# Instruction Manual

# ES200A

For Spare Parts or Repair Contact . . . . .


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# INSTALLATION

# OPERATING & MAINTENANCE MANUAL

# FOR THE

# ELECTROSTAT 200A

Control Description:

Serial Number _____

Model Number _____

Schematic Number _____

(Please refer to the above whenever contacting factory)

## IMPORTANT

READ THESE INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL OR OPERATE YOUR ELECTROSTAT 200A CONTROL. THESE INSTRUCTIONS SHOULD BE KEPT FOR FUTURE REFERENCE.

ELECTROSTAT 200A

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## INTRODUCTION

The Electrostat 200 Full Wave D.C. Adjustable Speed Control, with the associated D.C. Motor, is capable of operating over a 20:1 speed range continuously at rated torque. If it is necessary to operate continuously at rated torque over a speed range greater than 20:1, supplementary motor cooling is required.

The Electrostat 200 is available from 2 to 5 HP. The model classifications are an indication of the A.C. Input (230 or 115 VAC) and the feedback employed (armature voltage or tachometer). The Electrostat 200 Control contains a dual primary voltage transformer.

When contacting the factory regarding the operation of the Electrostat Drive, indicate the Serial Number, the Model Number, and the Revision Letter of the Drive. These are stamped on the nameplate to be found on the Control Heat-sinks.

This Instruction Book contains necessary information for installation and normal maintenance of the WER Electrostat 200 Static D.C. Adjustable Speed Drives.

An applicable Control Schematic and Connection Diagram is provided with each Drive. Operating and Maintenance Personnel should have a copy of this Instruction Book.

| Electrostat 200 Part No. | A.C. Input | Feedback | Max.Arm. Volts. (VDC) | Motor Field Voltage (VDC) |
|---|---|---|---|---|
| 990-1 | 230 | Armature | 180 | 200 |
| 990-2 | 115 | Armature | 90 | 100 |
| 990-3 | 230 | Tach. | 180 | 200 |
| 990-4 | 115 | Tach. | 90 | 100 |

## APPLICABLE DOCUMENTATION

990-1 230 VAC Single Phase D.C. Motor Control with Armature Feedback Schematic.

990-1A Customer Connection Drawing for 990-1

990-2 115 VAC Single Phase D.C. Motor Control with Armature Feedback Schematic.

990-2A Customer Connection Drawing for 990-2

See Page Two

APPLICABLE DOCUMENTATION (Continued)

| | |
|---|---|
| 990-3 | 230 VAC Single Phase D.C. Motor Control With Tach. Feedback Schematic. |
| 990-3A | Customer Connection Drawing For 990-3 |
| 990-4 | 115 VAC Single Phase D.C. Motor Control With Tach. Feedback Schematic. |
| 990-4A | Customer Connection Drawing For 990-4 |

In a Custom Engineered Drive System, the appropriate 990 Control Schematic should be referred to. The Customer Connections, however, will be as shown on the WER System Drawings for the particular Custom Engineered System.

## I. RECEIVING, HANDLING AND STORAGE

### A. Receiving

The equipment must be placed under adequate cover immediately upon receipt, as packing cases are not suitable for outdoor or unprotected storage.

Examine the shipment carefully upon arrival and check items with the Packing List. Any shortage or damage should be reported promptly to the carrier and to the nearest office of the WER Industrial Corporation.

### B. Storage

If equipment is not being installed immediately, it should be stored in a clean, dry location. Precaution should be taken to prevent moisture from accumulating in the equipment. Moisture, dust or dirt is detrimental to the equipment installation.

## II. DESCRIPTION

The Electrostat 200 Drive is a D.C. Adjustable Speed Drive which utilizes SCR's to convert Single Phase A.C. to D.C. Voltage.

Controlled D.C. Voltage is supplied to the D.C. Drive Motor. The Drive Speed may be adjusted over a wide speed range by controlling the armature voltage.

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The Electrostat 200 Drive consists of the following equipment:

1. The Electrostat Power Unit

The Electrostat Power Unit is a single printed circuit assembly containing the SCR's, Diodes, Regulator and associated power and control components. The Printed Circuit Assembly also incorporates all adjustment and customer connection terminal strip.

2. The Drive Motor

The Drive Motor is an adjustable speed Shunt Wound D.C. Motor. The Standard Electrostat D.C. Motor is designed to operate continuously at full rated torque over a minimum 20:1 speed range. For a broader speed range, additional cooling is required, provided by a motor mounted blower or by derating a larger horsepower motor. Applicable Instruction Manuals are supplied with the D.C. Motor.

3. The Operator's Control Station

The Operator's Station contains the speed setting potentiometer and necessary operating buttons. The station may vary in complexity from a simple three station unit to an Operator's Console with all controls for a coordinated System.

## III. INSTALLATION

### A. D.C. Motor

Remove all cover plates and other packing used for shipping purposes. Attach junction box if supplied loose. Install the motor in position on the machine. (If an adjustable base is used for belt tensioning, be sure it is mounted parallel with the load belt pulley).

1. When mounting the motor and connecting the motor to the load, follow procedures outlined in the Motor Instruction Manual supplied.

2. If motor blower kit is supplied, attach to opening of the motor at the commutator end. Select opening to provide position and location desired.

   a. If blower motor starter is supplied, the starter coil will be pre-wired and interlocked into the control circuit. Power leads to the controls are also pre-wired to the A.C. power input.

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D.C. Motor (Continued)

b. Connect blower motor to starter terminals in the control.

c. Be sure air passages are clear and impeller is free to rotate.

3. If a motor mounted tachometer is supplied, inspect to be sure all bracket bolts are tight and tachometer rotates freely.

B. Location

Install the Electrostat 200 in an area such that the louvers on the enclosure are not blocked from getting adequate cooling air. The cabinet must be mounted vertically so that adequate air can flow to and through the power semiconductor heatsinks. The cabinet must be mounted free from chemical fumes, oil vapor, steam, excessive moisture and dust.

The control unit should not be placed in the vicinity of a hazardous process or combustible fumes. If the motor must be located in such an environment TEFC or explosion proof motor should be used to operate the machine. Do not mount the Drive in a hot location. The maximum ambient temperature in which the Drive should be placed is 104° F.

C. Connections (See Diagram No. 1 on next page)

1. The A.C. Disconnect Switch must be supplied by the user, if required.

2. The Electrostat 200 is pre-wired and it is only necessary to make motor and operator station connections to the control terminal strip provided at the bottom of the panel. These connections are shown on the Connection Diagram supplied with the Drive.

3. Knockouts are provided along the bottom of the Electrostat Enclosure for convenience in bringing power to and from the Drive.

4. With the A.C. power removed from the Drive, measure the resistance of each terminal on the Terminal Strip to Control Cabinet chassis ground with an Ohmmeter, not a Megger, because the high Megger Voltage would damage the Semi-conductors. All readings should be greater than 1 Megohm.

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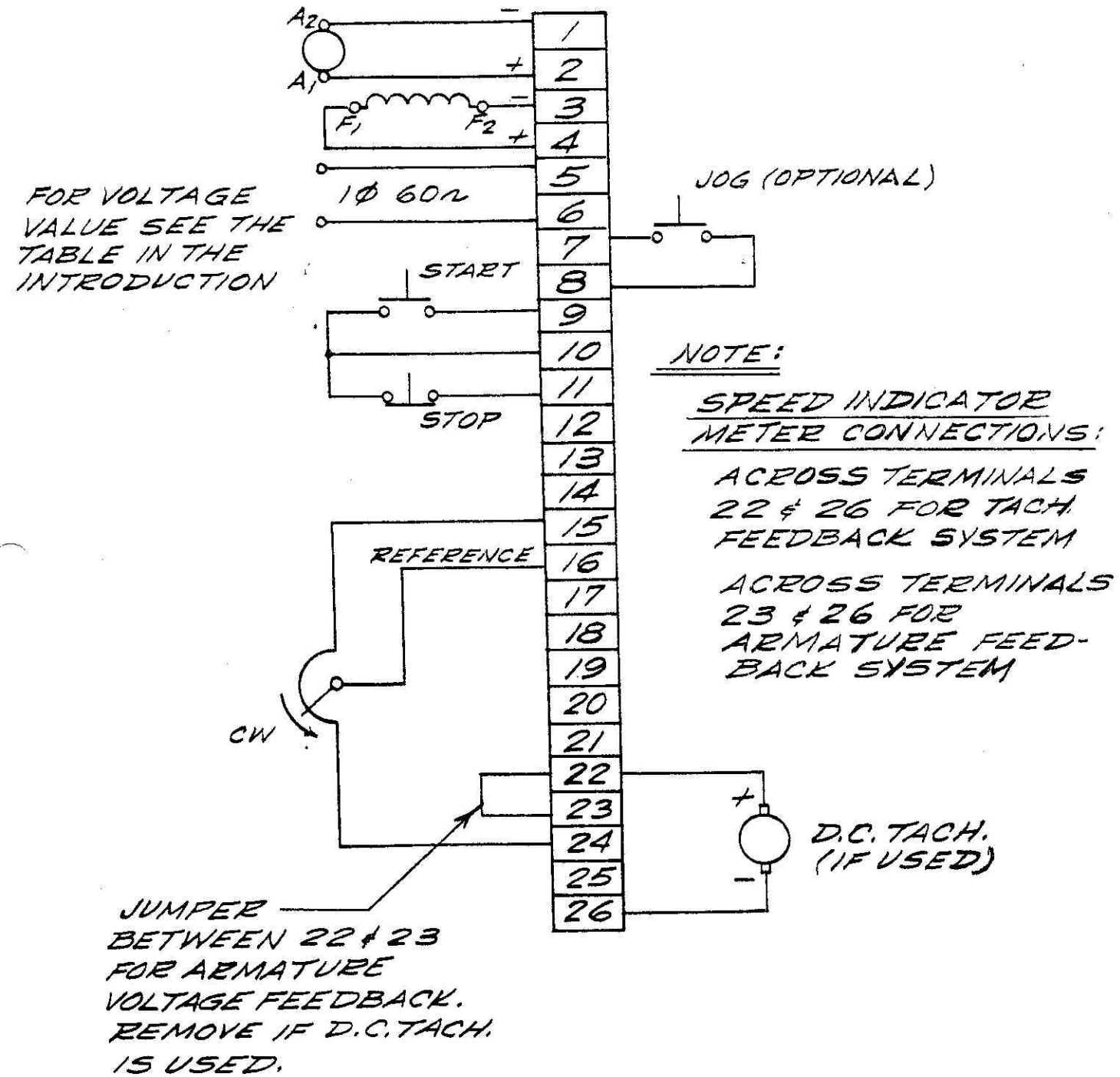
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23
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25
26
FOR VOLTAGE VALUE SEE THE TABLE IN THE INTRODUCTION
1Ø 60∼
START
STOP
JOG (OPTIONAL)
NOTE:
SPEED INDICATOR METER CONNECTIONS:
ACROSS TERMINALS 22 & 26 FOR TACH. FEEDBACK SYSTEM
ACROSS TERMINALS 23 & 26 FOR ARMATURE FEED-BACK SYSTEM
REFERENCE
CW
D.C. TACH. (IF USED)
JUMPER BETWEEN 22 & 23 FOR ARMATURE VOLTAGE FEEDBACK. REMOVE IF D.C. TACH. IS USED.

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5. Do not run the 990 Control Wires with other industrial wiring in the same conduit because of the possibility of electrical pickup which could affect System performance.

6. If a supply voltage greater than 230 VAC is to be used, either an Auto or an Isolation Transformer will be required, to step the voltage down to a voltage level suitable for the Electrostat 200 Model supplied.

7. D.C. Tachometer Feedback
On those drives where D.C. Tachometer Feedback for speed control is used, it is IMPORTANT that the polarity of the tachometer is correct in order to get the proper feedback to the Electrostat for Speed Control. If the polarity is incorrect, the Drive will turn full on when started.

8. Armature Rotation Reversing (Magnetic):
Pushbutton connections are made to the terminal strip located on the additional control panel supplied. This panel also holds the interlocked reversing contactors and dynamic breaking grids. Refer to the Wiring Diagram supplied with the particular Drive for terminal designations.

9. External Reference Signal or Follower Reference:
When a follower reference signal or external reference signal is to be used to control the output of the Electrostat 200, it is important that no electrical part of the circuit is grounded. If the reference circuit or follower circuit must be grounded, it will be necessary to use an isolating buffer circuit between the reference and the Electrostat 200. Such a buffer circuit can be supplied when required.

10. Speed Meter:

    a. Signal supplied from motor mounted tachometer:
    A calibrating potentiometer is located on the P.C. Board mounted on the back of the Speed Indicating Meter. To calibrate the meter it is necessary to use a hand tachometer on the shaft of the D.C. Motor to get the exact speed to calibrate to. Turn the calibration potentiometer until the electric speed indicator meter indicates the same speed as the hand held tachometer. Calibration should be made near base speed of the D.C. Motor in order to get the most accurate results.

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C. Connections (Continued)

b. Signal supplied from the D.C. Armature Circuit of the Electrostat Drive:
Use the calibration procedure as outlined above under "Signal supplied from motor mounted tachometer", except allow the D.C. Motor to approach operating temperature before calibrating in order to minimize drift during normal operation of the Drive.

## IV. START-UP AND ADJUSTMENTS

### WARNING

HIGH VOLTAGES TO GROUND ARE PRESENT AT MOST POINTS IN THE ELECTROSTAT SCR CONTROL, REGARDLESS OF WHETHER THE A.C. SUPPLY IS GROUNDED OR NOT. TO PROTECT THE OPERATOR FROM ELECTRICAL SHOCK AND POSSIBLE FATAL CONSEQUENCES, THE FOLLOWING PRECAUTIONS MUST BE TAKEN:

A. OPERATOR MUST NOT BE IN CONTACT WITH A GROUNDED SURFACE WHEN WORKING ON THE CONTROL. (STAND ON AN INSULATED SURFACE).

B. THE MOTOR ARMATURE, BRUSHES AND FIELD SUPPLY ARE ELECTRICALLY "HOT" REGARDLESS OF WHETHER THE D.C. ARMATURE CONTACTOR IS OPEN OR CLOSED. BEFORE WORKING ON THE MOTOR ALL A.C. POWER MUST BE DISCONNECTED FROM THE CONTROL.

C. WHEN A TEST INSTRUMENT IS BEING USED, CARE MUST BE TAKEN TO INSURE THAT ITS CHASSIS IS NOT GROUNDED EITHER BY A GROUNDING PLUG CONNECTION OR BY BEING IN CONTACT WITH A GROUNDED SURFACE. EXTREME CARE MUST BE TAKEN WHEN USING THE OSCILLOSCOPE SINCE ITS CHASSIS WILL BE ELECTRICALLY "HOT" TO GROUND WHEN CONNECTED TO THE CONTROL SYSTEM.

D. NO TERMINAL POINT IN THE CONTROL SHOULD BE GROUNDED EXCEPT WHERE SUCH GROUNDING IS SHOWN ON THE DRAWINGS OR IS APPROVED BY THE WER INDUSTRIAL CORPORATION. THIS INSTRUCTION, HOWEVER, DOES NOT APPLY TO CONTROL CABINET CHASSIS AND MOTOR FRAME GROUNDING, WHICH WE RECOMMEND TO GROUND.

NO PART OF THE A.C. OR D.C. ELECTRICAL CIRCUITRY MAY BE GROUNDED UNLESS A LINE ISOLATING TRANSFORMER IS USED ON THE A.C. INPUT, AND THEN A GROUND MAY BE MADE AT ONE POINT ONLY. CONSULT THE FACTORY FOR INSTRUCTIONS. THE SYSTEM IS DESIGNED TO OPERATE ON A.C. POWER SYSTEMS WHICH CAN BE GROUNDED BY THE CONVENTIONAL MEANS.

1. Make sure the A.C. Power to the Drive is Off. If the Control furnished is with tach feedback, connect it up with armature feedback temporarily, by removing tach lead from Terminal 22 and inserting a jumper between Terminals 22 and 23.

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2. Remove the motor armature leads from Terminals 2 & 1.

3. Connect a dummy load across these terminals such as:

   Two 60 CY 115 VAC light bulbs in series across Terminals 2 & 1.

4. Turn Speed Potentiometer fully counter-clockwise (Minimum position), and the "Gain" Pot on the control fully counter-clockwise.

5. Apply A.C. Power to the Drive.

6. Measure the A.C. Voltage across Terminals 5 & 6.

   This should be:

   Between 208 and 240 VAC for 990-1 and 990-3 and
   104 and 120 VAC for 990-2 and 990-4

   A multimeter will be adequate for this measurement and also for the following measurement.

7. Measure the motor Shunt Field D.C. Voltage across Terminals 3 & 4.

   This should be:

   Between 180 and 210 VDC for 990-1 and 990-3 and
   90 and 105 VDC for 990-2 and 990-4

8. Press the "Start" Button.

9. Test each of the following circuits as indicated.

   a. Speed Pot Voltage:

      D.C. Voltmeter from Terminal 24 (Neg.) to Terminal 26 (Pos.) - read approximately 8 VDC.

   b. Armature Voltage:

      (1) D.C. Voltmeter from Terminal 1 (Neg.) to Terminal 2 (Pos.).

      (2) Rotate Speed Potentiometer clockwise and note an increase in voltage. With the Speed Potentiometer rotated fully clockwise and if the Control is not equipped with tach feedback adjust the "Max. Speed" Control to read 180 VDC for the 990-1 & 990-3 Controls and 90 VDC for the 990-2 and the 990-4 Controls. If the control is to be used with tach feedback the "Max. Speed" Adjustment should be made as in Step 16.

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START-UP AND ADJUSTMENTS (Continued)

(3) Rotate the Speed Potentiometer fully counter-clockwise and adjust the "Min. Speed" on the Control so that the meter just reads zero volts.

10. Press the "Stop" Pushbutton.

11. Turn off the A.C. Power to the Drive.

12. Remove the dummy load from Terminals 1 & 2 and reconnect the armature to these terminals. See the Connection Diagram for proper polarity.

13. Turn on A.C. Power to the Drive.

14. With Speed Potentiometer set fully counter-clockwise, press the "Start" Button.

15. Accelerate the motor and load by rotating the Speed Potentiometer clockwise. If the motor runs in the wrong direction, interchange the armature leads at the motor. When the motor is running in the proper direction, if tach feedback is supplied, verify that the tach lead that was on Terminal 22 comes up positive with respect to Terminal 26 when the tach is rotating in the proper direction. With the power off, replace the tach lead on Terminal 26 and remove jumper between Terminals 22 & 23.

16. Press the "Start" Button and with the Speed Potentiometer set fully clockwise, adjust the "Max. Speed" Control to the desired maximum speed required, but in no case exceed the nameplate Armature Voltage as measured across the armature of Terminals 1 & 2 of the Drive.

17. Adjust the load on the D.C. Motor to the workload required. The load must not exceed the full load rating of the motor stamped on the Motor Nameplate. It may be necessary to insert a D.C. Ammeter in series with the armature to measure the load.

18. Adjust the I.R. Comp. Control to get the desired speed regulation between no load and full load. Rotating the I.R. Comp. clockwise increases the full load speed. However, I.R. Comp. should not be set too high or the Drive will be unstable.

19. If it is necessary to readjust the Current Limit setting, turn the Current Limit Control clockwise to increase the current at which limiting will begin. Turning the Control counter-clockwise will decrease this current. The

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START-UP AND ADJUSTMENTS (Continued)

ability to load down the motor and to measure the armature current is required to set current limit.

In no case must the Current Limit be set such that the limiting current exceeds 125% of the motor nameplate full load current.

20. The "Acceleration Rate" should be set to give the required acceleration rate when the Speed Pot is turned fully clockwise and the "Start" push-button is depressed. Turning the "Accel. Rate" clockwise results in increasing acceleration time.

21. If adjustable jog is supplied, depress and hold the Jog pushbutton and adjust the "Jog" Pot (P2) for the required Jog speed. A clockwise adjustment of the pot increases the Jog speed.

22. The "Gain" Pot on the Control should be turned clockwise as far as possible to obtain best System performance yet still maintaining drive stability.

23. This completes the Electrostat Set-Up & Adjustments. The I.R. and Current Limit Controls may require additional adjustments, depending on the future load requirements.

## V. OPERATION

### A. Acceleration

The Electrostat 200 is so designed that it can accelerate a high inertia load by electronically limiting the current to the motor until a preset speed is reached. The Speed Potentiometer can be set fully clockwise and the "Start" pushbutton depressed without harming either the Drive or Motor if the Current Limit is set per the instructions contained in this Manual.

The timed acceleration circuit can be adjusted between 2 to 35 seconds.

### B. Stopping

The Basic Drive is supplied without Dynamic Braking. When the "Stop" Pushbutton is depressed, the Drive will coast to a stop at a rate determined by the motor load.

Dynamic Braking can be supplied if specified at the time the Drive is ordered.

The Electrostat 200 can also be supplied with a controlled deceleration stopping.

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OPERATION (Continued)

C. Inching or Jogging

When Jog at Jog Speed is provided, pushing (Holding) the Jog Button causes the Drive to run at the Set Jog Speed.

D. Reversing

Magnetic reversing is available as an option and includes an electronic anti-plugging circuit.

E. Overload Protection

The Drive is protected against normal overloads by a built-in Current Limit Circuit. If, however, a severe overload or other fault should occur, the Drive is provided with a fast blow fuse. Use only the recommended kind of fuse and current rating.

VI. FUSE SIZES

USE ONLY THE RECOMMENDED FUSE TYPES (KAB)

| HP RATING | A.C. LINE FUSE 230 VAC (990-1 & 990-3) | A.C. LINE FUSE 115 VAC (990-2 & 990-4) |
|---|---|---|
| 1/6 | 3 Amp | 10 Amp |
| 1/4 | 5 Amp | 15 Amp |
| 1/3 | 5 Amp | 15 Amp |
| 1/2 | 10 Amp | 20 Amp |
| 3/4 | 15 Amp | 25 Amp |
| 1 | 20 Amp | |
| 1-1/2 | 25 Amp | |
| 2 | 30 Amp | |
| 3 | 35 Amp | |
| 5 | 50 Amp | |

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## VII. ROUTINE MAINTENANCE

Just a few simple precautions are required to get long, troublefree life from your Electrostat D.C. Motor Drive.

### A. Inspection and Cleaning

Periodically inspect the Drive & Motor for dirt, etc. Always turn off the A.C. Power before attempting to clean either the Drive or the Motor. Vacuum out any loose dirt or dust. Keep all liquids and vapors out of the Drive and Motor. If any parts appear to be deteriorated or worn, replace them with recommended spare parts.

### B. D.C. Motor

The Motor should be inspected at regular intervals and the followings checks made:

1. See that both the inside and outside of the Motor are not excessively dirty. This can cause added motor heating and therefore shorten motor life.

2. If a motor blower is used, make sure the air passages are clean and the impeller is free to rotate.

   If air filters are used, they should be cleaned at regular intervals or replaced if they are the disposable type. Any reduction in cooling air will increase motor heating.

3. Inspect the Commutator and Brushes.

   (a) Replace the Brushes if needed. Make sure the proper Brush Grade is used and sand in the Brushes to fit the Commutator. Clean off the sandpaper dust from the Brushes and the Commutator before putting Motor back in operation.

   (b) If the Commutator shows threading - raw copper grooves around the Commutator - and a plain copper look, the motor has been running under too light a load for some period of time. This condition will cause excessive Brush and Commutator wear and shorten the motor life. Consult the factory for corrective measures. A shiny light brown color on the Commutator in the area on which the Brushes ride is an ideal condition.

4. The motor bearings should be greased per the manufacturer's instructions regarding the type of grease used and the frequency of greasing. Overgreasing can cause excessive bearing heating and failure.

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## VIII. TROUBLESHOOTING

Basic Troubleshooting can be accomplished by using a typical Multimeter. A meter having a sensitivity of at least 100 Ohms/Volts on the A.C. Voltage ranges and 10,000 Ohms/Volts on the D.C. Voltage ranges will be satisfactory.

### SYMPTOM

Drive will not operate after the "Start" pushbutton is depressed and the "Speed Control" Pot has no affect.

### POSSIBLE CAUSES AND POINTS TO CHECK

1. Check that relay 1CR and Contactor relay M, pick up. If not, check for:

   (a) 115 VAC between Terminals 13 & 14.

   (b) Proper A.C. Voltage Input between Terminals 5 & 6.

   (c) Blown A.C. Fuse.

   (d) Malfunctioning 1CR Relay.

2. Check for Motor Field Voltage and that the Motor Field Circuit is not open-circuited. The motor will not run if the motor was reasonably loaded down and there was a Motor Field loss condition. The Drive Control would go into Current Limit, but there wouldn't be sufficient Motor Torque to overcome friction and load torque, to run the motor.

3. If there is an SCR output voltage across Terminals 1 & 2, check for the correct Motor Armature connections and the Motor Brushes are seated properly.

4. Check for approximately +16 VDC on Terminal 25 and approximately -16 VDC on Terminal 19 with respect to Terminal 26 (Regulator Common).

5. If relay 1CR picks up but its contacts are malfunctioning, replace the relay.

6. With the "Min. Speed" Pot set fully clockwise, check that there is a negative reference signal on Terminal 16 with respect to Regulator Common (Terminal 26) of approx. 3 VDC, when the Speed Control Pot is fully counter-clockwise and approx. 13 VDC when the Speed Control Pot is fully clockwise.

   Check that approximately the same voltage is present at Terminals 17 & 18 with respect to Regulator Common.

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If there is voltage at Terminal 16 and none at Terminal 17, check that Capacitor C4 is good. If not, replace it. If condition still exists replace Transistors Q4 and Q5 - one at a time.

7. Replace Integrated Circuit Operational Amplifier L1 and Unijunction Transistor Q2 - one at a time.

SYMPTOM

A.C. Fuse Blown

POSSIBLE CAUSES

1. If the fuse only blows when the "Start" pushbutton is pressed, check for:

   (a) Wrong polarity of tach signal if tach feedback is used.

   (b) Drive is overloaded. Check that the output shaft is free to rotate and for the release of brakes, etc.

   (c) Motor Field Voltage across Terminals 3 & 4 and that the Motor Field Circuit is not open-circuited.

   (d) The proper fuse rating. See the appropriate Control Schematic.

   (e) Check for grounds at all the Terminal connections.

   (f) The Current-Limit Setting may be too high.

   (g) Replace Integrated Circuits L2 & L1.

2. If the A.C. fuse blows without the "Start" pushbutton pressed, check for grounds at all the Terminal connections to Control Cabinet chassis ground and that the Motor Field Circuit is connected properly and then check for a mal-functioned Power Semi-Conductor by measuring the resistance between the Cathode and Anode of each device as follows:

   (1) Positive lead of the Ohmmeter on the Heatsink of one of the SCR's. The negative lead on the SCR's main terminal (Cathode). Resistance should be greater than 1 Megohm.

   (2) Reverse the Ohmmeter leads. Resistance should be greater than 20,000 Ohms.

   (3) Repeat Steps (1) & (2) above for the other SCR.

   (4) Positive lead of the Ohmmeter on the Heatsink containing the three Power Diodes. The negative lead on each of the outer 2 Diode Terminals (Cathode) one at a time. Resistance should be less than 20 Ohms.

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(5) Reverse the Ohmmeter leads as in Step (4) above. Resistance should be greater than 1 Megohm.

(6) Positive lead of the Ohmmeter on the Heatsink containing the three Power Diodes. The negative lead on the Terminal (Cathode) of the center Diode. Resistance should be less than 20 Ohms.

(7) Reverse the meter leads as in Step (6) above. Resistance should be greater than 20,000 Ohms.

(8) Replace any faulty components, and fuse.

SYMPTOM

Drive runs to top speed when minimum speed is requested.

POSSIBLE CAUSES

1. Check that the Speed Control Pot is connected properly. With the Speed Control Pot fully counter-clockwise check that the voltage from Terminal 16 is in the range of 0 to 4.3 VDC (negative) with respect to Terminal 26 (Regulator Common).

2. If the Drive employs D.C. Tach feedback, check that the tach is connected and with the polarities as shown on the Control Diagram.

3. If the Drive employs Armature Voltage Feedback, check that there is a Motor Field Voltage and that the Motor Field Circuit is not open-circuited.

4. Check that Terminal 16 is tied down to Terminal 26 (Regulator Common) through the impedance of the "Speed Control" and the "Min. Speed" Pots. With the wires on Terminals 24 & 16 removed, and both the "Speed Control" and "Min. Speed" Pots turned fully clockwise, check that there is an impedance of 3K between Terminals 26 and the wire that was on Terminal 16. If the circuit is open, replace the Pot which is open.

5. If there is not an open reference circuit, and the Voltage reference is in the range of 0 to 4.3 VDC, check that there is approximately the same voltage on Terminal 17. If the voltage here is much greater (in the range 10 to 16 VDC negative) replace Diode D7 and Transistor Q4 - one at a time.

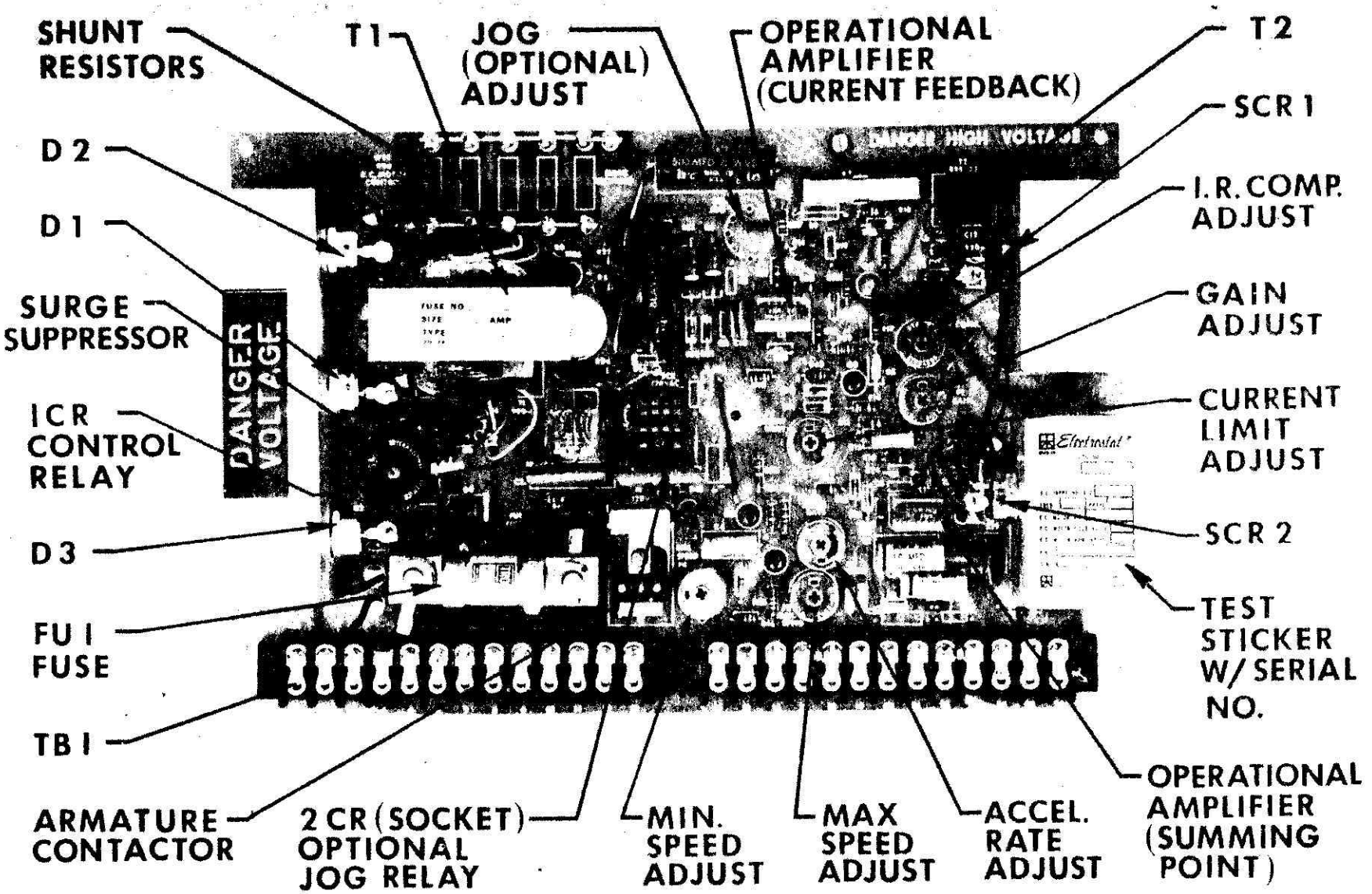
6. Replace Integrated Circuit L1.

See Page Sixteen

## IX. LIST OF TEST POINTS

All voltages are D.C. and with respect to Regulator Common (Terminal 26) except where specified.

| Description | Terminal | Voltage |
|---|---|---|
| Positive Power Supply | 25 | +16VDC |
| Negative Power Supply | 19 | -16VDC |
| Reference | 16 | 0 to (-)8 VDC depending on the setting of the "Min." & "Speed" Control Pots. (If the Speed Control Pot is fully clockwise, voltage should be -8VDC) |
| Timed Reference | 17 & 18 | Approx. the same as the Reference, for the same setting of the Speed Control Pot. |
| Armature Volts | 23 | Proportional to the Reference signal. For Maximum voltage for the control consult the Table in the Introduction. |
| Motor Field Voltage | 4 | Consult the Table in the Introduction. |
| Current Feedback (Positive) | 1 | Approx. 50 MV at rated load. |
| 115 VAC Relay Control Voltage | (Between 13 & 14) | 115 VAC |
| A.C. Supply Voltage | (Between 5 & 6) | Consult the Table in the Introduction |
| D.C. Tach Voltage (If Tach Feedback is used) | 22 | Positive D.C. Voltage for proper polarity, and the magnitude is proportional to tach rotational speed. See Volts per 1000 RPM rating on Tach Nameplate. |




**ELECTROSTAT 200A**
**P/N 990-1**