SERVO LADLE WITH TRIANGLE CONTROLS

SECTION 6: LADLE ELECTRICAL DRAWINGS

SECTION 7: LADLE MECHANICAL DRAWINGS

SERVO LADLE WITH TRIANGLE CONTROLS

MANUAL VERSION NUMBER	SOFTWARE VERSION NUMBER	COMMENTS	DATE	BY
.PRO	.PRO	PRELIMINARY RELEASE, FIRST FOR TRIANGLE CONTROLLED 405	12/20/96	DLC ACY
4.05E	4.05E	UPDATED TO NEW SOFTWARE VERSION AND CORRECTIONS MADE.	12/04/98	LWH ACY

WARNING

Please read entire manual before attempting any installation or Programming of this machine. Failure to do so may result in personal injury or machine damage.

The doors interlock switch located inside the control panel does not remove power from the entire control panel. This switch only disables I/O control power, therefore use extreme caution when door is open.

SERVO DRIVE LADLE

WARRANTY

For a period of six (6) months from the date of shipment or prior to the first 250,000 cycles, Rimrock Corporation will repair or replace, at its option, any part of the system that is found to be defective in workmanship or material. Determination of our obligation under this warranty will be made by Rimrock after examination of alleged defective materials are returned to Rimrock transportation prepaid.

The foregoing warranty is exclusive, and in lieu of all other warranties, whether written, oral, or implied, including the warranty of merchantability and the warranty of fitness for a particular purpose.

Any alteration, modification or repair to any circuit board contained in the 405 system will **VOID** all warranties. All electronic repairs **MUST** be handled through Rimrock Corporation.

1.INTRODUCTION

This manual contains information for many of Rimrock's Ladling products. In general, items discussed pertain to all machines, when information is different the difference is stated.

1.1 GENERAL EQUIPMENT SAFETY

The invention of automatic equipment used on die casting machines greatly enhanced the production and efficiency of making quality castings. Like any other machinery, if not used safely it can pose a hazard to personnel as well as damage to the equipment.

During the design and installation of any automated equipment, many codes and standards must be used. As this equipment is installed and operated in connection with your automated application these MUST be considered. Some of these include:

NFPA 79

NFPA 70

NEC

ANSI B11.19

ANSI B11.20

JIC

ANSI/RIA R15.06

UL 491

OSHA

Safety of operation begins with training personnel in the safe operation and maintenance of this equipment. Operator and maintenance personnel must understand how the equipment works in order to operate it safely. The owner/end user of this equipment is responsible for the training to safely operate and maintain this equipment. Rimrock will provide equipment training when requested.

Machine owners, operators, maintenance and service personnel must be aware that every day common safety practices are a vital part of their job and must be complied with constantly. Use of personal protective equipment and keeping the work area clean and free of potential hazards will enhance any safety program. In addition, all warning labels, signs and guards must always be replaced if they are removed for any reason. Safety violations should always be reported to the proper personnel.

Always remember automatic equipment starts by a signal and gives you no warning. Always be aware of this and make sure the equipment is shut off and all power sources locked out before you work on or around the equipment.

In addition to the safety precautions in the manual, all the latest OSHA Instructions, Local, Federal and National Safety Codes and Safety Rules must be understood and followed to operate equipment safely. For additional safety information on die casting, refer to NADCA's Die Casting Safety Manual E-908.

1.2 INSTALLATION SAFETY

Study the equipment manual before attempting to install this machine. The installation must be made with only qualified personnel capable of positioning, anchoring, making power connections and interlocking this equipment with other equipment. Failure to use qualified personnel could result in personal injury as well as damage to your equipment. The electrical connections must be made by a qualified electrician who must be able to read and understand electrical schematics in order to assure safe connections. Correct grounding of interlock connections are explained and illustrated in this manual. In addition, a **SAFETY BARRIER** must be installed to prevent personnel from entering the path of moving equipment while it is operating. It should also be noted that proper clearance must be allowed for all movements of your equipment. By following these recommended steps your equipment should operate safely and correctly.

1.3 SET-UP AND OPERATION SAFETY

Operator and maintenance personnel must read the equipment manual and be trained in the proper equipment operation to set-up and operate it safely. Always make sure all control panel switches are "OFF" when power is first applied. Never make any adjustments to the equipment while it is operating. Remember that the machine has the ability to strike, pinch or grab personnel or clothing, which may result in injury. It should never be necessary to adjust

this equipment with the power "ON". If you find it necessary to make an adjustment or for troubleshooting with the power "ON," a second qualified person should be at the operator panel operating the equipment in Manual Mode. The second person should always have sight of the person working on the equipment. Under NO circumstances would any adjustments be made while the equipment is moving. Never operate the equipment before making sure the area is clear and all safety guards and devices are in place. Only authorized personnel should be able to modify the programming of this equipment and it can never be operated without the recommended interlocks. Any unsafe conditions of equipment operation should be reported the proper personnel immediately.

1.4 MAINTENANCE SAFETY

Do not attempt to perform any maintenance on this equipment until you read and understand all the safety instructions and all the power sources are locked out according to OSHA's Lock Out Procedures. Be sure the electrical power in the interlock system is "OFF" when the machine power is disconnected. These are usually yellow wires and can supply power from another source when the main disconnect is off. Always turn power "OFF" before removing the circuit boards to prevent damage to the boards and also "Electrical Shock" to yourself. Keeping your equipment clean and the area in which it is located clean is a vital part of your safety program. Developing a set periodic maintenance program of your own, plus following recommended maintenance in this manual will extend your equipment's life and make it safer to operate. **DO NOT** attempt to alter, bypass or short circuit any safety device or systems on this equipment. All guards, shields, barriers or covers must be put back after any maintenance is performed or repairs are completed before the equipment is returned to service. The end user of this equipment is responsible for the safe operation of the equipment and for the safety of their operations and maintenance personnel.

1.5 MACHINE DESCRIPTION

The ladle is a fully programmable system using two servomotors and controllers to power its movements. One motor drives the arm and the other drives the dipper. The position of the arm and dipper is monitored throughout the cycle by an encoder connected to each motor. By utilizing two servo drives and controllers both axis (arm and dipper) are moved at the same time. This allows for faster cycle times as the path of the dipper can be controlled for optimal performance. The unit is controlled by a computer system, an input/output rack and a servo motor controller. Positions, speeds and timers are easily programmed by the keypad on the operator station. The operator station (keypad or video) is connected to the main control box via a serial communication cable. This allows the operator station to be located away from the main control box. Thus, creating more room at the operators station of the die cast machine.

The system also uses a three probe metal sensing system. One of the long probes is a common probe. The other long probe senses the metal level under normal conditions. This allows the Ladle to seek the level of the metal in the furnace as it is emptied and filled. The short probe senses a rising metal level while the dipper is in the metal. This high metal probe keeps the arm from becoming submerged in the metal if the furnace is being filled. A sensor check is used each cycle to insure that the sensor system is working properly

THE COMPUTER SYSTEM CONSISTS OF THE FOLLOWING:

Keypad - Mounted on the front of the operator panel, it is used to program the system and show digital readouts of all programmable functions of the unit. It communicates to the CPU board via a serial communication network. This allows the Keypad to be located away from the main control box.

Video Keypad - As an option this machine is available with a Video Touch Screen Operator Interface, for use as a Keypad. This Video Interface utilizes a Capacitive Touch Screen on front of a Color LCD Flat Panel Display. All Rimrock Machines in a cell can be controlled by this one interface. All functions are similar to utilizing a Standard Keypad. The only exceptions are in the teach area, where this device makes programming easier.

Card Cage - The card cage houses all the computer boards that are required to operate the ladle. This card cage is sometimes referred to as

the computer system. The Rimrock Triangle controls utilize a STD bus card cage system for communication between the various boards.

Servo Controller Board - This board sends position and speed commands to the servo amplifiers. It receives signals from the encoders built into the servomotors, which allows constant tracking of machine position.

Central Processing Unit (CPU) - The CPU Board, the brain of the entire system, is mounted in the card cage and handles all information to and from the other boards. This board also contains plug in chips (FLASH EPROM), which contain the system software, (this software is a computer program that tells the system how to work). The software has been electronically written into the EPROM. The information written to the EPROM is retained whether power is applied or not. It does not require battery back up to retain the program. The CPU board houses a set of battery backed RAM chips that are the storage chips for the operating parameters (the settings that the customer programs in for his operation). It has serial communications that allow it to communicate to the Keypad and the Message center. It also has Digital I/O that connects the computer to the I/O rack, which sends and receives signals from the input/output modules mounted on the I/O rack.

Input/Output Rack - This board-like rack contains modules that connect the computer to the outside world. All signals to and from the die cast machine and ladle are connected to plug in modules that interface computer signals to the die cast machine and the ladle.

Power Supply - The supply (located in the lower left side of the control panel) is a 5-12-24 volt DC regulated supply for the computer and keypad. The 24 volt DC supply powers the ladle limit switches and sensor probe circuits. This is a computer grade SWITCHING power supply, therefore, NEVER operate this supply without a load attached. If the power supply is on and the output power cable is disconnected, damage to the supply is possible.

Message Center - The ladle features a message center that communicates with the system CPU via a serial link. This message center is designed to make the users' job easier and faster, which increases productivity. Diagnostics, cycle and programming messages result in decreased set-up time, faster troubleshooting and even simpler programming. In case of a fault, the fault number and an explanation message is displayed by the message center.

1.6 UNPACKING & HANDLING

After removing the top and sides of the shipping crate, remove the control panel, and remove and assemble the mounting pedestal (see Assembling Pedestal). The interconnecting cables on the mechanical unit should <u>not</u> be removed.

Next, remove the fiberglass side covers from the ladle. Using a nylon sling of appropriate capacity, (the machine weight is approximately 500 lb.), place the sling under the three upper side plate spacers. After hooking the sling to a crane, remove the bolts that secure the steel plates to the crate. Lift the ladle out of the crate and mount it on top of the pedestal with the four bolts provided. After tightening the clamping bolts that secure the post in the pedestal, the ladle may be moved to the desired location.

1.7 ASSEMBLING PEDESTAL

The ladle pedestal is shipped unassembled. Please refer to the Ladle pedestal assembly drawings in **Section 7** of this manual. The base plate should be located on a flat level floor. The upper post can then be inserted into the base plate assembly. Next, install the "T" mount weldment by inserting it into the top of the upper pedestal assembly. It must be secured with the pivot pin supplied and locked in place with the snap rings. The last step is to install the ladle tilt bolts into the upper pedestal assembly. These bolts allow the ladle to be tilted forward or backward for proper positioning.

1.8 SAFETY BARRIER

To insure the safety of personnel the installation of a safety barrier around the ladle portion of the work cell is strongly recommended. Refer to drawing 305D11234 for a general construction outline. The safety barrier should be equipped with a device such as limit switches, safety mat, photo beams, etc. connected to the "External Safeties" interlock so if the barrier is violated the ladle will stop its movement. The "External Safety " controls power to the master control relay 801-CR. Wires 801 and 802 are used for

connecting the device supplied by the customer. A maintained contact closure across these wires is required for the ladle to enter Manual Mode. Refer to electrical drawings and interlocking section for proper connection of the External Safeties.

1.9 MODES OF OPERATION

There are two modes of operation available on the Servo Drive Ladle. The ladle can only be in one mode of operation at a time. These two modes are:

MANUAL with MANUAL TEACH

AUTOMATIC with AUTO TEACH

The mode of operation is selected by pressing either MANUAL or AUTO keys located on the keypad (See the Keypad drawing in **Section 3**).

1.9.1 MANUAL MODE:

This mode of operation allows the operator to run the ladle in a jog mode to determine the correct position settings for AUTO CYCLE with the die cast machine. In this mode of operation the dipper must be level to move the arm forward of the Clear Position. Manual Teach is also available in this mode.

1.9.2 AUTOMATIC MODE:

After the correct settings are found and input from the Manual Mode, the Ladle is now ready to operate with the die cast machine in full AUTO CYCLE. Auto Teach is available in this mode.

1.10 KEYPAD DISPLAY

The graphic display on the KEYPAD (video or keypad) shows the position and status of the ladle in all modes and all settings at all times. This graphic display gives the operator a convenient means of checking the status of the ladle.

Each section contains an LED numeric display, a set key and an LED indicator. The LED will light up when the Ladle is in that particular function and the LED numeric display will show the current setting of that function.

PLEASE REFER TO SECTION 3 FOR PROGRAMMING INSTRUCTIONS

1.11 SEQUENCE OF OPERATION

This is the default sequence of operation for the ladle. This sequence may be changed and adjusted to meet the needs of the application by programming options. Please see **Section 3** for programming details.

The ladle begins and ends each cycle at the Rest Position, located approximately at the point where the dipper is next to the support post. Upon receiving a start signal from the Die Cast Machine, the Delay Cycle Start Timer begins counting down. Once this timer times out, the ladle retracts to the Clear Position. At this position the arm changes to the Enter Metal Speed, and continues retracting as the dipper rotates down to the Fill Angle Position. The arm motion is stopped once the sensor probes contact the metal. The position where the arm stops is the Fill Position, so this position will change as the metal level changes. When the sensor probes contact the metal, the Fill Timer begins to count down. When this timer expires, the arm moves up out of the metal to the Spill-off Position, allowing the excess metal to run out of the dipper. The length of time that it holds at the Spill-off Position is determined by the value of the Spill-off Timer. After this timer times out the dipper rotates back to the Level Position, and the arm moves forward toward the Rest Position. The ladle will wait at the Rest Position until the "OK to Pour" (1 of 2), which is usually taken from the plunger retract signal, is made. The ladle will then continue to move forward to the Pour Position at the shot sleeve. Upon reaching the shot sleeve, the ladle waits for the DCM to signal "OK to Pour" (2 of 2), which is usually taken from the dies are locked signal, is made. Once these conditions are met, the ladle begins to pour metal. It uses its programmable three-step pour-contouring feature to accomplish this. This feature allows the dipper speeds and positions to be programmed so all the metal in the dipper cup can be poured into the machine. When the dipper reaches Pour Position 3, the Delay After Pour Timer holds the dipper at final pour position in order to let the metal completely drain from the dipper. Once this timer times out the Delay Pour Complete Signal Timer begins timing, allowing the metal to settle in the shot

sleeve before giving the signal that it has finished the pour. At the same time, the dipper cup starts returning to Level Position, and then the arm will return to the Rest Position. NOTE: if the ladle arm reaches the Rest Position before the Delay Pour Complete Timer times out, the Cycle Complete Interlock is canceled.

1.12 ARM POSITIONS

The following positions, shown on the diagram in the middle of the keypad, are programmable positions of the arm. The LED's on this diagram show the current position of the ladle.

1.12.1 REST

This position is the point where the forward stroke striker loses contact with the Home Proximity Limit Switch. This position is used as the zero point for the arm encoder. The REST LED will stay on when the arm is at this position.

1.12.2 FORWARD

The arm is in this range whenever it is between Rest and the Pout Position. See the body assembly drawing in **Section** 7 for the location of this limit switch (P/S 803).

1.12.3 POUR

This is the position at which the arm stops its forward motion and the pour is made. The Abort Cycle Timer begins timing at this position if the interlocks are not present. This position is programmable with a range up to the stroke of the machine. The default setting for this parameter is set at 0.0 when the new RAM is first installed and must be taught before the ladle will operate in the Auto Mode.

1.12.4 CLEAR

This position is the point where the arm stops retracting and the dipper and arm start their fill sequence. Care must be taken in setting this position. Improper placement of the Clear Position may result in sporadic faults (if sensors are shorted before the sensor check is started, a sensor fault occurs) or interference between the ladle and the furnace. When properly taught, the dipper should be able to rotate to the Fill Angle without contacting the metal or the dip well. Be sure that the sensors will not contact the dip well wall as the arm retracts to the metal. Setting the Clear Position at a point where the dipper bottom is just above the metal surface (with the dip well full) works well in most cases.

As mentioned previously, if the sensors do contact the metal before the Clear Position is reached, an erroneous sensor fault will result.

1.12.5 FILL

This position is automatically found by the sensor probes. The arm will stop retracting when the two outer probes contact the metal, so the Fill Position will vary with the level of the metal in the dip well. This position can be adjusted by the location of the probes with relation to the ladle arm. Once the dipper has reached the Fill Angle, the top of the metal surface should be at the center of the crossbar above the fill window. This allows only clean metal to enter the dipper.

1.12.6 SPILL-OFF

This position is not a fixed position, but remains at a fixed distance above the metal surface. Set this position so the fill slot on the dipper is above the metal surface, allowing the metal to spill out the back of the dipper. Usually it is best not to allow a curtain of metal to form, or an inconsistent shot size may result. Both the Fill and Spill-off Positions will vary as the metal level changes.

1.13 DIPPER POSITIONS

The following positions, shown on the diagram in the middle of the keypad, are the adjustable / programmable positions of the dipper. The LED's on this diagram show the current position of the ladle. When an LED is flashing that position is next in the sequence of operation.

1.13.1 DIPPER LEVEL

This position is the point where the dipper level cam makes contact with the Level Proximity Limit Switch as the dipper rotates forward. This switch should never have to be adjusted unless the chain is replaced, or has somehow become miss-timed. When properly set the line going between the lip of the dipper and the bottom of

the slot should be parallel to the floor. Refer to the Dipper Level Limit Switch section for more information. This is also the zero point for the dipper.

1.13.2 DIPPER POUR POSITIONS

These are the positions the dipper goes through when making the pour. The three positions are programmable between 0.0 and 90.0 degrees. The only requirement is that 90 > POS# 3 > POS# 2 > POS# 1>0.

1.13.3 FILL ANGLE

This is the rotation angle of the dipper. It determines the amount of metal that is carried in the dipper, and so determines the shot size. This position is programmable from 15.0 to 45.0 degrees. There can be up to four different fill positions available for foundry applications. See "AUX. 4" parameters in the programming section for more details.

2. INSTALLATION

2.1 INSTALLATION SAFETY

Study the equipment manual before attempting to install this machine. The installation must be made with only qualified personnel capable of positioning, anchoring, making power connections and interlocking this equipment with other equipment. Failure to use qualified personnel could result in personal injury as well as damage to the equipment. The electrical connections must be made by a qualified electrician who must be able to read and understand electrical schematics in order to ensure safe connections. Correct grounding of interlock connections are explained and illustrated in this manual. In addition, a safety barrier must be installed to prevent personnel from entering the path of moving equipment while it is operating. It should also be noted that proper clearance must be allowed for all movements of the equipment. By following these recommended steps, your equipment should operate safely and correctly.

2.2 SAFETY BARRIER

To insure the safety of personnel, the installation of a safety barrier around the ladle portion of the work cell is strongly recommended. Refer to drawing 305D11234 for a general construction outline. The safety barrier should be equipped with devices such as limit switches, safety mat, photo beams, etc., connected to the "External Safeties" interlock, so if the barrier is violated the ladle will stop its movement. The "External Safeties" control power to the master control relay 801-CR. A maintained contact (N.C.) of the customer supplied safety device should be connected across wires 801 and 802, so that the contact opens if a safety violation occurs. As long as this contact is open, the ladle will remain in Stop Mode.

2.3 PLACEMENT AND INITIAL ADJUSTMENTS

Either the ladle may be placed on the operator or helper side of the die cast machine. The unit is normally shipped configured for the side specified by the customer, but may be changed if so desired (Refer to the Sensor Assembly and Pedestal Assembly drawings in Section 7). To change the ladle from operator side to helper side, or helper side to operator, the following items must be relocated.

1. Interchange dipper and its mount bracket in the lower arm. Refer to dipper assembly drawing.

2. Reposition mount adapter to opposite side, being sure to keep support bolt pattern away from ladle side plate. Reattach support "T" to mount and position pedestal correctly in relation to furnace.

Several considerations come into play concerning the best placement of the ladle in reference to the dip well and the DCM. Refer to application and pedestal drawings for general installation parameters.

On a new installation, first line the ladle up with the DCM then line the furnace up with the ladle. To make sure that both the dipper and the sensor probes clear the dip well walls, set the ladle up when the metal is low in the dip well. Since the path of the dipper may not be straight up and down, having the metal low will allow any interference points to show up for the entire draw-down stroke.

> CAUTION
>
> When positioning the Ladle body over the pedestal base, care must be taken to keep the major portion of the body over the offset portion of the base plate. This will position the center of gravity of the Ladle over the large portion of the base plate. Improper positioning of the body and base plate could result in machine damage or personal injury.

In addition to aligning the ladle up with the dip well, make sure it is also in line with the pour hole. Height adjustments will probably have to be made in order to get the dipper to pour at the proper height in relation to the shot sleeve. The height is adjusted by the jack located on the mounting post. The tilt adjustment may also be used in order to line up the ladle with both the shot sleeve and dip well heights. Accomplish the tilt by using two tilt adjustment screws on the pedestal assembly. With these two adjustments, the ladle may be configured to fit many different situations. These adjustments will change the path of the dipper as it moves into the dip well. The path will become increasingly vertical as the

ladle is tilted backwards. As an additional aid in positioning the ladle in the cell, the position of the ladle body in relation to the pedestal may be moved backward or forward in two-inch increments.

2.4 ELECTRICAL

Requirements: Control (computer) 120 VAC, 5 amp, 1 phase with ground. Refer to electrical schematic for electrical requirements. Refer to Figure 2-1 and 2-2 for a guide to a typical electrical installation.

As with all computers, a proper ground connection is required. We strongly suggest using a dedicated, properly sized machine tool transformer as a power source for the ladle. Do not use a general-purpose transformer because it will not regulate the current, causing the voltage to vary when the transformer is near its saturation point. See Figure 2-2. A non-dedicated transformer may allow noise and/or spikes on the ladle power line, which will cause various computer related problems while cycling.

Do not "daisy-chain" the ground wires in the work cell; run all ground lines directly to a single earth ground rod. Note to PLC user:

All the interlocks required are dry contacts, and since a dry contact draws very little current, triac type outputs may not shut off. This is due to the nature of a triac, which requires a minimum of current draw to shut off completely.

To prevent this type of problem, either tie a load resistor across the output, or drive an interface relay with the PLC output. Some PLC manufacturers have already taken care of this problem by including an isolated interface for each I/O contact within the PLC. Check the PLC user manuals to determine which type you have.

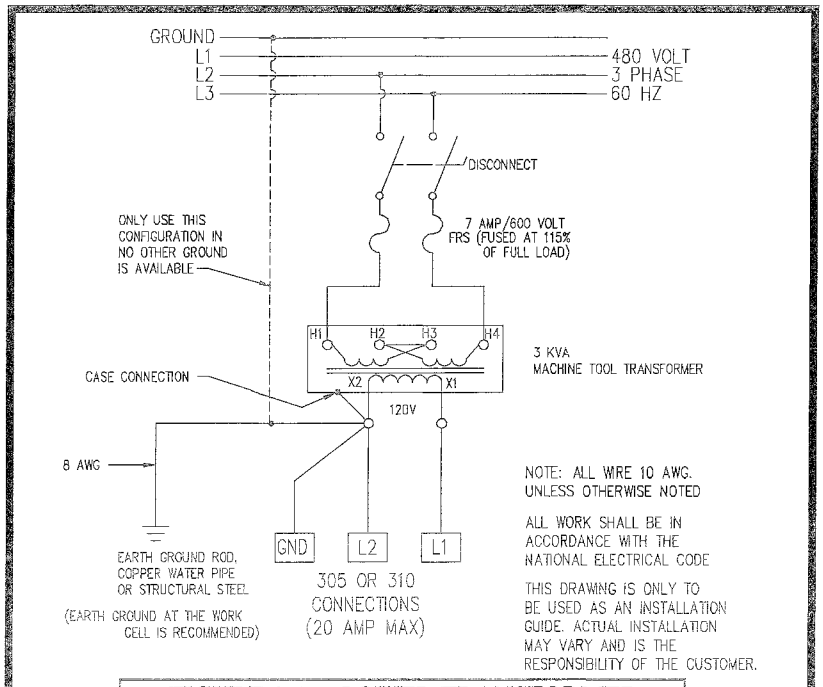


FIGURE 2-1 POWER TRANSFORMER

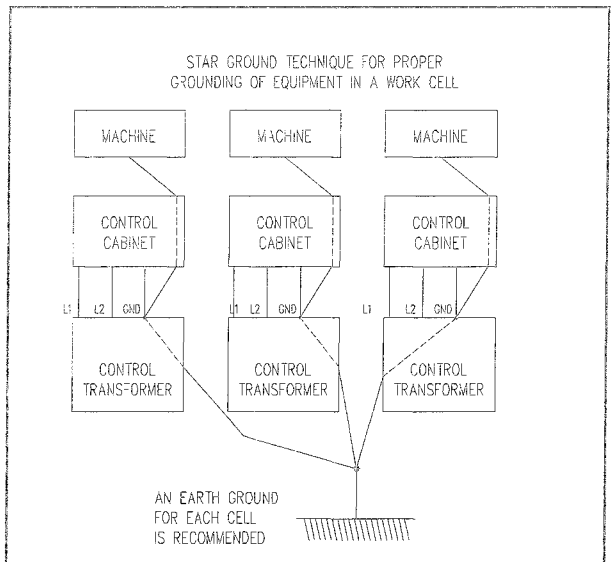


FIGURE 2-2 PROPER GROUNDING

2.5 INTERLOCKING *

* Please note that this is only a recommendation and is in no way the only procedure to interface a ladle with a die cast machine. Rimrock accepts no liability for the actual interlocking of our equipment with the die cast machine.

Reference electrical schematic drawings for your machine, sheet 1 shows interlocks.

The following input interlocks are designed for the safe operation of the ladle and should be used in all cases, and not defeated.

All contacts must be 120 VAC dry contacts, meaning that there will be no electrical link between the DCM and the ladle (isolated with relays). The interlock LED's on the keypad show whether or not the interlocks are present.

2.5.1 INPUTS *

2.5.1.1 LADLE START *

(SLOT #1/16) This input can be taken from the N.O. momentary closed contacts of the "DIE START OPEN" signal from the DCM **IN ALL MODES EXCEPT MANUAL**, and connected across wires 803 and 805. This is only an example of a start signal and not the only way to generate it. For instance, if the DCM has a short cycle time, possible signals are the fast shot limit switch, shot complete, or other appropriate contact to give an earlier start signal from the DCM **IN ALL MODES EXCEPT MANUAL.**

Reason: This signal is used to start the ladle cycle. It may be given at any time after the ladle has completed pouring.

LADLE START FILL ANGLE 2 * (SLOT #1/20) wires 803 and 843

LADLE START FILL ANGLE 3 * (SLOT #1/21) wires 803 and 844

LADLE START FILL ANGLE 4 * (SLOT #1/22) wires 803 and 845

These optional signals are similar to the ladle start signal described above except a different fill angle can be programmed for each start signal. To use this option 3 AC input modules (P/N 7622-402) are needed along with the appropriate wiring. See schematic drawing in **Section 6** for more details.

Reason: These signals are primarily used in foundry applications where it is necessary to pour different shot weights from one ladle.

For more information, see the programming procedure for this option in **Section 3** of this manual.

2.5.1.2 OK TO POUR (1 of 2) *

(SLOT #1/17) This input is usually taken from the N.O. contacts of the PLUNGER RETRACT signal and connected across wires 803 and 836.

The default setting for the "Hold at Rest" option is "ON.' The ladle will check (in both modes) the "OK TO POUR" (1 of 2) interlock after the dipper has filled, and the ladle is moving forward from the Spill-off Position. If the input is not active, the ladle will decelerate to a stop at the Rest Position and hold there until the input comes on or the Cycle Abort Timer expires.

If the Cycle Abort Timer expires, the ladle will go through a normal cycle abort. If the input was on while the unit was moving forward, it would advance to the pour position, the Cycle Abort Timer will not start and the ladle will pour upon arriving at the Pour Position.

If the "Hold at Rest" option is set to "OFF," the ladle will move to the Pour Position after filling

the dipper. The computer will check the "OK TO POUR" signals. If both interlocks are not "ON" the cycle abort timer will start and the ladle will not pour until both "OK TO POUR" interlocks are present. If both interlocks are "ON" when the ladle gets to the Pour Position, the Cycle Abort Timer will not start and the ladle will pour upon arriving at the Pour Position.

See programming in **Section 3** for more details.

2.5.1.3 OK TO POUR (2 of 2) *

(SLOT #1/18) This input is usually taken from the N.O. contacts of the DIES LOCKED signal and connected across wires 803 and 842. This operates similar to the "OK TO POUR" (1 of 2) operates.

Note: The "Hold at Rest" option has no effect on this input.

Reason: Once the ladle has filled the dipper and advanced to the Pour Position, it waits for the above conditions to be met before it pours the shot. The two conditions listed above are examples of what is normally found in the field. If more conditions need to be met before a pour is made, extra contacts could be added in series with the appropriate "OK TO POUR" signal.

NOTE: The length of time that the ladle will wait at the Pour Position before going into an abort cycle is programmed with the Abort Cycle Timer. As a rule of thumb, set the timer for one second per pound of metal poured.

2.5.1.4 EXTERNAL SAFETY *

This input is used with contacts from safety gates, mats, beams, etc. and connected across wires 801 and 802. Care must be taken when installing safety equipment, as not to install items that could cause nuisance trips of the external safety. Safety equipment that has fast (less than 0.5 sec) operation time should be avoided. The best method of installing safety equipment will be to use items that have maintained violation outputs. When more than one device is used, the output contacts must be connected in series with each other. If this connection is not made (i.e., safety violated) there will be no power to the Interlocks and servo amplifiers, but there will be power present at the power supplies. To restore power the safety must be made and the "MANUAL ON" key must be pressed.

Note: This interlock has the same effect as opening the control box door. If a remote Stop Pushbutton is required, see next section.

Reason: This interlock is used to provide a method of stopping the movement of the Ladle by turning off the servo amplifiers.

2.5.1.5 EXTERNAL STOP PUSH-BUTTON *

Provisions have been made for the installation of an external (remote) Stop Pushbutton. This interlock will also stop all equipment connected to a multiple Triangle control box. A maintained (Normally Closed) contact Stop Pushbutton can be connected across wires 38 and 39. When more than one contact is needed, they must be connected in series with each other. If this connection is not made (i.e., Stop violated) there will be no power to the interlocks and servo amplifiers, but there will be power present at the power supplies. To restore power the Stop Pushbutton must be pulled out and the Manual/On key must be pressed.

Note: This interlock has the same effect as opening the control box door.

Reason: This interlock is used to provide a method of stopping the movement of the ladle by turning off the servo amplifiers.

2.5.2 OUTPUTS *

* Please note that this is only a recommendation and is in no way the only way to interface a ladle with a die cast machine. Rimrock accepts no liability for actual interlocking of our equipment with the die cast machine.

2.5.2.1 POUR COMPLETE *

(SLOT #1/2) This signal is given through CR-803 (1 normally open contact) which close after the ladle has finished pouring the metal and the Delay Pour Complete Timer has expired. This signal is held on until the ladle reaches the Rest Position, so the Delay Pour Complete Timer must time out before the Rest Position is reached in order to get the signal that the pour is complete. This signal is given through wires 819 and 821 and is a momentary signal.

NOTE: Problems may be caused by noise generated by this relay when it is activated. Evidence of this is a randomly flashing LED on the keypad, or the ladle entering STOP mode while retracting from the Pour Position. Problems may be alleviated by adding a varistor/Quencharc to the coil of the relay in the die cast machine, which is activated by this signal.

Reason: The ladle signals the DCM that the pour is complete.

2.5.3 OPTIONAL OUTPUTS *

The following interlocks are optional. It will be necessary to add output modules in the appropriate slot, do the necessary wiring, and connect to relays for proper interlock isolation.

2.5.3.1 LADLE IN AUTO *

(SLOT #1/5) This is an optional output that will activate when the ladle is in the automatic mode (follows the AUTO LED's on the keypad)

2.5.3.2 LADLE FAULTED *

(SLOT #1/6) This optional output is activated when the ladle faults. If any one of the following conditions exists in AUTO, MANUAL, or STOP mode, this output will come on.

The conditions are:

1. Low Metal Abort
2. Cycle Abort
3. All Faults

2.5.3.3 LADLE AT READY TO POUR *

(SLOT #1/7) This optional output will activate when the ladle arm is at the Pour Position. This output is operational in Auto, Manual, and Stop Mode.

2.5.4 LOW METAL WARNING *

(SLOT #1/23) This optional output will activate in a flashing mode when the ladle arm reaches the Low Metal Warning Position. See **Section 3** for programming details. It can be used to activate a signaling device to alert the operator that metal is low in the furnace. This is only a warning not a fault, so operation of the ladle is not stopped. When the metal level rises above the warning point (i.e. the furnace is filled) the output stops flashing. If the metal level is not raised and the Low Metal Level Position is reached by the arm, a Low Metal Level Fault is generated (see LOW METAL LEVEL output).

2.5.5 LOW METAL LEVEL*

(SLOT #1/23) This optional output will activate when the arm reaches the Low Metal Position and remain so until the fault is cleared. See **Section 3** for programming details. It can be used to activate a signaling device to alert the operator that the furnace is empty. Since this is a fault condition, it stops operation of the ladle. Operator intervention is required to reset this output.

2.6 SERVO LADLE HOMING PROCEDURE

NOTE: If the ladle is being Homed for the first time after a new CPU board has been installed, or if the RAM chips have been replaced, a special Homing procedure is necessary. See Section 3.3.14 Parameter 4 for a detailed explanation of the additional steps that must be followed.

The control power for the ladle is controlled by the circuit breaker in the bottom of the control box panel. The ladle circuit breaker is the second circuit breaker from the left. When power is applied and communication between the Triangle CPU and the keypad or video terminal has been established, the Dipper Positions window will display the software version number. This may take several seconds. Once the version number is displayed, put the ladle in Manual Mode by pressing the MANUAL/ON key. At this point up to three LED's may be flashing depending on where the ladle was positioned when it was last turned off. These flashing LED's; the Manual/On LED, and possibly, the Level and/or Forward LED's indicate that the machine needs to be homed. If the Level LED is flashing, jog the dipper either forward or backward, as needed, to get it in the level position. When it reaches the level position, the LED will stop flashing and stay on solid. If needed, jog the arm forward until the Forward LED stops flashing and stays lit. With both these LED's on, the AUX. 5 key will start

flashing. Press the AUX. 5 key and the dipper and arm will move slightly to their home position and all keypad LED's will stop flashing. While the ladle is homing itself, the sensors will be tested for open or shorted sensor lines. This procedure will have to be followed each time power is applied to the ladle. To re-home the ladle, turn the power off then on again and follow the above procedure.

2.6.1 SETTING TEMPORARY LOW METAL AND READY TO POUR POSITIONS

After a new ladle is Homed for the first time, Pour Position and Low Metal Position parameters will both have default values of 0.0. It will be necessary to program temporary values for these before the arm can be jogged. See Section 3.4.1 and 3.4.4 for the procedures on programming a Pour Position and a Low Metal Position. For the 405, set Pour to 70.0 and Low Metal to 35.0. Other models should also be set to the maximum values. Use smaller values if these cause interference. Final values must be taught after the dipper is installed and the sensor probes are adjusted

2.7 MECHANICAL ADJUSTMENTS

The final mechanical adjustments on a new unit are to level the dipper and adjust the length of the sensor probes. The following description is for the Rimrock dipper. If another dipper is used, it may be necessary to modify this procedure.

2.7.1 LEVELING THE DIPPER

Before leveling the dipper on your new ladle, verify that the arm chains are correctly positioned. For the 405, jog the arm forward to a position of about 60.0 until the upper arm is vertical. If the Level LED is not on, press the POUR RETURN key until it is on. Remove the cover plates to observe the upper and lower turnbuckles. The turnbuckles should be centered in the inspection windows. If they are not centered, please see **Section 5** for details on chain positioning and tensioning. The other servo-driven ladle models are the double-arm design. For these ladles, please see the notes about chain positioning and tensioning on the Arm Assembly drawing in **Section 7** for the model being installed.

Before mounting the dipper, use the Fill Angle Chart in **Section 3** to verify you have the correct size for the required shot weight. Mount the dipper on the pour shaft and tighten the locking collar just enough for friction to hold it in position. Insert a straight edge through the fill window and across the front lip of the dipper cup. Placing a small line level on this straight edge will let you see when the dipper is level. Rotate the locking collar on the pour shaft until the line level shows the dipper is level, then tighten the collar to hold the dipper in that position.

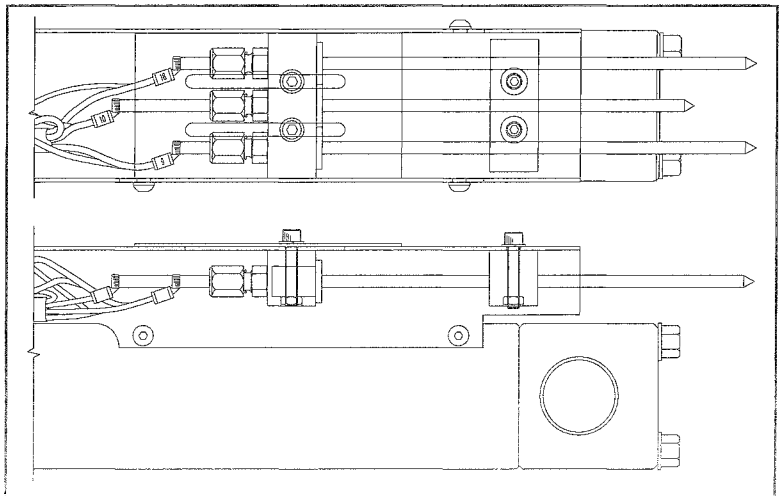


FIGURE 2-3 SENSOR ADJUSTMENT (405 SHOWN)

2.7.2 SENSOR PROBE LENGTH ADJUSTMENT

The correct probe length depends on the Fill Angle used. See the Fill Angle Chart in **Section 3** to find the Fill Angle for the required shot size. See Section 3.5.1 for the procedure on how to program this Fill Angle. Use the ARM RETRACT key to move the arm behind the Clear Position, then press the DIPPER FILL key to rotate the dipper to the Fill Angle.

Refer to figure 2-3. Loosen the two

screws in the Probe Isolator Block so the Sensor Cover Slide can be moved. It may be necessary to also loosen the two screws in the Probe Guide for the Sensor Cover Slide to move.

Place a level along the side of the dipper so it is on the center of the fill window. Move the Sensor Cover Slide to adjust the probe length until the probe tips just touch the level. Tighten the screws to hold the Sensor Cover in this position. The probes should be at the correct length now, but this needs to be verified while teaching the Low Metal and Clear Positions.

2.8 TEACHING CRITICAL POSITIONS

To avoid possible equipment damage from collision with the furnace or die cast machine, it is very important to carefully set three critical arm positions. These are Low Metal, Clear, and Ready to Pour.

2.8.1 TEACHING LOW METAL POSITION

Temporarily program a Fill Angle of 45.0 and a Pour 3 Angle of 90.0. Verify that Low Metal Position is set to the maximum value for this parameter. Move the arm back to about where the Clear Position is expected and press the DIPPER FILL key to rotate the dipper to 45.0. With an empty dip well, retract the arm until the bottom of the dipper is just above the bottom of the dip well and teach the Low Metal Position. The lowest usable metal level will be even with where the sensor probe tips are in this position. Move the arm up toward the expected Clear Position and make sure the dipper clears the edge of the dip well. The ladle should now be lined up with both the shot sleeve and the dip well, and freely rotate at any arm position between the lowest and highest metal levels.

2.8.2 TEACHING CLEAR POSITION

Fill the dip well with metal. Press the DIPPER FILL key to move the dipper to a 45.0 Fill Angle. Move the arm to a position where the bottom of the dipper is just clear of the metal and teach Clear Position.

Set the Fill Angle back to the value determined in Section 2.7.2 above. Next, move the arm back until the probes contact the metal, which stops the arm. Verify the dipper-sensor alignment. When the dipper is filling with metal, the metal surface should be at the middle of the bar above the fill window. This lets only clean metal enter the dipper. The depth the dipper is adjusted by increasing or decreasing the length of the sensor probes. If the dipper is too low, lengthen the probes slightly; if the dipper is too high, shorten the probes slightly.

2.8.3 TEACHING READY TO POUR POSITION

With the dipper Level, move the arm forward to the shot sleeve. Press the DIPPER POUR key to rotate the dipper to 90.0, carefully checking for possible interference. If the Arm Advance at Pour option is used, the arm will extend while the dipper is at Pour 3 Position. Be sure the dipper does not cause interference in this case. If no problems are found, teach the Ready to Pour Position. See Section 3.4.1 and 3.4.4 for a detailed procedure and explanation of the Arm Advance at Pour option.

2.8.4 EMPTYING THE DIPPER BEFORE HOMING

In the event that the dipper is full, the metal may be poured out before Homing the ladle. Move the arm to the furnace by pressing the ARM RETRACT key. Pressing the DIPPER JOG FORWARD key will allow the dipper to rotate forward if the Dipper Level LED is on, thus pouring the metal in the dipper into the furnace. If the Dipper Level LED is flashing, the dipper will stop at the Dipper Level Position if the dipper level limit switch is encountered. If this happens release the DIPPER JOG FORWARD key and press it again. This will allow the dipper to rotate forward pouring the metal in the dipper into the furnace. Since the ladle has not yet been homed, the operator must stop the dipper rotation, (by releasing the DIPPER JOG FORWARD key). When the dipper is empty, use the DIPPER JOG REVERSE key to rotate the dipper to the level position. The ladle may now be safely homed using the procedure described in section 2.8

2.9 DRY CYCLING

To dry cycle the ladle, jumper wire 803 to 836 and 842 to get the OK TO POUR signals. Also jumper wire 803 to 819 and 821 (on CR 803) to 805 to get the start signal for continuous cycling; leave this off for single cycling.

In place of the metal in the furnace, use a pad of steel wool to trigger the sensors. If the ladle is already placed next to the machine and furnace, simply remove the dipper and let the probes contact the metal as normal.

2.10 LIMIT SWITCH ADJUSTMENTS

Proximity limit switches are used on the ladle to establish physical positions of the dipper and arm before Homing. These limit switches are mounted on the body of the ladle. Refer to the placard on the ladle body opposite the dipper gearbox and the mechanical assembly drawings for location of limit switches.

2.10.1 DIPPER LEVEL PROXIMITY SWITCH:

(801 PS)

The dipper level proximity switch should activate when the turnbuckles on the chains are in the center of the windows on both the upper and lower arms. Remove the cover plates to observe the turnbuckles. The dipper should also be level at this time. With the dipper in this position the metal will be transported between the dip well and the shot sleeve without any metal spilling. If the dipper is out of alignment, it may be readjusted using the locking collar that clamps it to the pour shaft. Before adjusting the dipper on the shaft, use the DIPPER FILL RETURN key to get the mechanism to the level position. Do not move the level cam as this may allow the chain turnbuckles to reach one of the sprockets

The limit switch should only need to be adjusted if the chains have been replaced or the chain has become miss-timed. When properly timed, the chain turnbuckles will be centered in the inspection windows when this switch is activated.

This limit switch is used to zero the dipper servo during the homing sequence.

This limit switch activates I/O module #1/8.

2.10.2 DIPPER POUR OVER-TRAVEL LIMIT SWITCH (FORWARD DIRECTION)

(805 PS)

This proximity switch is used to stop the dipper from rotating beyond its mechanical constraints in the forward or pour direction. This switch is activated by an adjustable cam on the shoulder pivot shaft. When it is activated, the dipper motor is stopped. If it is activated, first clear the fault, then use the DIPPER JOG REVERSE key to jog the dipper back to Level Position.

To adjust the limit switch, first make sure the dipper is level and the dipper level (801 P/S) is activated. Remove the turnbuckle access covers from the arm assembly and make sure the turnbuckles are in a position that will keep them from contacting the chain sprockets. If the turnbuckles are not in approximately the center of the openings, jog the dipper until they are and reset the level limit switch as needed. Next, to set the cam, enter Teach Mode and program Pour Position 3 to 90 degrees. Jog the dipper toward Pour Position 3, when the dipper reaches 90 degrees it will stop. At this time proximity switch 805 should not be activated. Adjust the dipper pour over travel cam so the proximity switch will trip if the dipper is rotated any farther.

This limit switch sends a signal to the Servo Inter-Connection PCB board.

2.10.3 DIPPER FILL OVER-TRAVEL LIMIT SWITCH (REVERSE DIRECTION)

(804 PS)

This proximity switch is used to stop the dipper from rotating beyond its constraints in the reverse or fill direction. This switch is activated by an adjustable cam on the shoulder pivot shaft. When it is activated, the motion of the dipper motor is stopped. If it is activated, first clear the fault, then use the DIPPER JOG FORWARD key to jog the dipper back to the Level Position.

To adjust the limit switch, first make sure the dipper is level and the dipper level (801 PS) is activated. Remove the turnbuckle access covers from the upper and lower arm assembly and make sure the turnbuckles are in a position that will keep them from contacting the chain sprockets. If the turnbuckles are not in approximately the center of the adjustment

openings, jog the dipper until they are and reset the level limit switch as needed. Next, to set the cam, enter Teach Mode and program the Fill Angle to 45.0 degrees. Jog the dipper toward the Fill Position. When the dipper reaches 45.0 degrees, it will stop. At this time the (804 PS) should not be activated. Adjust the dipper fill over travel cam so the proximity switch will trip if the dipper is rotated any farther.

This limit switch sends a signal to the Servo Inter-Connection PCB board.

2.10.4 ARM FULL RETRACT LIMIT SWITCH

(802 PS)

This proximity switch defines the maximum rearward travel of the arm. All retract motion of the arm is stopped when this switch is activated. The arm can only be moved forward off this switch. It is factory set and not adjustable. If it is activated, first clear the fault, then use the ARM FORWARD key to jog the arm away from the switch.

This switch sends an arm retract over-travel signal to the Servo Inter-Connection PCB board.

2.10.5 ARM FULL FORWARD LIMIT SWITCH

(806 PS)

This proximity switch defines the maximum forward travel of the arm. All forward motion of the arm is stopped when this switch is activated. The arm can only be retracted off this switch. It is factory set and not adjustable. If it is activated, first clear the fault, then use the ARM RETRACT key to jog the arm away from the switch.

This switch sends an arm forward over-travel signal to the Servo Inter-Connection PCB board.

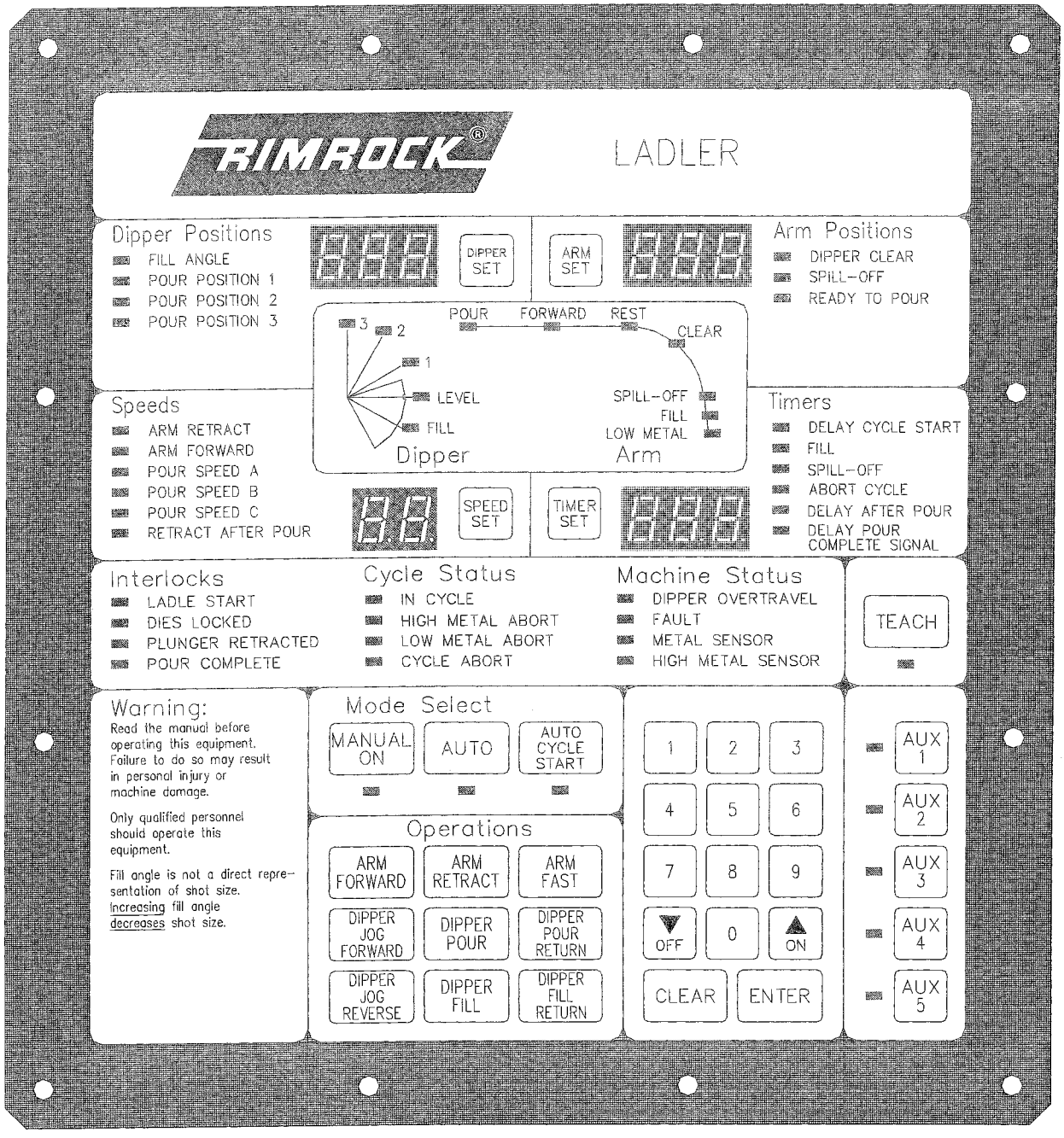
2.10.6 ARM HOME LIMIT SWITCH

(803 PS)

This limit switch is used to zero the arm servo each time the ladle is homed. It is factory set and not adjustable.

This limit switch activates I/O module #1/10.

3. PROGRAMMING



3. PROGRAMMING

Initial programming must be done in the Manual Mode. Programming in Auto Mode is used for fine adjustment and will be discussed in the next section.

Once the servo ladle has been set up with the die cast machine and aligned with the pour hole, according to the mounting instructions in **Section 1**, you can enter a program.

Programming of the servo ladle is very easy, especially if you have programmed any of Rimrock's MULTI-LINK EQUIPMENT. Setting the machine positions is identical to setting positions on other MULTI-LINK EQUIPMENT. Since it is very straightforward to program, extra care should be taken when changing parameters, because a parameter you want to keep could be easily overwritten.

INCORRECT PROGRAMMING CAN CAUSE DAMAGE TO THE MACHINE

You should completely read and fully understand the manual and know exactly what the machine will do before you make any change.

3.1 SET-UP AND OPERATION SAFETY

Operator and maintenance personnel must read the equipment manual and be trained in the proper operation of this equipment in order to set-up and operate it safely. Never adjust the equipment while it is operating. Remember that the machine has the ability to strike you, pinch or grab loose clothing, which may result in injury to you. It should never be necessary to adjust this equipment with the power "ON." If you find it necessary to make an adjustment or do troubleshooting with the power "ON," another qualified person should be operating the equipment in Manual Mode. The second person should always have unobstructed sight of the person working on the equipment. Under **NO CIRCUMSTANCES** would any adjustments be made while the equipment is moving. Never operate the equipment before making sure the area is clear and all safety guards and devices are in place. Only authorized personnel should be able to modify the programming of this equipment and it can never be operated without the recommended interlocks. Any unsafe conditions of equipment operation should be reported the proper personnel immediately.

3.2 GENERAL ALGORITHM

In general, any time a parameter needs to be changed, the sequence of keystrokes is:

1. While in Manual Mode, press the TEACH key, causing the Teach LED to flash.

2. Enter any of the four sections containing the parameter that needs to be changed by pressing its SET key or AUX. key.

3. Press this key again until the LED next to the parameter to be changed is illuminated. The present values in memory appear in the window as the parameters are scrolled through.

4. New values for any parameter can be entered with the numeric portion of the keypad. If in the Arm Position or Dipper Position section, you can jog the arm or dipper to the desired position.

5. Finally, to save the value to memory, press the ENTER key. When the new value is accepted the Teach LED will start flashing again.

Note: If a number punched in with the numerical portion of the keypad is incorrect, it may be cleared from the display with the CLEAR key. This is only effective if the ENTER key has not yet been pressed. If a value is out of the acceptable range for the parameter, the displayed value will flash until the CLEAR key is pressed.

If other parameters need to be changed, follow steps 2) through 5) again.

To exit the Teach Mode, press the TEACH key again. The Teach LED must be flashing in order to exit Teach Mode, if it is not, then the ENTER or CLEAR key must be pressed first to get the Teach LED back to its flashing condition. Also, the Teach Mode will be exited if no key is pressed for 30 seconds; this is the "hands-off" feature of the Triangle controls.

3.3 KEYPAD

The ladle utilizes a touch sensitive keypad for an operator interface. This keypad is color-coded and uses terminology familiar to personnel working in the Die Casting industry.

YELLOW KEYS = MANUAL MODE Controls the ladles movement and manual operation of

functions. Movement or operation will cease upon release of the key that is pressed.

GREEN KEYS = AUTO MODE Puts the ladle in an automatic mode allowing a start signal to come from the AUTO CYCLE START key or from the DCM.

BLUE KEYS = TEACH MODE Entering the TEACH mode allows the operating parameters of the machine to be taught or changed. The parameters most commonly changed are in four sections, POSITION SET, DIPPER SET, TIME SET, and SPEED SET. Each section contains a LED numeric display, a set key, and indicator LED's.

The Auxiliary 5 Key (also blue) is used to home the machine and will be discussed later in the programming section.

Note: Machines that utilize video operator stations do not have LED's as listed below. They display the current mode on the video screen in text and graphics. All the keys operate in the same fashion as if a standard keypad was being utilized.

3.3.1 LADLE STOP PUSHBUTTON (maintained)

A maintained red mushroom-head pushbutton is located on the operator's panel. Depressing this pushbutton puts the ladle in Stop Mode, which is a standby mode. It does this by interrupting power to the main control relay. This removes all power from the servo amplifier circuits. However, it does not remove power from all components in the control box. Provisions have been made for daisy chaining more maintained STOP pushbuttons in series with this switch. This may be done per user requirements.

NOTE: Opening the control panel door and causing 901 DS to open is equivalent to pressing the STOP pushbutton. In a multiple-machine control box, pressing the STOP pushbutton will put all RIMROCK machines connected to this control box into Stop Mode.

3.3.2 MANUAL Key with LED

When the MANUAL/ON key is pressed, the machine enters Manual Mode, a jog type of mode. The LED stays on until the AUTO key or STOP pushbutton is pressed. If the ladle needs to be Homed, the Manual LED will flash until the unit is Homed. The machine can be Homed if the Rest and Level Proximity Limit switches are activated, and the AUX. 5 key is pressed. For a complete description of the homing sequence, see Homing Sequence in Section 2.

The Interlock LED's and Machine Status LED's are always active. All machine interlocks are considered when manually moving the machine. This key activates the control system power.

Pressing the MANUAL key while the ladle is in Auto Mode will cause the ladle to enter the Manual Mode.

NOTE: The yellow pushbutton on the right hand side of the keypad labeled ON duplicates this key.

3.3.3 AUTO Key with LED

When the AUTO key is pressed, the machine enters Auto Mode, a fully automatic mode. The LED stays on until the MANUAL key or STOP pushbutton is pressed. To enter the Auto Mode the ladle arm must be above the Clear Position.

NOTE: The green pushbutton on the right hand side of the keypad labeled AUTO duplicates this key.

3.3.4 AUTO CYCLE START Key with LED

This key begins an automatic cycle. If a cycle start signal is present from the die cast machine or the system is in Auto Teach this key will not start a cycle.

NOTE: The green pushbutton on the right hand side of the keypad labeled AUTO CYCLE START duplicates this key.

3.3.5 TEACH Key with LED

When the TEACH key is pressed the machine enters Teach Mode, which is the programming mode. The Teach LED flashes until a set key is pressed, the TEACH key is pressed again, or 30 seconds elapses without any key being pressed. If in Manual Mode, Teach Mode terminates when the TEACH key is pressed while the Teach LED is flashing, or after the 30 second "HANDS OFF" feature times out. The flashing of the Teach LED indicates a SET key or AUX. Key

can now be pressed to change or review the values in that section. When the Teach LED is on, it indicates a set function is active and a new value can be entered, or an old value reviewed. The TEACH key will be used to setup, change, or review the machine parameters. Parameters changed through this key will be allowed during Manual Mode (Manual Teach) using either the operation keys or the numeric keypad and during the Auto Mode (Auto Teach) using only the arrow keys.

3.3.6 ENTER Key

This key is used to enter a new parameter in memory. The current value displayed will be entered, replacing the old value. This happens at the next convenient time, therefore if the ENTER key is pressed for the move that is currently taking place, the new value will be saved after the move is completed. If the value is invalid for that parameter, the display will flash until the CLEAR key is pressed or 30 seconds elapses.

3.3.7 CLEAR Key

This key is used to clear an entry before the ENTER key is pressed, or to exit a section if no values have been changed. This key will never destroy data in memory. Pressing this key before a parameter has been modified will start the Teach LED flashing, allowing you to exit the Teach Mode. This key may also used to clear a fault condition.

3.3.8 NUMERIC Keys

The numbers 0-9 are used to enter numeric data (such as the Ready to Pour Position in inches). The numeric keys are only active in the Manual Teach Mode.

3.3.9 UP/DOWN ARROW KEYS

The up and down arrow keys will change the display in the direction indicated by 1 unit.

NOTE: The arrow keys will increase their rate-of-change after a ten-digit change. While in Auto Teach Mode these keys are the only means of altering a parameter.

While using the arrow keys, when the displayed parameter reaches 999 it will roll over to 0 and if going in the opposite direction, when it reaches 0 it will roll under to 999

3.3.10 AUXILIARY KEYS

If an AUXILIARY key is pressed, the number of the parameter to be changed will be shown in the numeric display next to the SPEED SET key. The associated parameter data will be shown in the numeric display next to the TIMER SET key. Each time the AUXILIARY key is pressed the next parameter in the group will be displayed.

3.3.11 AUX. 1

This auxiliary key has seven possible parameters, depending on the number of fill angles selected. It is used to set all auxiliary speed values. The AUX. 1 speed parameters are explained in the SPEEDS section.

3.3.12 AUX. 2

This auxiliary key only used to set the "Blow Off Time". This is the time the dipper will wait inverted before moving back to the level position.

3.3.13 AUX. 3

This auxiliary key has six possible parameters, depending on the number of fill angles selected. It is used to set all auxiliary position values. The AUX. 3 positions are explained in the POSITION section.

3.3.14 AUX. 4

This auxiliary key has fourteen parameters. It is used to set option values. The AUX. 4 options are explained in the OPTIONS section.

3.3.15 AUX. 5

After power is turned on this key is used to start the automatic sequence to move the machine to its Home Position and zero its position encoders. This auxiliary key is used in Auto Mode to display the Cycle Counter. Press the TEACH key, then press this key and the Cycle Counter will be shown on the numeric displays next to the DIPPER SET and ARM SET keys. These displays should be read as a single display. For example, if the dipper display reads "11" and the

arm display reads "518", the Cycle Count is 11518.

3.3.16 LADLE OPTIONS

NOTE: See Table 3.12 FACTORY SETTINGS for factory default option parameter values and option parameter range information.

AUX. 4 PARAMETER 1

POUR TO CLEAR ON/OFF

With this option turned on (1), during an auto cycle and after pouring, the arm will return to the Clear Position instead of the Rest Position.

AUX. 4 PARAMETER 2

NUMBER OF FILL ANGLES

This parameter sets the number of Fill Angles from 1 to 4. Foundries sometime use this option, when several molds requiring different shot weights pass the Ladle's pour point on a conveyor. Each fill angle has a separate start signal. For example, Start Signal 1 uses Fill Angle 1, Start Signal 2 uses Fill Angle 2, and so on. When teaching the fill angle(s), the number of the angle that is being taught shows in the numeric display next to ARM SET key.

AUX. 4 PARAMETER 3

ACTIVE FILL ANGLE

When the number of fill angles is two or more, one of the fill angles programmed will be used as the Active Fill Angle. This Active Fill Angle will be used when the dipper is moved in Manual Mode by jogging, or with the FILL POSITION key, or if the cycle is started from the keypad.

AUX. 4 PARAMETER 4

LADLE TYPE

Servo systems must be closely matched to the mechanical systems they move. This is done with "gain" parameters that adjust the performance of the servo system and determine its power output. If the "gains" are incorrect, low performance or even damage to the mechanical unit can result. These "gain" parameters are stored in the software and are loaded in the servo controller board just after power is applied to the ladle.

A default type was created to allow all Rimrock servo ladles to safely home. The first time a ladle is powered on after a new CPU board is installed, or after the RAM chips have been replaced, a default type of 888 will be used to initially home the ladle. After Homing, only the TEACH key will be active. The Message Center will display "SYSTEM INITIALIZED: MUST TEACH AUX 4.4 TO OPERATE". Use the following procedure to select the ladle type that matches the mechanical unit to which this control box is connected.

This parameter is used to match the control system to the mechanical unit. It can only be changed in Manual Teach Mode. To cycle through the available machine types press the UP or DOWN ARROW key until the desired type is displayed in the Timer window. Press the ENTER key to select the matching type, then turn the power off. After waiting about 15 seconds, turn the power back on and Home the ladle. The new type is now set.

NOTE: Changing ladle type will destroy existing parameters and reset all memory areas to their default values for the new ladle type.

AUX. 4 PARAMETER 5

HOLD AT REST ON/OFF

When this is selected to "ON" (1) and in Auto Mode, the ladle will check the "OK TO POUR" interlock (PLUNGER RETRACTED, 1 of 2) after the dipper has filled and the ladle is moving forward from the Spill-off Position. If that input is on, the ladle will continue forward to the Pour Position as if in a normal cycle. If the input is not on, the ladle will decelerate to a stop at the Rest Position and hold there until either the input comes on, or the Cycle Abort Timer times out. If the cycle abort timer does expire, the ladle will go through a normal Interlock Cycle Abort. If the input is activated while the unit is at the Rest Position it will move forward to the Pour Position and begin the pour.

AUX. 4 PARAMETER 6

POUR BACK AFTER ABORT ON/OFF

When this parameter is "ON" (1) the ladle will go back to the furnace and pour back the metal during a cycle abort. When the parameter is selected to "OFF" (0) the ladle will return to the Clear Position and not pour back the metal

during a cycle abort. For most applications the default of "1" is the best choice. The "0" setting is sometimes used when there is interference between the dipper and the furnace.

AUX. 4 PARAMETER 7

POUR 3 HOLD ON/OFF

The ladle will function normally if this option is "OFF" (0). Turning this option "ON" (1) allows the dipper to stay in Pour Position 3 until the next start signal is received. When a start is received, the ladle will go into motion with the dipper in the fully poured position. It is used in applications where the metal refuses to empty out of the dipper completely, and will allow any remaining solidified metal to be blown out of the dipper at the Rest Position.

AUX. 4 PARAMETER 8

ACTIVE MEMORY AREA

There are thirty memory areas to store programmed parameter values. This allows jobs to be changed quickly by just entering the next job's memory area. This parameter can only be changed in Manual Teach.

AUX. 4 PARAMETER 9

MESSAGE CENTER PRIORITY ON/OFF

Note: this parameter only applies to the shared Red Lion type Message Center that has red characters. If your Message Center has blue characters, it does not apply, and should be set to 0.

This parameter will set the message center to receive only Ladle messages. If another machine (Reciprocator or Extractor) activates the message center, then this parameter will reset automatically (be turned off). If a fault occurs that machine takes over priority of the message center, this will allow the message center to always reveal the current fault in a multiple machine environment. If any machine enters Teach Mode, the message center will be taken over by that machine and all teach messages are displayed on the message center.

AUX. 4 PARAMETER 10

ABORT CYCLE RETRIES

This parameter will allow the ladle to recycle after a Cycle Abort if the Abort Timer times out before the Pour Interlocks are made. The value of the parameter is the number of additional times that it will restart (without any additional start signals from the die cast machine). If the final restart attempt fails, the machine will return to the Rest or Clear Position, depending on how AUX 4 Parameter 6 is set.

AUX. 4 PARAMETER 11

STOP AT CLEAR ON/OFF

When this parameter is set to "ON" (1) the arm will stop at the Clear Position and the dipper will rotate to the Fill Angle before continuing toward the furnace at the Enter Metal Speed. When set to "OFF" (0), the arm does not stop at the Clear Position, but will have decelerated to the Enter Metal Speed by the time it reaches that position. It will then begin moving the dipper to the Fill Angle as it continues toward the furnace.

NOTE: If Aux. 4 Parameter 1, Pour to Clear is set to "ON" (1) it will cancel the effect of this option.

AUX. 4 PARAMETER 12

PRE-POUR ON/OFF

When this parameter is set to "ON" (1), the dipper will move to the Pour 1 Position as soon as the arm reaches the Ready to Pour Position. After the dipper completes the move to Pour 1, the Cycle Abort Timer will begin timing while the pour interlocks are checked. If the interlocks are OK, the dipper will continue the pour. If the interlocks are not OK, and the Cycle Abort Timer times out, the ladle will begin a Cycle Abort.

AUX. 4 PARAMETER 13

DELAYED FILL ON/OFF

When this parameter is set to "ON" (1), the dipper will move down to the metal before rotating to the fill position. The option is used only with special dippers to remove dross from the surface of the metal.

AUX. 4 PARAMETER 14

DIPPER BLOW ON/OFF

When this parameter is set to "ON" (1), the arm will move to the rest position after pouring the metal. The dipper will then rotate to the inverted position, pause for the blow off time set in AUX 2 parameter 1. The dipper will then move to the level position and the cycle will continue.

3.3.17 AUXILIARY KEYS (Video Terminal)

In the Video Terminal, the Auxiliary keys are not used. Since it is a graphic display, the function of these keys was just added to their respective sections. Therefore the functions of AUX. 1 (Speed) is located under the Speed Section. The AUX. 3 (Position) is located under the Arm Section. The AUX. 4 (Options) is located under an Options Section. The AUX. 5 (Homing) key is renamed HOME. The HOME key is only visible when the machine needs to be Homed.

3.4 ARM POSITIONS

This section pertains to the positions of the arm of the ladle. These positions are described by their location on the path of the ladle and are measured in approximate inches.

NOTE: See Table 3.12 FACTORY SETTINGS for factory default arm parameter values and arm parameter range information.

3.4.1 READY TO POUR

This is the position where the arm will stop to make the pour. The default setting for this parameter is 0.0 and must have a value taught before the ladle will move. During initial setup, it will be easier to use Manual "Teach by Example" if the maximum value from Table 3.12 is taught now.

The most effective method of teaching this position is to use Manual "Teach by Example." The steps to teach this position are as follows:

1. While in Manual Mode, press the TEACH key.

2. Press the ARM SET key three times to light the Ready to Pour LED.

3. Press the ARM FORWARD key until the dipper pour point is in position with the pour hole.

4. Press the ENTER key; and the new value will appear in the window and the Teach LED will start flashing again.

(Note: If the new Pour Position is expected to use more stroke than the current programmed position it is necessary to increase the Pour Position to a value larger than the expected stroke before manually teaching the Pour Position.)

3.4.2 CLEAR

This position is very important for the ladle to function properly. The correct setting of this parameter will allow the Ladle to operate as quickly and as accurately as possible. If set incorrectly, a 4.01 fault can occur. Refer to the Arm Position description section for further explanation. This parameter is measured from the Rest Position back toward the dip well.

NOTE: This position must always be set to a smaller value than the value that the Low Metal Position is set.

The most effective method of teaching this position is to use Manual "Teach by Example." The steps to teach this position are as follows:

1. Fill the dip well so the metal is at its highest level.

2. While in Manual Mode, press the TEACH key.

3. Press the ARM SET key once to light the Dipper Clear LED.

4. Press the ARM RETRACT key until the dipper is at a point above the metal where it can rotate back to the maximum Fill Position of 45.0 degrees without the sensor probes touching the metal.

5. Press the ENTER key once more and the Teach LED will start flashing.

(Note: If the new Clear position is expected to use more stroke then the current programmed position it is necessary to increase the Clear Position before using Manual "Teach by Example" to teach the Clear position.)

3.4.3 SPILL-OFF

The factory set value is usually sufficient for any application. This parameter is measured up from the metal surface.

1. Enter the Teach mode by pressing the TEACH key.

2. Press the ARM SET key twice to light the Spill-off LED.

3. Enter in the new value with the numerical portion of the keypad.

4. Press the ENTER key.

3.4.4 AUX. 3 PARAMETERS (POSITIONS)

This key is used to adjust the auxiliary positions:

AUX. 3 PARAMETER 1

LOW METAL POSITION

NOTE: Since it is set to 0.0 by default, on a new ladle it will be necessary to teach the Low Metal Position before Clear Position can be taught. The Low Metal Position must always be set to a larger value than the value that the Clear Position is set.

The Low Metal Position sets the maximum distance the arm allowed to retract. This position can be set by manual teaching or by entering in the correct position from the keypad. With the dipper at a Fill Angle of 45.0 degrees, this position should be set to stop the arm from retracting when the bottom of the dipper is 1" above the bottom of the dip well. This parameter was set to 0.0 at the factory to require it be correctly set for the cell during installation.

NOTE: This parameter must be re-taught if the shot height is changed.

If the furnace has metal in it, use a metal rod to locate the bottom of the dip well. Then rotate the ladle around so that the arm is away from the furnace. Jog the arm down to the position 1" above the dip well bottom and set that position as Low Metal Position. When this position is reached in a normal ladle cycle the ladle will go into stop mode and indicate a LOW METAL FAULT. Output module #1/23 will also be on solid.

AUX. 3 PARAMETER 2

ARM ADVANCE OFFSET

This position is the number of inches that the arm will travel during Arm Advance, a 'go forward and pour' move, which occurs as the dipper moves from Pour 2 to Pour 3. This position allows the arm to advance forward at a programmed speed while the metal is being poured. The speed is set under the Aux. 1 key. The total of the Pour Position and this offset must not be more than the maximum ladle stroke. If an attempt is made to set this position at a value greater than the maximum stroke the display will flash and not accept this value.

AUX. 3 PARAMETER 3

LOW METAL WARNING OFFSET

If the arm reaches the Low Metal Warning Position then output module #1/23 will flash. This position can be set by manual teaching or by entering an offset from the keypad. If the furnace has metal in it, use a metal rod to locate the bottom of the dip well. Then rotate the ladle around so that the arm is away from the furnace. Jog the arm down to the desired position and set this offset at that point. This position and the corresponding output can be used to activate a signaling device to alert the operator that metal is low in the furnace. This is only a warning, so the ladle will continue to operate even if this position is reached. When the metal level rises above the warning point (i.e. the furnace is filled) the warning is canceled and the output stops flashing. If the metal level is not raised and the Low Metal Position is reached by the Ladle arm, a LOW METAL LEVEL FAULT is generated (see LOW METAL LEVEL output).

AUX. 3 PARAMETER 4

ALLOWABLE CHANGE IN FILL POSITION

This parameter adjusts a software retract over-travel limit. The ladle remembers the arm position where metal is found after power up. In Auto Mode, the arm must find metal by this parameter value below the remembered value, or a Fill Level Abort sequence will begin and a 4.12 FAULT - ALLOWABLE CHANGE IN FILL LEVEL EXCEEDED will occur. This will help prevent the arm submerging in the metal if something goes wrong. The default parameter value may not be the best choice for your applications, since the change in level depends on the surface area of the furnace and the shot size. You should choose one that is about ten times the distance the metal level drops each time the dipper fills.

AUX. 3 PARAMETER 5

POUR BACK OFFSET

This parameter adjusts the arm distance above the metal where the metal is poured back into the furnace after a cycle abort. If the pourback after abort option is turned on, the ladle arm will move back until the probes contact the metal, then the arm will move up the distance programmed in the pour back offset. The dipper will then empty the dipper back into the furnace. This feature may be used to insure the dipper is

above the metal when the dipper is fully forward. The range of of adjustment is from 0.0 inches, (no liftoff) to 9.9inches for a 405 ladle.

AUX. 3 PARAMETER 6

BLOW OFF OFFSET

This parameter, only active when the dipper blow off option is turned on, allows the position of the arm at which the dipper is inverted to selected. If the blow off offset is set to zero, the arm will move to the rest position before inverting the dipper. The programmed offset will stop the arm a specified distance in front of the rest position before inverting the dipper. This feature may be used in cases where there is a mechaanical interference when the dipper inverts and the arm is at the rest position. The range of of adjustment is from 0.0 inches, (dipper inverts when the arm is at the rest position) to 33.0inches for a 405 ladle.

3.5 DIPPER POSITIONS

This section pertains to the positions of the dipper. These positions are described by their rotation around the pour shaft on the arm of the dipper and are measured in degrees.

3.5.1 FILL ANGLE

This parameter determines how much metal the ladle will pour; the larger the angle (the further back the dipper tilts), the less metal the dipper will carry. Refer to the Fill Angle Chart to get appropriate values for this parameter. The steps to enter this value are as follows:

1. Press the TEACH key.

2. Press the DIPPER SET key once, which will light the Fill Angle LED.

3. Enter the new value for the angle with the numeric portion of the keypad, then press the ENTER key.

NOTE: If more than one fill angle is selected in AUX 4 parameter 2, you will be asked to program the corresponding additional fill angles.

3.5.2 POUR POSITIONS

The pour positions, when used in conjunction with the pour speeds constitute the characteristics of the pour, also known as the pour contour. An almost limitless number of combinations of pour speeds and positions exist for creating a pour contour. The purpose of this section, along with the speed set section, is to set up a rough contour. This contour can be optimized once the ladle is in operation.

1. Set up the ladle at the dip well and get metal in the dipper; by first jogging the arm back to the Clear Position, then jog the dipper back to Fill Angle, then jog the arm down into the metal. The sensor probes will stop the arm at the Fill Position. After the dipper fills with metal, jog the dipper up a few inches to let the excess metal spill off.

2. Press the TEACH key then the DIPPER SET key twice to light up the Pour Position 1 LED, jog the dipper forward until the metal is at the lip of the dipper. This will be Pour Position 1.

3. Press the ENTER key.

4. Press the DIPPER SET key until the Pour Position 2 LED lights up.

5. Jog the dipper forward to a point where most of the metal pours out quickly. This will be Pour Position 2.

6. Press the ENTER key.

7. For Pour Position 3 a value of 70 to 75 is usually sufficient. Watch out for potential clearance problems as the dipper rotates to the final pour position.

3.6 SPEEDS

To initially set the speeds, enter them numerically with the keypad, then fine-tune them later. Speeds are programmed as a percent of the full speed of the ladle. All the necessary speeds are adjustable, and are labeled as to their function. The programming steps are as follows:

1. While in Manual Mode, press the TEACH key.

2. Press the SPEED SET key until the LED next to the parameter to be programmed is lit.

3. Enter in the new value with the numerical portion of the keypad.

4. Press the ENTER key.

3.6.1 ARM RETRACT

This is the speed the arm will travel between the Rest Position and the Clear Position.

3.6.2 ARM FORWARD

This is the speed the arm travels from the Spill-off Position to the Ready to Pour Position.

3.6.3 RETRACT AFTER POUR

This is the speed the arm travels back to the Rest Position, after the pour is made.

3.6.4 AUX. 1 PARAMETERS (SPEEDS)

This key is used to adjust the auxiliary speeds:

AUX. 1 PARAMETER 1

ENTER METAL SPEED

The speed the arm travels from the Clear Position down into the metal. If the Fill Angle is small, (the dipper is carrying a nearly full load of metal) a high AUX. 1 speed will cause waves in the metal upon entry, which will contact the high metal probe. This contact will cause the arm to jump up and down in the metal in its attempt to seek a new metal level.

An AUX. 1-1 value of 10 or less will usually remedy this situation. This speed will also effect the associated manual speeds.

AUX. 1 PARAMETER 2

EXIT METAL SPEED

The speed the arm travels from the metal up to the Spill-off Position.

AUX. 1 PARAMETER 3

ABORT ARM SPEED

The speed the arm travels during an Abort Cycle. Caution must be used in setting this position, the larger the value the larger the possibility of spilling metal.

AUX. 1 PARAMETER 4

DIPPER LEVEL TO FILL SPEED

The speed the dipper travels from the Level Position to the Fill Position.

AUX. 1 PARAMETER 5

DIPPER FILL TO LEVEL SPEED

The speed the dipper travels from the Fill Position to the Level Position.

AUX. 1 PARAMETER 6

DIPPER POUR TO LEVEL SPEED

The speed the dipper travels from Pour Position 3 to the Level Position.

AUX. 1 PARAMETER 7

ARM ADVANCE DURING POUR SPEED

The speed the arm travels during the Arm Advance move.

To change any of these auxiliary speeds, follow this procedure:

1. Press the TEACH key.

2. Press the AUX. 1 key once. This will cause the LED next to the AUX. 1 key to turn on, and the SPEED window will display '1' for the first parameter. The Timer window will display the speed for this parameter.

3. Enter in a new value with the numeric keypad if desired, and press the ENTER key

4. Press the AUX. 1 key again. The SPEED window will display the next parameter number and the Timer window will display the speed for this parameter.

5. Repeat steps 3 and 4 until all AUX. 1 parameters of interest have been displayed and edited.

6. Press the Teach key once more, or press any of the Set keys, to exit from AUX.1 teach.

3.6.5 POUR SPEEDS

The following pour speeds are used in conjunction with the pour positions to give the pour contour. As mentioned in the dipper positions section, an almost unlimited number of speed and position combinations can be created. The purpose of this section, along with the pour positions, is to give a starting point from which minor modifications can later be made.

POUR SPEED A

This is the speed the dipper travels between the Level Position and Pour Position 1. The factory default value may not be the best choice for your

applications, so you should choose a setting that fits your needs. If the speed is too high in relation to Pour Speed B, then the metal will be more likely to slosh out of the dipper when the transition is made from Pour Speed A to Pour Speed B.

POUR SPEED B

This is the speed that the dipper travels at between Pour Position 1 and Pour Position 2. The majority of the metal is poured at this speed. The factory default setting may not be the best choice for your application, so you should choose a setting that fits your needs. For foundry operations in which a slow steady pour is needed, a value of 3.0 or 4.0 may be necessary.

POUR SPEED C

This is the speed that the dipper travels at between Pour Position 2 and Pour Position 3. This is the final speed of the pour. This speed may be the fastest of the three in order to get the remainder of the metal out of the dipper before it solidifies.

The idea behind this method of pour contouring is to start with values that are probably a little slower than needed and then speed them up later when the machine is cycling. This is covered in the Auto Teach section. An optimal contour is one in which the metal pours out of the dipper as quickly as possible without spillage. With proper installation and programming, any needed pour contour should be attainable.

3.7 TIMERS

Six timers are used by the ladle. All values are in seconds. Their sequence from top to bottom on the control panel is the order that they are used during the ladle cycle. The steps for entering them are as follows:

1. While in Manual Mode, press the TEACH key.

2. Press the TIMER SET key until the LED next to the parameter to be changed is lit.

3. Enter in the new value using the numerical portion of the keypad.

4. Press the ENTER key.

3.7.1 DELAY CYCLE START

This timer synchronizes the ladle with the DCM. If the DCM is running a relatively slow cycle this timer will keep the ladle at the Rest Position for the programmed amount of time, after the start signal is received. This keeps the ladle from waiting at the shot sleeve with a dipper full of metal while the DCM closes the dies.

3.7.2 FILL

This timer allows the metal to completely fill the dipper. This timer should NOT be used to set the amount of metal the dipper will pour.

3.7.3 SPILL-OFF

This timer allows the excess metal to spill back out of the dipper. It begins timing when the arm reaches the Spill-off Position.

3.7.4 ABORT CYCLE

This timer determines how long the ladle will wait at the Pour Position if the Plunger Retract and/or the Dies Locked interlocks are not present. If these interlocks are made at any time while the abort cycle is timing, the ladle will make the pour. If this does time out, an Abort Cycle will begin.

NOTE: Care must be taken not to let the metal solidify in the dipper. As a rule of thumb set the timer for one second per pound of metal to be poured.

3.7.5 DELAY AFTER POUR

This timer is used to hold the dipper at Pour Position 3 for a specified amount of time in order to let the remaining metal pour out of the dipper. Once this timer times out the dipper goes back to the Level Position.

3.7.6 DELAY POUR COMPLETE SIGNAL

This timer allows the dipper to clear the shot sleeve before giving the signal to make the shot. This timer is used to delay the Pour Complete Signal so the wave of metal in the shot sleeve is in the correct position. It begins timing right after the Delay After Pour timer times out.

3.7.7 DIPPER BLOW OFF TIME

This timer allows the dipper pause during the inverted position. The dipper blow off option must be turned on for this parameter to be active. An output is available through a auxillary I/O card which will go true during the dipper blow off time. This signal may be used to activate a solenoid valve, turning on a stream of air directed into the inverted dipper. This stream of air will blow out any residue remaining in the bottom of the dipper. The allowed range is 0.0 to 9.9 seconds.

3.8 TEACHING IN AUTO MODE

As mentioned earlier, teaching in Auto Mode is used to fine adjust the parameters. Teaching in Auto Mode is much like teaching in Manual Mode except the only way to change a parameter is to use the UP and DOWN ARROW keys to increase or decrease the values.

NOTE: It is not possible to change two of the Options parameters in Auto Teach. Both the Ladle Type and Active Memory Area parameters must be changed in Manual Teach only.

Teaching in Auto Mode does not interrupt the machine cycle. The value that is entered will be used on the next cycle. As with Manual Mode teaching, if no key is hit for 30 seconds while in Teach Mode, the Teach Mode will be exited.

The steps for Auto Mode teaching are as follows:

1) While in Auto Mode press the TEACH key; this will cause the display windows to go blank.
2) Press one of the SET or AUX keys to get the LED lit next to the parameter that needs to be altered.
3) Press the up or down arrow key to change the parameter as needed.
4) Press the ENTER key.

The value just entered will be used on the next machine cycle.

3.9 ABORT CYCLE

When the ladle reaches the Ready to Pour Position and the OK to Pour (Plunger Retract and Dies Locked), interlocks are not present; the Abort Timer begins timing down. If the interlocks are satisfied before this timer expires, then the pour will be made. If it times out before the interlocks are made, the ladle goes through an Abort Cycle.

3.10 FILL ANGLE TRIM

This option, which very few ladles have, is another method for adjusting the Fill Angle. It allows fine adjustments to be made in either Manual or Auto Modes without entering Teach Mode. Incremental adjustments of 0.5 degree, with a total adjustment of 5.0 degrees per cycle, can be used to either increase or decrease the angle.

The interface includes a 3-position 800T switch with spring return to the center. The switch positions are labeled "INCREASE," "OFF," AND "DECREASE." Pilot lamps labeled "INCREASE" and "DECREASE" blink on to confirm the adjustment has been entered.

To enter an adjustment the Operator must move the switch to the desired position, wait until the pilot light blinks then allow the switch to return to center before making additional adjustments. The Message Center (or Video Terminal) will display "FILL ANGLE TRIM ANGLE INCREASED: LESS METAL," or "FILL ANGLE TRIM ANGLE DECREASED: MORE METAL" for Increase and decrease adjustments, respectively. Adjustments can be cancelled by repeating the procedure in the opposite direction. A maximum of ten adjustments in one direction during a cycle is allowed. Adjustments should be made between dipper Fill to Level move and the Level to Fill move of the next cycle (i.e., the end of the current fill cycle and the start of the next one).

4. COMPONENTS

4.1 ELECTRICAL - GENERAL

4.1.1 The ladle electrical system has four functional groups of components:

4.1.1.1 Power - The components in this group includes the switching power supply and the servo amplifiers.

4.1.1.2 Logic - The components in this group are the card cage, CPU board, and servo controller board.

4.1.1.3 Input/Output – This group includes the breakout panel, I/O rack, I/O modules, relays, proximity limit switches, sensors, and keypad or video terminal.

4.1.1.4 Interconnections – These include numerous flat and round cables to connect everything together, screw terminal strips, and circuit breakers.

The function of each of the major components listed above will be explained in the following sections.

4.1.2 Power Source
Referring to the schematic, 140D11850-01, the primary power source is the customer supplied 120 VAC. This is the input power to the regulated DC power supply. It also powers the interlocks, the pour complete relay (803 CR), and the servo amplifiers on all models of servo drive ladles except the 458.

4.2 ELECTRICAL - SPECIFIC

4.2.1 POWER SUPPLY

This converts the 120 VAC to 5 VDC, 12 VDC and 24 VDC needed by the control system. The 5 VDC is used by the card cage, the 12 VDC is used by the serial communications, and the 24 VDC is used by the limit switches and the sensors. The 5 VDC also powers the keypad on any servo ladle that has a Message Center with a red display. The card cage requires a steady voltage input, so the power supply is regulated. The adjustment pot for 5 VDC is located at the top of the unit near the wiring connector. It should be set for an output of 5.20-5.25 VDC across wires 15 and 16 measured at the DIN rail mounted terminal strip. The other outputs from the supply are fixed. This is a computer grade SWITCHING power supply, therefore NEVER operate this supply without a load attached. If the power supply is on and the output power cable is disconnected, damage to the supply is possible.

P/N: 11450-70

4.2.2 CARD CAGE

The card cage houses the boards referred to above. The boards may be placed in any of the slots in the cage and in any order. The only thing that matters is that the correct cables are connected to each board. It will be easier to route the 60-conductor I/O ribbon cable if the CPU board is plugged in slot 2, and the other boards placed to the right of it. The card cage and the boards plugged into it receive power from the connector on the bottom of the card cage. The boards are very voltage sensitive, so the voltage going to the card cage must be between 5.20 and 5.25 volts. Refer to the power supply section for adjusting this voltage.

Be sure the power is off when inserting or removing the boards from the card cage.

P/N: 11444-01

4.2.3 CPU (CENTRAL PROCESSING UNIT) BOARD

The CPU is the brain of the ladle. It contains the logic circuits and software, and interfaces to the other boards. The software is contained on Flash EPROM chips, and the CPU uses static RAM for its processing. This RAM is powered by a battery (made non-volatile) when the main power is turned off. This allows a section of the RAM to be used to store the Teach parameters. Refer to drawing 140B11450-05 for the detail of this board. The front edge connectors of this board are used for the KEY PAD and MESSAGE CENTER serial communications links. The 60-pin connector near the center of the board is where the I/O ribbon cable connects.

P/N: 11440-05

4.2.4 SERVO CONTROLLER BOARD

The Servo Controller Board is the interface between the CPU Board, the Servo Amplifiers, and the Servomotors. During every move the ladle makes, the Servo Controller Board translates position and speed commands sent by the CPU, and continuously outputs speed signals to the Servo Amplifiers and reads encoder signals input from the Servomotors.

P/N: 11442-11

4.2.5 SERVO INTERCONNECT BOARD

The Servo Interconnect Board is a cable junction for the cables connecting the Servo Controller Board, the Servo Amplifiers, and the encoders in the servomotors. Monitor LEDs for over-travel inputs, and amplifier enable and arm brake outputs are also provided. This board is mounted on the base of the I/O Module, under the I/O Rack.

4.2.6 SERVO AMPLIFIERS

There are two Servo Amplifiers in the Servo Ladle control box. One of these powers the arm motor and the other powers the dipper motor. The amplifiers receive analog signals from the Servo Controller Board in the card cage and convert it into the appropriate 3-phase speed and direction signals to power the motors. The table on the schematic shows the wiring of the servo drive and the motor controller. The control box wiring diagram, 411D11450-19, shows the motor controller pots and dip switch settings. The settings for these pots are also shown on this drawing and are shown at their correct positions.

The Rimrock Servo Ladles use Brushless PWM Servo Amplifiers. Refer to the parts lists for the type used on your machine since the type varies with the load requirements of the machine. The amplifier has a red/green LED near its signal connector. When the LED is red the amp is powered, but not enabled. When the LED is green the amp is powered and enabled. Enabled indicates that the motor can move if given a command. This amplifier has four user potentiometers, which are described in the following paragraphs.

WARNING: Hazardous voltages are exposed during the set up and operation of the servo amplifier. **Exercise extreme caution-ONLY** qualified personnel should perform adjustments to the motor control unit.

Potentiometer 1 - Loop Gain

This control sets the voltage to current scaling factor. Turning it clock-wise increases the loop gain. ***As shipped, Potentiometer 1 is in the full CCW position and it is recommended that it not be changed.***

Potentiometer 2 - Current Limit

This control limits the maximum torque (current) of the motor. It adjusts both continuous and peak current limit, maintaining a selected ratio. Turning it clock-wise increases the current limit. ***As shipped, Potentiometer 2 is in the full CW position and it is recommended that it not be changed.***

Potentiometer 3 - Reference Gain

This control adjusts the ratio between the input signal and the output variables (voltage, current, and phasing). Turning it clock-wise increases the reference gain. ***As shipped, Potentiometer 3 is in the full CW position and it is recommended that it not be changed.***

Potentiometer 4 - Offset / Test

This control adjusts the imbalance in the input signal or in the amplifier (servo motor 3-phase power supply). ***As shipped, Potentiometer 4 is in the middle of its adjustment and it is recommended that it not be changed.***

Wires 803 and L2 feed in the power to the servo amplifier.

P/N: 06664-51

4.2.7 I/O RACK

The I/O rack interfaces the various input and output signals between the card cage, the ladle and the DCM. Each module on the I/O rack has a fuse and LED that correspond with it. The fuse is adjacent to each module and the LED is next to the module.

The LED's indicate when the module is "on." It is possible for the LED to be on if the fuse is blown, so if a function corresponding to a certain module is not working but the LED is lit, check the fuse. The LED is part of the circuit, and must be working for the slot to work.

P/N: 7622-401

4.2.8 I/O MODULE

The I/O Rack uses I/O Modules to interface the computer with outside signals. These modules are available in different voltages. They are used as per their need.

INPUT, 120 VAC: 7622-402 (yellow)

OUTPUT, 120 VAC: 7622-403 (black)

INPUT, 24 VDC: 7622-404 (white)

OUTPUT, 24 VDC: 7622-405 (red)

WATCHDOG OUTPUT, 120 VAC (N.C.): 7622-406 (blue)

4.2.9 DOOR SWITCH

The door switch, located on the side opposite the hinge of the control box enclosure, is used to disable most of the power inside the control box. It is in series with the control power. The ladle will not go to Manual or Auto Mode until the door switch is either pressed in by the cabinet door or pulled out if the door is open. It is open in the intermediate position.

P/N: 02833

4.2.10 CONTROL POWER RELAY (801 CR)

This relay is the control power relay and is activated by the watchdog output module in slot 0 on the I/O rack and the door switch closure. It is closed when in Manual or Auto Mode.

P/N: 07622-30 (standard duty)

4.2.11 ENCODERS

The encoders used on servo ladles are an integral part of the servomotors, and are connected to the rotor shaft opposite from the output end. The encoder's cable connects to the Servo Interconnect Board, then to the Servo Controller Board in the card cage, which supplies power and reads the encoder's output signals to track the motor's position and speed. Care should be taken when working with servo motors, since the encoder is easily damaged by pressure on the output end of the shaft or a blow to the case. The encoder cable should be routed away from power wiring to avoid picking up "noise," which could cause position errors.

4.2.13 KEYPAD

The keypad is a combination of the membrane keyboard and a circuit board mounted behind it. The new Message Center is also part of this unit. The keypad is linked directly to the CPU board in the card cage by a serial communications cable. A 13-pin connector, located on the back of the keypad, is used to connect any remote switches. This connector may also be used to troubleshoot any bad keys on the keypad (see the Troubleshooting section).

P/N: 11120-200 (Keypad only)

P/N: 11120-109 (Display Board only)

P/N: 11083-09 (Display Board Ribbon Cable)

P/N: 11083-10 (Message Center Cable)

P/N: 11450-126 (SDB Power Supply Assembly)

P/N: 11450-156 (LCD PCB Assembly)

4.2.14 VIDEO KEYPAD

As an option, this machine is available with a Video Touch Screen Operator Interface in place of the Keypad. This interface is a combination of a Single Board Computer, LCD Color Flat Panel Display, a Capacitive Touch Screen, and Power Supply, all mounted in one control box. All Rimrock machines in a cell can be controlled by this interface. All functions operate similar to a standard Keypad. The only exception is in Teach, where this interface makes programming easier.

P/N: 11450-59 (Assembly)

4.2.15 PROXIMITY SWITCHES

The ladle uses six proximity limit switches: dipper level, dipper forward over-travel, dipper reverse over-travel, arm retract over-travel, arm forward of Home, and arm forward over-travel.

These switches connect to optical isolation devices on the Servo Interconnect PCB Board, which sends a corresponding 5VDC logic signal to the Servo Controller Board.

P/N: 02863-20

4.2.16 SENSOR CIRCUIT

The sensor circuit uses the molten metal in the dip well to complete a circuit across the probes. The two long probes are the primary sensors, while the short probe is used to test for a high metal condition. A high metal condition occurs when the furnace is being filled while the dipper is in the metal. To avoid covering the end of the arm, the ladle will move up out of the metal, and then go back down and find the new metal level.

Also included in the sensor circuit are two diodes, which are used to check the sensor circuit for proper operation. The diodes are in the form of a bridge rectifier, which is mounted in the Sensor Assembly on the arm. The sensor check tests the circuit between the diodes and the probes for open or shorted conditions.

P/N: 9759-200 (rectifier)

4.2.17 MESSAGE CENTER

The Ladle features a Message Center that displays messages sent by the CPU via the RS232 serial link. This Message Center is designed to make the operators' job easier and faster. Diagnostics, cycle, and programming messages result in decreased set-up time, faster troubleshooting and simplified programming. If a fault occurs, an explanation is displayed on the Message Center. This Message Center is standard on all Ladles using the standard Keypad as an operator interface, and is mounted in that unit. Ladles that utilize the Video Touch Screen as their operator interface have the same messages displayed on the LCD touch screen.

See the Keypad description for part numbers.

5. MAINTENANCE AND TROUBLE SHOOTING

5.1 MAINTENANCE SAFETY

Do not attempt to perform any maintenance on this equipment until you read and understand all the safety instructions and all the power sources are locked out according to OSHA's Lock Out Procedures. Be sure the electrical power in the interlock system is "OFF" when the machine power is disconnected. These are usually yellow wires and can supply power from another source when the main disconnect is off. Always turn power "OFF" before removing the circuit boards to prevent damage to the boards and also "Electrical Shock" to yourself. Keeping your equipment clean and the area in which it is located clean is a vital part of your safety program. Developing a set periodic maintenance program of your own, plus following recommended maintenance in this manual will extend your equipment's life and make it safer to operate. Do not attempt to alter, bypass or short circuit any safety device or systems on this equipment. All guards, shields, barriers or covers must be put back after any maintenance is performed or repairs are completed before the equipment is returned to service. The end user of this equipment is responsible for the safe operation of the equipment and for the safety of their operations and maintenance personnel.

5.2 MAINTENANCE

NOTE: TO AVOID SAFETY HAZARDS TO PERSONNEL, A QUALITY PERIODIC MAINTENANCE PROGRAM SHOULD BE ADOPTED.

This section is concerned with items that are shown on assembly drawings included with this manual. Please refer to the assembly drawings in Section 6 and 7. These drawings will provide the part numbers for items discussed in this section.

5.2.1 CHAIN MAINTENANCE

Inspect the dipper drive chains after the initial 10 hours of maintenance, then every 200 hours of operation.

1. Chain Lubrication: During each inspection lubricate the chain with high temperature grease. (DuBois HTG- 3048)

a. Remove the arm covers.

b. Remove all the old grease and any foreign particles with a solvent rag.

c. Re-lubricate the chain and sprocket shafts.

d. Replace the covers.

2. If the sprocket teeth show signs of wear, then replace the chain. Replace the sprockets if the teeth are excessively worn.

3. Check the chain tension. Refer to the Chain Tensioning section for details.

4. Every six months the dipper shaft should be removed, cleaned, and inspected. Replace it if it shows signs of excessive wear.

5.2.2 CHAIN TENSIONING

1. With the ladle at the rest position and with the dipper level, remove the upper and lower arm access covers.

2. Loosen the locking nut on the turnbuckle assembly. Rotate the turnbuckle in the direction needed to either tighten or loosen the chain. The chain will be in proper adjustment when 15 lb. of force applied to the chain causes it to just touch the inside of the arm.

3. Re-tighten the locking nuts and replace the arm covers. Do not use screws longer than 3/16" (4 mm) or these will interfere with the chain.

5.2.3 CHAIN REPLACEMENT

1. Move the ladle to the rest position with the dipper level.

2. Remove the arm covers and loosen the turnbuckles until the chain falls free.

3. To remove the lower arm chain the end cap on the arm must be removed first.

4. Place the new chains in the arm with the turnbuckles located at the center of the arm openings. Failure to do this may cause the turnbuckles to ride onto the sprocket when in operation.

5. Re-tighten the chains as specified in the chain tensioning section and replace the arm covers.

NOTE: Should the arm become immersed in metal it is recommended that the chain, pour shaft and pour shaft bearings be replaced as they will be annealed at high temperatures and pose a safety hazard.

5.2.4 LUBRICATION

Every 200 hours of operation, the bearings in the arm should be lubricated with high temperature grease. In the lower arm, the fittings are located in the shaft ends. In the upper arm, the fittings are located in the bearing housings. The recommended high temperature grease is DuBois HTG-3048.

GEARBOXES

The gearbox used by the 405 arm is a precision speed reducer. It is filled with grease by the manufacture. A grease change should be done every 20,000 hours or every 4-5 years. New grease (Shell Alvania 2) should be re-packed after removing the old grease and cleaning the internal parts.

The dipper gearbox is filled at the factory with the oil recommended by the gearbox manufacture. This is a synthetic lubricant from Mobil (SHC 634). After the first 50 hours of operation, the gearbox housing should be drained, flushed out and refilled with new oil to the oil plug level. Then the oil should be changed every six months or 2,500 operating hours. The oil should be changed more often if sludge forms in the housing.

5.2.5 REPAIRING DIPPERS MADE OF 304 STAINLESS STEEL

1. Completely remove the old coating. Sandblasting is the best method, but a wire brush will do.

2. Place the dipper in a caustic soda bath to remove all the aluminum on the walls of the dipper. This is very important, as any repair will fail quickly if aluminum is left on the area to be repaired.

3. Make the necessary repairs to the dipper, using a 308 stainless rod and a heliarc welder. The weld area should be flooded with argon gas or be protected in some other manner to prevent weld contamination.

4. Grind the repaired area to match as closely as possible the original material thickness.

5. Coat the dipper. Follow the coating manufacturer's directions closely when coating the dipper. For best results, coat the dipper every 4 to 8 hours.

NOTE: TO AVOID ANY HAZARDS TO SURROUNDING EQUIPMENT AND/OR PERSONNEL MAKE SURE THAT DIPPER HAS COMPLETELY DRIED BEFORE USE.

5.3 TROUBLESHOOTING

Often a good place to start when troubleshooting is to look at the I/O modules and make sure each function is working correctly. The main indication of a bad module is its LED not lighting. If an LED does not light up when it should, the first course of action is to replace the module with one that is known to be good. If this does not work, then check to make sure the pins are making good contact with the rack terminals. Next, check the fuse on the rack to make sure it is good. Each module has its own fuse. They are located adjacent to the module (they look like small resistors). The function and location of each module is listed later in this section.

5.3.1 LADLE FAULT LIST

Most faults can be cleared by pressing the Clear key. The explanation of faults below will indicate the reason for the fault, and give the correction for the fault in most cases.

COMMUNICATION FAULTS
3.95 FAULT- COMMUNICATION TIME OUT ERROR **3.96 FAULT**- TOO MANY ERRORS **3.97 FAULT**- TOO MANY BAD CHECKSUMS (KEYPAD) **3.98 FAULT**- TOO MANY CONSECUTIVE RETRIES (KEYPAD) **3.99 FAULT**- UNRECOGNIZED COMMAND RECEIVED (KEYPAD)
OPERATIONAL FAULTS with related TROUBLE CODES
4.00 FAULT- CONTROL POWER INPUT SENSING FAILURE TROUBLE CODE: 7 - 801-CR IS SHORTED OR JUMPERED OUT **4.01 FAULT**- METAL SENSED BEFORE CLEAR POSITION **4.02 FAULT**- ARM SERVO SYSTEM ERROR TROUBLE CODES: 11 - ARM SERVO FOLLOWING ERROR 12 - ARM SERVO COMMAND ERROR **4.03 FAULT**- DIPPER SERVO SYSTEM ERROR TROUBLE CODES: 21 – DIPPER SERVO FOLLOWING ERROR 22 – DIPPER SERVO COMMAND ERROR **4.04 FAULT**- SENSOR FAILURE, WIRE 10 AND INPUT MODULE 15 TROUBLE CODE: 1 - HIGH METAL PROBE WAS STUCK ON (SHORT) 4 - HIGH METAL PROBE WAS STUCK OFF (OPEN) **4.05 FAULT**- SENSOR FAILURE, WIRE 9 AND INPUT MODULE 14 TROUBLE CODES: 2 - METAL PROBE WAS STUCK ON (SHORT)

5 - METAL PROBE WAS STUCK OFF (OPEN)

4.06 FAULT- SENSOR FAILURE, WIRE 18 AND INPUT MODULE 13

TROUBLE CODES:

3 - COMMON PROBE WAS STUCK ON (SHORT)

6 - COMMON PROBE WAS STUCK OFF (OPEN)

4.07 FAULT- ARM REACHED FILL OVER-TRAVEL LIMIT

4.08 FAULT- ARM REACHED POUR OVER-TRAVEL LIMIT

4.09 FAULT- DIPPER REACHED FILL OVER-TRAVEL LIMIT

4.10 FAULT- DIPPER REACHED POUR OVER-TRAVEL LIMIT

4.11 FAULT- ARM REACHED CLEAR IN HIGH METAL ABORT

4.12 FAULT- ALLOWABLE CHANGE IN FILL LEVEL EXCEEDED

5.3.2 LADLE FAULT RECOVERY

Most of the time recovering from a fault requires identifying the fault and correcting the problem that caused the fault. Identifying the fault can be accomplished by reading the fault message, either on the Message Center or video display. If neither is available, the fault code is displayed on the keypad. The table above lists the faults.

5.3.2.1 COMMUNICATION FAULT RECOVERY

Communication faults indicate that the computer in the main control box is having trouble communicating with the keypad or video terminal. This communication happens via a serial communication network and data is transferred over the communication cables at a high rate. When a fault occurs it is typically due to problems with this cable. The cable could be damaged or picking up electrical noise from another source. The best place to start in an existing system (one that has run) is to look at what might have changed. This can point you in the direction of the problem. If this fails to uncover the problem or you are installing a new system, all cable connections must be checked. The schematics and wiring diagrams in this manual indicate all cable connection points. If communication problems persist contact Rimrock for technical support. Remember to pass along the fault that is reported.

5.3.2.2 4.00 FAULT – CONTROL POWER INPUT SENSING FAILURE

The control power sense module is used to signal the computer that power is applied to the control circuits on the Ladle. This fault indicates that control power is not being received correctly on the Control Power Sense Module. This fault can be caused when control power should be on, but is not being sensed, or it should be off, but is being sensed. If no power is applied, then the ladle can not function, so this fault is indicated. If a short circuit occurs, power will be sensed when it is not supposed to be applied to the control circuits, so this fault is also indicated. A Trouble Code of 7 indicated that 801-CR has shorted. Check your schematic for items that will cause this fault. They include; Input module #19, 801-CR relay, output module #0, 811-CR relay, external safeties, door switch, and 801-CB circuit breaker. Once the reason for the fault is corrected the manual key can be pressed to enter Manual Mode.

5.3.2.3 4.01 FAULT – METAL SENSED BEFORE CLEAR POSITION

This fault indicates that the sensor probes have come in touch with the metal before the Clear Position has been reached. Another explanation is that module #14 has been activated before the arm has reached the programmed Clear Position. This is typically caused when the value that is programmed into the Clear Position is too large (low), possibly due to teaching this position with a partially full furnace. Other possible causes are:

The sensors may be shorted (sensor probe 9 or 10 touching sensor probe 18 as the arm is retracting; this can be happening in the cabling or be a physical miss-adjustment). The arm servo system may be operating incorrectly (the Clear Position will not be found).

5.3.2.4 4.02 FAULT – ARM SERVO SYSTEM ERROR

This fault indicates the arm servo system is unable to maintain the desired arm position. The Trouble Code gives additional information. All cabling must be checked for damage, miss-wiring, and loose connections. The servo controller board may have failed (try a known working board) or the servo amplifier could be the cause. Check the servo amplifier's power LED. The LED will be red if power is applied to servo drive, and it will be green if it is enabled and trying to make move. For this to be the case, an Auto or Manual Mode move of this axis must have been initiated. If the LED remains red when a move is attempted, the amplifier is probably the cause.

5.3.2.5 4.03 FAULT – DIPPER SERVO SYSTEM ERROR

This fault indicates the dipper servo system is unable to maintain the desired dipper position. The Trouble Code gives additional information. All cabling must be checked for damage, miss-wiring, and loose connections. The servo controller board may have failed (try a known

working board) or the servo amplifier could be the cause. Check the servo amplifier's power LED. The LED will be red if power is applied to servo drive, and it will be green if it is enabled and trying to make move. For this to be the case, an Auto or Manual Mode move of this axis must have been initiated. If the LED remains red when a move is attempted, the amplifier is probably the cause.

5.3.2.6 SENSOR FAULTS

This is a sensor-checking fault and indicates that the functionality of the sensors has been jeopardized. The Trouble Code gives additional information. The sensor check system is in place to allow the Ladle to catch itself when the sensors are not going to work correctly. This check is active whenever the arm is told to move. It is a high-speed check and the sensor modules are blinking on and off very fast, or may look dim. The sensor check system functions by placing voltage on the high metal probe #10 and then checking for this voltage to be present on the other sensor modules. This happens by allowing this voltage to travel through all the wires and diodes in the sensor system. The diodes (using a bridge rectifier placed at the end of the Ladle arm) are used to send the voltage to the adjacent probe. There are two steps in the check process. The first step looks for short circuits, and the second step looks for open circuits. Refer to the Ladle schematic for detailed information on the sensor circuit.

A 4.04 FAULT indicates a problem with Module #15 or the wire #10 in the control box. If the Trouble Code is 1, the problem is a short circuit. A Trouble code of 4 means an open circuit.

A 4.05 FAULT indicates a problem with Module #14, wire #10 outside the control box, wire # 9, or the diode between probe 9 and 10. If the Trouble Code is 2, the problem is a short circuit. A Trouble Code of 5 means an open circuit.

A 4.06 FAULT indicates a problem with Module #13, wire #18, or the diode between probe 9 and 18. If the Trouble Code is 3, the problem is a short circuit. A Trouble Code of 6 means an open circuit.

5.3.2.7 4.07 FAULT - ARM REACHED FILL OVER-TRAVEL LIMIT

This fault indicates that the arm has moved in the reverse direction to where it has activated the retracted (Fill) over-travel limit (proximity) switch. After clearing the fault, use the ARM FORWARD key to move the arm away from the limit.

5.3.2.8 4.08 FAULT - ARM REACHED POUR OVER-TRAVEL LIMIT

This fault indicates that the arm has moved in the forward direction to where it has activated the forward (Pour) over-travel limit (proximity) switch. After clearing the fault, use the ARM RETRACT key to move the arm away from the limit.

5.3.2.9 4.09 FAULT - DIPPER REACHED FILL OVER-TRAVEL LIMIT

This fault indicates that the dipper has moved in the reverse direction to where it has activated the reverse (Fill) over-travel limit (proximity) switch. After clearing the fault, use the DIPPER JOG FORWARD key to move the dipper away from the limit. See Section 2.10.2 on how to check the adjustment of the Fill Over-Travel Limit switch.

5.3.2.10 4.10 FAULT - DIPER REACHED POUR OVER-TRAVEL LIMIT

This fault indicates that the dipper has moved in the forward direction to where it has activated the forward (Pour) over-travel limit (proximity) switch. After clearing the fault, use the DIPPER JOG REVERSE key to move the dipper away for the limit. See Section 2.10.3 on how to check the adjustment of the Pour Over-Travel Limit switch.

5.3.2.11 4.11 FAULT - ARM REACHED CLEAR IN HIGH METAL ABORT

This fault indicates that the arm reached the programmed Clear Position during a High Metal Abort. Since the Clear Position should be "clear of metal" this fault indicates that flash may be on the metal probes or the sensors may have failed during the High Metal Abort.

5.3.2.12 4.12 FAULT – ALLOWABLE CHANGE IN FILL LEVEL EXCEEDED

The arm position where metal was found is stored whenever the sensor probes make contact with the metal, except during aborts. This fault indicates that the arm has traveled more than the taught Allowable Change in Fill Position value (Aux. 3 Parameter 4) deeper into the metal than the previous metal found position. The cause of this rapid change in the metal level in the furnace should be checked out.

5.3.3 TROUBLESHOOTING CHART

SYMPTOMS	CAUSE/REMEDY
Sensor Fault	1) Sensors are contacting the metal while the dipper is at or above the Clear Position 2) Bad rectifier diodes. 3) Broken or shorted wires between the sensor probes and the control cabinet 4) Flash, oil, cross between probes 5) Bad fuse on input slot 6) Bad input module 7) Bad ribbon cable between I/O rack and I/O connector on the CPU board 8) Bad CPU board 9) Bad I/O Rack 10) Bad fuse on output slot 11) Bad output module 12) LED burnt out on slot
Biscuit Size Varying	1) Using the Spill-off timer to set the amount of metal poured 2) Dipper slipping on shaft 3) Metal freezing in dipper 4) Dipper not being emptied each cycle 5) Bad dipper servo motor/encoder 6) Problem with dipper servo motor/encoder cable. 7) Metal Building up on probes.
Dipper Bobbing Up and Down in Dip well	1) AUX. 1-1 speed set to high causing waves in the dip well which contact the short probe
Incomplete Abort Cycle	1) AUX. 4 parameter 6 not selected to "On (1)"

SERVO LADLE WITH TRIANGLE CONTROLS

SYMPTOMS	CAUSE/REMEDY
Arm Stopping Short Of The Pour Hole	1) Unit is programmed incorrectly 2) Mechanically bound up
Unit Going into Stop Mode	1) Check 5V power supply to make sure it 5.1 - 5.2 volts 2) Problem with door switch or external safeties 3) Voltage spike coming in through interlocks. 4) Bad power source 5) Check for defective boards by replacing them one at a time (make sure power is off).
Arm or Dipper not Repeating Position	1) Incorrect jumpers on servo controller board 2) Noise coming in through encoder cable - shielding bad 3) Bad servo motor/encoder 4) Bad servo interface board 5) Bad servo controller board
Not Going into Manual Mode * Manual LED will blink on for 1/4 of a second then fall back to stop mode in these situations	1) Door switch open 2) External safety not made 3) Manual On key is bad see keypad section 4) Power sense module bad 5) Bad fuse on power sense slot 6) Control power module (Watchdog module) bad 7) Bad fuse on control power slot 8) LED burnt out on control power slot 9) Bad CPU board 10) Bad I/O Rack 11) Bad ribbon cable between I/O rack and I/O connector on CPU board 12) 24 volt power supply is bad 13) Bad fuse on low volt side of I/O rack 14) A key on keypad may be shorted (see keypad checkout section) 15) Wiring problem 16) Stop Pushbutton Depressed

SERVO LADLE WITH TRIANGLE CONTROLS

SYMPTOMS	CAUSE/REMEDY
Not Jogging in Manual	1) Bad key on keypad 2) Interlock not made I.E. "OK to Pour" 3) Bad servo cable between servo interface board and servo controller board 4) Bad servo amplifier 5) Bad servo interface board 6) Bad servo controller board 7) Fuse blown on servo amplifier
Arm Diving in to Metal	1) Bad servo cable between servo interface board and servo controller board 2) Bad servo amplifier 3) Bad servo interface board 4) Bad servo controller board 5) Arm Brake not functioning
Locking up in AUTO mode	1) Power problem from source 2) Noise coming in through POUR COMP. relay 3) Bad CPU board
Going to Pour Position but not Making Pour	1) One or both "O.K. to Pour" Interlocks not present
Won't Respond to a limit switch or other input like sensors or Interlocks	1) Bad fuse on input rack 2) Bad input module 3) Bad ribbon cable between I/O rack and I/O connector on CPU board 4) Bad CPU board 5) Bad I/O Rack
Won't turn on output to interlock	1) Bad fuse on output rack 2) Bad output module 3) LED burnt out on slot 4) Bad ribbon cable between I/O rack and I/O connector on CPU board 5) Bad CPU board 6) Bad I/O Rack 7) Limit switch not made or bad 8) Not in proper mode (some work in auto only and under certain conditions see interlock section for more details)

5.3.4 INPUT/OUTPUT RACK ASSIGNMENTS

INPUTS			
I/O #	**WIRE #**	**COLOR**	**FUNCTION**
1,8	3,11	WHITE	Activated by **dipper level** limit switch
2,2	14,11	WHITE	Activated by arm forward over travel limit switch <
2,3	4,11	WHITE	Activated by arm reverse over travel limit switch <
1,10	5,11	WHITE	Activated by **home** limit switch
3,3	6,11	WHITE	Activated by dipper reverse over-travel limit switch <
3,2	7,11	WHITE	Activated by dipper forward over-travel limit switch <
1,13	1,18	WHITE	**Common sensor probe** module - on at all times - pulses sensor check routine
1,14	1,9	WHITE	**Metal sensor probe** module - on when continuity is made between it and the common probe - pulses during sensor routine
1,15	1,10	WHITE	**High metal probe** module - on when continuity is made between it and common probe - pulses during sensor check routine
1,16	805,8L2	YELLOW	**Ladle start interlock** - on when start signal is given by the DCM
1,17	836,8L2	YELLOW	**Plunger retracted interlock** - first OK to pour condition
1,18	842,8L2	YELLOW	**Dies locked interlock** - second OK to pour condition
1,19	803,8L2	YELLOW	**Power sense**- operated by the door switch, external safeties and STOP push button

OPTIONAL INPUTS (Used for multiple pour weights)			
1,20	843,8L2	YELLOW	Activated from **2nd AUX. start** source using pour weight
1,21	844,8L2	YELLOW	#2
1,22	845,8L2	YELLOW	Activated from **3rd AUX. start** source using pour weight #3
			Activated from **4th AUX. start** source using pour weight #4

SERVO LADLE WITH TRIANGLE CONTROLS

OUTPUTS			
1,0	30,12	BLUE	Switches the **control power** – Watchdog (N.C.)
1,2	803,808	BLACK	Turns on **POUR COMPLETE** signal (803 CR) - stays on until the **REST** position is reached
1,3	18,11	RED	Activates sensor circuit - on when sensing metal - pulses during sensor check routine
1,4	10,11	RED	Enables sensor check routine - pulses dimly during sensor check routine
2,1	1,28	RED	Controls the arm brake, used for holding arm w/o power

OPTIONAL OUTPUTS (Used for additional interfacing)			
5	847,848	BLACK	Activated when **ladle is placed in Auto Mode**
6	849,850	BLACK	Activated when **ladle has faulted**
7	851,852	BLACK	Activated when **ladle is in position to pour**

5.3.5 SENSOR CIRCUIT

The sensor circuit is powered by the 24 VDC power supply. The voltage across wires #1 and #11 should be 24-28 VDC. Also included in the sensor circuit are I/O modules #3, #4, #13, #14, #15, and the bridge rectifier.

Module #13 is the common probe module and should be "ON" when Module #3 is "ON" except when in STOP mode. Module #14 is the metal probe module and should be "ON" whenever continuity is made between it and the common probe when not in STOP mode. Module #15 is the high metal probe and should come "ON", along with module #14, whenever continuity is made between it and the common probe, again while not in STOP mode. Do not attempt to short out the probes while in Auto Mode, do all testing in Manual Mode.

Module #3 is the common probe output and it will be "ON" at all times except during a sensor check. The purpose of this module is to tie the common probe to wire #11 (common), prohibiting the flow of electricity through the diodes.

Module #4 is used for the sensor check. When the ladle arm is moving, all sensor module's will flash on and off. This is due to the software sensor testing, allowing the electricity to flow through the diodes and checking the circuit wiring. During this circuit check, all five modules will be "on."

To check the modules by hand simply take a wire and jump either the metal probe (wire #9) or the high metal probe (wire #10) to the common probe (wire #18). This should light up the LED on the corresponding input module (#14 or #15).

If the test fails, jump out the wires between the probes and the control box to check if one of the wires is broken somewhere. If this does not work replace the module. Sensor problems are usually caused by a broken wire or bad diode. It is possible that the fuse on the I/O rack for one of the modules will have blown.

If the machine is not passing the sensor check in Auto Mode make sure the wires are connected correctly to the bridge rectifier, which functions as a set of diodes.

Also check to make sure there is no continuity between any of the probes, to each other or from any probe to ground.

5.3.6 SERVO AMPLIFIER

To test the servo amplifier, first check the LED on the controller in question. If the unit has power supplied to it, this LED will be red or green. A red LED indicates that power is applied but controller is not enabled. The servo amplifier is enabled only when a move has been attempted. A green LED indicates that the servo amplifier is enabled and a move has been attempted or is in process. If the LED stays red when a move is attempted, then the servo amplifier is defective. If the LED is off check wires 803 and 8L2 to make sure that the correct AC voltage is present while in Manual Mode. If so, and the LED is off check the fuse located in the power plug. If fuse is good then the servo amplifier is defective. If voltage is present on 803 and 8L2, and the LED is green, but no motor motion is noticed, check for a command signal. The command signal tells the servo amplifier how to move the motor. This command signal is a +\-10 volt DC signal. The higher this voltage the more power the servo amplifier is supplying to the motor, and the higher the torque the motor should be putting out. This voltage is present on wire #51 and #52 (arm), and #61 and #62 (dipper). It must be checked while a move is being commanded.

Check the potentiometers to make sure they are all set as specified in the motor controller portion of Section 4 of this manual.

5.3.7 POWER SUPPLY

As mentioned in the component section, this power supply converts the incoming 120 AC voltage to several DC voltages. The main DC voltage is 5 VDC, which should have a reading of 5.1-5.2 VDC across wires #15 and #16. This voltage is used by the card cage and keypad. To check the isolation between the DC and Ground, take DC readings from wire #15 to GND. The readings should be less than 0.5 VDC. Do the same from wire #16 to GND.

To check the AC ripple on the DC voltage, take AC readings across wires #15 and #16. The value should be less than 0.3 VAC.

5.3.8 CIRCUIT BOARDS

The only method available for checking a circuit board is to replace it with one that is known to be good.

Remember, do not remove or insert a circuit board in the card cage with the power on.

5.3.9 KEYPAD

If a key on the keypad does not respond, the problem may be that the key has worn out.

Testing Keypad switches:

NOTE: If the key being tested is the MANUAL/ON key, make sure that the door switch is not the cause of the problem. If the switch is in its center, or open position, the ladle will not go into Manual Mode.

Using a DVM set on the low resistance (ohms) scale or continuity (CONT), the keypad can be checked using the following pin out chart. The pins referred to are located in the lower right hand corner next to the blue ribbon connector on the rear of the display circuit board. They are numbered from the top down. With the leads on the desired pins, depressing the key you wish to test should give you a "0" reading if the key is functioning correctly, or an "OL" reading if the key has worn out.

5.3.10 KEYPAD KEY PIN OUT

On the back side of the Keypad display board is a set of 13 pins. These pins are in the lower right (non component) side of this board. They are the multiplexed pins from the Keypad. Troubleshooting can be done on these pins to look for shorted or unresponsive keys. A continuity meter is all that is required. The following chart shows what key on the keypad relates to which pins. The pins are numbered from the top down. When testing is done on these pins power must be removed from the control circuit.

KEY	PIN #S	KEY	PIN #S
STOP	3,9	DIPPER POUR	2,8
MANUAL/ON	3,5	DIPPER POUR RTN	8,10
AUTO	2,5	DIPPER FILL	9,10
AUTO CYCLE START	5,10	DIPPER FILL RTN	9,11
DIPPER SET	3,4	UP ARROW	8,13
ARM SET	2,4	DOWN ARROW	8,11
SPEED SET	4,10	CLEAR	9,12
TIMER SET	4,11	ENTER	9,13
TEACH	4,12	1	5,11
AUX. 1	1,5	2	5,12
AUX. 2	1,6	3	5,13
AUX. 3	1,7	4	6,11
AUX. 4	1,8	5	6,12
AUX. 5	1,9	6	6,13

SERVO LADLE WITH TRIANGLE CONTROLS

ARM FORWARD	3,7	7	7,11
ARM RETRACT	2,7	8	7,12
ARM FAST	7,10	9	7,13
DIPPER JOG FORWARD	3,8	0	8,12
DIPPER JOG REVERSE	2,9		

5.3.11 LADLE SPARE PARTS LIST

MECHANICAL

DESCRIPTION		PART NUMBER
Lower Arm Chain Kit	405	10535-01
Upper Arm Chain Kit	405	10535-02
Pour Shaft	405	10759-3
Pour Shaft Keyed	405	10759-4
Pour Shaft Bearings	405	10763-1
Sensor Isolator Block		11750-02
Sensor Probe	405	05527-14

ELECTRICAL

Bridge Rectifier	09759-200
Mini I/O Rack	07622-401
Mini I/O Module 120 VAC Input	07622-402
Mini I/O Module 120 VAC Output	07622-403
Mini I/O Module 24 VDC Input	07622-404
Mini I/O Module 24 VDC Output	07622-405
Triangle CPU Board	11440-05
Triangle CPU Breakout I/O Board	11440-11
Triangle Servo Board	11442-11
Triangle Message Center	11145-11
Triangle Power Supply	11450-70
Keypad Display Board	11120-109