DESCRIPTION OF APPARATUS

3 Phase THYRISTOR Drives

Device designations are same as those on the schematic diagram.

1. CB - Main line circuit breaker or disconnect located in the incoming A.C. line supplied by customer.

2. 1T Transformer - 3 phase transformer used to provide the proper A.C. voltage for the 3 phase bridge rectifier circuitry and the single phase control circuitry.

3. Silicon Diode Rectifiers

   2D, 4D, 6D - Connected in a 3 phase bridge rectifier circuit; used to convert the applied A.C. voltage to full wave D.C. for application to the D.C. motor armature circuit.

   10D - Commutating or free wheeling diode rectifier used to discharge the inductive energy of the motor during the non-conduction period of the 3 phase bridge rectifier.

   7D, 8D - Rectifying diodes for converting A.C. to D.C. for the motor shunt field, and D.C. control circuitry. Used only with 240V motors.

4. THYRISTORS

   1TN, 3TN, 5TN - Silicon "controlled" rectifiers which function in a similar manner to switches and are used to control the conduction period of the 3 phase bridge rectifier.

5. 3 Phase Bridge Rectifier

   Composed of diodes 2D, 4D, 6D, THYRISTORS 1TN, 3TN, 5TN, and is used to convert the incoming A.C. supply to D.C.

6. Contactors and Relays

   1M - Main line contactor for applying and removing D.C. power from the motor. Also is used when dynamic braking is provided to insert a resistance across the motor armature circuit when stopping.

   CR, MR - Master relays for controlling start-stop & jog operation of the drive.

7. Resistors

   FBR - Armature current signal Resistor

   MFR - Motor shunt field voltage dropping resistor; motor base speed vernier adjust. (480V D.C. operation only) through the error winding thus controlling the angular relationship between the firing pulse from the gating amplifier and the applied A.C. voltage to the THYRISTORS.

7. a) Assume that a 24 volt reference produces an armature voltage of 240V. D.C. or 480 V. D.C. according to the transformer secondary. (Speed pot at maximum).

   b) Assume that it requires 0.8 AT (current X turns) to produce 240V. D.C. or 480V. D.C. from the 3 phase bridge rectifier.

   c) Assume that the armature feedback voltage is 22.3V. D.C. when the armature voltage is 240V. D.C. or 480V. D.C.

   d) Assume that the 24 volt reference produces 1.2 AT when the armature feedback voltage is zero, due to the error limit circuit.

   e) Initially, current flows from the positive side of the reference voltage source, thru 3P and 1P, 26R1, 26R2 from 9 to 10 on the "error" winding (+AT), thru 30D thru SPD Rheo (1P) and to the negative side of the reference supply.

   f) This increases the armature voltage and the armature feedback voltage begins to appear across 1P (max. arm. volts).

   g) The armature feedback voltage across 1P (MAV) opposes the reference voltage, hence the current flowing thru 1P (MAV) and the "error" winding decreases.

   h) When the armature voltage reaches 240 volts the feedback voltage is 22.3 volts. The error voltage (reference volts (-) feedback volts) is 1.7 volts which will permit sufficient current to pass thru the "error" winding to produce the 0.8 AT required to maintain 240 or 480 volts across the armature.

Regulating Action

Should the armature voltage decrease below 240 or 480 volts, the error voltage would increase. More current would flow thru the "error" winding and the output pulses from the gating amplifiers would direct the THYRISTORS to fire earlier thus increasing the voltage applied to the motor armature.

Should the armature voltage increase above 240 volts, the error voltage would decrease, less current would flow thru the "error" winding and the THYRISTORS would fire later or conduct less to reduce the armature voltage.

I.R. Compensation - Speed regulation by CEMF Control

Speed of a D.C. motor is proportional to CEMF. Assuming the drive is not provided with the IR compensation feature, when the loading on the motor increases, the motor current increases and speed decreases due to IR drop (V=CEMF + IR) In order to obtain a more constant motor speed for varying load conditions, CEMF and not armature voltage should be fed into the regulator. The only way to measure CEMF is by subtracting the IR drop from the armature voltage. A resistor in series with the motor armature (FBR) senses the motor current and provides the regulator with a voltage signal proportional to the motor current.

Current Limit

A current limit circuit is provided to:

1) Prevent excessive armature current from flowing during acceleration and deceleration of the motor.
2) Limit the maximum value of armature current for any given operating condition.

The current signal is used to decrease the armature voltage when the load current exceeds a preset value. When the preset value is exceeded, silicon diodes 23D, 25D, 26D, 27D conduct and current flows in a plus to minus direction thru winding 7-8 of the gating amplifier such that terminal 8 is positive with respect to terminal 7. Negative AT are produced and the output pulses from the gating amplifier decreases the conduction time of the THYRISTORS to reduce the aramture voltage.

NOTE: Diodes 23D, 25D, 26D, 27D do not conduct until the voltage applied to them from 4P is sufficient to overcome the combined forward voltage drop of the diodes.

The armature voltage decrease caused by current limit action will be approximately great enough to limit the motor current to a maximum of 170% full load current with the motor stalled.

Capacitor 4C provides a time delay for the current limit signal under normal operating conditions. However, when the current signal increases above a predetermined level, diodes 25D and 26D conduct readily to eliminate the time delay.

Dynamic Braking

Drives which incorporate the dynamic braking feature, slow the motor rapidly when the "Stop" button is pressed, by connecting a low resistance across the motor armature. The motor then acts as a generator and dissipates its rotational energy in the dynamic braking resistor in the form of heat.

START-UP INSTRUCTIONS

3 Phase THYRISTOR Drives

A. Preliminary

1. WARNING - Check phase detector before energizing DC armature circuit. If phasing is incorrect, damage to gating amplifier, THYRISTOR, and fuses will result. Phase detector light should be on. If not interchange any two leads on the line side of the CB breaker until light is on.

2. Check the A.C. line voltage between U, V, and W. Voltage should be 208 V. A.C., ± 4% or 400V. A.C., ± 4%, according to schematic. If the voltage is outside the allowable tolerance, adjust the taps on the transformer.

3. The drive has been thoroughly tested and adjusted at the factory so that only minor adjustments should be required at installation.

   NOTE: Any attempt to adjust the current limit potentiometer (4P) will automatically VOID the Westinghouse guarantee.

4. Place a D.C. voltmeter across the motor armature connections 1MAP (+) and 1MAN (-) NOTE: A. D.C. voltage of approximately 130 volts will be noted when the armature contactor is open. This is normal.

B. Start-Up

1. Assuming that the preceding steps have been satisfactorily completed, place the speed pot at minimum.

2. Close the main line A.C. breaker or disconnect switch.

3. Depress start pushbutton. Slowly advance the speed pot to maximum and check the armature voltage and motor speed. The speed should be approximately base speed. The armature voltage will depend upon motor load and may be as low as 240 (480) volts or as high as 265 (525) volts.

4. Depress the STOP Pushbutton and check that the drive decelerates to a complete stop.

5. With the speed pot still at maximum, depress the START pushbutton and observe that the drive gradually accelerates to full speed within 5 to 6 seconds.

6. Turn the speed pot to intermediate values between minimum and maximum and check the operation of the drive. Acceleration and deceleration should be smooth and once the new speed is attained, it should remain constant for constant load conditions.

7. Should any trouble be encountered while performing the preceding steps, refer to the alignment and trouble shooting procedures.

8. I.R. compensation has been preset at the factory to provide approximately flat speed regulation, no load to full load, at 25% base speed. However, if flat speed regulation is desired at some other speed, proceed as outlined in the alignment procedure.

DESCRIPTION OF OPERATION

3 Phase THYRISTOR Drives

This drive is designed to operate over a speed range of 10:1 by armature voltage control.

1. A.C. line power is applied to a three phase bridge rectifier circuit comprised of three THYRISTORS and three silicon diode rectifiers.
2. The three Magamp type gating amplifiers supply the THYRISTORS with the necessary firing pulses.
3. The angular relaitonship between the A.C. supply voltage and the firing pulse from the gating amplifiers determines the THYRISTOR conduction period, hence, the D.C. power applied to the motor.
4. A commutating or free wheeling diode 10D provides a path for the inductive discharge of the motor armature which cannot flow through the THYRISTORS when their conduction period is small. This means that at low speeds the full armature current of the motor would try to flow through the TNR resistors, increasing the THYRISTOR voltage and causing:
   a) The THYRISTORS to be switched on well into the next half cycle of the AC applied voltage (negative half voltage)
   b) Smaller voltage range and therefore a smaller speed range.
5. The gating amplifier output is controlled by the net or total ampere turns (AT) of the control windings. Positive AT (odd numbered control winding terminal has a positive polarity with respect to the even numbered terminal) produce an output pulse which will increase the THYRISTOR conduction time. Negative AT produce the exact opposite effect.
6. Voltage regulation is obtained through the "error" control winding which is associated with a voltage matching circuit comprised of an adjustable D.C. reference voltage and the D.C. armature feedback voltage. The net difference between these two voltages is the error voltage which causes a current to flow