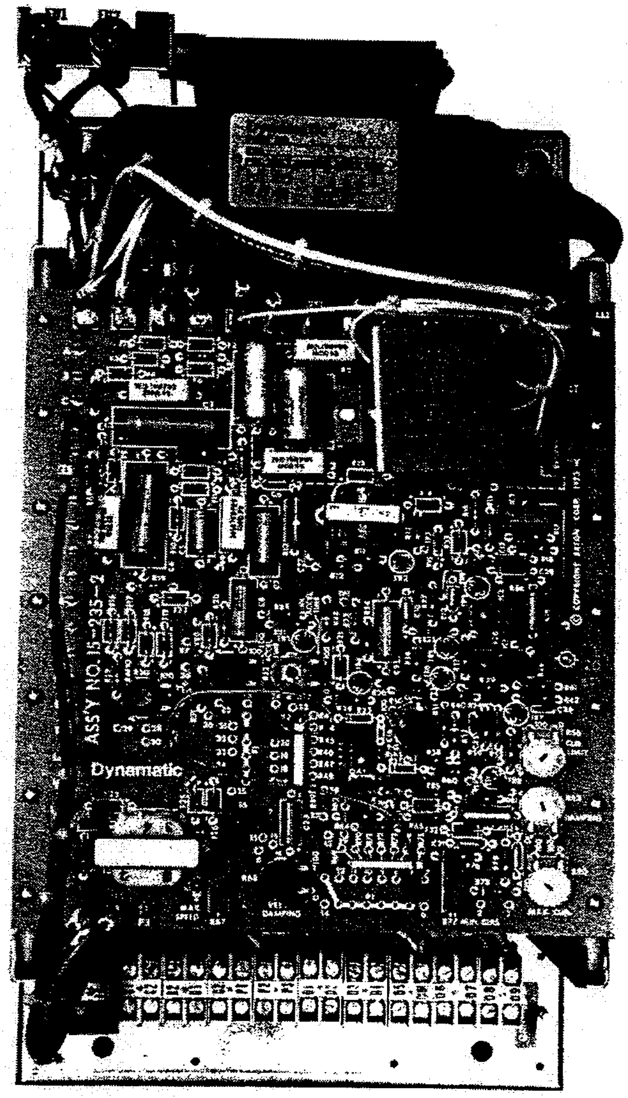
Instruction Manual

DRIVE SOURCE INTERNATIONAL INC.
7900 Durand Avenue, P.O. Box 0361,
Sturtevant, Wisconsin, U.S.A. 53177
Tel.: 262.554.7977 • Fax: 262.554.7041
Toll Free: 800.548.2169
E-mail: drivesourceusa.com

Dynamatic

Mark III Stamping Press Controller



Caution:

Rotating shafts and above ground electrical potentials can be hazardous. Therefore, it is strongly recommended that all electrical work conform to National Electrical Codes and local regulations. Installation, alignment and maintenance should be performed only by qualified personnel.

Factory recommended test procedures, included in the instruction manual, should be followed. Always disconnect electrical power before working on the unit.

Although shaft couplings are generally not furnished by the manufacturer, rotating shafts and couplings must be protected with securely mounted metal guards that are of sufficient thickness to provide protection against flying particles such as keys, bolts and coupling parts.

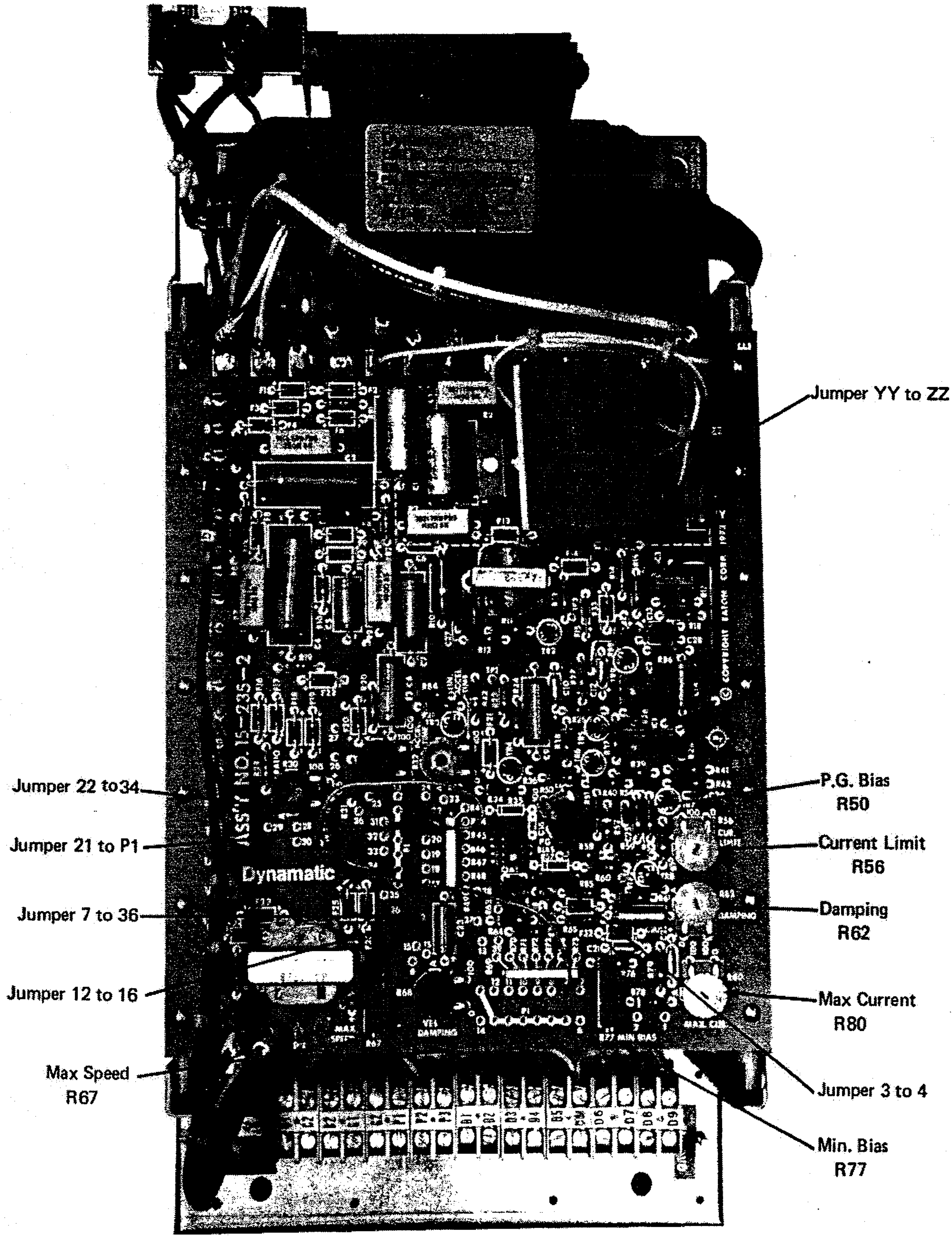
REFER TO OSHA RULES AND REGULATIONS, PARAGRAPH 1910.219, FOR GUARDS ON MECHANICAL POWER TRANSMISSION APPARATUS.

Provide immediate corrective measures if abnormal noises are detected. If noise is due to excessive vibrations, check for misalignment, unbalanced shaft couplings, buildup of foreign material or erosion on internal rotating components or bearing failure.

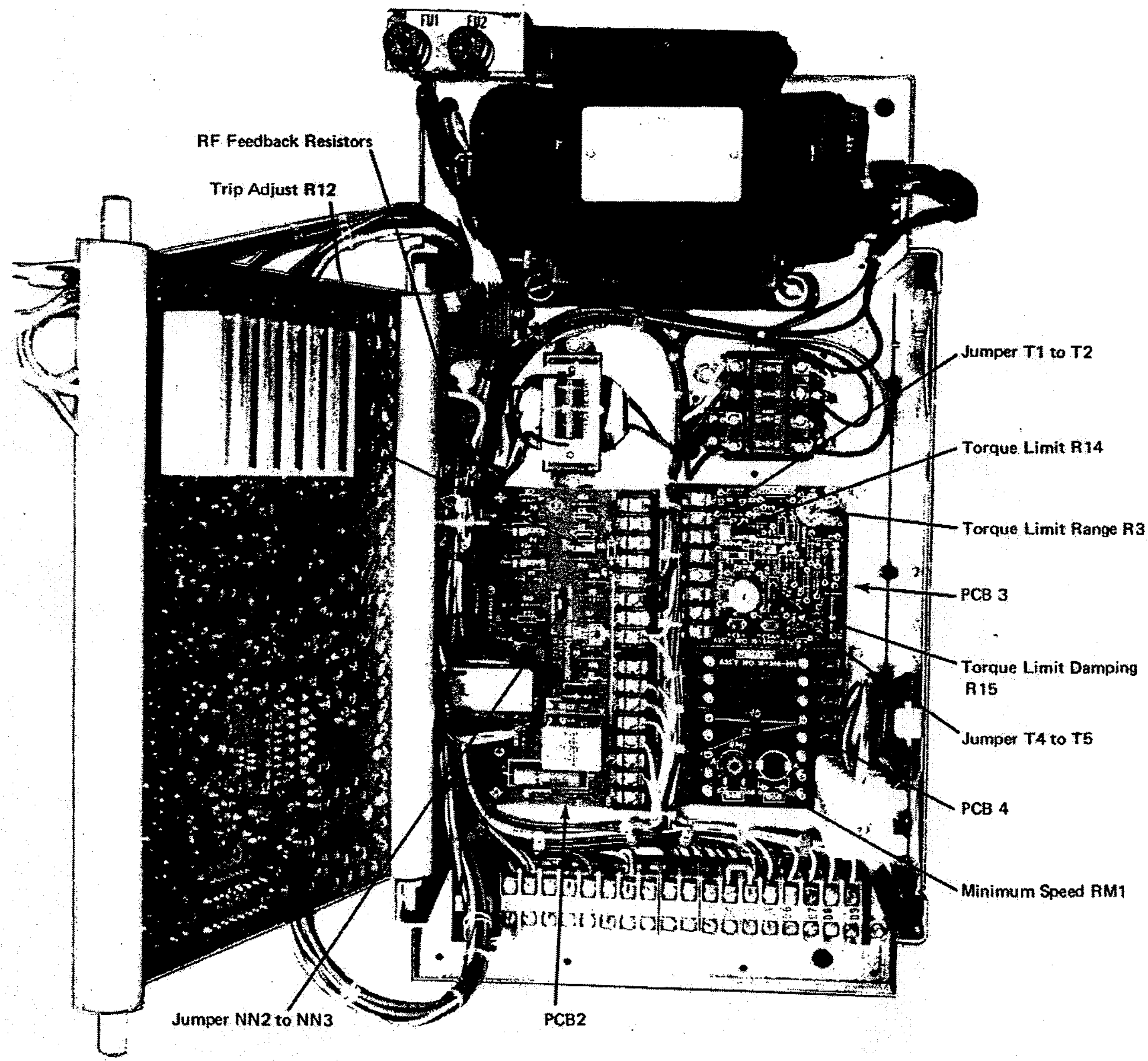
Note:
Since improvements are continually being made to available equipment, the enclosed data is subject to change without notice. Any drawings are for reference only, unless certified. For additional information contact your nearest Eddy Current representative listed in the Yellow pages under "Power Transmission Equipment". Or write: *DYNAMATIC Corporation*, 3122 - 14th Avenue, P.O. Box 1412, Kenosha, WI 53141-4121.

TABLE OF CONTENTS

List of Illustrations



Mark III PCB-Jumper and Adjustment Locations



Modification Boards - Jumper and Adjustment Locations

Mark III Stamping Press Controller
(Ref. Schematic Diagram ED-51603)

I. Introduction

A. This control is configured to meet the requirements of a Stamping Press application, and provides two basic functions:

1. Accelerating the flywheel to running speed.
2. Providing speed control with a limit on the running torque to smooth out peak motor loads during a production run.

B. During acceleration, drive torque is limited by the setting of the Torque Limit potentiometer. (This allows the drive to accelerate high inertia loads without overloading the motor for an excessive time.

C. When running at production speed, the speed is determined by the setting of the Run Speed potentiometer (adjustable) and the maximum motor load is limited by the setting of the Torque Limit potentiometer (adjustable).

D. The controller also includes a Trip circuit which actuates a relay at a preset speed. One normally open contact and one normally closed contact is supplied for use by the press manufacturer. Refer to the specific schematic and wiring diagram for this application.

II. Preliminary Adjustments

A. Externally mounted potentiometers

1. Run Speed (R5) located remotely on operator station. 0% full CCW

B. Mark III (15-235-2) PCB 1

(1) Single Turn
(2) Twenty Turn

1.	Pulse Generator Bias Factory dial dot	(1)	(P.G. Bias)	(R50)
2.	Minimum Bias 0% Full (CCW)	(2)	(Min. Bias)	(R77)
3.	Maximum Current 100% Full (CW)	(1)	(Max. Cur.)	(R80)
4.	Damping 50% Full (CW)	(1)	(Damping)	(R62)
5.	Current Limit Factory dial dot	(1)	(Cur. Limit)	(R56)
6.	Maximum Speed 0% Full (CCW)	(2)	(Max. Speed)	(R67)

7. Verify the following jumper connections:
3 to 4
12 to 16
21 to P1
7 to 36
22 to 34

8. Terminal YY to ZZ

C. Trip Circuit PCB (15-242-2) PCB 2
   1. Trip Adjust. (R12) 0% (full CCW)
   2. Jumper Connections NN2 to NN3.

D. Torque Limit PCB (15-240-8) PCB 3
   1. Torque Limit Range (R3) 100% (full CW)
   2. Torque Limit (R14) 0% (full CCW)
   3. Torque Limit Damping (R15) 0% (full CCW)
   4. Jumper Connections - - T1 to T2, T4 to T5.

E. Minimum Speed Pot. (RM1) on PCB 4, 15-240-199, 0% (full CCW).

F. Verify that the feedback resistor (RF) mounted on panel is jumpered correctly for clutch current. See Figure 1. Hot clutch current rating can be found on the name-plate mounted on the clutch housing.

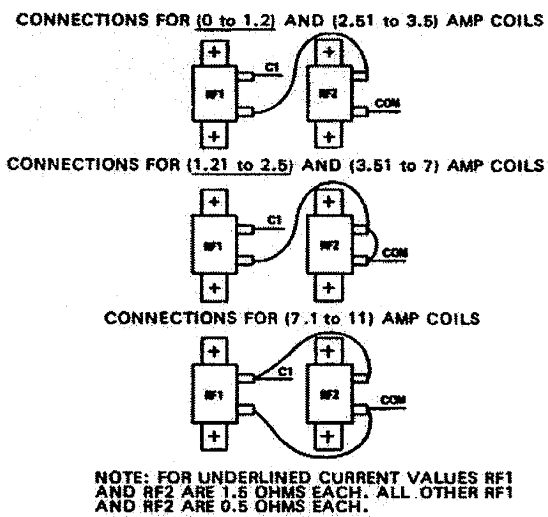


Figure 1 (RF) Feedback Resistor Connections

III. Adjustment Procedure

NOTE: To complete the following adjustment procedure it will be necessary to "Operate" the drive. This may require "jumpers" in the press manufacturers associated circuits to allow the drive to operate. Please refer to press manufacturer's circuit description to determine if jumpers are required.

CAUTION: The following procedure will cause rotation of the output shaft.

A. Minimum Bias (R77) located on PCB 1, 15-235-2.
   1. Turn the Minimum Speed (RM1) and Run Speed (R5) potentiometers to zero, 100% CCW .
   2. Apply power to the control and the drive.
   3. Turn the Minimum Bias CW until the output shaft just starts to rotate, then back off until the output shaft just stops rotating.

B. Maximum Speed (R67) located on PCB 1 , 15-235-2 .
   1. With the Minimum Speed pot at zero, turn the Run Speed pot to 100%.

   NOTE: The center lug of the Run Speed Pot is connected to the control through a contact supplied by the press manufacturer. This contact must be closed to make the following adjustments. Refer to press manufacturer's circuit description for details.

2. Turn the Maximum Speed pot CW until the drive is running at Maximum rated speed. Determine output speed by use of a tachometer or stroboscope.
3. Since there may be some interaction between Minimum Bias and Maximum Speed, it may be necessary to re-adjust until the desired speed range is obtained.

C. Trip Adjustment (R12) located on PCB 2, 15-242-2.

1. With the Minimum Speed pot at zero, turn the Run Speed pot until the drive is running at the speed you require to operate the trip function.
2. Turn the Trip Adjust potentiometer CW until the relay is just energized (the L.E.D. will light). Back off the adjustment until the L.E.D. just goes out.
3. Check operation of the Trip Adjustment by turning the Run Speed pot slightly CCW, the L.E.D. should come on.

D. Damping (R62) located on PCB 1, 15-235-2.

1. With the Drive about 50% running speed, turn the Damping pot CCW until a hunting condition develops. Turn the potentiometer CW until hunting condition is eliminated.

E. Minimum Speed (RM1) located on PCB 4, 15-240-199.

1. With the Run Speed pot at zero, adjust the Minimum Speed pot for the desired minimum speed.

F. Torque Limit Range (R3) located on PCB 3, 15-240-8.

1. Torque Limit Range is a gain matching control and needs no adjustment.

G. Torque Limit Damping (R15) located on PCB 3, 15-240-8.

1. Preset this pot at 100% CW until Torque Limit has been set.

H. Torque Limit (R14) located on PCB 3, 15-240-8.

1. This is a 20-turn pot. To insure a zero setting for starting adjustments, first turn 20 complete turns CCW.
2. Potentiometer Adjustment (when motor can be fully loaded).
   a. The Torque limit board may be adjusted so that the drive output will not exceed a given torque. Since motor current is proportional to torque, motor current can be measured to indicate the torque limit setting. For example, assume that the AC drive motor is rated at 25 amperes and it is desired to limit the torque to 150%. 150% of 25 amperes is 37.5 amperes. The torque limit circuit should be adjusted to limit motor current to 37.5 amperes under load.
   b. Connect an AC ammeter (preferably clamp-on type) in one leg of the AC drive motor supply leads (T1, T2, or T3).
   c. Start the AC motor with no load applied.
   d. With the Mark III controller de-energized, set the Operator's Speed potentiometer (R5) to maximum. (100% CW)
   e. Connect the drive output shaft to a load that will represent normal operating conditions.
   f. Set the Torque Limit potentiometer at about 50% of rotation, 10 turns CW.
   g. Start the drive and note the maximum current on the AC ammeter during acceleration.
   h. If the current is less than 150% of rated motor current (37.5 amperes) increase the Torque Limit potentiometer setting. Press the Stop button and then repeat step g after the unit stops.

i. If the current is greater than 150% of rated motor current (37.5 amperes), decrease the Torque Limit setting, press the Stop button and then repeat step g after the unit stops.

j. If the motor current during acceleration never rises to 150% of rated motor current (37.5 amperes), it is possible that the load is not large enough to draw this current. Increase the load and repeat steps g and h , or i .

3. Potentiometer Adjustment (when motor cannot be fully loaded).

CAUTION: Only qualified personnel acquainted with electrical safety procedures should make this adjustment. When making this adjustment, the resistor (R100) should not be disconnected from current transformer secondary.

a. Apply load to the motor and note the motor current (IR). (A load of 50% of full load, or more, is desirable).

b. Check the motor nameplate for full load current (IF) of the motor.

c. Connect a voltmeter across terminals X1 and X2 (current transformer) and measure the voltage (VR).

d. Calculate what the voltage would be across terminals X1 and X2 at full load.

$$VF = \frac{(VR)\,(IF)}{IR}$$

VF = Voltage across Resistor R100 at full load.
VR = Voltage across Resistor R100 at reduced load.
IF = Motor current at full load.
IR = Motor current at reduced load.

e. Remove control power and disconnect the current transformer leads to the full wave bridge rectifier (TL7 and TL8), and connect a variac to the bridge.

f. Apply control power and adjust the variac for VF and adjust the Torque Limit until the output speed just begins to decrease. Increasing the output of variac slightly will cause the speed to decrease sharply. **When making this adjustment, DO NOT exceed 5 volts out of variac.**

g. Remove control power, disconnect the Variac and reconnect the current transformer leads.

I. Torque Limit Damping (R15) located on PCB 3, 15-240-8 .

1. Turn the Torque Limit Damping potentiometer CCW until instability (hunting) develops; then turn CW until stability is attained.

J. Tach Indicator Calibration (located on rear of tach indicator).

NOTE: With drive stopped, zero the tach indicator with screw adjust located on face of meter.

1. Start the drive and run the Press. Turn the Run Speed pot clockwise until the drive is operating at approximately 3/4 of rated Press speed.
2. Determine present speed by counting stroking rate.
3. Adjust the tach indicator (adjusting screw located on rear of tach indicator) for correct reading.

NOTE: Pulse Generator Bias (R50) and Current Limit Potentiometer (R56) are both located on the Mark III PCB and are factory preset at dial dots. If adjustment becomes necessary, use the following procedure.

K. Pulse Generator Bias (R50) located on PCB 1, 15-235-2.

1. Remove power to the control and the motor.
2. Turn the External Run speed, Minimum Bias, and the P.G. Bias potentiometers to zero. (Full CCW).
3. Connect a voltmeter (0 to 3 VDC range) to leads C1 (positive) and C3 (negative).
4. Apply control power and adjust P.G. Bias potentiometer CCW until the meter just starts to deflect.
5. Remove control power and disconnect the meter.

L. Current Limit Potentiometer (R56), located on PCB 1, 15-235-2 .

CAUTION: The following procedure will cause rotation of the output shaft if the motor is energized.

1. Control power off, motor off.
2. Remove suitcase shaped jumper located between the center arm of the Maximum Speed potentiometer and the 100K resistor input to the positive summing junction of the Operational Amplifier. These receptacles are numbered 16 and 12 respectively on the PCB.
3. Connect a voltmeter (0 to 50 VDC range) to terminals C1 (positive) and C2 (negative).
4. Apply power to the control only.
5. Turn the External Run Speed potentiometer to 100% (full CW). Adjust the Current Limit potentiometer until 33 VDC is attained on the meter.
6. As the coil heats up its resistance will rise. The coil voltage will also increase because only the current level is being controlled. At any temperature, the maximum sustained coil voltage should not exceed 45 VDC.
7. Turn the External Run Speed pot to zero (full CCW) and remove control power.
8. Replace suitcase jumper between receptacles 12 and 16. Disconnect the meter.

NOTE: After completing adjustment procedure remove all jumpers across press builder's circuitry and restore drive to original condition.

IV. Maintenance

WARNING: Turn off power to unit before making tests, except when taking voltage measurements. Only qualified personnel acquainted with electrical safety procedure should service the equipment.

Corrective Maintenance

A. If the Control will not run - - check:

1. Fuses and disconnect device.
2. Incoming line voltage.
3. Voltage across outside terminals of Run Speed pot R5 should be approximately 9 volts DC. Voltage from P1 to center arm of R5 should rise from 4½ to 9 volts as pot is rotated from 0 to 100% end if minimum speed is set for 4½ volts.
4. Transformer voltages.
5. For open circuit in clutch field coil (C1 and C2).
6. Press manufacturers interlocks.

B. If the Control "hunts" (erratic speed control) - - check:

1. Damping potentiometer (R62) setting. Re-adjust if necessary.
2. Driven load on output shaft may pulse or reflect erratic load to the controller.

V. Trouble-Shooting

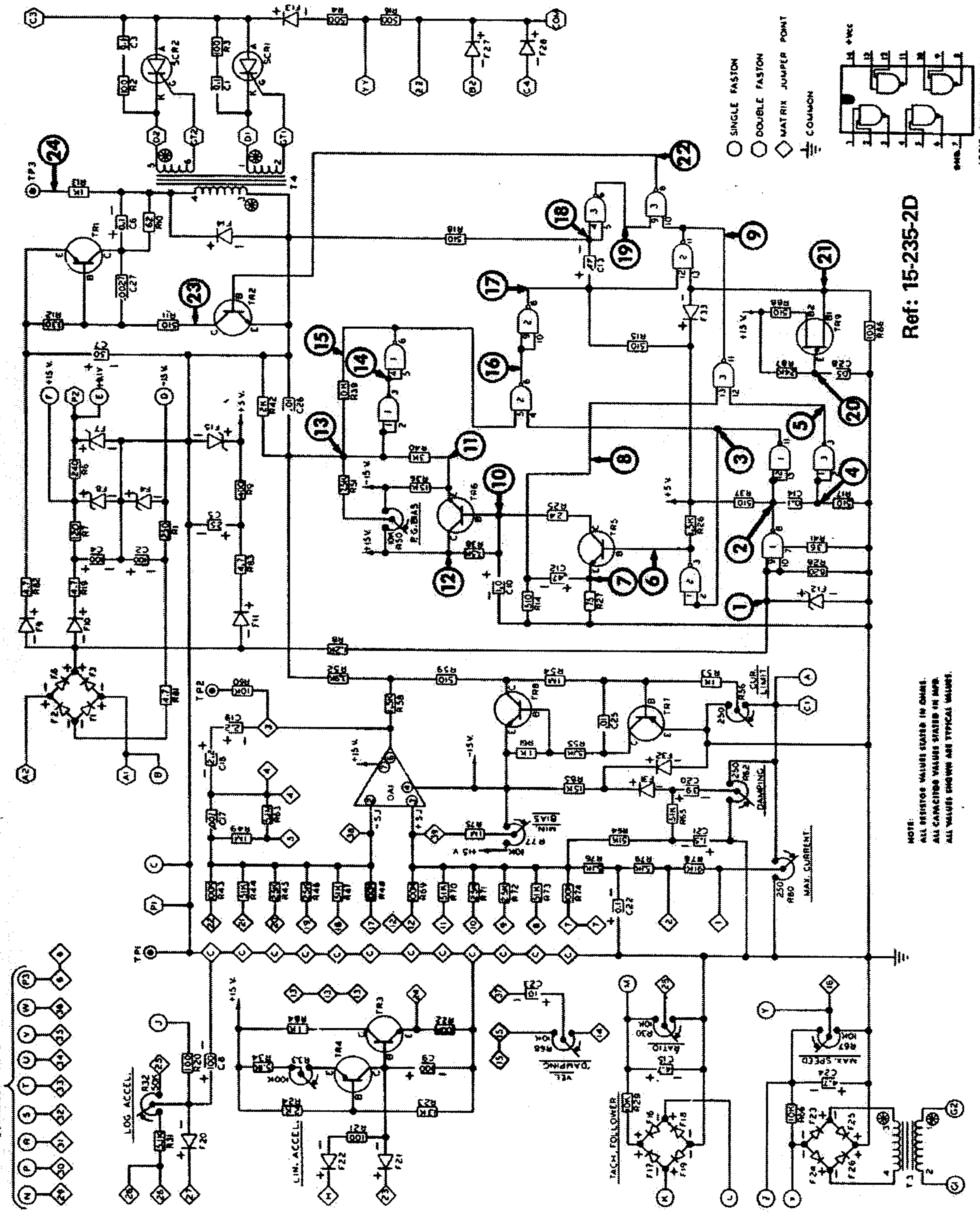
Although this manual is not intended as a trouble-shooting guide, the following information is provided to assist the technician in a more thorough checking of the circuit boards.

CAUTION: Above ground electrical potentials exist and can be hazardous. Only qualified personnel should attempt to trouble-shoot this equipment. When checking voltages, a good quality 20,000 ohm/voltmeter is required. When checking waveforms, use a good quality DC scope capable of at least two to five megahertz bandwidth. Common (ground) is terminal P1.

When checking integrated circuits and transistors, to avoid damage to the components, do not short out adjacent pins with the probe.

Voltage required - - use your specific wiring diagram(s) for reference purposes .

1. Determine if L1, L2, and L3 (incoming) lines show proper line voltage.
2. Check all fuses and disconnect device.
3. The primary voltage of T2-P at terminals LA and H2 should be 230 VAC.
4. The proper secondary voltage of T1 at terminals X1 and X2 can be obtained from the controller connection diagram (shipped with controller). Check to see that this voltage is correct.
5. The secondary voltage of T2-S should be 48 V.C.T.
6. +15 VDC between terminals F(+) and P1(-).
7. -15 VDC between terminals D(-) and P1(+).
8. +9.1 VDC between terminals E(+) and P1(-).
9. The voltage reading between test point TP2 and P1 will vary from -13 VDC to +13 VDC, depending upon the summation of input currents to the operational amplifier OA1.



Ref: 15-235-2D

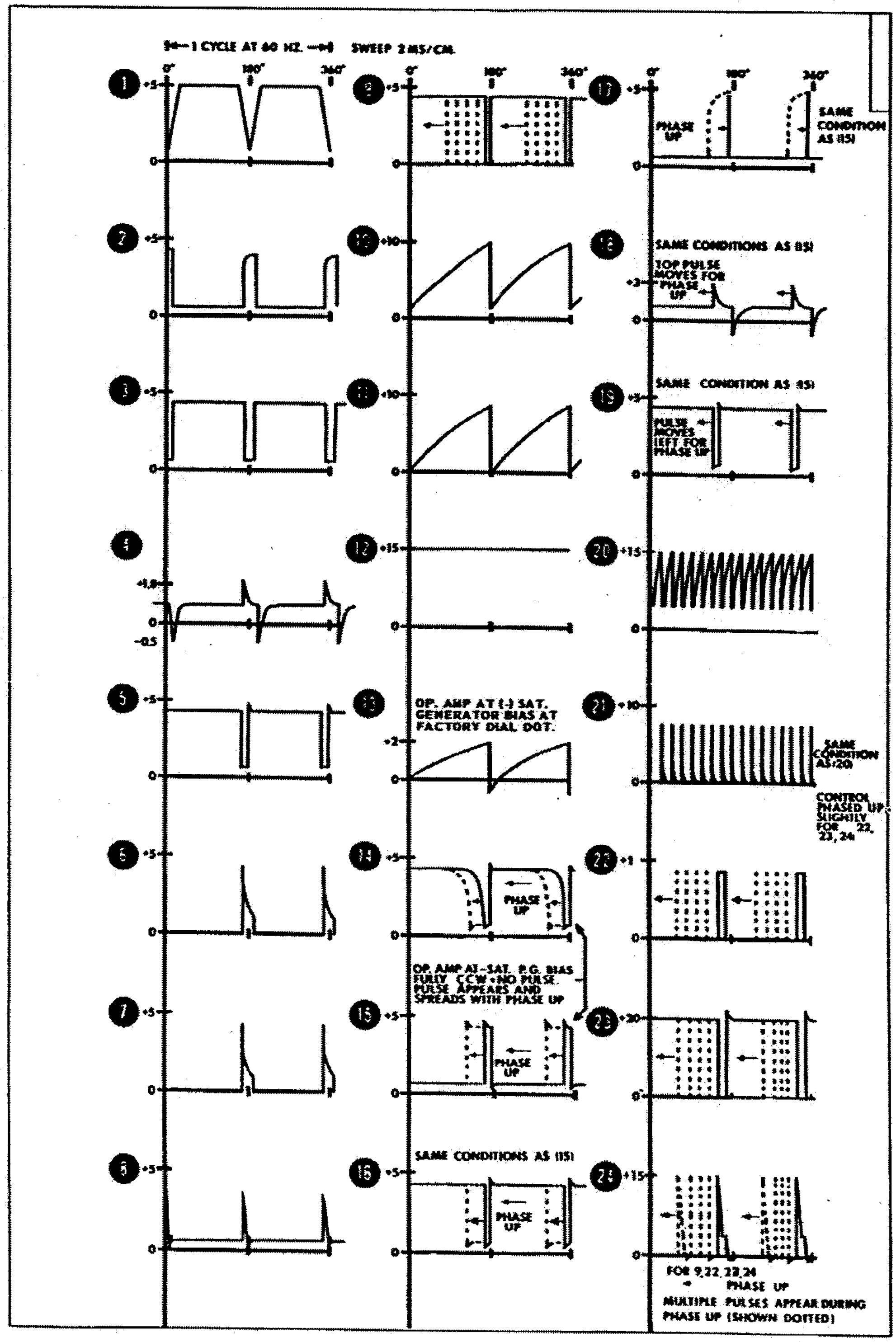
Mark III Schematic With Test Points

Figure 2

Test Points

The schematic drawing for the basic Mark III control, Figure 2, on the preceding page is marked with reference points of 1 through 24. The following waveforms, Figure 3, pictures the signal which should be observed at each of these points.

Figure 3 **Test Point Waveforms**



Electrical Noise Interference Modification

The following instructions cover a means of modifying the Mark III controller to reduce the possibility of a runaway condition caused by excessive transients on the AC incoming lines to the controller. These types of transients are typically caused by rectifier type DC drives connected to the plant AC distribution system.

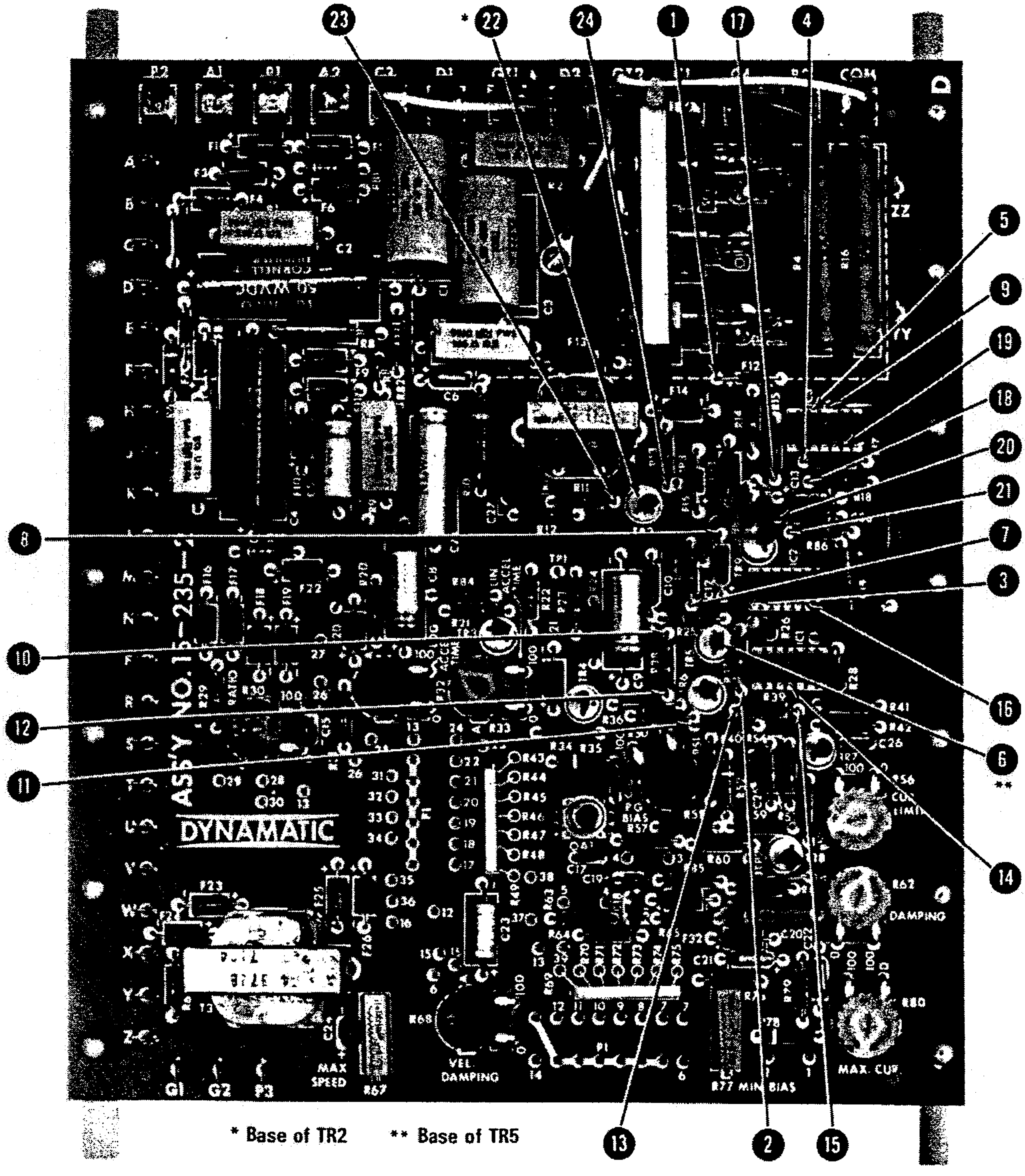
This modification removes the automatic zero sync pulse from the controller. This pulse is generated at the zero crossing of the AC line and is used as a minimum pulse for inverting. This pulse is illustrated at points 7 and 8 in the Test Point Waveforms. The Pulse Generator Bias, when at the factory dial dot setting, places a minimum phase-up pulse well ahead of this automatic zero pulse; therefore, when this automatic pulse is removed the Pulse Generator Bias ensures that there will be a minimum pulse for inversion. If the Pulse Generator Bias is mis-adjusted and no automatic zero pulse is present, the control will not invert properly.

The automatic zero pulse circuit is affected by zero-going line transients, which the circuit detects as zero crossings of the AC line. When the circuit detects what it thinks is a zero crossing, it emits a zero sync pulse not at zero. This proceeds to fire the SCR's at the wrong phase angle, normally causing a runaway condition.

The removal of the automatic pulse allows the control to operate on noisy lines without improper firing of the SCR's. If a line is extremely deteriorated, some jitter can be caused by the average value of line voltage changing. This can normally be damped out by the damping circuit adjustment pot (R62).

The mechanics of the modification are simple. A capacitor is removed from the automatic zero pulse path. The following steps should be taken in making the modification. (Note: Location of the components C12 and R27 on the printed circuit board in the following instructions can be made by referring to the illustration).

1. To determine if the modification will eliminate the runaway condition from the control and jumper out resistor R27 (located at point 7 in the Figure 4)with a small clip jumper. Apply power and determine if runaway condition has been eliminated.
2. If the runaway condition is eliminated by Step 1, remove the power from the control and then remove the clip jumper in Step 1. Remove capacitor C12 (located at point 8 in the Figure 4) from PCB by clipping with wire cutters or unsoldering. This will complete the modification.
3. If some speed jitter is present, which could be caused by an extremely deteriorated AC line, turn the Damping Pot adjustment (R62) in a clockwise direction until jitter is minimized.



* Base of TR2 ** Base of TR5

Figure 4 **View of Mark III PCB 15-235-2**

VI. Theory

The Mark III controller is, basically, the electronic portion of an eddy-current speed control system. The electronic circuits contained in this controller are connected and packaged in such a way as to provide maximum flexibility.

This control system utilizes feedback, or closed loops to linearize and stabilize its performance characteristics. A block diagram of a generalized closed-loop system is shown in Figure 5. The reference input sets the desired level of the controlled quantity. The controller provides the power, or energy, to modify the quantity to be controlled. The error detector determines if the actual level is high or low with respect to the reference level and feeds this information to the controller, which then modifies the controlled quantity accordingly.

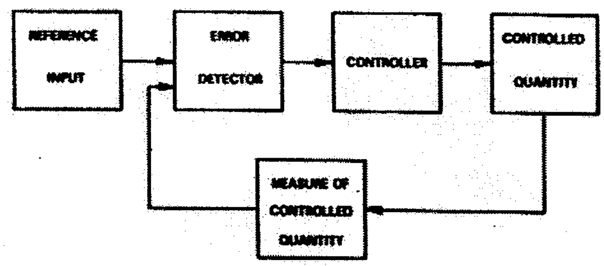


Figure 5 **Generalized Closed Loop System**

An example of a closed-loop system used in the controller is the basic velocity control loop shown in Figure 6. Inspection shows the **Controlled Quantity** is shaft velocity, the **Reference Input** is a potentiometer, the **Error Detector** is a summing amplifier. The **Controller** is a combination of the power amplifier, the motor and eddy-current clutch. **Measure** of the **Controlled Quantity** is accomplished by means of the tachometer generator, which produces an output voltage proportional to the shaft velocity.

In the operation of this system, the summing amplifier detects any difference between the desired speed (speed reference) and the actual speed.

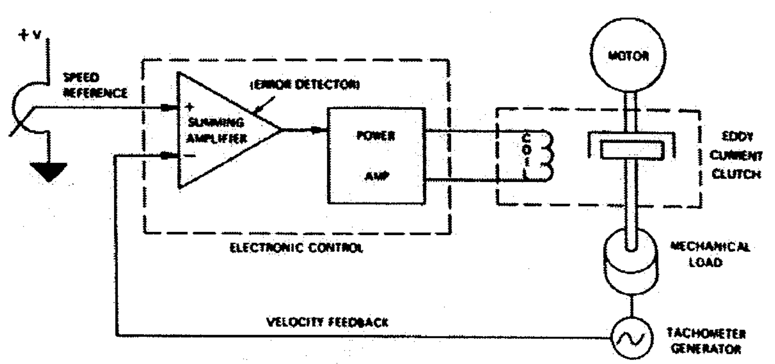
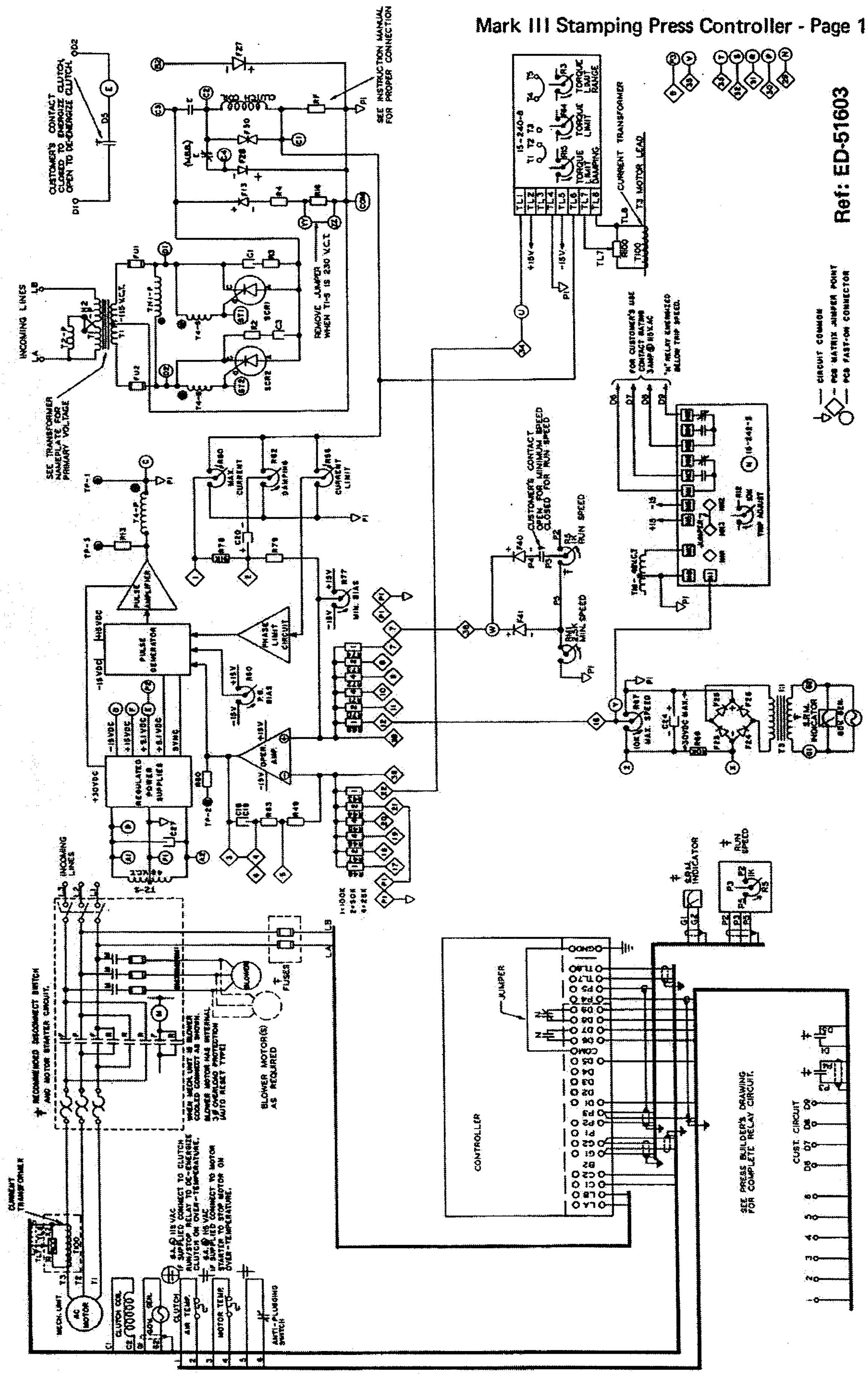


Figure 6 **Basic Velocity Control Loop**



Schematic and Connection Diagram

Figure 7

This difference is fed to the power amplifier, which modulates the clutch coil current. If the speed is too low, the coil current is increased, causing the eddy-current clutch to transmit more torque to the load. This results in an acceleration of the load shaft, which brings the speed up to the desired point. The opposite effect takes place for the case where the speed is too high.

In addition to the functions shown in the simplified block diagram, this universal control has many other features. Some of these are: Current feedback circuits for stability, current limiting circuits for coil protection, regulated power supplies, isolation transformers for safety, reliability and noise immunity, and programable reference circuits for universal applications.

The schematic diagram shown in Figure 7 shows all electronic functions of the controller. Each section will be described.

Power Supplies

Transformer T2 provides 48 VAC C.T. for the regulated power supplies. The voltages shown, except for the unregulated +30 VDC, are obtained by zener regulators. This power supply has 30 ma of power available from the ±15 VDC for external electronic functions.

Operational Amplifier (Summing Amplifier)

This amplifier can accept a multitude of inputs from sources between -10 and +10 VDC. The resistors R69 to R74 and R43 to R48 provide balanced summing inputs to the positive (+) and negative (-) summing junctions of the amplifier. A positive voltage applied to the positive summing inputs causes the amplifier output to increase positively. A negative voltage to the positive summing inputs will cause the amplifier output to move in the negative direction. The converse is true for the negative summing inputs. The gain of the amplifier is a function of the ratio of the feedback resistors R63 and R49 to the input resistors at the summing inputs. The Minimum Bias potentiometer R77 provides a means of setting the minimum operating point of the controller.

The output of the summing amplifier provides an input to the pulse generator, which is the first stage of the power amplifier. Figure 8 shows a simplified schematic of the power amplifier.

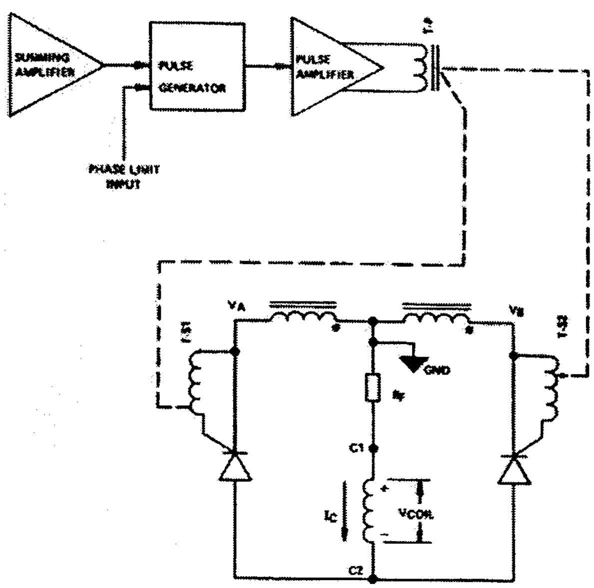


Figure 8 Simplified Schematic Power Amp

Power Amplifier

The power amplifier utilizes a phase control technique with a pair of thyristors (SCR's) connected in a full-wave center-tapped bridge circuit. In simplified form, the SCR's may be thought of as power switches which willl stay in the off state until gated by a firing pulse. If the firing pulse occurs when the SCR has a positive anode voltage, the SCR will turn on and stay on until the current through the device goes to zero. This is known as commutating the device off. The SCR's switch their cathode voltage (VA & VB) to the coil load at varying electrical degrees, as shown in Figure 9.

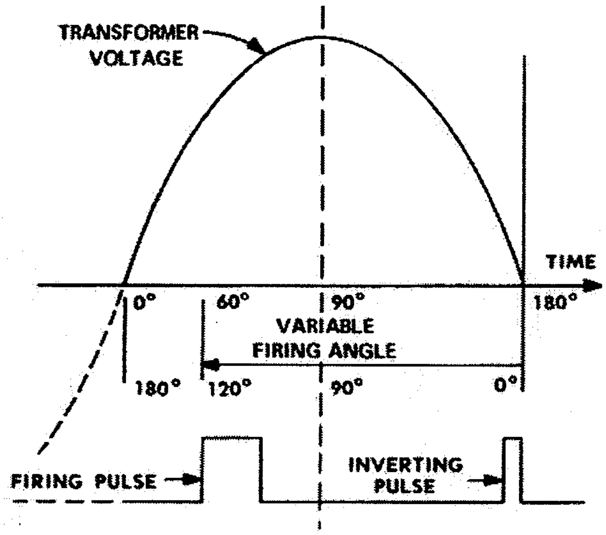


Figure 9 SCR Firing Waveform

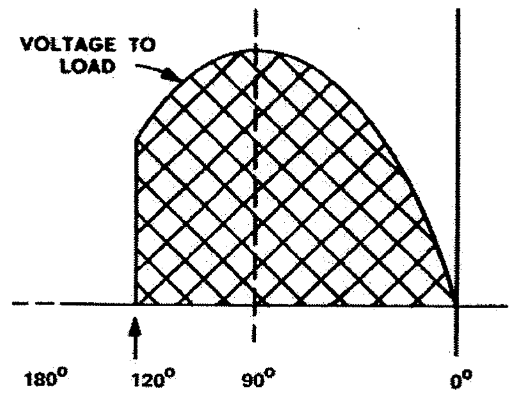


Figure 10 Resistive Load

In Figure 10 the SCR is turned on for 120° in the cycle and it stays on until the anode current goes to zero. This picture is true for a resistive load. The waveforms shown in Figure 11 show the load voltage going negative (shaded portions of the curves). This occurs in the case of an inductive load such as the eddy-current coil. When the transformer voltage reaches zero, the current flowing in the coil represents an energy equal to 1/2 LI^2. This energy generates a voltage of a magnitude and direction to maintain the current flowing in the coil. The result is that the coil voltage will follow the sinusoidal transformer waveform in the negative direction until the next SCR is turned on.

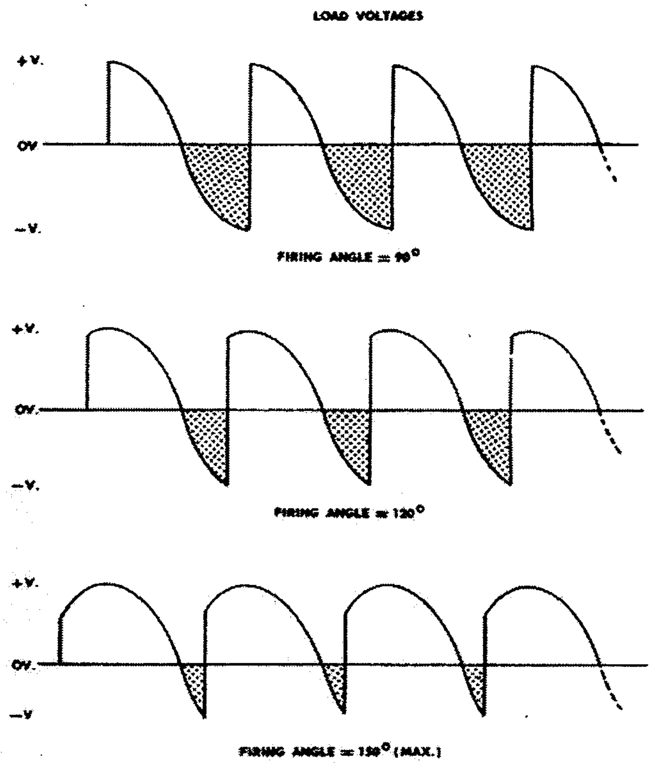


Figure 11 **Inductive Load**

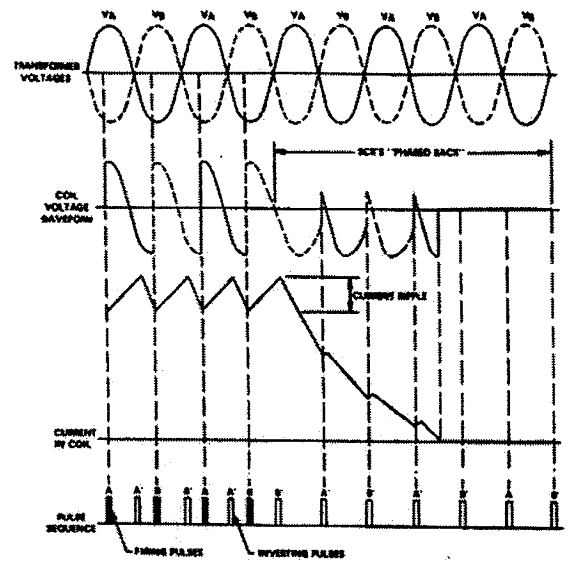


Figure 12 **Pulse Sequence**

Figure 12 shows what happens when the SCR's firing pulses are phased back (firing angle is zero). The load voltage remains mostly negative. The slight positive peaks occur when each SCR is fired in turn by the inverting pulses while their anodes are slightly positive. This causes the load waveform to follow each anode excursion into the negative region until the coil energy is dissipated. The inverting pulses, which are shown in Figures 9 and 12 are merely stationary minimum firing pulses. They make certain a pulse will always be present in the phased back condition. This insures that the SCR will fire at a slightly positive voltage (Figure 12) and continue to conduct while the transformer voltage and load voltage are negative (inverted). SCR conduction while the transformer voltage is negative provides a fast decay of energy from the coil by pumping this energy back into the power lines. This **Inversion** of coil energy results in a fast "Down Response Time" for coil current decay. Since the torque response follows current, this provides an improved down time for total system response.

Both the moving firing pulses and the stationary inverting pulses are generated by the pulse generator. The transfer function of this pulse generator is shown in Figure 13. The inputs to the pulse generator are the summing amplifier output and the phase limit circuit. The firing angle and therefore the voltage output of the SCR bridge will follow the operational amplifier output. The pulse amplifier raises the power level of the pulse generator output to drive the pulse transformer which fires SCR1 and SCR2.

The additional power circuit components shown in Figure 7 are described functionally below: R3-C1 and R2-C3 provide a shunt path across the SCR's for dv/dt supression. F13, R4, and R16 provide a minimum current for SCR latching. F30 is a supressor across the clutch coil. F28 is switched across the clutch coil in the power-off mode to provide a decay path for the coil energy, thus protecting both the relay contacts and the coil. RF1 and RF2 provide a low resistance in series with the clutch or brake coil. The voltage across this resistance is proportional to the clutch or brake current, and provides a current feedback sensor. The remaining E relay contacts switch the power circuit from the clutch to the brake (if used) when the E relay is de-energized.

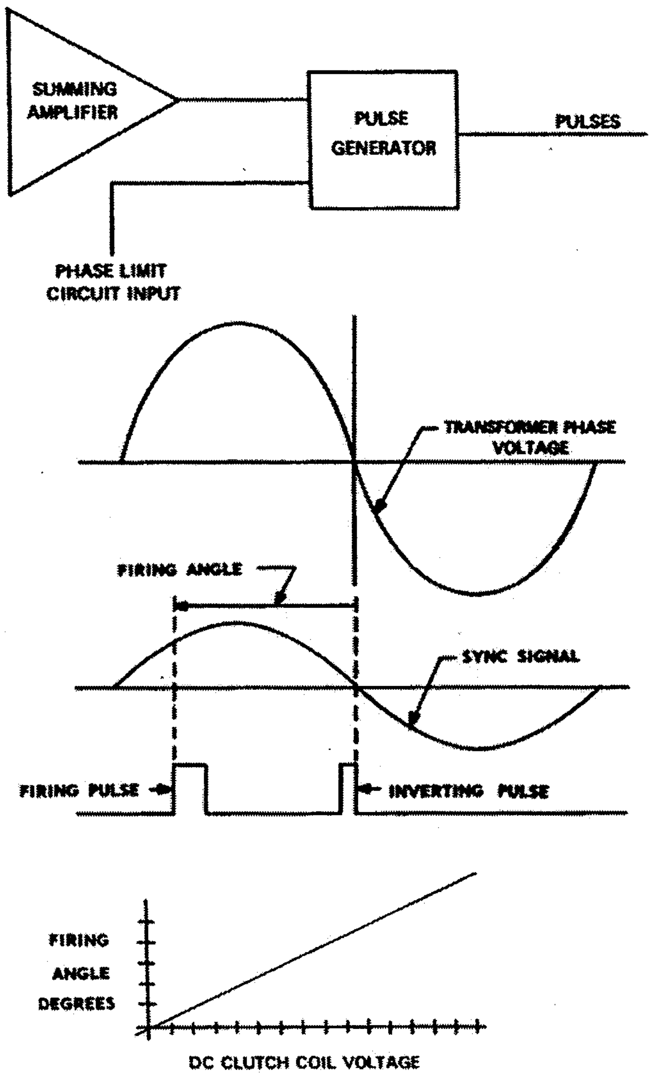


Figure 13 Pulse Generator Transfer Function

Phase Limit Circuit

The phase limit circuit provides a means of adjusting the maximum output current of the controller. Potentiometer R56 is across the feedback resistors and sets the current feedback signal that is fed to the phase limit comparator circuit. When the coil current exceeds the set level, the comparator trips and the phase limit feeds a negative signal to the pulse generator. This signal overrides the operational amplifier input and limits the pulse generator output and, thus, the coil current.

Current Feedback Circuits

The Maximum Current Potentiometer R80 and the Damping Potentiometer R62 are across the current feedback resistors. R80 provides a means of proportional current feedback. This is used in current controls and to stabilize various specialized control systems. In general, the use of current feedback provides greater stabilization at the expense of system gain.

The Damping potentiometer R62 provides an AC coupled current feedback path. This provides for an adjustable dynamic stabilization with no degeneration in static gain or regulation. This provides a system with both high regulation and stable operation.

Velocity Feedback Circuit

The standard velocity feedback circuit utilizes an internal AC tachometer generator. This AC tach signal is isolated by transformer T3, which feeds the rectifier and filter circuit made up of diodes F23 to 26 and resistors R66, R67, and capacitor C24. The voltage across potentiometer R67 is adjusted to match the tachometer feedback to the reference voltage. Decreasing this voltage increases the output speed of the closed-loop velocity control, thus this potentiometer is called the Maximum Speed potentiometer.

VII Control Modifications

A. Torque Limit Modification

1. Torque Limit Description

This circuit is intended to prevent output motor torque from exceeding some preset value. The range of adjustment is from 75% to 150% of rated motor torque. An external current transformer of the 64-20 type with an external 7.5 ohm load resistor is provided.

The Torque Limit circuit operates as a comparator circuit phasing back the main eddy-current control when the motor current exceeds some value set by the Torque Limit pot.

The sharpness of the cutoff, or phase-back, is determined by the Torque Limit Range pot and a jumper. The dynamic performance is adjustable from over to under-damged by the Torque-Limit Damping pot. It is normal on stamping presses to set the pot to allow 150% rated main motor current, during the initial acceleration of the flywheel from rest.

2. Torque Limit Theory

In normal operation, the Torque Limit circuit output is clamped to zero volts when the voltage from the Torque Limit pot exceeds the motor current signal voltage. The output of the operational amplifier is clamped slightly negative by the feedback diode and this negative drop is cancelled by the diode in the forward path. When the operational amplifier is in its linear region, the feedback diode is reverse-biased and the drop across the diode in the forward path is compensated for, since the linear feedback is taken from the cathode of this diode. The resistor in series with the arm of the Torque Limit Range pot is included to provide some protection against accidental grounding of the output.

The operational amplifier is brought into its linear region when the motor current signal voltage exceeds the voltage from the Torque Limit pot. The ratio of summing resistors for the motor current signal and the Torque Limit pot is such that the full range (0-150% of motor current) of the current transformer may be utilized. The resistor from the diode bridge to common minimizes variation of the diode threshold voltage with temperature. The filter in the motor current path has a breakpoint at 10 radians.

The Torque Limit Damping pot is connected to the clutch current feedback resistor and provides current rate feedback for stabilization when the operational amplifier is in its linear region.

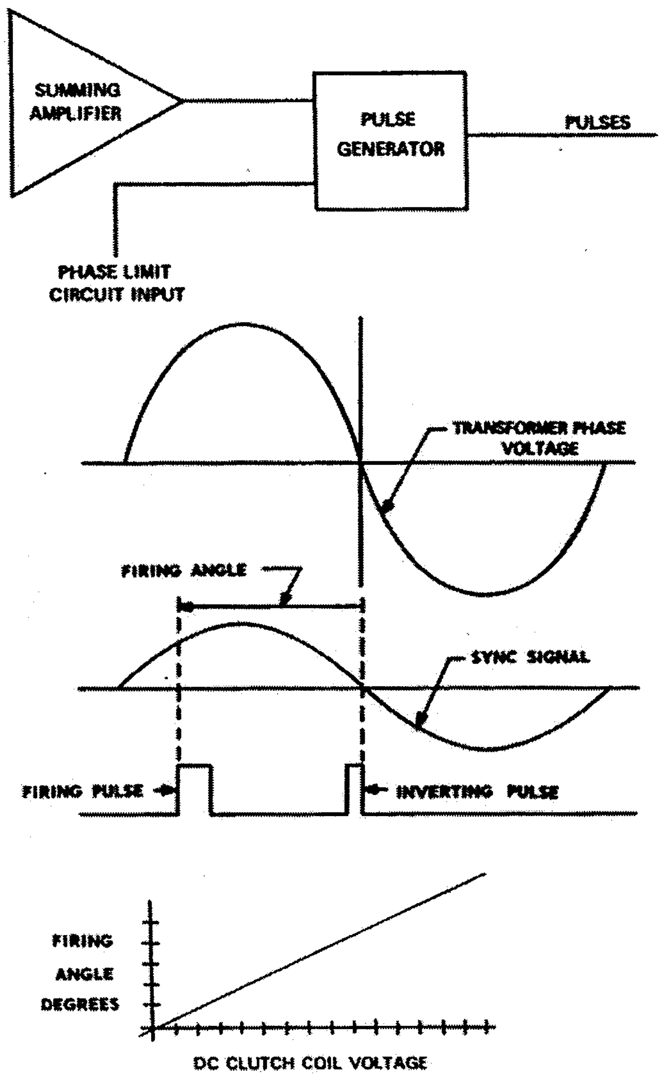


Figure 13 Pulse Generator Transfer Function

Phase Limit Circuit

The phase limit circuit provides a means of adjusting the maximum output current of the controller. Potentiometer R56 is across the feedback resistors and sets the current feedback signal that is fed to the phase limit comparator circuit. When the coil current exceeds the set level, the comparator trips and the phase limit feeds a negative signal to the pulse generator. This signal overrides the operational amplifier input and limits the pulse generator output and, thus, the coil current.

Current Feedback Circuits

The Maximum Current Potentiometer R80 and the Damping Potentiometer R62 are across the current feedback resistors. R80 provides a means of proportional current feedback. This is used in current controls and to stabilize various specialized control systems. In general, the use of current feedback provides greater stabilization at the expense of system gain.

The Damping potentiometer R62 provides an AC coupled current feedback path. This provides for an adjustable dynamic stabilization with no degeneration in static gain or regulation. This provides a system with both high regulation and stable operation.

Velocity Feedback Circuit

The standard velocity feedback circuit utilizes an internal AC tachometer generator. This AC tach signal is isolated by transformer T3, which feeds the rectifier and filter circuit made up of diodes F23 to 26 and resistors R66, R67, and capacitor C24. The voltage across potentiometer R67 is adjusted to match the tachometer feedback to the reference voltage. Decreasing this voltage increases the output speed of the closed-loop velocity control, thus this potentiometer is called the Maximum Speed potentiometer.

VII Control Modifications

A. Torque Limit Modification

1. Torque Limit Description

This circuit is intended to prevent output motor torque from exceeding some preset value. The range of adjustment is from 75% to 150% of rated motor torque. An external current transformer of the 64-20 type with an external 7.5 ohm load resistor is provided.

The Torque Limit circuit operates as a comparator circuit phasing back the main eddy-current control when the motor current exceeds some value set by the Torque Limit pot.

The sharpness of the cutoff, or phase-back, is determined by the Torque Limit Range pot and a jumper. The dynamic performance is adjustable from over to under-damged by the Torque-Limit Damping pot. It is normal on stamping presses to set the pot to allow 150% rated main motor current, during the initial acceleration of the flywheel from rest.

2. Torque Limit Theory

In normal operation, the Torque Limit circuit output is clamped to zero volts when the voltage from the Torque Limit pot exceeds the motor current signal voltage. The output of the operational amplifier is clamped slightly negative by the feedback diode and this negative drop is cancelled by the diode in the forward path. When the operational amplifier is in its linear region, the feedback diode is reverse-biased and the drop across the diode in the forward path is compensated for, since the linear feedback is taken from the cathode of this diode. The resistor in series with the arm of the Torque Limit Range pot is included to provide some protection against accidental grounding of the output.

The operational amplifier is brought into its linear region when the motor current signal voltage exceeds the voltage from the Torque Limit pot. The ratio of summing resistors for the motor current signal and the Torque Limit pot is such that the full range (0-150% of motor current) of the current transformer may be utilized. The resistor from the diode bridge to common minimizes variation of the diode threshold voltage with temperature. The filter in the motor current path has a breakpoint at 10 radians.

The Torque Limit Damping pot is connected to the clutch current feedback resistor and provides current rate feedback for stabilization when the operational amplifier is in its linear region.

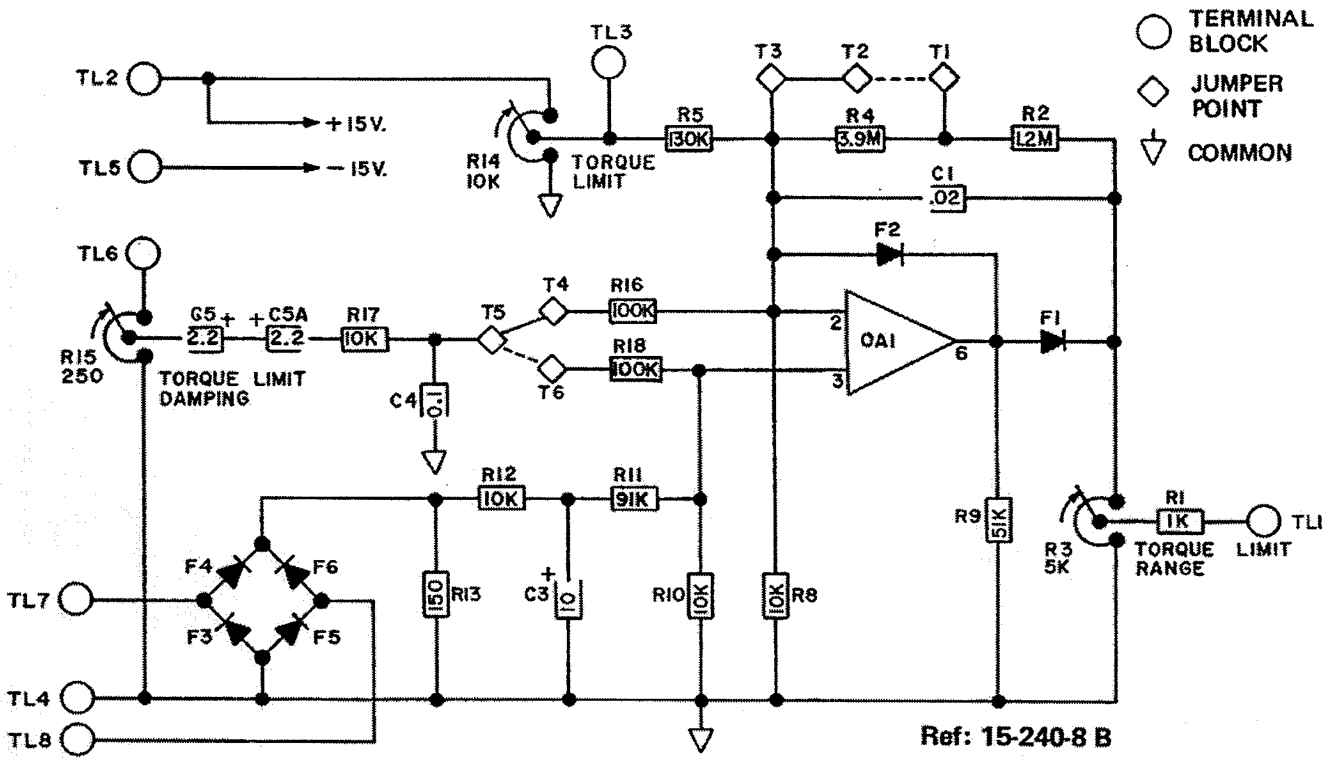


Figure 14 Torque Limit Modification

B. Speed Trip Modification

1. Speed Trip Description

This circuit provides a relay transfer output (both NC and NO contacts available) upon sensing a pre-set absolute voltage input. The absolute trip level is set by an internal pot adjustment. The allowable input voltage range is ± 10 volts on the unfiltered inputs and 0 to −10 volts on the filtered inputs. On a stamping press the normal input at which the trip operates is 1 volt. (Approx. 50 RPM of flywheel).

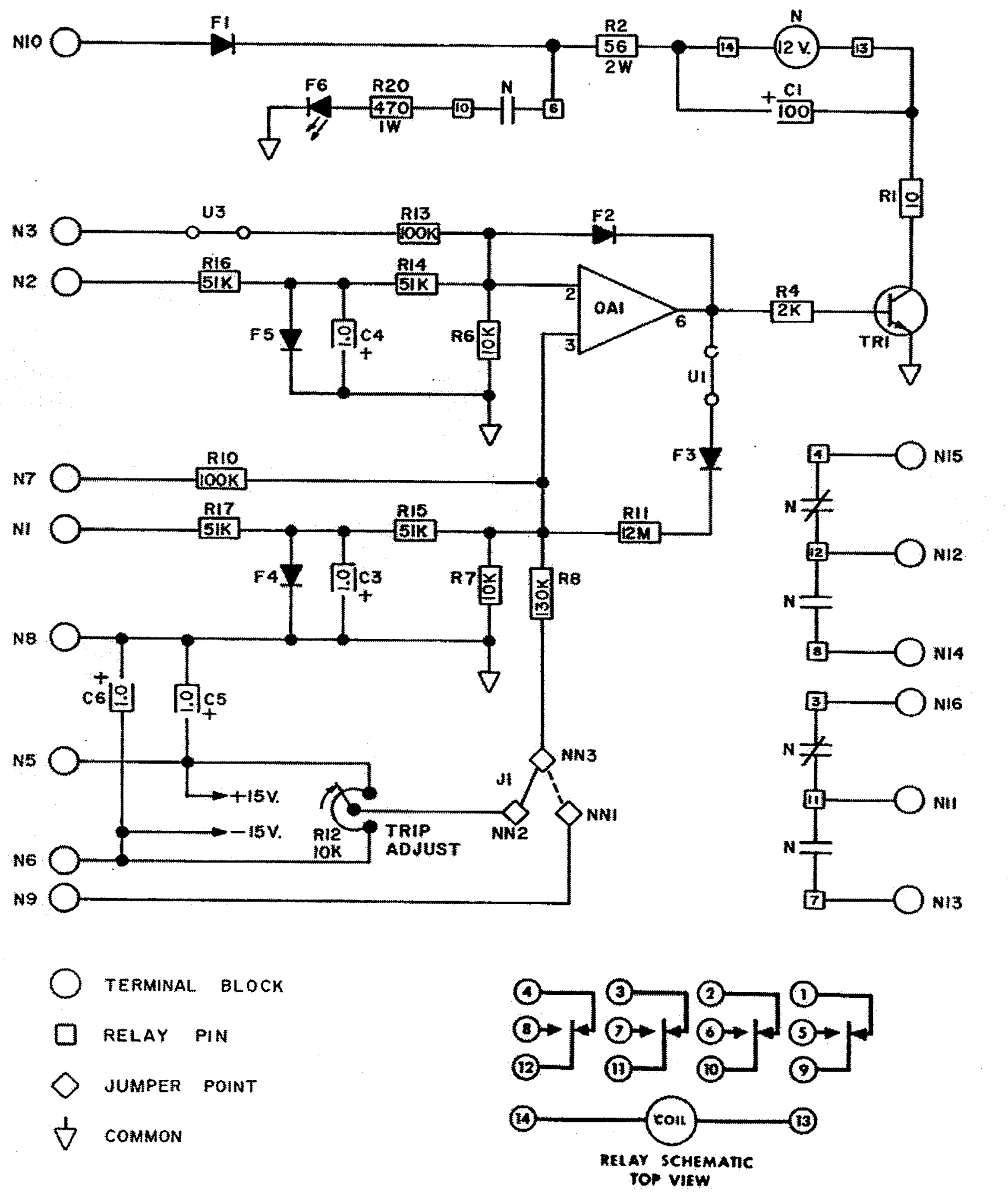
2. Speed Trip Theory

One filtered and one unfiltered input is available to each summing junction of the operational amplifier. Both filtered inputs require a negative polarity signal and are intended to be used with the maximum speed circuit of the main eddy-current control. Protection against polarity reversal on the filtered inputs is provided by diodes shunting the filter capacitors.

The internal Trip Adjust pot is set to allow the input signal to turn the relay on depending upon desired operation.

The diode in the negative feedback path limits the negative swing of the operational amplifier to - 0.7 volts to protect the transistor from excessive reverse bias.

The relay driver consists of a transistor switch which energizes the relay coil when the operational amplifier output swings positive. The collector resistor limits the peak collector current through the capacitor, which provides filtering and suppression for the relay coil. The resistor in series with the diode limits the steady state dissipation of the relay coil.



Ref: 15-242-2C

Figure 15 Speed Trip Modification

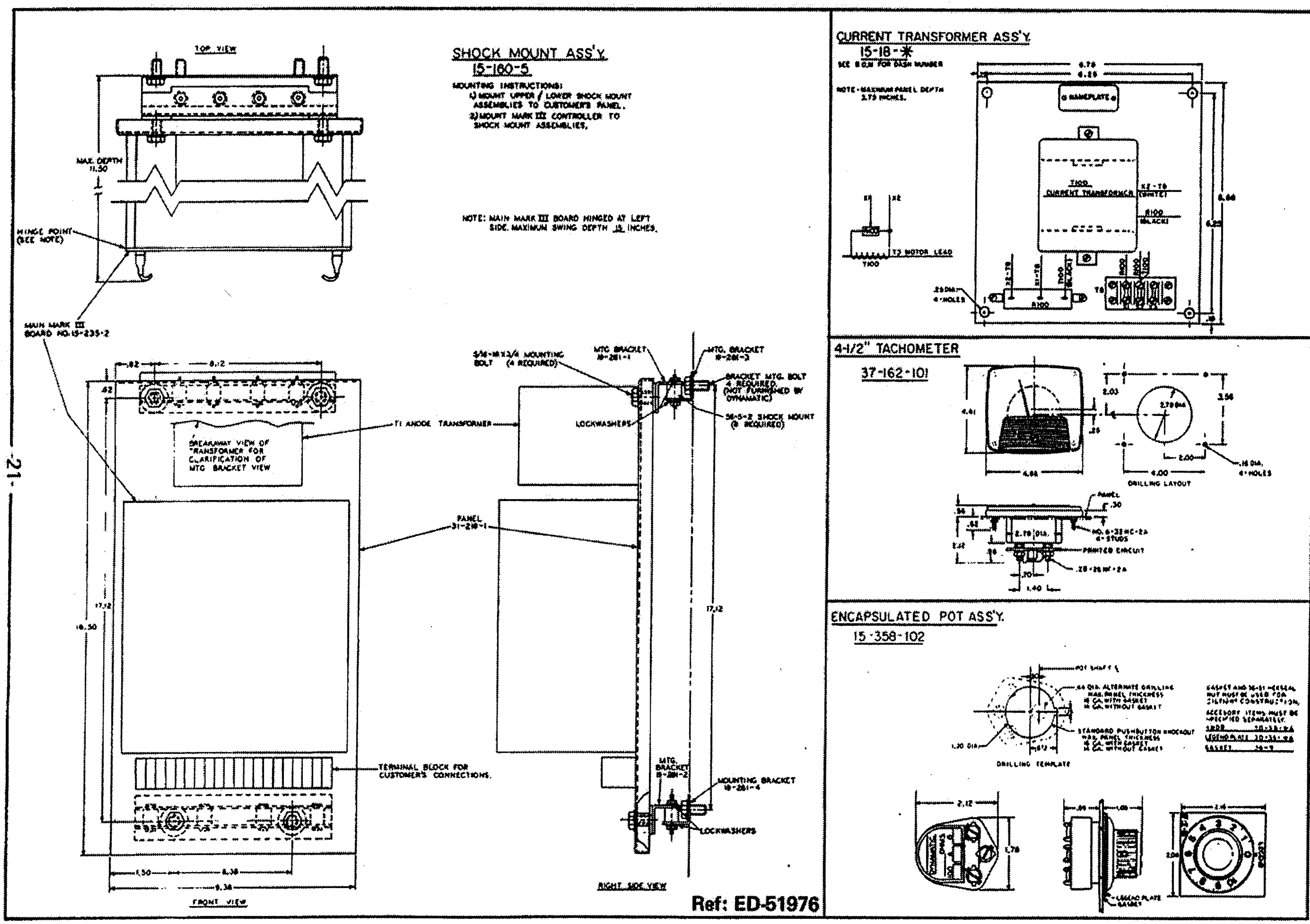


Figure 16

Control Mounting and Loose Items

DRIVE SOURCE INTERNATIONAL INC.
7900 Durand Avenue, P.O. Box 0361,
Sturtevant, Wisconsin, U.S.A. 53177
Tel.: 262.554.7977 • Fax: 262.554.7041
Toll Free: 800.548.2169
E-mail: drivesourceusa.com

092-11001, 12-80, 2.5M, PS
Litho in U.S.A.