GEK-24916A

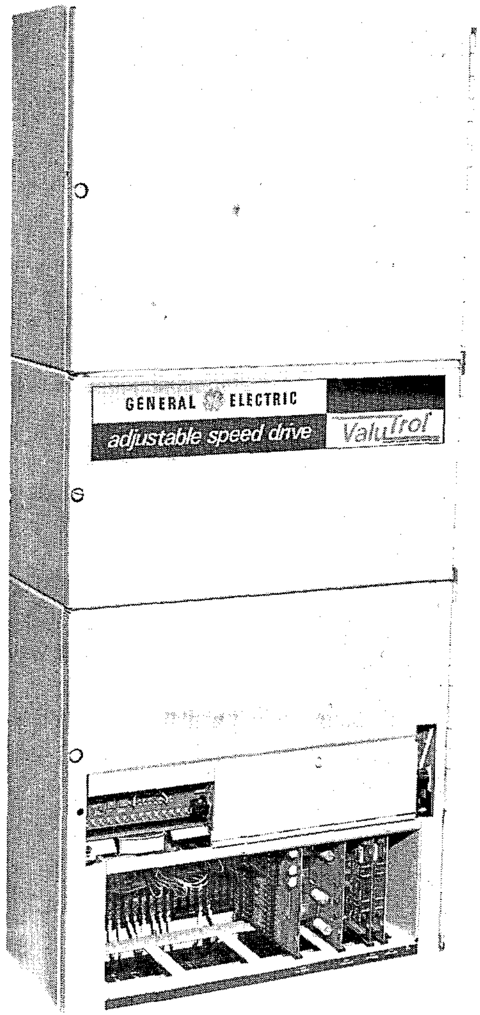
INSTRUCTIONS

maxspeed®

CRANE DRIVE

FULL WAVE, REGENERATIVE

INSTALLATION - OPERATION - MAINTENANCE



(Photo MG-5368-6)

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to General Electric Company.

GENERAL ELECTRIC

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INTRODUCTION

This instruction book contains helpful suggestions for placing Maxspeed Crane* Drive equipment in service. It contains general information about drive operation and maintenance.

The operator and maintenance personnel should have access to a copy of this instruction book.

Additional instructions are included in the supplementary instruction publications and diagrams included in the instruction folder with the equipment.

RECEIVING, HANDLING, AND STORAGE

RECEIVING

The equipment should be placed under adequate cover immediately upon receipt. As packing cases are not suitable for out-door or unprotected storage. Each shipment should be carefully examined upon arrival and checked with the packing list. Any shortage or damage should be reported promptly to the carrier. If required, assistance may be requested from General Electric Company Speed Variator Products Operation, Erie, PA. When seeking assistance, please use requisition number and model number to identify the equipment. Telephone (814) 455—3219.

HANDLING

Wall mounted power units may be transported by lift trucks with the forks completely under the base using care that the unit does not tip.

Floor mounted power units have lifting lugs or holes for lifting bars so that crane hooks may be used to pick up the unit. Spreader bars should be used as required.

STORAGE

If the equipment is not to be installed immediately, it should be stored in a clean, dry location at ambient temperatures from —20°C (—4°F) to +55°C (131°F). The surrounding air must be free of chemical and electrically conductive or corrosive contaminants.

Precautions should be taken to prevent condensation from forming within the equipment enclosure. If the storage environment exceeds a 15°C (27°F) drop in temperature at 50% humidity over a 4-hour period, a space heater should be installed inside each enclosure to prevent condensation. (A 100 watt lamp can sometimes serve as a substitute source of heat). Higher humidities with smaller temperature changes will also cause condensation.

Condensation occurs when air containing some moisture is cooled below its dew point. The dew point represents saturation of the air, and is the temperature at which the moisture starts to condense into water. It is not a fixed temperature but rather is related to the initial temperature of the air and its relative humidity at that temperature. The amount of moisture that can be held in the air is related to the air temperature. The following examples illustrate some of these relationships.

TABLE I
Relationship Between Air Temperature, Relative Humidity and Dew Point

AIR TEMP °F	°C	RELATIVE HUMIDITY %	WGT. OF MOISTURE IN 1 LB. OF DRY AIR. GRAINS	DEW POINT °F	°C
104	40	100	345	104	40
104	40	80	270	97	36
104	40	40	130	75	24
104	40	10	32	37	3
50	10	100	54	50	10
50	10	80	42	43	6
50	10	40	21	25	4

In industrial drives, condensation is a possibility in applications where air temperature changes are large and rapid and/or the air is moist. For example, an outdoor crane operating in sunshine on a winter day, which then is shut down and parked in the shade will experience a rapid drop in temperature. This can result in condensation inside the equipment. Adding heat to keep the air temperature above its dew point can prevent condensation.

If storage temperatures below —20°C (—4°F) are likely to be present then auxiliary heat should be added in each enclosure to maintain temperature at or above —20°C. For assistance in heater size selection, contact General Electric Company.

When a drive that has been in operation is shut down for either a short or extended period of time, it is recommended that environmental conditions be maintained the same as when in operation. Power, ventilation or heating and air-conditioning (if used) should be left on during downtime to prevent large changes in temperature and possible moisture condensation.

*Trademark of General Electric U.S.A.

SAFETY FOR PERSONNEL AND EQUIPMENT

The following paragraphs list some general safety reminders and safety recommendations to be followed when operating or installing this equipment.

WARNING

DENOTES OPERATING PROCEDURES AND PRACTICES THAT MAY RESULT IN PERSONAL INJURY OR LOSS OF LIFE IF NOT CORRECTLY FOLLOWED.

COLOR — BLACK OR WHITE LETTERING ON RED FIELD.

CAUTION

DENOTES OPERATING PROCEDURES AND PRACTICES THAT, IF NOT STRICTLY OBSERVED, MAY RESULT IN DAMAGE TO OR DESTRUCTION OF THE EQUIPMENT.

COLOR — BLACK LETTERING ON AMBER FIELD.

NOTE

DENOTES AN OPERATING PROCEDURE OR CONDITION WHICH SHOULD BE HIGHLIGHTED.

COLOR — BLACK LETTERING ON A WHITE FIELD.

WARNING

IMPROPER LIFTING PRACTICES CAN CAUSE SERIOUS OR FATAL INJURY.

LIFT ONLY WITH ADEQUATE EQUIPMENT AND TRAINED PERSONNEL.

WARNING: HIGH VOLTAGE

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. CIRCUIT BREAKERS, IF SUPPLIED AS PART OF THE TOTAL SYSTEM, MAY NOT DISCONNECT ALL POWER TO THE EQUIPMENT. SEE SYSTEM ELEMENTARY DIAGRAMS. WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGE TO GROUND WILL BE PRESENT AT MANY POINTS. WHEN INSTRUMENTS SUCH AS OSCILLOSCOPES ARE USED TO WORK ON LIVE EQUIPMENT, GREAT CAUTION MUST BE USED.

WHEN ONE OF THE INSTRUMENT LEADS IS CONNECTED TO THE CASE OR OTHER METAL PARTS OF THE INSTRUMENT, THIS LEAD SHOULD NOT BE CONNECTED TO AN UNGROUNDED PART OF THE SYSTEM UNLESS THE INSTRUMENT IS ISOLATED FROM GROUND AND ITS METAL PARTS TREATED AS LIVE EQUIPMENT. USE OF AN INSTRUMENT HAVING BOTH LEADS ISOLATED FROM THE CASE PERMITS GROUNDING OF THE CASE EVEN WHEN MEASUREMENTS MSUT BE MADE BETWEEN TWO LIVE PARTS.

CAUTION

DO NOT REMOVE PRINTED CIRCUIT CARDS FROM THE EQUIPMENT WHILE POWER IS APPLIED. THIS CAN DAMAGE THE EQUIPMENT.

NOTE

ALWAYS READ THE COMPLETE INSTRUCTIONS PRIOR TO APPLYING POWER OR TROUBLE SHOOTING THE EQUIPMENT. FOLLOW THE START UP PROCEDURE STEP BY STEP.

READ AND HEED ALL WARNING, CAUTION AND NOTE LABELS POSTED ON THE EQUIPMENT.

CAUTION

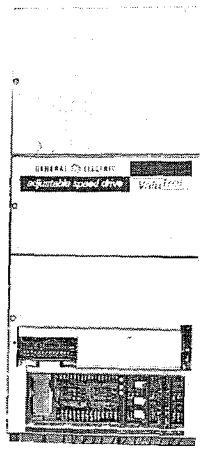
DO NOT REMOVE INPUT POWER FROM THE DRIVE UNTIL IT HAS FULLY EXECUTED A STOP SEQUENCE, AS THIS CAN DAMAGE THE DRIVE SYSTEM.

INSTALLATION

LOCATION

DC-SCR drive power units are suitable for most factory areas where other industrial equipment is installed. They should be installed and operated in well-ventilated areas with ambient temperatures ranging from 0°C (32°F) to 40°C (104°F) and relative humidities up to 90 percent. It should be recognized; however, that since the life expectancy of any electronic component decreases with increased ambient temperature, reduction of the ambient temperature will bring about extended component life. For example, longer component life should be expected if the ambient temperature is held between 20°C (68°F) and 30°C (87°F).

Proper performance and normal operational life can be expected by maintaining a proper environment for the drive system.



(Photo MG-5368-1)

FIG. 1 VALUTROL POWER UNIT

Environments which include excessive amounts of one or more of the following characteristics should be considered hostile to drive performance and life:

1. Dirt, dust and foreign matter.
2. Vibration and shock.
3. Moisture and vapors.
4. Temperature excursions.
5. Caustic fumes.
6. Power line fluctuations.
7. Electromagnetic interference (noise).

Totally enclosed power units should be positioned to permit heat radiation from all surfaces except the bottom; otherwise, the enclosure can be positioned as follows:

A wall mounted power unit enclosure (or floor mounted enclosure) may be placed side by side with another enclosure. Clearance at least equal to the width of the enclosure should be available in front so that the door may be fully opened for easy access.

WARNING

SOME POWER UNITS ARE FURNISHED WITH PARTIAL ENCLOSURES OPEN AT TOP AND BOTTOM. THESE ARE INTENDED ONLY FOR MOUNTING IN ANOTHER ENCLOSURE OR IN A CONTROL ROOM HAVING ACCESS BY QUALIFIED PERSONNEL ONLY.

EXPLOSIONS OR FIRES MIGHT RESULT FROM MOUNTING DRIVE POWER UNITS IN HAZARDOUS AREAS SUCH AS LOCATIONS WHERE INFLAMMABLE OR COMBUSTIBLE VAPORS OR DUSTS ARE PRESENT. DRIVE POWER UNITS SHOULD BE INSTALLED AWAY FROM HAZARDOUS AREAS, EVEN IF USED WITH DC MOTORS SUITABLE FOR USE IN SUCH LOCATIONS.

MOUNTING

Wall mounted enclosures may be mounted on any firm, reasonably flat, vertical surface.

NOTE

FOUR HOLES (ONE IN EACH REAR CORNER) ARE PROVIDED FOR MOUNTING THE POWER UNIT. THE BOTTOM LEFT HAND MOUNTING HOLE IS COVERED BY A WIRE BUNDLE. TO GAIN ACCESS TO THIS HOLE, PULL ON THE TAIL ATTACHED TO THE HARNESS AND IT WILL POP DOWN OUT OF THE WAY. AFTER THE POWER UNIT HAS BEEN INSTALLED, POP THE HARNESS BACK INTO PLACE.

An optional mounting arrangement is also available which consists of two external brackets (one at the top rear and one at the bottom rear of the power unit enclosure). Each bracket is fitted with two mounting holes for external mounting of the wall mounted enclosure.

CONNECTIONS

All internal electrical connections between components in DC-SCR drive power units are made at the factory by the General Electric Company.

Be sure to protect the interior panel mounted components and sub-assemblies from metal particles when cutting or drilling entrances for interconnecting wiring and cables.

If additional relay, contactors, or electrical solenoids are added in the proximity of the SCR equipment enclosure, RC suppression networks should be added across the coils. A series combination of a 220 ohm resistor and a 0.5 mfd capacitor in parallel with the relay coils is recommended for 115VAC control circuits.

NOTE

SOME SYSTEM TRANSFORMERS AND OTHER APPARATUS ARE SHIPPED SEPARATELY AND MUST BE MOUNTED AND CONNECTED TO THE SYSTEM.

WARNING

ALL MOTOR BASES AND EQUIPMENT ENCLOSURE HOUSINGS SHOULD BE CONNECTED TO THE FACTORY OR FACILITY EARTH GROUNDING SYSTEM.

NOTE

IT IS RECOMMENDED THAT THE DRIVE SYSTEM COMMON CIRCUIT BE GROUNDED AT ONLY ONE POINT. THIS MEANS THAT IF THAT DRIVE REFERENCE IS SUPPLIED BY A NUMERICAL CONTROL OR PROCESS INSTRUMENT WITH GROUNDED COMMON, THE DRIVE COMMON SHOULD NOT BE GROUNDED. IF A SEPARATE POWER TRANSFORMER IS USED AND IF THE SECONDARY OF THE TRANSFORMER MUST BE GROUNDED, IT IS RECOMMENDED THAT HIGH RESISTANCE GROUNDING BE USED. CONSULT THE FACTORY FOR DETAILS.

CAUTION

INSTALLATION WIRING MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND BE CONSISTENT WITH ALL LOCAL CODES. SECONDARIES OS 115 VOLT CONTROL TRANSFORMERS TYPICALLY HAVE ONE SIDE FUSED AND THE OTHER GROUNDED OR AVAILABLE FOR GROUNDING BY THE USER.

CAUTION

MEGGERING CAN DAMAGE ELECTRONIC COMPONENTS. DO NOT MEGGER OR HI—POT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS OPERATION, GENERAL ELECTRIC COMPANY.

CAUTION

DO NOT CONNECT ANY EXTERNAL CIRCUITS OTHER THAN SHOWN ON THE ELEMENTARY DIAGRAM, (SUCH AS AMMETERS ON THE SHUNT OR VOLTMETERS ON THE TACHOMETER) BECAUSE THE PERFORMANCE OF THE DRIVE SYSTEM MAY BE DEGRADED.

CAUTION

DO NOT USE POWER FACTOR CORRECTION CAPACITORS WITH THIS EQUIPMENT WITHOUT CONSULTING THE SPEED VARIATOR PRODUCTS OPERATION, GENERAL ELECTRIC COMPANY. DAMAGE MAY RESULT FROM HIGH VOLTAGES GENERATED WHEN CAPACITORS ARE SWITCHED.

Before power is applied to the drive system, checks should be made to see that all internal connections are tight, that plug in printed circuit cards in the optional regulator rack are fully seated and that all open relays and contactors operate freely by hand. Check that the equipment is clean and dry and that no metal chips are present.

MAINTENANCE

Periodically inspect and maintain the equipment protective devices (particularly air filters when supplied) per instructions in this section. Check all electrical connections for tightness; look for signs of poor connections and over heating (arcing or discoloration). Check for evidence of dirt, moisture, or corrosion and correct immediately.

FANS AND FILTERS

On force ventilated drives, the power unit contains a fan and perhaps an air filter in the intake of the enclosure and/or on equipment inside the enclosure.

Inspect the fan at regular intervals to see that it is operating properly. Check for excessive noise and vibration, loose fan blades and over heating of the motors. Keep the fan blades clean.

Clean and/or replace air filter as appropriate depending on the accumulation of dirt for the type supplied.

To clean metal filters, flush only with warm water, dry and recoat lightly with RP® Super Filter Coat or equivalent (light oil) or replace the filter.

Be sure to install filters with air flow direction as indicated on the filter.

DC MOTORS

Maintenance instructions covering brushes, commutator and lubrication are in GEK-2304 which is a part of the master system instruction book.

PRINTED CIRCUIT CARDS

Printed circuit cards normally do not require maintenance except to keep them clean and tightly secured to their respective terminal boards or tightly plugged in the optional modification rack receptacles. Clean as follows:

1. Dry Dust — Vacuum clean, then blow with dry filtered compressed air (low pressure supply).

2. Oily Dirt — Certain components (electrolytic capacitors, switches, meters, potentiometers and transformers can be damaged by solvent, so its use is not recommended. If absolutely necessary, use solvent sparingly on a small brush and avoid above components. Clean contact terminals with dry non-linting cloth after solvent has been used. Recommended solvents: Freon* RE or TF.

3. Corrision — If the card is badly contaminated or corroded, replace.

SILICON CONTROLLED RECTIFIERS

Keep SCR's and heatsink free from dirt, oil or grease, since any accumulation of dirt may cause overheating. Clean as follows:

1. Dry Dust — Vacuum clean, then blow with dry, filtered compressed air (low pressure).

CAUTION

SOLVENT CAN HARM NON—METAL COMPONENTS.

2. Oily Dirt — Wipe with dry or barely moist (with solvent) non-linting cloth. Repeat until cloth remains clean. All contact tips must be cleaned with dry non-linting cloth after solvent has been used. Recommended solvents: Freon* RE or TF.

CONTROL DEVICES

Inspect all relays and contactors at regular intervals and keep them free from dirt, oil or grease. Check for freedom of moving parts, corrosion, loose connection, worn or broken parts, charred insulation or odor, proper contact pressure and remaining wear allowance on contacts. Do not lubricate the contacts as lubrication shortens their life.

Both copper and silver contacts will become darkened and somewhat roughened in normal operation. This does not interfere with their performance, and does not indicate that the contacts should be filed. In general, contacts will not need attention during their normal life. But if prominent beads form on the surfaces due to severe arcing, the contact faces may be dressed with a fine file. Do not use sand paper or emery cloth.

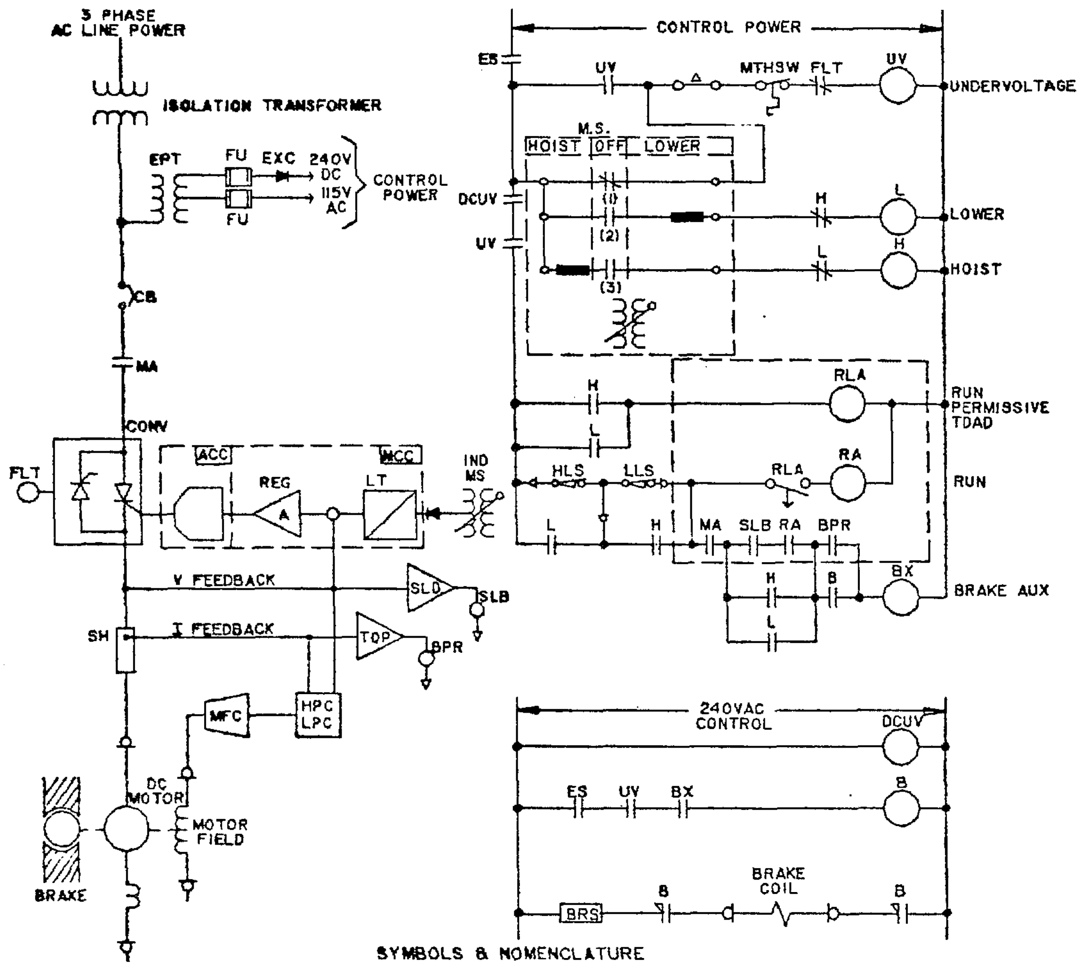
Any contact that is worn to the point where contact wipe or pressure is lost should be replaced. Contactor shunts which are badly frayed or broken should also be replaced.

Cleaning procedure is the same as previously given for SCR and heatsink.

*Trademark of E. I. DuPont Company.

TYPICAL ELEMENTARY

STANDARD CAB CONTROLLED HOIST DRIVE SYSTEM



SYMBOLS & NOMENCLATURE

o-Δ-o	— TERMINAL BOARD JUMPER WHICH MAY BE REPLACED BY AN EXTERNAL FUNCTION SUCH AS A LIMIT SWITCH OR AUXILIARY CONTACT	HPC, LPC	MOTOR FIELD PROGRAMMING FUNCTION
-D-	— COLLECTOR	LLS	— LOWER LIMIT SWITCH
A	— AMPLIFIER	LT	— LINEAR TIME
B	— BRAKE CONTACTOR	MA	— LINE CONTACTOR
BPR	— BRAKE PERMISSIVE RELAY	MFC	— MOTOR FIELD CONTROL
BRS	— BRAKE RESISTOR	MS	— MASTERSWITCH - INDUCTION TYPE
BX	— BRAKE AUXILIARY RELAY	MTHSW	— MOTOR THERMAL SWITCH
DCUV	— DC UNDERVOLTAGE	RA	— RUN RELAY
EPT	— EXCITER POWER TRANSFORMER	RLA	— RUN TIMER
EXC	— STATIC EXCITER	SH	— SHUNT
FLT	— FAULT RELAY	UV	— UNDERVOLTAGE RELAY
FU	— FUSE	SLB	— VOLTAGE RELAY
HLS	— HOIST LIMIT SWITCH	ES	— EMERGENCY STOP RELAY
CB	— CIRCUIT BREAKER	H	— HOIST RELAY
		L	— LOWER RELAY
		TQP	— TORQUE PROVING

© FIG. 2 TYPICAL SIMPLIFIED ELEMENTARY DIAGRAM

INSTRUCTION INFORMATION

The instruction folder furnished with the equipment includes detailed instructions and diagrams applicable for each specific drive system.

In addition to this general instruction, the folder includes instruction for the motor(s) and other components furnished. Start-up and troubleshooting guides are included. All instructions and the accompanying diagrams should be consulted before applying power to the system.

THE FOLLOWING INFORMATION IS OF PARTICULAR IMPORTANCE.

TYPES OF DIAGRAMS

Different types of control diagrams are provided for specific purposes. The type of control diagram is noted in the title block of each diagram sheet.

The two major types of diagrams are ***Elementary***, (sometimes called schematic) and ***Layout*** or ***Connection***.

The ***Elementary*** diagrams represent (in symbolic form) the fundamental operation and relationship of the electrical parts of a system. These diagrams are drawn so that the operation of the control system may be easily understood. Connections made between control devices and power devices within the enclosure are also shown in this type of diagram.

The ***Layout*** or ***Connection*** diagram, when supplied is one which shows the relative physical position of the devices as well as other electrical components located within the same enclosure.

The ***Elementary*** diagram also identifies adjustments, signals and test points. In this instruction book, adjustments are in special type. Example: ***FMAX*** (Maximum motor field adjustment).

Signals and test points are ***CAPITALIZED***, Example: CFB (Current Feedback).

PRINCIPLES OF OPERATION

MAXSPEED CRANE DRIVE DESCTIPTION

The Maxspeed Crane Drive System is a DC adjustable-voltage drive operating from an AC power source. The basic drive consists of a DC shunt wound motor, an SCR power conversion module operating on AC power and supplying adjustable voltage DC power to the DC motor, an AC/DC control panel and a master switch or pendant station for controlling direction of rotation and speed. In addition, the drive includes provision for a brake, normally magnetic shunt wound and spring-set, and limit switches. The control panel is furnished as a packaged unit complete with internal wiring and interconnections, plus terminals for external power and control leads. The enclosure doors are removable for increased accessibility. See Figure 2 for simplified crane drive elementary diagram.

The Maxspeed Drive is a speed control drive providing programmed speed versus load characteristics and smooth acceleration and deceleration independent of how rapidly the operator manipulates the controller. The Maxspeed Drive "number" refers to the programmed speed characteristic selected for the drive and is the percent of full load hoist speed at which the drive will operate in the hoisting direction at no-load. For example, the no-load hoisting speed of a Maxspeed 250 is 250 percent of full load hoist speed.

In the Maxspeed Drive no armature loop or field reversing contactors are required because reversing is accomplished statically. The motor armature is controlled by a three-phase static reversing phase-controlled rectifier, and the motor field is controlled by a static unidirectional phase-controlled rectifier.

To stop from a fast speed, the Maxspeed Drive decelerates the motor by regenerative braking before the mechanical brake is set. This saves wear on the brake and lessens the strain on the machinery.

The Maxspeed 100 Drive is a regulated speed control drive using the inherent characteristics of a shunt wound motor. The maximum no-load hoisting speed is approximately the same as full-load hoisting speed (See Figure 3) with the armature voltage being regulated. The throw of the masterswitch determines the direction and speed. Since the maximum speed is rated speed, no field weakening is required; therefore, there may be no motor field programmer in the Maxspeed 100, and the D-C motor field may be connected to a static exciter. The lowering speeds are approximately those shown in Figure 3.

The Maxspeed 175, 250 and 320 Drives have common speed versus load characteristics (See Figure 3); however, intermediate characteristics are provided to meet various applications. The curves in Figure 3 show the range of speeds from minimum throw of the masterswitch to full throw for each characteristic where speed is a function of

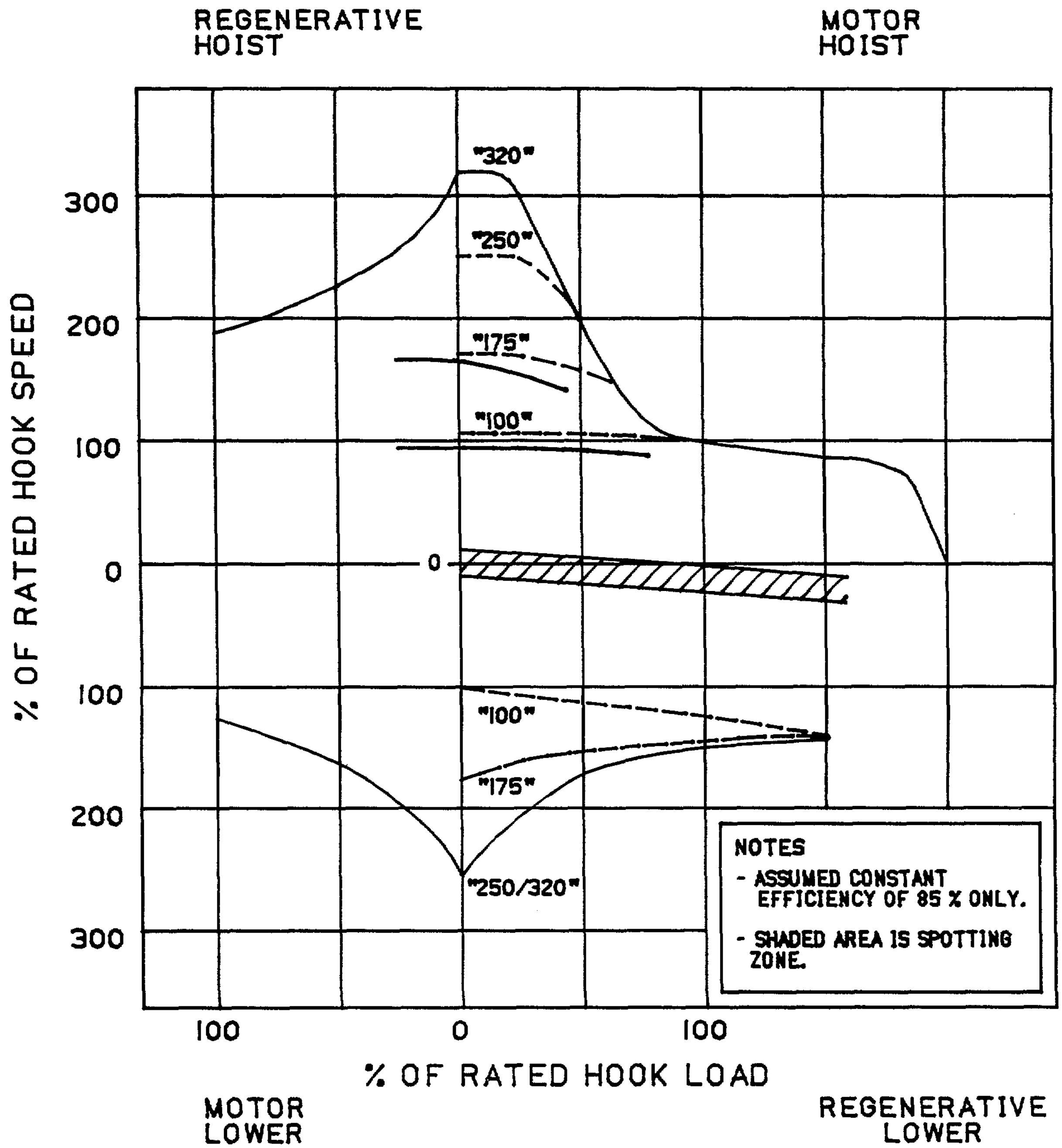


FIG. 3 TYPICAL SPEED - LOAD CURVES FOR MAXSPEED HOIST DRIVES

hook load. The particular characteristic selected for a drive is determined by the application requirements and the capability of the D-C Motor. How this characteristic is set-up in the regulator is covered in later sections.

GENERAL DESCRIPTION

The basic elements of a typical 3 phase full wave VALUTROL Maxspeed Drive System are shown in the simplified typical block diagram, Figure 4.

Power is fed through the fuses (and optional external circuit breaker), the MA contactor, through current transformers, and enters the power conversion modules (SCR A and SCR B) where it is converted to DC adjustable voltage. DC current is fed through a shunt and a DC fuse to the DC motor armature. The AC contactor (MA) removes power from the Valutrol Power Unit when it is stopped leaving the drive system otherwise completely energized. The speed of the motor is proportional to the DC voltage applied to its armature.

The basic control is manufactured on six (6) removable printed circuit boards. These are the power supply card (PSC), the main control card (MCC), the auxiliary control card (ACC), the interface card (IFC), the motor field control card (MFC) and the diagnostic card (DGC).

Custom features of the Maxspeed Drive are found in the modification rack. These features include a reference card (REF) and a torque proving card (TQP). If motor field programming is required, hoist and lower programming cards (HPC and LPC) are provided. The brake permissive relay (BPR) provides a pilot signal to the brake contactor.

The three-phase input also supplies power to the motor field control (MFC) and to the control power transformer. This transformer is fitted with a 460/230V reconnectable primary winding and two isolated secondary windings: (1) 115V to operate the coil of the MA contactor and conversion module cooling fans, and (2) the second winding is a 50 volt center tapped secondary which provides AC input to the power supply card.

POWER SUPPLY CARD (PSC)

The power supply card rectifies the AC input and provides regulated plus and minus 20 volts for the printed circuit cards. Unregulated plus and minus 30 volts DC is also provided to drive the static logic switches and the MAX relay. All of the DC outputs are fused to protect the power supply card against overloads. The regulated plus and minus 20V DC outputs are protected against over voltage conditions caused by a power supply card failure.

MAIN CONTROL CARD (MCC)

The primary purpose of the main control card is to drive the conversion modules (SCR A and SCR B) as commanded by the speed reference and feedback signals. Connection to the SCR gates is by way of the auxiliary control card (ACC).

This card also performs several additional functions such as linear timing of the reference, current limit, "Ready to Run" indicator, and various scaling and trimming adjustments.

A total of twelve (12) potentiometers are provided on this card, ten (10) of which are accessible from the front of the controller. The eleventh potentiometer, the card zero adjustment ***ZERO ADJ***, is preset at the factory and should normally not be disturbed. The twelfth potentiometer is the line impedance compensation adjustment, ***LINE***. The ten (10) accessible potentiometers are:

DAMP	***MAX SPEED***	***MIN SPEED***
CUR LIMIT	***GAIN***	***REF SCALE***
CEMF LIMIT	***RESPONSE***	***LIN TIME***
COMP		

AUXILIARY CONTROL CARD (ACC)

The primary function of this card is to combine phase control signals, leg current signals, and oscillator signals and amplify the resulting pulse trains and direct them to the appropriate SCR gates by way of twelve (12) pulse transformers. One secondary function is to scale the output of three (3) current transformers (CT's) in the three-phase AC power inputs to the conversion modules (SCR A and SCR B).

Another function is to detect circulating overcurrent faults which would not be detected by the shunt in the motor armature loop.

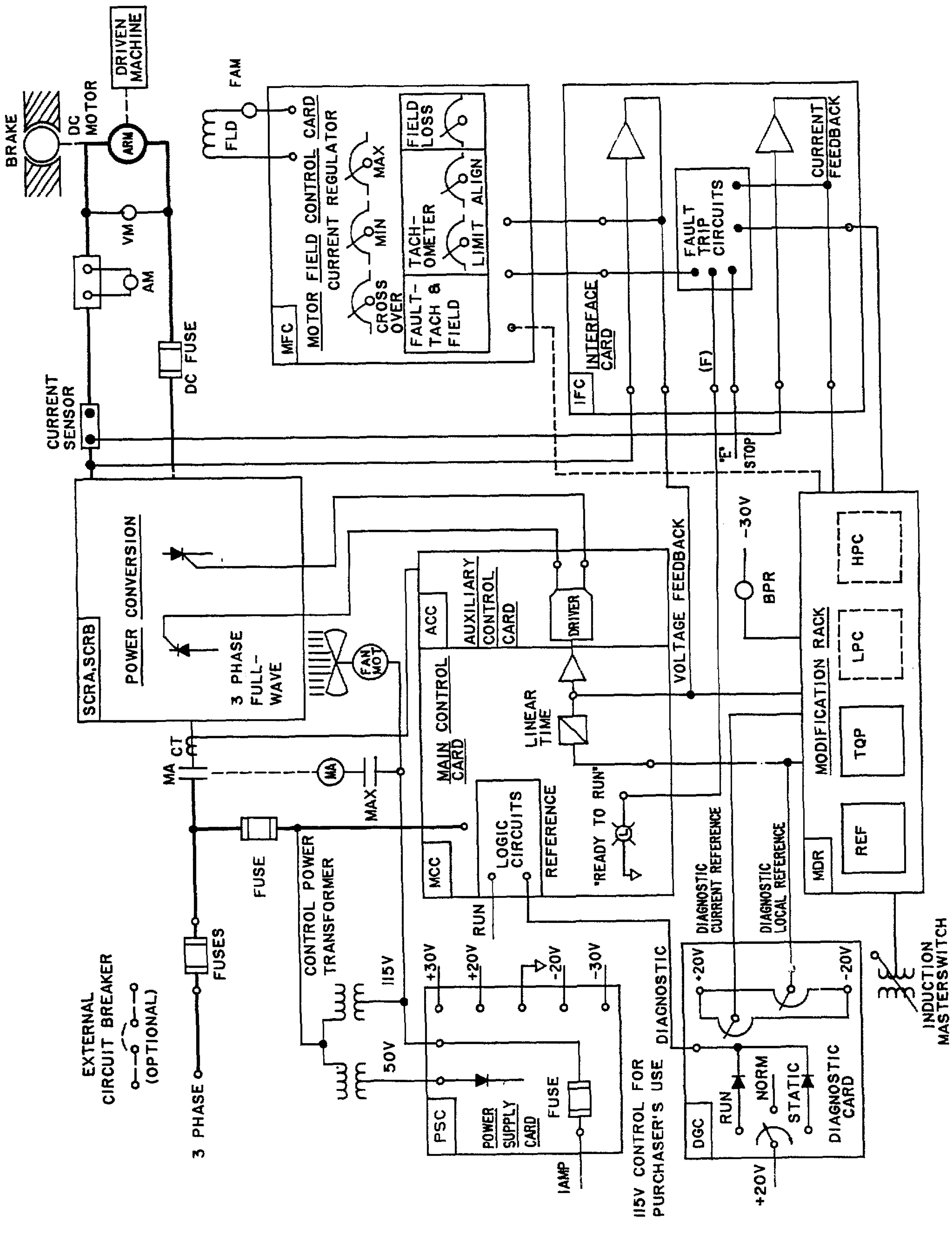
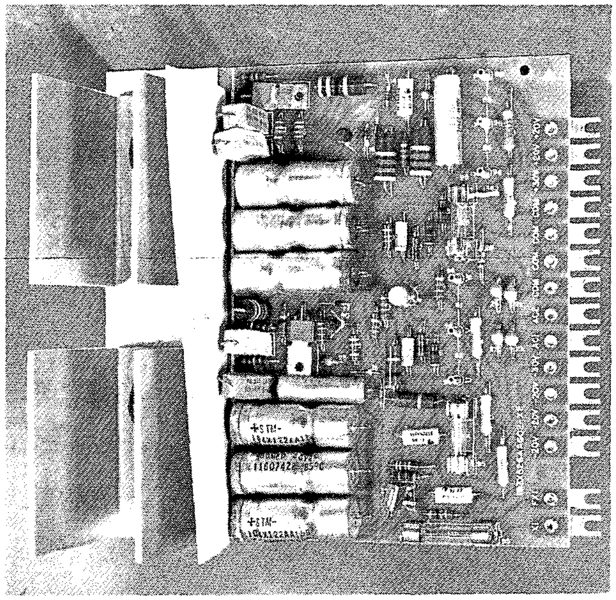


FIGURE 4
VALUTROL MAXSPEED DRIVE BLOCK DIAGRAM (3 Phase Full Wave)

An additional function is to generate a TRIP signal which suppresses SCR firing, executes a system fault, and may be used to operate an optional shunt trip circuit breaker.

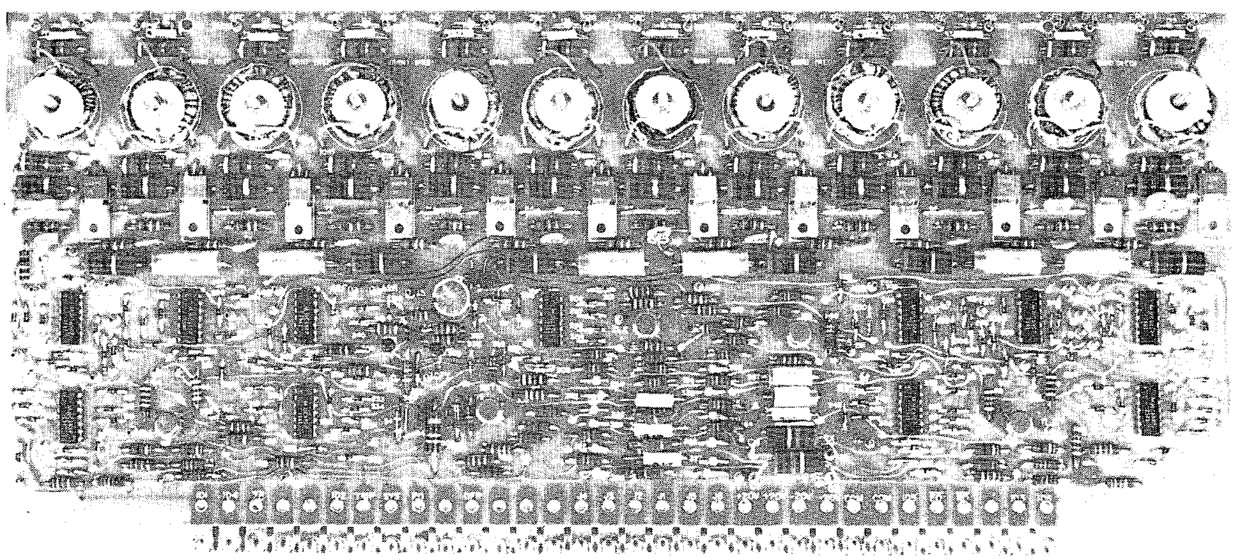
TEST INSTRUMENT AND PROBE

Located below the main control card (to the left) is a test instrument and probe that can be used to read out signals from any of the drive test points. The probe is fitted with two connections, one for the 4 volt instrument scale and the other for the 20 volt scale. Always apply the 20 volt connection first. If the reading is below 4 volts, switch to the 4 volt connection for improved accuracy of the meter reading.



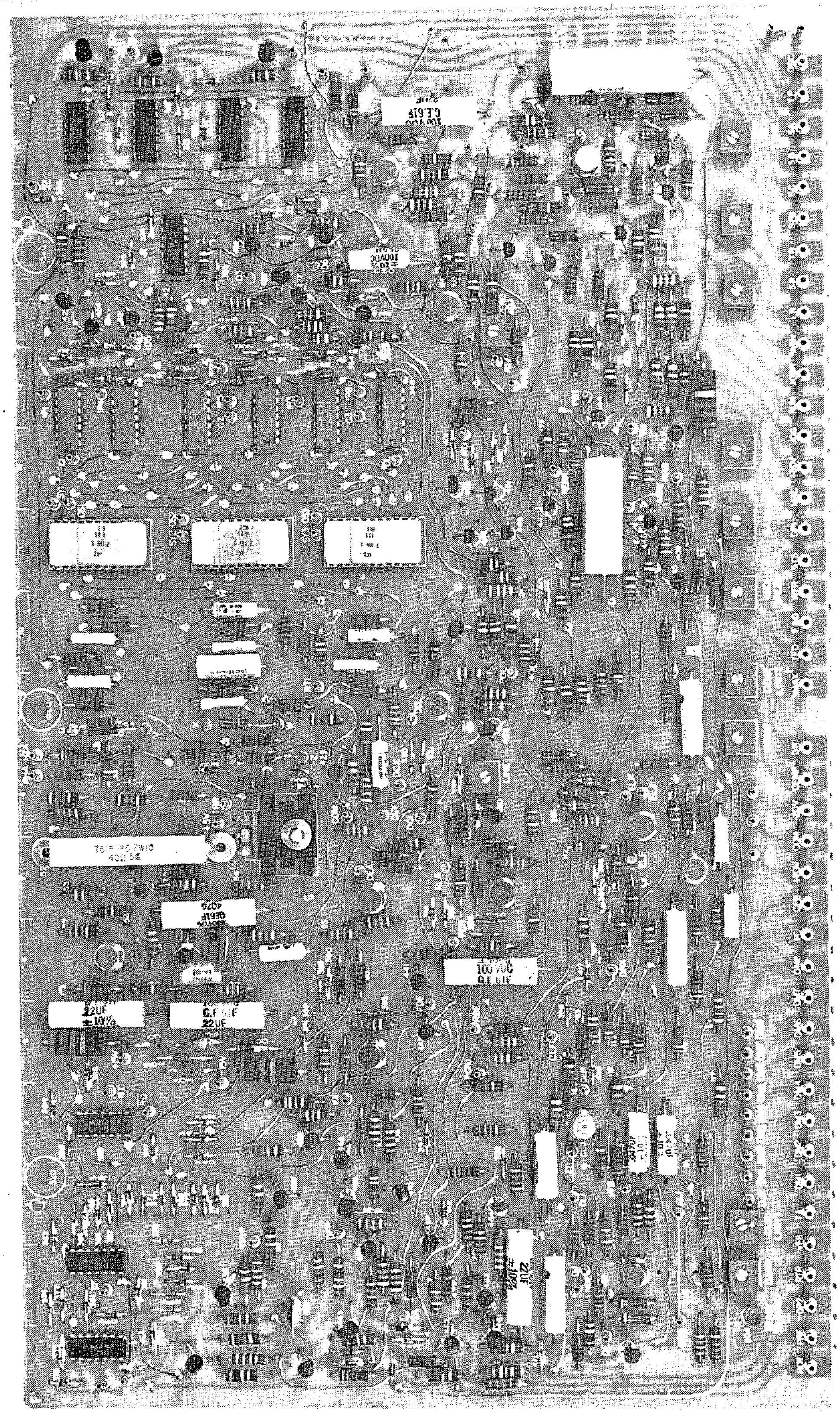
(Photo MG-5236-20)

FIG. 5 POWER SUPPLY CARD



(Photo MG-5374-2)

FIG. 6 AUXILIARY CONTROL CARD



(Photo MG-5374-1)

FIG. 7 MAIN CONTROL CARD
(NOTE: TEST POSTS ALONG LARGE EDGE)

INTERFACE CARD (IFC)

The primary purposes of the interface card are:

1. To provide low level isolated signals corresponding to the three-phase AC, DC armature voltage, armature current and tachometer feedback.
2. To control the start, stop and synchronizing of the drive while monitoring the system for abnormal operating conditions.
3. To provide one milliampere signals for external speed and current indication.

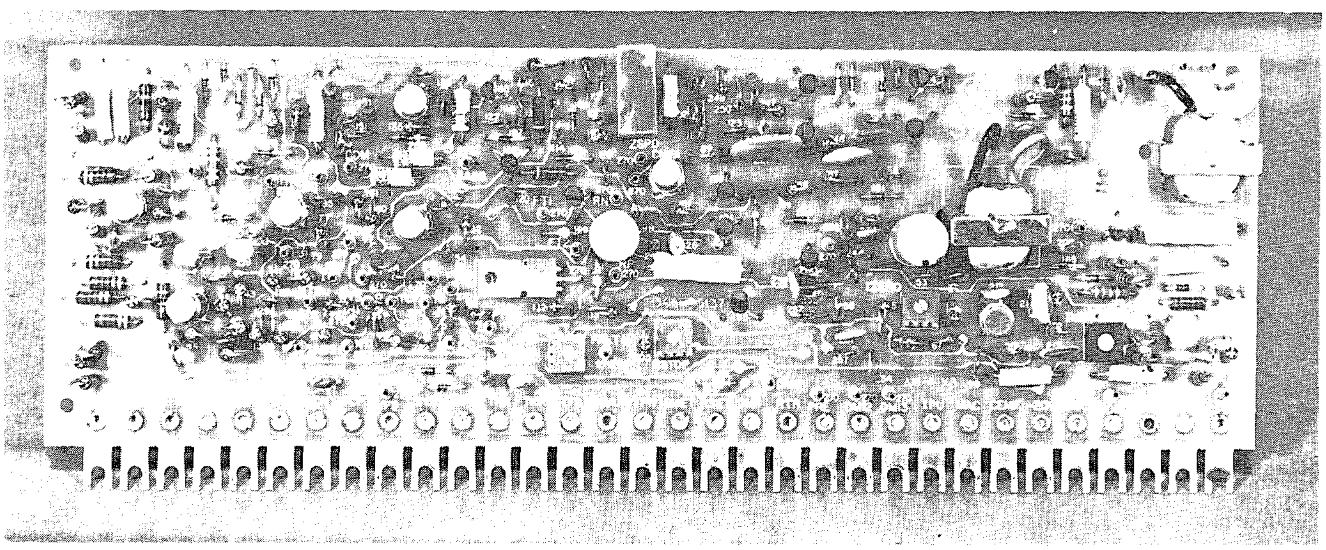
Other outputs provide:

1. A NO/NC contact indicating MA closure (MAX)
2. A NO contact indicating a fault condition (FLT)

There are (5) potentiometers on this card.

1. The ***IZERO*** is a bias adjustment for the current feedback output and is factory set. This control should not be disturbed.
2. ***ICAL*** is the calibration adjustment for CFB and is factory set. This control should not be disturbed.
3. ***R STOP*** is the drop out level of the regenerative stop sequencing circuit and is also factory set.
4. ***IMET*** is the calibration adjustment for the current indicator.
5. ***SMET*** is the calibration adjustment for the speed indicator.

Adjustment 4 and 5 will be factory set if the indicators are ordered with the drive and mounted in the power unit enclosure.



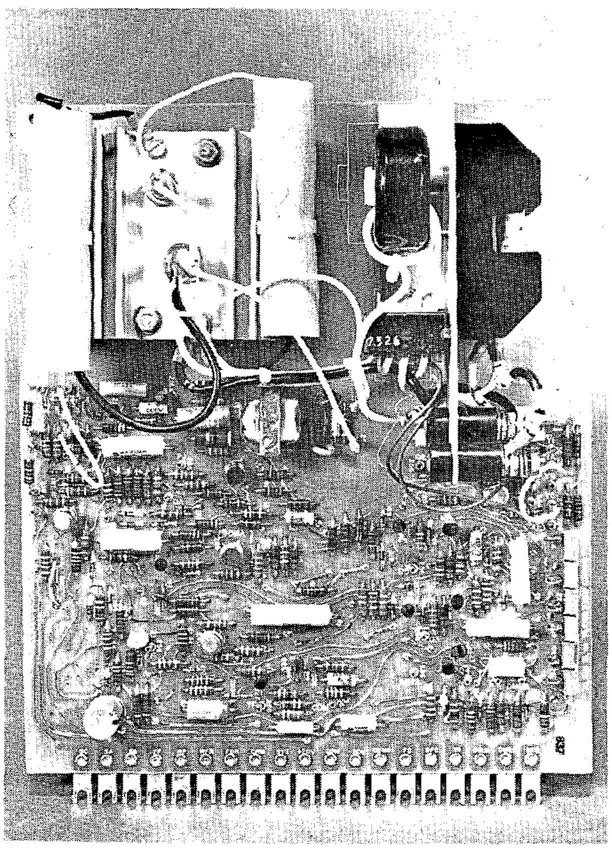
(Photo MG-5236-13)

FIG. 8 INTERFACE CARD

MOTOR FIELD CONTROL CARD (MFC)

This card provides a current regulated motor field supply for the DC motor. Constant field excitation is supplied for Maxspeed 100 Drives. On Maxspeed Drives where field programming is required, the current reference is modified by the hoist or lower programming card to achieve the desired speed versus load characteristic.

The tachometer monitor circuit is used to monitor SFB and detect an overvoltage. Loss of motor field is also detected by this card. Any of these faults will shut down the drive. A field economy circuit is also included on this card, which automatically reduces the level of motor field excitation whenever the drive is shut down, thereby avoiding the possibility of excessive temperature (at stand still) and/or reduced insulation life. See GEK-24971 for detailed instructions.

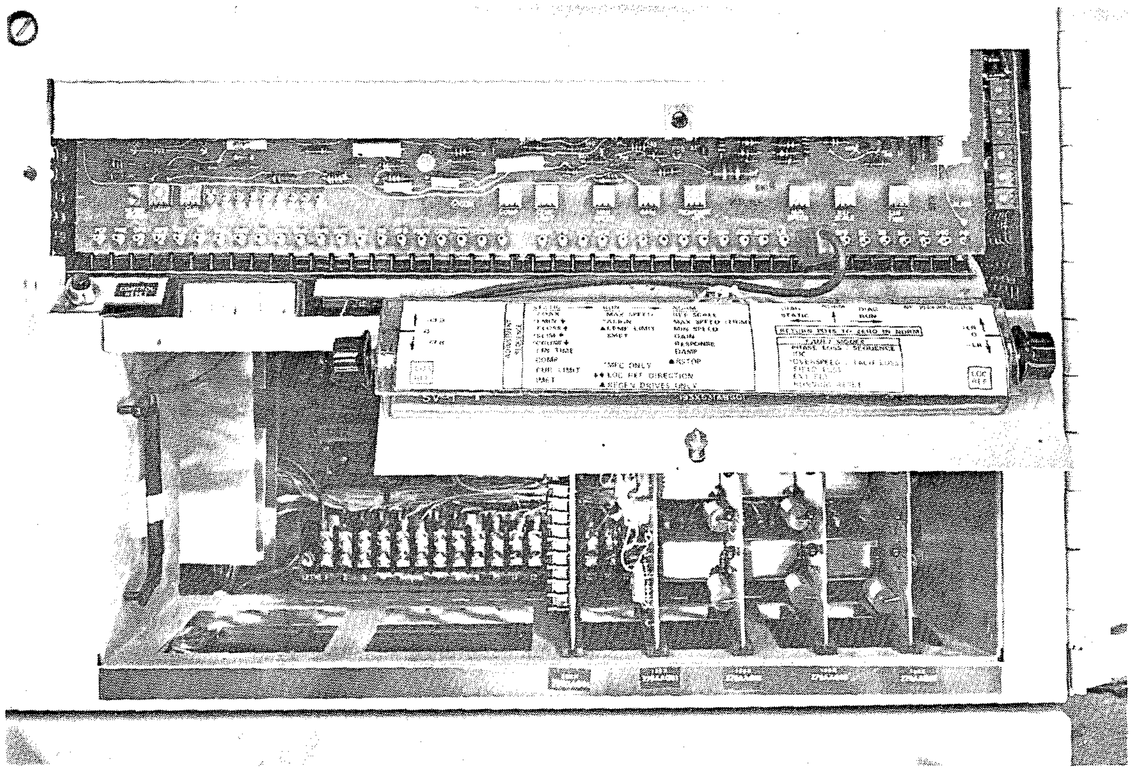


(Photo MG-5236-15)

FIG. 9 MOTOR FIELD CONTROL CARD

DIAGNOSTIC CARD

The diagnostic card performs no function under normal operating conditions but will program the drive into a diagnostic run mode and diagnostic static mode for ease of initial start up and troubleshooting.



(Photo MG-5393-1)

FIG. 10 DIAGNOSTIC CARD AND MODIFICATION RACK

CONTROL FUSES, MOV'S

The signal power for the control is taken from the three-phase input through control fuses to the control voltage transformer. The control fuses are used to protect the control transformer and the metal oxide varistors (MOV) which are used to protect the power unit from excessive transient over voltage conditions. Three (3) high resistance wires which provide line synchronization are connected to the load side of these fuses. The drive will not operate if any one of these fuses is open.

POWER CONNECTIONS

The power connections are the three-phase input at L1, L2, L3 on the fuses; motor field F1 and F2 on the ATB terminal board and the DC power output DA1 and DA2.

SIGNAL CONNECTIONS

All signal connections are made on the 2TB, 3TB and 4TB terminal boards. Signals appearing on these terminal boards and their functions are described in Table II.

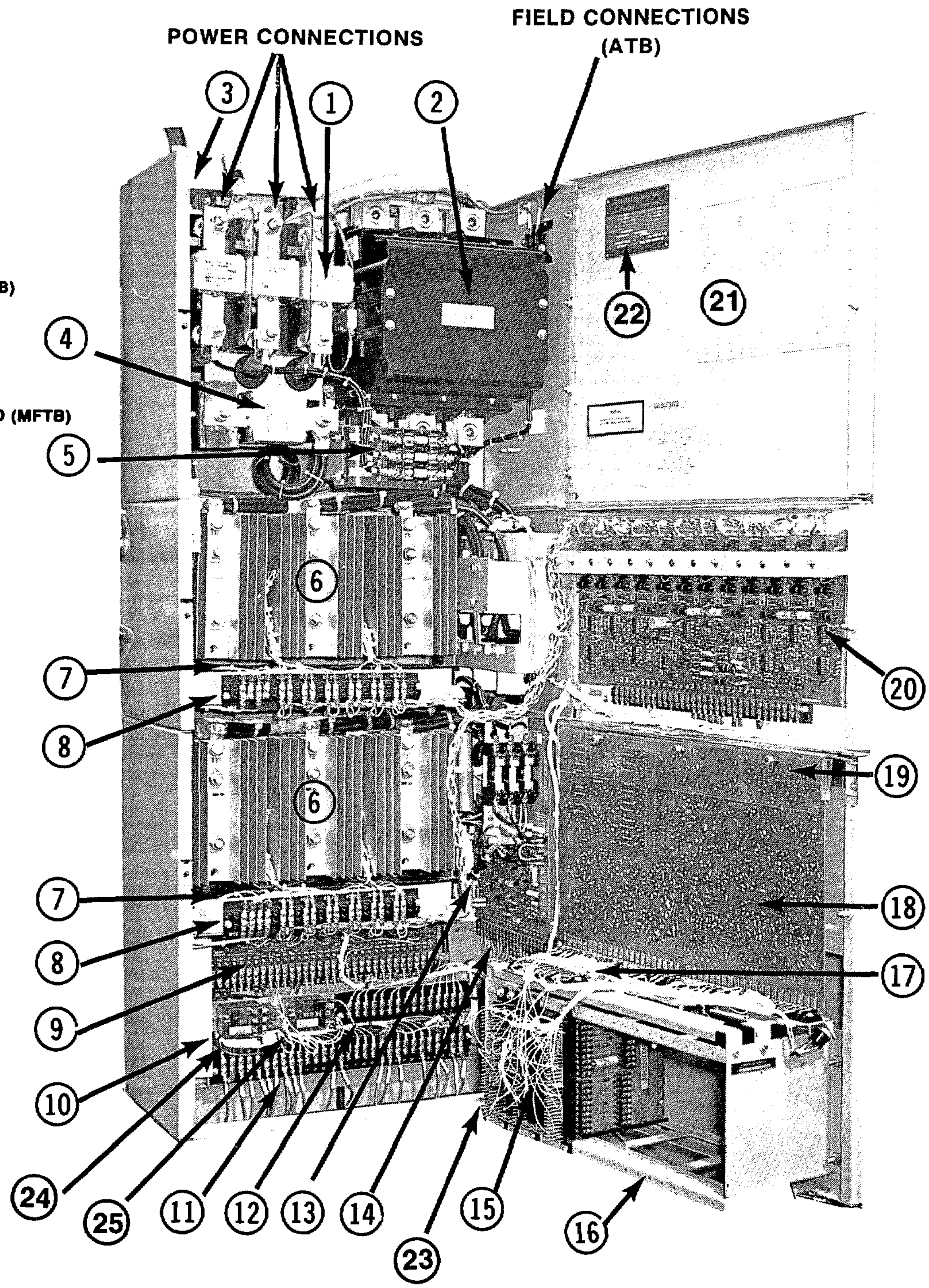
MODIFICATION RACK (MDR)

Provided on printed circuit cards located in the modification rack below the main control card are the special features and functions of the Maxspeed Drive. These features include:

- Operational check
- Provision for induction masterswitch
- Torque proving
- Slowdown or spotting control
- Hoist motor field programming

See Modification features for details of these functions. Other special functions such as stepped reference or independent timed acceleration and deceleration adjustments may also be added.

1. FUSE
2. MA CONTACTOR
3. SHUNT (HIDDEN)
4. DC FUSE
5. MOV/CONTROL FUSES
6. HEATSINK MODULES
7. FANS
8. MODULE TERMINAL BOARD (MTB)
9. INTERFACE CARD (IFC)
10. POWER SUPPLY (PSC)
11. 2TB
12. 3TB
13. MOTOR FIELD CONTROL (MFC)
14. MOTOR FIELD TERMINAL BOARD (MFTB)
15. S—22 CARDS
16. MODIFICATION RACK (MDR)
17. RACK TERMINAL BOARD (RTB)
18. MAIN CONTROL CARD (MCC)
19. HIGH VOLTAGE SHIELD
20. AUXILIARY CONTROL CARD
21. TEST RECORD
22. NAMEPLATE
23. 4TB (SIDE WALL MOUNTED)
24. MA AUXILIARY RELAY (MAX)
25. FAULT RELAY (FLT)



(Photo—MG—5368—4)

FIG. 11 COMPONENT AND SIGNAL CONNECTION LOCATION

TABLE II SIGNAL CONNECTIONS

2TB NO.	NOMENCLATURE	DESCRIPTION
1	—30V	Unregulated negative DC voltage used as the return line for the CONTOL ON function and the static switches RUN and JOG, and possible modifications.
2	CONTROL ON	If CONTROL ON is not connected to —30V the drive will not start. If CONTROL ON is opened with the drive operating, the contactor will open and the drive will coast.
3, 4	FLT	A normally open, held closed relay contact. Under normal conditions this contact is closed. If a fault condition is detected, this contact opens. Usually connected to the undervoltage circuit to remove control power.
5, 6, 7	MAX	A NO/NC relay contact which actuates when the contactor actuates.
8, 27	COM	Signal common. All signals are measured with respect to common, unless otherwise noted.
9	EST	External Fault Stop input. If EST is momentarily disconnected from common, the contactor will open and the motor will coast. The drive may not be restarted until the reset line is momentarily connected to COMMON (2TB—12). (See RESET below).
10, 11	FX1, X2	The internal 115V AC. FX1 is fused for external use.
12	RSET	Reset input. All fault shut downs inhibit the drive from starting until the fault has been cleared and the drive is reset. After the motor has come to a stop, the drive may be reset by momentarily connecting RSET to common. The drive will not restart until RSET is released from common. Momentarily connecting RSET to common or pushing the RESET BUTTON will initiate a coast stop shutdown.
13, 15 16, 17 18, 19 24, 25	SP1 to SP8	These are special purpose wires which are used to bring additional signals out of 2TB. Refer to the system elementary for details. Additional SP wires may be connected to 3TB and 4TB as required.
14	RUN	The drive will not start unless either RUN or JOG are connected to —30V, either at 2TB or by special purpose logic in the MDR. When RUN and JOG are released from —30V, the drive will decelerate to a stop and open the MA contactor.

TABLE II SIGNAL CONNECTIONS (continued)

2TB NO.	NOMENCLATURE	DESCRIPTION
20, 21	+20V, —20V	Regulated power supply outputs.
22	IMET	Output to an optional 1ma load instrument. The instrument is calibrated with the ***IMET*** potentiometer on the Interface Card. ***IMET*** is an absolute (-) signal.
23	SMET	Output to a 1ma speed instrument. The instrument is calibrated with the ***SMET*** potentiometer on the Interface Card. ***SMET*** is an absolute (-) signal.
26	SMIN	Output from the ***MIN SPEED*** potentiometer on the main control card.
28	SR	Speed Reference input.
29, 30	TKP, TKN	Input connections for motor mounted tachometer or machine mounted tachometer. **NOTE:** WITH A DC TACHOMETER, TKP MUST BE POSITIVE WHEN SYSTEM REFERENCE IS NEGATIVE AND DA1 IS POSITIVE WITH RESPECT TO DA2.

3TB NO.	NOMENCLATURE	DESCRIPTION
1	RLA	Input to time delay relay card (TDR) for relay RLA.
2	RA	Input to logic relay RA used for run.
6, 7, 8	BPR	A NO/NC relay contact which actuates when the brake permissive relay actuates. BPR responds to a signal from the torque proving card.

4TB NO.	NOMENCLATURE	DESCRIPTION
1	RUN	Run signal which is time delayed after deenergization which is connected to the CONTROL ON input through a UV contact.
2	NSW	Negative switch input to reference card to enable negative reference.
3	PSW	Positive switch input to reference card to ènable positive reference.
7, 9, 10, 11 12, 13, 14	SP37, SP39 to SP44	Special purpose wires for additional signals.
15	+30V	Unregulated positive DC voltage for reference card input switches.

START-UP

The VALUTROL Maxspeed Drive is factory tested as a complete drive system. It is ready to operate provided the external power and control connections have been properly made and the following step by step procedures are followed:

1. Verify that the terminal board screws are tight.

2. Verify that incoming power is the proper voltage and the incoming wiring is complete and correct.

3. Set the diagnostic switch to its NORMAL (center) position. Apply power to the drive. If the green "Ready to Run" light located on the lower left hand corner of the main control card (MCC) is not illuminated, press and release the RESET pushbutton on the panel below. If the light does not turn on, the most probable cause is incorrect incoming phase rotation. Remove power, reverse any two of the incoming AC power leads and repeat.

4. Verify that the speed reference voltage, SR, from 2TB(28) to 2TB(27) is variable with the external speed adjust controller. (SR must be negative in the hoist or forward direction).

   When an induction masterswitch is used, the reference polarity may be changed by interchanging wires on terminals X1 and X3 and on X2 and X4 on the masterswitch terminal board.

5. Slowly move the master controller until the motor starts to rotate. Check motor rotation. If incorrect, remove power and interchange the motor field leads F1 and F2 on ATB terminal board.

6. Run the drive from the external speed reference up to top speed. Adjust ***MAX SPEED*** on MCC as may be required to set the maximum armature voltage.

   If field programming is used adjust ***MFH*** on the hoist card for the no-load hoisting speed and ***MFL*** on the hoist card for the no-load lowering speed. The value of test point FC (field current) on the MCC at the top no-load speeds should be recorded for future reference. DO NOT OVERSPEED.

7. Close and secure the doors of the power unit.

WARNING

BEFORE LIFTING A LOAD, THE BRAKE LININGS SHOULD BE "WORN IN" SUFFICIENTLY PER THE MANUFACTURER'S INSTRUCTIONS.

TABLE III FAULT CONDITIONS

A fault has occurred if the fault relay contact (FLT) is open or if the "READY TO RUN" light is off. The conditions that can initiate a fault are as follows:

1. No three phase power.
2. Loss of an incoming phase.
3. Incorrect phase rotation.
4. AC power fuse blown.
5. Control fuse is open.
6. Power supply plus or minus DC fuse is open.
7. Instantaneous overcurrent (IOC) level exceeded.
8. Motor thermo-switch MTHSW. (If connected to fault circuitry).
9. Timed overcurrent (TOC) — electronic. (If connected to fault circuitry).
10. Loss of motor field. (FF)
11. External Fault Stop momentarily released from Common.
12. Other special functions to System Trip (SYS) or External Fault Stop inputs.
13. System Trip input (SYS) momentarily connected to +10 volts.
14. RESET button depressed or RSET input momentarily connected to Common with motor rotating.
15. RESET button held depressed or RSET input held connected to Common.
16. Diagnostic mode selected with the motor rotating.
17. Oscillator (OSC) failed "on."
18. Tachometer fault (loss of tachometer signal). (If tachometer is used). (TF)
19. Overspeed (Overvoltage indication on reference card).
20. Trip actuated from ACC (by AC overcurrent or SCR commutation failure).
21. Operational Check (OCK) (Indication on reference card).

After the fault condition has been cleared and the motor has come to standstill, the drive can be RESET by any of the following three methods:

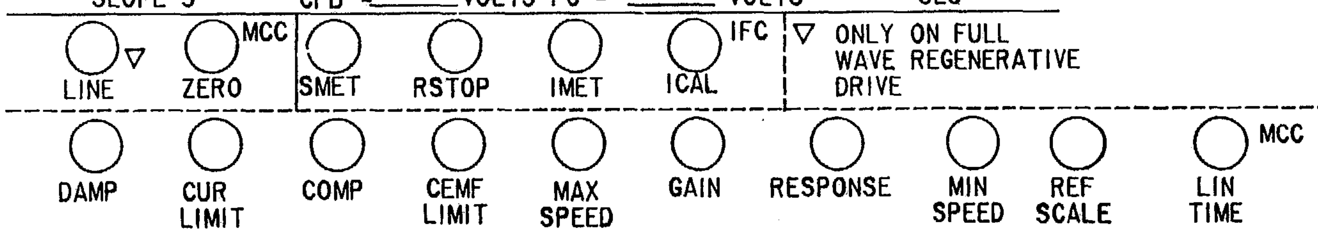
1. Momentarily remove the three-phase power and re-apply.
2. Push the RESET button.
3. Momentarily connect RESET to common.

Note: If all fault conditions have been cleared but the drive fails to RESET, the RSTOP adjustment may be set too low.

MAXSPEED ____ CRANE DRIVE TEST DATA (ALL DATA ± 5%, EXCEPT WHERE NOTED)

		ADJUSTMENT	
VFB	− ______ VOLTS + ______ MOTOR VOLTS	NONE	______
CEMF	− ______ VOLTS + ______ NO LOAD MOTOR VOLTS	NONE	______
MAX FIELD	______ AMPS, FC = ______ VOLTS	FMAX	______
MIN FIELD	______ AMPS, FC = ______ VOLTS	FMIN	______
FIELD LOSS	______ AMPS, FC = ______ VOLTS	FLOSS	______
OVERSPEED	______ % SFB = ______ VOLTS	SLIM	______
CROSSOVER	FULL CCW	CROSS	______
IR COMP	CFB=5 VOLTS AT CEMF = ______ VOLTS	COMP	______
CURRENT LIMIT	AMPS ± 10% CFB = ______ VOLTS	CUR LIM	______
LINEAR TIME	______ SECONDS, ZERO TO 10 VOLTS AT TR	LIN TIME	______
CFB	______ VOLTS AT ______ MOTOR AMPS ± 10%	NONE	______
CEMF AT LIMIT	− ______ VOLTS AT + ______ MOTOR VOLTS ± 3%	CEMF LIMIT	______
SFB	+ ______ VOLTS AT ______ MOTOR VOLTS/RPM	MAX SPEED	______
TR	− ______ VOLTS AT ______ VOLTS MAX. REF AT SR	REF SCALE	
IOC TRIP	______ %, CFB = − ______ VOLTS ± 10%	SELECT	

HOIST FIELD PROGRAMMING (SETTINGS MADE IN DIAGNOSTIC)		ADJUSTMENT
STANDBY FLD ADJ	______ AMPS, FC = ______ VOLTS	SFA
MIN FLD HOIST	______ AMPS, FC = ______ VOLTS	MFH
HOIST BREAK PT	HB = ______ VOLTS	HB
MIN FLD LOWER	______ AMPS, FC = ______ VOLTS	MFL
SLOPE 1	CFB = ______ VOLTS FC = ______ VOLTS	SL1
LOWER BRK 2	LB2 = ______ VOLTS	LB2
SLOPE 2	CFB = ______ VOLTS FC = ______ VOLTS	SL2
LOWER BRK 3	LB3 = ______ VOLTS	LB3
SLOPE 3	CFB = ______ VOLTS FC = ______ VOLTS	SL3



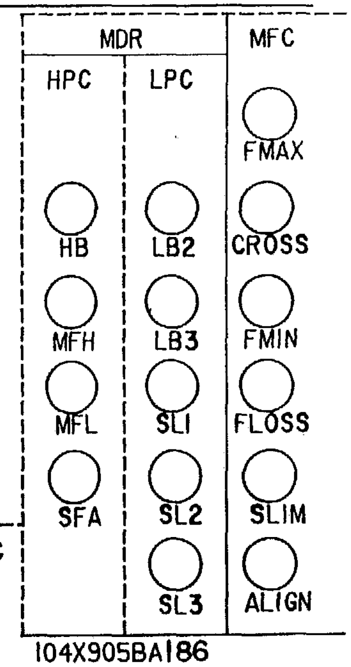


FIG. 12 TEST DATA SHEET

SEQUENCE OF OPERATION

POWER APPLIED

The control transformer (CPT) is energized through its primary fuses. The fans (if supplied) will come on.

The power supply card is energized and the DC output (±20 volt) is applied through its fuses to the rest of the cards. All readings carry a tolerance of ±10%.

The motor field supply is energized. Refer to the motor field supply instructions for details.

If no faults have been detected by the monitor section of the interface card, the fault relay FLT will close, and the "Ready to Run" indicator on the main control card will illuminate. Table III tabulates the fault conditions which are monitored.

The oscillator will start, and the synchronizing signals SA, SB, SC will measure 8.5 volts RMS, (±10%). See Figure 19.

SWITCH LOGIC

RUN will be switched from +30V to —30 volts by an RA contact which is a function of the run permissive relay and masterswitch. The control line MAC from the main control card to the interface card will be pulled down to —20 volts.

The interface card checks that no faults exist and that "control on" is connected to —30 volts before applying power to the coil of the pilot relay MAX.

MAX picks up, releasing the preconditioning signal PRE from common and applies power to the coil of the MA contactor.

When PRE is released from common, it switches to —4 volts which will release the main control card preconditioning after approximately 80 milliseconds.

Releasing preconditioning allows the drive to send firing pulses to the gates of the SCR's in the conversion module, and allows the normal signal flow to occur.

SIGNAL FLOW

When RUN is switched, the reference at SR is applied to the linear time section. The timed reference output TR will ramp to a voltage proportional to SR. The MAX NEG or MAX POS adjustment on the Reference Card is used to set TR to 10.0 volts when the masterswitch is set for top speed.

The time for TR to ramp from 0 to 10 volts is adjustable from .3 to 60 seconds with the ***LIN TIME*** adjustment. See jumper table on system elementary. (Ranges: .3 to 7 sec. or 2 to 60 sec.).

The VFB feedback from the motor is isolated with a resistor network in the feedback harness. VFB is connected to the system feedback. The output of the system feedback section is SFB, and will be 10 volts at top voltage. ***MAX SPEED*** is adjusted to make the actual top voltage correspond to desired top voltage.

The timed reference TR and the system feedback SFB are summed by the regulator error amplifier. The error amplifier output EAO will be a low voltage (nearly zero) when the drive is regulating voltage. EAO will not be low when the drive is in current limit or CEMF limit. The gain of the error amplifier is set with the ***GAIN*** adjustment. The ***GAIN*** adjustment is used primarily to improve the response of the drive in the constant horsepower region when the motor field supply is a motor field control MFC.

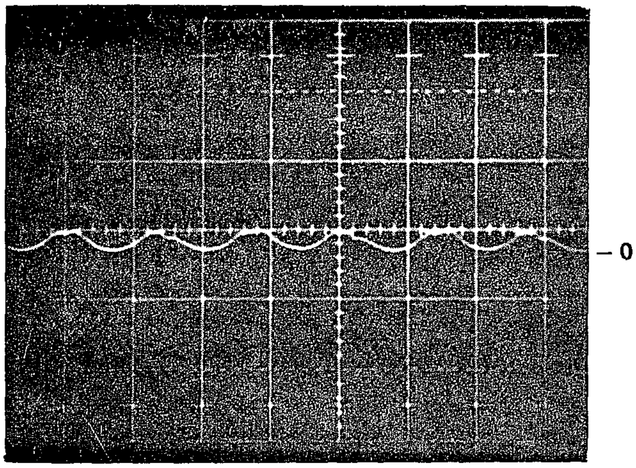
To maintain good load regulation, the error amplifier is fed into the regulator integrator. The output of the integrator is the reference, DR, to the driver. The response of the control below base speed is set with the ***RESPONSE*** adjustment.

There is a limit, however, to how responsive a drive may be set. Stability of the drive is decreased as its response is increased. The ***RESPONSE*** adjustment is desensitized when the drive is operating in the constant horsepower region of the torque speed curve by the WFR signal from the motor field control (MFC).

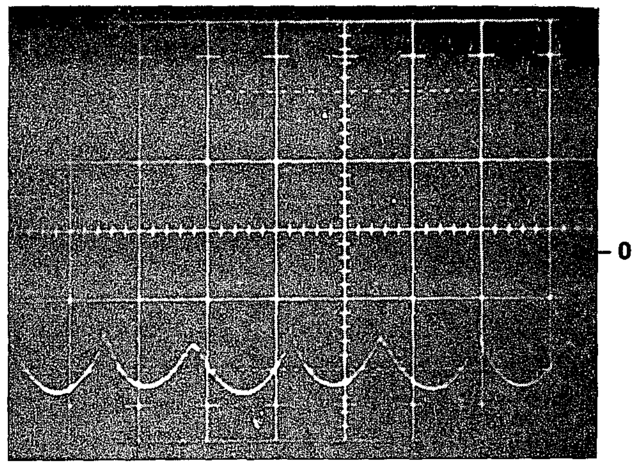
To protect the system three limit sections are provided; counter EMF (CEMF) limit and two current limits. The output of the CEMF limit and the primary current limit drive the regulator integrator and will override the error amplifier, if required. The primary current limit is set with the ***CUR LIMIT*** adjustment and the counter EMF limit with the ***CEMF LIMIT*** adjustment. Typically, the primary or regulator current limit is set at 150% of the motor nameplate current or 3.75 volts (±10%) of current feedback, CFB. The counter EMF is normally limited to 250 armature volts at no load, or 5.75 volts (±10%) of CEMF for drives rated 240 volts DC. For drives rated 500 volts DC the CEMF limit is normally 510 volts at no load or 5.60 volts (±10%) at CEMF. The secondary or driver current limit is in the driver section and will be described later. The primary current limit, if used, should not be set higher than the driver current limit. The driver current limit may be inhibited or adjusted.

WAVEFORMS

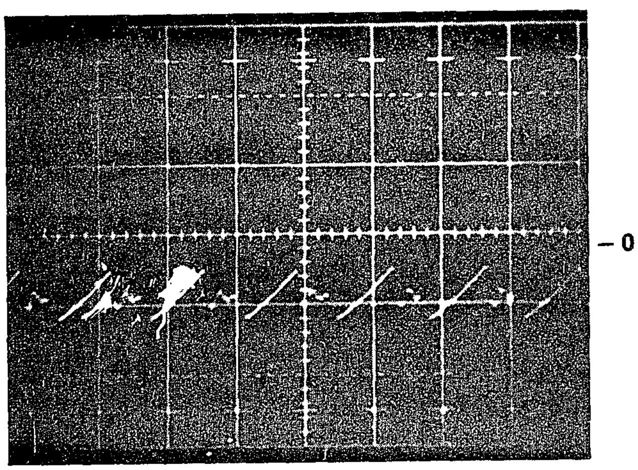
All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



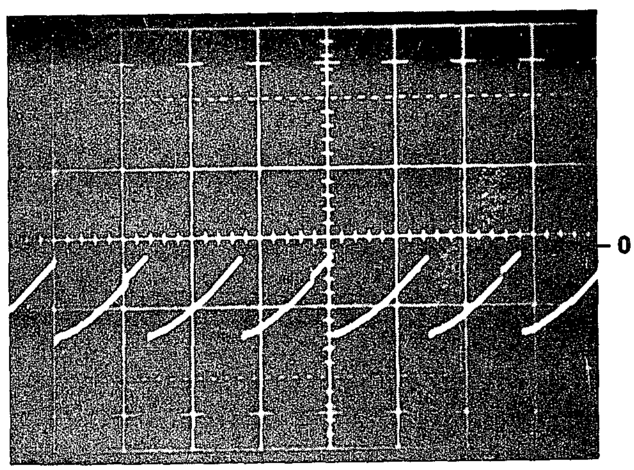
2 msec/div
At low current level 1 volt/division
FIG. 13 CURRENT FEEDBACK (CFB)



2 msec/div
At continuous current 1 volt/division
FIG. 14 CURRENT FEEDBACK (CFB)



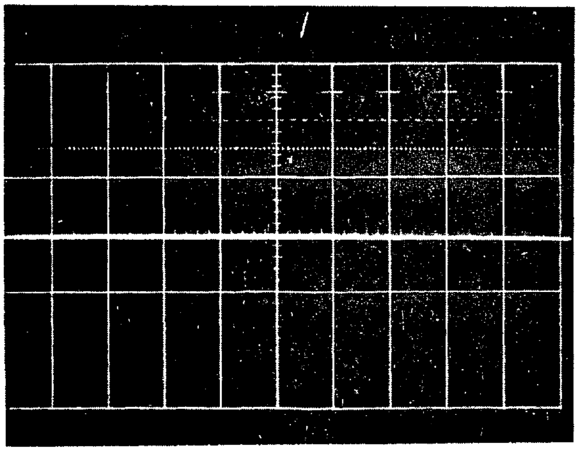
2 msec/div
At low current and 200 volts 5 volts/division
FIG. 15 VOLTAGE FEEDBACK (VFB)



2 msec/div
At continuous current and 200 volts 5 volts/division
FIG. 16 VOLTAGE FEEDBACK (VFB)

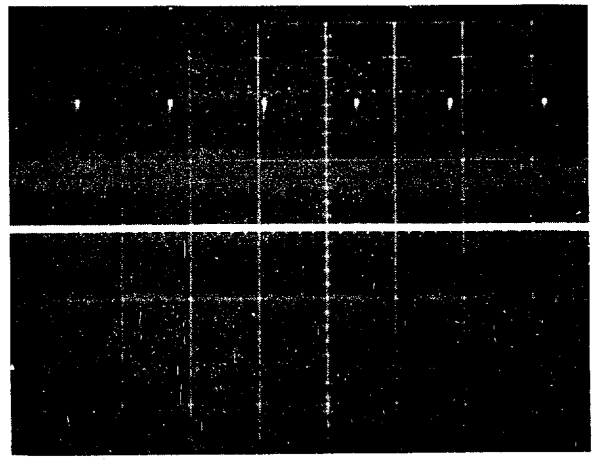
WAVEFORMS

All illustrations were photographed in the forward motoring quadrant with zero volts on center line at 2 msec per division.



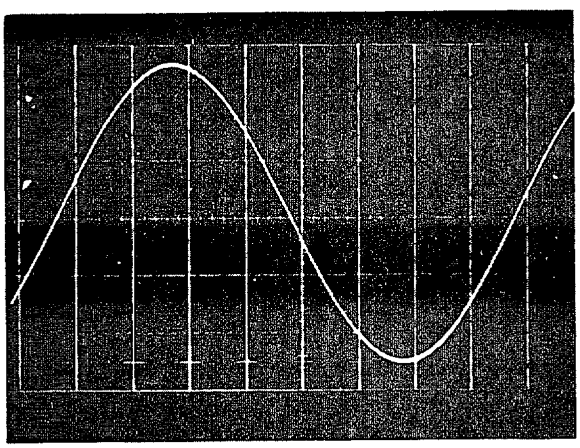
— 0

2 msec/div
10 volts/division
FIG. 17 OSCILLATOR (OSC)

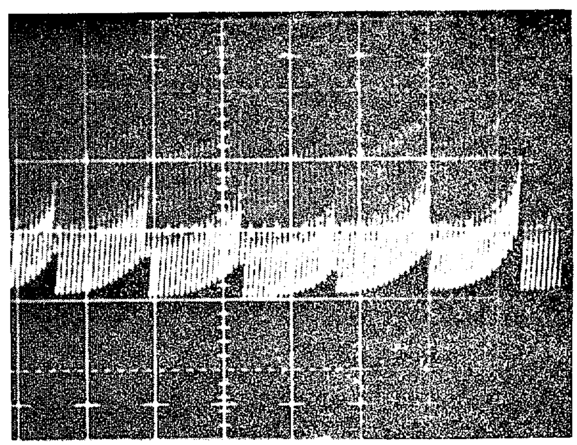


— 0

2 msec/div
2 volts/division
FIG. 18 INITIAL PULSE (IPU)



2 msec/div
Typical of SA, SB & SC
SB lags SA by 120°
SC lags SB by 120°
FIG. 19 SYNCHRONIZING SIGNAL (SA)



2 msec/div
AC Coupled
0.1 volt/division
FIG. 20 PULSE OUTPUT (PO)

The main purpose of the secondary, or driver, current limit is to be an operating current limit if the regulator, or primary current limit, is not used and the system is controlled by other signals summed at the driver junction. The driver current limit may be increased by connecting a jumper from DCX to DCY on the main control card which will increase the limit from approximately 130% to 175% of the motor nameplate current. Alternative levels may be established by connecting a resistor between DCL and DCX on the main control card. For normal levels of regulating current limit, either DCX should be jumpered on DCY to increase the driver current limit or it should be inhibited by connecting DCI to COM. For regulating current limit above 150%, a resistor should be connected between DCL and DCX to raise the driver limit above 175% or it should be inhibited with a jumper between DCI and COM.

The counter EMF signal CEMF is developed on the main control card by subtracting a signal proportional to the IR drop of the motor from voltage feedback. This is set with the ***COMP*** adjustment. For most Maxspeed Drives, the ***COMP*** adjustment is set so there is no IR compensation. CEMF is then equal to the voltage feedback VFB.

The driver reference, DR, the voltage feedback, VFB, an armature current signal from damping adjustment, ***DAMP***, and the driver current limit output are summed at the input to the driver. The driver converts this error to pulse trains which drive the SCR gates in such a manner as to maintain the motor voltage proportional to the driver reference. The damping adjustment ***DAMP*** controls the response of the driver.

Generally speaking, ***DAMP*** is used only to quiet small oscillations which occur in the current under light load conditions. Too much damping will slow down the system response and tend to cause over shoot.

The driver provides a signal IPU to the oscillator on the interface card to generate an initial pulse at the exact point in time that an SCR is to be fired. See Fig. 18.

Two driver monitor points are available, PCR and PO. PCR is the phase-control reference which causes the output pulse trains to phase shift in time with respect to the AC line. As PCR moves from zero to +6 volts (±10%), the output pulses will shift from full off to full on. PO is used to monitor the pulse outputs to the SCR's. See Fig. 20.

STOP

There are two stop sequences, normal stop and fault stop. With a normal stop the drive regenerates to near zero speed before setting the brake and opening the MA contactor. A fault stop sets the brake and opens the MA contactor.

NORMAL STOP — Move the masterswitch to the OFF position. NSW or PSW on the reference card will open, removing the reference from SR.

The timed reference TR will begin to time down to zero and the drive speed will come down accordingly.

Signal level detector relay SLB will drop out at a low value of CEMF and set the brake to stop the drive. After a time delay, set by run permissive relay RLA, RA drops out removing power from the MAX coil which in turn drops out MA. The time delay allows jogging of the drive without dropping out MA and sets the brake if the event SLB does not drop out or the drive does not respond to a stop command.

FAULT STOP — Fault detected (See Table III) or CONTROL ON is open. An emergency stop will initiate a fault stop sequence by opening CONTROL ON and removing control power.

The preconditioning signal PRE is immediately applied to the main control card, forcing the drive into zero current or coast conditions. As soon as the current goes to zero, preconditioning is established throughout the card.

The contactor unconditionally drops out 100 milliseconds after the fault condition occurs. The brake contactor drops out immediately. The drive cannot be restarted until the motor has come to rest and the masterswitch has been returned to the OFF position.

After the motor has stopped, push the RESET button.

DIAGNOSTIC STATIC (SWITCH TO LEFT POSITION)

LOGIC

The RUN and JOG inputs are inhibited. This prevents the references SR and JOGR from activating the drive and holds the contactor open.

The current reference potentiometer ***CUR REF*** controls the current feedback signal CFB.

The local reference ***LOC REF*** potentiometer is connected into the input of the linear time section and into the system feedback section. The local reference is also connected to the field diagnostic reference DFDR. Refer to the motor field programmer description for details of operation.

To simplify signal tracing, the gain of the regulator and drive is reduced and the system feedback signal to the regulator error amplifier is removed.

SIGNAL FLOW

The local reference LR is applied to the input of the last stage of the system feedback section. The output SFB will be equal to LR in magnitude, but opposite in polarity. The tachometer scaling circuit and its output TFB are unaffected by the local reference and will remain at zero. The signal from SFB into the regulator error amplifier is inhibited. The primary purpose of exercising SFB is to check any special function circuits in the modification rack which are programmed from SFB and/or SFB functions of an MFC.

A dummy feedback signal to replace the normal SFB signal is connected from the output of the regulator integrator output DR to the input of the regulator error amplifier. Under these conditions, DR is equal to the magnitude of TR but opposite in polarity as long as the current reference is zero. When the current reference is raised, the current feedback signal CFB will exceed the current limit level set by ***CUR LIM*** and force the DR output into negative saturation for forward current limit and positive saturation for reverse current limit.

The current reference will also program the CEMF output to a level proportional to the CFB level and the ***COMP*** adjustment.

The load instrument output IMET will also respond to the current reference.

The gain of the drive is reduced so that the phase control reference PCR is equal to the magnitude of the driver reference DR as long as the current reference is set to zero.

With an oscilloscope, the initial pulse output IPU, and the pulse output PO may be monitored to verify proper operation. See Fig. 18 and 20.

DIAGNOSTIC RUN (SWITCH TO RIGHT POSITION)

In diagnostic run, the local reference LR and the diagnostic switch are substituted for the reference(s) SR, JOGR and the RUN and JOG switch inputs just as in diagnostic static. MA is inhibited from picking up in diagnostic run on Maxspeed Drives to prevent running beyond operating limit switches.

CALIBRATION PROCEDURE

The diagnostic card is used to generate the appropriate test signals and operating modes to calibrate the drive. If a diagnostic card has not been furnished, one may be ordered or the test circuit shown in Figure 21 may be used.

Make all connections prior to applying input power.

*All connections may be made to the test posts on the front of the main control card except for DFDR which is located on the 5TB terminal board.

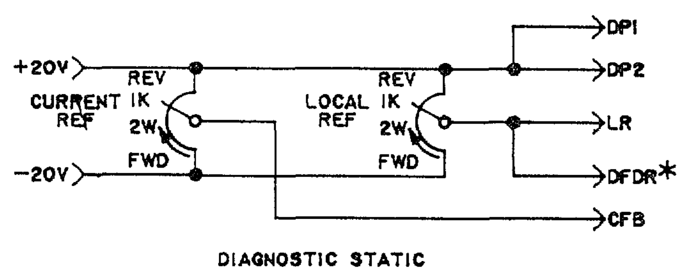


FIG. 21 DIAGNOSTIC TEST CIRCUIT

To avoid confusion and possible interaction, the adjustments should be made in the following sequence. The hoist and lower programming card adjustments are necessary only when motor field programming is provided. Refer to the system elementary to determine what has been furnished.

TABLE IV
Recalibrating Adjustment Sequence

	MCC, MFC AND IFC ADJUSTMENTS	MDR ADJUSTMENTS
DIAGNOSTIC	***LINE***	***A LEVEL***
STATIC MODE,	***FMAX***	***B LEVEL***
ADJUST SEQUENCE	***FMIN****	***ZERO ADJ***
	FLOSS	***SFA***
	SLIM	***MFH***
	CROSS*	***HB***
	LIN TIME	***MFL***
	COMP	***SL1***
	CUR LIMIT	***LB2***
	IMET (IF	***SL2***
	USED)	***LB3***
	ALIGN	***SL3***

TABLE IV (continued)

DIAGNOSTIC RUN MODE ADJUST SEQUENCE	DIAGNOSTIC RUN MODE IS INHIBITED	
NORMAL MODE, ADJUST SEQUENCE	***MAXSPEED***	
	CEMF LIMIT	***MAX NEG***
	REF SCALE	***MAX POS***
		SLOW (IF USED)
	GAIN	
	RESPONSE	***MFH***
	DAMP	***MFL***

*Note: A motor field control card is furnished on base speed drives (constant field) to provide field economy, voltage monitor, and field current regulation. Set ***CROSS*** full CW and ***FMIN*** per test data sheet.

All of the high voltage inputs to the controller have been scaled down with the scale factors shown on the test data sheet. For example: On a 240V motor voltage feedback VFB will be 5 volts when the armature voltage is 216 volts. If VFB is 3.2 volts, then the armature voltage is 3.2 X 216/5 = 138 volts. If armature voltage is 67 volts, VFB will be 67 X 5/216 = 1.55 volts. All values have a tolerance of ±10%.

All readings can have a tolerance of ±10%.

Select Diagnostic Static and set the ***CUR REF*** and ***LOC REF*** to the center positions. Remove the Torque Proving Card from the MDR.

LINE (Line Impedance Compensation)

This function is factory set at approximately mid-range (3½% impedance). CW rotation of ***LINE*** pot adjusts for greater line impedance. Range is 2% to 5% with no jumper RLA to PCR. Range is 4% to 10% with jumper RLA to PCR. If impedance is unknown a mid-range setting with no jumper is suggested.

FMAX (Maximum Field)

Set the ***LOC REF*** potentiometer for zero volt at LR. Adjust ***FMAX*** until FC corresponds to maximum field FC on the test data sheet.

FMIN (Minimum Field — Limit)

Set ***LOC REF*** potentiometer for —7 volts at LR. Adjust ***FMIN*** until FC corresponds to minimum field FC on the test data sheet.

FLOSS (Field Loss — Fault)

Set the ***LOC REF*** to center position and reset the drive. Adjust ***FLOSS*** full CCW.

Monitor FC and move the ***LOC REF*** potentiometer Rev (+LR) until FC corresponds to the field loss value on the test data sheet. Slowly rotate ***FLOSS*** CW until the "Ready to Run" light turns off indicating a drive fault. Reset the drive.

SLIM (Overvoltage Fault)

Set the ***LOC REF*** to center position and reset the drive. Adjust ***SLIM*** full CW.

Monitor SFB and move the ***LOC REF*** potentiometer Fwd (—LR) until SFB corresponds to the overspeed limit on the test data sheet. Slowly adjust ***SLIM*** CCW until the "Ready to Run" light turns off indicating a drive fault. Reset the drive.

CROSS (Crossover — Field)

Field crossover is not used on Max Speed 100 Crane drives. ***CROSS*** should be set full CW on these drives.

On hoist dries with field programming, set ***CROSS*** full CCW. CRS and CMA on the MFC should be jumpered to common to enable programming.

LIN TIME (Linear Time)

Monitor TR and set to zero with the ***LOC REF*** potentiometer. Rapidly turn the ***LOC REF*** full Fwd and measure the time for TR to ramp to 10 volts (±10%). Adjust ***LIN TIME*** until this time corresponds to the test data sheet linear time.

COMP (Compensation — IR)

COMP should be set full CCW. IR compensation is not used on voltage regulated drives.

CUR LIMIT (Current Limit)

Set ***CUR LIMIT*** full CW. Adjust the ***CUR REF*** potentiometer until CFB corresponds to the current limit level on the test data sheet. Monitor DR and turn ***CUR LIMIT*** CCW until DR just moves away from zero.

IMET (Load Instrument Calibration) (If used)

Adjust the ***CUR REF*** until CFB corresponds to full load current. Verify that the optional load instrument reads full load. If not, remove power; adjust ***IMET*** and repeat.

ALIGN (Tachometer Loss Align-Fault)

Set **ALIGN** full CW for voltage regulated drives.

The following adjustments are located on printed circuit cards in the modification rack (MDR).

A LEVEL / B LEVEL

(Sets drop out point of signal level detector relays SLA and SLB. Refer to GEK-24946 for details).

Set **COMP** full CW. Adjust **CUR REF** until CEMF is .3 volts (5% CEMF). Adjust **A LEVEL** until SLA drops out.

Adjust **CUR REF** until CEMF is at the desired level for brake setting. Normally, .6 volts (10%) for travel drives and 1.2 volts (20%) for hoists drives. Adjust **B LEVEL** until SLB drops out. Return **COMP** full CCW and **CUR REF** to center.

ZERO ADJ (Reference Card)

(Used with induction masterswitches). With the masterswitch in the OFF position, set **ZERO ADJ** for 0 ±.1 volt at D1S on the reference card.

The following adjustments are on the hoist and lower programming cards in the modification rack. If motor field programming is not provided, proceed with the normal run adjustments. Set all adjustments on the hoist and lower card.

SFA (Standby Field Adjust)

Adjust **SFA** until FC corresponds to standby FC on the test data sheet.

MFH (Minimum Field Hoist)

Monitor LR and set to —5.6 volts with **LOC REF**. Set 0 volts at CFB with **CUR REF**. Adjust **MFH** until FC equals the minimum field hoist value of FC on the test data sheet.

HB (Hoist Breakpoint)

Adjust **HB** until HB on the hoist card corresponds to the value on the test data.

MFL (Minimum Field Lower)

Monitor LR at set and +5.6 volts with **LOC REF**. Set 0 volts at CFB with **CUR REF**. Adjust **MFL** until FC equals the minimum field lower value of FC on the test data sheet.

Current Feedback in the following steps is negative in polarity.

SL1 (Slope 1)

Set CFB at the value listed on the test data using **CUR REF**. Adjust **SL1** until FC equals the value listed.

LB2 (Lower Breakpoint 2)

Adjust **LB2** until LB2 on the Lower card corresponds to the value on the test data.

SL2 (Slope 2)

Set CFB at the value listed on the test data. Adjust **SL2** until FC equals the value listed.

LB3 (Lower Breakpoint 3)

Adjust **LB3** until LB3 on the lower card corresponds to the value on the test data.

SL3 (Slope 3)

Set CFB at the value listed on the test data using **CUR REF**. Adjust **SL3** until FC equals the value listed.

Return the Diagnostic switch to Normal. Insert the Torque Proving Card back into the MDR.

MAX SPEED (Maximum Speed)

Set **REF SCALE** full CW. Monitor the armature voltage from DA1 to DA2. Adjust the masterswitch until the motor is running at actual top voltage. Adjust **MAX SPEED** until SFB is 10 volts.

CEMF LIMIT (Counter EMF Limit)

Turn **CEMF LIMIT** full CCW and set the masterswitch at full throw. Adjust **CEMF LIMIT** until CEMF corresponds to the **CEMF LIMIT** on the test data sheet. Return **REF SCALE** full CCW.

***MAX NEG/MAX POS* (Maximum Reference)**

Move the masterswitch to the full hoist or forward position. Adjust the ***MAX NEG*** potentiometer until SFB is +10 volts. This normalizes the timed reference TR and system feedback, SFB for 10 volts at top voltage. Move the masterswitch to the full lower or reverse position. Adjust the ***MAX POS*** potentiometer until SFB is —10 volts. If out of range adjust the REF SCALE pot as needed.

***SLOW* (Slowdown or Spotting Reference)**

With the masterswitch at full throw, actuate the thumb switch, spotting pushbutton or slowdown limit switch to drop out the slowdown relay. Adjust ***SLOW*** for the desired slowdown or spotting speed. Normally ***SLOW*** is set at 20-25% of maximum voltage.

***MFH and MFL* (If used)**

With the masterswitch at full throw, trim the ***MFH*** and ***MFL*** adjustments for the no load hoisting and lowering top speeds.

***GAIN, RESPONSE, and DAMP* (Stability Adjustments)**

1. Set ***DAMP*** potentiometer at minimum 7 o'clock position.

2. Set the ***GAIN*** adjustment by calculating the ***GAIN*** number and referring to the chart (Fig. 22).

$$\text{Gain No} = \frac{\text{Maximum Operating Speed}}{\text{Motor Base Speed}}$$

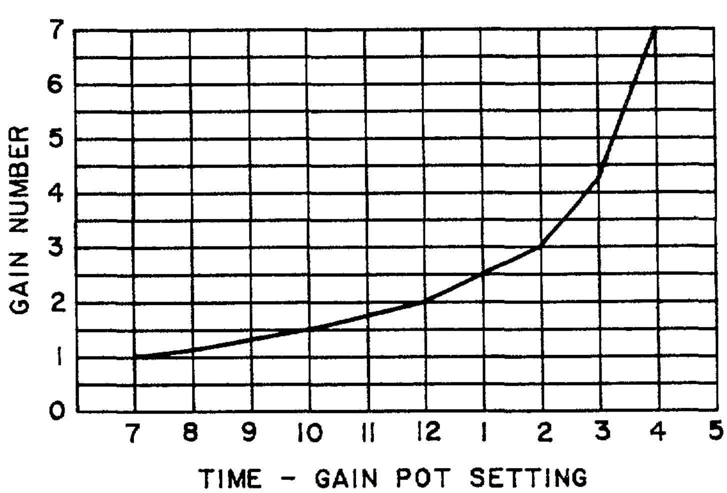


FIG. 22 GAIN ADJUSTMENT

After this setting has been made, make no further adjustments to the Gain Pot.

See motor nameplate under — Speed.
Motor Base Speed/Maximum Operating Speed.
Example: 1150/3600 RPM

3. Set ***LIN TIME*** potentiometer at minimum (7 o'clock).

4. Set ***RESPONSE*** potentiometer at minimum (7 o'clock).

   When the drive is functioning properly in all other respects make small incremental step increases and decreases in speed below base speed. Observe armature current for bumping repeatedly before steady state speed is attained.

   Increase the ***RESPONSE*** setting (move CW) until bumpy current is observed. Then reduce the ***RESPONSE*** setting until no bumps (or only one) is observed. This is the maximum ***RESPONSE*** setting.

   In general, settings below 10 o'clock will show signs of increasing sluggishness. Settings greater than 2 o'clock may show signs of hard or even continuous bumping. Full ***RESPONSE*** setting (5 o'clock) will usually trip the IOC.

5. Reset ***LIN TIME*** to required setting.

TROUBLE SHOOTING

Although many of the problems which may arise can be effectively located with a multi-meter, an oscilloscope is a very powerful trouble shooting tool. The only requirements are that the selected scope have a DC input capability and a line synchronization mode. Caution should be exercised in measuring any point with a possible high potential with any instrument; however, particular care should be taken with an oscilloscope since the common clip is normally connected directly to the instrument case. If the grounded plug has not been defeated, it will cause a short circuit between the high potential point under test and ground.

RECOMMENDED INSTRUMENTATION

Simpson Multi-meter (or equivalent) 10,000 ohms/volt (or higher).

Hewlett-Packard, Tektronix or equivalent dual trace oscilloscope rated for operation from DC to 10 MHZ at 0.01V/CM with deflection factors to provide 0.01V/CM to 1300 peak to peak deflection when used with appropriate attentuator probes.

PROCEDURES

In trouble shooting this drive system, the most appropriate place to start is to follow the SEQUENCE OF OPERATION (previously described) until a discrepancy or fault is noted.

This step by step procedure will determine which part, subassembly or printed circuit card is causing the problem.

Included in this procedure is the use of the built-in Diagnostic Card (DGC) (or Test Circuit Fig. 21). This is another powerful tool for quickly locating drive system faults.

If the malfunction is a performance problem, then the quickest way to discover the problem is to follow the CALIBRATION PROCEDURE (previously described). There are two calibration procedures: (1) Without motor field programming (Maxspeed 100) and (2) With motor field programming (Maxspeed Hoist Drives). Detailed adjustments are found in GEK-24971 for the MFC card.

HOW TO TEST AN SCR

WARNING

ELECTRIC SHOCK CAN CAUSE PERSONAL INJURY OR LOSS OF LIFE. WHETHER THE AC SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS THROUGHOUT THE SYSTEM.

1. Disconnect the AC power and make sure the loop contactor (MA) is open.

2. Using a multi-meter selected to read ohms on the times 1K scale, check the forward and reverse resistance of SCR cell pair. This is done by reading across power terminals T1 and DA1, T2 and DA1, T3 and DA1 for power conversion module SCR A (upper). Check the lower modules SCR B by reading across power terminals T1 and DA2, T2 and DA2, T3 and DA2. Be sure that the DC fuse DCFU is not open in the above.

SCR Description	Forward Reading	Reverse Reading
Good SCR	100K to Infinity	100K to Infinity
Shorted SCR	Zero	Zero
Inoperative SCR	1 to 2K	100K to Infinity
Open SCR	100K to Infinity	100K to Infinity

3. Since an open SCR will give about the same resistance reading as a good SCR another method must be used to find this type of fault. It should be pointed out; however, that practically all cells fail by shorting and very few by opening. If an open SCR is suspected or it is desired to check the switching operation of an SCR, the following circuit should be used:

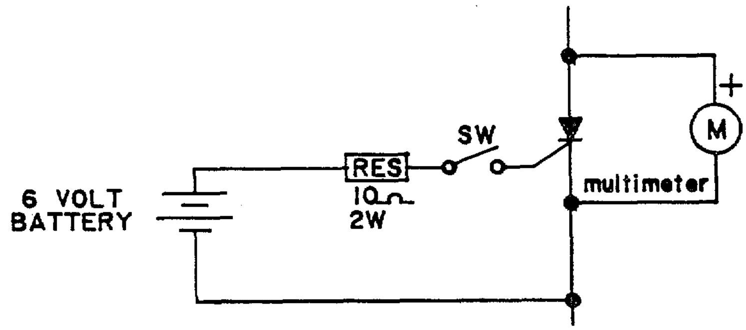


FIG. 23 SCR TEST CIRCUIT

The multimeter is selected to read ohms on the 1K scale, and is connected to read the forward resistance of the SCR. When switch SW is closed, the forward resistance of a good SCR will change from a high value (100K to infinity) to a low value (1 to 10K). When the switch is opened a good SCR will revert to its high forward resistance or blocking state, if the holding current (multi-meter battery) source is momentarily removed. A faulty SCR will not switch remaining in either an open or a conducting state.

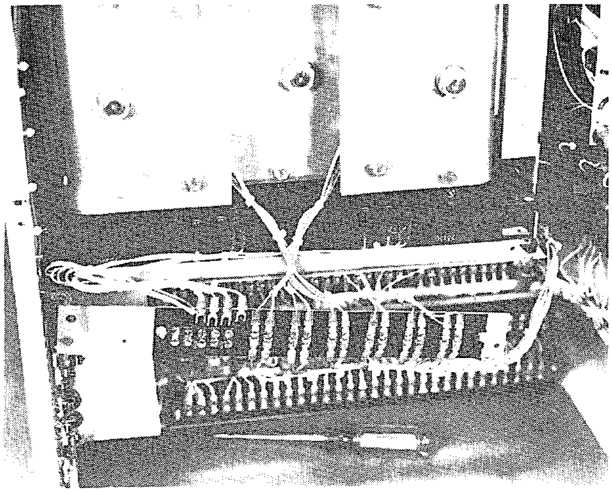
4. If any SCR's are suspected of being faulty from the above resistance checks, the appropriate SCR conversion module should be removed from the case. After the SCR cathode and gate leads have been disconnected, recheck the forward and reverse resistances before replacing the SCR heat sink assembly. This should be done before any SCR is definitely classified as damaged or faulty, since a fault in another SCR or another part of the circuitry can produce a faulty reading from a good SCR before it is disconnected from the circuit.

REMOVAL/REPAIR

CONVERSION MODULE

The conversion module is best removed as follows:

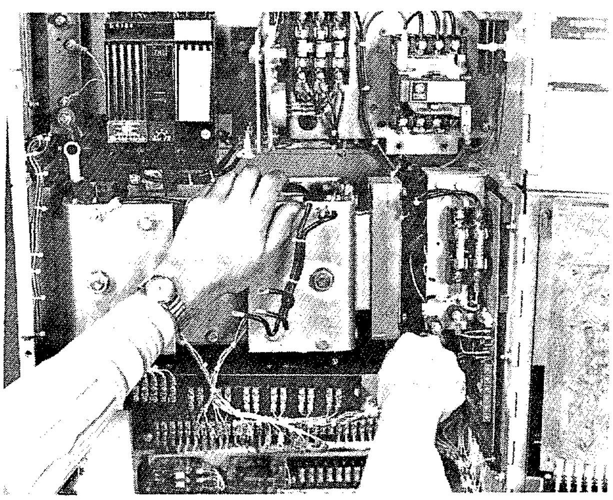
Disconnect the three AC input power and DC output leads.



(Photo MG-5236-7)

FIG. 24 REMOVAL OF GATE LEADS

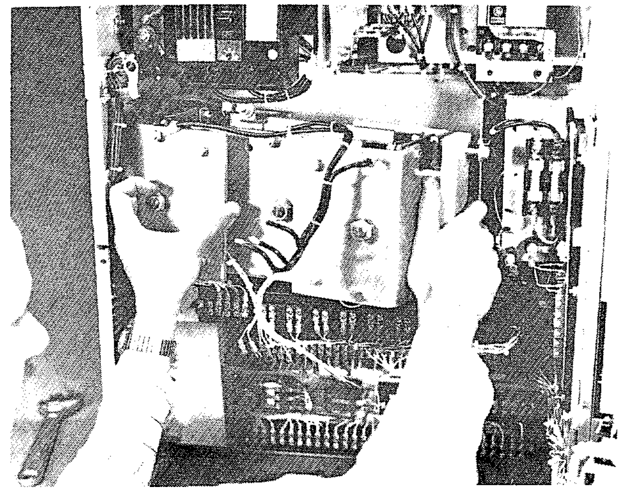
Disconnect the SCR gate leads from the terminal board MTB. If markings are not legible, remark prior to removal.



(Photo MG-5236-10)

FIG. 25 REMOVAL OF SLOTTED SPACER

Loosen two nuts on the right hand side and remove the slotted spacer.



(Photo MG-5236-22)

FIG. 26 REMOVAL OF CONVERSION MODULE

Slide module to the right and pull out.

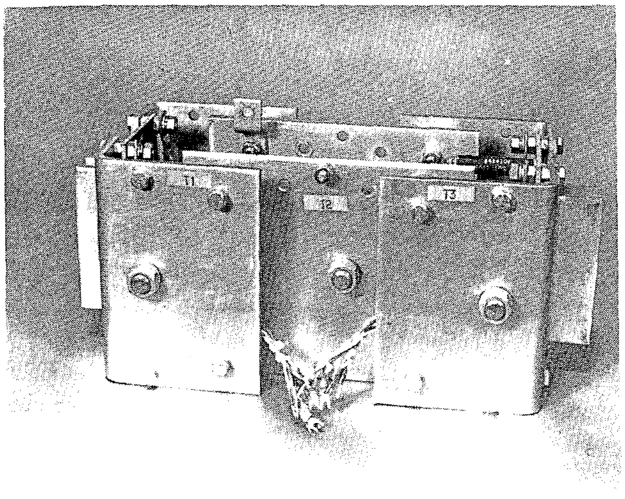
SCR REPLACEMENT

The joint between the SCR and the heat sink performs two functions: (1) it carries the current and (2) it conducts the heat out of the SCR. To perform these functions properly, special care must be taken when reassembling an SCR to the heat sink as follows:

STUD MOUNT SCR'S

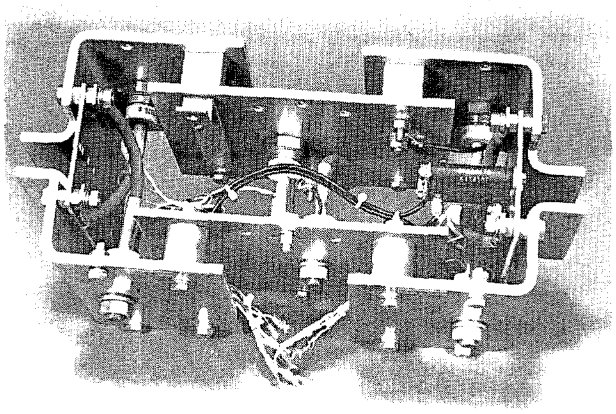
Clean all surfaces of old lubricant and stray dust. Apply a thin film of General Electric G322L VERSILUBE™ and tighten with a torque wrench to the following specifications:

STUD SIZE	TORQUE
1/4 - 28	30 inch lbs.
1/2 - 20	135 inch lbs.



(Photo MG-5236-26)

FIG. 27 STUD MOUNT HEAT SINK (Front View)



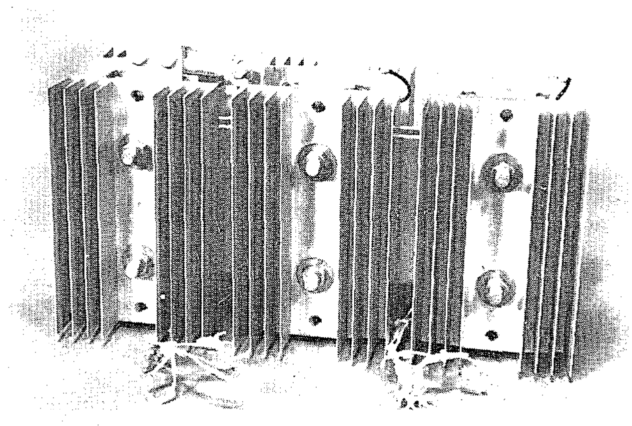
(Photo MG-5236-27)

FIG. 28 STUD MOUNT HEAT SINK (Top View)

PRESS PAK SCR'S

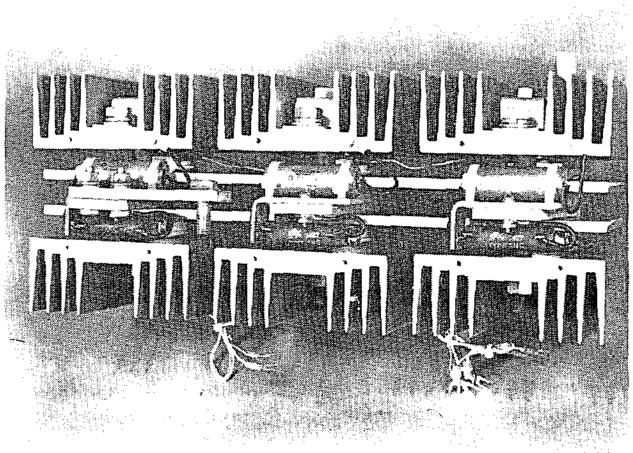
Clean both surfaces of old lubricant and dust. Apply a thin film of General Electric G322L VERSILUBE. Line up the assembly and evenly tighten the nuts finger tight. Tighten the nuts, one at a time, alternating between nuts according to the following specifications.

CELL THICKNESS	TORQUE
1/2", 5/8"	40 inch lbs.
1"	80 inch lbs.



(Photo MG-5236-24)

FIG. 29 PRESS PAK HEAT SINK (Front View)

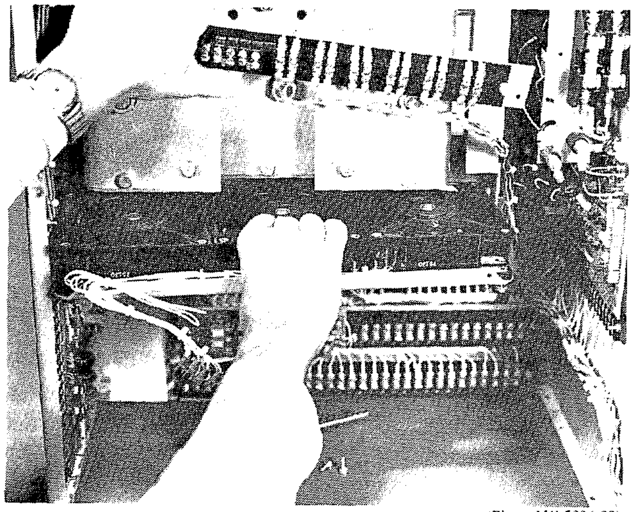


(Photo MG-5236-18)

FIG. 30 PRESS PAK HEAT SINK (Top View)

FANS (if supplied)

Remove the fan wires from the terminal board assembly and remove the two screws holding the terminal board assembly to the fan shelf. Loosen the two nuts on the bottom of the fan bracket and slide the fan bracket out.



(Photo MG-5236-23)

FIG. 31 REMOVAL OF FANS

NOTE

There should be no need to retune the drive after removal/repair of a conversion module, an SCR or any other removable sub-assembly unless, of course, an adjustment was inadvertently moved or disturbed. If a printed circuit card is replaced (other than the power supply card PSC):

1. Add stab-on jumpers to the replacement card just like the jumpers on the card that was replaced or as listed on the System Elementary Diagram "Programming" Table.

2. Add stab-on resistors and capacitors to the replacement card just like the components on the card that was replaced or as shown with values on the system elementary main control card (MCC) at stab-on terminals TR, RJ, SFB, NDE, CL1, CLJ, and LT2 or on the DM1, DM2, etc.

3. Set the potentiometers on the replacement printed circuit card to the position as was set on the card that was replaced or the position shown on the test data sheet. Recheck the recalibration procedures described.

4. **Use caution when connecting or disconnecting stab-on connectors on the printed circuit cards to avoid breaking of the connector posts. Support the card if possible and use a pair of long nosed pliers to hole on the connector crimp. Avoid pulling on wires when removing connectors. Pull straight up on stab-on. Side pressure can cause solder joints to break.**

MODIFICATION FEATURES

With the various types of crane drive applications, there are many special features required which differ from one crane drive system to another. Below are listed some of the more frequently used features which may be found in a particular crane drive.

LIMIT SWITCHES

There are various functions of limit switches. An "operating" limit switch may bring the drive to a stop or slowdown the drive as part of normal operation. The stop is by regenerative braking before setting the brake, and the slowdown may simply recalibrate the regulator reference for a slow speed.

A "back-up" or "overtravel" limit switch is designed to initiate an immediate stop by setting the brake and preconditioning the drive. Such a limit switch may be an overhoist or end-of-travel limit switch.

A "power" limit switch is sometimes required as an overhoist limit switch which actually interrupts the power loop of the D-C motor and connects a dynamic braking resistor across the motor armature (Fig. 32). A contact on the power limit switch (PLS) deenergizes the brake directly. When backing out of the limit switch, the masterswitch picks up the lower contactor (L) which bypasses PLS, energizing the brake and applying power to the motor armature.

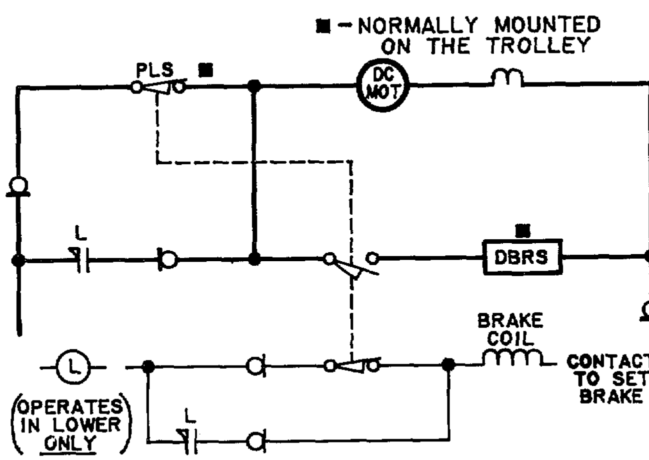


FIG. 32 POWER LIMIT SWITCH CIRCUIT

STATIC EXCITER

The static exciter is a full-wave, single phase bridge supplying constant-potential, direct-current power supply, employing static components. It consists of a transformer, rectifiers, and protective components. See GEI-43710. It provides DC control power for DC shoe brakes.

EMERGENCY DYNAMIC BRAKING

This safety modification is designed to prevent the free fall of an overhauling load under the condition of simultaneous failure of the power supply and the holding brake. This is accomplished by a contactor which drops out due to loss of power, inserting a resistor across the motor armature. The voltage across this resistor is then fed through a rectifier bridge, for the correct polarity, to the motor shunt field to self-excite the motor for a controlled lowering speed.

LOAD SPOTTING

The masterswitch is recalibrated to provide 25% speed at full throw. This reduces the minimum hoisting and lowering speeds and gives the operator more accurate speed control for spotting the load.

LOAD FLOAT

Load float enables the operator to hold or spot the load without the use of the holding brake. Load float control is initiated by depressing the masterswitch thumb latch or a pushbutton which releases the brake and recalibrates the drive speed relationship. Top drive speed now becomes 20 to 25 percent of normal speed.

NOTE: The motor capability limits the time of stalling at absolute zero speed.

TRANSFER SWITCHING

For some crane drive systems the same crane drive may be operated from different control locations, in which case it is necessary to transfer the crane drive control from one masterswitch to another. This transfer may be accomplished by SB type switches or relays.

RADIO REMOTE CONTROL

Radio control can be substituted for the masterswitch for remote operation. By the nature of radio control, all speed control is stepped and all functions and interlocking must be performed by relays.

PENDANT STATION

A pendant station may be substituted for the masterswitch for a floor-operated crane. On a pendant station, the speed potentiometer is operated by depressing the hoist or lower pushbutton proportional to the speed required. While a masterswitch can have twelve contacts (standard maximum) for interlocking, the interlocking must be performed by relays for a pendant station control. Other functions supplied in an operator's cab, such as a spotting pushbutton are supplied on the pendant station.

TRAVEL MOTIONS

Many crane drives require bridge, trolley, gantry, or a combination of motions to be incorporated in one crane drive system. Depending on the application and duty cycle, the travel motions may be operated simultaneously with the hoist, in which case separate drives are used for each function; or the travel motions may be operated with the hoist on a first-come, first-serve basis powered by the same drive. In this case, the hoist or travel motion is chosen by a selector switch or by whichever masterswitch is operated first, locking out the other functions.

Each travel motion then has the same protective devices, brake circuitry, and provisions for limit switches as described previously for the hoist function. Two differences for travel motions are that (1) the torque or current limit function is normally set for 150 percent of rated torque, and (2) the drive is allowed to regenerate to 10 percent armature volts before setting the brake on a stop. These lower settings prevent skidding of wheels and make braking less severe.

TRAVEL DRIFT

The travel drift modification is to enable the operator to "coast" the crane drive for a travel motion. Drift control is initiated by depressing the masterswitch thumb latch or pushbutton which releases the travel brake and recalibrates torque or current limit. The current limit now becomes 50 percent instead of 150 percent of rated current, thus reducing the braking torque during the regeneration to a low value.

HOIST MOTOR FIELD PROGRAMMER

(Refer to GEK-45130 and GEK-45131 for hoist and lower programming card elementary diagrams).

The purpose of the motor field programmer is to control motor field current as a function of armature current to obtain a constant horsepower characteristic. From no load to some small hook load, depending on the characteristic, the motor shunt field is held constant; from that point to approximately 100 percent rated hook load, armature current is constant and the field is varied to change speed and torque to give a constant horsepower characteristic. At 100 percent rated load, the motor field control reaches a maximum output, and the motor field is held essentially constant for further increases in load.

The motor field programmer consists of the motor field control, the hoist programming card (HPC) and the lower programming card (LPC).

In the OFF position, the field is set by the field economy circuit on the motor field control which reduces the field excitation to 70% of the ***SFA*** setting whenever the drive is shut down.

A direction sensing circuit on the hoist card senses the polarity of the CEMF signal. When the CEMF signal is negative, pin 23 will switch positive to open a FET switch and provide an off bias signal (KL) to the lower card. When the CEMF signal is positive, pin 23 will switch negative to open another FET switch and provide an off bias signal (KH) to the hoist card.

With zero volts at CFB and CEMF, the adjustment range of 75% to 100% of the nominal field current as set by ***FMAX*** on the MFC card. This allows ***SFA*** to be set at the rated field level and ***FMAX*** to be set for a field forcing level of up to 33%.

HOIST

In the hoist direction, a negative CEMF signal on pin 25 of the hoist card is inverted to provide a positive signal at pin 30. This signal weakens the motor field. The ***MFH*** adjustment adjusts the amount the field is weakened and therefore is used to set the no load hoist speed (Point A on Fig. 33). If the CFB signal, which is negative in hoisting, exceeds a preset bias level, the voltage at pin 6 will go negative to strengthen the field as a function of armature current. Field strengthening (Point B in Fig. 33) can be adjusted to occur from 80% to 100% of rated current by hoist bias potentiometer ***HB***.

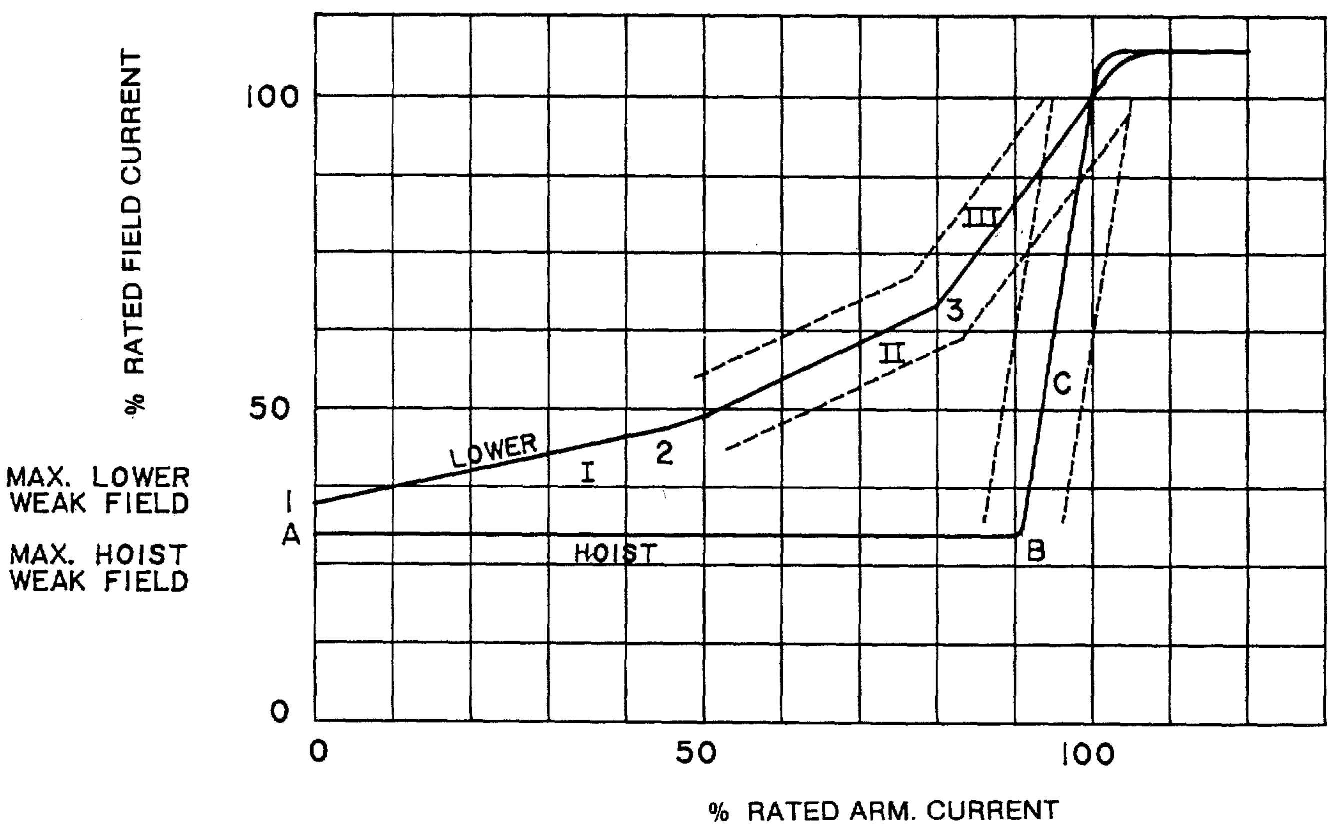


FIG. 33 MOTOR FIELD VERSUS ARMATURE CURRENT SIGNAL (TYPICAL CURVE)

The gain of the field strengthening circuit (Slope C, Fig. 33) may be decreased by connecting pin 5 to pin 6. It may be increased by connecting pin 5 to common.

During regenerative hoist operation, when CFB is positive, a bias signal is applied to OA2-2 to prevent field strengthening.

LOWER

Positive CEMF in the lower direction will cause LV to go positive and weaken the motor field. The ***MFL*** adjustment on the hoist card is used to set the no load lower speed (Point 1 on Fig. 33).

The field increase as a function of 2CFB is controlled by three amplifier stages. The first stage (OA2-1) increases the field current with no offset bias. The gain (Slope 1 on Fig. 33) is adjusted by ***SL1***. The second stage (OA3-1) is biased such that additional field increase starts at a given armature current (Point 2 on Fig. 33). This bias is set by potentiometer ***LB2***. The gain (Slope 2 on Fig. 33) is set by ***SL2***. ***LB3*** sets the bias for the third stage amplifier, OA3-2 (Point 3 on Fig. 33). ***SL3*** sets the gain of OA3-2 (Slope 3 on Fig. 33).

The adjustments for the lower characteristic must be made in the sequence as listed in the Calibration Procedure.

Output filtering on both the voltage and current programming sections of the lower card controls the rate of change of the motor field. The time constants of OA1-2 and OA4-2 may be changed by jumpers connected from pins 3 and 30. The time constant in the voltage section may be increased by moving the jumper from pin 18 to pin 21, 24 or 25. The time constant in the current section may be increased by moving the jumper from pin 10 to pin 7, 8 or 6.

Increasing these constants will decrease the amount of speed overshoot when lowering full load but will also increase the lower no load acceleration time to top speed.

The motor field may be set up in the "Diagnostic Static" mode. The CEMF signal is replaced by FDR (Field Diagnostic Reference) which is changed with the ***LOC REF*** potentiometer on the diagnostic card. The ***CUR REF*** potentiometer allows for varying the CFB signal to program the field.

In the "Diagnostic Run" mode --20V is applied from DGC (MAC) to DMAC on pin 29 of the lower card and pin 3 of the hoist card. This signal closes FET switch T2, applying diagnostic reference LR to the MFC (FDR) and inhibits the hoist card output CRM. This allows the ***FMIN*** and ***FLOSS*** values to be checked.

REFERENCE CARD (REF)

(Refer to GEK-45129 for the reference card elementary diagram).

The reference card provides a circuit to convert the output of an induction masterswitch to a bidirectional DC reference for a reversing drive. With the induction switch connected to pins 8X, 9, 8 and 6, the output (D1S) at pin 10 will vary from —20V ±2V to +20V ±2V for full throw of the masterswitch.

A reference polarity check is also provided. A negative input at pin 19X can be supplied to pin 30 or 30X only if +30V is applied to pin 11 (NSW).

A positive input at pin 19X can be supplied to pin 5X or 3X only if +30V is applied to pin 13 (PSW).

The voltage monitor circuit will generate a fault trip signal at SYS when a 25% error exists between the driver reference DR and the system feedback SFB. When the voltage at pin 28X exceeds 10V the output of the latch circuit on pin 23 (SYS) will exceed +10V to initiate a system trip. The OCK indicating light will also turn on. With the error voltage at pin 28X reduced to less than 10V, the circuit can be reset with the reset pushbutton.

This circuit will also indicate an overvoltage fault (TF) as detected by the overspeed circuit of the MFC.

TORQUE PROVING CARD (TQP)

(Refer to GEK-45128 for the torque proving card elementary diagram).

The basic card function is to prevent releasing the motor brake until proper current response to both a positive and negative reference has been detected.

SEQUENCE OF OPERATION

When preconditioning is released and a reference signal is applied, the TR voltage will time up as a function of the reference signal until the clamp level of 1.6V to 2.0V is reached.

The TR voltage is now inverted by OA1 such that ATR = —TR. This ATR signal is applied to the regulator in addition to the TR signal, but at twice the current level resulting in a net effect of inverting the applied reference.

The initial test involves checking for proper current polarity in response to the inverted reference.

For a negative input the TR voltage is negative and the ATR voltage is positive which should result in a positive CFB signal. If CFB > +.8V with ATR > +.8V the voltage at pin 27 is pulled low (<1V), the voltage at pin 13 swings high (>+15) and the voltage at IC1(4) swings low, LED1(LC) is illuminated to indicate the detection of a positive CFB signal with ATR positive.

The second test is then initiated by checking for a current response to the TR reference only. As IC1(4) swings low, transistor T8 is turned on to close the FET switches T6 and T7. This changes OA1 to a non-inverting amplifier such that ATR = TR. The auxiliary timed reference is now removed from the regulator by the closing of T7. The regulator then only sees the clamped TR voltage which should result in a current reversal.

For a negative reference as described above, both TR and ATR is negative and a negative CFB voltage should result. Thus if CFB < —.7V with ATR < —.7V the voltage at IC1 (8) swings low to latch in the circuit. Now as IC1(8) swings low LED2(HC) is illuminated to indicate the detection of a negative CFB signal with ATR negative.

If the input reference is positive the test would be performed in the reverse order by LED2(HC) being illuminated before LED1(LC).

With both current polarities detected, pin 10 and pin 13 have both changed to a high state (>15V) making IC1(10) swing low. The output of the second half of OA1 at pin 22 then switches from positive saturation to negative saturation. This turns on transistor T17 to energize the external BPR relay. At the same time T2 is opened to remove the TR clamp, the T1 switch is closed for a period adjustable by P1 from zero to .5 seconds to clamp the TR voltage at zero until the brake opens.

If the input signal is removed shortly after application, it is possible to detect and latch up in one direction, but not in the other as the reference is removed. If the test is not completed, i.e., if the voltage at pin 22 does not swing negative within 1 second following the detection of one current polarity transistor T16 will turn on to reset the circuit.

When the drive is preconditioned by the PRE voltage changing from —3.5V to zero, transistor T14 turns on to reset the circuit. In the Diagnostic mode a positive signal, DP2, is applied at pin 6 to override the preconditioning reset which allows a diagnostic check of the circuit.

TORQUE PROVING CHECK (TQP)

(A) Switch the Diagnostic switch to static.

(B) Turn the ***LOC REF*** pot CW (+LR).

(C) Turn the ***CUR REF*** pot CW, until the HC light turns on. Now turn the ***CUR REF*** pot CCW until the LC light comes on. The BPR relay should pick up at this time.

(D) To reset TQP return the Diagnostic switch to normal, switch back to static.

(E) Turn the ***LOC REF*** pot CCW (—LR).

(F) Turn the ***CUR*** pot CCW until LC light comes on. Now turn the ***CUR REF*** pot CW until the HC light comes on. The BPR relay should pick up at this time.

GLOSSARY OF TERMS

	PAGE
ACC — Auxiliary Control Card	14, 16, 21, 25
ALIGN — Tachometer Loss Align Adjustment	(1), 33
BPR — Brake Permissive Relay	14, 23
*CEMF — Counter EMF	(1), 27, 30, 31, 40
CEMF LIMIT — Counter EMF Limit Adjustment	14, 27, 33
*CFB — Current Feedback	27, 28, 30, 31, 32, 40, 41
*COM — Regulator Common	22
COMP — IR Compensation Adjustment	14, 30, 31, 32
CPT — Control Power Transformer	20, 27
CROSS — Crossover Adjustment	(1), 31, 32
CUR REF — Diagnostic Current Reference Potentiometer	25, 30, 32, 42
CUR LIMIT — Current Limit Adjustment	14, 27, 31, 32
DAMP — Dampening Adjustment	14, 30, 34
Diagnostic — Nórmal	32, 33
Diagnostic — Run	19, 31, 32, 41
Diagnostic — Static	19, 30, 31, 41
DGC — Diagnostic Card	14, 19
*DM1 — DM8 Dummy Input/Output points	38
DP1 — DP2 Diagnostic Switching Signals	31
*DR — Driver Reference	27, 30, 31, 32, 41
*EAO — Error Amplifier Output	27
EST — External Fault Stop	22
F1 — F2 — Motor Field Connections	(1), 20, 24
*FC — Field Current Signal	(1), 24, 32, 33
FDR — Field Diagnostic Reference	(1), 30, 31
FEA — Field Economy Adjust	(1)
FF — Field Fault	(1), 25
FLOSS — Field Loss Adjustment	(1), 31, 32
FLT — Fault Relay	21, 22, 25, 27
FMAX — Motor Field Maximum Adjustment	(1), 31, 32, 40
FMIN — Motor Field Minimum Adjustment	(1), 31, 32
GAIN — Speed Loop Gain Adjustment	14, 27, 34
HB — Hoist Breakpoint Adjustment	31, 33, 40
HPC — Hoist Programming Card	14, 40
IFC — Interface Card	14, 18, 21
IMET — Current (Load) Instrument Output and Adjustment	18, 23, 31, 32
IOC — Instantaneous Over Current	25, 34
*IPU — Initial Pulse	29, 30

*TEST Points Located on Door Front (See MCC Illustration, Fig. 7)
(1) Also see Motor Field Control Instructions, GEK-24971

GLOSSARY OF TERMS
(continued)

	PAGE
*JOG — Jog Switch Input	22, 30, 31
*JOGR — Jog Reference	30, 31
LB — Lower Breakpoint Adjustment	31, 33, 41
LINE — Line Impedance Compensation	31, 32
LIN TIME — Linear Timing Adjustment	14, 27, 31, 32, 34
LOC REF — Diagnostic Local Reference Potentiometer	25, 30, 32, 42
LPC — Lower Programming Card	14, 40
*LR — Local Reference from DGC	31
MA — Line Contactor	14, 27, 30
*MAC — MAX Control Signal	27
MAX — Pilot Relay for M	14, 21, 22, 27, 30
MAX NEG — Maximum Negative Reference Adjustment	27, 33
MAX POS — Maximum Positive Reference Adjustment	27, 33
MAX SPEED — Adjustment	14, 24, 27, 33
MCC — Main Control Card	14, 17, 21
MDR — Modification Rack	14, 20, 21
MFC — Motor Field Control Card	(1), 14, 19, 21, 27
MFH — Minimum Field Hoist Adjustment	24, 31, 33, 34, 40
MFL — Minimum Field Lower Adjustment	24, 31, 33, 34, 41
MIN SPEED — Adjustment	14, 23
MOV — Metal Oxide Varistor	20
*OSC — Oscillator	25, 27, 29
OCK — Operational Check	25, 41
*PCR — Phase Control Reference	30, 31
PO — Pulse Outputs	29, 30
*PRE — Preconditioning	27, 30
PSC — Power Supply Card	14, 16, 21
REF — Reference Card	14, 41
REF SCALE — Adjustment	14, 33
RESPONSE — Speed Loop Response Adjustment	14, 27, 34
RESET — Pushbutton	22, 24, 25, 30
RSTOP — Regenerative Stop Adjustment	18, 25
*RTR — "Ready to Run" Indicator	24, 25, 27
*RUN — Run Switch Input	22, 27, 30, 31
*SA, SB, SC — Synchronizing Signals	27, 29
SFA — Standby Field Adjustment	31, 33, 40
*SFB — Speed Feedback	(1), 27, 31, 41
SL — Slope Adjustment	31, 33, 41

*TEST Points Located on Door Front (See MCC Illustration, Fig. 7)
(1) Also see Motor Field Control Instructions, GEK-24971

GLOSSARY OF TERMS
(continued)

PAGE

SLIM — Speed Limit Adjustment .... (1), 31, 32
SLOW — Slow Speed Adjustment 34
*SMET — Speed Instrument Output and Adjustment 18, 23

*SMIN — Minimum Speed Reference Adjustment and Input 23
*SR — Speed Reference 23, 24, 27, 30
*SYS — System Fault Trip .... (1), 25

*TA — Tachometer Align Output .... (1)
TF — Tach Fault .... (1), 25, 41
TKN — Negative Tachometer Input 23
TKP — Positive Tachometer Input 23
TQP — Torque Proving Card 14, 41
*TR — Timed Reference 27, 30, 32, 33
TRIP — Trip Signal for Optional Circuit Breaker 16, 25

*VFB — Voltage Feedback 27, 28, 30, 32

*WFR — Weak Field Reference .... (1), 27

*TEST Points Located on Door Front (See MCC Illustrations, Fig. 7)
(1) Also see Motor Field Control Instructions, GEK-24971

HOT LINE TELEPHONE NUMBER

The Contract Warranty for MAXSPEED drives is stated in General Electric Apparatus Handbook, Section 105, Page 71.

The purpose of the following is to provide specific instructions to the Maxspeed—Drive user regarding warranty administration and how to obtain assistance on out-of-warranty failures.

1. In the event of failure or misoperation during "in warranty" refer to the instruction book to identify the defective part or subassembly.

2. When the defective part has been identified (or for assistance in identification) call:

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCT OPERATION
ERIE, PENNSYLVANIA

814—455—3219

(24 Hour Phone Service)

or

Contact the nearest

General Electric Installation and Service Engineering Office listed in your telephone directory. Before calling, list model and serial numbers of the power unit and DC motor.

GENERAL ELECTRIC COMPANY
SPEED VARIATOR PRODUCTS OPERATION
ERIE, PENNSYLVANIA 16531

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GEK-24916A (1/84) 600 (P)