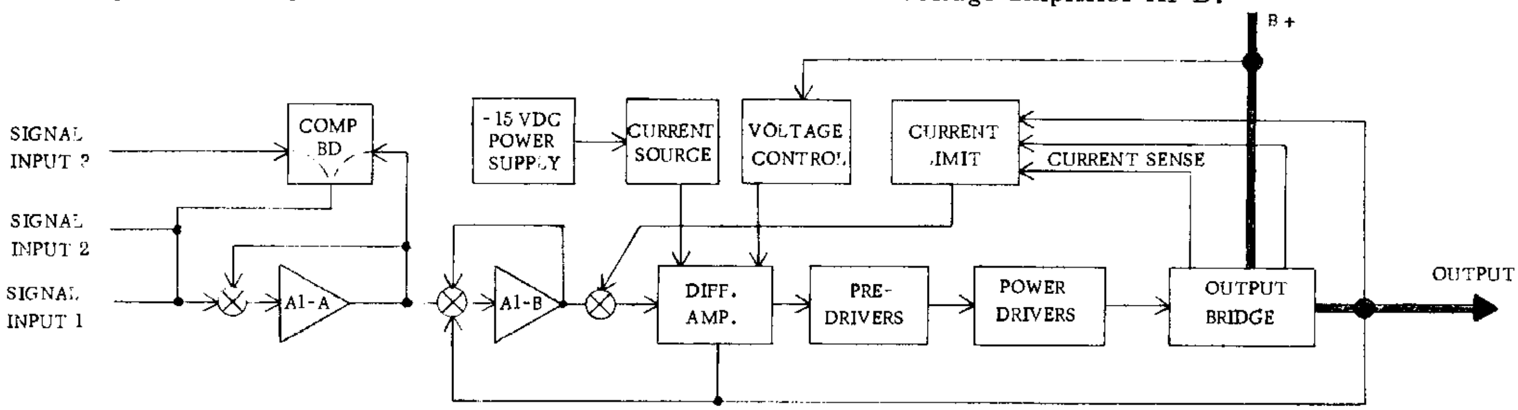


Fig. 4

COMPENSATION BOARD

The Compensation Board is attached to the main circuit board with mounting srews and is designed so that components may be easily changed to suit the requirements of different systems. All of the functional elements of the compensation board are shown in Fig. 5, including their interrelationship with operational amplifier A1-A.

On the Compensation Board there are three groups of components. The Lead Network C1, R1, R2, the Lag Network C2, R4, R5 and the Diode Clamping Network CR1 thru CR14. In addition to the preceding groups of components there is another resistor R3 and the input resistor which replaces R11 on the main board whenever the Compensation Board is utilized. The purpose of the Compensation Board is to provide a means to alter the frequency response of the amplifier for the purpose of stabilizing a closed loop servo system. Compensation of servo systems is a special subject and the methods and procedures are not covered herein. The flexibility of the compensation board is such as to enable the stabilization of very high performance, closed loop, velocity or position systems.

Shown are various versions of Compensation Boards. A particular application is the determining factor as to which board will be mated to the amplifier.

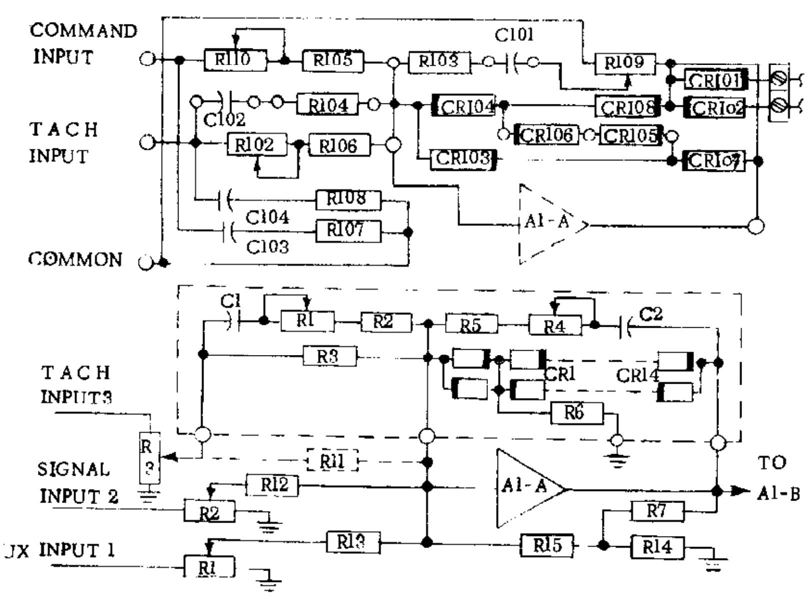


Fig. 5

PRE-AMPLIFIER Fig. 6

The pre-amplifier A1-A accepts bi-polar D.C. input signals from three channels through a resistive summing junction at its inverting input. Pre-amplifier A1-A supplies a large amount of gain and also an inversion of input signals.

A1-A has a balance pot R4 to compensate for input offset levels. The output of A1-A is resistively tied to the inverting input of the second voltage amplifier A1-B.

SECOND VOLTAGE AMPLIFIER Fig. 7

Voltage amplifier A1-B is connected as a typical inverting amplifier. Employing a 4.7 K Ohm input resistor and a 1 meg Ohm feedback resistor amplifier A1-A would typically have a very high gain. However, there is an additional negative stabilizing feedback loop from the output of the bridge. In addition, there is a back to back Diode Network at the input to prevent input saturation and two back to back Zener Diodes shunting the standard feedback resistor to prevent large output voltage excursions. The output of the second voltage amplifier is summed with the output of the current limit amplifier A2 and proceeds to the input of the Differential Amplifier.

DIFFERENTIAL AMPLIFIER Fig. 8

The Differential Amplifier is formed by Q2 and Q3, R37, 38, CR20, 21 CR34 and 35, transistors Q2 and Q3 forming the active elements and resistors R37 and 38 the bias elements. Diode CR20, CR21 CR34 and CR35 are to compensate for temperature variations and to provide current limiting. Diode CR22 through CR33 are employed to snub peak currents. The constant current transistor Q1 is biased, so that with zero signal the collectors of Q2 and Q3 are approximately equal to one half of the main power supply voltage. If a plus signal is applied to the base of Q2, it will appear amplified in a 180° inverted at Q2 collector. It will also be coupled through Q2 emitter to Q3 and will appear amplified and in phase at Q3 collector. When this occurs, the voltage at Q2 collector will decrease and the transistor will conduct more current. At the same time the voltage at the collector of transistor Q3 will increase and the transistor will conduct less current.

PRE-DRIVER TRANSISTORS Fig. 8

As transistor Q2 conducts more current, it provides greater base drive for pre-driver transistor Q9 and less base drive for pre-driver transistor Q7. As the voltage at the collector of Q3 increases, it provides greater base drive for pre-driver transistor Q8 and less base drive for pre-driver transistor Q10.

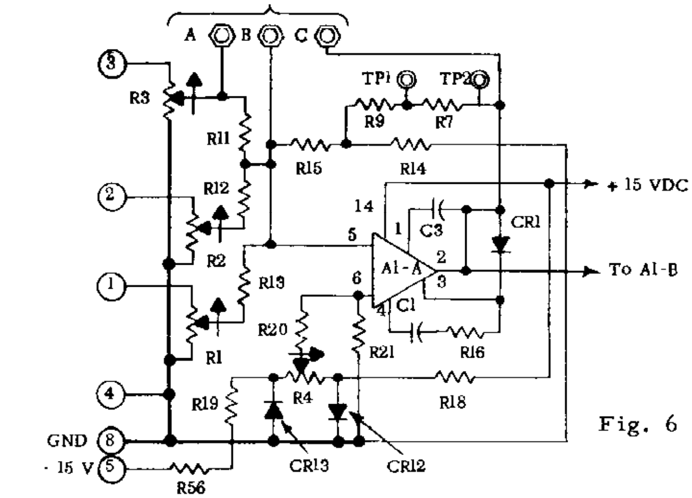


Fig. 6

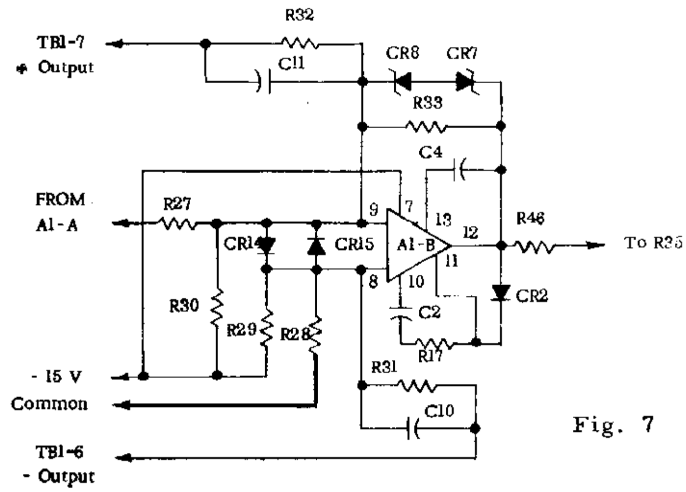


Fig. 7

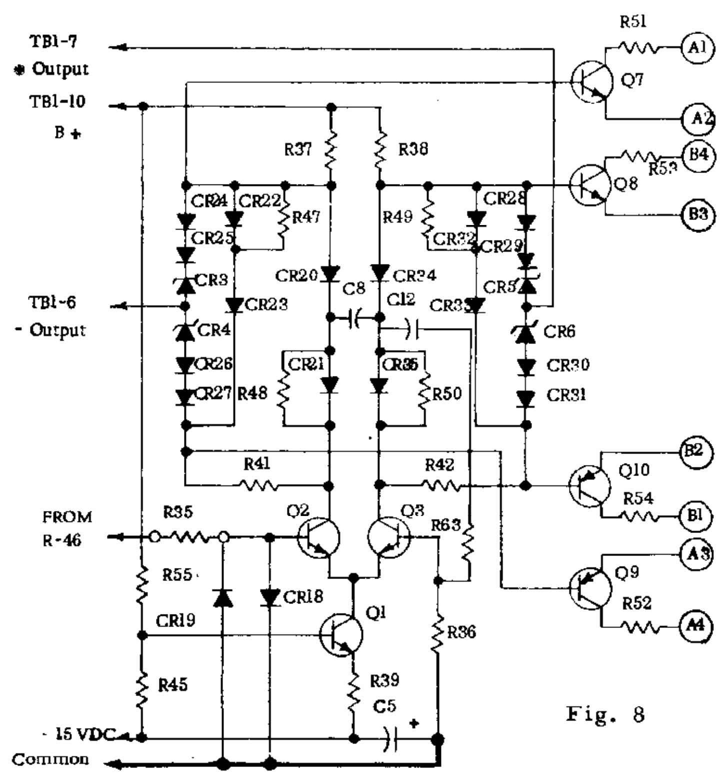


Fig. 8

POWER DRIVERS Fig. 9

The purpose of the power drivers is to provide additional current gain from the low power pre-driver transistors to the high power output bridges. Pre-driver transistor Q7 is tied to driver transistor Q3, therefore, transistor Q3 will conduct in exactly the same manner as Q7. Also, pre-driver transistor Q10 and driver transistor Q1 are connected together, also pre-driver transistor Q8 and driver transistor Q2, pre-driver transistor Q9 and driver transistor Q4.

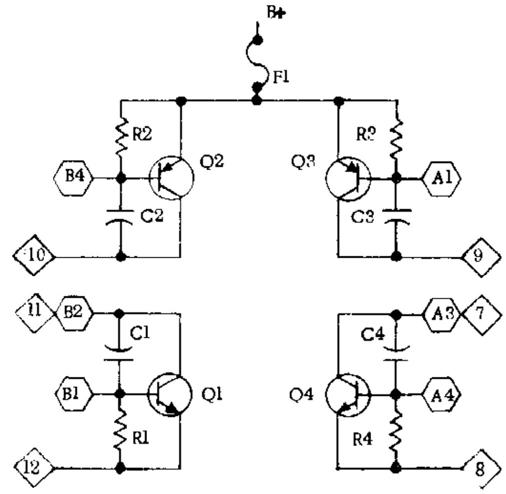


Fig. 9

OUTPUT BRIDGE Fig. 10

The output is operated as a current supply for the motor armature, with two transistors connected to power supply plus and two connected to Signal Common. Because the output for the load is derived from a bridge, Null or zero output is achieved, when all transistors within the bridge are conducting equally. As the bridge is driven out of a balance or as diagonal pairs of transistors conduct more heavily, current will be supplied to the motor or other load. Bipolar outputs are achieved by driving opposite diagonal pairs of transistors to heavier conduction. The basic heatsink consists of four transistors in a single bridge. Outputs may be connected in parallel from two to seven bridges.

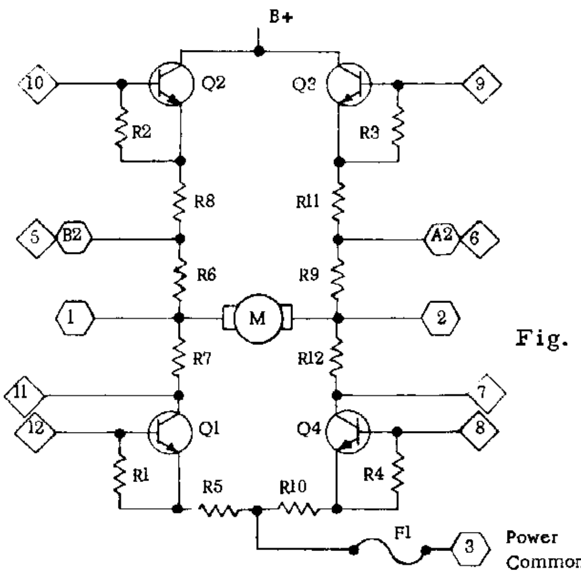


Fig. 10

CURRENT SENSE Fig. 10

As the bridge is driven out of balance and current flows through the load, it also flows through sampling resistors in each heatsink R6, 7, 8, 9, 11 & R12, providing a voltage output proportional to current.

CURRENT LIMIT AMPLIFIER Fig. 11

At the input to the current limit amplifier A2 are two voltage dividers, consisting of R57 and 58 and R59 and R60 connected across the sampling resistors on each heatsink. The outputs of these two voltage dividers are connected differentially to the current limit amplifier A2 at the inverting and non-inverting inputs. As current flows through the sampling resistors altering the voltage drop across them, the two dividers will be driven out of balance, providing an input for current limit amplifier A2. If load current flows from TB1-7 through the load and returns to TB1-6, resistors R59 and R60 will be driven more positive than resistors R57 and R58, which results in a positive potential at R43 with respect to R34. This positive potential is impressed at the inverting input Terminal 4 of the current limit amplifier A2.

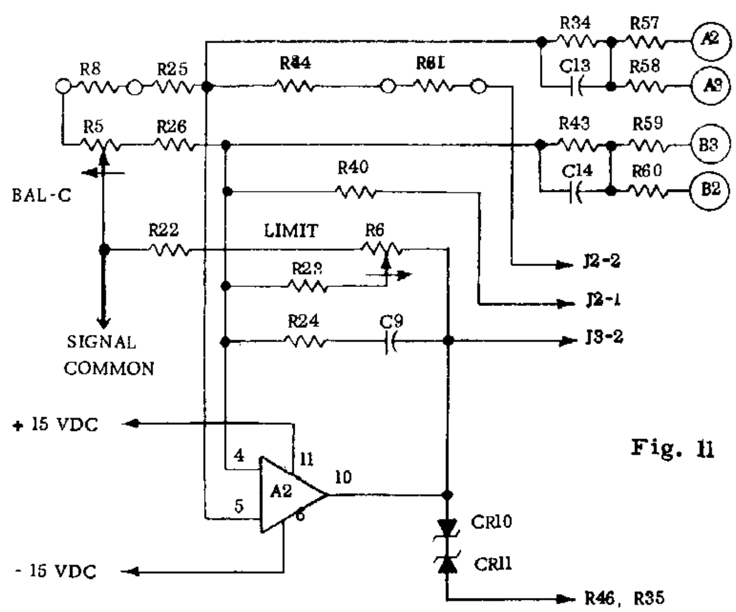


Fig. 11

The signal is amplified and inverted and appears at Terminal 10 of A2 of the negative voltage. When this negative voltage reaches a magnitude of approximately 5.7 Volts D.C., Diodes CR10 and CR11 conduct and apply the negative signal in its opposition to the positive signal at the junction of R46 and R35. This prevents any further increase in the voltage level at that junction. Therefore, output current will be limited. The level at which output current will be limited, is determined by the gain of current limit amplifier A2. The gain of A2 is set by the potentiometer R6 and the feedback loop around A2. Adjusting R6 counter-clockwise provides less feedback around amplifier A2 and the gain will be increased. It will then take less output current to drive A2 to the level of clamping, thus adjustable current limit is achieved. Capacitor C7 and resistor R62 tied across back to back Zener Diodes CR10 and CR11 form a speed-up network. This network is provided to pass sudden D.C. excursions at less than the break-down voltage of CR10 and CR11, thereby preventing current spikes on the output. To lower the common mode, voltage is applied to Pin 4 and 5 of current limit amplifier A2. Resistors R25 and 26 are employed in conjunction with factory selected resistors R8 and C balance pot R5 with the wiper terminated at Signal Common. Resistor R8 is selected to balance the input impedance of A2 with R5 set to mid range. After R8 is selected, balance pot R5 may then be adjusted to compensate for impedance changes caused by various settings of R6.

TEST SET - DRIVER/OUTPUT HEAT SINK A524/528 Fig. 12

Shown to the right is a schematic for a heat sink tester, using four push buttons and a 4 pole 5 position selector switch. For a quick test in field service, it is possible to use two resistor decade boxes connected alternately to the different terminal pairs to be tested.

The purpose of this test set is to be able to test the driver/output heat sink portion of the amplifier without having to use a circuit board. The output bridge portion of the amplifier consists of four quadrants and this test set will enable the user to isolate a trouble to any one of the four. The test set is useful for locating the following kinds of trouble:

1. Shorted transistors 2. Open transistors 3. Low Gain

The test set is designed to provide base drive to the driver transistor and this is accomplished by supplying positive DC to the base through a resistor. The amount of resistance used is selected with a selector switch which connects the same base input resistance to each of the four driver quadrants. This test should always be done by starting with the highest resistance first and then decreasing the resistance step by step until the proper output is obtained. The test indication is obtained from a DC ammeter connected in series with the power supply to the heat sink. In addition, it may be desirable to use a resistor in series with the DC supply of a 1 Ohm value to limit the ultimate maximum current which may pass through the unit under test.

CAUTION: This test can be destructive since it is essentially a short circuit test. In the short circuit condition, small currents cause high power dissipation and, therefore, the test buttons should be pressed momentarily so as to get a reading on the ammeter.

The buttons on the tester labelled 7, 8, 9, and 10, correspond to the equivalent transistors on the circuit board identified as Q7, Q8, Q9, and Q10. The vertical button pairs, 7 and 9, and pair 8 and 10 turn on transistors in the bridge which are directly in series across the DC power supply. Button pairs 7 and 10 and pair 8 and 9 turn on transistors in the arrangement which would be turned on for normal operation of the amplifier. In order to get a complete test when pressing these diagonal pairs, it is necessary to connect the output terminals of the amplifier through a load resistance

The normal procedure for operating the tester is to connect the plug J1 into the matching plug from the heat sink. Then connect the heat sink to the DC power supply with an appropriate ammeter, and a series resistor if desired. Do not connect a load resistor yet. Now, press buttons 7 and 9 and decrease the resistance to the base of the transistors by turning the switch clockwise from position 1 towards position 5 in order to get an adequate reading on the ammeter. However, if there are some shorted transistors, there may be readings on the ammeter for the first few positions of the switch. Now, press buttons 8 and 10 and there should be about the same current reading on the ammeter. By pressing only one button, a current reading indicates that there are shorted transistors in the associated part of the bridge. If it is not possible to get any current reading, then there are open transistors in the associated part of the bridge. Now, an additional check can be made by either connecting the load resistor to the output terminals and repeating the test by pressing buttons 8 and 9 and checking for a current reading.

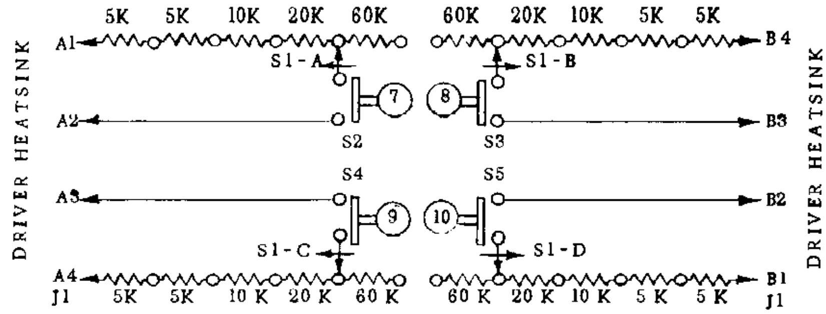


Fig. 12

DUMMY LOAD FOR CIRCUIT BOARD: Shown below is a schematic for a Dummy Load to be used in testing the circuit board without the Power Driver and Output transistors. Troubleshooting of the amplifier is simplified when the circuit board and the power transistors are tested separately. Preliminary troubleshooting of the circuit board can be done with output plug J1 removed and J6 on the interconnect board removed. However, to test for full output voltage swing and symmetry at TP-1 and 2 on dummy load, it is necessary to have the dummy load connected.

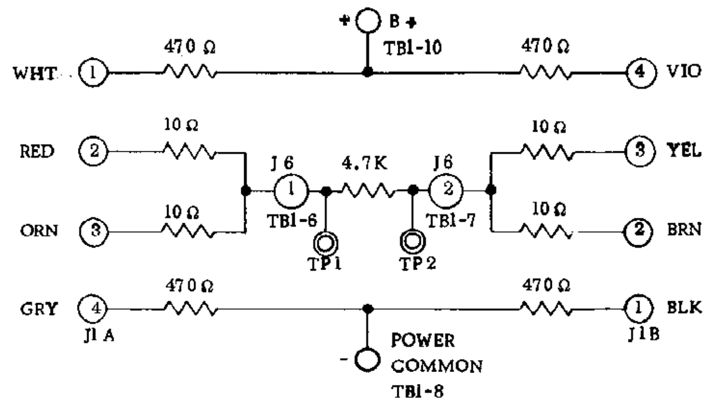


Fig. 13

DC SIGNAL SIMULATOR: Shown below is a schematic for a DC signal source for providing + and - variable amplitude signals. The unit also has push button switches to create step outputs and reverse signals useful for servo system alignment.

SW1	DPDT	Toggle	R1	18 K	1/4 W	R5	470 Ω	1/4 W
SW2	DPDT	Mom Pushon	R2	180 K	1/4 W	R6	470 Ω	1/4 W
SW3	SPST	Toggle	R3	1-8 M	1/4 W	R7	5 K	Dual
SW4	SPST	Mom Pushon	R4	not used		B1	9 V Battery	
						B2	9 V Battery	

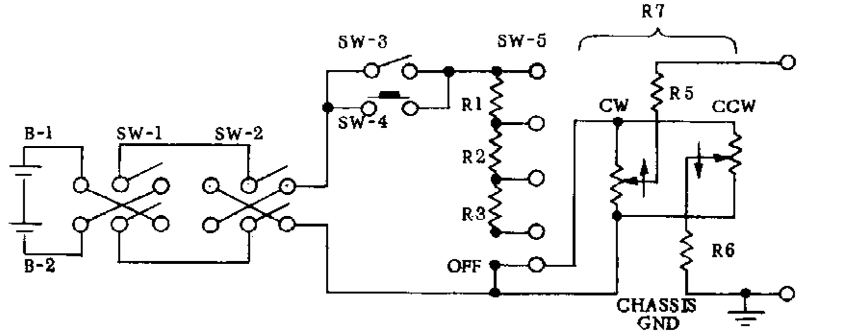


Fig. 14

ALIGNMENT PROCEDURE
A528

CONNECT PER INSTALLATION DRAWING (REFER TO SPECIFIC MODEL FOR CORRECT DRAWING)

Check to be certain the primary jumpers on the power transformer are connected for the voltage to be applied.

1. PRELIMINARY ADJUSTMENTS

1.1 Adjust "C-BAL" pot to mid range.
1.2 Adjust "A-BAL" pot to mid range.
1.3 Connect decade resistor for R61 tentatively set to 510 Ohms.
1.4 Connect decade resistor for R8 tentatively set to 1.6 K Ohms.
1.5 Adjust R6 "LIMIT" pot fully C.W.
1.6 Jumper TP-1 to TP-2 on Main Board.

2. CURRENT LIMIT ADJUSTMENTS

2.1 Connect Simpson 260 VOM set to 2.5 VDC scale to TB1-9 w.r.t. TB1-4.
2.2 Connect Voltmeter to TB1-7 w.r.t. TB1-6 (output voltage monitor)
2.3 With no output load connected, apply power to the Amplifier.
2.4 Using oscilloscope referenced to TB1-4, check for presence of + 15 ± 0.5 VDC at CR9-C.
2.5 Check for presence of - 15 ± 0.5 VDC at TB1-5.
2.6 With all gain pots fully C.C.W., verify zero output volts (if necessary adjust R4 "A-BAL" to zero output.
2.7 Trim decade resistor R-8 for zero Volts at TB1-9 w.r.t. TB1-4.
2.8 Rotate Gain Pots fully C.W. and apply sufficient input signal to drive amplifier to full output.
2.9 Trim decade resistor R-61 for zero volts at TB1-9 w.r.t. TB1-4.
2.10 Install selected values for R-8 and R-61.

3. BALANCE

3.1 With all gain pots fully C.C.W., measure 0 ± 0.5 VDC output. "A-BAL" may be adjusted.

4. GAIN AND PHASE

4.1 Connect a 10 Ohm 1000 W load to the output terminals.
4.2 Connect variable tap connections on power transformer secondary to X_1 and X_4.
4.3 Rotate gain pot under test fully C.W. All other gain pots fully C.C.W.
4.4

OUTPUT TB1-7 w.r.t. TB1-6	G1	G2	G3	INPUT w.r.t. TB1-4	
+ 10 VDC	CW	CCW	CCW	+ 0.2 to 0.3 VDC	____
- 10 VDC	CW	CCW	CCW	-0.2 to - 0.3 VDC	____
+ 10 VDC	CCW	CW	CCW	+ 8 to + 10 MVDC	____
- 10 VDC	CCW	CW	CCW	- 8 to - 10 MVDC	____
+ 10 VDC	CCW	CCW	CW	+ 8 to + 10 MVDC	____
- 10 VDC	CCW	CCW	CW	- 8 to - 10 MVDC	____

5. MAXIMUM OUTPUT

5.1 Apply a + 0.5 VDC input signal and read 45 VDC or greater at the output ____
5.2 Apply a - 0.5 VDC input signal and read - 45 VDC or greater at the output ____

6. CURRENT LIMIT

6.1 Refer to Model Spec sheet for continuous current for specific model being tested. ____
6.2 Connect suitably rated center zero ammeter and load resistor in series to the output.

Compute load resistor as follows:

A 5281

$$\frac{\text{E output (rated)}}{\text{I output (rated)}} \times 0.8 \quad \text{Example} \quad \frac{40}{12.5} \times 0.8 = 2.56\ \Omega$$

Use 2.5 Ohm Load

6.3 Apply a positive 0.5 VDC input signal and read rated positive output current ± 5% ____
6.4 Apply a negative 0.5 VDC input signal and read rated negative output current ± 5% ____
6.5 Adjust "LIMIT" pot R6 fully C.C.W. Adjust "C-BAL" pot R5 for zero volts at TB1-9 w.r.t. TB1-4 Check ____
6.6 Apply a positive 0.5 VDC input signal and read 25% rated positive output current or less ____
6.7 Apply a negative 0.5 VDC input signal and read 25% rated negative output current or less.
6.8 Adjust "LIMIT" pot R6 fully C.W. Readjust "C-BAL" R5 for zero volts at TB1-9 w.r.t. TB1-4 Check ____

7. MOTOR LOAD (INERTIAL MOTOR, INTEGRAL TACHOMETER)

7.1 Connect hollow cup motor with tachometer to amplifier with tach output connected to TB1-3 w.r.t. TB1-4.
7.2 Connect Command Signal Input to TB1-2 w.r.t. TB1-4.
7.3 Adjust closed tach loop by A528 Manual Instructions for optimum performance.

BURN IN AMPLIFIER FOR 8.0 HOURS Check ____

After burn-in, conformal coat amplifier where applicable and check for conformance to Production Acceptance Test Data Sheet Check ____

PRODUCTION ACCEPTANCE TEST DATA SHEET

WESTAMP MODEL A528
D.C. TRANSISTOR AMPLIFIERS SERIAL NO. _____ DATE _____

APPROVED: ___________ DATE: _________

VALIDATION _____________ TESTER _____________

1. TEST EQUIPMENT REQUIRED

1.1 Oscilloscope, Tektronix 502 A or equivalent.
1.2 VOM, Simpson 260 or equivalent.
1.3 D.C. Signal Simulator
1.4 D.C. Signal Input Voltmeter, Dynamics A502 or equivalent.
1.5 Resistive Loads
10 Ω, 1000 Watt and 0.2 Ω, 1000 Watt
1.6 Appropriate rating center Zero D.C. Ammeter
1.7 Motor Load with Tachometer. Inertial Motor, Integral Tach.

2. CONNECT PER INSTALLATION DRAWING (SPECIFIC MODEL)

NOTE: DO NOT USE POWER LINE GROUNDED TEST EQUIPMENT ON OUTPUT CIRCUITS.

Unless otherwise indicated, perform test with resistive load (10 Ω, 1000 Watt)

3. NULL

With Gains 1, 2, & 3 fully C.C.W., read 0 ± 0.5 VDC max output "BAL A" may be adjusted to achieve this. _______

4. GAIN AND PHASE (Input under test fully C.W.)

Standard Gains: Gain 1 = 40 ± 10%
Gain 2 = 1000 ± 10%
Gain 3 = 1000 ± 10%

4.1 Output IB-1 w.r.t. IB-2 — Input TB1-3 w.r.t. TB1-4

R102 fully CCW
or Gain 3 fully CW

R110 fully CCW
or Gain 2 fully CCW

+ 5 VDC — + 4.25 to 5.5 MVDC ____
- 5 VDC — - 4.25 to 5.5 MVDC ____

Gain 1 fully CCW

4.2 Output IB-1 w.r.t. IB-2 — Input TB1-2 w.r.t. TB1-4

R110 fully C.C.W.
or Gain 2 fully C.W.

+ 5 VDC — R102 fully C.C.W. — + 4.25 to 5.5 MVDC ____
- 5 VDC — or Gain 3 fully CCW — - 4.25 to 5.5 MVDC ____

Gain 1 fully CCW

4.3 Output IB-1 w.r.t. IB-2 — Input TB1-1 w.r.t. TB1-4

Gain 1 fully CW
Gain 2 & 3 fully CCW

+ 5 VDC — R102 and R110 fully CCW — + .106 to .138 VDC
- 5 VDC — - .106 to .138 VDC

5. MAXIMUM OUTPUT Gain 2 and 3 fully C.W.

5.1 Apply a + 500 MVDC Signal at TB1-3 with respect to TB1-4 and read + _____ VDC or greater at IB-1 w.r.t. IB-2. ________
5.2 Apply - 500 MVDC Signal at TB1-3 with respect to TB1-4 and read - _____ VDC or greater at IB-1 w.r.t. IB-2 ________

6. CURRENT LIMIT USE 0.2 Ω LOAD
(Momentary Test)

6.1 Connect Scope across Load Resistor (set vertical attenuator _____ V/Div.)
6.2 Apply a + 500 MVDC Pulse at TB1-3 w.r.t. TB1-4 w.r.t. TB1-4 and read + _____ VDC. Peak Output on Oscilloscope ________
6.3 Apply a - 500 MVDC Pulse at TB1-3 w.r.t. TB1-4 and read - _____ VDC Peak Output on Oscilloscope. ________

7. MOTOR LOAD

Take care not to overspeed the motor.

Apply a varying input signal to ensure motor speed smoothly follows command input. ________

END OF TEST

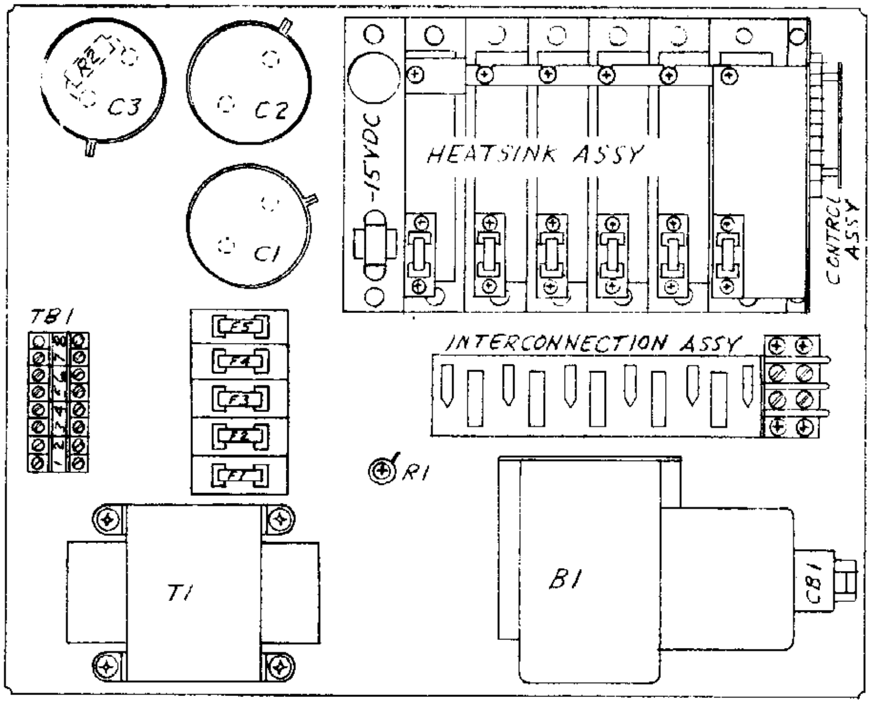


Fig. 15
Top Assembly
A524 Series

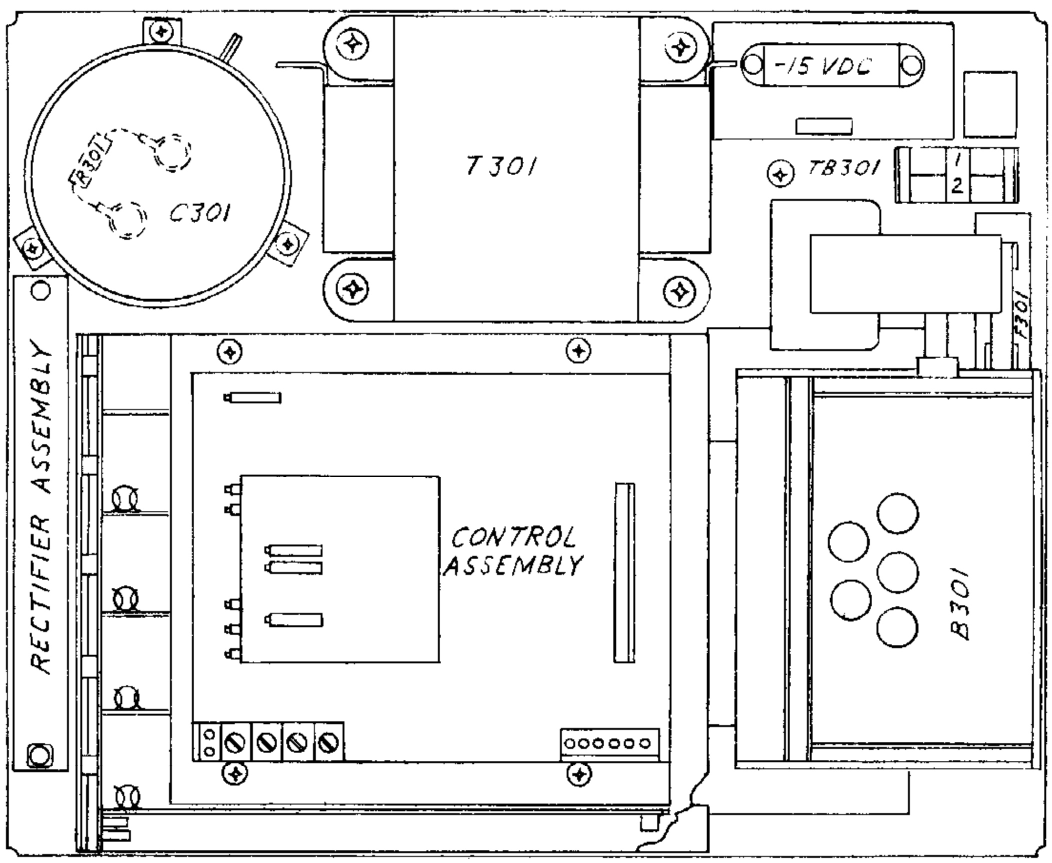


Fig. 16
Top Assembly
A528 Series

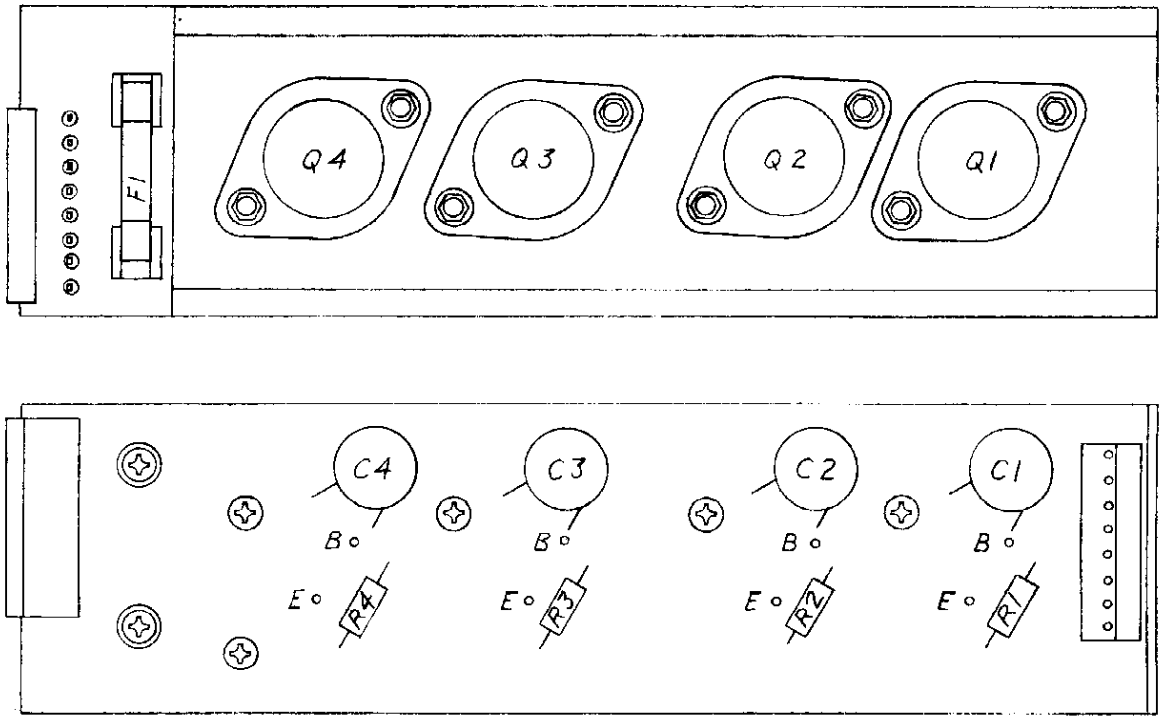


Fig. 17
Driver Heatsink
A528 Series

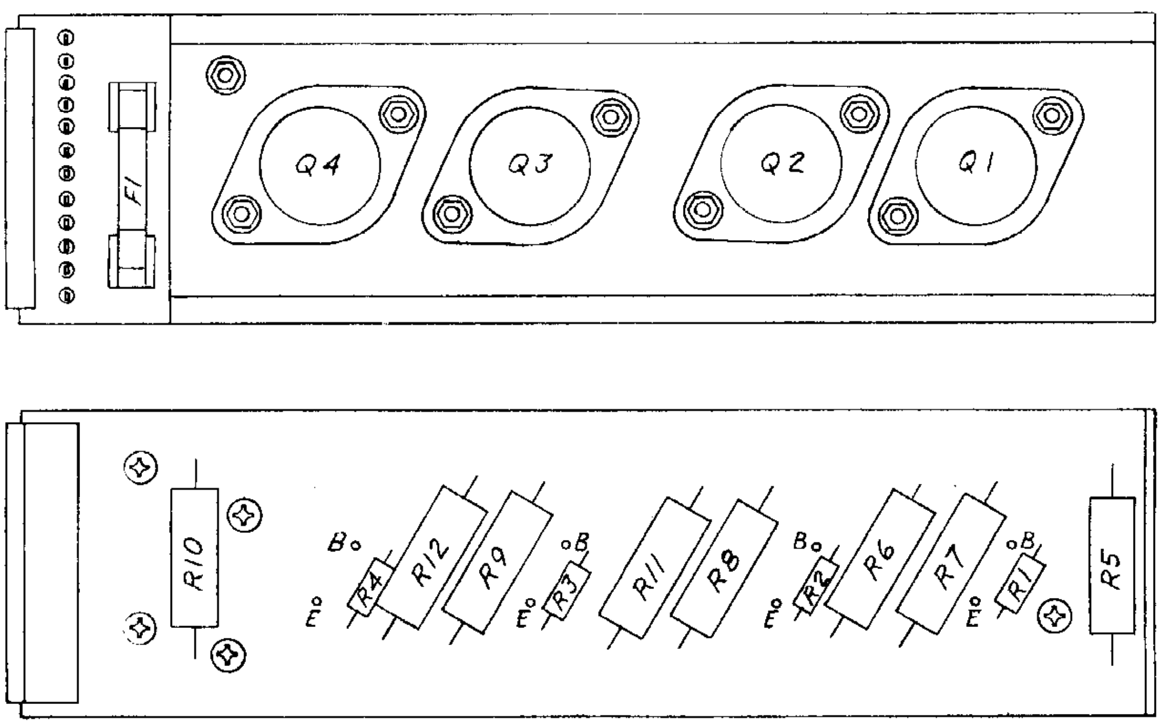


Fig. 18
Output Heatsink
A528 Series

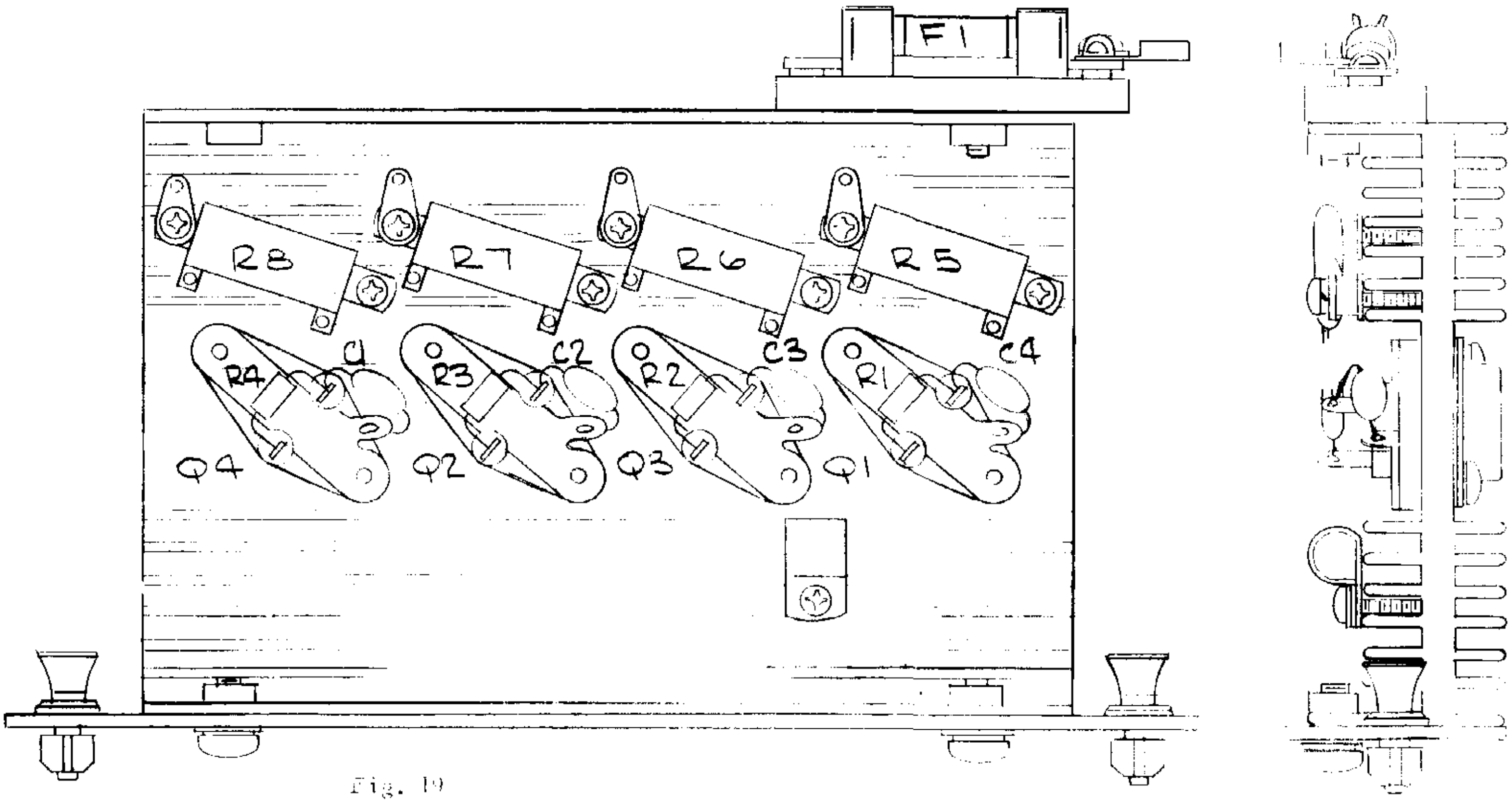


Fig. 19
Driver Heatsink
A524 Series

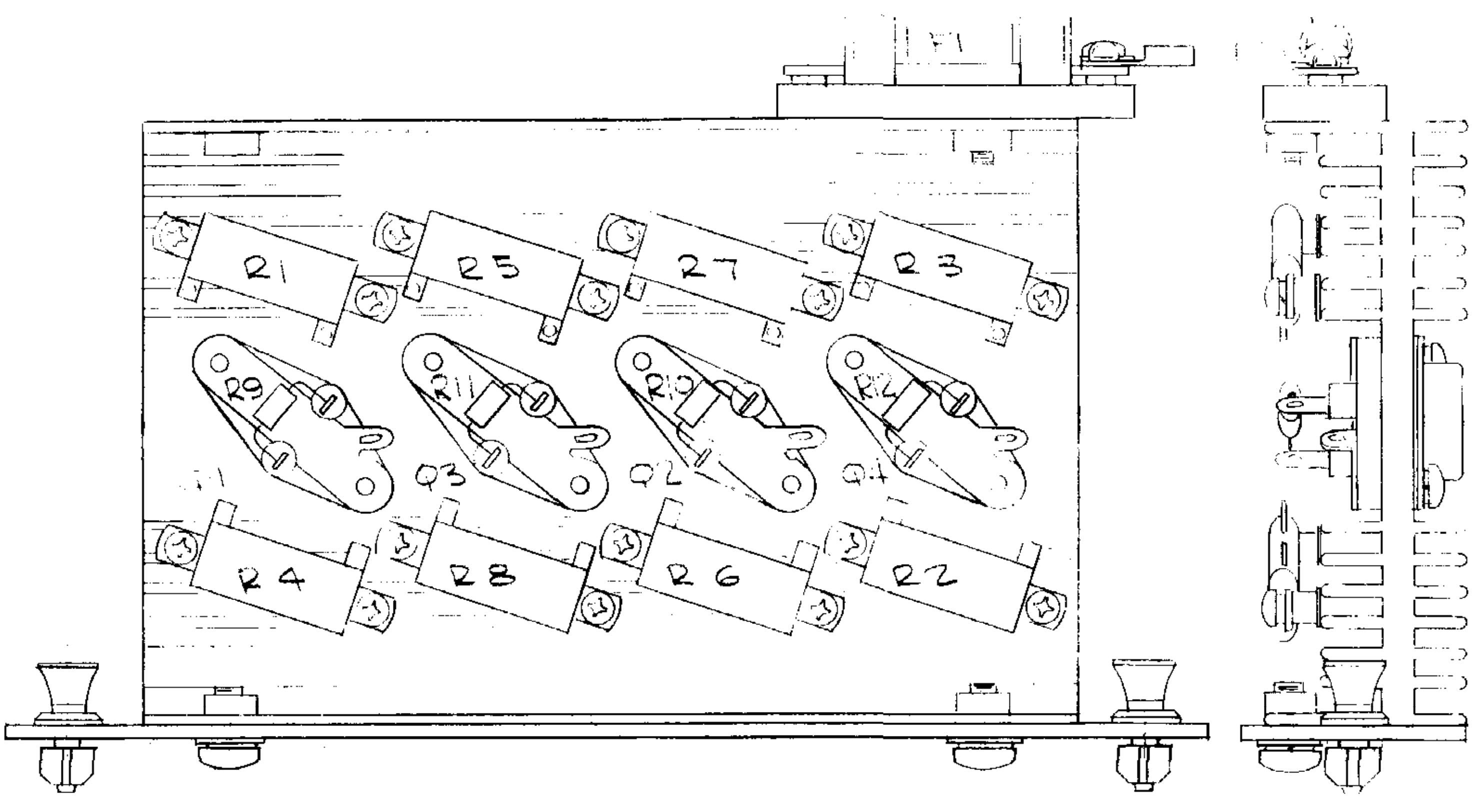


Fig. 20
Output Heatsink
A524 Series

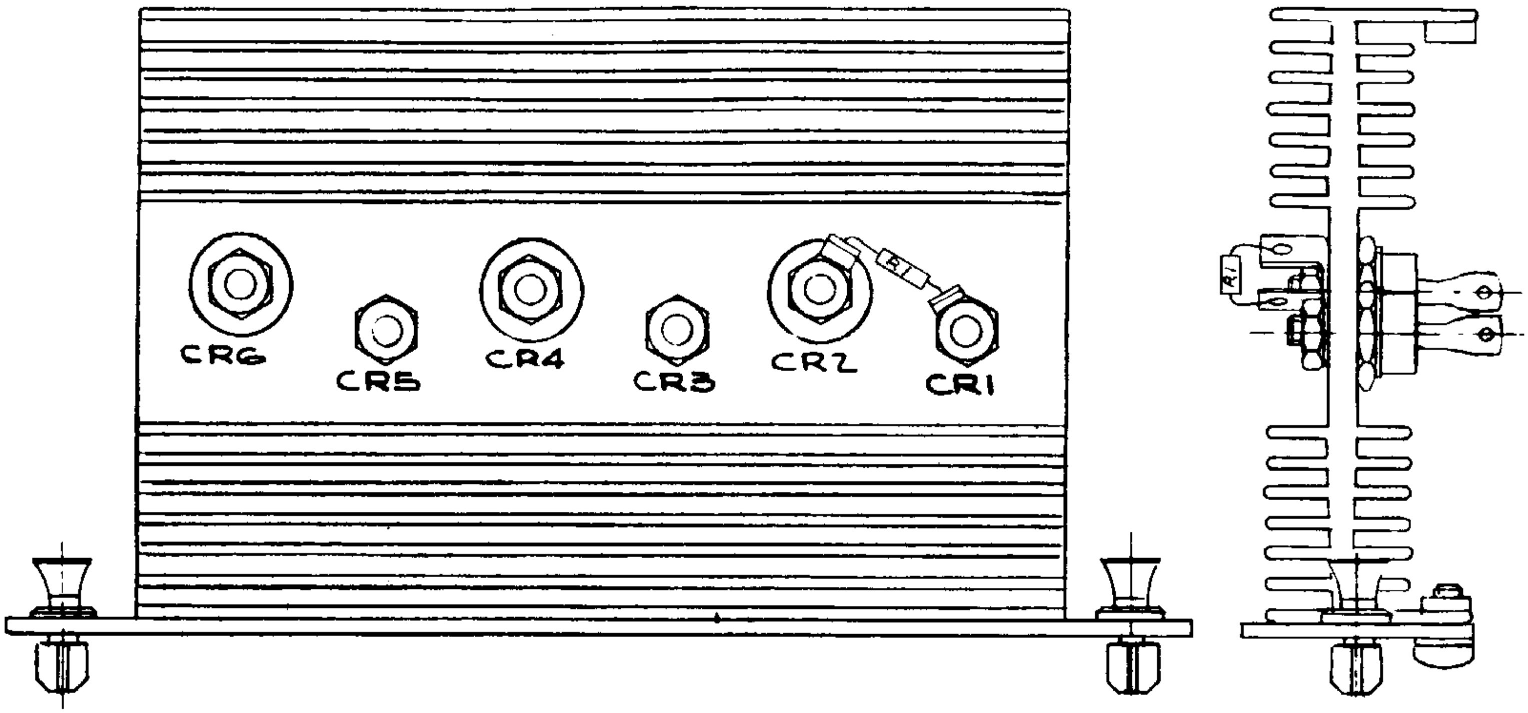


Fig. 2I
Rectifier Assembly
A524 Series

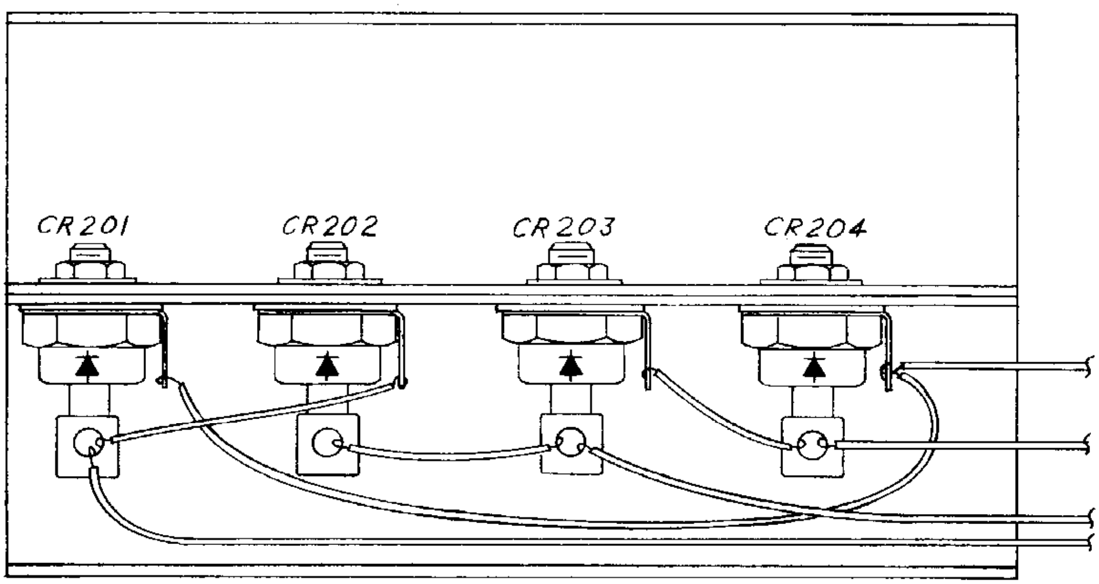


Fig. 22
Rectifier Assembly
A528 Series

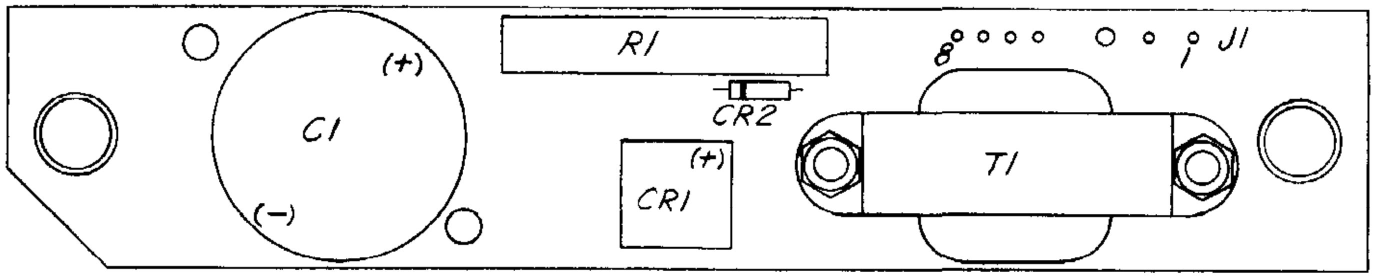


Fig. 23
•15 VDC Power Supply
A524 Series

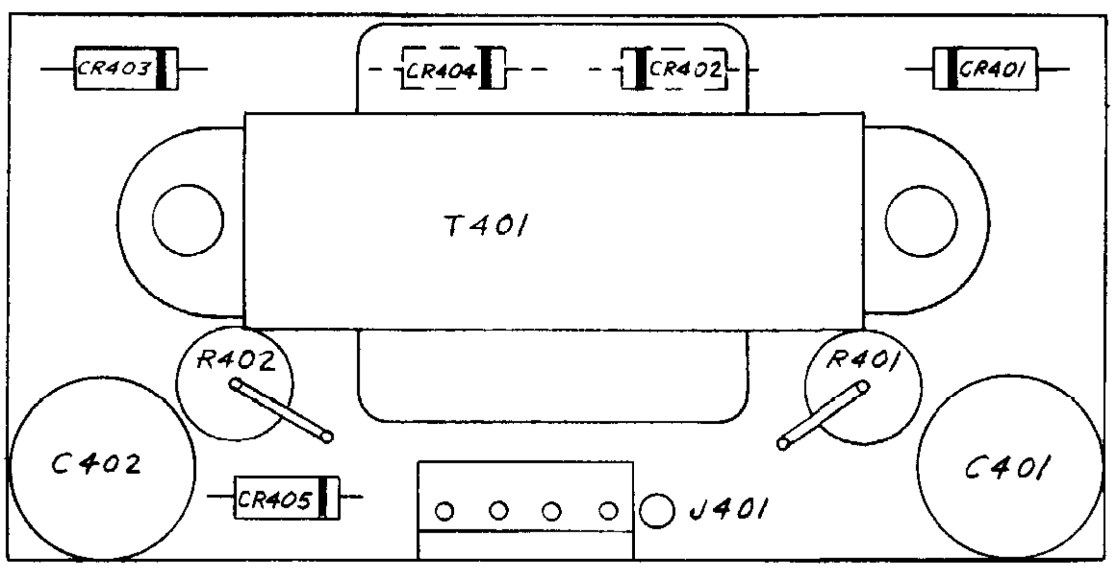


Fig. 24
•15 VDC Power Supply
A528 Series

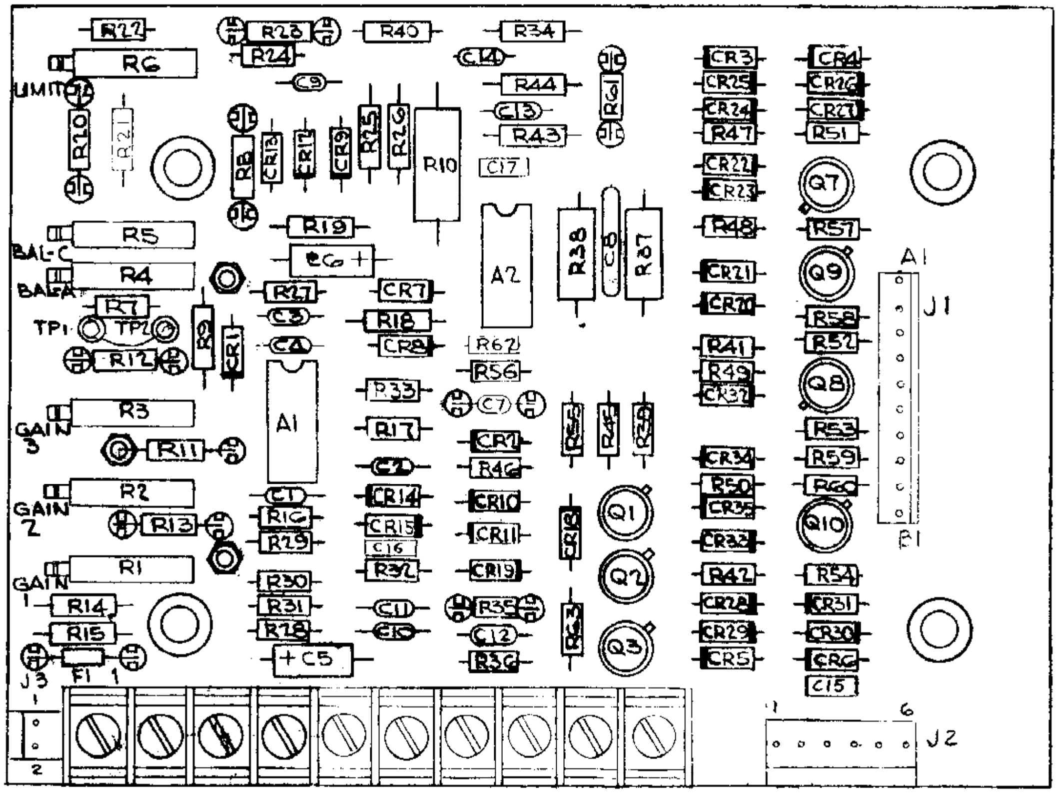


Fig. 25

Main Board Assembly

A524/A528 Series

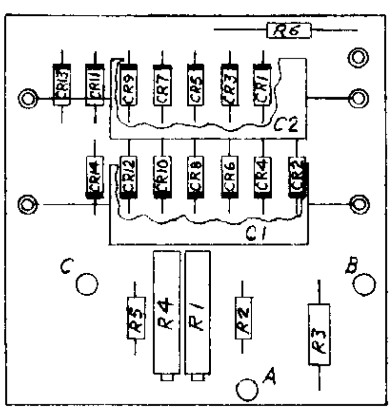


Fig. 26

Compensation Board Assembly

A524 Series

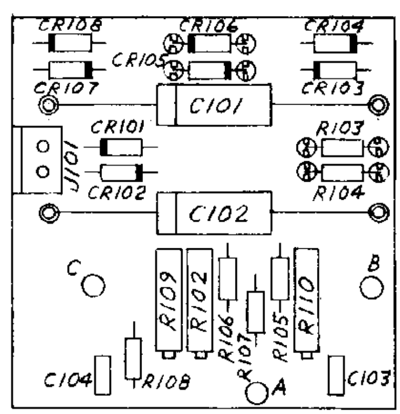


Fig. 27

Compensation Board Assembly

A528 Series

SERVO AMPLIFIER ASSEMBLY 28975 Fig. 16 (A528)

B301	27846-3	
C301	14000 MF	75 VDC
F301	MDA5A	5A
R301	1.2 K	5 W
R302	not used	
T301	28902	

DRIVER HEATSINK ASSSEMBLY 28984 Fig. 17 (A528)

C1	.0047 uf	500 VDC
C2	.0047 uf	500 VDC
C3	.0047 uf	500 VDC
C4	.0047 uf	500 VDC
F1	312003	3 AMPS
Q1	2N4915	
Q2	2N4906	
Q3	2N4906	
Q4	2N4915	
R1	1 K	1/2 W
R2	1 K	1/2 W
R3	1 K	1/2 W
R4	1 K	1/2 W

OUTPUT HEATSINK ASSEMBLY 28985 Fig. 18 (A528)

F1	312005	5 AMPS
Q1	2N6258	
Q2	2N6258	
Q3	2N6258	
Q4	2N6258	
R1	100 Ω	1/2 W
R2	100 Ω	1/2 W
R3	100 Ω	1/2 W
R4	100 Ω	1/2 W
R5	.1 Ω	5 W
R6	.1 Ω	5 W
R7	.1 Ω	5 W
R8	.1 Ω	5 W
R9	.1 Ω	5 W
R10	.1 Ω	5 W
R11	.1 Ω	5 W
R12	.1 Ω	5 W

RECTIFIER ASSEMBLY 28969 Fig. 22 (A528)

CR201	1N1184A
CR202	1N1184A
CR203	1N1184A
CR204	1N1184A

15 VDC POWER SUPPLY 28605 Fig. 24 (A528)

C401	100 uf	50 VDC
C402	100 uf	50 VDC
CR401	1N645	
CR402	1N645	
CR403	1N645	
CR404	1N645	
CR405	1N4744	
R401	300 Ω	2 W
R402	300 Ω	2 W
T401	T963	

D.C. AMPLIFIER ASSEMBLY 28107 Fig. 25 (A524/A528)

A1	MC1437L	
A2	MC1741CL	
C1	.005 uf	50 VDC
C2	.005 uf	50 VDC
C3	220 pf	500 VDC
C4	220 pf	500 VDC
C5	15 uf	20 VDC
C6	15 uf	20 VDC
C7	not used	
C8	.015 uf	200 VDC
C9	330 pf	500 VDC
C10	680 pf	500 VDC
C11	680 pf	500 VDC
C12	220 pf	500 VDC
C13	220 pf	500 VDC
C14	220 pf	500 VDC
C15	.22 uf	100 VDC
C16	not used	
C17	not used	
CR1	1N914	
CR2	1N914	
CR3	1N5221	
CR4	1N5221	
CR5	1N5221	
CR6	1N5221	
CR7	1N748A	
CR8	1N748A	
CR9	1N4744	
CR10	1N751A	
CR11	1N751A	
CR12	1N914	
CR13	1N914	
CR14	1N914	
CR15	1N914	
CR16	not used	
CR17	not used	
CR18	1N914	
CR19	1N914	
CR20	1N914	
CR21	1N914	
CR22	1N914	
CR23	1N914	
CR24	1N914	
CR25	1N914	
CR26	1N914	
CR27	1N914	
CR28	1N914	
CR29	1N914	
CR30	1N914	
CR31	1N914	
CR32	1N914	
CR33	1N914	
CR34	1N914	
CR35	1N914	
F1	1/2 A	
Q1	2N5320	
Q2	2N657	
Q3	2N657	
Q4	not used	
Q5	not used	
Q6	not used	
Q7	2N5320	
Q8	2N5320	
Q9	2N5322	
Q10	2N5322	
R1	10 K	
R2	10 K	
R3	10 K	
R4	10 K	
R5	200 Ω	
R6	20 K	
R7	430 K	1/4 W
R8	( )	1/4 W
R9	47.5 K	1/4 W
R10	1.6 K	2 W
R11	100 K	1/4 W
R12	100 K	1/4 W
R13	2.49 meg	1/8 W
R14	2 K	1/4 W
R15	200 K	1/4 W
R16	1.5 K	1/4 W
R17	1.5 K	1/4 W
R18	2.43 K	1/4 W
R19	2.43 K	1/4 W
R20	1 meg	1/4 W
R21	86.6 K	1/4 W
R22	2.2 K	1/4 W
R23	69.8 K	1/4 W
R24	3.9 Ω	1/4 W
R25	3.01 K	1/4 W
R26	4.99 K	1/4 W
R27	4.7 K	1/4 W
R28	4.7 K	1/4 W
R29	100 K	1/4 W
R30	100 K	1/4 W
R31	100 K	1/4 W
R32	100 K	1/4 W
R33	1 meg	1/4 W
R34	20 K	1/4 W
R35	910 Ω	1/4 W
R36	1.5 K	1/4 W
R37	3 K	1 W
R38	3 K	1 W
R39	560 Ω	1/4 W
R40	20 K	1/4 W
R41	75 Ω	1/4 W
R42	75 Ω	1/4 W
R43	20 K	1/4 W
R44	19.6 K	1/4 W
R45	3.3 K	1/4 W
R46	1.1 K	1/4 W
R47	220 Ω	1/4 W
R48	82 Ω	1/4 W
R49	220 Ω	1/4 W
R50	82 Ω	1/4 W
R51	82 Ω	1/4 W
R52	82 Ω	1/4 W
R53	82 Ω	1/4 W
R54	82 Ω	1/4 W
R55	18 K	1/4 W
R56	3.9 Ω	1/4 W
R57	100 Ω	1/4 W
R58	100 Ω	1/4 W
R59	100 Ω	1/4 W
R60	100 Ω	1/4 W
R61	select	1/4 W
R62	1 K	1/4 W
R63	10 K	1/4 W

SERVO AMPLIFIER ASSEMBLY 27861 Fig. 15 (A524)

B1	4C005	
C1	14,000 uf	75 VDC
C2	14,000 uf	75 VDC
C3	14,000 uf	75 VDC
CB1	not used	
F1	MDA-3	3 AMPS
F2	MDA-3	3 AMPS
F3	AGC-15	15 AMPS
F4	AGC-15	15 AMPS
F5	AGC-1/8	1/8 AMP
F6	MDL-20	20 AMPS
R1	.05 Ω	40 W
R2	1.2 K	5 W
T1	27858	

DRIVER HEATSINK ASSEMBLY 27804 Fig. 19 (A524)

C1	.0047 uf	500 VDC
C2	.0047 uf	500 VDC
C3	.0047 uf	500 VDC
C4	.0047 uf	500 VDC
F1	AGC3A	3 AMPS
Q1	2N4906	
Q2	2N4906	
Q3	2N4915	
Q4	2N4915	
R1	1 K	1/2 W
R2	1 K	1/2 W
R3	1 K	1/2 W
R4	1 K	1/2 W
R5	0.1 Ω	15 W
R6	0.1 Ω	15 W
R7	0.1 Ω	15 W
R8	0.1 Ω	15 W

OUTPUT HEATSINK ASSEMBLY 27803 Fig. 20 (A524)

F1	AGC 10A	10 AMPS
Q1	23612A	
Q2	23612A	
Q3	23612A	
Q4	23612A	
R1	0.1 Ω	15 W
R2	0.1 Ω	;5 W
R3	0.1 Ω	15 W
R4	0.1 Ω	15 W
R5	0.1 Ω	15 W
R6	0.1 Ω	15 W
R7	0.1 Ω	15 W
R8	0.1 Ω	15 W
R9	100 Ω	1/2 W
R10	100 Ω	1/2 W
R11	100 Ω	1/2 W
R12	100 Ω	1/2 W

RECTIFIER ASSEMBLY 27834 Fig. 21 (A524)

CR1	1N1184A
CR2	1N1184AR
CR3	1N1184A
CR4	1N1184AR
CR5	1N1184A
CR6	1N1184AR
R1	not used

± 15 VDC POWER SUPPLY ASSEMBLY 28601 Fig. 23 (A524)

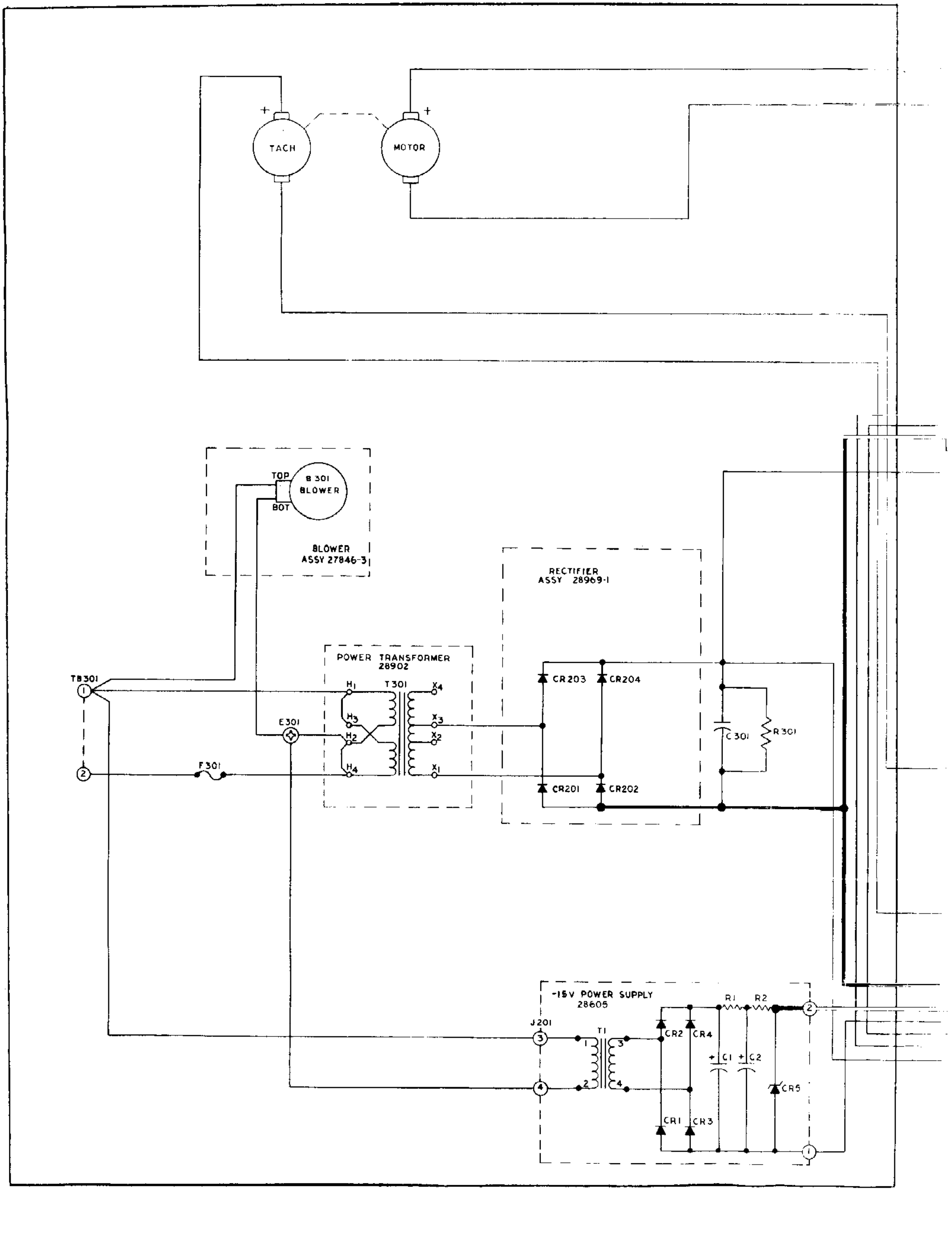
C1	300 uf	150 VDC
CR1	1.5 A	200 V
CR2	1N4744	15 V
R1	600 Ω	12 W
T1	T942 H	

COMPENSATION BOARD ASSEMBLY 24624 Fig. 26 (A524/A528)

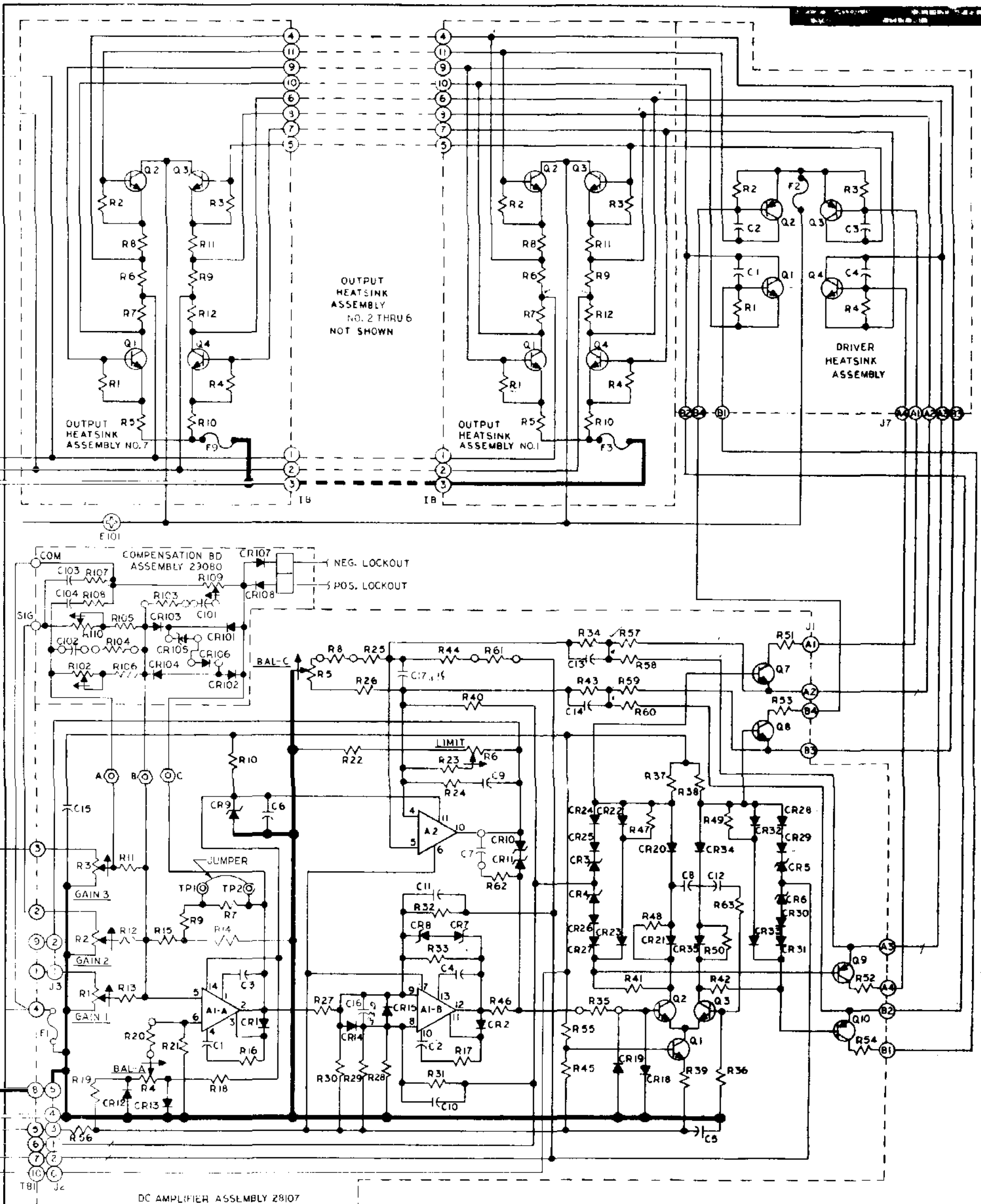
C1	not used	
C2	.22 uf	100 V
CR1	1N914	
CR2	1N914	
CR3	1N914	
CR4	1N914	
CR5	1N914	
CR6	1N914	
CR7	1N914	
CR8	1N914	
CR9	1N914	
CR10	1N914	
CR11	1N914	
CR12	1N914	
CR13	1N914	
CR14	1N914	
R1	not used	
R2	not used	
R3	100 K	1/4 W
R4	50 K	
R5	510 Ω	1/4 W
R6	2.4 K	1/4 W

COMPENSATION BOARD ASSEMBLY 29080 Fig. 27 (A524/A528)

C101	.033 uf	100 VDC
C102	.033 uf	100 VDC
C103	.01 uf	200 VDC
C104	.01 uf	200 VDC
CR101	1N914	
CR102	1N914	
CR103	1N914	
CR104	1N914	
CR105	1N748A	
CR106	1N914	
CR107	not used	
CR108	not used	
R101A	not used	
R101B	not used	
R101C	not used	
R102	500 K	
R103	(1 K)	1/4 W
R104	(5.1 K)	1/4 W
R105	51 K	1/4 W
R106	20 K	1/4 W
R107	470 Ω	1/4 W
R108	470 Ω	1/4 W
R109	5 K	
R110	100 K	



TACH
MOTOR
TOP
B 301
BLOWER
BOT
BLOWER
ASSY 27846-3
RECTIFIER
ASSY 28969-1
POWER TRANSFORMER
28902
T301
TB301
E301
F301
CR203
CR204
CR201
CR202
C301
R301
-15V POWER SUPPLY
28605
J201
T1
R1
R2
CR2
CR4
CR1
CR3
C1
C2
CR5



PART NO	DESCRIPTION	MATERIAL
UNLESS OTHERWISE SPECIFIED: TOLERANCES: FRACTIONS ± 1/64 .XX ± .01 .XXX ± .005 ANGLES ± 2° BEND RADII BREAK SHARP EDGES .005 – .010	SYSTEM SCHEMATIC DIAGRAM	WESTAMP INCORPORATED 1542 15TH STREET SANTA MONICA, CALIF.
FINISH	MODEL A524, A528 SERIES	DWG NO. 28999
	DATE 12-3-73	SHEET 1