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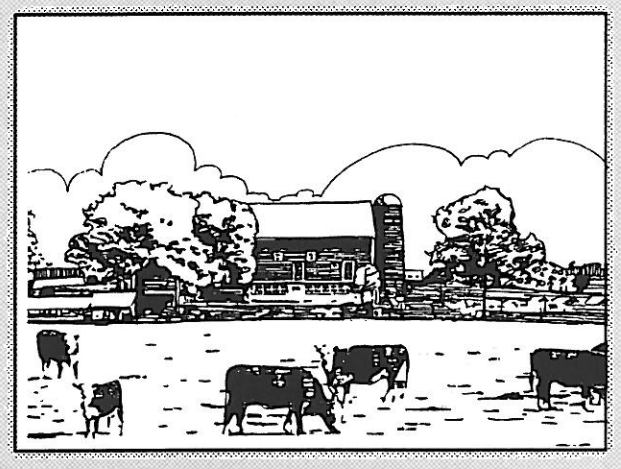
Separators for the Dairy Industry

Operating Instructions

USING THE ALLEN-BRADLEY PROGRAMMABLE LOGIC CONTROLLER

This publication contains procedures for the modification of certain events in the operating program of the dairy separators listed below:

MSD 90-01-076
MSD 130-01-076
MSD 170-01-076
MSD 200-01-076
MSD 250-01-076
MSD 300-01-777



WESTFALIA SEPARATOR

CENTRICO, INC.

For future reference it is recommended that the user record pertinent information concerning the separating system. Ensure the following is complete. This information will assist with the ordering of replacement parts and will be requested during any inquires to the factory.

Application.....

Purchaser.....

Purchaser P. O. Number.....

Installation Location.....

Centrico Project No.....

Year of Construction.....

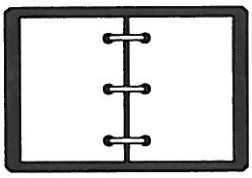
Equipment Assembly No.....

Separator Model & Serial No.....

Technical Manual No..... *9139-9015-001*

Manual Issue Date & Revision..... *Oct. 15, 1991 - Rev. 1*
Jan. 10, 1994 - Rev. 2

EEPROM No..... *004*



Read and Understand the entire contents of this manual and the separator manual before attempting operation or maintenance.

THIS MANUAL SHALL BE CONSIDERED A PERMANENT PART OF THE SEPARATOR SYSTEM. SHOULD THIS EQUIPMENT BE TRANSFERRED TO NEW OWNERSHIP, THIS MANUAL (AND ALL TECHNICAL DOCUMENTATION) SHOULD ACCOMPANY THE TRANSFER.

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INTRODUCTION.

This manual is published as a guide to the start-up and operation of dairy industry separators. The procedures outlined here are not dedicated to one particular separator, they are however, applicable to the major components and operating characteristics of a number of *similar* separators. Any operating procedures or machine characteristics peculiar to just one or two models that have an effect on the general operation instructions provided will be noted as such throughout the text of this publication.

APPLICABILITY.

The machines addressed in this manual are as follows:

- MSD 300-01-777
- MSD 250-01-076
- MSD 200-01-076
- MSD 170-01-076
- MSD 130-01-076
- MSD 90-01-076

In addition to the models listed above, accessory packages are available to suit individual requirements. It is recommended that the user become familiar with the operation of the basic machine as well as any components that were ordered.

CAUTION:

The intended use of this publication is to assist the user in the operation of the separator models listed. It is not furnished as a substitute for the technical instructions supplied by the manufacturer of the separator. Read and understand the manufacturer supplied material before attempting operation or maintenance.

Refer to Table F-1 for a brief description of the machines and option packages covered in this manual. Note the similarities shared by most models. The major difference between these machines is the capacity of product they are capable of processing. The largest capacity machine, the MSD 300, is a belt driven separator with a water cooled motor. The other separators are driven through a heavy-duty gear drive and fluid clutch.

TABLE F-1.
DAIRY SEPARATORS

SEPARATOR MODEL NO.	FUNCTION	APPLICATION	SPECIFICATIONS (PARTIAL LIST)	OPTIONAL ACCESSORY GROUP PACKAGE	PART NO.
MSD 300-01-777	Separation of milk or whey into skim milk and cream which are discharged under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey. Minimum temp. is 77°F; 59°F for clarification.	Bowl speed- 4800 RPM Total bowl volume- 15.8 gal. Sediment holding space- 3.32 gal. Capacities: Separation of milk/whey- 9247 gal./hr Clarification & standardization of milk- up to 11889 gal./hr	Set B Set C Set C1 Set F	9140-5700-728 9140-5700-729 9140-5700-729 9140-5700-730
MSD 250-01-076	Separation of milk or whey into heavy and light phases under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey, minimum temp. is 77°F.	Bowl speed- 4700 RPM Total bowl volume- 15.8 gal. Sediment holding space- 3.17 gal. Capacities: Separation of milk/whey- 7926 gal./hr Clarification & standardization of milk- up to 9247 gal./hr.	Set B Set C Set C1 Set F	9140-5700-731 9140-5700-732 9140-5700-732 9140-5700-733
MSD 200-01-076	Separation of milk or whey into skim milk and cream which are discharged under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey. Minimum temp. is 77°F; 59°F for clarification.	Bowl speed- 4700 RPM Total bowl volume- 13.2 gal. Sediment holding space- 3.32 gal. Capacities: Separation of milk/whey- 6605 gal./hr Clarification & standardization of milk- up to 9247 gal./hr	Set B Set C Set C1 Set F	9140-5700-731 9140-5700-732 9140-5700-732 9140-5700-733

SEPARATOR MODEL NO.	FUNCTION	APPLICATION	SPECIFICATIONS (PARTIAL LIST)	OPTIONAL ACCESSORY GROUP PACKAGE	PART NO.
MSD 170-01-076	Separation of milk or whey into skim milk and cream which are discharged under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey. Minimum temp. is 77°F; 59°F for clarification.	Bowl speed- 4500 RPM Total bowl volume- 13.2gal. Sediment holding space- 3.32 gal. Capacities: Separation of milk/whey- 5284 gal./hr Clarification & standardization of milk- up to 7926 gal./hr	Set B Set C Set C1 Set F	9140-5700-731 9140-5700-732 9140-5700-732 9140-5700-733
MSD 130-01-076	Separation of milk or whey into heavy and light phases under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey, minimum temp. is 77°F for separation and standardization, 59°F for clarification	Bowl speed- 5900 RPM Total bowl volume- 6.6 gal. Sediment holding space- 1.45 gal. Capacities: Separation of milk/whey- 3963 lit./hr Clarification & standardization of milk- up to 5944 gal./hr.	Set B Set C Set C1 Set F	9140-5700-731 9140-5700-732 9140-5700-732 9140-5700-733
MSD 90- 01-076	Separation of milk or whey into skim milk and cream which are discharged under pressure. Sediment is ejected from the bowl at pre-determined intervals while the bowl is rotating at full speed.	Separation, clarification and standardization of milk; separation of whey. Minimum temp. is 77°F. for separation and standardization, 59° F. for clarification.	Bowl speed- 5900 RPM Total bowl volume- 7.3 gal. Sediment holding space- 1.45 lit. Capacities: Separation of milk/whey- 2642 gal./hr Clarification & standardization of milk- up to 3963 gal./hr	Set B Set C Set C1 Set F	9140-5700-731 9140-5700-732 9140-5700-732 9140-5700-733

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CHAPTER 1 - DESCRIPTION OF THE CONTROL COMPONENTS

INTRODUCTION.

This chapter discusses the control of the separation process through the components of the control cabinet.

1-1. COMPONENTS (Fig. 1-2).

The dairy separators discussed in this manual are controlled by an Allen-Bradley Programmable Logic Controller. This unit consists of 3 major components:

- Timer-Counter-Access Terminal (TCAT).
- SLC 150 Programmable Controller (PLC).
- SLC 100 Relay Output Expansion Unit (EU).

To operate and control the separator, in addition to the above, the following components are provided:

- Speed Indicator
- Speed Measuring Device
- 4.5 amp Time Delay Fuse (250VAC)
- Transformer
- Plug-in Relay
- 24 VDC Power Supply

Also provided are an assortment of push-button, indicator lights, selector switches, etc., that are required to operate the separator. Refer to chap. 3 for the wiring diagrams and bill of material.

1-2. PURPOSE AND FUNCTION.

CAUTION:

- *If any of the process control units require replacement, it is essential that they be replaced with a component of the same part/model number.*

- *The timing unit shall be energized prior to separator start-up and remain energized until the separator bowl comes to a complete stop.*

The purpose of the program is to provide a set of operating parameters (times) within which the separator and associated components may function. A selected event requires a certain amount of time to complete.

Different components of the system will open/close or energize/de-energize for pre-determined periods to accomplish the selected task. For example: With the separator in the milk separation mode the bowl opening/closing, filling and metering are all accomplished by valves, solenoids, etc. The opening and closing of these components for specific time periods allows water and product to flow into and out of the separator. These time intervals were pre-programmed at the factory, according to the operators specifications, into the EEPROM memory module (fig. 1-5, item 10). The PLC allows the factory to store this timing information and the operator to access and modify some of the times.

The operator may modify some time intervals through the TCAT. When modifying the process time (ref. para. 1-4 and chapter 2) it is imperative for the operator to be aware of the following: *Some process timing may be changed to suit immediate requirements, this is however, an "overwrite" procedure only. Should power be removed/cut off; the pre-programmed times will replace the operators modified times. To avoid this circumstance, the EEPROM memory module must be removed after the modified times are entered, thus preserving the operator's instructions.* To further understand the control process, the definitions of a few terms are presented:

- Accumulated Time: As indicated through the TCAT Data Display window (figs. 1-3 & 1-4) by timers and counters throughout the system. The data display shows process time in 1/10th second increments starting at 0 (zero), ascending to the pre-set time.

- Pre-set Time: As indicated thru the TCAT Data Display window (figs. 1-3 & 1-4). This display shows the pre-determined time span stored in the EEPROM for any given event.

- Counter: Keeps count of the actual number of times a process has been accomplished. For example: A counter will monitor the number of partial de-sludgings that occur before a full de-sludging.

- Sequencer: The sequencer controls the "order" in which events will occur within a process.

- Address: An address is a number assigned to a function or component for the purpose of differentiating one component from another or one process from another.

In the following example (milk separation, partial de-sludging), the sequencer will initiate bowl closing and metering chamber filling. Refer to fig. 1-1. The timer will close the bowl, or ensure that the bowl *is* closed for 24 seconds (1) and energize the filling valve for 8 seconds (2). Ten seconds into process the metering valve is energized by compressed air for 8 seconds (3). Twelve seconds into this process, the sequencer will signal the bowl to open for 2.5 seconds using the collected water from the metering chamber to eject accumulated solids (4). (Note that this event may be modified).

1-3. CONTROL CABINET (Fig. 1-2).

The separator is controlled/operated thru a NEMA 12 stainless steel enclosure measuring 24.0 in. wide x 24.0 in. high x 8.0 in. deep. The control panel (front cover) contains the following:

A. TCAT display
B. Illuminated graphic panel (valve position and machine status lights)
C. Motor start/stop buttons
D. Power on/off buttons and indicators
E. CIP (clean in place) and process selector
F. Function selector (milk only)
G. Program start and manual de-sludging
H. Program stop (feed valve divert or close)
I. Flush water (whey only, program stop)
J. Speed indicator (RPM)

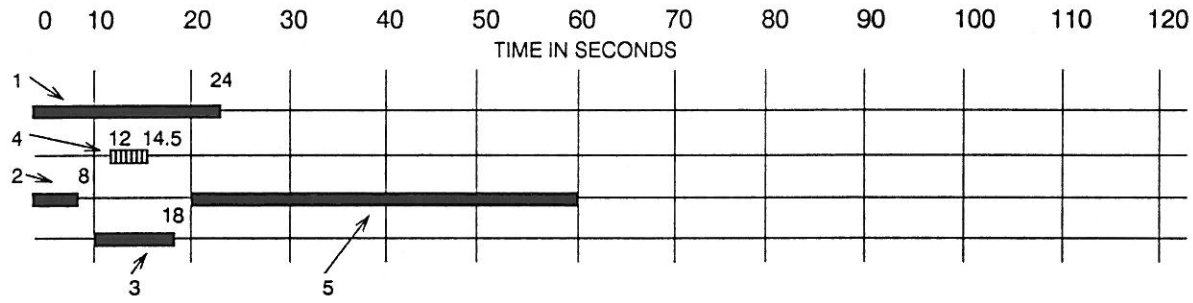


Figure 1-1. Sequence of Events. (Typical)

Lastly, the sequencer will again energize the filling valve (for 40 seconds), 20 seconds into the process (5).

In summary, the *sequencer* activates the control component (valve, solenoid etc.) in pre-determined order and the *timer* regulates the time required to complete the process. The time indicated by ▥ in the above graph (and the complete timing chart in chapter 2) indicates to the operator the function whose timing *may* be changed to suit immediate requirements. All functions indicated by ■ *may not* be altered.

The control cabinet (interior) contains the following components:

K. SLC 150 Programmable Controller
L. SLC 100 Relay Output Expansion Unit
M. Fuse
N. Wire terminals (not all illustrated)
O. Speed measuring device
P. 24 VDC power supply
Q. Plug-in relay

(Front Cover, Outside)

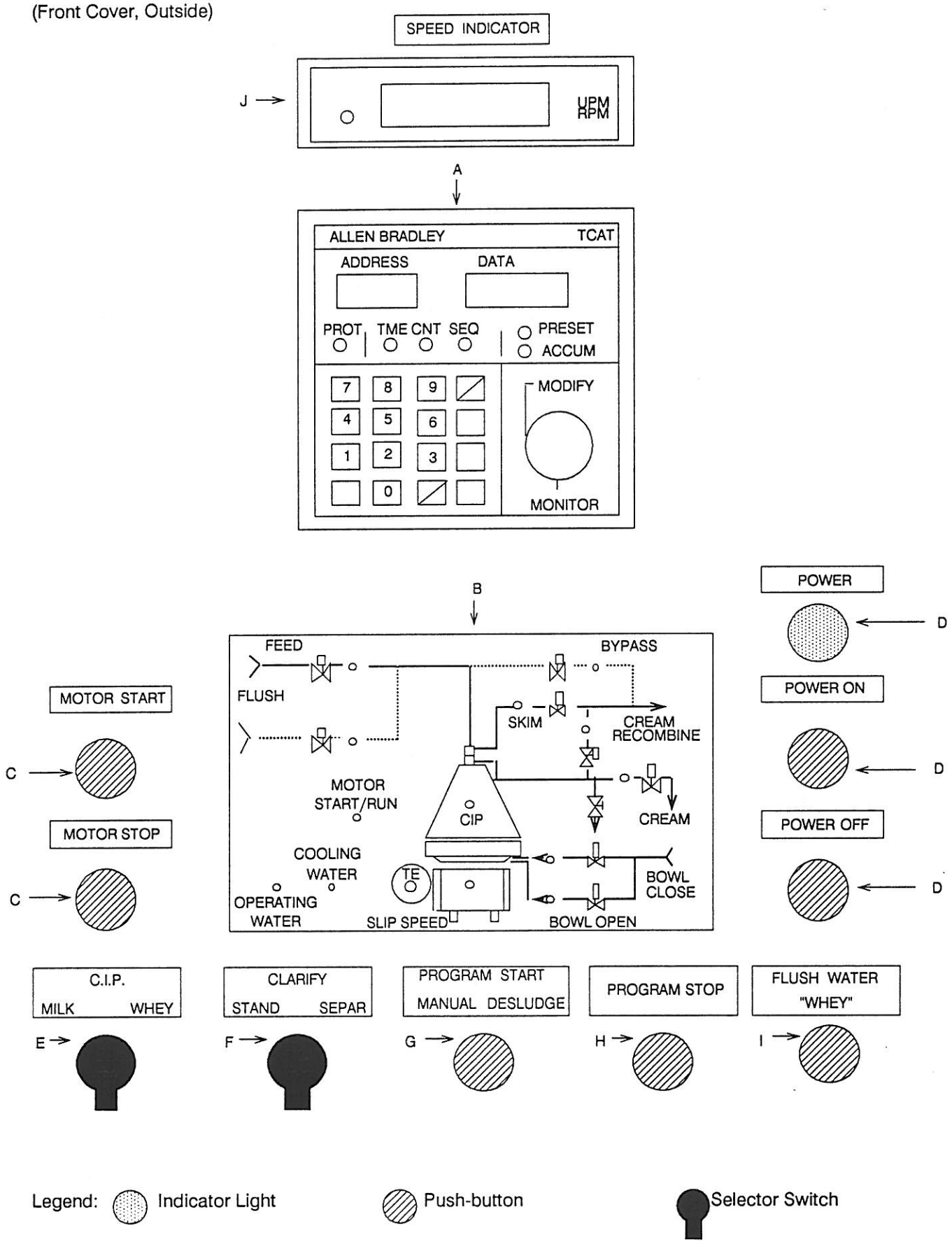
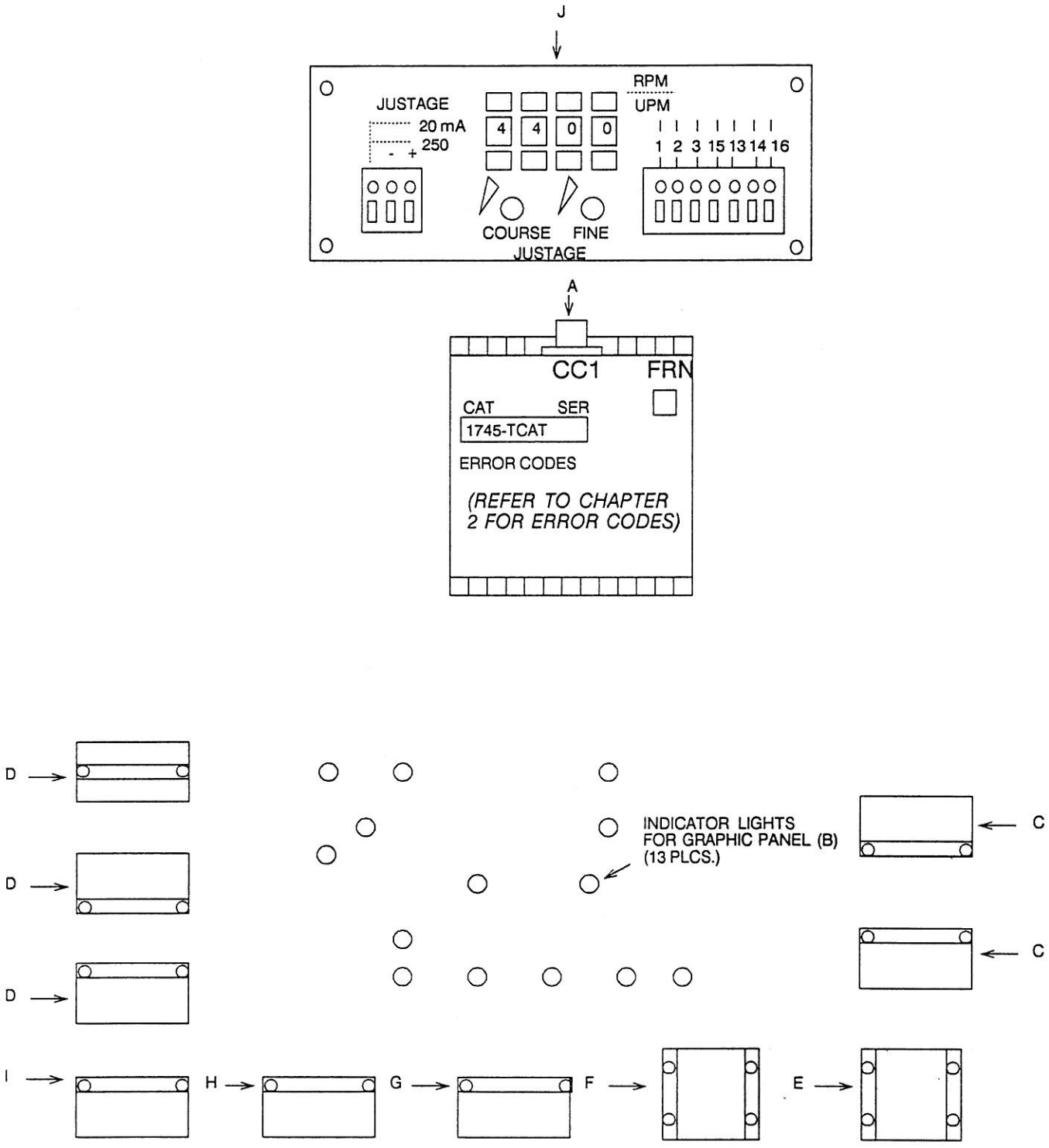


Figure 1-2. Control Cabinet.
(Sheet 1 of 3)

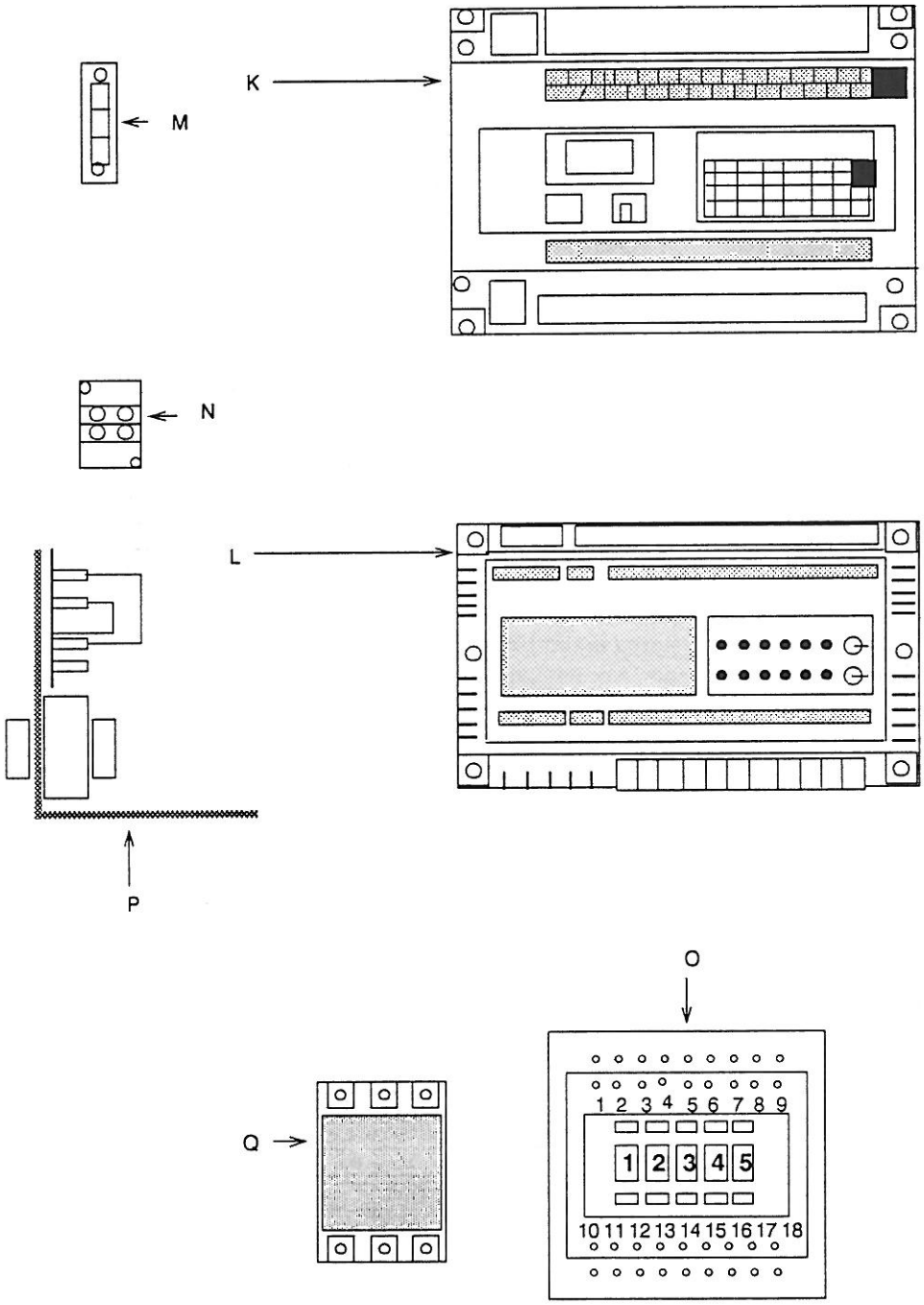
(Front Cover, Inside)



Wiring and cabinet not shown for clarity

Figure 1-2. Control Cabinet.
(Sheet 2 of 3)

(Cabinet, Inside)



Wiring and cabinet not shown for clarity

Figure 1-2. Control Cabinet.
(Sheet 3 of 3)

1-4. TCAT (Fig. 1-3).

NOTE:

The following paragraphs provide a brief description of the TCAT (Timer/Counter Access Terminal). Refer to the User's Manual (bulletin 1745) found inside the control cabinet for a detailed description of this component.

The TCAT is used in conjunction with the SLC 150 Programmable Controller (PLC) and the SLC 100 Relay Output Expansion Unit (EU).

With the SLC 150 PLC in the RUN mode, the TCAT provides the operator with access to counter, sequencer and timer data. This allows authorized personnel to monitor this data "on-line".

Some data in the PLC may be modified to suit specific requirements. A keyswitch prevents unauthorized modifications. With the keyslot in the vertical position the MONITOR mode is in effect. The key may be removed. With the key inserted and turned clockwise 90° horizontal the MODIFY mode is selected. In this mode the key cannot be removed.

To monitor or modify a function, the "address" must be accessed through the keyboard. The address display indicates the address number entered and the data display will show either the pre-set time or the accumulated time.

For Example (Fig. 1-4):

To access address 904 the operator will depress the ADDRESS pad (1) and the respective pads for the 904 address (2) on the keyboard (the number 9 will automatically appear; depress 0 and 4). Depress the ENTER pad (3). The numbers 904 will appear in the ADDRESS INDICATOR window(4). One of the following indicators will light (5): TME, CNT or SEQ indicating to the operator that the 904 address is either a timer, counter or sequencer. The PROT will light red (6) if the address is protected in the program; this means that the address cannot be modified. Shown in the DATA DISPLAY window (7) will be either the pre-set or accumulated time, depending on which indicator light (8) is lit. To change the indication, depress either the PRESET or ACCUM pads (9). Pre-set time is the pre-determined time span, stored in the EEPROM, that any given process will run. Accumulated time is displayed in 1/10th of a second increments starting at 0 (zero) and *ascending* to the pre-set time. Refer to chapter 2 for detailed TCAT access.

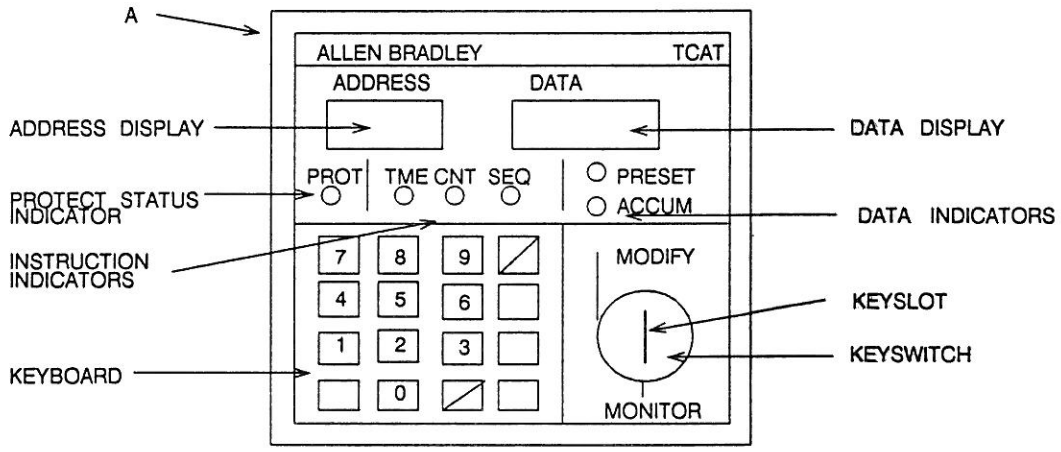


Figure 1-3. TCAT

Located on the back of the TCAT are listed ERROR CODES which will alert the operator to specific problems in the system or operating procedure. These codes are listed in the English and French languages.

The TCAT receives operating power from the SLC 150 PLC thru a 6.0 ft. interconnect cable.

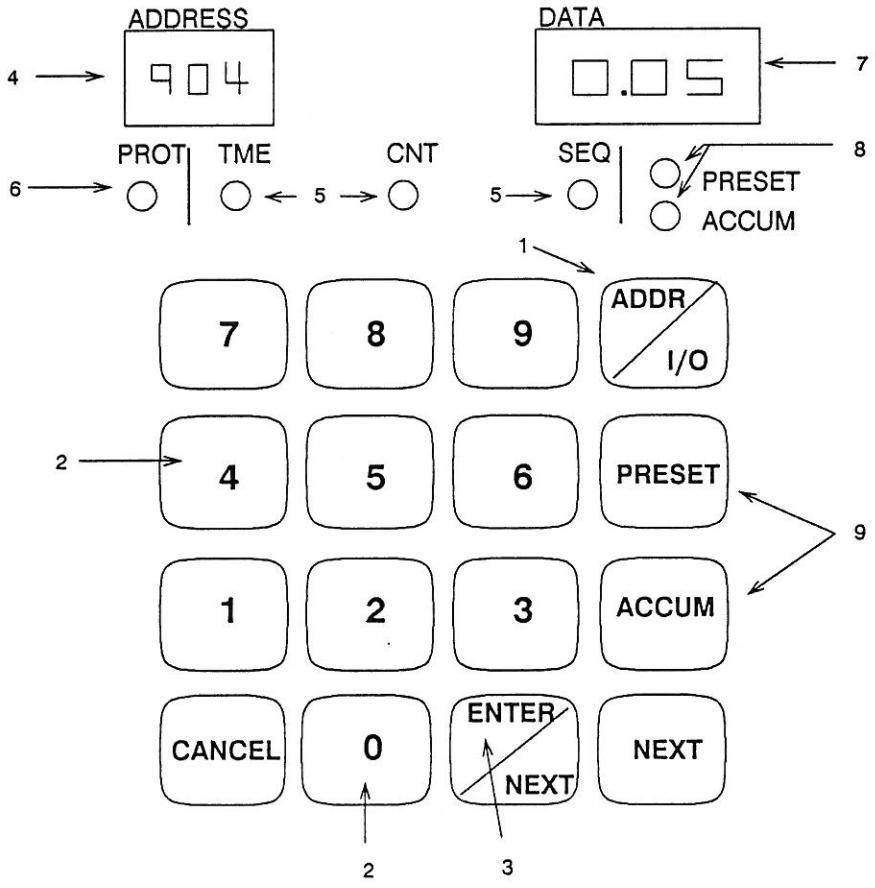


Figure 1-4. TCAT Keypad.

1-5. PROGRAMMABLE CONTROLLER (Fig. 1-5).

The dairy separators covered in this manual are primarily controlled thru an SLC 150 Programmable Controller (PLC). This unit contains the processor (CPU and capacitor-backed CMOS RAM memory), a power supply and 32 I/O ports. The number of I/O ports is increased to 44 through the SLC 100 Relay Output Expansion Unit (EU, discussed in para. 1-6). The 44 I/Os are broken down to include 20 inputs (1) and 12 outputs (2) in the PLC. There are 12 outputs in the EU, which has no input circuits but is connected to the PLC by a ribbon cable (3).

The PLC receives operating power thru #14 AWG wires/terminals at the upper left corner of the terminal strip (4). This connection is pre-wired at the factory *from the terminal strips to the PLC*. Customer connection is required from system components to the terminal strip in the control cabinet. Refer to chapter 3 for wiring schematics.

Located in the middle right side of the PLC is an INPUT INDICATOR PANEL (5). This panel indicates the following diagnostics or indicators:

- DC Power- Indicates the PLC is energized and DC power is being applied.
- PLC Run- Indicates the PLC is in the RUN mode.
- CPU Fault- Indicates the PLC has detected an error in either the CPU or memory. Operation is *automatically halted*.
- Battery Low- This is an option not available.
- Forced I/O- Indicates that one or more of the I/Os have been forced to an ON or OFF state.

Also located in the input indicator panel are the INPUT STATUS INDICATORS (6) which are 20 red LEDs, numbered 1 thru 10 and 101 thru 110. When an input circuit is energized, the corresponding status indicator will light. OUTPUT STATUS INDICATORS (7) are 12 red LEDs identified by the numbers 11 thru 16 and 111 thru 116. When a programmed output instruction is energized (on), the corresponding output status indicator will light and the corresponding output circuit will energize.

Located in the upper left corner of the PLC may be found the INPUT POWER FUSE (8). If line terminal voltage is present, but the DC power LED is not lit, the fuse may be blown. Refer to chapter 3 for wiring schematics.

After a power loss or brown out, the PLC may be restarted by selecting one of the following in the AUTO/MANUAL SWITCH (9):

- AUTO- Upon power-up, the PLC runs through its normal diagnostic tests, then automatically enters the RUN mode *if* the PLC was in RUN when powered down.

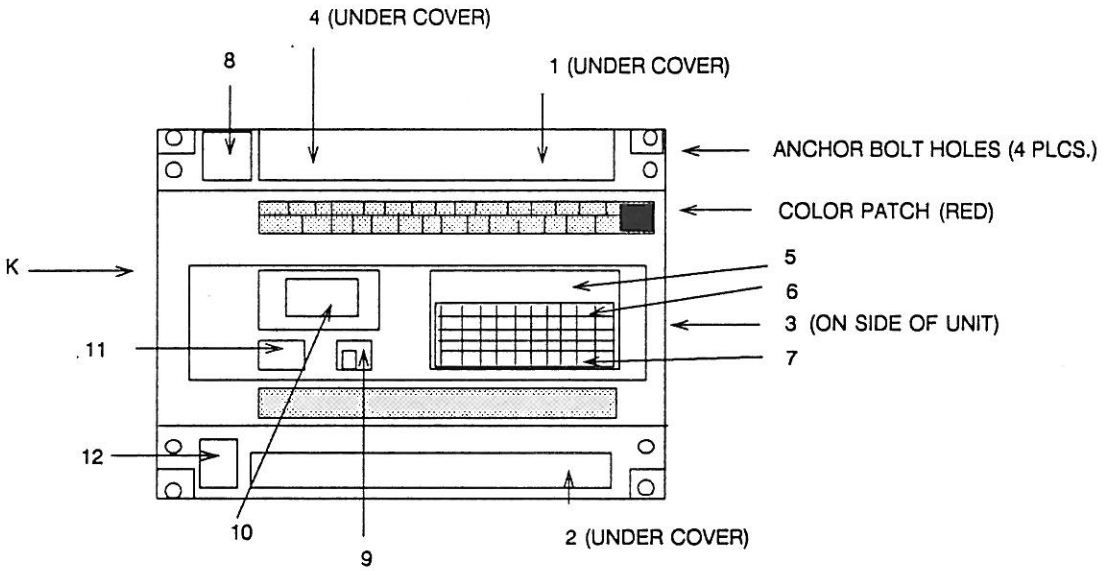


Figure 1-5. SLC 150 Programmable Controller.

• MANUAL- Upon power-up, the PLC will again accomplish its diagnostic tests but will *not* enter the RUN mode. To enter RUN the operator must select the AUTO mode.

The program designed for use in this application is stored in the EEPROM MEMORY MODULE (10).

NOTE:

It is recommended that the software and revision number be recorded for future reference.

The PLC and the TCAT are interfaced by a cable that connects to the COMMUNICATION PORT (11). This port may also be used to connect the PLC to a pocket programmer or a personal computer (IBM) interface converter. Both of these are optional items not supplied for this application, but are available from the PLC manufacturer.

Although not supplied for this application, a BACK-UP BATTERY ASSEMBLY (12) is available to safeguard PLC memory. A standard capacitor back-up is provided which provides memory back-up for 2 weeks at 30 C and 1 week at 60 C.

If the PLC is operated at temperatures above 50 C for extended periods, capacitor life cannot be guaranteed beyond 2 years. For operation under these conditions, installation of a battery back-up is recommended.

1-6. EXPANSION UNIT (Fig. 1-6).

The SLC 100 Expansion Unit is used in conjunction with the PLC to expand the number of available I/O circuits. Although the total number of circuits may be boosted to 112, this application requires a total of 44; 12 provided by the use of the expansion unit. The expansion unit (EU) has the same basic construction as the programmable controller (PLC), however, it does not have input circuits. The EU receives its operating power, from the PLC, thru wiring terminals (1) at the upper left side of the unit. The terminals, under a flip up cover, accept 2 #14 AWG wires. The chassis ground is also located here. Located to the right of the incoming power terminals are 6 upper output circuits (2).

The 6 lower output circuits (3) are located on the bottom edge of the unit. These connections are pre-wired at the factory *from the terminal strips to the EU*. Customer connection is required from system components to the terminal strip in the control cabinet. Refer to chapter 3 for wiring schematics.

Located in the middle right side of the EU is a STATUS INDICATOR PANEL. This panel illustrates the following diagnostic indicators:

• DC Power (5)- Indicates the PLC is energized and DC power is being applied.

• Output Status Indicators (6)- 12 red LEDs numbered 11E thru 16E corresponding to output contact wiring terminals 11E thru 16E (7). When a programmed output instruction is energized (on), the corresponding output status indicator will light and the corresponding output contact will close. Refer to Figure 1-7.

WARNING:

• Before power is turned on, ensure there is no maintenance being performed on the system. Lock the main power shut-off, per OSHA requirements, if maintenance is to be performed. High voltage is present in the separator system. Severe injury or death may result from electrocution.
• Check, using a voltmeter, for any residual electricity remaining in electrical components to avoid electrical shock.

Located behind the front cover will be found the INPUT POWER FUSE (8). If line terminal voltage is present but the DC power LED is not lit, it is possible the fuse has failed. The front cover may be removed by backing out the two screws on either side of the cover. Refer to chapter 3 for wiring schematics.

The EU is interconnected to the PLC by a RIBBON CABLE (9) entering the unit on the right side.

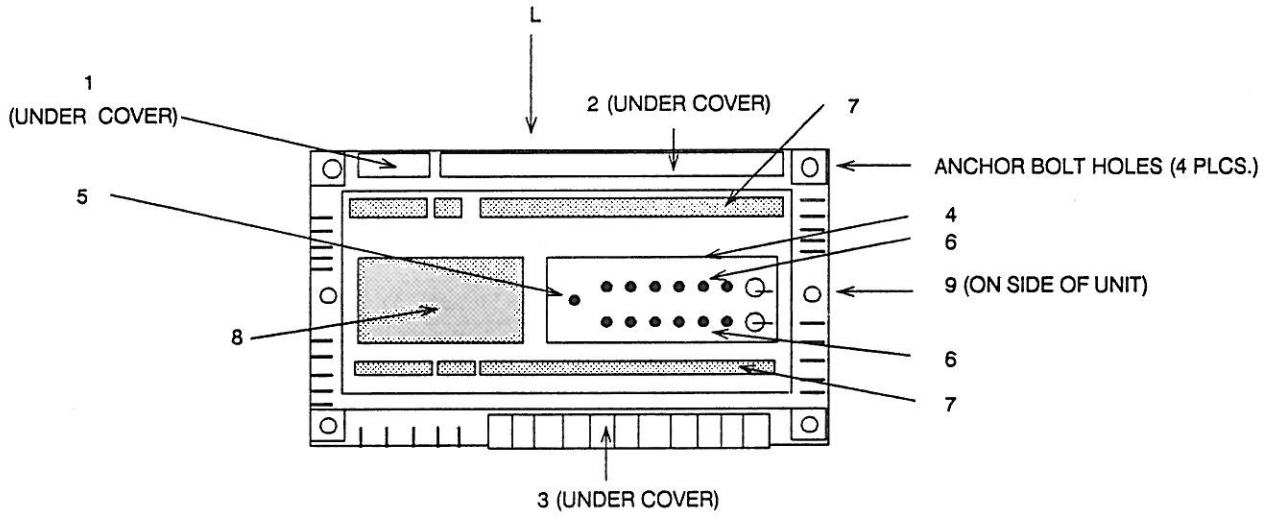


Figure 1-6. SLC 100 Relay Output Expansion Unit.

Both upper and lower wiring strips are numbered 11E thru 16E. In order to avoid confusion it will be necessary to further identify each terminal as a separate entity.

This has been accomplished by assigning the upper terminal strip the number 2 (two); the lower strip number 3 (three). These numbers have been written as in fig. 1-7. The upper terminal strip connections are now numbered 211E thru 216E; the lower connections 311E thru 316E.

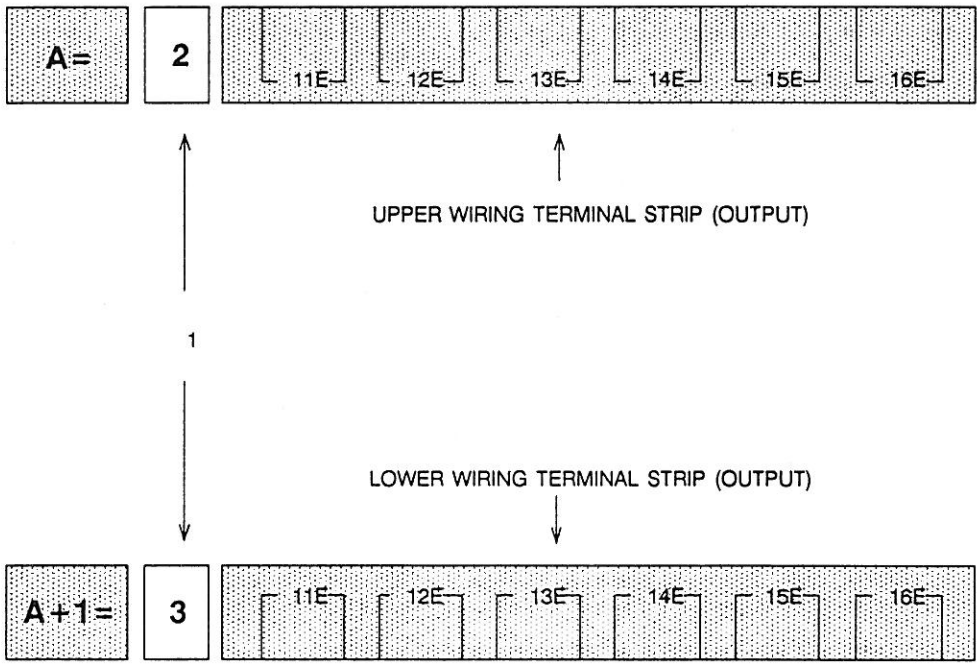


Figure 1-7. EU Address Block Numbering.
(Item #7 in Fig. 1-6)

1-7. SPEED INDICATOR (Fig. 1-8).

The speed indicator is used to indicate the bowl speed. An electronic limit value device allows the operator to monitor the separator for decreased bowl speed. The bowl speed is indicated in RPMs (2); UPM is a German abbreviation.

A limit speed has been pre-set at the factory. During operation, the pre-set speed and the actual speed are compared. If the actual value exceeds the pre-set limit, the output relay opens. If the actual speed falls below the pre-set limit the output relay closes. The LED (1) indicates the limit value and will light up when the pre-set value is exceeded. The speed limit value is set using buttons in the rear of the unit. Refer to chap. 2, para. 2-19 for adjustment of the speed indicator.

LEGEND:
1. Light emitting diode (LED)
2. Digital display (four digit, 7 segment LED, 20 mm high)

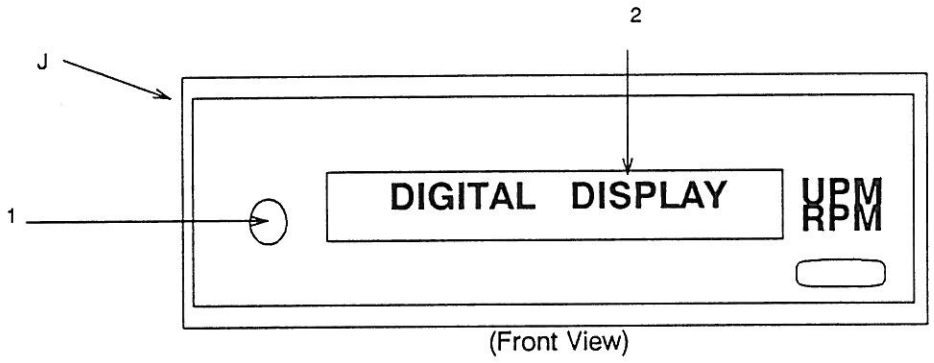


Figure 1-8. Speed Indicator.

1-8. SPEED MEASURING DEVICE (Fig. 1-9).

The Speed Measuring Device (FSU-2 or WHEM) takes a signal from an N-type proximity switch inside the separator frame and relays it to the Speed Indicator (ref. para. 1-7) to record the RPM of the bowl. The input pulses are converted to an output current of 4 - 20mA for acceptance by the speed indicator.

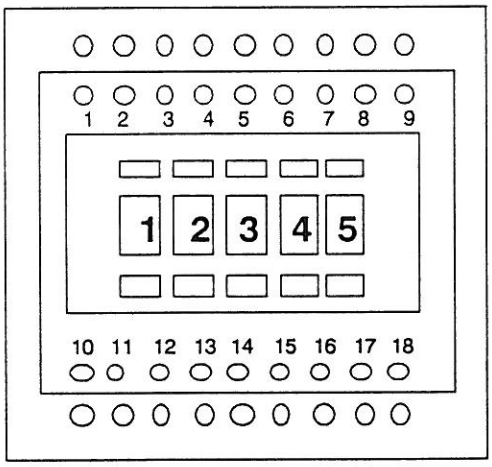


Figure 1-9. Speed Measuring Device.

1-9. ILLUMINATED GRAPHICS PANEL (Fig. 1-10).

The graphic panel provides the operator with a visual "guide" to a limited number of separator system functions. Lights within the panel illuminate as some events occur. For example: when the process medium is feeding into the separator, the green indicator light in the feed line of the graphic panel will illuminate. During separator start-up, the green motor start/run light will first flash on and off while the separator is running up to speed and then remain illuminated after run speed has been attained. A de-energized indicator light will indicate a closed or non-functioning component. Refer to chap. 2, para. 2-18.

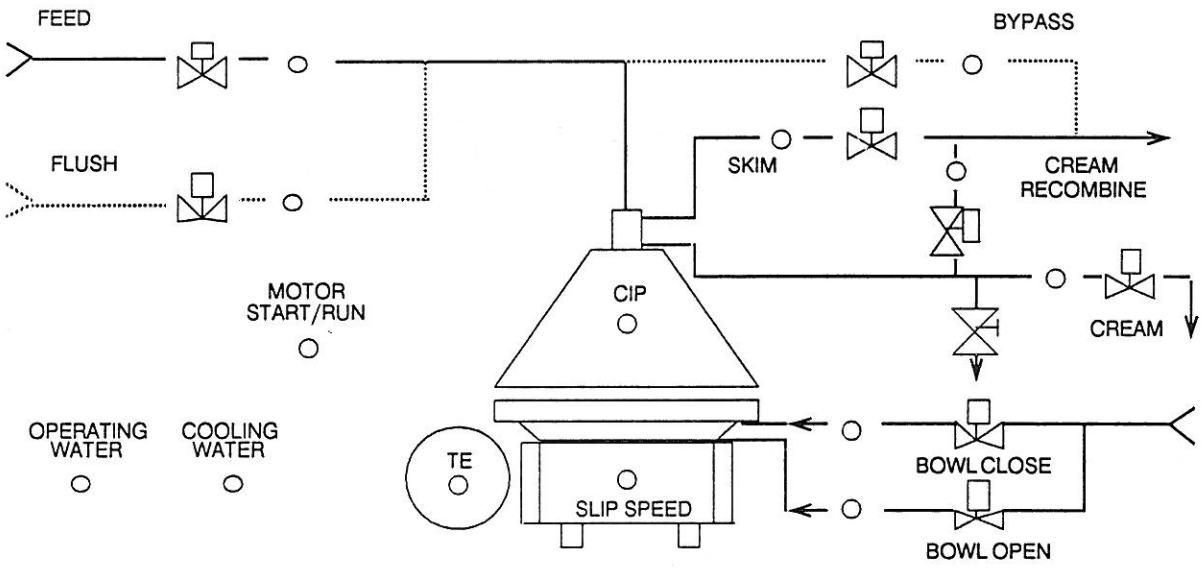


Figure 1-10. Illuminated Graphics Panel.

INTRODUCTION.

In Chapter 1 a description of the control system was presented. This chapter will provide the operator with the procedures required to operate the system and monitor/modify certain events.

2-1. CONTROLS AND INDICATORS.

The system is operated through a control cabinet. This cabinet contains most of the components that monitor and control system functions, including the PLC. Refer to chap. 1.

2-2. INITIAL PROCEDURES.

Perform the following before start-up of the separator:

NOTE:

Refer to the technical material provided by the manufacturer of the separator for detailed information concerning separator installation, operation and maintenance.

- Assemble and install the separator bowl.
- Check the height and assembly of the bowl. No components may be omitted or replaced with the same components of another bowl. Lock-rings have left hand thread. All "O" marks shall be radially in line. Ensure a thin coat of Darina grease has been applied to the sliding surfaces of the hydraulic system parts and the bowl lock ring.
- Verify that all protection devices, if any, are installed properly.
- Ensure that all components that move are free to do so.
- Verify that the area is clear of all unnecessary material and personnel.
- Inspect for leaks, liquid accumulations, loose or broken wires and missing components.
- Check the oil sight glass of the separator (lower section of frame). With the bowl stationary, the oil level shall be up to the upper third of the sight glass. Use only the grade of oil specified in the lubrication section of the separator manual.
- Ensure the brake is not applied.
- Ensure operating water, compressed air and product are supplied to the separator (refer to table 2-1).
- Check directional rotation of the bowl (clockwise when viewed from above).

TABLE 2-1. WATER & AIR PRESSURE

MSD 90, 130, 170, 200 & 250
- Operating Water Pressure with bowl closing water ON- 35 PSIG
- Air Pressure- 60 PSIG

MSD 300-01-777
- Operating Water Pressure with bowl closing water ON- 35 PSIG
- Air Pressure- 60 PSIG
- Motor Cooling Water - 1 GPM @ 60°F

2-3. STARTER CABINET (Figs. 2-1 & 2-2).

Although the separator system is started and controlled through the timing unit discussed in chap. 1, all electrical power is supplied thru the starter control panel remotely located from the separator system and briefly discussed here.

The starter cabinet for the *MSD 300* machines (fig. 2-1) contains the following indicating/control components:

- Ampere meter- Constant display of the amps drawn during start-up and operation.

- Running Time Meter- Records the total run time accumulated on the machine.

- Motor Overtemp Stage #1 & 2 Indicators- Time & temperature dependent indicators that light incrementally to display a motor over-heat condition.

- Over Current Indicator- Will light to indicate an excess current draw. If the draw reaches the pre-set limit the separator will automatically shut-down.

- Starting, Accelerating & Running Indicators- Incremental indicators that will light sequentially during the start-up period. The Starting and Accelerating indicators will extinguish when the Running indicator lights, showing the machine is fully up to speed.

- Separator Stop Push-button- Will stop the separator.

- Alarm Silence- Will silence the malfunction alarms.

- Alarm Re-set- Will re-set the malfunction alarms.

- Main Power Shut-off- Energizes the entire system. A receptacle is provided to enable the operator to physically lock-out the system.

The starter cabinet for all other machines (fig. 2-2) contains the following indicating/control components:

- Running Time Meter- Records the total run time accumulated on the machine.

- Motor Overtemp Indicator- Displays a motor over-heat condition.

- Ampere meter- Constant display of the amps drawn during start-up and operation.

- Main Disconnect Handle- Energizes the entire system. A receptacle is provided to enable the operator to physically lock-out the system.

2-4. ENERGIZING THE SYSTEM.

WARNING:

- *Read and understand all Safety Notices in the separator manual before operation.*

- *Before power is turned on, ensure there is no maintenance being performed on the system. Lock the main power shut-off, per OSHA requirements, if maintenance is to be performed. High voltage is present in the separator system. Severe injury or death may result from electrocution.*

- *Ensure that the electrical system, including the separator and the starter cabinet, are properly grounded before applying electrical power.*

CAUTION:

- *Read and understand the technical manual provided with the separator before starting the system.*

- *Inspect all components and electrical connections to ensure all wiring is connected properly.*

1A. To power-up the *MSD 300 system*, move the MAIN POWER SHUT-OFF selector switch (1A, fig. 2-1) to the ON position (located in the green area of the handle).

1B. To power-up all other separators place the MAIN DISCONNECT HANDLE (1B, fig. 2-2) in the power-on position.

2. Energize the Timing Unit (1, fig. 2-4). Ensure all utility valves are open and the feed valve is in the closed position.

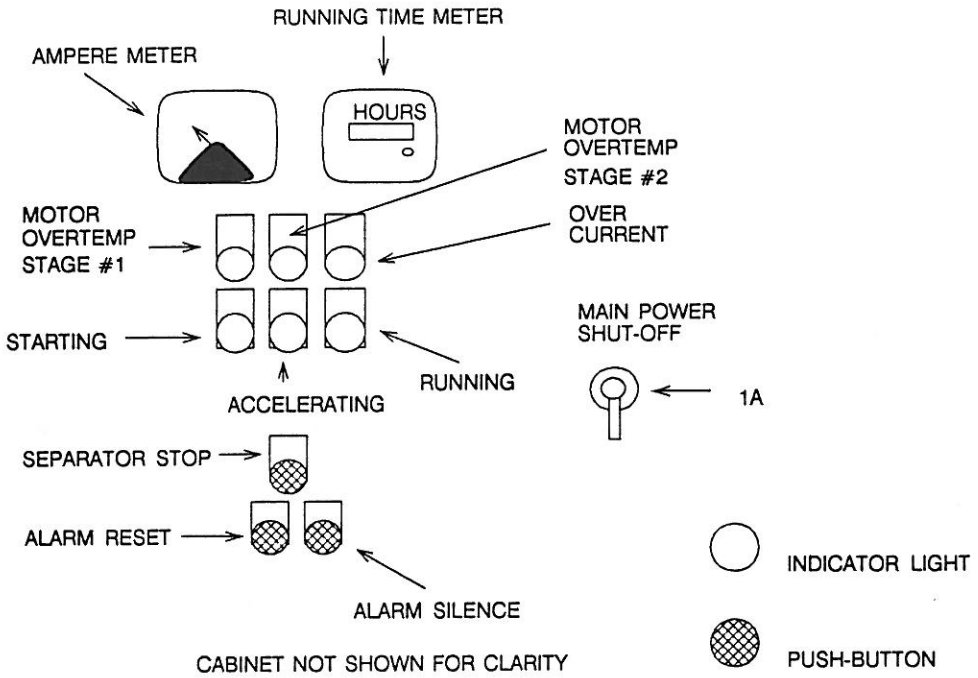


Figure 2-1. Starter Controls for MSD 300 Machines.

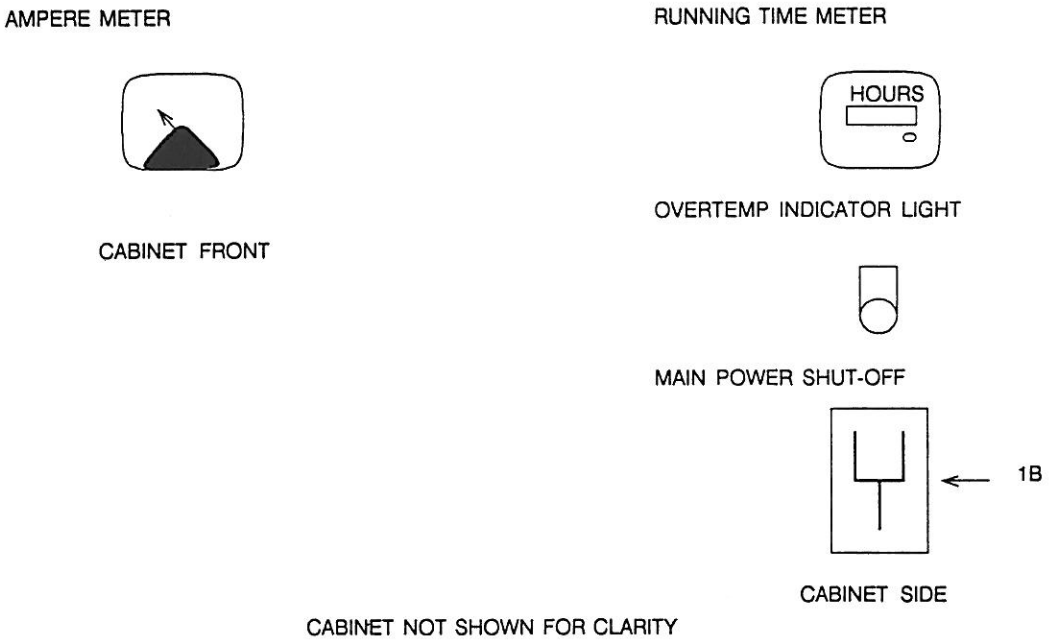


Figure 2-2. Starter Controls for MSD 90, 130, 170, 200, 250 Machines.

2-5. ENERGIZING THE TIMING UNIT (Run/Auto Mode, the normal operating mode).

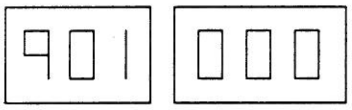
REQUIRED CONDITIONS:
- SLC 150 PLC in the RUN mode.
- Manual/Auto switch set at AUTO.

When the system is initially energized the TCAT/PLC will undergo a series of diagnostic tests and then display the lowest timer/counter/sequencer address number in the program; 901.

The example illustrated in figure 2-3 shows a typical power-up display.

Address 901 in this example is an unprotected Timer. The following will occur when the unit is energized:

The TCAT/PLC will go through it's diagnostic tests, then automatically scan addresses 901 thru 932. The display will show 901 which is the first (and lowest) address used.



(Either TME,CNT or SEQ indicator will light)

Figure 2-3. TCAT Display in Run/Auto Mode During Start-Up.

NOTE:

- *Various abbreviations and symbols appear in the DATA display to indicate the timer, counter and sequencer instructions. Refer to Table 2-7 for a brief summary.*

- *Procedural errors (and other errors) may occur when operating the TCAT/PLC. Refer to table 2-6 for an explanation of Error Codes. A listing of error codes also appears on the back of the TCAT module and on the key/ID tag.*

- *The TCAT keyboard is inoperative while the PLC is scanning to an address used in the program.*

To move to the next instruction depress the NEXT keypad (fig. 2-5). If the NEXT keypad is activated while the PLC is still scanning, the display will again show the addresses. If, for example, the scan stopped at address 929, the display would show 930, 931 and then stop at 932 (the highest address) in the same manner as illustrated in fig. 2-3.

Any time the NEXT key is activated after the scan is completed, the TCAT shows (in sequence) only those instructions you used in the program. In this example, activating the NEXT keypad would display instructions 901 thru 932.

2-6. STARTING THE PROCESS (All products, Fig. 2-4).

CAUTION:

The Timing Unit shall be energized prior to start-up and will remain energized until the bowl comes to a complete stop.

NOTE:

The bowl opening timer has been entered into the EEPROM memory at 2 seconds. The amount of the partial shoot is controlled by the piston metering valve in the operating water line. An increase of water injection volume will increase the amount of partial de-sludging.

1. Press Motor Start push-button (2). The start/run light (3) will flash until the motor has come up to speed. During the motor start period, only the motor stop push-button may be used, All other push-buttons and controls are disabled. When the bowl has come up to speed (refer to the separator manual for starting times and RPMs) the operating water line will seal the bowl. The start/run indicator will now be lit (no longer be flashing).

2. Using the Product Selector Switch (4) select Milk, Whey or C.I.P. Using the Process Selector Switch (5), select Sep., Stand. or Clar.

When the program is performing a de-sludging, the Timing Unit will continue until the cycle is completed.

In the event of power failure, the Motor Run relay will open, de-activating the motor. Once power is re-established, the Motor Start sequence will have to be re-activated at the timing unit by pressing the motor start button (2).

2-7. PROCESSING MILK (Fig. 2-4).

NOTE:

Milk processing will access milk partial de-sludging sequencing. Refer to table 2-2.

1. With Product Selector Switch set to Milk. (4), push Program Start Button (6A).

2. Program Start (6A) will initiate a partial de-sludging. Using the Process Selector Switch (5) choose either Sep., Stand. or Clar. If Sep. is selected, the cream control valve will close or divert the cream to the cream tank. If Stand. or Clar. are chosen, the cream control valve will open, recombining part or all of the cream with skim (the flush water switch is disabled).

3. Adjust the skim back-pressure for foam-free discharge and cream back-pressure for cream concentration. Increase cream back-pressure for thicker cream and decrease the back-pressure for thinner cream.

4. For standardization (stand.), adjust surplus cream valve to remove desired amount of cream, maintaining standardized cream concentration.

Program Stop (6B) will close or divert the Feed and Cream Control Valve and stop the de-sludging sequence.

Program Start (6A) will initiate the next de-sludging, reset the process timer and open the feed valve to the separator. Adjust partial de-sludging volume as required.

CAUTION:

Do not idle the separator with the bowl open or empty of product. Gasket failure and coating of interior bowl parts will occur.

5. Monitor separator function during process run and adjust valving, if required, for back-pressure and cream concentration.

6. Adjust time between partial de-sludgings using address 901 to clean sediment holding space. Monitor solids discharge to ensure excessive solids are not building up in the bowl.

NOTE:

Immediately de-sludge entire contents of bowl and flush with water at the end of processing and prior to C.I.P.

7. Refer to para. 2-13 for C.I.P. and shut-down.

2-8. PROCESSING WHEY (Fig. 2-4).

NOTE:

Whey processing will access whey partial and full de-sludging sequencing. Refer to table 2-3.

1. Set Product Selector Switch (4) to whey. Adjust de-sludging frequency, adjust partial de-sludging volume. Adjust partial/full counter (address 903, table 2-3) based upon separable whey solids in product feed and flow rate for whey with heaviest solids loading.

2. Depress Program Start (6A) to initiate a full de-sludging on initial start and a partial de-sludging on subsequent starts (until 903 pre-set is attained).

Program Stop (6B) will close or divert the feed valve, stop de-sludging sequencing and cream displace between de-sludgings. Pushing the Program Start button (6A) will initiate the full de-sludge again and will reset all applicable timers and counters to zero.

3. Adjust whey back-pressure valve for foam free discharge and cream back-pressure for cream concentration. Increase cream back-pressure for thicker cream. Cream is to be discharged to open balance tank at separation.

4. During normal operation and between de-sludgings, the cream control valve will briefly open for a few seconds to discharge some cream from the separator between displacement and de-sludging. Use timer (address 913, table 2-3) to adjust the occurrence interval of this process (usually 2 - 3 occurrences).

5. Timer (address 914, cream displace ON, table 2-3) should be adjusted to thin the whey cream to approximately 20 - 30% concentration.

6. During the partial de-sludging sequence the cream will be displaced prior to a de-sludging (without water flush during a partial de-sludging). Adjust timer (address 908, table 2-3) to thin cream to 10 - 20% concentration.

7. Adjust partial bleed timer (address 909, table 2-3) to ensure the discharged cream is not heavier than 45% concentration when normal CPV air pressure is applied.

NOTE:

When using warm water to remove solids from the disc stack or as an aid in cream discharge, the water should be approximately the same temperature as the whey.

8. During full de-sludgings, adjust timer (address 925) to discharge all the cream prior to the bowl opening. Water flush adjustment (address 928, table 2-3) may be adjusted to aid discharging the cream and removing solids from the disc stack. The bleed timer (address 929, table 2-3) can be adjusted to re-establish the cream concentration.

9. Monitor the operation to ensure correct operation.

NOTE:

Immediately de-sludge entire contents of bowl and flush with water at the end of processing and prior to C.I.P.

10. Refer to para. 2-13 for C.I.P. and shut-down.

(Front Cover, Outside)

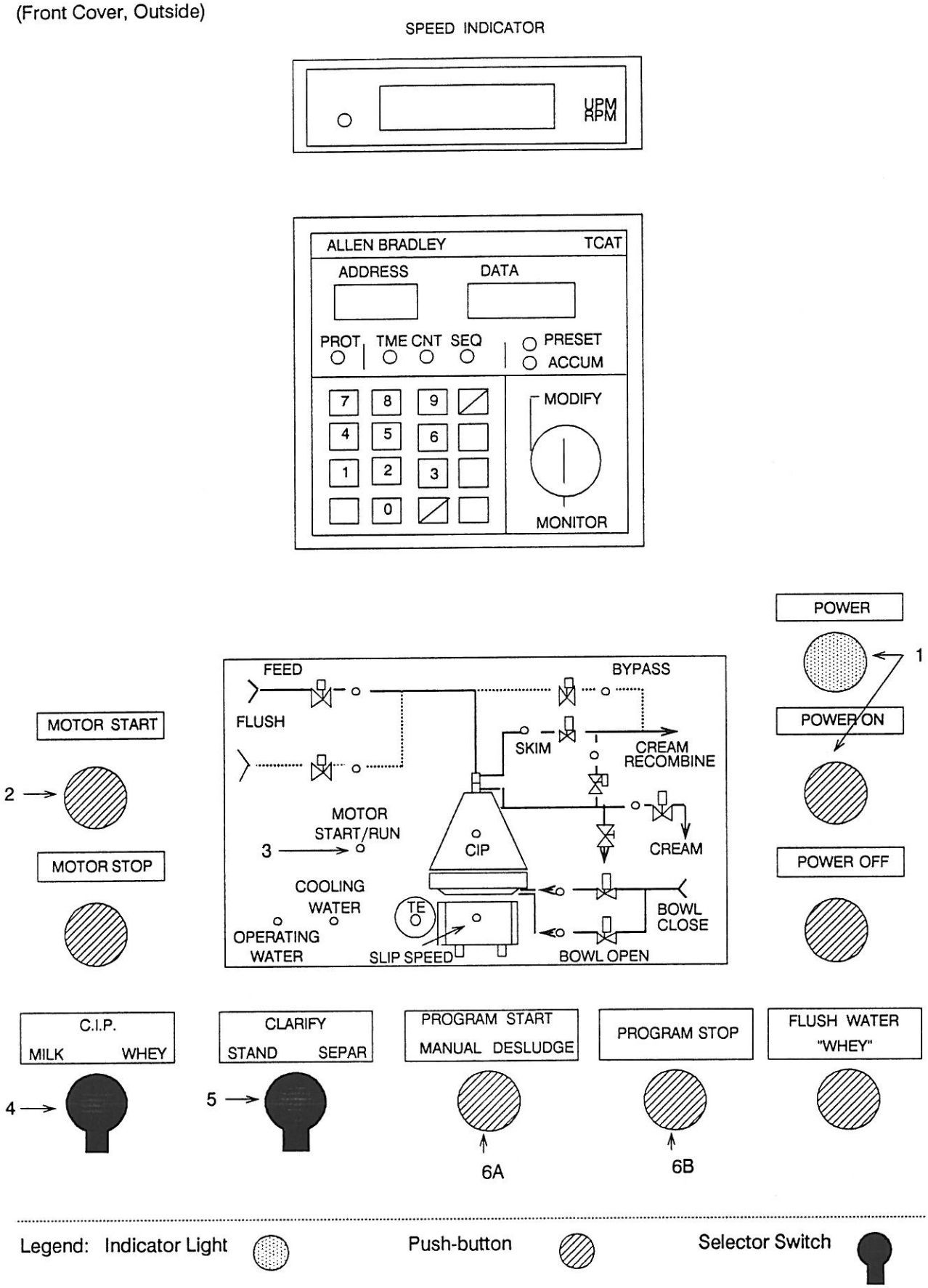


Figure 2-4. Control Cabinet, Separator Controls.

2-9. MONITORING A TIMER INSTRUCTION (Fig 2-5).

NOTE:

- *Refer to tables 2-2 through 2-5 for a description of separator functions and function times.*
- *The index numbers on figure 2-5 reflect the procedural steps in para. 2-9 with the same number.*

In the following example, address 905 (partial bowl open adjustment) will be used to illustrate how a timer may be monitored by the operator. For this purpose address 905 will be called a timer with a PR value of 2.0 (seconds) and is *not* protected in the program.

1. Energize the TCAT/PLC per para. 2-5.

2. Ensure Keyswitch is in the Monitor mode. The Address Display will show address 901 (the lowest in the program).

3. Depress the ADDR key. The 0 & 1 in the Address Display will be replaced with flashing dashes. This indicates a request for the entry of a new address.

4. Using the keypad, enter 0 & 5. Depress Enter Key. The Address Display will show address 905, the Data Display will show .0. The TME and ACCUM LEDs will light. This indicates to the operator that address 905 is a Timer (TME).

If the Timing Unit is in mid-process, the operator will have to wait until the chosen address "comes around" in the cycle to monitor the event. It is possible to bring up the desired event by depressing the program start button (6A, fig. 2-4), which will initiate the de-sludge program from it's beginning.

5. Depress the PRESET keypad. The TME and PRESET LEDs will light. The Address Display will show the current address of 905 while the Data Display indicates the pre-set time value.

6. Depress the ACCUM keypad. The TME and ACCUM LEDs will light. The Address Display will show the current address of 905 while the Data Display indicates the accumulated time value.

NOTE:

- *All process timers and counters will automatically reset after 10 seconds.*
- *If the ACCUM keypad is depressed twice, an error code will appear in the data display. Refer to table 2-6 for corrective action.*

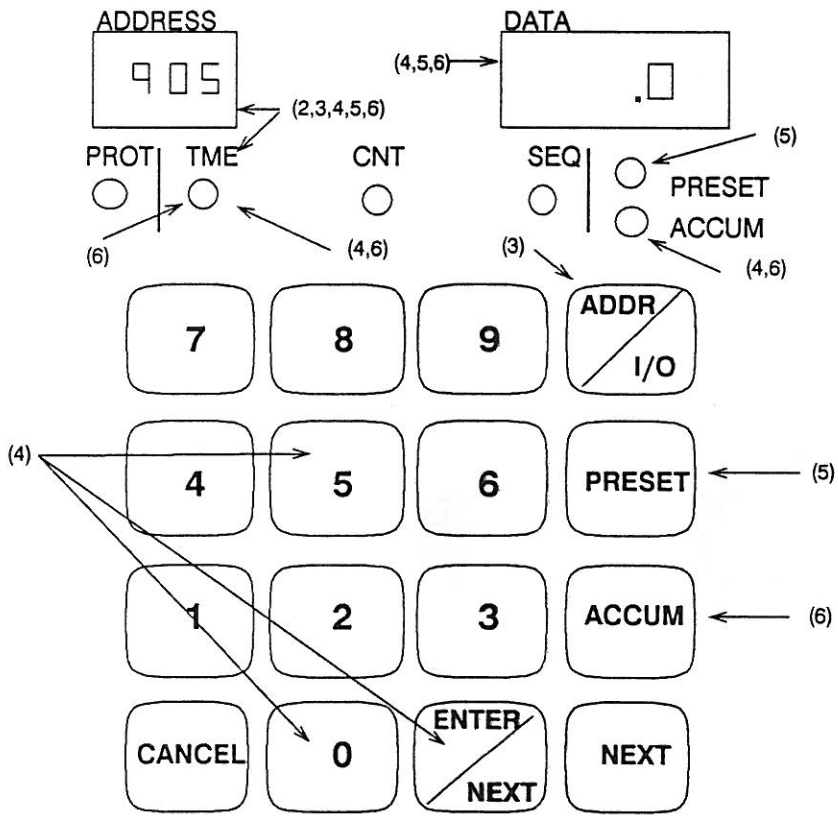


Figure 2-5. Monitoring a Timer Instruction.

2-10. MONITORING A COUNTER INSTRUCTION (Fig 2-6).

NOTE:

- *Refer to tables 2-2 through 2-5 for a description of separator functions and function times.*
- *The index numbers on figure 2-6 reflect the procedural steps in para. 2-10 with the same number.*

In the following example, address 901 will be used to illustrate how a function may be monitored by the operator. For this purpose address 901 will be called a counter with a PR value of 20 (minutes) and is *not* protected in the program.

1. Energize the TCAT/PLC per para. 2-5.

2. Ensure Keyswitch is in the Monitor mode. The Address Display will show address 901 (the lowest in the program).

3. Depress the ADDR key. The 0 & 1 in the Address Display will be replaced with flashing dashes. This indicates a request for the entry of a new address.

4. Using the keypad enter 1 & 4. The Address Display will show address 901, the Data Display will show 0. The CNT and ACCUM LEDs will light. This indicates to the operator that address 901 is a Counter (CNT).

If the Timing Unit is in mid-process, the operator will have to wait until the chosen address "comes around" in the cycle to monitor the event. It is possible to bring up the desired event by depressing the program start button (6A, fig. 2-4), which will initiate the de-sludge program from it's beginning.

5. Depress the PRESET keypad. The CNT and PRESET LEDs will light. The Address Display will show the current address of 901 while the Data Display indicates the pre-set time value.

6. Depress the ACCUM keypad. The CNT and ACCUM LEDs will light. The Address Display will show the current address of 901 while the Data Display indicates the accumulated time value.

NOTE:

- *All process timers and counters will automatically reset after 10 seconds.*
- *If the ACCUM keypad is depressed twice, an error code will appear in the data display. Refer to table 2-6 for corrective action.*

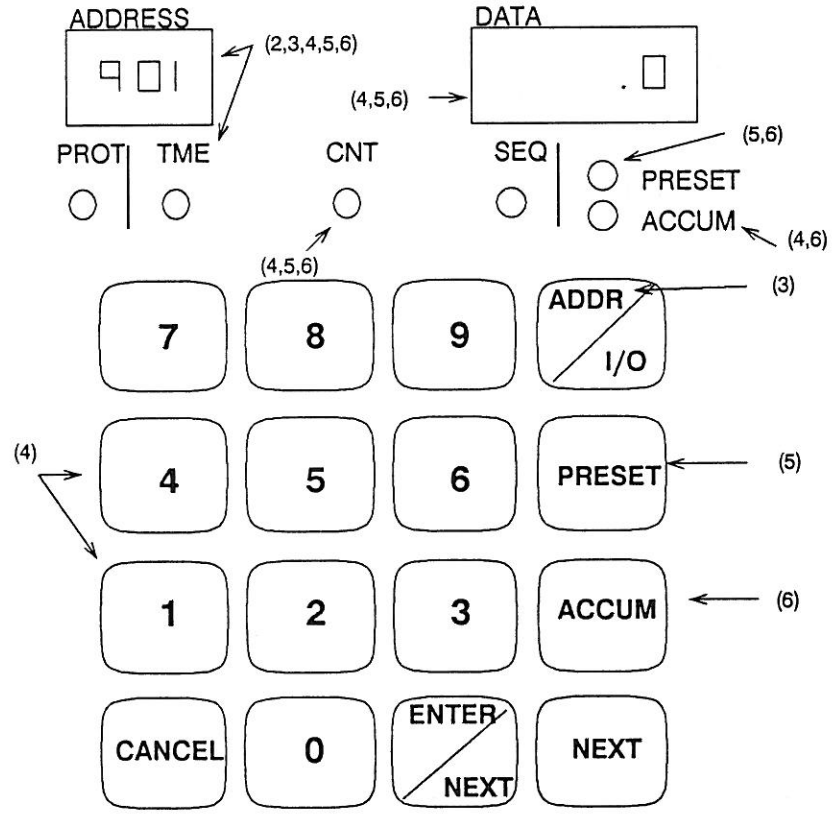


Figure 2-6. Monitoring a Counter Instruction.

2-11. MODIFYING A TIMER INSTRUCTION (Fig 2-7).

NOTE:

- *Refer to tables 2-2 through 2-5 for a description of separator functions and function times.*
- *The index numbers on figure 2-7 reflect the procedural steps in para. 2-11 with the same number.*

In the following example, address 905 will be used to illustrate how a timer function may be modified by the operator. For this purpose address 905 will be called a timer with a PR value of 2.0 (seconds) and is *not* protected in the program.

1. Energize the TCAT/PLC per para. 2-5.

2. Select the Modify mode at the key-switch. The Address Display will show address 901 (the lowest in the program).

If the Timing Unit is in mid-process, the operator will have to wait until the chosen address "comes around" in the cycle to monitor the event. It is possible to bring up the desired event by depressing the program start button (6A, fig. 2-4), which will initiate the de-sludge program from it's beginning.

3. Depress the ADDR key. The 0 & 1 in the Address Display will be replaced with flashing dashes. This indicates a request for the entry of a new address.

4. Using the keypad, enter 0 & 5. Depress Enter Key. The Address Display will show address 905, the Data Display will show .0. The TME and ACCUM LEDs will light. This indicates to the operator that address 905 is a Timer (TME).

5. Depress the PRESET keypad. The TME and PRESET LEDs will light. The Address Display will indicate 905 and the Data Display will indicate that the pre-set value is 2.0.

6. Depress the PRESET keypad again. The 2.0 in the Data Display will be replaced by flashing dashes, indicating to the operator that a new pre-set value may be entered.

7. Using the keypad, enter 2.5 (arbitrary number for this example) and ENTER keypad. The Data Display will show 2.5 indicating that the pre-set value has been changed.

8. Depress the ACCUM keypad. The TME and ACCUM LEDs will light. The Address Display will indicate 905.

9. Move keyswitch to monitor position. Monitor process for proper operation.

NOTE:

- *All process timers and counters will automatically reset after 10 seconds.*
- *If the ACCUM keypad is depressed twice, an error code will appear in the data display. Refer to table 2-6 for corrective action.*

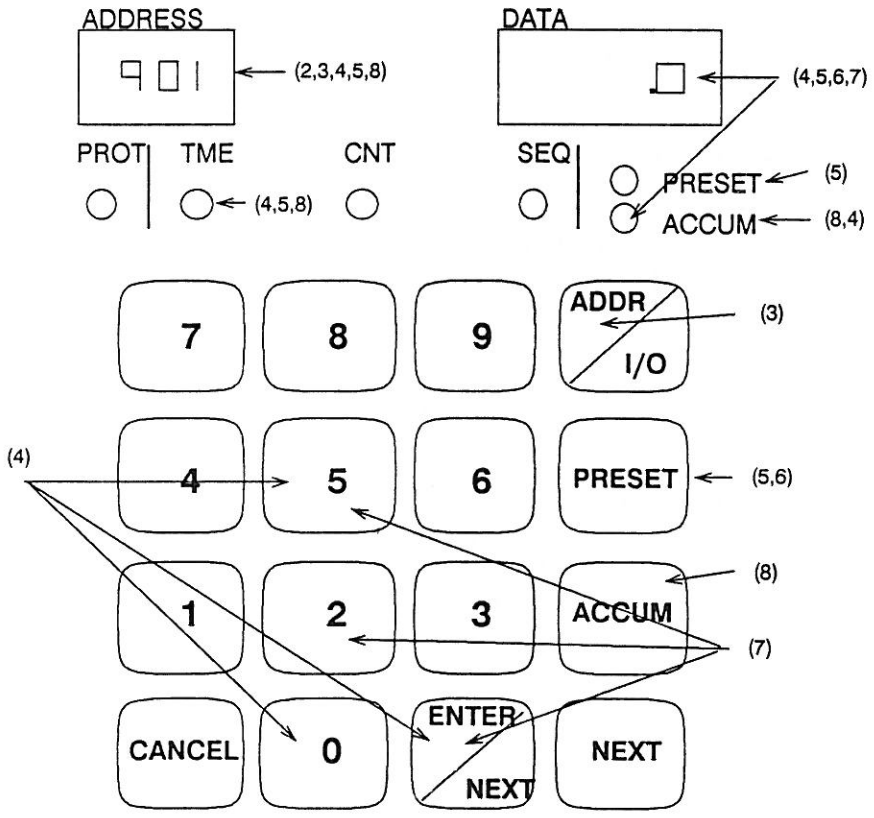


Figure 2-7. Modifying a Timer Instruction.

2-12. MODIFYING A COUNTER INSTRUCTION (Fig 2-8).

NOTE:

- *Refer to tables 2-2 through 2-5 for a description of separator functions and function times.*
- *The index numbers on figure 2-8 reflect the procedural steps in para. 2-12 with the same number.*

In the following example, address 901 will be used to illustrate how a counter function may be modified by the operator. For this purpose address 901 will be called a counter with a PR value of 20 (minutes) and is *not* protected in the program.

1. Energize the TCAT/PLC per para. 2-5.

2. Select the Modify mode at the key-switch. The Address Display will show address 901 (the lowest in the program).

If the Timing Unit is in mid-process, the operator will have to wait until the chosen address "comes around" in the cycle to monitor the event. It is possible to bring up the desired event by depressing the program start button (6A, fig. 2-4), which will initiate the de-sludge program from it's beginning.

3. Depress the ADDR key. The 0 & 1 in the Address Display will be replaced with flashing dashes. This indicates a request for the entry of a new address.

4. Using the keypad, enter 0 & 1. Depress Enter Key. The Address Display will show address 901, the Data Display will show .0. The CNT and ACCUM LEDs will light. This indicates to the operator that address 901 is a Counter (CNT).

5. Depress the PRESET keypad. The CNT and PRESET LEDs will light. The Address Display will indicate 901 and the Data Display will indicate that the pre-set value is 20.

6. Depress the PRESET keypad again. The 20 in the Data Display will be replaced by flashing dashes, indicating to the operator that a new pre-set value may be entered.

7. Using the keypad, enter 22 (arbitrary number for this example) and ENTER keypads. The Data Display will show 22 indicating that the pre-set value has been changed.

8. Depress the ACCUM keypad. The CNT and ACCUM LEDs will light. The Address Display will indicate 901.

9. Move keyswitch to monitor position. Monitor process for proper operation.

NOTE:

- *All process timers and counters will automatically reset after 10 seconds.*
- *If the ACCUM keypad is depressed twice, an error code will appear in the data display. Refer to table 2-6 for corrective action.*

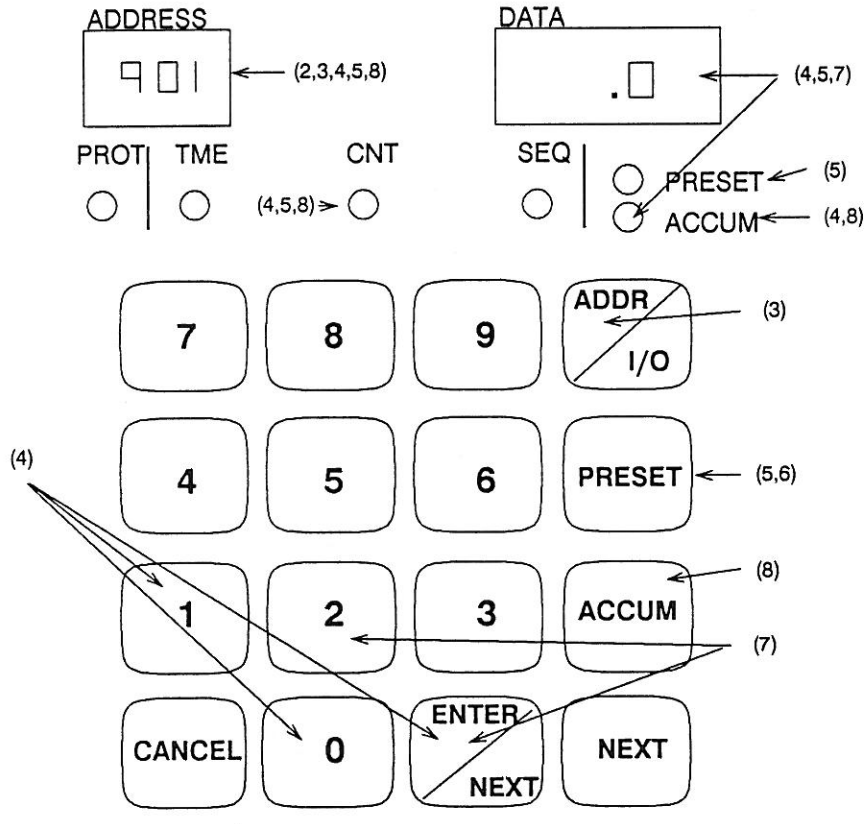


Figure 2-8. Modifying a Counter Instruction.

TABLE 2-2.
FUNCTION TIMES
(SEPARATION/STANDARDIZATION OF MILK)

ADDRESS NUMBER	FUNCTION	FUNCTION DESCRIPTION	PRE-SET TIME	FIELD-SET TIME *
901	Process Timer	In progress mode- Amount of time between de-sludgings	15 min.	
904	C.I.P. Counter	In C.I.P. mode- Amount of time between de-sludgings	10 min.	
905	Partial Bowl Open Adjustment	Adjustment timer to change the pre-set time of bowl open valve during partial de-sludgings	2.0 sec.	
907	Partial Bowl Close Fine Adjustment	Adjustment timer to change the pre-set time of bowl close valve during partial de-sludgings	20 sec.	
910	Standardize Valve Interval (C.I.P.)	Amount of time between activation of standard valve interval	5 min.	
911	Standardize Valve On (C.I.P)	Amount of time that standard valve is activated in C.I.P.	60 sec.	
912	Turbidity Delay Before De-sludging	Delay time between turbidity signal and de-sludging	10 sec.	
918	Turbidity Delay After Desludging	Delay time between start of de-sludge and recognition of another turbidity signal	30 sec.	
922	Bowl Close First Time	Amount of time the bowl close valve is energized after receiving a motor run signal	10 sec.	
923	Bowl Close Pulser Sequencer	Every 59 sec. for 1 sec. bowl close valve is energized		
925	Deleted			
926	Solid Discharge Valve Delay (proc. & C.I.P.)	Time delay after de-sludging begins and before the solid discharge valve energizes	45 sec.	
927	Solid Discharge Valve On (proc. & C.I.P.)	Amount of time the solid discharge valve is energized after delay	120 sec.	
932	Program Identification	Identifies the software number and revision date		

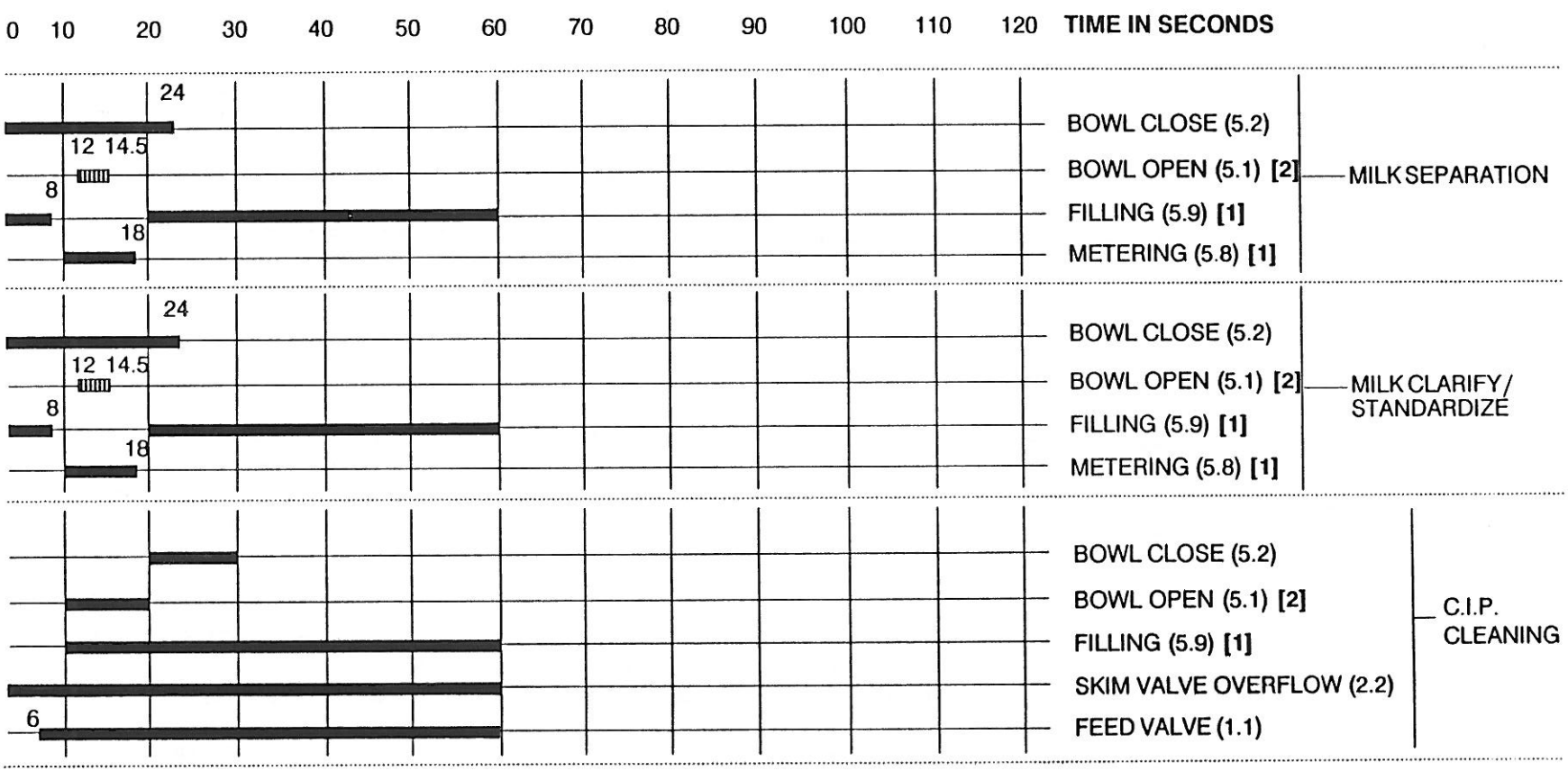
* If different from pre-set time.

TABLE 2-3.
FUNCTION TIMES
(SEPARATION/CLARIFICATION OF WHEY)

ADDRESS NUMBER	FUNCTION	FUNCTION DESCRIPTION	PRE-SET TIME	FIELD-SET TIME *
901	Process Timer	In progress mode- Counts minutes between de-sludgings	15 min.	
903	Partial/Full Counter	Number of partial desludgings prior to full de-sludge		
904	C.I.P. Counter	In C.I.P. mode- Amount of time between de-sludgings	10 min.	
905	Partial Bowl Open Adjustment	Adjustment timer to change the pre-set time of bowl open valve during partial de-sludgings	2.0 sec.	
908	Partial Cream Displace Fine Adjustment	Adjusts cream displace prior to partial de-sludge	12 sec.	
909	Partial Bleed Fine Adjustment	Adjusts bleed valve after partial de-sludge	38 sec	
912	Turbidity Delay Before De-sludging	Delay time between turbidity signal and de-sludging	10 sec.	
913	Whey - Cream Displace Interval (proc.)	Time between energizing cream displace valve in whey (proc.) mode	7 min.	
914	Whey - Cream Displace On (proc.)	Time cream displace valve is energized for whey (proc.) mode	15 sec.	
915	Cream Displace Interval (C.I.P.)	Time between activation of cream displace valve in C.I.P. mode	2 min.	
916	Cream Displace Time On (C.I.P.)	Amount of time the cream displace valve is activated in C.I.P. mode	120 sec.	
917	Cream Bypass Time On (C.I.P.)	Amount of time the cream re-combine valve is activated during cream displace or C.I.P.	20 sec.	
918	Turbidity Delay After Desludging	Delay time between start of de-sludge and recognition of another turbidity signal	8 min.	
922	Bowl Close First Time	Amount of time the bowl close valve is energized after receiving a motor run signal	10 sec.	
923	Bowl Close Pulser Interval	Every 59 sec. for 1 sec. bowl close valve is energized		
925	Full Cream Displace Fine Adjustment	Full cream displace fine adjustment timer during full de-sludgings	15 sec.	
926	Solid Discharge Valve Delay	Time delay after de-sludging begins and before the solid discharge valve energizes	45 sec.	
927	Solid Discharge Valve On	Amount of time the solid discharge valve is energized after delay	120 sec.	
928	Full - Flush Water (0 - 12 sec.)	Flush valve fine adjustment timer during full de-sludging	10 sec.	
929	Full Bleed Fine Adjustment	Bleed valve fine adjustment timer during full de-sludging	50 sec.	
932	Program Identification	Identifies the software number and revision date		

* If different from pre-set time.

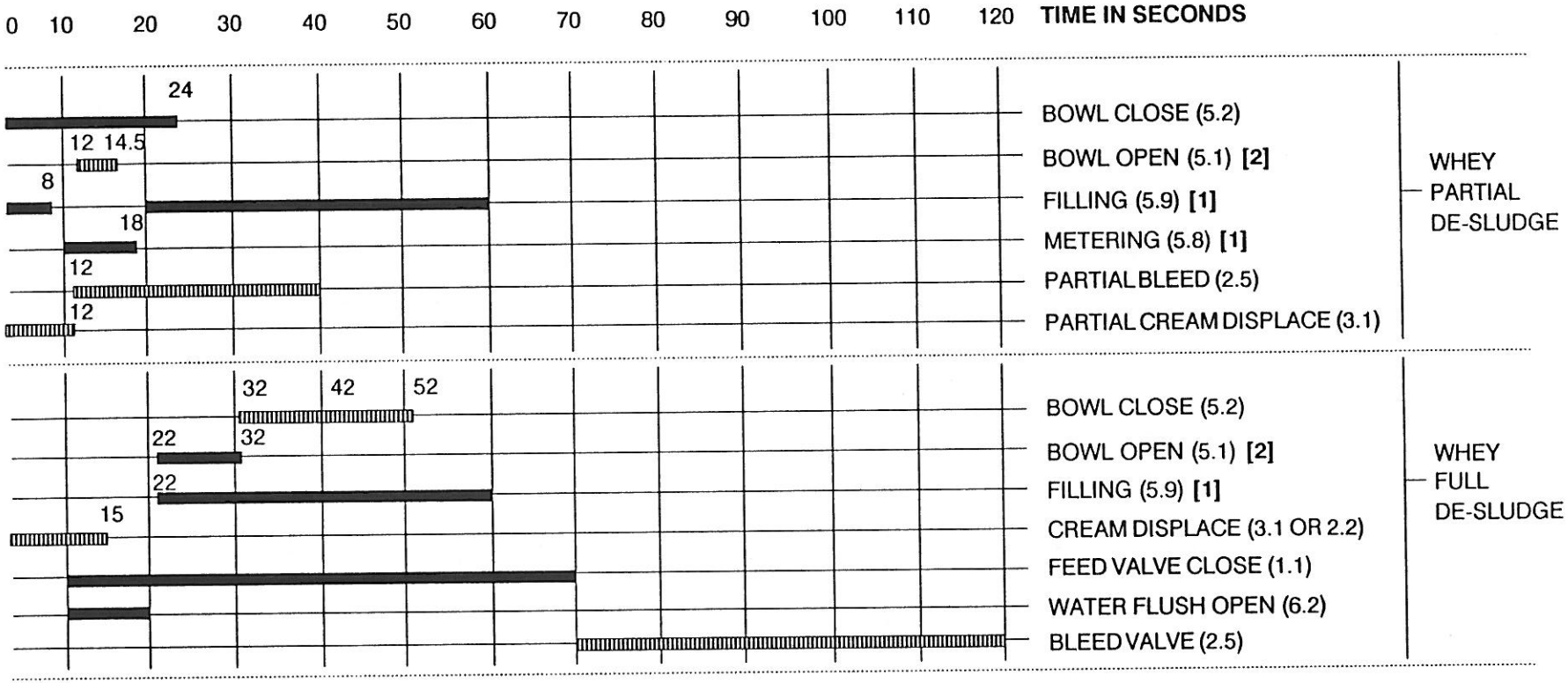
TABLE 2-4.
DE-SLUDGING TIMES FOR MSD & WATER SAVING MACHINES



▥ INDICATES THIS TIME IS ADJUSTABLE WITHIN 1 SECOND USING THE TCAT

[1] NOT USED WITH WATER SAVING (NON MSD) MACHINES
[2] OUTPUT 5.1 TO BE SET AT 2.0 SECONDS (REFER TO SEPARATOR MANUAL FOR PARTIAL BOWL ADJUSTMENT)

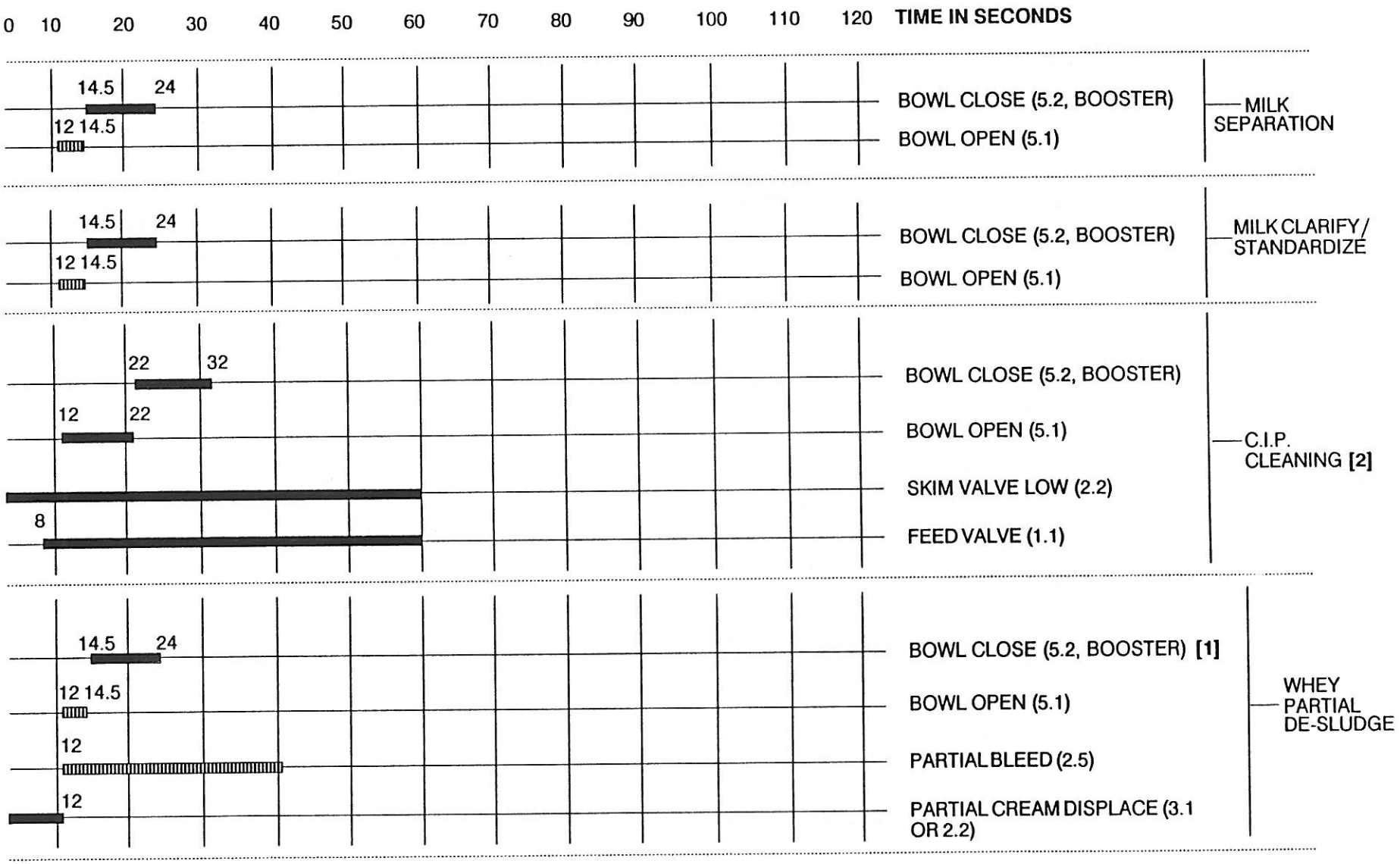
DE-SLUDGING TIMES FOR MSD & WATER SAVING MACHINES (cont'd)



▥ INDICATES THIS TIME IS ADJUSTABLE WITHIN 1 SECOND USING THE TCAT

[1] NOT USED WITH WATER SAVING (NON MSD) MACHINES
[2] OUTPUT 5.1 TO BE SET AT 2.0 SECONDS (REFER TO SEPARATOR MANUAL FOR PARTIAL BOWL ADJUSTMENT)

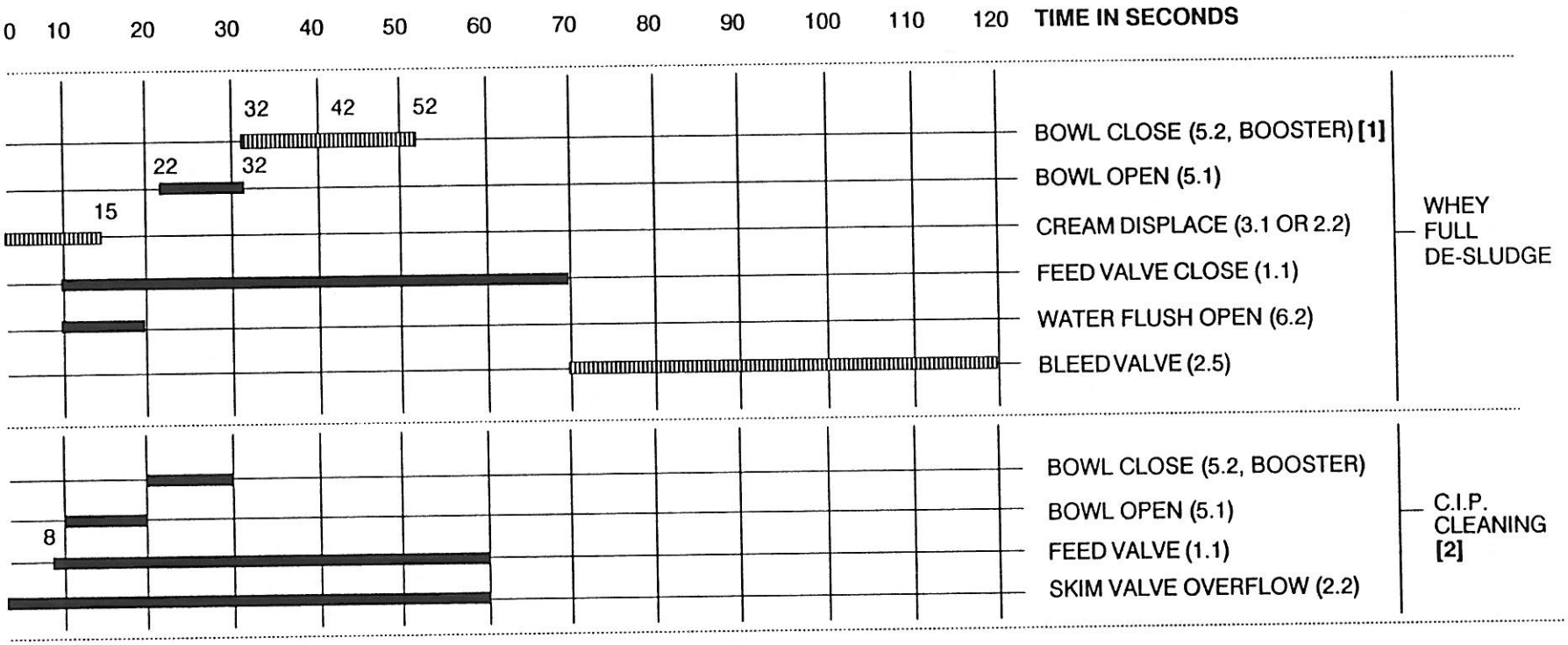
TABLE 2-5.
DE-SLUDGING TIMES FOR NON-WATER SAVING MACHINES



INDICATES THIS TIME IS ADJUSTABLE WITHIN 1 SECOND USING THE TCAT

[1] NOT USED ON MSD 50/60 **[2]** ALL PROCESS VALVES PULSED DURING C.I.P.

DE-SLUDGING TIMES FOR NON-WATER SAVING MACHINES (cont'd)



INDICATES THIS TIME IS ADJUSTABLE WITHIN 1 SECOND USING THE TCAT

[1] NOT USED ON MSD 50/60 **[2]** ALL PROCESS VALVES PULSED DURING C.I.P.

2-13. TYPICAL C.I.P. CLEANING AND SHUT-DOWN (Fig. 2-9).

Proceed with the following to perform a clean-in-place of the separator system.

WARNING:

- *Before power is turned on, ensure there is no maintenance being performed on the system. Lock the main power shut-off, per OSHA requirements, if maintenance is to be performed. High voltage is present in the separator system. Severe injury or death may result from electrocution.*

- *Read and understand the Warnings and Cautions in the separator manual before operation.*

- *The separator shall not be exposed to chlorine in either a cleaning solution or a sanitizing agent.*

NOTE:

- *Refer to the technical material provided by the manufacturer of the separator for detailed information concerning separator installation, operation and maintenance.*

1. De-activate the feed valve by stopping the program (1).

2. Make all necessary connections to perform a C.I.P.

3. Select C.I.P. (3) for either milk or whey.

4. Flush the separator and associated piping with water. If processing whey, the rinse water should be the same temperature as the product. Make proper preparation to catch/dispose of the waste water.

5. Perform three manual de-sludgings (5) of the separator at four to six minute intervals while water rinsing the system.

6. Upon completion of the water rinse, connect the C.I.P. discharges to recirculate the C.I.P. solution.

7. Circulate a caustic solution of 1.8 to 2.0 % strength at a temperature of 165°F for forty-five minutes (minimum). Perform one manual de-sludge (7) after three minutes of circulating time and thereafter every ten minutes. This procedure is automatic when the timing unit is in the C.I.P. mode (adjust timer 904, tables 2-2 & 2-3, as required).

NOTE:

Amount of solution required will vary according to the size and capacity of the system.

8. Rinse the caustic solution from the system using water and perform three manual de-sludgings (8) at four to six minute intervals.

9. Circulate an acid solution with a ph of 4.5 and a temperature of 160° F for thirty minutes. Perform one manual de-sludge (9) after three minutes of circulating time and thereafter every twelve minutes (for a total of 3 manual de-sludgings made during a 27 minute period).

10. After the acid rinse has been completed, flush the system with water making one manual de-sludge (10) while rinsing.

11. De-activate all pumps used for C.I.P. cleaning.

12. De-activate program at control cabinet by depressing the motor stop button (13). The bowl will open fully for ten seconds automatically de-activating the run program. The bowl will remain open.

CAUTION:

The timing unit shall be energized prior to separator start-up and remain energized until the separator bowl comes to a complete stop.

WARNING:

Do not loosen or remove any part of the separator or feed and discharge lines before the bowl has stopped completely. The bowl will not be at rest until it can be observed as being stopped through the inspection cover.

14. After the bowl has come to a complete stop; de-activate timing unit (14) at the control cabinet. Use brakes to stop the bowl *only if necessary*. It is recommended that the bowl come to a stop by slowly winding down.

CAUTION:

When using hot water (bath or spray) to clean, ensure the water temperature does not exceed limitations or damage to component/material may occur.

15. Wash the external surfaces of the separator.

16. Turn off utilities.

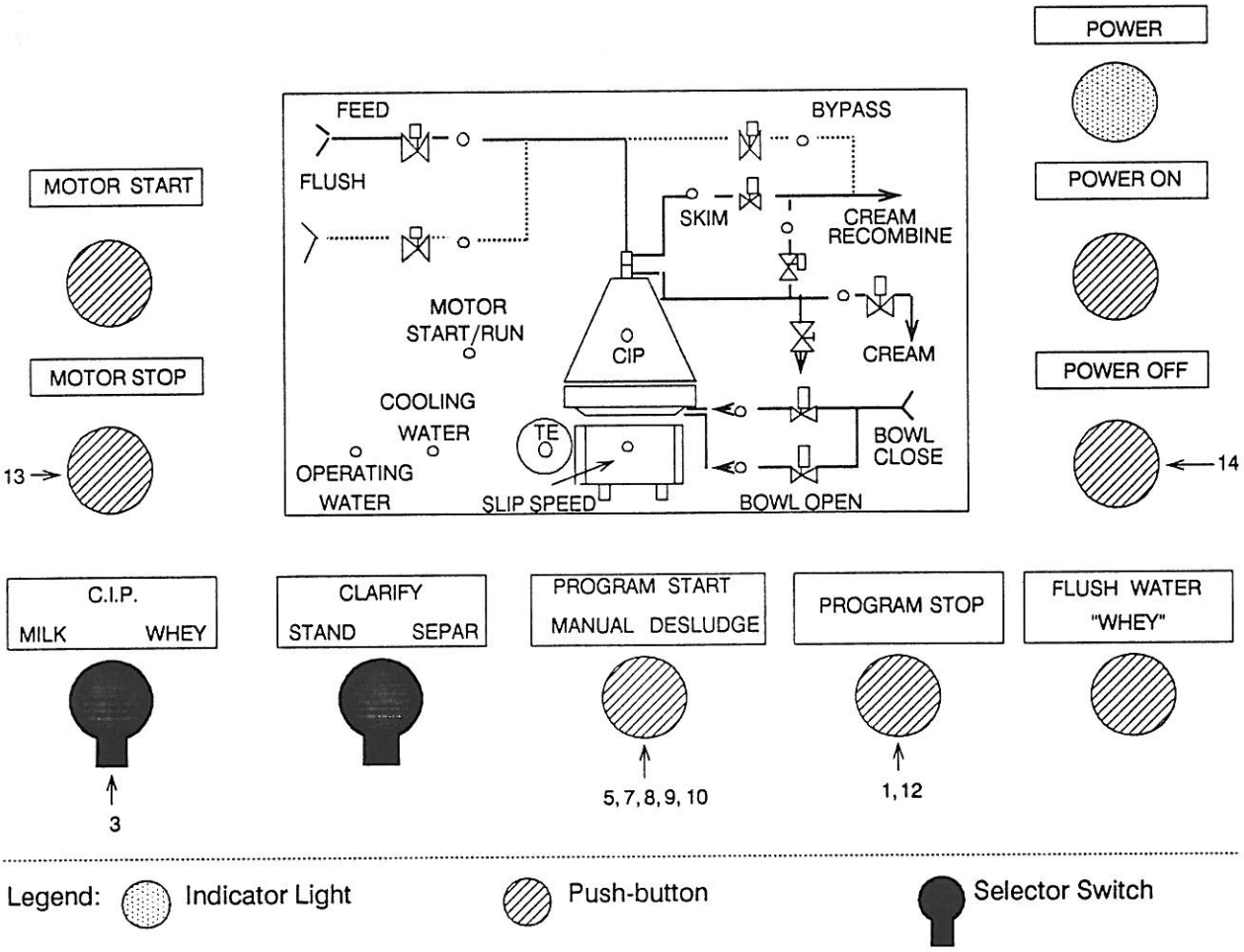


Figure 2-9. Separator Controls (partial).

2-14. TROUBLESHOOTING TCAT DISPLAYS.

During initial start-up and when energizing the Timing Unit for subsequent starts, certain errors may be encountered.

If the Timing Unit is energized with the selector switch in the Run/Man mode, in a mode other than run or without a user program, the TCAT will advise the operator through indications in the Address and Data Displays. Refer to the following paragraphs for troubleshooting these errors.

NOTE:

Refer to table 2-6 for additional TCAT error codes and table 2-7 for Instruction Symbols.

2-14.1. ENERGIZING THE TIMING UNIT (Run/Man Mode).

REQUIRED CONDITIONS:
- SLC 150 PLC in the RUN mode.
- Manual/Auto switch set at MAN.

When the system is initially energized the TCAT/PLC will undergo a series of diagnostic tests and then display:

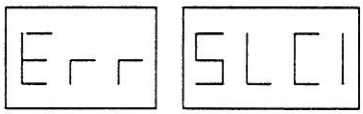


Figure 2-10. TCAT Display in Run/Man. Mode During Start-Up.

To clear this error code, turn the PLC AUTO/MAN switch to the AUTO mode (ref. fig. 1-5, item 9). The TCAT will then automatically return to address 901.

2-14.2. ENERGIZING THE TIMING UNIT (In a mode other than RUN).

REQUIRED CONDITIONS:
- SLC 150 PLC in a mode other than RUN.

When the system is initially energized the TCAT/PLC will undergo a series of diagnostic tests and then display:

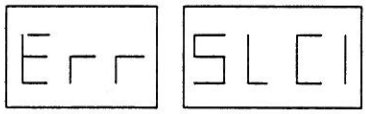


Figure 2-11. TCAT Display in a Mode Other Than RUN.

To clear this error code a Pocket Programmer (not normally supplied) or the assistance of a trained and qualified service technician is required.

2-14.3. ENERGIZING THE TIMING UNIT (Without a user program in memory).

REQUIRED CONDITIONS:
- PLC does not have a user program in memory.
- The program does not have any timer/counter/sequencer instructions.

When the system is initially energized the TCAT/PLC will undergo a series of diagnostic tests, scan addresses 901 thru 932 and then display:

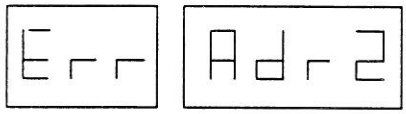


Figure 2-12. TCAT Display Without a Program in Memory

To clear this error code a Pocket Programmer (not normally supplied) or the assistance of a trained and qualified service technician is required.

TABLE 2-6. TCAT ERROR CODES

ADDRESS DISPLAY	DATA DISPLAY	EXPLANATION	
Err	SLC1	Processor is not in the RUN mode, or the Auto/Manual switch is in Manual, or a processor error has occurred.	
	SLC2	Communication error with the processor.	
	tCAt	Error discovered during the TCAT/PLC power-up self test.	
	Adr1	Invalid address (not within the 901 to 932 range)	*
	Adr2	Address not found in the user program.	*
	Mod	This code appears when you attempt to modify data while in the monitor mode or depress pre-set or accum twice in succession.	*
	StEP	Invalid sequencer step.	*
	grP	Invalid I/O group number.	*
Err	Prot	This error code appears when you attempt to modify data which is protected.	*

* These errors indicate that the wrong data was entered or an invalid procedure was attempted. Remedy: Press the cancel key, which returns the display to the point it was *before* the error was made.

TABLE 2-7. DISPLAY INSTRUCTION SYMBOLS.

DATA DISPLAY	EXPLANATION
	Retentive On-Delay timer instruction.
	Retentive Off-display timer instruction.
	Up-counter instruction.
	Down-counter instruction.
	Sequencer output instruction. Event driven. The last two digits (in this case, zeros) indicates the sequencer group number.
	Sequencer output instruction. Time driven. The last two digits (in this case, zeros) indicates the sequencer group number.
	Sequencer input instruction. Event driven. The last two digits (in this case, 07) indicates the sequencer group number.
	Sequencer input instruction. Time driven. The last two digits (in this case, 07) indicates the sequencer group number.
	This is a prompt message applying to address group numbers. It asks the operator to enter a group number.
	This is a prompt message applying to sequencer instructions. It asks you to enter the sequencer step number

2-15. MALFUNCTIONS INDICATED ON THE ILLUMINATED GRAPHICS PANEL (Fig. 2-13).

The following malfunction indications may be indicated on the Graphics Panel during operation:

1. Cooling water indicator - This light will flash on and off if if there is a loss or drop in flow of the cooling water supplied to MSD 300 separators equipped with a motor cooling system.

2. Motor over-temperature indicator (TE) - Should the separator motor experience an over-temperature condition, this indicator will flash on and off and shut-down the separator.

3. Bowl Open Indicator - This indicator will flash if the bowl fails to shoot indicating that the bowl did not eject some sediment causing an increase in amperage draw. Note that the bowl close indicator light will flash for 1 second every 59 seconds to maintain bowl close water.

4. Slip Speed - This indicator will flash if the bowl speed has dropped too low for separation to occur properly. Refer to para. 2-19.

2-16. ADJUSTING SPEED INDICATOR (Fig. 2-14).

NOTE:

Refer to chap. 1, paras. 1-7 and 1-8 for a description of the speed indicator and speed measuring device.

The speed indicator has been adjusted at the factory to the maximum bowl speed of the separator (according to the name plate), corresponding to a 20 mA input. To re-adjust the unit, proceed as follows:

1. Switch on speed indicator.

WARNING:

Remove electrical power from the speed measuring device before proceeding.

2. Remove the measuring line of the speed measuring device from the measuring input of the speed indicator (+ and - ,if connected, fig. 2-14).

3. Install the adjusting bridge (3) per fig. 2-14.

4. Turn the course adjustment trimmer (5), slowly, to + (plus) or - (minus) until the digital display (2) on the front panel *approximates* the desired speed (fig. 1-8).

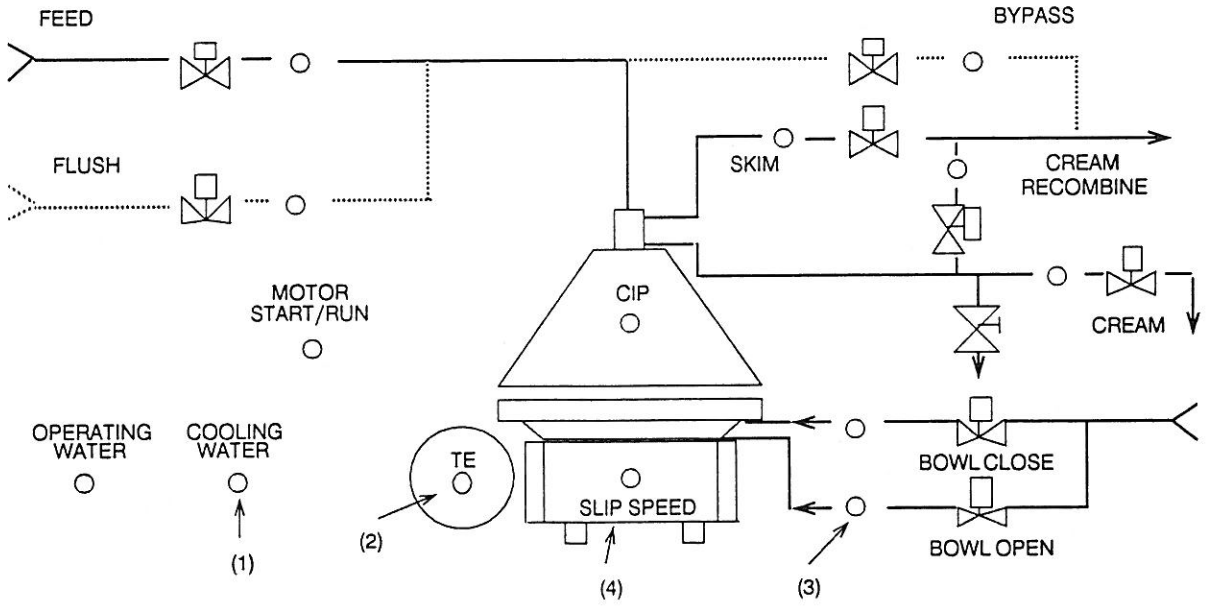


Figure 2-13. Illuminated Graphics Panel (Malfunction Indications).

1 & 2. Not illustrated. Refer to fig. 1-8
3. Adjustment Bridge
4. Measuring input 4-20 mA
5. Coarse adjustment trimmer
6. Fine adjustment trimmer
7. Limit value output
8. Auxiliary voltage 110/220 VAC (change over using wire bridges.
9. Limit value adjuster

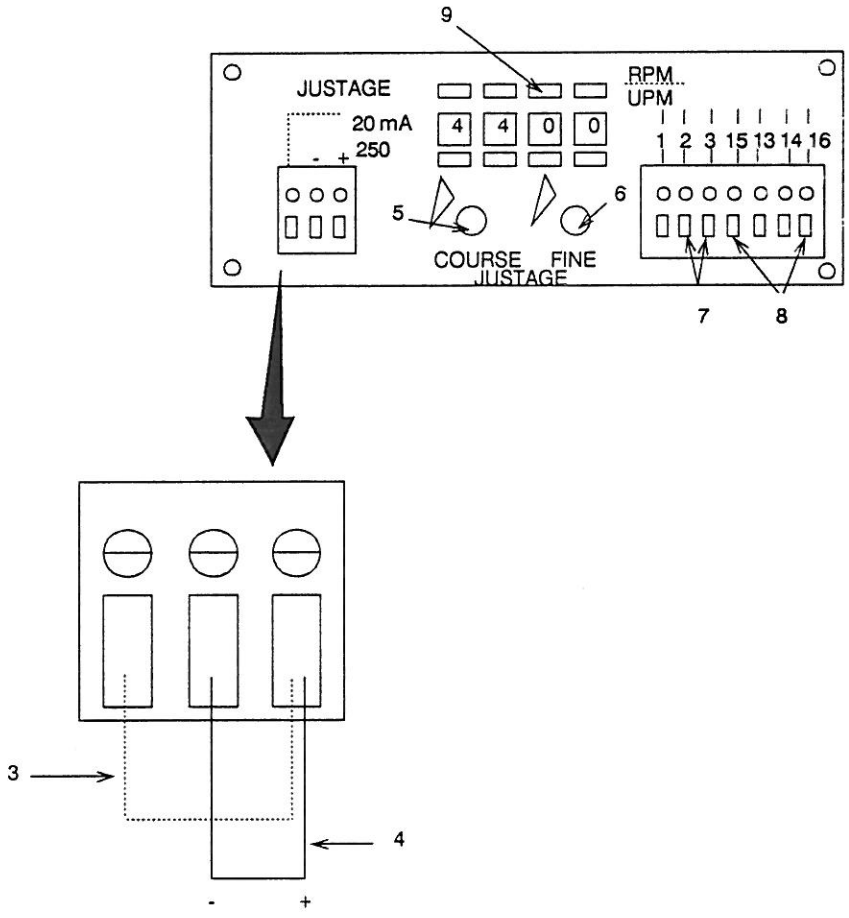


Figure 2-14. Speed Indicator (Adjustment).

NOTE:

The speed indicator is manufactured in Germany. The word "JUSTAGE" that appears on the back of the unit means ADJUSTMENT.

5. Turn the fine adjustment trimmer (6), slowly, to + (plus) or - (minus) until the digital display (2) on the front panel indicates the *desired* speed value. The unit will display "0" on the display panel (Fig. 1-8).

6. Remove the adjusting bridge and re-connect the measuring line (+ and -).

7. Set the limit value adjuster to approximately 50 - 100 RPM *below* the bowl speed. Adjustment is now complete.

Deviations of the displayed value from the rated bowl speed on the separator name plate may be corrected by re-adjusting the trimmer of the speed measuring device while both the separator and the measuring device are operating.

INTRODUCTION.

The following pages provide detailed schematics depicting the wiring of the separator system. It must be understood that these diagrams are of the wired connections inside the control cabinet. Making some of these connections is the responsibility of the operator, specifically the component to terminal strip connections. Operator responsible connections are indicated as such.

Included in this chapter is the parts list (bill of material) calling out the components used in the control cabinet.

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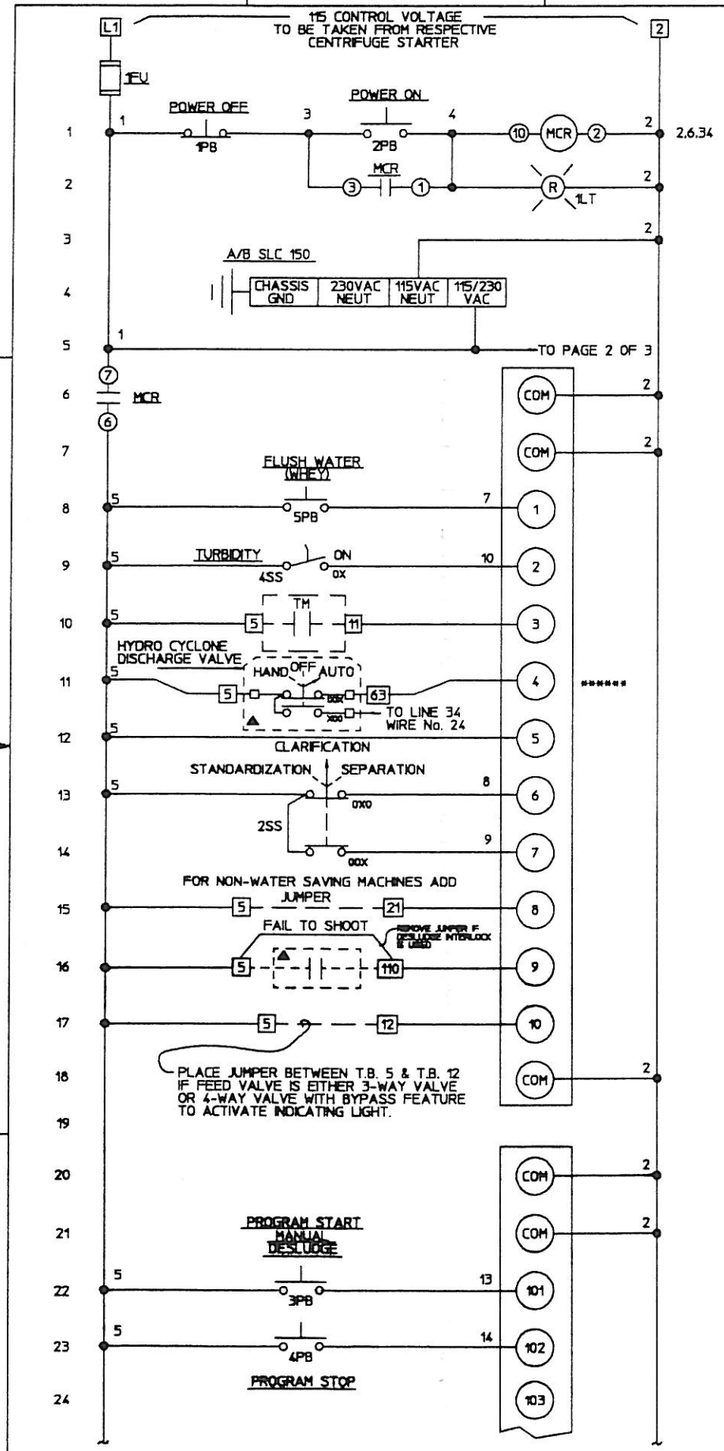
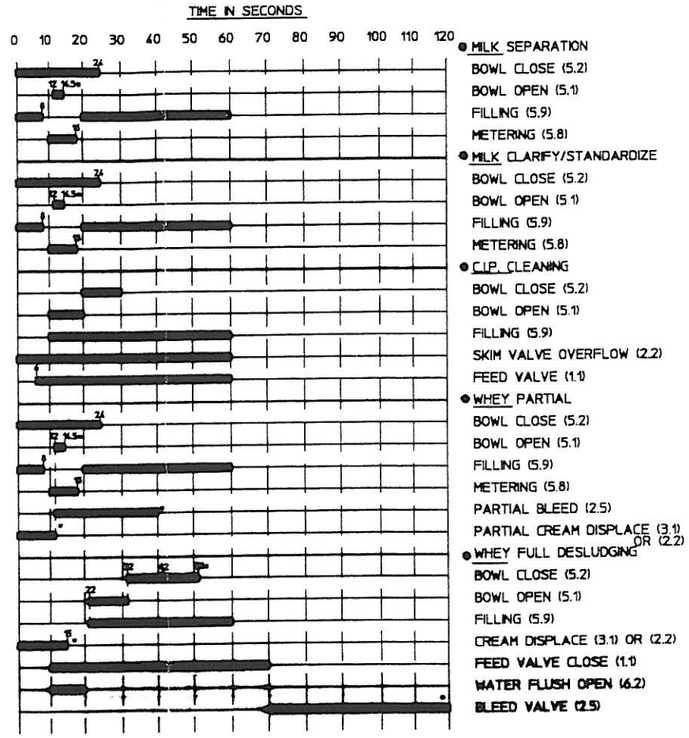
REVISIONS				
ZONE	No.	DESCRIPTION	DATE	APPROVED
C7	1	TURBITITY HAD BEEN OPTIONAL	11/12/91	DI





DESLUDGING CHART FOR MSD & WATER SAVING MACHINE

NOTES:
1. BOWL CLOSING PULSER EVERY 59 SEC 1 SEC.
2. FOR NON-WATER SAVING DESLUDGING CHART REFER TO PAGE 2 OF 3.

● 0.1 SEC EXTERNALLY ADJUSTABLE
( ) = REPRESENT ITEM TAG NUMBER ON P & ID AND AIR/WATER CONTROL BOX.
▲=REMOTE

THIS DRAWING REDRAWN FROM 9128-5900-C90 REV.7

T E F 10/17/90

WESTFALIA SEPARATOR CENTRICO Incorporated

Figure 3-1
WIRING DIAGRAM
KC-2054/T

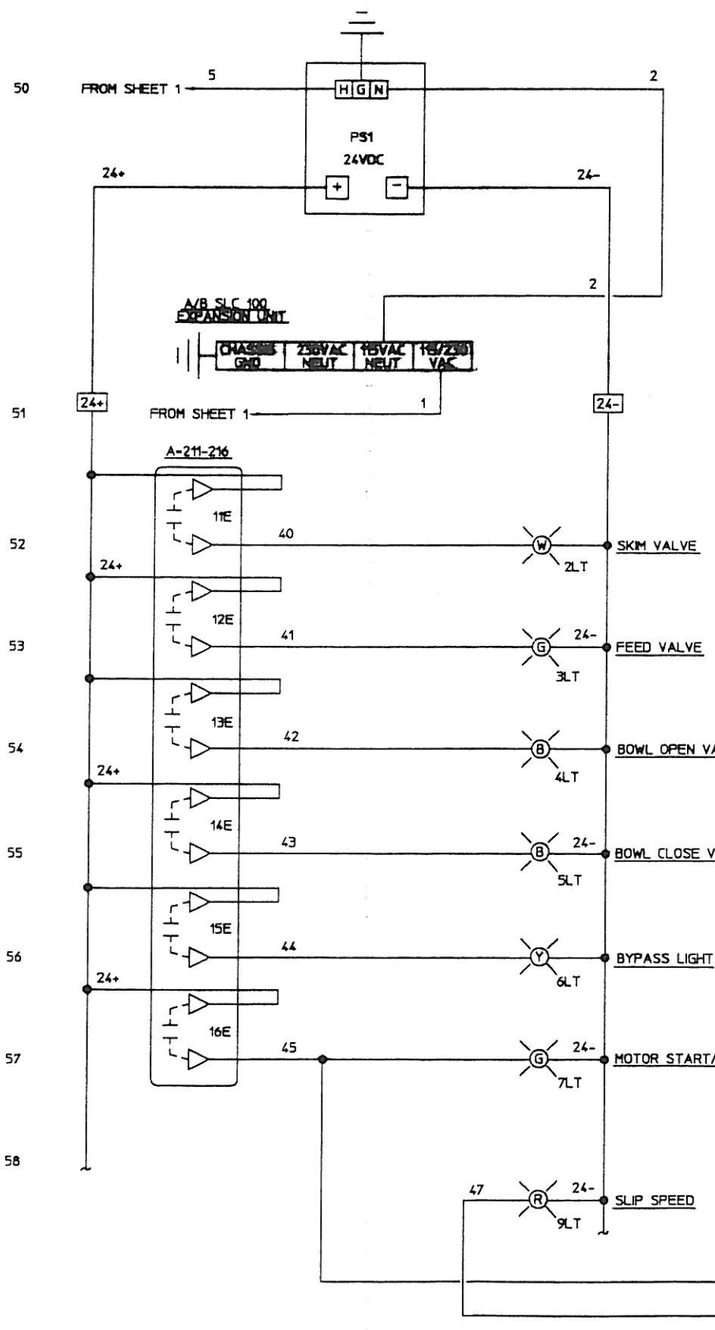
D 9128-5900-114 2

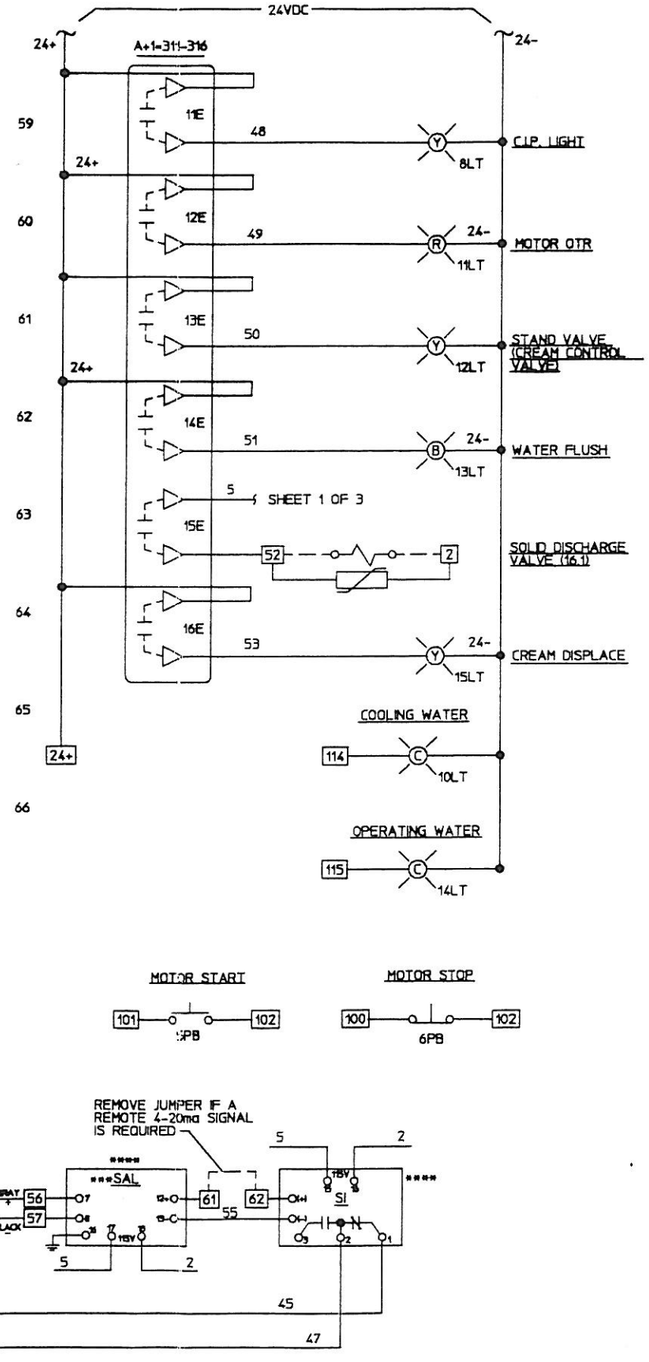
1 of 3

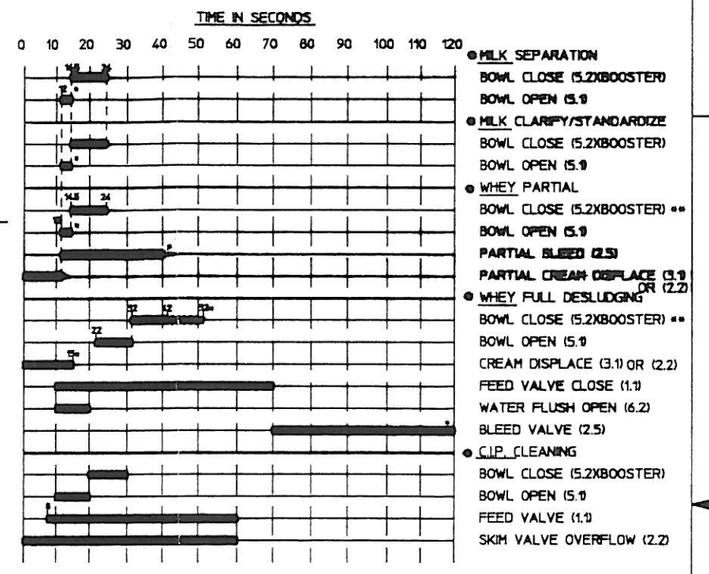
CPO No

REVISIONS				
ZONE	No.	DESCRIPTION	DATE	APPROVED
	2	REVISE TIME IN SECONDS CHART.	09/15/92	

NOTE: ALL LIGHT BULBS MUST BE 28 VOLTS







ALL PROCESS VALVES PULSED DURING C.I.P.

VALVE SEQUENCE DIAGRAM

NON-WATER SAVING MACHINES USE SOFTWARE #04, AND FOR MSD 50/60 (WATER SAVING) MACHINES, USE SOFTWARE #15

* EXTERNALLY ADJUSTABLE VIA TCAT IN 0.1 SEC. INTERVALS-MAXIMUM TIME SHOWN
** NOT USED ON MSD 50/60
*** FOR MSD 300 SET SAL ON 417 HZ
FOR MSD 250 AND DOWN, SET SAL ON 300 HZ
FOR MSA MACHINES SET SAL ON 300 HZ
**** OPTION: SPEED INDICATOR
****** OPTION: HYDRO CYCLONE DISCHARGE VALVE

Drawn	T E F	Date 10/17/90
Checked	-	Date -
Approved	-	Date -
Mod No.		
Previous Order No.		
Prod. Approved		

WESTFALIA SEPARATOR — CENTRICO Incorporated

Title: WIRING DIAGRAM KC-2054/T

Size	F.S.C.M. No.	Dwg. No.	Rev.
D		9128-5900-114	2
Scale ~		Sheet 2 of 3	

REVISIONS				
ZONE	No.	DESCRIPTION	DATE	APPROVED

SI

55
62
BLUE

45 47

5 2

PLUG

TCAT

TURBIDITY

5 — 4SS — 10

A/B SLC 150

CABLE CONNECTION TO TCAT ON PANEL FACE

CHASSIS GND
230VAC NEUT
115VAC NEUT
115/230 VAC
COM
1 2 3 4 5 6 7 8 9 10
101 102 103 104 105 106 107 108 109 110
11 VAC 12 13 14 15 16 111 VAC 112 113 114 115 116

RIBBON CONNECTION

L1	
5	TURBIDITY CONTACT
11	
12	
103	FROM STARTER
104	
105	
20	
21	
2	HYDRO CYCLONE DISCH. VALVE
24	
25	FEED VALVE (LO.)
2	
26	FEED VALVE (HI.)
2	
27	BOWL CLOSE VALVE
2	
28	BOWL OPEN VALVE
2	
29	FILLING VALVE
2	
30	METERING VALVE
2	
31	SKIM VALVE
2	
32	BLEED VALVE
2	
33	CREAM VALVE
2	
34	STANDARDIZE VALVE
2	
35	WATER FLUSH
2	
101	FROM STARTER
102	
100	
102	
52	SOLIDS DISHCHARGE VALVE
2	
56+	PROXIMITY SWITCH
57-	
114	COOLING WATER (24V)
115	OPERATING WATER (24V)
61	4-20ma SPEED IND. SIGNAL
62	
63	HYDRO CYCLONE DISCH. VALVE
110	FAIL TO SHT.
24+	
24-	

NON-WATER SAVING (ADD JUMPER)

A/B SLC 100

L1 1 F C T 1

CHASSIS GND
230VAC NEUT
115VAC NEUT
115/230 VAC
2 1 24+ 40 41 42 43 44 45
A-211-216 11E 12E 13E 14E 15E 16E
A+1-311-316 11E 12E 13E 14E 15E 16E
24+ 48 49 50 51 5 52 53

POWER
4 — (R) — 2
1LT

POWER ON
3 — 2PB — 4

POWER OFF
1 — 1PB — 3

BYPASS
44 — (Y) — 24-
6LT

SKIM
40 — (W) — 24-
2LT

FEED
41 — (G) — 24-
3LT

CREAM RECOMBINE
50 — (Y) — 24-
12LT

FLUSH
51 — (B) — 24-
13LT

CREAM
53 — (Y) — 24-
15LT

BOWL CLOSE
43 — (B) — 24-
5LT

C.I.P.
48 — (Y) — 24-
8LT

MOTOR START/RUN
45 — (G) — 24-
7LT

BOWL OPEN
42 — (B) — 24-
4LT

SLIP SPEED
47 — (R) — 24-
9LT

T.E.
49 — (R) — 24-
11LT

COOLING WATER
114 — (C) — 24-
10LT

OPERATING WATER
115 — (C) — 24-
14LT

MOTOR START
101 — 5PB — 102

MOTOR STOP
100 — 6PB — 102

FLUSH WATER (WHEY)
5 — 5PB — 7

PROGRAM STOP
5 — 4PB — 14

PROGRAM START MANUAL DESLUDGE
5 — 3PB — 13

CLARIFICATION
STANDARDIZATION SEPARATION
5 — 2SS — 8 (0X0) / 9 (0XX)

CIP
MILK WHEY
5 — 3SS — 19 (X00) / 8 (0X0) / 18 (0X0)

1 5
8 7 6 5 4
MCR
9 10 11 1 2 3
23 4 24 4 2 3

56 57 BLUE
6 7 8 9 + - E
SAL
10 11 12 13 14 15 16 17 18
BLUE 61 55 5 2

5 2
24VDC PS1
24+ 24-

TIMING UNIT HAS TO BE ENERGIZED PRIOR TO START UP AND UNTIL BOWL HAS COME TO A COMPLETE STOP

T E F	10/17/90	WESTFALIA SEPARATOR / CENTRICO	
–	–	Title: WIRING DIAGRAM KC-2054/T	
–	–	Size: D	Dwg. No.: 9128-5900-114
		Scale: ~	Rev.: 2
			Sheet: 3 of 3

TABLE 3-1.
BILL OF MATERIAL
WIRING DIAGRAM 9128-5900-114

SEQUENCE	DESCRIPTION	MANUFACTURER	PART NO.	QTY.
.....	Enclosure, Stainless Steel, NEMA 4	Hoffman	A24H2408SS	1
.....	Back Plate, Equipment Mounting	Hoffman	1A-24P24	1
PC	Processor	Allen-Bradley	1745-LP151	1
PC	Expansion Unit, Relay Output	Allen-Bradley	1745-E105	1
TCAT	Terminal, Timer/Counter Access	Allen-Bradley	1745 TCAT	1
TB	Block, Terminal	Buchanan	0521	44
TB	Block, End	Buchanan	0530	1
1FU	Fuse, Time Delay, 4.5 AMP, 250V	Gould	TR-4½R	1
1FU	Block, Fuse, Single Pole, 30A/250V	Marathon	F30A1S	1
2FU	Fuse, 2 AMP	Gould	TR-2R	1
2FU	Block, Fuse, Single Pole	Marathon	F30A1S	1
T1	Transformer	Edwards	599	1
T1/TB	Block, Terminal, 2 point	Marathon	202	1
MCR	Socket, 8 pin	Customer connection	0T08-PC	1
MCR	Relay, Plug-in, 120VAC, 2 pole NC/NO	IMO	60.12U	1
MOV	Suppressor	General Electric	V120LA10	13
GS	Panel, Graphic, Engraved (5.25 x 8.5 in.)	Austin Associates		1
GS	Light, Pilot	Austin Associates		14
2LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
2LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
2LT	T2- Lens, Pilot Cartridge (white)	Sylvania	PCTLLW	1
3LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
3LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
3LT	T2- Lens, Pilot, Cartridge (green)	Sylvania	PCTLLG	1
4LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
4LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
4LT	T2- Lens, Pilot, Cartridge (blue)	Sylvania	PCTLLB	1
5LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
5LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
5LT	T2- Lens, Pilot, Cartridge (blue)	Sylvania	PCTLLB	1
6LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
6LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
6LT	T2- Lens, Pilot, Cartridge (yellow)	Sylvania	PCTLLY	1
7LT	T2- Socket, Pilot Cartridge	Sylvania	SM2A	1
7LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
7LT	T2- Lens, Pilot, Cartridge (green)	Sylvania	PCTLLG	1
8LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
8LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
8LT	T2- Lens, Pilot, Cartridge (yellow)	Sylvania	PCTLLY	1
9LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
9LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
9LT	T2- Lens, Pilot, Cartridge (red)	Sylvania	PCTLLR	1
10LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
10LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
10LT	T2- Lens, Pilot, Cartridge (clear)	Sylvania	PCTLLC	1

SEQUENCE	DESCRIPTION	MANUFACTURER	PART NO.	QTY.
11LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
11LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
11LT	T2- Lens, Pilot, Cartridge (clear)	Sylvania	PCTLLC	1
12LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
12LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
12LT	T2- Lens, Pilot, Cartridge (yellow)	Sylvania	PCTLLY	1
14LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
14LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
14LT	T2- Lens, Pilot, Cartridge (clear)	Sylvania	PCTLLC	1
15LT	T2- Lugs, Turret, Pilot Cartridge Socket	Sylvania	SM2A	1
15LT	T2- Lamp, Pilot Cartridge, 28 volt	Sylvania	28PC	1
15LT	T2- Lens, Pilot, Cartridge (yellow)	Sylvania	PCTLLY	1
1LT	Light, Pilot, 120VAC, Red (transformer type)	Cutler Hammer	E22-H2X11	1
1PB	Push-button, Miniature, Flush-head, Black	Cutler Hammer	E22P1	1
1PB	Block, Contact, N.O.	Cutler Hammer	E22B2	1
2PB	Push-button, Miniature, Flush-head, Red	Cutler Hammer	E22P2	1
2PB	Block, Contact, N.C.	Cutler Hammer	E22B1	1
3PB	Push-button, Miniature, Flush-head, Green	Cutler Hammer	E22P3	1
3PB	Block, Contact, N.O.	Cutler Hammer	E22B2	1
4PB	Push-button, Miniature, Flush-head, Red	Cutler Hammer	E22P2	1
4PB	Block, Contact, N.C.	Cutler Hammer	E22B1	1
5PB	Push-button, Miniature, Flush-head, Black	Cutler Hammer	E22P1	1
5PB	Block, Contact, N.O.	Cutler Hammer	E22B2	1
6PB	Push-button, Miniature, Flush-head, Red	Cutler Hammer	E22P2	1
6PB	Block, Contact, N.C.	Cutler Hammer	E22B1	1
7PB	Push-button, Miniature, Flush-head, Black	Cutler Hammer	E22P1	1
7PB	Block, Contact, N.O.	Cutler Hammer	E22B2	1
2SS	Switch, Selector, Miniatuire, 3 position	Cutler Hammer	E22VH1	1
2SS	Block, Contact, N.O./N.C.	Cutler Hammer	E22B11	1
3SS	Switch, Selector, Miniatuire, 3 position	Cutler Hammer	E22VG1	1
3SS	Knob, Yellow	Cutler Hammer	E22AV4	1
3SS	Block, Contact, N.O./N.C.	Cutler Hammer	E22B11	1
2SS	Block, Contact, N.C.	Cutler Hammer	E22B1	1
SAL	Relay, Slip Speed	Pepperl & Fuchs		1
SI	Indicator, Speed	Schlicher		1
PS1	Supply, Power	GFC Power	CHOF2-24	1

INTRODUCTION.

The Appendix contains information supplementary to the main body of text in this manual. Provided in the appendix are the following:

- **Glossary of Terms and Abbreviations** - An explanation of the abbreviations and a description of the terms or phrases used throughout the text.

- **Symbols** - A listing of symbols and their meanings as used on manual schematics.

- **Conversion Factors** - Reference tables provided to aid the operator in calculating volume, weight, metric conversions etc.

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Bar
A measure of pressure (14.7 lbs./sq. in.)

Bowl:
The internal, rotating section of the separator where the separation of light phase from heavy phase with simultaneous removal of solids takes place.

Check Valve:
Prevents the reversal of flow direction through a line. The pressure of the flowing medium keeps the valve open, with a reversal of flow closing it.

Centripetal Pump:
The pump fixed to the hood of the separator which discharges the light or heavy phase under pressure.

Clarification:
The process used to remove solids from a single liquid.

CMOS RAM
Complimentary Metal Oxide Semiconductor Random Access Memory

CPU
Central Processing Unit

Control Valve:
Used to regulate or throttle the medium.

Displacement Water:
Water used to displace the light phase (cream) in the bowl prior to desludging.

Divert Valve or CIP line:
Employed where the valve is to be normally open or completely closed to permit a straight, full flow, no flow at all or a diverted flow.

EEPROM
Electrically Erasable Programmable Read Only Memory

Flush Water:
Water introduced into the bowl to clean the disc set and displace the light phase prior to a de-sludging.

GPM
Gallons Per Minute

I/O
Input/Output

KG/CM^2
Kilograms per Centimeter Squared

Lb.
Pound

LED:
Light Emitting Diode

LPM
Liters Per Minute

mm:
Millimeter

N.C.
Normally Closed

N.O.
Normally Open

Operating Water:
The water used to hydraulically operate the sliding piston for opening and sealing the bowl.

$\triangle$ P:
Delta pressure (differential pressure).

PSI
Pound-force per Square Inch (lb_f/in^2)

PSIG
Pound-force per Square Inch Gauge

RAM
Random Access Memory

S.S.:
Stainless Steel

Sealing Lip:
The raised area of the sliding piston which seals against the gasket and bowl top to prevent solids or medium from escaping from the bowl.

Separating Zone:
The region between the light and heavy phase when being separated.

Shoot (Desludging):
The action of the bowl opening and ejecting the solids during the desludging cycle.

Sliding Piston:
Situated in the bowl bottom, it rotates at the same angular velocity as the other bowl parts but can be moved axially. It moves downwards and opens the discharge ports in the bowl bottom during desludging.

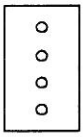
Solids:
The solids collected in the bowl and removed via the discharge ports during the desludging cycle.

Solids Tank:
The tank into which the separator solids are discharged.

TCAT:
Timer/Counter Access Terminal

AMMETER:

ANNUNCIATOR:

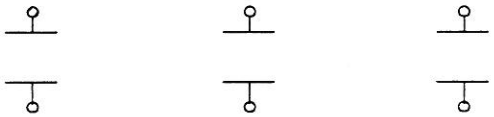


CONDUCTOR, ASSOCIATED OR FUTURE:

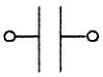
CONDUCTORS; NOT CONNECTED:

CONDUCTOR, JUNCTION OF CONNECTED PATHS:

CONTACTOR:



NORMALLY OPEN CONTACT:

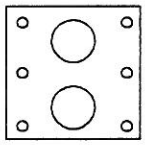


NORMALLY CLOSED CONTACT:

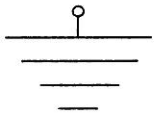
NORMALLY CLOSED CONTACT WITH TIME DELAY OPENING:

FUSE:

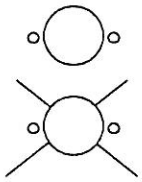
GFCI (GROUND FAULT CIRCUIT INTERRUPTER):



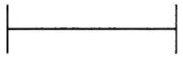
GROUND:



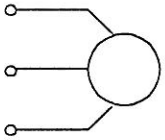
COIL OPERATING INDICATING LIGHT:



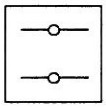
FLUORESCENT LIGHT:



MOTOR:

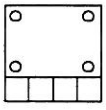


OUTLET:



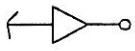
OVERLOAD, THERMAL ELEMENT ACTUATING DEVICE:

OVERTEMPERATURE RELAY FOR MOTOR (OTR):

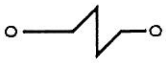


P.C. INPUT:

P.C. OUTPUT:

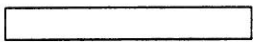


SOLENOID:



LIMIT SWITCH, NORMALLY CLOSED (N.C.):

SPACE HEATER:



FLOAT SWITCH, CLOSING ON RISING LEVEL:

FLOAT SWITCH, OPENING ON RISING LEVEL:

PRESSURE SWITCH, CLOSING ON RISING PRESSURE:

PRESSURE SWITCH, OPENING ON RISING PRESSURE:

FLOW SWITCH, CLOSING ON INCREASING IN-FLOW:

FLOW SWITCH, OPENING ON INCREASING IN-FLOW:

TEMPERATURE SWITCH (THERMOSTAT) CLOSING ON RISING TEMPERATURE

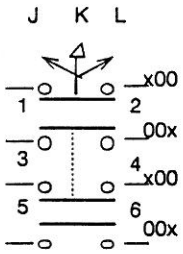
TEMPERATURE SWITCH (THERMOSTAT) OPENING ON RISING TEMPERATURE:

PUSH-BUTTON SWITCH, NORMALLY OPEN:

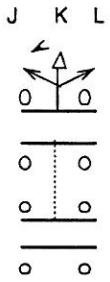
PUSH-BUTTON SWITCH, NORMALLY CLOSED:

PUSH-BUTTON SWITCH, NORMALLY CLOSED MUSHROOM HEAD:

SELECTOR SWITCH, ROTATED IN ONE OR MORE POSITIONS:

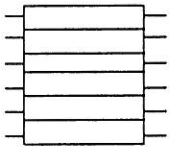


SELECTOR SWITCH, WITH SPRING RETURN:

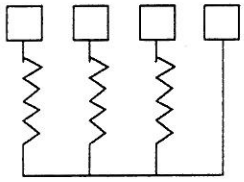


TERMINAL:

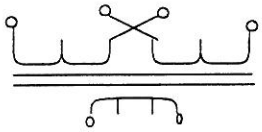
TERMINAL BOARD:



THERMISTERS IN MOTOR:



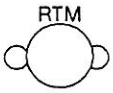
CONTROL TRANSFORMER, SINGLE PHASE:



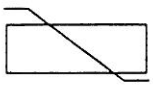
CURRENT TRANSFORMER:

REMOTE:

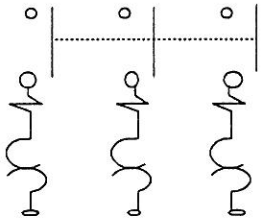
RUNNING TIME METER:



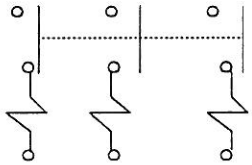
VARISTOR OR RC SUPPRESSOR:



CIRCUIT BREAKER, 3 POLE WITH THERMAL AND MAGNETIC TRIP CIRCUIT:



CIRCUIT BREAKER, 3 POLE WITH MAGNETIC TRIP CIRCUIT:



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Multiply	By	To Obtain
Atmospheres	76.0	Cms. of mercury
Atmospheres	29.92	Inches of mercury
Atmospheres	33.90	Feet of water
Atmospheres	1.0333	Kgs./sq. cm.
Atmospheres	14.70	Lbs. sq./ inch.
Atmospheres	1.058	Tons/sq. ft.
Barrels----Oil	42	Gallons-Oil
British Thermal Units	.02520	Kilogram-calories
British Thermal Units	777.5	Foot-lbs.
British Thermal Units	3.927×10^{-4}	Horse-power-hrs.
British Thermal Units	107.5	Kilogram-meters
British Thermal Units	2.98×10^{-4}	Kilowatt-hrs.
B.T.U./min.	12.96	Foot-lbs./sec.
B.T.U./min.	0.02356	Horse-power
B.T.U./min.	0.01757	Kilowatts
B.T.U./min.	17.57	Watts
Centares (Centiares)	1	Square meters
Centigrams	0.01	Grams
Centiliters	0.01	Liters
Centimeters	0.3937	Inches
Centimeter	0.01	Meters
Centimeter	10	Millimeters
Centimeters of Mercury	0.01316	Atmospheres
Centimeters of mercury	0.4461	Feet of water
Centimeters of mercury	136.0	Kgs./sq. in.
Centimeters of mercury	27.85	Lbs./sq. ft.
Centimeters of mercury	0.1934	Lbs. /sq. inch
Centimeters/second	1.969	Feet/min.
Centimeters /second	0.03281	Feet/sec.
Centimeters/second	0.036	Kilometer/hr.
Centimeters/second	0.6	Meters/min.
Centimeters/second	0.02237	Miles/hr.
Centimeters/second	3.278×10^{-4}	Miles/min.
Cms./sec./sec.	0.03281	Feet/sec.
Cubic centimeters	3.531×10^{-5}	Cubic feet
Cubic centimeters	6.102×10^{-2}	Cubic inches
Cubic centimeters	10^{-6}	Cubic meters
Cubic centimeters	1.308×10^{-4}	Cubic yards
Cubic centimeters	2.642×10^{-4}	Gallons
Cubic centimeters	10^{-3}	Liters
Cubic centimeters	2.113×10^{-3}	Pints (liq.)
Cubic centimeters	1.057×10^{-3}	Quarts (liq.)

Multiply	By	To Obtain
Cubic feet	2.832×10^{4}	Cubic cms.
Cubic feet	1728	Cubic inches
Cubic feet	0.02832	Cubic meters
Cubic feet	0.03704	Cubic yards
Cubic feet	7.48052	Gallons
Cubic feet	28.32	Liters
Cubic feet	59.84	Pints (liq.)
Cubic feet	29.92	Quarts (liq.)
Cubic feet minute	472.0	Cubic cms./sec.
Cubic feet minute	0.1247	Gallons/sec.
Cubic feet minute	0.4720	Liters/sec.
Cubic feet minute	62.43	Lbs. of water/min.
Cubic feet/second	0.646317	Million gals./day
Cubic feet/second	448.831	Gallons/min.
Cubic inches	16.39	Cubic centimeters
Cubic inches	5.787×10^{-4}	Cubic feet
Cubic inches	1.639×10^{-5}	Cubic meters
Cubic inches	2.143×10^{-5}	Cubic yards
Cubic inches	4.329×10^{-3}	Gallons
Cubic inches	1.639×10^{-2}	Liters
Cubic inches	0.03463	Pints (liq.)
Cubic inches	0.01732	Quarts (liq.)
Cubic meters	10^{6}	Cubic centimeters
Cubic meters	35.31	Cubic feet
Cubic meters	61,023	Cubic inches
Cubic meters	1.308	Cubic yards
Cubic meters	264.2	Gallons
Cubic meters	10^{3}	Liters
Cubic meters	2113	Pints(liq.)
Cubic meters	1057	Quarts (liq.)
Cubic yards	7.646×10^{5}	Cubic centimeters
Cubic yards	27	Cubic feet
Cubic yards	46,656	Cubic inches
Cubic yards	0.7646	Cubic meters
Cubic yards	202.0	Gallons
Cubic yards	764.6	Liters
Cubic yards	1616	Pints (liq.)
Cubic yards	807.9	Quart (liq.)
Cubic yards/min.	0.45	Cubic feet/sec.
Cubic yards/min.	3.367	Gallons/sec.
Cubic yards/min	12.74	Liters/sec.
Decigrams	0.1	Grams
Deciliters	0.1	Liters
Decimeters	0.1	Meters
Degrees (angle)	60	Minutes
Degrees (angle)	0.01745	Radians
Degrees (angle)	3600	Seconds

Multiply	By	To Obtain
Degrees/sec.	0.01745	Radians/sec.
Degrees/sec.	0.1667	Revolutions/min.
Degrees/sec.	0.002778	Revolutions/se
Dekagrams	10	Grams
Dekaliters	10	Liters
Dekameters	10	Meters
Drams	27.34375	Grains
Drams	0.0625	Ounces
Drams	1.771845	Grams
Fathoms	6	Feet
Feet	30.48	Centimeters
Feet	12	Inches
Feet	0.3048	Meters
Feet	1/3	Yards
Feet of water	0.02950	Atmospheres
Feet of water	0.8826	Inches of mercury
Feet of water	0.03048	Kgs./sq. cm.
Feet of water	62.43	lbs. sq. ft.
Feet of water	0.4335	Lbs./sq. inch
Feet/min.	0.5080	Centimeters/sec.
Feet/min.	0.01667	Feet/sec.
Feet/min.	0.01829	Kilometers/hr.
Feet/min.	0.3048	Meters/min.
Feet/min.	0.01136	Miles/hr.
Feet/sec./sec.	30.48	Cms./sec./sec.
Feet/sec.sec.	0.3048	Meters/sec./sec.
Foot-pounds	1.286×10^{-3}	British Thermal Units
Foot-pounds	5.050×10^{-7}	Horse-power-hrs.
Foot-pounds	3.241×10^{-4}	Kilogram-calories
Foot-pounds	0.1383	Kilogram-meters
Foot-pounds	3.766×10^{-7}	Kilowatt-hrs.
Foot pounds/min.	1.286×10^{-3}	B.T Units/min.
Foot-pounds/min.	0.01667	Foot-pounds/sec.
Foot-pounds/min.	3.030×10^{-5}	Horse-power
Foot-pounds/min.	3.241×10^{-4}	Kg.-calories/min.
Foot-pounds/min.	2.260×10^{-5}	Kilowatts
Foot-pounds/sec.	7.717×10^{-2}	B.T. Units/min.
Foot-pounds/sec.	1.818×10^{-3}	Horse-power
Foot-pounds/sec.	1.945×10^{-2}	Kg.-calories/min.
Foot-pounds/sec.	1.356×10^{-3}	Kilowatts
Gallons	3785	Cubic centimeters
Gallons	0.1337	Cubic feet
Gallons	231	Cubic inches
Gallons	3.785×10^{-3}	Cubic meters
Gallons	4.95×10^{-3}	Cubic yards
Gallons	3.785	Liters
Gallons	8	Pints (liq.)
Gallons	4	Quarts (liq.)
Gallons, Imperial	1.20095	U.S. Gallons
Gallons U.S.	0.83267	Imperial gallons
Gallons, Milk	8.6	Pounds, Milk
Gallons water	8.3453	Pounds of water
Gallons/.min.	2.228×10^{-3}	Cubic feet/sec.
Gallons/min.	0.06308	Liters/sec.
Gallons/min.	8.0208	Cu. ft./hr.
Gallons water/min.	6.0086	Tons water/24 hrs.
Grains (troy)	1	Grains (avoir.)
Grains (troy)	0.06480	Grams
Grains (troy)	0.04167	Pennyweights (troy)
Grains (troy)	2.0833×10^{-3}	Ounces (troy)
Grains/U.S. gal.	17.118	Parts/million
Grains/U.S. gal.	142.86	Lbs/million gal.
Grains/imp. gal.	14.286	Parts/million
Grams	980.7	Dynes
Grams	15.43	Grains
Grams	10^{-3}	Kilograms
Grams	10^{3}	Milligrams
Grams	0.03527	Ounces
Grams	0.03215	Ounces (troy)
Grams	2.205×10^{3}	Pounds
Grams/cm.	5.600×10^{-3}	Pounds/inch
Grams/cu. cm.	62.43	Pounds/cubic foot
Grams/cu. cm.	0.03613	Pounds/cubic inch
Grams/liter	58.417	Grains/gal.
Grams/liter	8.345	Pounds/1000 gals.
Grams/liter	0.062427	Pounds/cubic foot
Grams/liter	1000	Parts/million
Hectograms	100	Grams
Hectoliters	100	Liters
Hectometers	100	Meters
Hectowatts	100	Watts
Horse-power	42.44	B.T. Units/min.
Horse-power	33,000	Foot-lbs./min.
Horse-power	550	Foot-lbs./sec.
Horse-power	1.014	Horse-power (Metric)
Horse-power	10.70	Kg.-calories/min.
Horse-power	0.7457	Kilowatts
Horse-power	745.7	Watts

Multiply	By	To Obtain
Horse-power (boiler)	33,479	B.T.U./hr.
Horse-power (boiler)	9.803	Kilowatts
Horse-power-hours	2547	British Thermal Units
Horse-power-hours	1.98×10^4	Foot-lbs.
Horse-power-hours	641.7	Kilograms-calories
Horse-power-hours	2.737×10^5	Kilogram-meters
Horse-power-hours	0.7457	Kilowatt-hours
Inches	2.540	Centimeters
Inches of mercury	0.03342	Atmospheres
Inches of mercury	1.133	Feet of water
Inches of mercury	0.03453	Kgs./sq. cm.
Inches of mercury	70.73	Lbs./sq. ft.
Inches of mercury	0.4912	Lbs./sq. inch
Inches of water	0.002458	Atmospheres
Inches of water	0.07355	Inches of mercury
Inches of water	0.002540	Kgs./sq. cm.
Inches of water	0.5781	Ounces/sq. inch
Inches of water	5.202	Lbs./sq. foot
Inches of water	0.03613	Lbs./sq. inch
Kilograms	980,665	Dynes
Kilograms	2.205	Lbs.
Kilograms	1.102×10^{-3}	Tons (short)
Kilograms	10^3	Grams
Kgs./meter	06720	Lbs./foot
Kgs./sq. cm.	0.9678	Atmospheres
Kgs./sq. cm.	32.81	Feet of water
Kgs./sq. cm.	28.96	Inches of mercury
Kgs./sq. cm.	2048	Lbs./sq. foot
Kgs./sq. cm.	14.22	Lbs./sq. inch
Kgs./sq. millimeter	10^6	Kgs./sq. meter
Kiloliters	10^3	Liters
Kilometers	10^5	Centimeters
Kilometers	3281	Feet
Kilometers	10^3	Meters
Kilometers	0.6214	Miles
Kilometers	1094	Yards
Kilometers/hr.	27.78	Centimeters/sec.
Kilometers/hr.	54.68	Feet/min.
Kilometers/hr.	0.5396	Knots
Kilometers/hr.	0.9113	Feet/sec.
Kilometers/hr.	16.67	Meters./min.
Kilometers/hr.	0.6214	Miles/.hr.
Kms./hr. sec.	27.78	Cms./sec./sec.
Kms./hr./sec.	0.9113	Ft./sec./sec.
Kms./hr./sec.	0.2778	Meters/sec./sec.

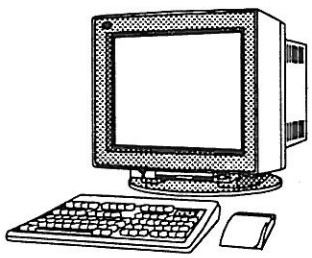
Multiply	By	To Obtain
Kilowatts	56.92	B.T. Units/min.
Kilowatts	4.425×10^4	Ft.-lbs./min.
Kilowatts	737.6	Ft.-lbs/sec.
Kilowatts	1.341	Horse-power
Kilowatts	14.34	Kg..-calories/min.
Kilowatts	10^3	Watts
Kilowatts-hours	3415	British Thermal Units
Kilowatt-hours	2.655×10^6	Foot-lbs.
Kilowatt-hours	1.341	Horse-power-hrs.
Kilowatt-hours	860.5	Kilogram-calories
Kilowatt-hours	3.671×10^5	Kilogram-meters
Liters	10^3	Cubic centimeters
Liters	0.03531	Cubic feet
Liters	61.02	Cubic inches
Liters	10^{-3}	Cubic meters
Liters	1.308×10^{-3}	Cubic yards
Liters	0.2642	Gallons
Liters	2.113	Pint (liq.)
Liters	1.057	Quarts (liq.)
Liters/min.	5.886×10^{-4}	Cubic ft./sec.
Liters/min.	4.403×10^{-3}	Gals./sec.
Lumber Width (in.) x $\frac{\text{Thickness (in.)}}{12}$	Length (ft.)	Board feet
Meters	100	Centimeters
Meters	3.281	Feet
Meters	39.37	Inches
Meters	10^{-3}	Kilometers
Meters	10^3	Millimeters
Meters	1.094	Yards
Meters/min.	1.667	Centimeters/sec.
Meters/min.	3.281	Feet/min.
Meters/min.	0.05468	Feet/sec.
Meters/min.	0.06	Kilometers/hr.
Meters/min.	0.03728	Miles/hr.
Meters/sec.	196.8	Feet/min.
Meters/sec.	3.281	Feet/sec.
Meters/sec.	3.6	Kilometer/hr.
Meters/sec.	0.06	Kilometers/min.
Meters/sec	2.237	Miles/hr.
Meters/sec.	0.03728	Miles/min.
Microns	10^{-6}	Meter
Miles	1.609×10^5	Centimeters
Miles	5280	Feet
Miles	1.609	Kilometers
Miles	1760	Yards

Multiply	By	To Obtain
Miles/min	2682	Centimeters/sec.
Miles/min.	88	Feet/sec.
Miles/min.	1.609	Kilometers/min.
Miles/min.	60	Miles/hr.
Milliers	10^3	Kilograms
Milligrams	10^{-3}	Grams
Milliliters	10^{-3}	Liters
Millimeters	0.1	Centimeters
Millimeters	0.03937	Inches
Milligrams/liter	1	Parts/million
Million gals./day	1.54723	Cubic ft./sec.
Miner's inches	1.5	Cubic ft./min.
Minutes (angle)	2.909×10^{-4}	Radians
Ounces	16	Drams
Ounces	437.5	Grains
Ounces	0.0625	Pounds
Ounces	28.349527	Grams
Ounces	0.9115	Ounces (troy)
Ounces	2.790×10^{-5}	Tons (long)
Ounces	2.835×10^{-5}	Tons (metric)
Ounces, troy	480	Grains
Ounces, troy	20	Pennyweights (troy)
Ounces, troy	0.08333	Pounds (troy)
Ounces, troy	31,103481	Grams
Ounces, troy	1.09714	Ounces (avoir.)
Ounces (fluid)	1.805	Cubic inches
Ounces (fluid)	0.02957	Liters
Ounces/sq. inch	0.0625	Lbs./sq. inch
Parts/million	0.0584	Grains/U.S. gal.
Parts/million	0.07016	Grains/Imp. gal.
Parts/million	8.345	Lbs./million gal
Pennyweights (troy)	24	Grains
Pennyweights (troy)	1.55517	Grams
Pennyweights (troy)	0.05	Ounces (troy)
Pennyweights (troy)	4.1667×10^{-3}	Pounds (troy)
Pounds	16	Ounces
Pounds	256	Drams
Pounds	7000	Grains'
Pounds	0.0005	Tons (short)
Pounds	453.5924	Grams
Pounds	1.21528	Pounds (troy)
Pounds	14.5833	Ounces (troy)

Multiply	By	To Obtain
Pounds (troy)	5760	Grains
Pounds (troy)	240	Pennyweights (troy)
Pounds (troy)	12	Ounces (troy)
Pounds (troy)	373.24177	Grams
Pounds (troy)	0.822857	Pounds (avoir.)
Pounds (troy)	13.1657	Ounces (avoir.)
Pounds (troy)	3.6735×10^{-4}	Tons (long)
Pounds (troy)	4.1143×10^{-4}	Tons (short)
Pounds (troy)	3.7324×10^{-4}	Tons (metric)
Pounds of water	0.01602	Cubic feet
Pounds of water	27.68	Cubic inches
Pounds of water	0.1198	Gallons
Pounds of milk	.1163	Gallons
Pounds of water/min.	2.670×10^{-4}	Cubic ft./sec.
Pounds/cubic foot	0.01602	Grams/cubic cm.
Pounds/cubic foot	16.02	Kgs./cubic meter
Pounds/cubic foot	5.787×10^{-4}	Lbs./cubic inch
Pounds/cubic inch	27.68	Grams/cubic cm.
Pounds/cubic inch	$2{,}768 \times 10^4$	Kgs./cubic meter
Pounds/cubic inch	1728	Lbs./cubic foot
Pounds/foot	1.488	Kgs./meter
Pounds/inch	178.6	Grams/cm.
Pounds/sq. ft.	0.01602	Feet of water
Pounds/sq. ft.	4.883×10^{-4}	Kg./sq. cm.
Pounds/sq. ft.	6.945×10^{-3}	Pounds/sq. inch
Pounds/sq. inch	0.06804	Atmospheres
Pounds/sq. inch	2.307	Feet of water
Pounds/sq. inch	2.036	Inches of mercury
Pounds/sq. inch	0.07031	Kgs./sq. cm
Quarts (dry)	67.20	Cubic inches
Quarts (liq.)	57.75	Cubic inches
Quintal/Argentine	101.28	Pounds
Quintal, Brazil	129.54	Pounds
Quintal, Castle, Peru	101.43	Pounds
Quintal, Chile	101.41	Pounds
Quintal, Mexico	101.47	Pounds
Quintal, Metric	220.46	Pounds
$\frac{1}{\text{Sq. ft./gal./min.}}$	8.0208	Overflow rate (ft./hr.)
Temp. (°C.) + 273	1	Abs. temp. (°C.)
Temp. (°C.) + 17.78	1.8	Temp. (°F.)
Temp. (°F.) + 460	1	Abs. temp. (°F.)
Temp. (°F.)-32	5/9	Temp. (°C.)
Tons (long)	1016	Kilograms
Tons (long)	2240	Pounds
Tons (long)	1.12000	Tons (short)

Multiply	By	To Obtain
Tons (metric)	10^3	Kilograms
Tons (metric)	2205	Pounds
Tons (short)	2000	Pounds
Tons (short)	32000	Ounces
Tons (short)	907.18486	Kilograms
Tons (short)	2430.56	Pounds (troy)
Tons (short)	0.89287	Tons (long)
Tons (short)	29166.66	Ounces (troy)
Tons (short)	0.90718	Tons (metric)
Tons of water/24 hrs.	83.333	Pounds water/hr.
Tons of water/24 hrs.	0.16643	Gallons/min.
Tons of water/24 hr.	1.3349	Cu. ft./hr.
Watts	0.05692	B.T. Units/min.
Watts	44.26	Foot-pounds/min.
Watts	0.7376	Foot-pounds/sec.
Watts	1.341×10^{-3}	Horse-power
Watts	0.01434	Kg.-calories/min.
Watts	10^{-3}	Kilowatts
Watt-hours	3.415	British Thermal Units
Watt-hours	2655	Foot-pounds
Watt-hours	1.341×10^{-3}	Horse-power--hours
Watt-hours	0.805	Kilogram-calories
Watt-hours	367.1	Kilogram-meters
Watt-hours	10^{-3}	Kilowatt-hours

Centrico's policy is one of continuous improvement; therefore all information contained in this manual is subject to change without notice and without incurring obligation.



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All components and parts may be obtained through Centrico at the following address. Please reference the item part number and the project identification information found in the front matter of this manual. Copies of this technical manual are also available, at a nominal charge.

Centrico, Inc.
100 Fairway Court
Northvale, New Jersey 07647

- **Telephone: (201) 767-3900**
- **Main Office Fax: (201) 767-3416**
- **Parts Sales Dept. Fax: (201) 784-4409**

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