D-M-E

3-STAGE CLOSED-LOOP
MULTI-PARAMETER PROCESS CONTROL
DME-4000

OPERATING MANUAL

IMPORTANT

This manual is valid for units with Serial #B0150 and higher. These units have full control of SCREWBACK and DECOMPRESS in both MONITOR and CONTROL positions. Units with lower serial numbers CANNOT control these settings during the MONITOR position.

To bring the older units up to this performance level requires a slight internal modification. If you feel you need this feature, please notify your D-M-E Technical Service Representative or contact:

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SECTION 1

GENERAL DESCRIPTION

THREE-STAGE MULTI-PARAMETER PROCESS CONTROL FOR PLASTICS INJECTION MOLDING

Molding machines today are usually designed to have two separately controlled hydraulic injection stages. The First-Stage Injection, sometimes called "booster," is used to fill and pack the mold, while the Second-Stage Injection, often called "holding" pressure, maintains cavity pressure until the gates freeze. The fact that the fill rate and pack rate of plastics in the mold are tied together can be a serious disadvantage when trying to achieve specific molded part properties. It is common to find that many molded parts require different fill and pack rates to achieve optimum part properties. A molded part, for example, might require a slow fill with a fast pack, or a fast fill with a slow pack or any combination of fill and pack rates to obtain the desired properties.

Internal molded part stress, warp, flash and short shots can often be traced to incorrect fill and/or pack rates. Therefore, it is desirable to separate these two injection phases so that the molder can adjust the molding conditions to avoid a specific problem or gain particular molded part properties that he needs. Separating the mold fill and pack steps by adding a Third-Stage Hydraulic Injection Pressure to a molding machine allows this capability.

The Model DME-4000 3-Stage Multi-Parameter Process Controller converts the standard two-stage injection molding machine into a controlled three-stage injection molding machine.

This system usually eliminates the need for any kind of electronically or mechanically programmed injection control. Since the hydraulic changes required to add a third stage are simple, it accomplishes the goal of programmed injection control without the problems encountered with installation and maintenance of electro-hydraulic servo valves and at about one third the cost. This Closed-Loop Control System automatically compensates for resin or process variations. It gives the molder automatic compensation <u>and</u> increased processing capabilities for better machine performance.

The three-stage molding machine is not new. More then thirty years ago some molding machine builders recognized that a separation of fill and pack phases was desirable. However, in practice, the molder with three injection stages could never keep the fill and pack controls adjusted properly because small changes in plastics viscosity or machine conditions would change the flow rate. Therefore, fill and pack rates would require continual readjustment.

For control purposes it is important that First-Stage Injection, which controls fill rate, end as soon as the cavities are filled, otherwise this rate of fill becomes the rate of packing. The control system separating the two hydraulic injection phases is important. When this was done manually without a control, the adjustments needed were so frequent that the advantages of three-stage control were lost. The result was that the whole idea of three-stage injection was dropped and nearly forgotten.

The advent of mold pressure and screw stroke position sensing, however, has made possible the reintroduction of this type of control using self-compensating (closed-loop) electronic controllers. The result is that easily installed Three-Stage Control Systems can now be used to program the injection phases without sophisticated and expensive electro-hydraulic servo systems.

HOW DOES THREE-STAGE CLOSED-LOOP CONTROL WORK?

The Three-Stage Closed-Loop Program Injection System separates the fill, pack and hold phases of molding. Each phase is automatically controlled by the control system. The filling phase of the molding cycle should be set independently of the other phases because fill rate affects molecular orientation, venting requirements and surface appearance. The mold filling conditions may be entirely different from the required pack conditions. Likewise, the best pack may be high or low, but in any case, it should be adjustable by the molder. And finally, the holding pressure determines final weight, dimensions and affects warp. It should have its own pressure control setting.

The separation of the three injection phases enables set-up personnel and foreman to correct specific molded part problems by independent adjustments of fill, pack and hold pressures, ram positions and rates. If a change in the aforementioned controls is required, the specific control can be adjusted without affecting the other phases.

FIRST-STAGE --- FILL PHASE

Figure #1 shows the Hydraulic Injection Pressure and Cavity Pressure profiles during one cycle using the Three-Stage Hydraulic Program Injection Control System. During the filling phase of the cycle (Area 1) plastics flows into and fills the cavities. The filling portion of the cycle can normally be accomplished very rapidly; the limiting factor being burning of material or excess induced stress in parts. Filling is done by using the high pressure and high volume First-Stage Injection Pump. The DME-4000 Control System allows the molding machine to be automatically shifted from the fill phase to the pack phase at the instant the cavities are full, regardless of when filling occurs. This is accomplished by measuring plastics pressure in a cavity or runner using a mold pressure transducer, or by measuring ram position with a screw travel potentiometer connected to the injection cylinder or screw.

SECOND-STAGE --- PACK PHASE

The pack phase of the cycle (Area 2) begins when the cavity is full of plastics but not packed. This phase is continued using any injection pressure from 0 to 2000 psi, but at the lower volume provided by the Second-Stage Hydraulic Injection Pump. This lower volume allows the injection ram or screw to slow down, thereby controlling the packing of the cavity without rapid dynamic pressure build-up, which induces molded part stress and causes parting line flash. If this Second-Stage Injection Pressure is increased, the pack phase will be completed sooner. Figure #4 shows an example where a low First-Stage Injection Pressure allows a slow fill and then a higher Second-Stage Pressure causes a faster pack rate.

Figure #3 shows the pressure conditions required for parts where flash is a problem. Here a fast fill is combined with a slow pack to avoid high pressure surges in the cavity. Hydraulic pressure adjustments, with appropriate Fill and Pack setpoints, cause the desired plastics flow and pack rates.

Using this Three-Stage Control System, the plastics is "packed" in the cavities using Second-Stage Hydraulic Pressure until the Pack setpoint causes the control system to shift hydraulic pressure from its Second-Hydraulic Stage to a Third-Stage Hydraulic Holding Pressure.

THIRD-STAGE --- HOLDING PHASE

The Third-Stage Hydraulic Injection Pressure operates using a low volume pump. The holding pressure (Figure #1, Area 3) is used to maintain pressure on the plastics until the gates freeze. It is raised or lowered to control molded part weight and dimensions. It is also used to relieve any excess stress of the gate area by allowing a "controlled" discharge of plastics. This is a very useful control technique for eliminating warp in thin-walled parts. However, it is only possible with closed-loop control. This is shown in Figure #6, "Programmed Discharge".

Warp at or near gate areas is caused by high plastics pressure resulting in an excess of plastic molecules near the gate. This appears as a "doming" of the plastics part in three-plate or hot runner molds, or as a gate distortion in parts from a two-plate mold. In either case, the problem is that so much pressure is required to fill out the part that excess pressure is needed to provide the desired part properties, resulting in high stress in the gate area. The solution is to fill and pack the part as required, and then allow discharge of some material out of the cavity. This relieves the stress in the gate area.

However, since plastics viscosity and cooling rate varies slightly, the exact instant to allow discharge can only be controlled by cavity pressure sensing. The amount of discharge can be controlled by raising or lowering Third-Stage Pressure, as shown in Figure #6.

ABORT

Abort allows for programmable termination of the injection pressure until the end of the injection forward portion of the cycle. During the set-up procedure the Abort function allows the user to stop injection at the end of fill or pack. This allows the user to precisely set the degree of filling or packing. It also allows for interrogation of mold balance. While running parts, the Abort setpoint is set to some number greater than the peak mold pressure or stroke. This provides protection against overpacking the cavities and possibly damaging the mold. Along with terminating the injection pressure, the Abort feature may alert the operator of undesirable conditions. It could also be used to automatically sort parts, since it indicates if a part is either overpacked or a short shot.

APPLICATIONS

Applications for this control system are wide ranging. Inconsistent production cycles with varying dimensions, flash, sink, etc., are well suited to this control system. Thin-walled parts with relatively long flow paths are particularly suited to this control method. The restricted flow means that filling must happen quickly or else freeze-off and a short shot will occur. However, the high injection pressure required to fill this type of part means that overpacking or flash is likely to occur. Separately controlled fill and pack phases eliminate this problem. In addition, the ability to allow controlled discharge by adjusting Third-Stage Hydraulic Pressure after packing is complete, adds a whole new dimension to controlling warp in thin-walled parts. Since the trends in plastics part design is towards thin-walls, Three-Stage Closed-Loop Control is an important development.

Another important application is for molded parts requiring close dimensional control. The precise plastics mold pressure control built into this system means that part dimensions can be adjusted up or down by several thousands of an inch to achieve desired part dimensions. Dimensions can then be consistently held to better than ±.001"/" using Closed-Loop Control.

For those machines having marginal clamp capacity for a particular mold, Three-Stage Closed-Loop Control means that automatic control of fill and pack rates and pressure eliminates "overpressure" which causes flash, thereby saving molded parts as well as preventing mold damage.

MULTI-PARAMETER CONTROL

Another important feature of the DME-4000 Multi-Parameter Controller is the ability to use different inputs for the Fill and Pack setpoints. Screw position, in addition to mold pressure or hydraulic injection pressure, can be used to control the process. In Figure #1 the Fill setpoint is determined by screw position (stroke), while the Pack setpoint is controlled by mold pressure. These are switch selectable so the molder can: fill on stroke and pack on mold pressure (Figure #7); fill on mold pressure, pack on stroke (Figure #8); or any combination of inputs. If a mold pressure sensor is not in the mold, the DME-4000 can still provide good process control by filling and packing on the basis of stroke, or using hydraulic pressure in combination with stroke. This allows a molder to have process control for every mold in the shop. While mold pressure control is usually the best method available, the other alternatives are much better than the previous two-stage open-loop molding machine controls.

The examples that follow show some of the the many combinations of sensor inputs that can be used with the DME-4000. Figure #9 shows an application of filling on stroke and packing on pressure.

The addition of a digital measurement of screw position also allows set-up of the injection end of the machine to be "by the numbers" as opposed to mechanical limit switches. Whereas screw forward, screwback and decompress were previously set by trial-and-error with limit switches, these adjustments can now be set precisely from numbers on a set-up sheet.

FIGURE #1

THREE-STAGE PROCESS CONTROL

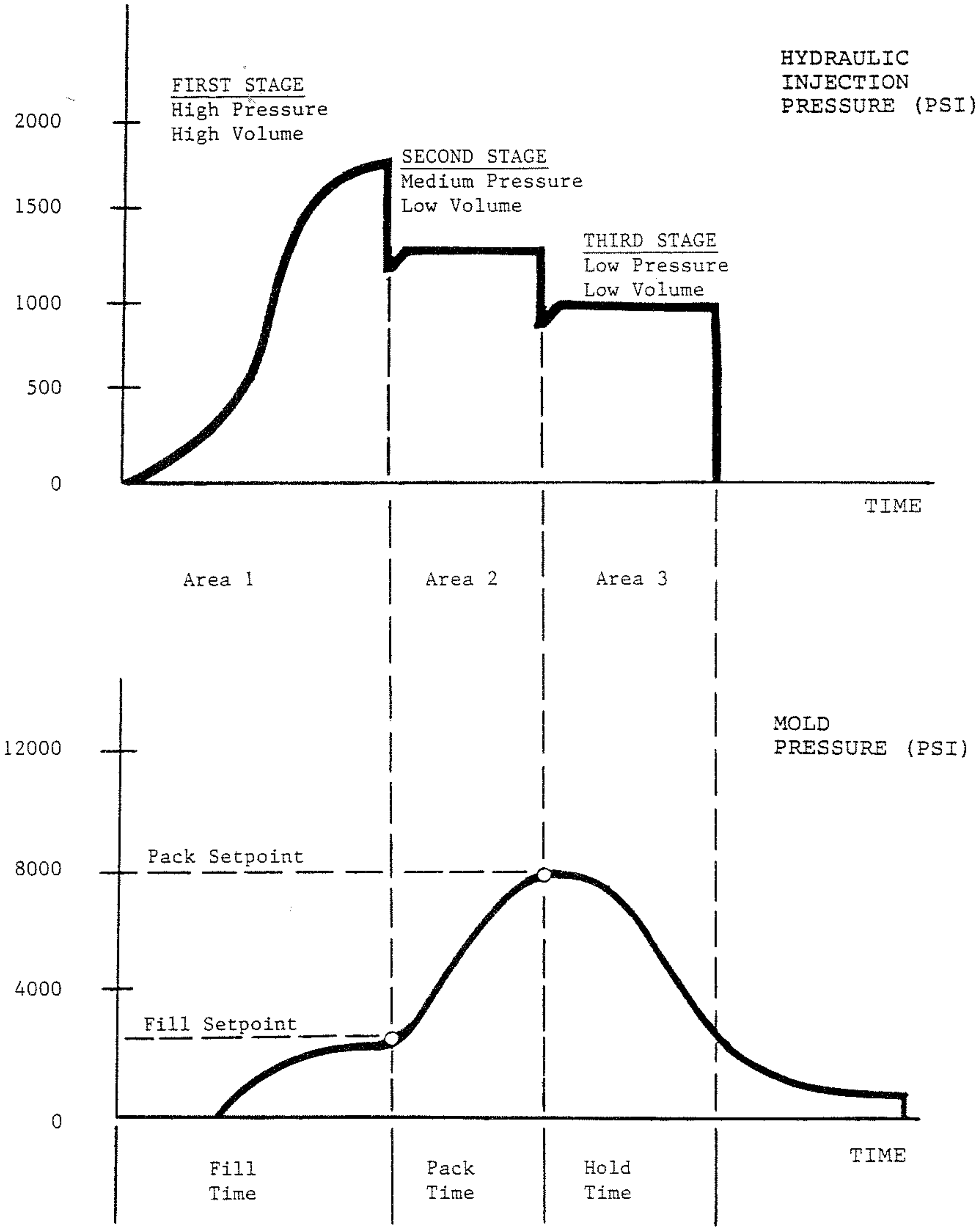


FIGURE #2

THREE-STAGE PROCESS CONTROL

* Fast Fill
* Fast Pack

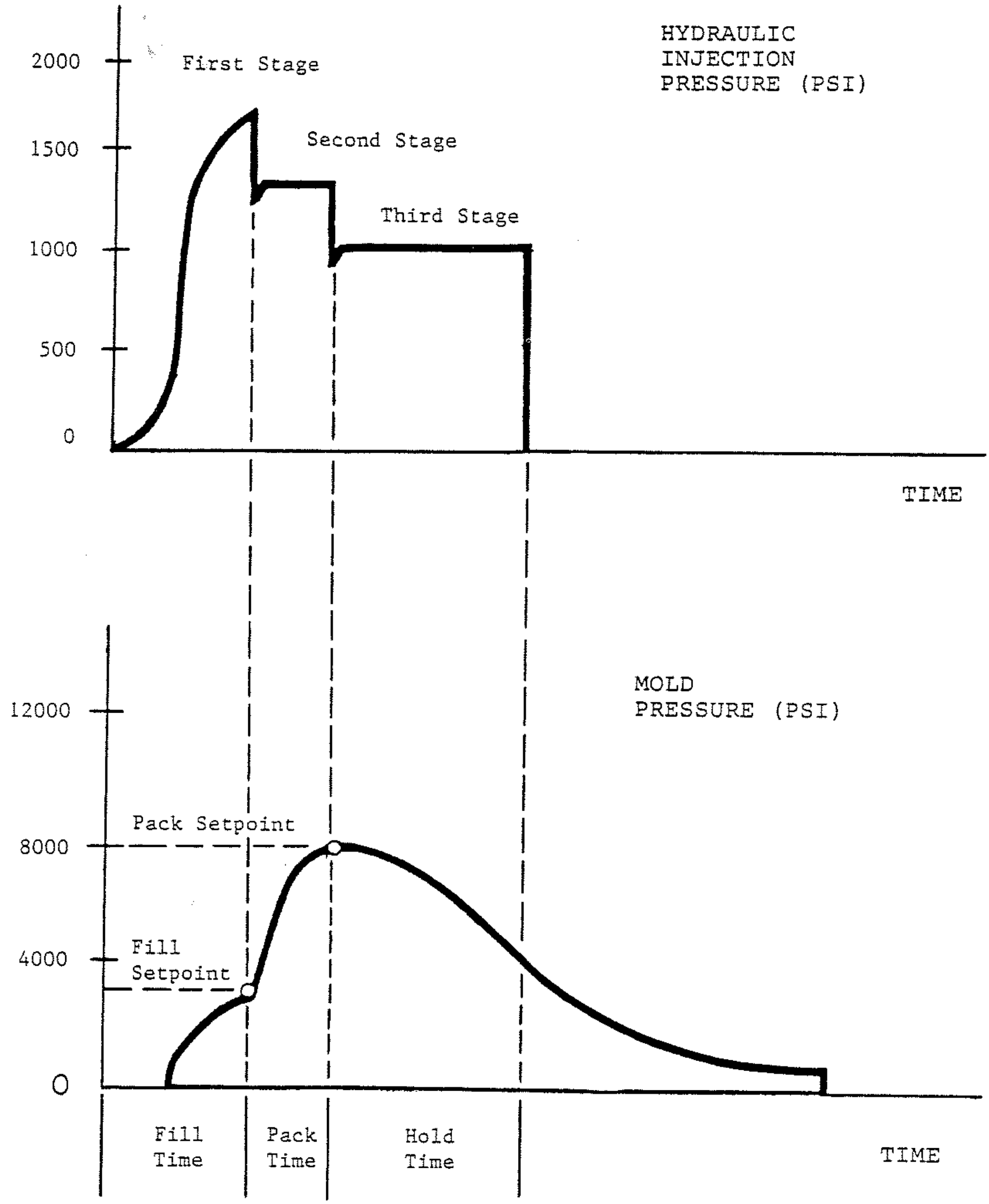
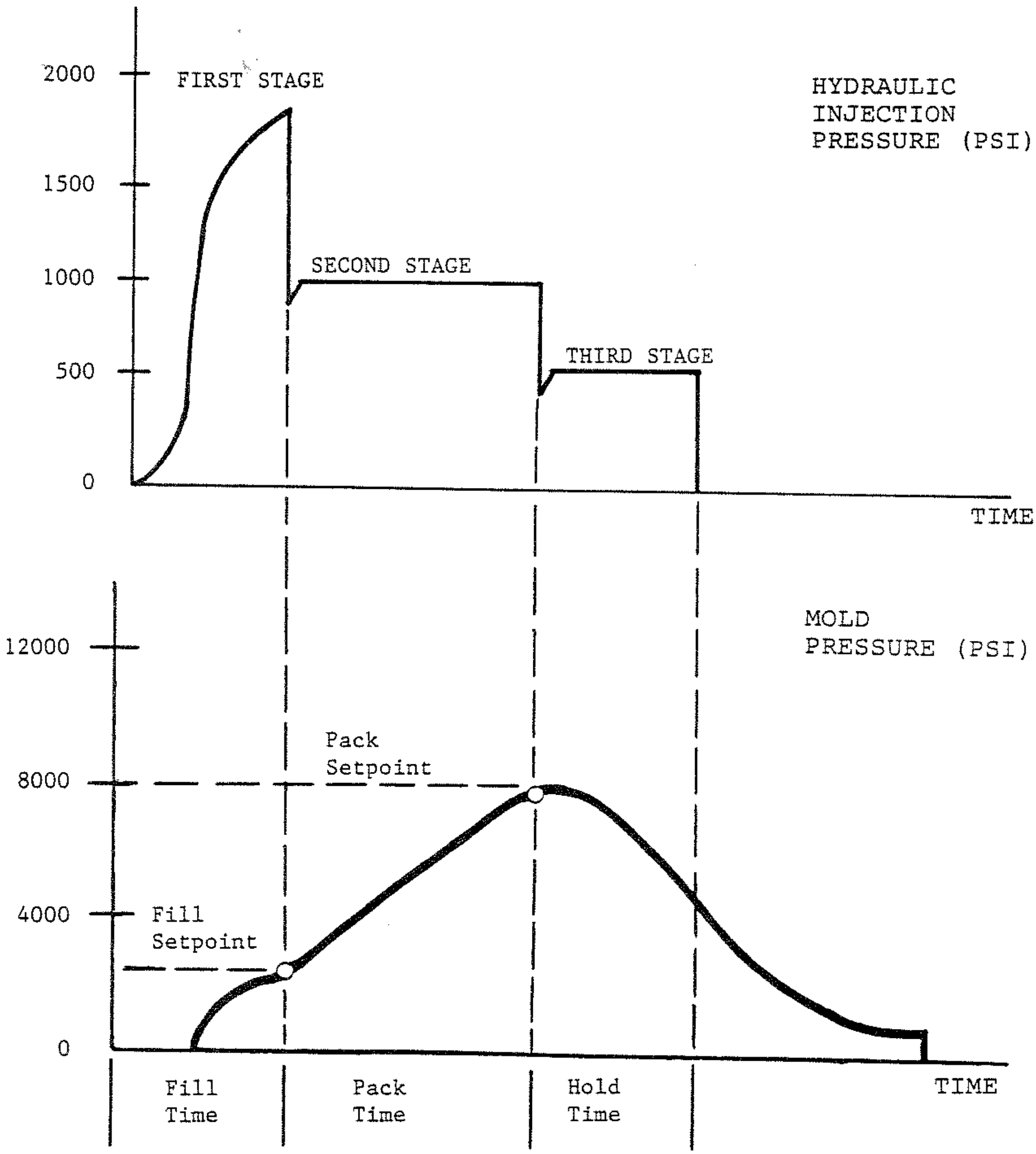


FIGURE #3

THREE-STAGE PROCESS CONTROL

* Fast Fill

* Slow Pack



NOTE: Slow pack can be better defined as a situation where mold pressure appears to stop increasing but ram position continues to increase. In other words, the pressure seen by the sensor in one part of the mold may stop rising or fall off, while other areas of the mold are still being packed.

FIGURE #4

THREE-STAGE PROCESS CONTROL

* Slow Fill

* Fast Pack

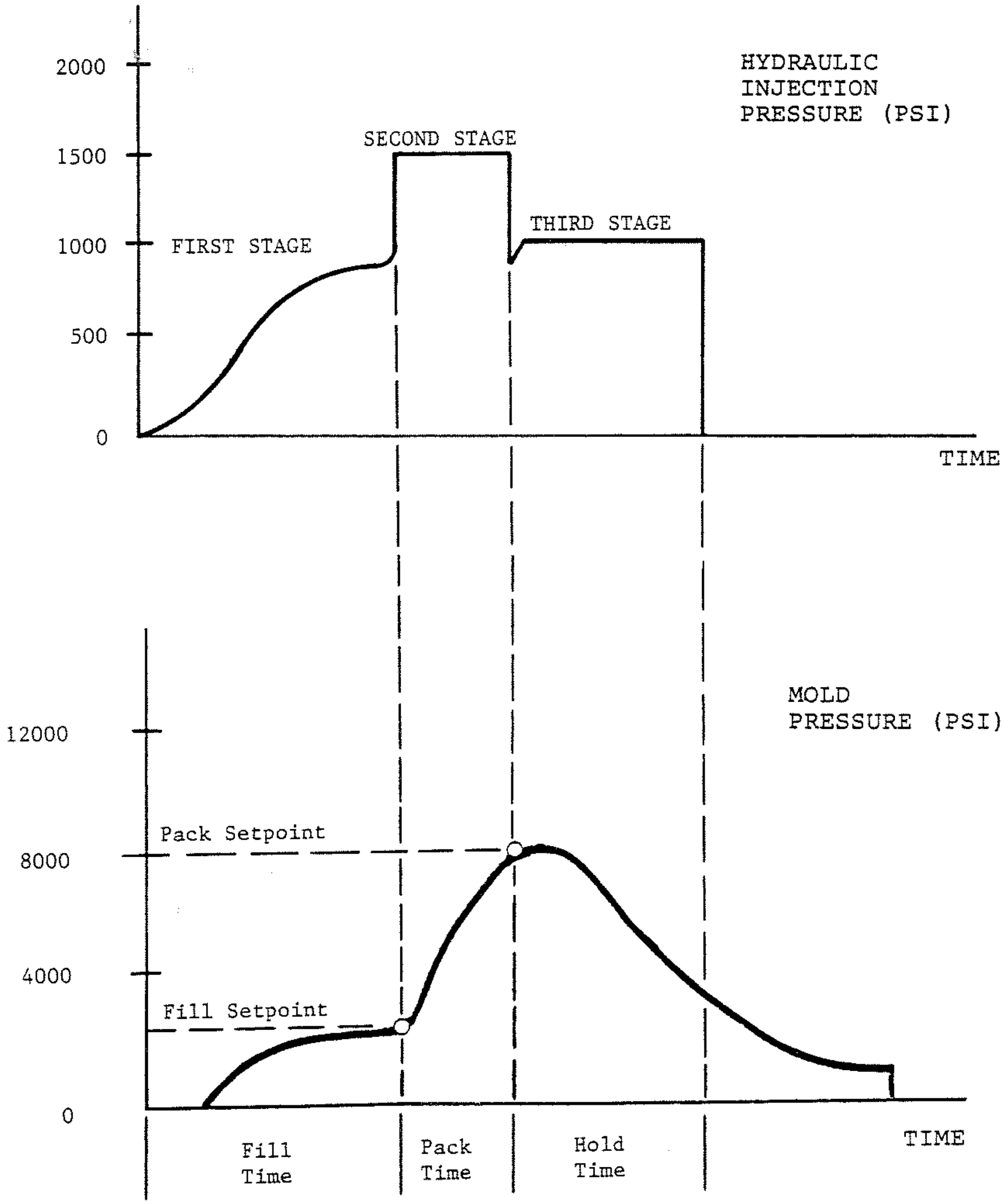


FIGURE #5

THREE-STAGE PROCESS CONTROL

* Slow Fill

* Slow Pack

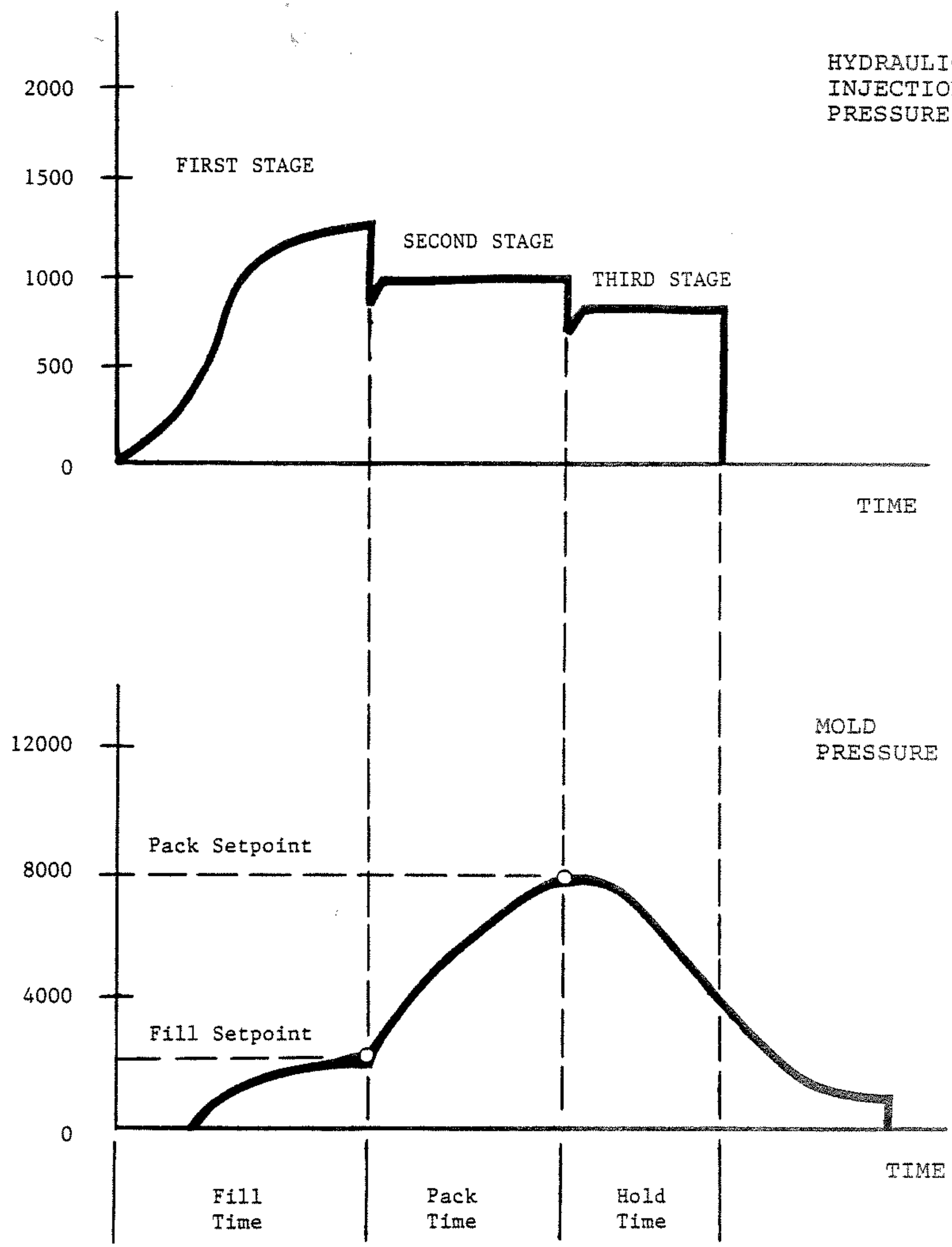


FIGURE #6

THREE-STAGE PROCESS CONTROL

* Fast Fill
* Fast Pack
* Programmed Discharge

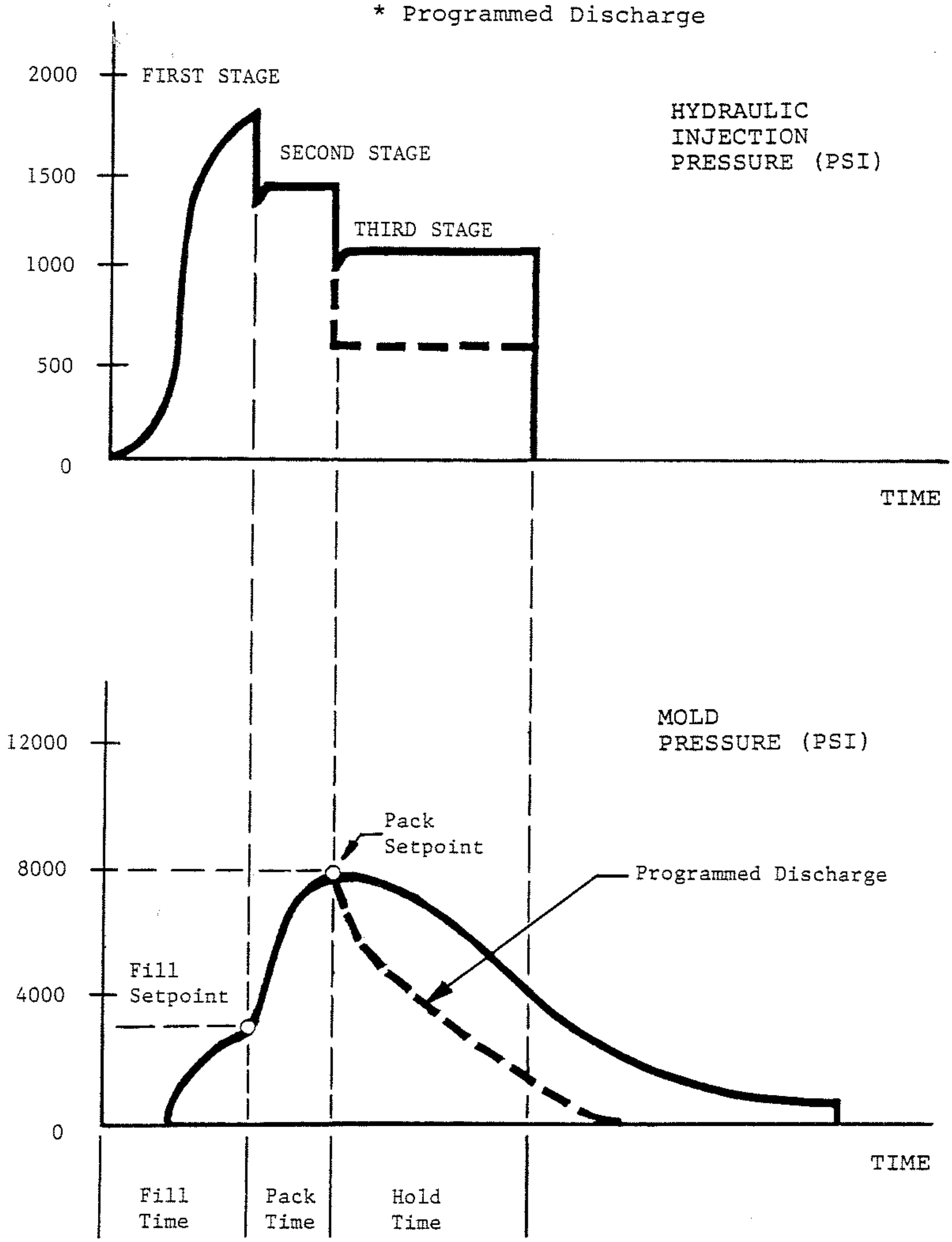
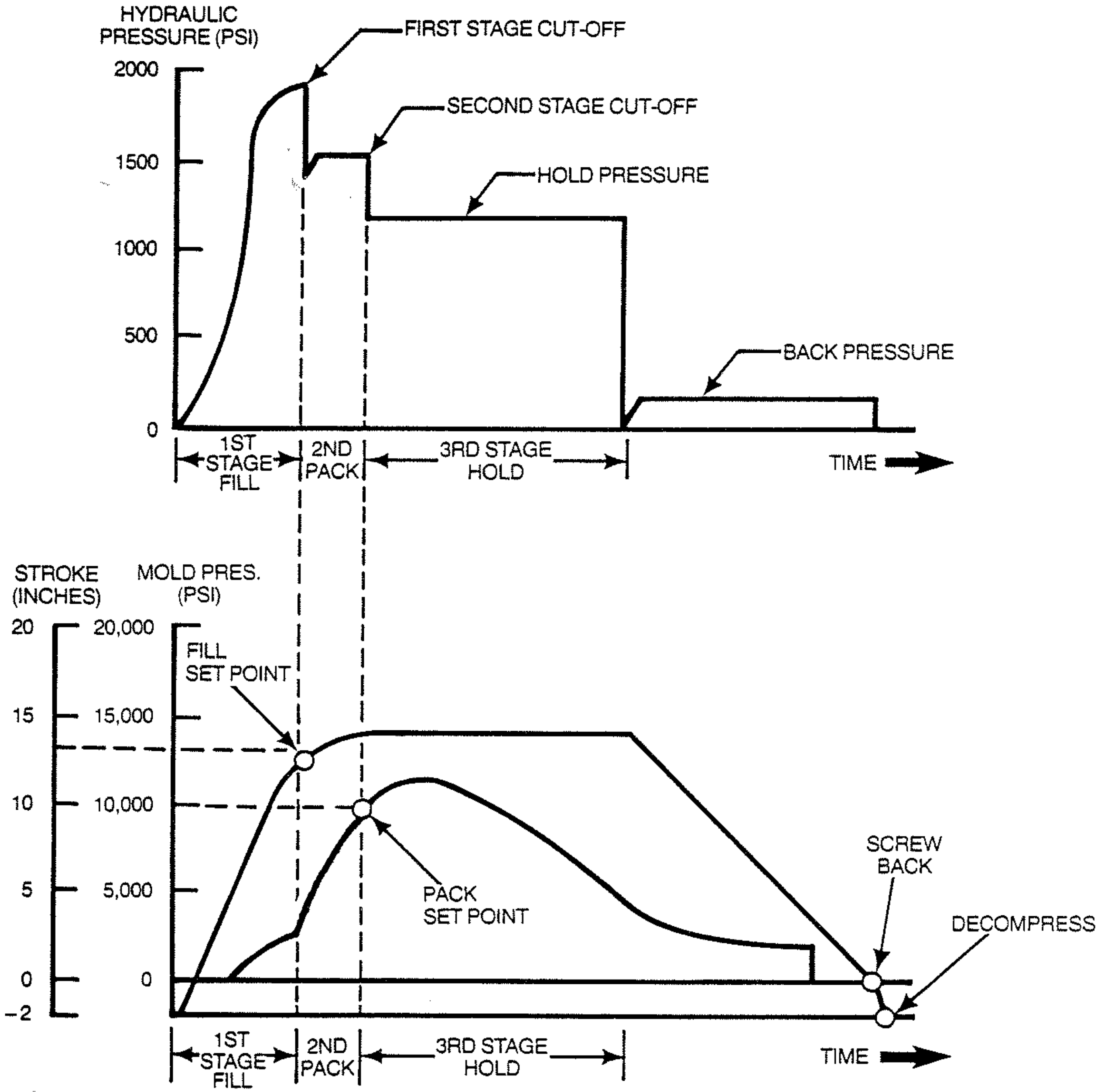


FIGURE #7

THREE-STAGE PROCESS CONTROL



- **FILL with STROKE**
- **PACK with PLASTICS PRESSURE**

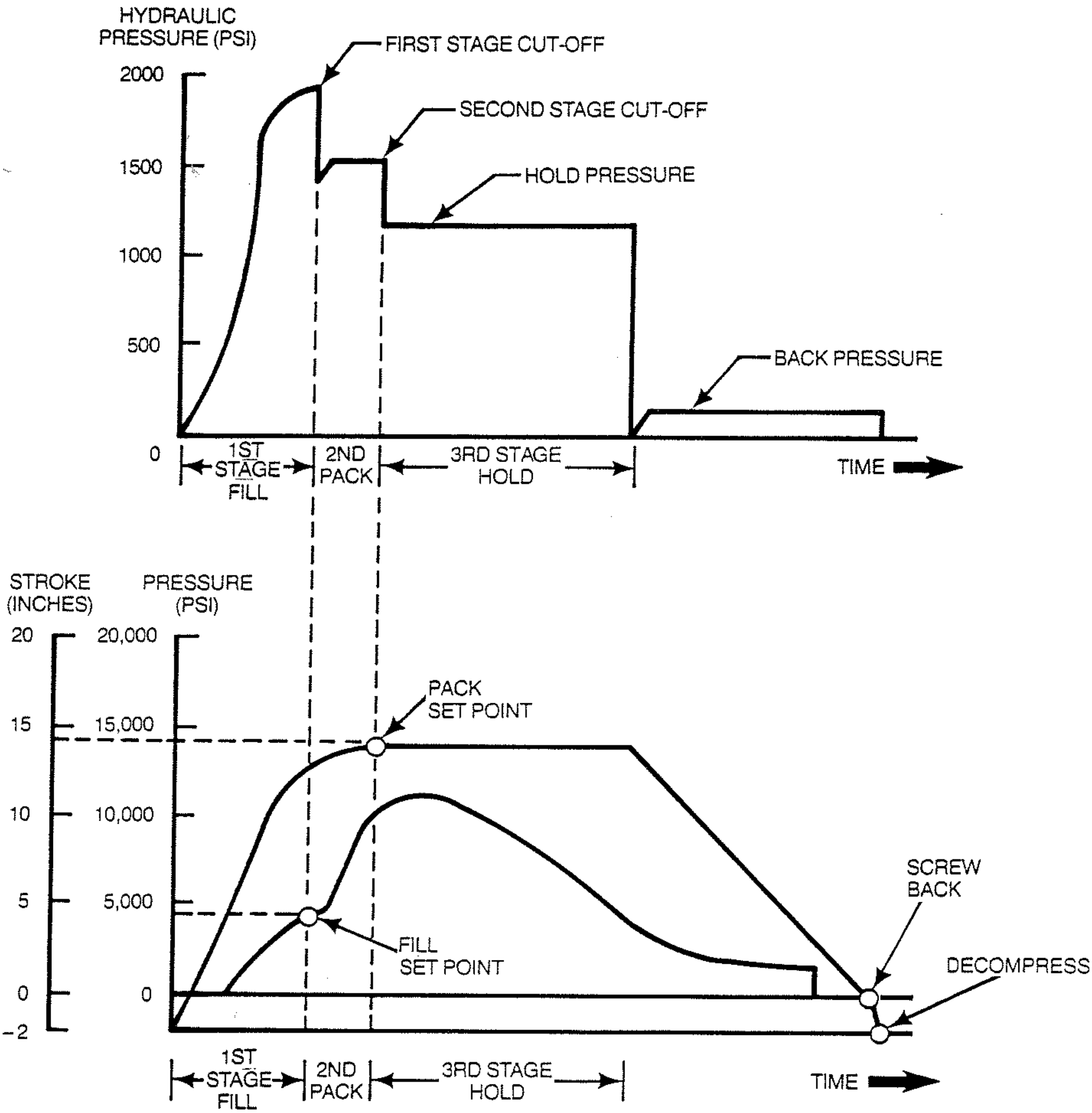
Figure #7 illustrates controlling fill with screw position (stroke) and controlling pack based on plastics pressure in the mold.

The stroke setpoint triggers the transition from fill to pack. This point is set to stop rapid plastics flow when the cavity is just filled with material, switching the machine from high-pressure/high-volume fill to high-pressure/low-volume pack.

The pack rate is determined by the amount of hydraulic pressure used during the pack phase. If a slow rate of pack is desired, a lower pressure is used. But in all cases, the pack rate is adjusted by the molder. The amount of pack is controlled by the second stage or pack setpoint which terminates the pack at a desired plastics pressure cutoff point. This setpoint then switches the machine to the third-stage low-volume holding pressure used to maintain pressure while the material solidifies in the mold.

FIGURE #8

THREE-STAGE PROCESS CONTROL



* FILL with PLASTICS PRESSURE

* PACK with STROKE

Figure #8 illustrates the ability for the molder to control fill by using plastics pressure and pack by using screw position (stroke) as the control parameter.

Used in this manner, a plastics pressure setpoint is employed to trigger the transition from fill to pack. The molding machine high-volume first stage can be set as a high or low pressure depending on the desired fill rate.

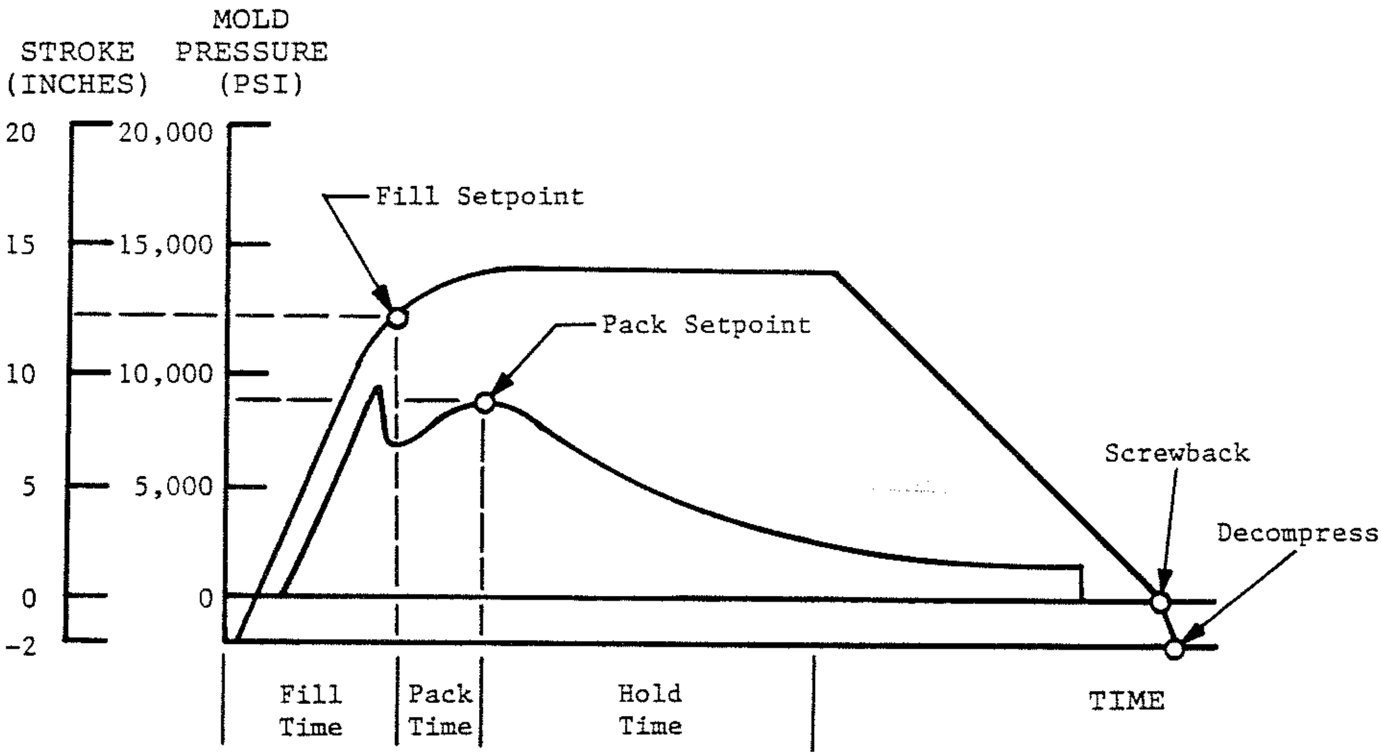
The amount of pack is controlled by the second stage or pack set-point which in this case is based on stroke. When this setpoint has been reached the controller then switches the machine to third stage holding pressure. This method is benefical when a long pack time is required.

FIGURE #9

INSULATED RUNNER OR DISTRIBUTOR TUBE

* Fill on Stroke
* Pack on Pressure

Breakthrough pressure in an insulated runner can cause tube pressure to rise above the pressure setpoint. The DME-4000 Multi-Parameter Controller has the capability of fill on stroke, hold off the pressure sensor until the Fill setpoint is reached, then continue packing on pressure. This has not been possible with previous control systems.



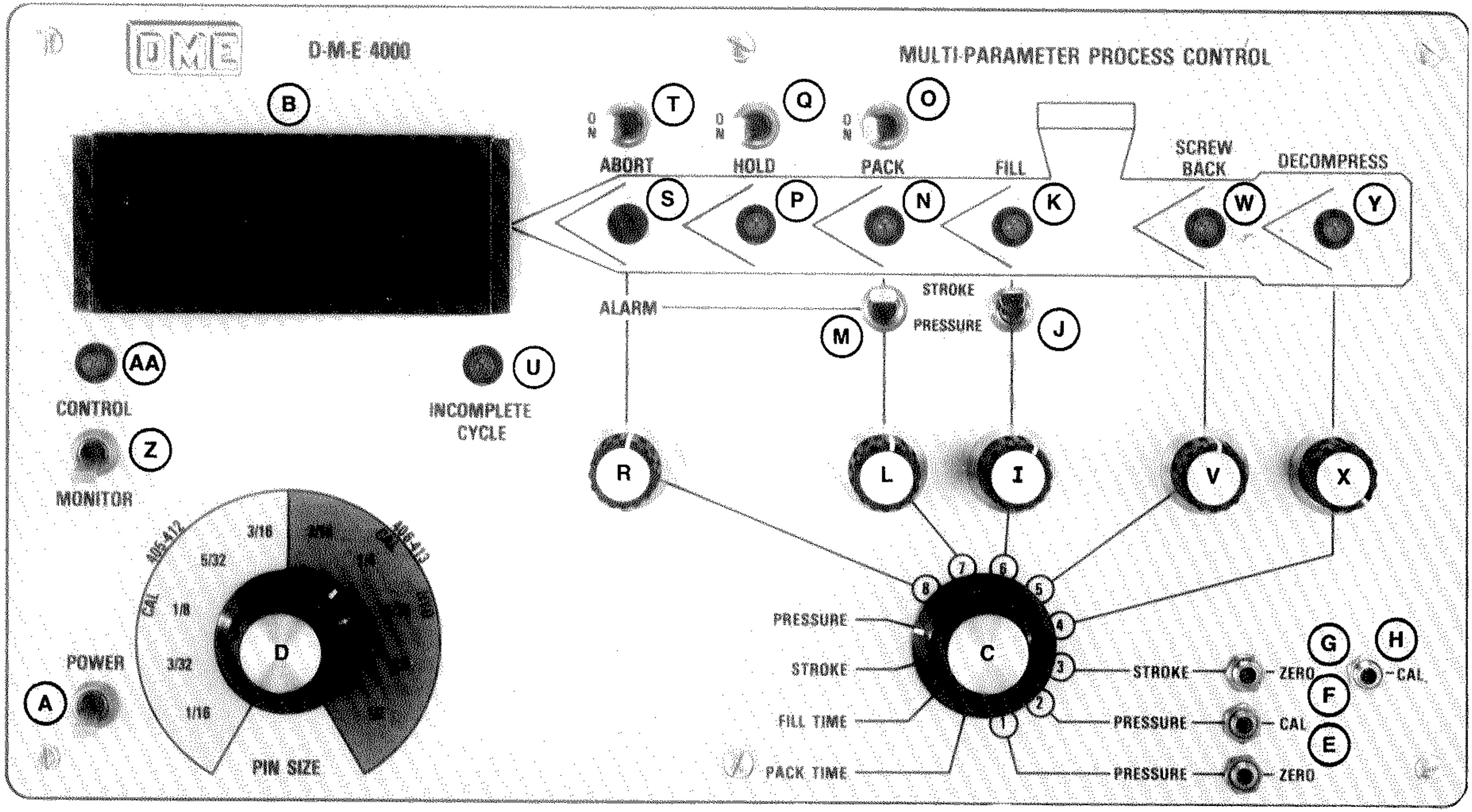


FIGURE #10

FRONT PANEL COMPONENTS

S E C T I O N 2

SYSTEM COMPONENTS

I. FRONT PANEL COMPONENTS

A. POWER Switch

This switch controls 120 VAC power on all system components except the Failsafe Abort section. This Power Off Failsafe feature can only be overridden by setting the ABORT Switch to the "off" position. If power to the unit is lost, the Abort contacts will trip, unless overridden by switching the ABORT Set-Up Switch to "off".

B. Digital Readout

This meter displays controller setpoints, calibrations, stroke positions, pressures, and fill and pack times. The following table shows how the different values are read:

Stroke Position or Stroke Setpoints (maximum calibrated values)

19.99 inches = 19.99 on the display

Plastics Pressure

19,990 psi = 19.99 on the display (x 1000)
1,999 BARS = 19.99 on the display (x 100)

(one BAR = 100 KN/M^2; 100 KPa)

Hydraulic Pressure

1,999 psi = 19.99 on the display (x 100)
0199 BARS = 19.90 on the display (x 10)

Fill and Pack Time

19.99 seconds = 19.99

Values for pressure depend on whether the system is calibrated in psi or BARS.

C. Display Selector Knob

This knob is used to determine what is displayed on the digital readout. The start-up adjustments are labeled 1 to 8 and are described later. NOT NUMBERED are the most frequently used switch positions, being:

PRESSURE - The peak mold pressure attained during the cycle will be shown and held for display until the end of injection forward.

STROKE - The position of the screw with respect to the screwback position is shown at all times.

FILL TIME - The time from the start of injection forward until the Fill setpoint is reached is shown on the digital readout every cycle.

PACK TIME - The time from the end of fill until the Pack setpoint is reached is shown every cycle.

D. PIN SIZE Selector

This switch is used to select the diameter of any common size ejector pin so that the pressure reading will be in actual psi. Whenever the sensing pin used is not listed refer to Section 5,II of this manual, "Calibration for Unlisted Ejector Pin Sizes". A hydraulic pressure sensor may also be selected.

Use the following chart if metric pin sizes are used:

(inches)	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8	1/2
(mm)	2	3	4	5	6	8	10	12	16

E. PRESSURE-ZERO Adjustment Screw

This adjustment is used to set a digital readout of zero psi or BAR when no pressure is being applied to the mold or hydraulic sensor. With the Display Selector in Position 1 during the molding cycle, mold or hydraulic pressure can be observed on the readout; but, the peak hold feature of the system is bypassed.

F. PRESSURE-CAL Adjustment Screw

This adjustment is used prior to start-up so that true pressure readings can be obtained. Since the sensitivity of each sensor may vary, the calibration adjustment is used to set the sensor's calibration number on the digital readout. All new production sensors have a calibration number of 8900 psi or 390 BARS.

CAUTION: Turning the Display Selector to or past Position 2 during injection will cause control setpoints to be accidentally activated. This normally causes short shots.

G. STROKE-ZERO Adjustment Screw

This adjustment is used to set a digital readout of "zero" inches when the machine's screw is at its full forward position (screw bottom). This position is electrically the same as the STROKE postion.

H. STROKE-CAL Adjustment Screw

This adjustment is used prior to start-up so that true readings can be obtained. Since there are several possible choices in screw travel potentiometer lengths, the calibration adjustment is used to set an actual measured screw displacement on the digital readout.

I. Fill Setpoint Adjustment Knob

A 0 to 19,990 psi (19.99 BARS) or 0 to 19.99-inch setpoint, is used to set the mold or hydraulic pressure or stroke at which the machine's hydraulic injection pressure will be switched from first to second stage.

J. Fill Parameter Select Switch

This switch allows selection of either STROKE or PRESSURE as the control input for fill.

K. FILL Sequence Light

This light indicates that the unit is in control and that the machine is using first-stage hydraulic pressure.

L. PACK Setpoint Knob

A 0 to 19,990 psi (19.99 BARS) or 0 to 19.99-inch setpoint, is used to set the hydraulic or mold pressure or stroke at which the machine's hydraulic injection pressure will be switched from second to third stage.

M. PACK Parameter Select Switch

This switch allows selection of either STROKE or PRESSURE as the control input for pack.

N. PACK Sequence Light

This light indicates that the unit is in control and that the machine is using second-stage hydraulic pressure, unless the PACK Switch is "off".

SYSTEM COMPONENTS (cont'd.)

O. PACK Set-Up Switch

This switch is used during start-up or troubleshooting to abort injection forward at the end of fill. The pack and hold sequences are prevented with the PACK Switch "off". This allows for accurate setting of the Fill setpoint.

P. HOLD Sequence Light

This light indicates that the unit is in control and that the machine is using third-stage hydraulic pressure, unless the PACK or HOLD Set-Up Switch is "off".

Q. HOLD Set-Up Switch

This switch is used during start-up or troubleshooting to abort injection forward at the end of pack. The hold sequence is prevented with the HOLD Switch "off". This allows for accurate setting of the Pack setpoint.

NOTE: There is no Hold setpoint adjustment on the controller. Hold pressure is set with the third-stage hydraulic valve, which is installed on the machine.

R. ABORT Setpoint Knob

ABORT is a 0 to 19,990 psi (19.99 BARS) or 0 to 19.99-inch setpoint, which can be used to:

1. Provide a prewired safety abort (injection dropout) when an unsafe condition exists, such as overpacking the mold.
2. Signals operator of overpacked parts or extreme pressure variations.
3. Signals operator of need for material.
4. Automatically QC and/or sort defective parts.

NOTE: This control is active in both CONTROL and MONITOR positions.

S. ALARM Sequence Light

This red light signals that:

1. The mold was packed above the Abort setpoint due to excessive injection or plastics pressure.
2. The screw continued past the desired cushion, indicating a possible need for material or a leaking check ring.
3. If at the end of injection forward (along with the Incomplete Cycle light) indicates that an "Incomplete Cycle" condition exists.

SYSTEM COMPONENTS (cont'd)

T. ABORT Set-Up Switch

With this switch in the "off" position, all alarm and abort circuits are bypassed. This also means that the positions of the PACK and HOLD switches are deactivated.

U. INCOMPLETE CYCLE Light

This yellow light indicates that injection forward terminated without the unit reaching the Pack setpoint. This light will not come on until the end of injection forward when the ALARM light will also come on. Both lights will extinguish at the beginning of the next injection cycle.

NOTE: During an injection cycle the FILL, PACK, HOLD and ABORT lights will sequence. That is, when the PACK light turns on, the FILL light turns off; when the HOLD light turns on, the PACK light turns off. The ABORT will turn on if the Abort setpoint is exceed.

V. SCREWBACK Setpoint Knob

A 0 to -19.99-inch setpoint used to set the point at which screw recovery is terminated and where DECOMPRESS if selected, begins. The Screwback setpoint will be a negative number in the display indicating that the screwback motion is in the opposite direction of inject. All other setpoints use this as their zero reference. (The "zero" for this setpoint is screw bottom.)

NOTE: This control is active in both CONTROL and MONITOR positions.

W. SCREWBACK Light

This light indicates that the screw is at SCREWBACK or between SCREWBACK and DECOMPRESS positions. When on, the light indicates that the machine has finished plasticizing the next shot.

X. DECOMPRESS Setpoint Knob

A 0 to -3.00-inch setpoint used to the point at which DECOMPRESS terminates. This setpoint will be a negative number in the display indicating that the decompress motion and position are in the opposite direction of inject. The numbers are a measure of the distance from SCREWBACK to the end of DECOMPRESS.

NOTE: This control is active in both CONTROL and MONITOR positions.

Y. DECOMPRESS Light

This light indicates that the screw is at the DECOMPRESS position and that the controller is waiting for the next injection cycle.

Z. CONTROL/MONITOR Switch

With the switch in the MONITOR position, no control sequences occur, except SCREWBACK, DECOMPRESS and ABORT. Mold pressure, hydraulic pressure and screw position can be monitored. All other setpoints may be adjusted without affecting the process.

In MONITOR, the transfer from first to second stage is determined by the standard machine controls, and no third stage hold is present.

NOTE: While the machine is running DO NOT change any of the STROKE and PRESSURE screw adjustments for ZERO or CAL, because the change will affect the ABORT, SCREWBACK and DECOMPRESS settings.

With the switch in the CONTROL position, all control sequences are in operation.

AA. Control/Monitor Light

When on, this light indicates that the unit is in control.

II. SIDE PANEL COMPONENTS

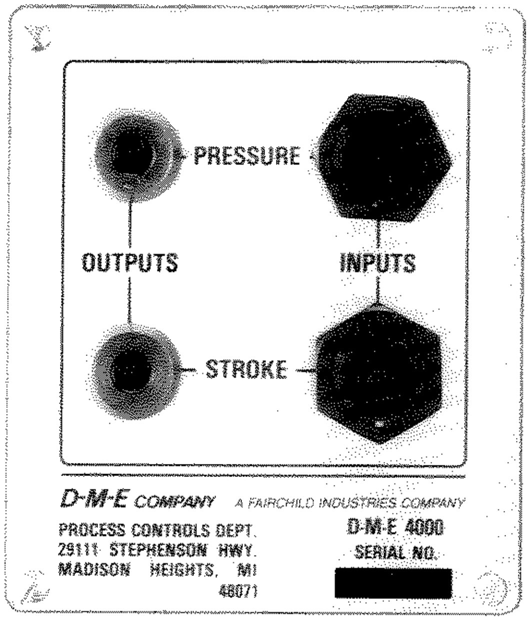


FIGURE #11

SIDE PANEL COMPONENTS

1. Pressure Sensor Input
   This input mates to the connector used on all current D-M-E mold and hydraulic pressure sensors. The input voltage ranges from approximately 0 to 20mv. Excitation voltage is provided by the controller. Other brands of sensors may be used with the appropriate conversion cables, which are available from D-M-E.

2. Stroke Input
   This input mates to the cable provided with any one of four D-M-E Screw Travel Potentiometers (Models STP-471, STP-472, STP-473 and STP-474). These potentiometers have a resistance of approximately 266 ohms per inch of travel. Excitation voltage is provided by the controller.

3. Pressure Output
   This analog output jack allows a 0 to 5VDC signal to be sent to a portable process recorder, which provides a permanent record of plastics pressures. These recordings are useful for troubleshooting, machine start-up and training.

4. Stroke Output
   Much the same as the Pressure Output, this jack allows the molder to monitor and permanently record stroke.

NOTE: The mold pressure sensors, hydraulic pressure sensors and screw travel potentiometer connectors are the same. Be sure when connecting the sensors that the inputs are not reversed.

III. Important Internal Components

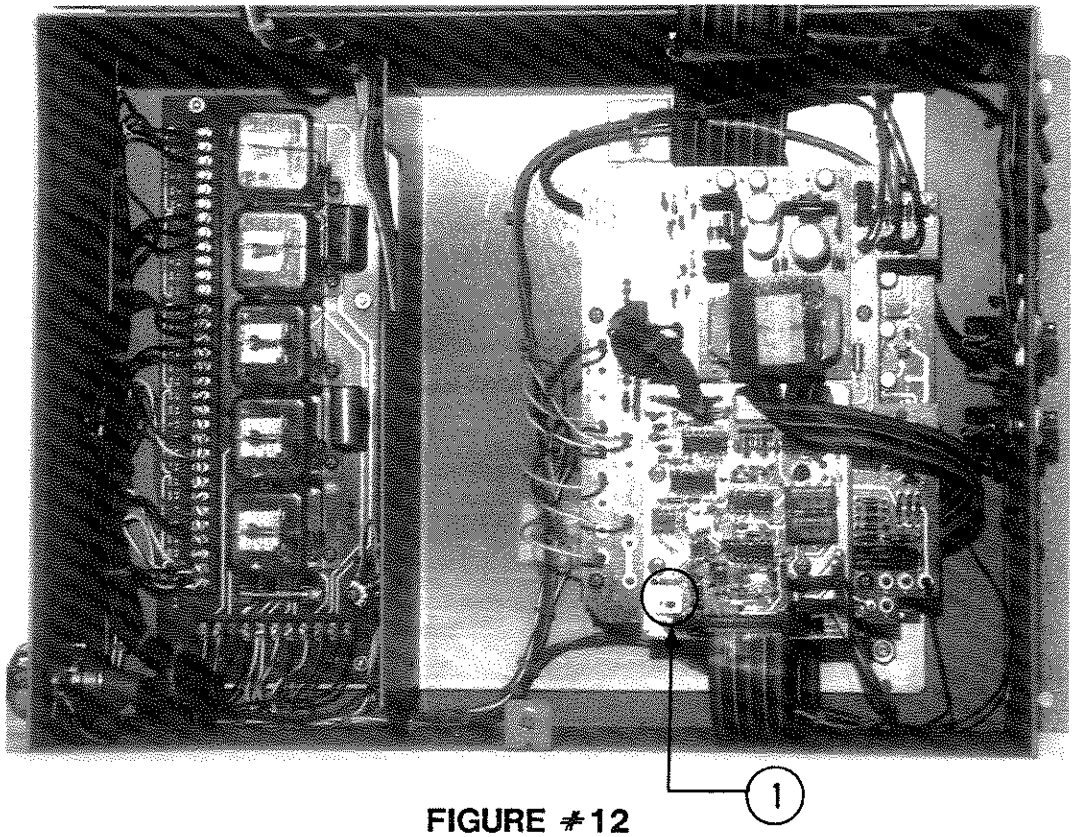


FIGURE #12

MAJOR INTERNAL COMPONENTS

1. STP Polarity Switch
   With this switch in the left position, the display readout will increase (positively) when the shaft is withdrawn from the Screw Travel Potentiometer. With the switch in the right position the display readout will increase when the shaft is pushed in. This allows for flexibility in mounting the Screw Travel Potentiometer.

2. Power Interface Relays
   See Appendix IV for PI-930 Interface Wiring.

   A. Decompress/Suckback Relay
      This relay is energized when the Decompress setpoint is reached during DECOMPRESS. It remains energized until the screw moves forward past the Decompress setpoint. The Form "C" Output contacts are used to stop the DECOMPRESS sequence on the machine.

B. Screwback Relay
Energized when the Screwback setpoint is reached during screw recovery. Remains energized until the screw moves forward past the Screwback setpoint. The Form "C" Output contacts are used to stop extruder run and force the machine into DECOMPRESS (if selected on the machine).

C. Pack Relay and Pack Auxillary
This relay energizes when the Fill setpoint is reached during FILL and remains energized until the end of injection. The Form "C" Outputs contacts and normally open contact are used to transfer the machine from first stage to second stage.

D. Hold Relay
Energizes when the Pack setpoint is reached during PACK and remains energized until the end of injection. The normally open contact is used to supply power to the VA-30M third-stage hydraulic valve. These are hot contacts with 120 VAC power, which is applied internally to operate the valve.

E. Abort/Alarm Relay
The relay is used to provide a safety and/or quality control output for the controller, if the ABORT Switch is in the "ON" position. The relay is wired so that if power to the controller is lost, the Abort contacts open, stopping injection. Two contacts are provided: A normally open held closed (abort) and a normally closed held open (alarm). The relay drops out when the Abort/Alarm setpoint is reached or if the Pack setpoint is not reached before the end of injection. It is re-energized at the beginning of the next injection forward.

NOTE: All relays are 3 pole double throw, 120 VAC, 10 AMP, 1/4 h.p. (6-2/3 A, 1/3 h.p. @ 250V), Potter & Bromfield KUP14A15. To remove, move bail clip to the side and pull out. Replace in the same manner.

NOTE: The unit must have all relays present to function properly.

3. Fuse
1A, 120V, type 3AG.

SECTION 3

ZERO AND CALIBRATION PROCEDURES

I. General Description

Prior to start-up of the DME-4000 it is necessary to zero and calibrate the Screw Travel Potentiometer (STP). If a mold or hydraulic sensor is used, it is also necessary to calibrate it. Zero and calibration of the STP is required because of the variations in available lengths and in its mounting. Zero and calibration of the pressure sensor is necessary due to small variations in the load cells used to construct the sensors.

SCREWBACK and DECOMPRESS set-up are required in both MONITOR and CONTROL positions. This assures repeatable cushion and shot size.

Care should be taken in the mounting of both the STP and the pressure sensors.

Be sure that all cabling is tied down and out of the way of moving parts.

Be sure that all mold sensors are properly installed and that the proper sensor was installed so as to avoid overloading.

Be sure that the end of the STP shaft is fitted with a Rod End Bearing. Verify that the shaft does not bind when moving. There should be no apparent bending in the shaft or freeplay in the mounting.

NOTE: Failure in checking the above points may necessitate repair or replacement of the STP or sensor.

II. Zero and Calibrate Procedures
(Mold or Hydraulic Pressure)

1. Select the correct sensor:
   a. Use SS-405C (BS-412C) sensor for pin sizes 1/16" through 3/16" diameters.
   b. Use SS-406C (BS-413C) sensor for pin sizes 3/16" through 1/2" diameters.
   c. Use HPS-420 for 0 to 2000 psi hydraulic pressure.

2. Obtain calibration number from sensor tag: 8900 psi for constant output sensors, 390 Bars for metric.

3. Connect sensor to PRESSURE INPUT of controller. Allow 5 minutes for warm-up.

4. Set PIN SIZE Switch to:
   a. 'CAL' 1/8" for SS-405C or BS-412C.
   b. 'CAL' 1/4" for SS-406C or BS-413C or HPS-420.

5. Turn the Display Selector to Position 1 (PRESSURE-ZERO).

6. Adjust the ZERO Screw until the display reads "0.00" (±0.05). Use a small blade screwdriver in the Zero Adjustment Hole.

7. Turn the Display Selector to Position 2 (PRESSURE-CAL).

8. Adjust CAL Screw until the number on the sensor tag is displayed. EXAMPLE: CAL number on tag reads 8900 psi. Adjust CAL Screw until 8.90 is displayed (3.90 for metric).

9. Reset PIN SIZE Switch to actual size of the pin in the mold or to "HYD 5/16" for HPS-420 hydraulic pressure sensor. Reset PRESSURE-ZERO if necessary.

10. Installation of Mold Pressure Sensor:
    a. Sensor should slide in freely with hand force.
    b. Sensor should be fully in and behind the ejector pin.
    c. Controller should still read "0.00" (±0.05). Rezero if necessary.
    d. Controller should read pressure when ejector pin is pressed.
    e. Tie sensor cable out of the way to prevent damage.
    f. If a slide sensor is installed in such a manner that it may slip out of the mold while running, a retaining device should be used.
11. Installation of Hydraulic Pressure Sensor:
    a. Install HPS-420 into the hydraulic circuit between the injection cylinder and the injection flow control valve.
    b. Controller should read "0.00" (±0.05).
    c. Controller should read pressure when screw injects.

III. Screw Travel Potentiometer (STP) (Stroke of STP-471 thru STP-474)

A. General

Screw Position Measurement:

The machine's stroke position scale is positioned with "zero" for screw bottom. The stroke length increases (numbers get larger) as the screw recovers (Figure #13) and this is still used to zero the stroke input of the DME-4000 controller.

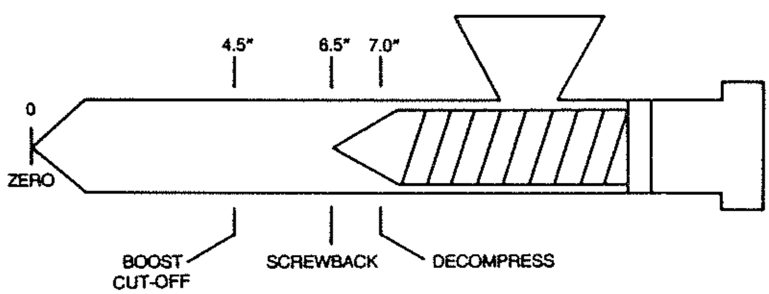


FIGURE #13: Machine stroke position with example limit switch setting.

The DME-4000 controller modifies this scale in two ways. First, it changes the zero point from screw bottom to the Screwback setpoint (limit switch) position. Second, it uses a positive and negative scale, i.e., any number forward of the new zero point is positive and any number to the rear (decompress) is negative (Figure #15).

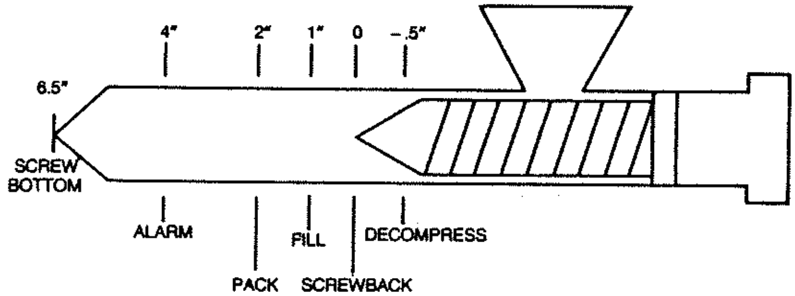


FIGURE #14: DME-4000 setpoint positions

This procedure is performed for two important reasons. As the screw travels forward (injects), the setpoints are now a direct measure of the volume of material injected. Next, by shifting the zero point to the Screwback setpoint, the cushion can now be changed without altering any of the other setpoints. It is important to keep in mind that while all other setpoints are referenced to the Screwback setpoint, this setpoint itself is referenced from screw bottom as "zero" (Figure #14).

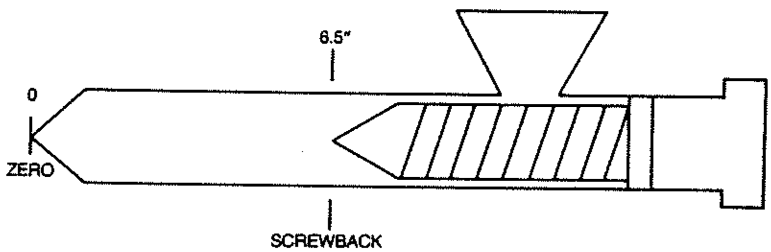


FIGURE #15: DME-4000 stroke position scale.

While this may sound confusing, just remember that the Screwback setpoint is the number of inches or centimeters from screw bottom to screw stop. All other setpoints are the number of inches or centimeters (+ and -) from the Screwback setpoint.

It is important to note that SCREWBACK, DECOMPRESS and ABORT controls are active at all times, in either the CONTROL or MONITOR positions. All other setpoints are active only in the CONTROL position. This allows the molder to set-up the shot size and pull back for any mold in the shop with digital position control.

ZERO AND CALIBRATION PROCEDURES (cont'd.)

B. Zero and Calibrate STP

NOTE: The length of the STP should closely match the maximum stroke length of the machine. Any STP that is too long cannot be calibrated properly.

1. Be sure the STP is correctly mounted to the machine:
   a. The STP should have no freeplay in the mounting, either at the machine or screw mounting points.
   b. The STP needs 1/4" to 1/2" (1 to 2 cm) in over-travel when the screw is fully bottomed and retracted.
   c. The STP shaft should slide freely over the full travel of the screw. There should be no apparent bend in the STP shaft. Be sure to use the Rod End Bearing supplied with the STP.
   d. With the screw bottomed, the STP should be within 2-inches of its travel limit, but no more than 1/2".

2. Plug the STP into the STROKE INPUT of the controller and see that:
   a. CONTROL/MONITOR Switch is in the MONITOR position.
   b. ABORT Switch is in the "off" position.
   c. Machine decompress "off".

3. Place the Display Selector in Position 5. Turn the SCREWBACK Setpoint Knob fully counterclockwise so that the display reads "0.00" (±0.05).

4. Turn the Display Selector to Position 3 and "bottom" the screw. If the numbers displayed are negative they should move toward zero or beyond into the positive range. If the numbers are positive they should increase as the screw is bottomed.

   If the numbers move higher in the negative range, turn the controller power "off", then open the front of the controller and change the STP Polarity Switch (in the lower left corner of the top circuit board) to its opposite position. (See Figure #12.)

5. Adjust the STROKE-ZERO Screw so that the display reads approximately "0.00" (±0.05).

6. Place the Display Selector in Position 5 and turn the SCREWBACK Setpoint Knob fully clockwise so that the display reads -19.90.

7. Run the screw back to its normal stop position and record this distance for later use (see Step IV-1).

8. Move the machine screw stop control and run the screw so that it recovers fully to its maximum shot size.

9. Turn the SCREWBACK Setpoint Knob (Position 5) full counterclockwise.

ZERO AND CALIBRATION PROCEDURES (cont'd)

10. With a scale, measure the distance from screw bottom to the full SCREWBACK position. Dial this number into the STROKE-CAL Adjustment Screw in Position 3 so that this number appears in the display (this will be a negative number).

11. Bottom the screw and verify that the ZERO adjustment is still good by turning the Display Selector to Position 3 (zero ±0.05). Readjust zero if necessary.

IV. Screwback and Decompress Set-Up

1. Turn the Display Selector to Position 5 and enter the shot size or screw stop distance into the display with the SCREWBACK Setpoint Knob. (This is the number recorded in Step III-7 above. This is a negative number.)

2. Let the screw recover to this new screw stop position to verify its setting.

3. Turn the Display Selector to Position 4 and enter the desired amount of decompress with the DECOMPRESS Setpoint Knob. This will be a negative number.

4. Turn on the machine decompress and allow the screw to pull back to this new decompress stop position to verify the setting.

5. Move the machine screw stop and decompress controls to position just behind the new DME-4000 settings. If your machine has a timer for decompress, add 10% to the setting.

SECTION 4

OPERATING PROCEDURES

General Description

A. Controlling on Mold Pressure and Stroke

The DME-4000 Three-Stage Multi-Parameter Control System is designed to make start-up as easy as possible for the molder. Five different start-up procedures are available.

The first two of the five procedures are for "Takeover Approach". When using any of these the Fill and Pack setpoints are set at the peak pressure or stroke. The controller is put into control and on subsequent shots the Fill setpoint is reduced. This approach to start-up works extremely well when short shots cannot be tolerated.

The third and fourth procedures can only be used when both the Screw Travel Potentiometer (STP) and a pressure sensor are available for use.

The molder must first start-up using the first or second procedure prior to implementing the third or fourth procedure, respectively.

The fifth procedure does not utilize the Takeover Approach and should not be used unless short shots can be tolerated. This procedure, however, is extremely helpful when overpacking or flashing is not tolerable.

When using only a Screw Travel Potentiometer, only the first and fifth procedures will apply.

If the molder is familiar with the model CPI-3000 and/or desires control based on pressure only, then the second procedure (Section 4-Step II) will be of particular interest.

For many applications, the third procedure (Section 4-Step III), filling on stroke and packing on pressure will yield optimum performance. This particular method can sometimes be helpful in insulated runner systems. The pressure spike seen at the beginning of injection (breakthrough) no longer prevents proper control. In the past this pressure spike would "trip" the Fill setpoint prematurely causing a short shot. (See Figure #9 in Section 1.)

When the application involves slow packing, Procedure 4 (Section 4-Step V) or perhaps Procedure 1 (Section 4-Step I) will be desirable. Slow packing does not always work well when controlling pack on pressure.

OPERATING PROCEDURES (cont'd)

Slow pack can be better defined as a situation where mold pressure appears to stop increasing, but ram position continues to increase In other words, the pressure seen by the sensor in one part of the mold may stop rising or fall off while other areas of the mold are still being packed out.

It should be noted that because of the vast differences in applications, there is no one procedure sufficient for all uses. Each application should be analyzed individually. The Flow Chart (Figure #19) at the end of this section should help in selecting the correct procedure.

NOTE: This chart assumes correct installation of the controller, STP and/or sensors. The machine should also be capable of making good parts, prior to using a controller.

When the final set-up is determined for all machine settings, controller setpoints and readouts should be recorded on a Mold Set-Up Sheet (Section 5). Strip chart recordings of stroke, mold and/or hydraulic pressure should be taken where possible and attached to the Mold Set-Up Sheet. This will insure easy reproduction of the same molding conditions at any time.

B. Controlling on Hydraulic Pressure

Hydraulic pressure does not always provide a good parameter for control. Strip chart recordings of hydraulic pressure should be obtained and the curves analyzed. Hydraulic pressure should only be used when a slope is observed on the hydraulic pressure curve during filling and packing of the mold.

Figure #16 is an example where both fill and pack could be controlled with hydraulic pressure. Notice the gradual slope of hydraulic pressure in both first and second stages.

NOTE: Observe that the second-stage hydraulic pressure is higher than the first-stage pressure; therefore, both fill and pack may be controlled by hydraulic pressure. If first-stage hydraulic pressure were higher than second-stage pressure, then only fill could be controlled with hydraulic pressure.

Figure #17 is an example where neither fill or pack may be controlled with hydraulic pressure. Notice the fast rise or step in the hydraulic pressure curve.

Figure #18 is an example where fill is controlled with hydraulic pressure and pack is controlled with ram position (stroke). If the hydraulic pressure curve was higher in second stage than in first stage, ram position could be used for fill and hydraulic pressure for pack.

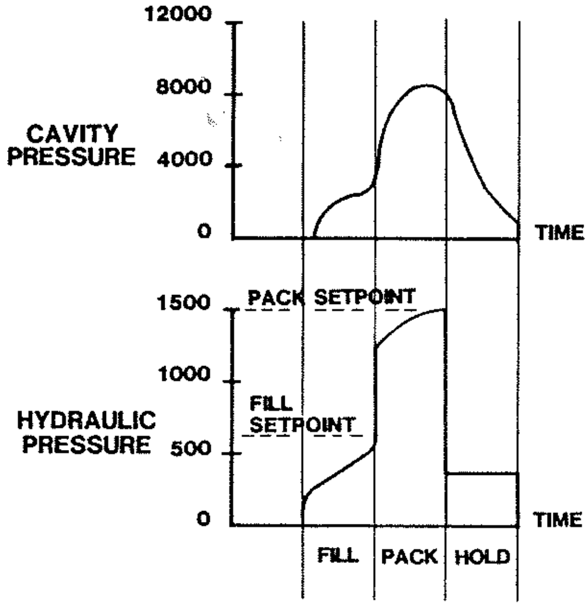


FIGURE #16

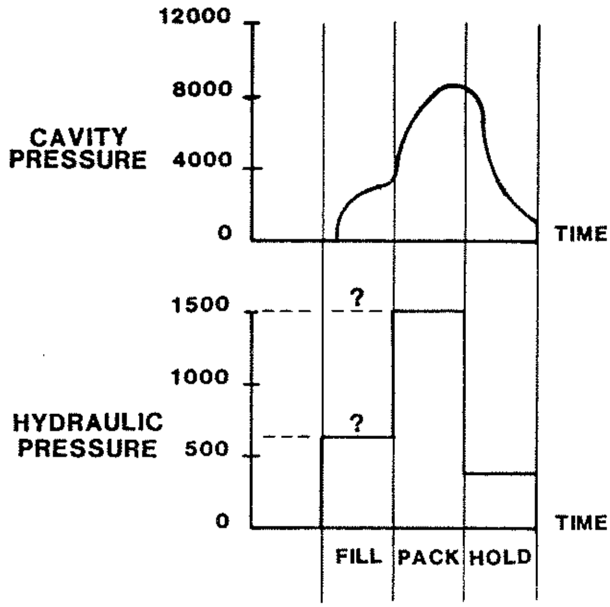


FIGURE #17

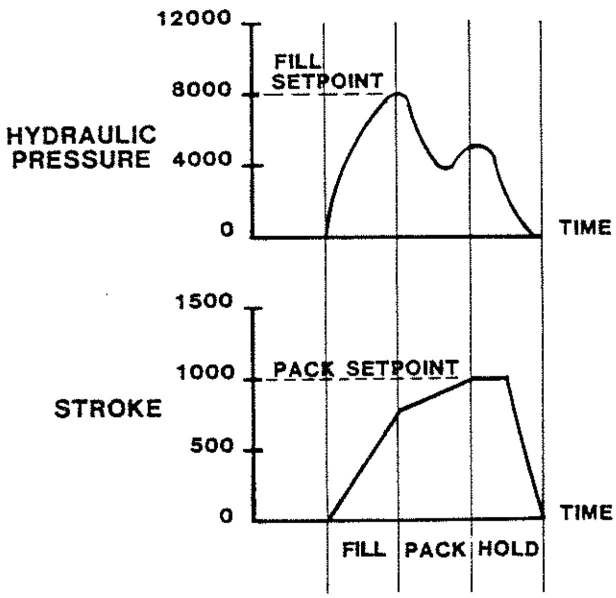


FIGURE #18

OPERATING PROCEDURES (cont'd)

I. Procedure 1 - Takeover Approach
Fill on Stroke - Pack on Stroke

Use Procedure 1 when:
a. No pressure sensors are available.
b. Cannot control on hydraulic pressure.
c. Cannot short shot.
d. Mold sensor at end of fill path and process involves slow pack.

Procedure 1:
1. Connect controller to Power Interface Box and turn power "on".

2. Zero, calibrate and set up the SCREWBACK and DECOMPRESS as described in Section 3.

3. With the machine cycling, mold acceptable parts with the CONTROL/MONITOR Switch in the MONITOR position and the ABORT Switch in the "off" position. The STROKE-PRESSURE Selectors, Positions 6 and 7, should be in the STROKE position.

4. Set the Display Selector to STROKE. Record the displayed number, which is the maximum forward position of the screw during an acceptable part. Enter a number .05 or less than the recorded number into both the Fill and Pack setpoints in Positions 6 and 7 by setting the Display Selector to each position and adjusting the appropriate setpoint knob.

5. Turn the Display Selector to Position 8, and with the ALARM Setpoint Knob enter the number recorded in Step #4 plus .10" to .25" (2 to 4 mm). This is an alarm setting and not a cushion.

6. Turn the PACK, HOLD and ABORT Switches to the ON position, the CONTROL/MONITOR Switch to the CONTROL position and the third-stage holding valve (VA-30M) on the machine to minimum hydraulic pressure (fully counterclockwise).

7. Start making parts again and begin to increase the third-stage holding valve pressure until sink marks disappear from the part. If the controller does not go to the third-stage "hold" setting, lower the Pack setpoint until it does.

8. On succeeding shots, lower the Fill setpoint until three distinct stages (sequence lights) are observed on the controller or a low ALARM occurs.
   a. If an incomplete cycle occurs, increase second-stage hydraulic pressure on the machine until three distinct stages are observed on the controller. (If no effect, check to insure cushion. Adjust SCREWBACK if necessary.)

9. Observe FILL TIME reading. Lower Fill setpoint until FILL TIME reading is less than the first-stage timer setting on the machine. (This insures the controller is controlling the process.)

10. Set the first stage timer on the machine to 10% longer than the FILL TIME observed on the controller. (If a limit switch is used to terminate first-stage, it should be moved forward carefully.)

11. See, "VI. Cycle Optimization," or continue to "III. Procedure 3 - Takeover Approach" if filling on stroke and packing on pressure.

II. Procedure 2 - Takeover Approach
Fill on Pressure - Pack on Pressure

Use Procedure 2 when:

a. Cannot short shot.
b. A mold sensor is available, but:
   1. Not an insulated runner or a distributor tube sensor location.
   2. A sensor is not at the end of the fill path.
   3. Not a slow packing application.
c. If a mold sensor is not available, but a hydraulic sensor is and:
   1. Hydraulic pressure curve exhibits a slow pressure rise during first and second stage.
   2. Second-stage pressure is higher than first.

Procedure 2:

1. Connect controller to Power Interface Box and turn power "on".

2. Zero and calibrate equipment and set-up SCREWBACK and DECOMPRESS as noted in Section 3.

3. Mold acceptable parts with the CONTROL/MONITOR Switch in the MONITOR position and the ABORT Switch in the "off" position. The STROKE-PRESSURE Selectors, Positions 6 and 7, should be in the PRESSURE position.

NOTE: Observe the peak mold pressure reading on the controller.

4. Set the Pack setpoint, Position 7 on the controller, slightly below the peak mold pressure observed.

5. Set the Fill setpoint, Position 6 on the controller, equal to the Pack setpoint.

6. Set the third-stage hydraulic pressure on the machine to the minimum value. (All the way out.)

7. Set the high Alarm setpoint, Position 8 on the controller, 400 psi (0.40 BARS) above the peak mold pressure observed.

8. Turn the PACK, HOLD and ABORT Switches to the "ON" position.

9. Turn the CONTROL/MONITOR Switch on the controller to the CONTROL position.

10. Start making parts again and begin to increase the third-stage holding valve pressure until sink marks disappear in the part, then increase slightly to remove sinks. If the controller does not go to the third-stage "hold" setting, lower the Pack setpoint until it does.

11. On succeeding shots, lower the Fill setpoint until three distinct stages (sequence lights) are observed on the controller or an Incomplete Cycle occurs.

12. Observe FILL TIME reading. Lower Fill setpoint until FILL TIME reading is less than the first-stage timer setting on the machine. (This insures the controller is controlling the process.)

13. Set the first stage timer on the machine to 10% longer than the FILL TIME observed on the controller. (If a limit switch is used to terminate first-stage, it should be moved forward carefully.)

14. See, "VI. Cycle Optimization" or continue to "IV. Procedure 4" if filling on pressure and packing on stroke.

III. Procedure 3 - Takeover Approach
Fill on Stroke - Pack on Pressure

Use Procedure 3 when:

a. Cannot short shot, but can overpack.
b. Mold sensor is available and process is not a slow pack application.
c. A mold sensor is not available, but a hydraulic sensor is and hydraulic pressure exhibits a slow pressure rise during second stage.

Procedure 3:

1. Set-up the controller to FILL and PACK on STROKE. (See Procedure 1.)

2. While making acceptable parts, set the Display Selector to PRESSURE and record the displayed "peak" reading for that shot.

NOTE: The next three steps should be done with the machine in "manual" and not cycling.

3. Turn the Display Selector to Position 7 and enter the peak pressure into the display with the PACK Setpoint Knob.

4. Change the PACK STROKE-PRESSURE Selector (Position 7) to PRESSURE. Leave the FILL Selector (Position 6) in STROKE.

5. Turn the Display Selector to Position 8 and enter the "peak" cavity pressure number from Step #3 plus 200 to 400 psi (0.20 to 0.40 BARS) into the display with the ALARM Setpoint Knob.

   RETURN MACHINE TO NORMAL OPERATION AND THE CONTROL/MONITOR SWITCH TO "CONTROL".

6. Lower the Pack setpoint to the minimum value needed to make acceptable parts. This optimizes the set-up.

   The DME-4000 controller is now set to FILL on STROKE and PACK on PRESSURE with a maximum pressure alarm.

7. See, "VI. Cycle Optimization".

IV. <u>Procedure 4 - Takeover Approach</u>
Fill on Pressure - Pack on Stroke

<u>Use Procedure 4 when:</u>

a. Cannot short shot, but can overpack.
b. Mold sensor is available and:
   1. Not at the end of the fill path.
   2. Not working with an insulated runner sensor location.
   3. Not working with distributor tube sensor location.
c. A mold sensor is not available but a hydraulic sensor is and:
   1. Not working with an insulated runner.
   2. Not working with a distributor tube system.
   3. Hydraulic pressure exhibits and shows a pressure slope during first stage, until the mold is filled.

<u>Procedure 4:</u>

1. Set-up the controller to FILL and PACK on PRESSURE (use Procedure 2).

2. While making good parts, set the Display Selector to STROKE and record the maximum reading for that shot.

<u>NOTE:</u> The next three steps should be done with the machine in "manual" and not cycling.

3. Turn the Display Selector to Position 7 and enter the maximum stroke into the display with the PACK Setpoint Knob.

4. Change the PACK STROKE-PRESSURE Selector (Position 7) to STROKE. Leave the FILL Selector (Position 6) in PRESSURE.

5. Turn the Display Selector to Position 8 and enter the maximum stroke from Step #3 plus 1/8" to 1/4" (2 to 4 mm) into the display with the ALARM Setpoint Knob.

   RETURN MACHINE TO NORMAL OPERATION AND THE CONTROL/MONITOR SWITCH TO "CONTROL".

6. Lower the Pack setpoint to the minimum value required to make acceptable parts. This optimizes the set-up.

   The DME-4000 is now set to FILL on PRESSURE and PACK on STROKE with a maximum STROKE alarm.

7. See, "VI. Cycle Optimization".

V. Procedure 5 - Initial Start-Up Approach
USED WITH EITHER PRESSURE OR STROKE

Use Procedure 5 when:
a. Cannot overpack.
b. Able to short shot.
c. Mold diagnostics (i.e., balance) are desirable.
d. Choose FILL and PACK parameters based upon suggestions mentioned in Procedures 1 thru 4 or see the Flow Chart (Figure #19).

The basic start-up method, by which optimum molding conditions are established, is to begin by molding short shots and, on successive cycles, to increase filling until a full part is made. (If for a particular mold a short shot cannot be tolerated, a Takeover Approach, described on pages 4 thru 7 should be used.) The first step in start-up, using the DME-4000 Control System, is to fill, but not pack, the mold. This is done by setting the PACK and HOLD Set-Up Switches to the "off" position. (ABORT must be on.) The Fill setpoint is set approximately to make a short shot. The Fill setpoint is raised on succeeding shots until the mold is just filled or slightly short. The ability to discontinue the PACK and HOLD injection phases allows the molder to see exactly what effect on the part each adjustment has.

Once the desired FILL of the part is established, the molder adds the PACK phase to his set-up by turning the PACK Switch to the ON position. The initial Pack setpoint should be set slightly higher than the peak pressure or maximum stroke read on the digital readout when only FILL was used. On successive cycles, the Pack setpoint is raised until the desired level of packing is reached. (NOTE: Sink marks may still be present on parts because no third-stage HOLD is being used.) The ram is stopped as soon as the Pack setpoint is reached so that effects of each adjustment can be seen. Pack speed can be adjusted by changing second-stage injection pressure on the machine. Having found the desired pack pressure and pack speed, the molder can turn on third-stage holding pressure by switching the HOLD Switch to ON.

The third-stage pressure is set on the third-stage valve added to the molding machine. This third-stage pressure should be set as low as possible to make an acceptable part. The third-stage is set to eliminate sinks, reduce warpage, eliminate part sticking and to closely control part dimensions.

The set-up described above is accomplished by adjusting each injection phase independently to achieve the best molded part properties. The molder can, at any time, check for process changes by stopping injection at the end of fill or the end of pack to observe how the mold is being filled or packed. This ability greatly simplifies diagnosing problems such as hot runner gate balancing or burning problems.

NOTE: Do not use this procedure if short shots cannot be tolerated. Use one of the Takeover Approaches.

1. Set the following switches:
   a. POWER on
   b. PACK off
   c. HOLD off
   d. ABORT "ON"

2. Zero and calibrate the STP and any sensors used (see Section 3).

3. Set SCREWBACK and DECOMPRESS as desired (see Section 3).

4. Set the FILL and PACK STROKE-PRESSURE Selectors as desired.

5. Set the following machine conditions:
   a. First-stage pressure - slightly above that pressure normally used to fill the mold.
   b. Second-stage pressure - slightly above that pressure normally used to pack the mold.
   c. Third-stage pressure - zero.
   d. Injection timers - same as in normal set-up.

6. Set the following controller settings:
   a. CONTROL/MONITOR Switch to CONTROL.
   b. Turn the Display Selector to Position 6 and if using STROKE for FILL, enter the length of the stroke minus 50 percent into the display with the FILL Setpoint Knob. If using PRESSURE for FILL enter 0.10 into the display with the FILL Setpoint Knob. In either case, make sure the number entered is low enough to guarantee a short shot.
   c. Set the ALARM Setpoint Knob totally clockwise.

7. Set the Display Selector to STROKE or PRESSURE, whichever is desired to control fill, and begin molding. On successive cycles raise the Fill setpoint until the mold fills to the desired level.

NOTE: Observe the maximum stroke or pressure reading on the display.

8. Adjust the machine's first-stage injection pressure as necessary to obtain a faster or slower fill rate. The change can be monitored on the display by setting the Display Selector on the FILL TIME position.

NOTE: A change in FILL TIME may require a readjustment of the Fill setpoint.

9. Set the Display Selector to FILL TIME and close the machine's injection speed (flow control) valve until the FILL TIME increases slightly. This insures closer control over FILL TIME.

10. Set the Display Selector to either STROKE or PRESSURE, whichever is desired to control PACK. Turn the Display Selector to Position 7 and:
    a. If using STROKE for pack, enter the length of stroke minus 20 percent into the display.
    b. If using PRESSURE for PACK, enter 0.10 into the display.

11. Put the PACK Switch (Position 7) to the ON position. This turns on the machine's second-stage injection pressure.

12. On successive cycles, raise the Pack setpoint until the mold is packed to the desired level. (Parts may still have sink marks because no third-stage hold pressure is used.)

NOTE: If an incomplete cycle occurs, check to insure that cushion, injection timers and second stage pressure are sufficient to allow the Pack setpoint to be reached.

13. Adjust the machine's second-stage injection pressure as necessary to obtain a faster or slower pack rate. The change can be monitored on the display by setting the Display Selector to the PACK TIME position.

NOTE: Any change in the PACK TIME may require a readjustment in the Pack setpoint to make acceptable parts.

14. Put the HOLD Switch in the ON position. This turns on the machine's third-stage injection pressure.

15. Set the Display Selector to PRESSURE (if a pressure sensor is installed.) On succeeding shots raise the third-stage injection pressure to hold the proper amount of material in the mold to eliminate sinks or voids, and to closely control part dimensions.

NOTE: Third-stage pressure should not be set so high as to cause additional packing in the mold. If additional packing is necessary, raise the Pack setpoint accordingly.

16. Set the Display Selector to Position 8, ALARM, and using the ALARM Setpoint Knob enter the maximum stroke observed in Step #15 +1/4-inch to 1/2-inch or 100 to 200 psi (0.1 to 0.2 BARS).

17. The Alarm setpoint can be used for the following purposes:
    a. To set an upper limit above which molded parts are rejected: Find the maximum pressure which still can produce good parts by raising the Pack setpoint.
    b. To provide the prewired Injection Abort Safety: Find the pressure at which a part will flash, stick or cause possible mold damage by gradually raising the Pack setpoint.
    c. To alarm if high plastic pressure occurs: Observe the normal mold pressure variation and set the Alarm setpoint at 200 psi above the highest mold pressure observed on the Digital Readout.
    d. To alarm if excessive stroke occurs: Observe the normal maximum stroke and set the Alarm setpoint 1/8-inch to 1/4-inch (2 to 4 mm) above greater than the maximum observed stroke.

VI. Cycle Optimization

1. Optimize FILL TIME by adjusting injection speed.

2. Minimize PACK TIME by increasing the second-stage hydraulic pressure on the machine.

3. Decrease overall cycle or cooling timer by amount of FILL TIME and PACK TIME reduction.

4. Minimize "peak" mold pressure by lowering Pack setpoint on the controller.

5. Minimize the third-stage hydraulic pressure on the machine.

VII. Troubleshooting

1. If no mold pressure is read or numbers do not change:
    a. Check to insure sensor is correctly installed in the mold. Then recheck zero and calibration.
    b. Check cable from the sensor to unit. Make sure sensor is plugged into the PRESSURE INPUT and not reversed with the STROKE INPUT on the side panel.

2. If no stroke is read or numbers do not change:
   a. Check to insure the Screw Travel Potentiometer (STP) is mounted properly to the machine. Recheck zero and calibration.

   b. Check cable from the STP to the controller. Be sure the cable is plugged into the STROKE INPUT and not reversed with the PRESSURE INPUT.

   c. Check STP by moving screw, which if working, will indicate a change in stroke on the meter display. Replace if necessary.
   d. Replace control unit.

3. STROKE reads backwards:
   a. If a decrease in stroke is occurring as the screw is bottomed, change the STP Polarity Switch to opposite position.

4. If mold pressure varies up or down:
   a. Check second-stage pressure to insure it is adequate to always allow Pack setpoint to be reached.
   b. Check that there is a cushion.

5. IF FILL TIME varies up or down:
   a. Insure first-stage hydraulic pressure is adequate to obtain desired fill speed.
   b. Insure that the machine flow control valve is restricted, thereby controlling FILL TIME.

6. If sink marks occur in the part:
   a. Increase third-stage hydraulic pressure.
   b. Increase Pack setpoint.

VIII. <u>Shutdown Procedures</u>

If it becomes necessary to turn the controller off and return to standard machine controls, this can be accomplished simply without affecting the molding operation. Reasons for doing this could include failure of a mold sensor, recalibration of the system or diagnosis of a mold or machine problem. Returning to machine control can be done in two ways: 1)switching from the CONTROL to MONITOR position or 2)turning the controller "off".

1. Switching from the CONTROL to MONITOR position:
   a. Switch the machine to semi-automatic or manual.
   b. After a cycle is complete, turn the Display Selector and read the FILL TIME.

c. Set the First-Stage Boost Timer to the FILL TIME reading in Step #2 above.
d. If stroke was used to fill the part, set the Boost Cut-Off Switch to the Fill setpoint (Display Selector Position 6). Otherwise, move the Boost Cut-Off Switch back to its original position.
e. Place the CONTROL/MONITOR Switch in the MONITOR position.
f. Start molding parts and readjust pressures and times as required.
g. If ABORT is not desired, place the ABORT Switch in the "off" position.

2. Turning the controller "off":
   a. Switch the machine to semi-automatic control.
   b. Turn the machine decompress (if used) "off".
   c. Allow the screw to recover to the SCREWBACK position.
   d. Move the machine's Screwback Limit Switch or control back to the above SCREWBACK position.
   e. Turn the machine decompress "on" and allow the screw to move to the decompress stop position.
   f. Move the machine's Decompress Limit Switch or control back to this decompress stop position.
   g. Set the machine's First-Stage Boost Timer or Boost Cut-Off Limit Switch back to their original positions before the DME-4000 controller was used.
   h. Place the CONTROL/MONITOR Switch in the MONITOR position.
   i. Turn the ABORT Switch to "off".
   j. Turn the POWER Switch to "off".
   k. Run parts and readjust pressures and times as required. This returns control of the machine to the standard machine controls.

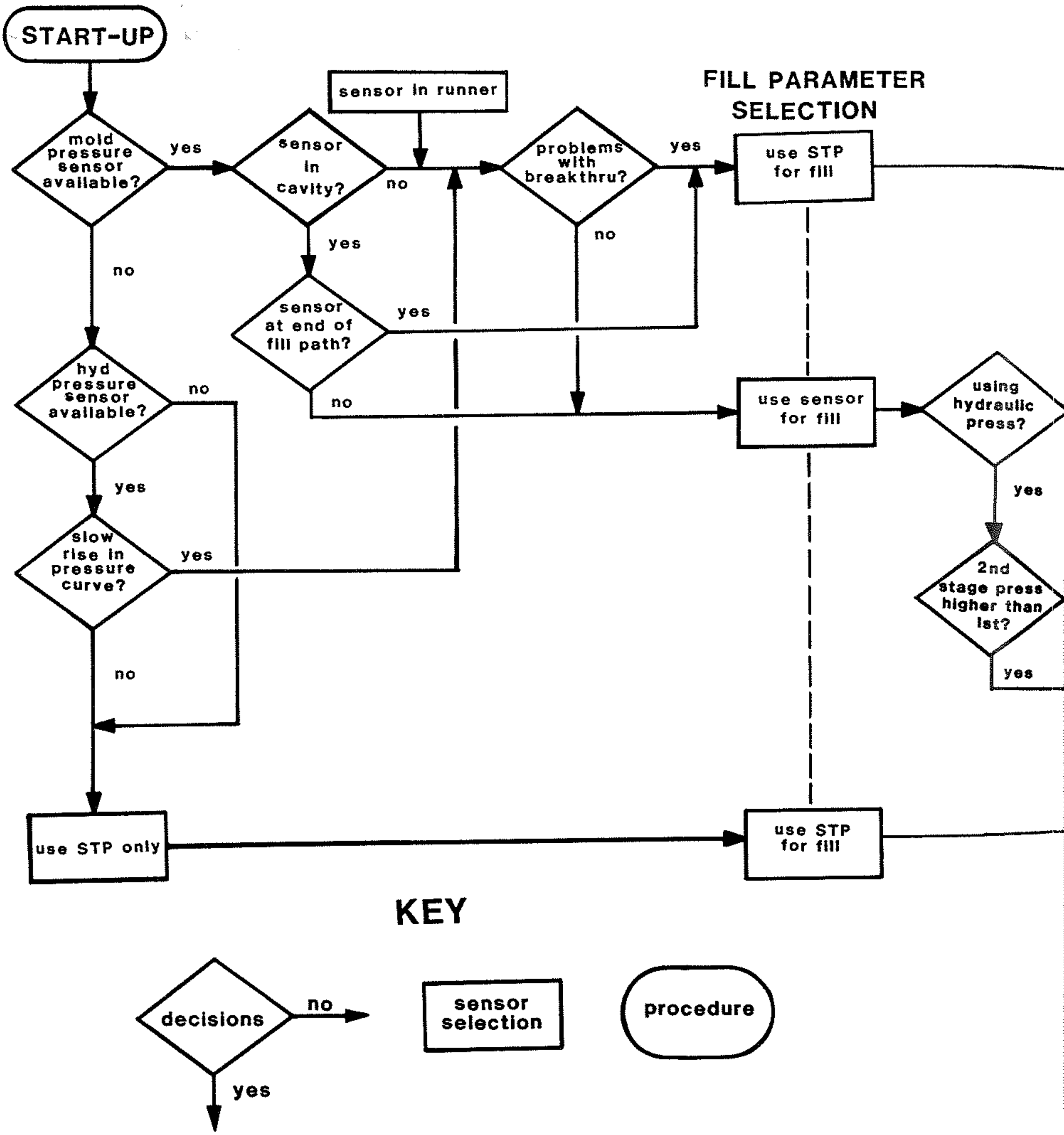
3. Removal of the DME-4000 Controller

   If it is necessary to move the DME-4000 controller from one machine to another or to remove it for any reason, use the following procedures.

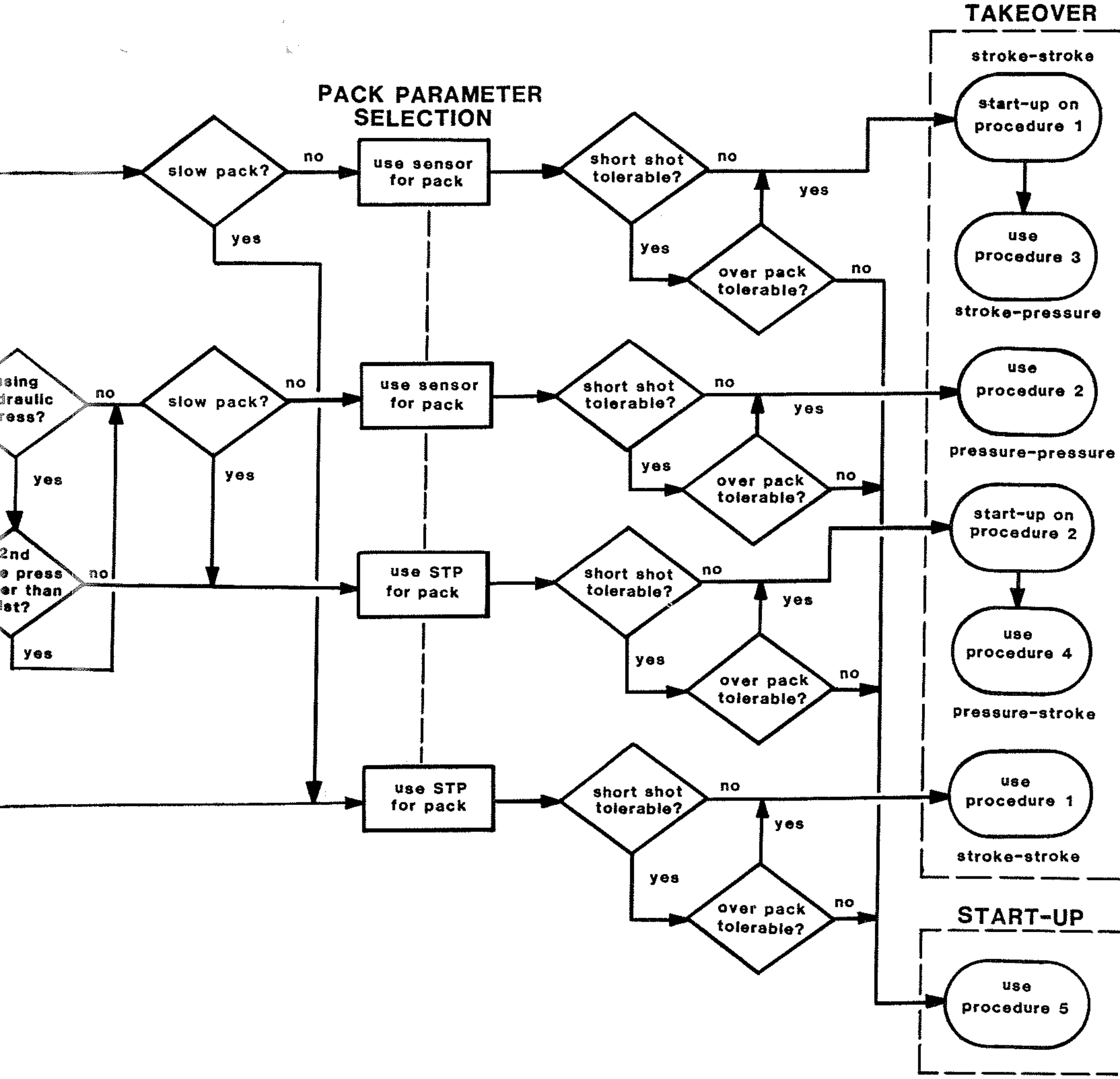
   a. Turn the controls "off" as stated in Step #2.
   b. Turn the machine "off".
   c. Unplug the DME-4000 from the PI-930 Power Interface Box.
   d. Reconnect the Jumper Plug to the PI-930. (Jumper Plug is chained to the Control Interface Connector.)

<u>NOTE:</u> This reconnects all normally closed relay contacts used in the controller. The machine <u>will</u> <u>not</u> run unless this plug is installed.

SET-UP PROCEDURE SE



E SELECTION


TAKEOVER
PACK PARAMETER SELECTION
slow pack?
no
yes
use sensor for pack
short shot tolerable?
over pack tolerable?
use STP for pack
2nd press er than 1st?
stroke-stroke
start-up on procedure 1
use procedure 3
stroke-pressure
use procedure 2
pressure-pressure
start-up on procedure 2
use procedure 4
pressure-stroke
use procedure 1
stroke-stroke
START-UP
use procedure 5

SECTION 5

APPENDIX

I. DME-4000 SPECIFICATIONS

DME-4000 SPECIFICATIONS	
Accuracy	Analog Output & Digital Display: ± 1% full scale. DP Control Setpoint: .8% full scale maximum.
Repeatability	Analog Output & Digital Display: .5% full scale. Setpoint: .25% full scale.
Recorder Output: Pressure	Proportional to cavity pressure. 5VDC corresponds to 20,000 psi (or 2,000 Kg/cm). Maximum load: 1K ohm.
Recorder Output: Stroke	Proportional to screw position. 5VDC corresponds to 20 inches. Maximum load: 1K ohm.
Control Span Range: Pressure	Setpoints: 0 to 20K psi Pin sizes: Model SS-405C or BS-412C Sensor- (diameter) 1/16, 3/32, 1/8, 5/32, 3/16" (2 to 6mm) Model SS-406C or BS-413C Sensor- (diameter) 3/16, 1/4, 5/16, 3/8, 1/2" (6 to 16mm)
Control Span Range: Stroke	Setpoints: Fill, pack, alarm: 0 to 20 inches Screwback: 0 to 20 inches Decompress: 0 to -3.5 inches Stroke measurement: 0 to 24 inches
Temperature Range	50 to 130°F
Power Required	115VAC (105-125), 50-60Hz
Zero Drift, Analog-Output	Long term: .1%/month With temperature: .1%F
Output Contact Rating	10 amps, 1/3 hp, 125-250VAC
Injection Forward Input Circuit	105-130VAC, 47-65Hz, 10K ohm input impedance
Dimensions	18"W x 8"D x 12" H

STROKE MEASUREMENT RANGES OF SCREW TRAVEL POTENTIOMETER*		
Cat. No. STP-471	0-9 inches	(267Ω/inch)
Cat. No. STP-472	0-12 inches	(267Ω/inch)
Cat. No. STP-473	0-18 inches	(267Ω/inch)
Cat. No. STP-474	0-24 inches	(267Ω/inch)

* Potentiometers with a maximum measuring range of 36 inches are available on special order.

VA-30M (VALVE ASSEMBLY) SPECIFICATIONS	
OPERATING PRESSURE	2000 psi (maximum)
FLOW RATE	3 GPM (pilot flow) (maximum)
POWER	115VAC, 50-60Hz

II. Calibration for Unlisted Ejector Pin Sizes

A. General

Prior to using unlisted ejector pin sizes (i.e., not shown on the PIN SIZE Selector) to measure pressure, a new calibration number must be determined. Once the new calibration number is calculated, the only adjustment required is to turn the Display Selector to Position 2 (PRESSURE-CAL) and turn the calibration adjustment to the new calibration number.

NOTE: THE PIN SIZE SELECTOR MAY BE PLACED IN ANY POSITION NECESSARY TO ACHIEVE THE NEW CALIBRATION NUMBER.

B. Determining New Calibration Number

1. Calculate a new calibration number ("new cal") for the unlisted size using the following equation:

   $$\text{New calibration number} = \frac{A^2}{B^2} \times \text{cal number on sensor ID tag}$$

   A = Diameter listed on sensor ID tag

   A = 1/8" for Model 405

   A = 1/4" for Model 406

   A = 1/8" for Model 412

   A = 1/4" for Model 413

   B = Diameter of unlisted pin

2. If "new cal" number is higher than 20,000 psi, divide "new cal" number by two (2) and use this value as the calibration setting. The digital meter will now read one-half the actual pressure in the mold (i.e., multiply the meter reading by 2 to find the actual mold pressure).

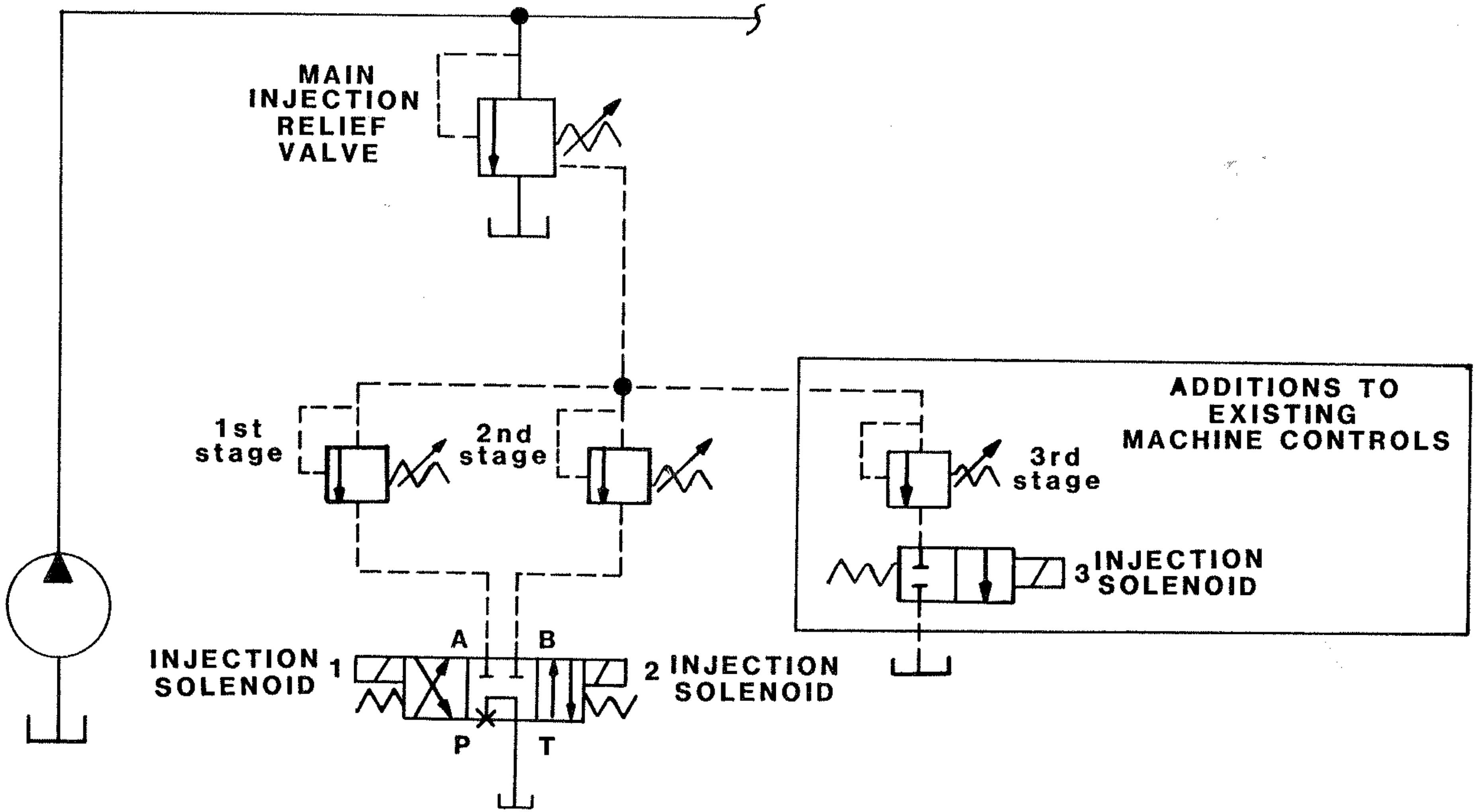
III. Hydraulic Modifications

VA-30M THIRD-STAGE RELIEF VALVE
INSTALLATION PROCEDURES

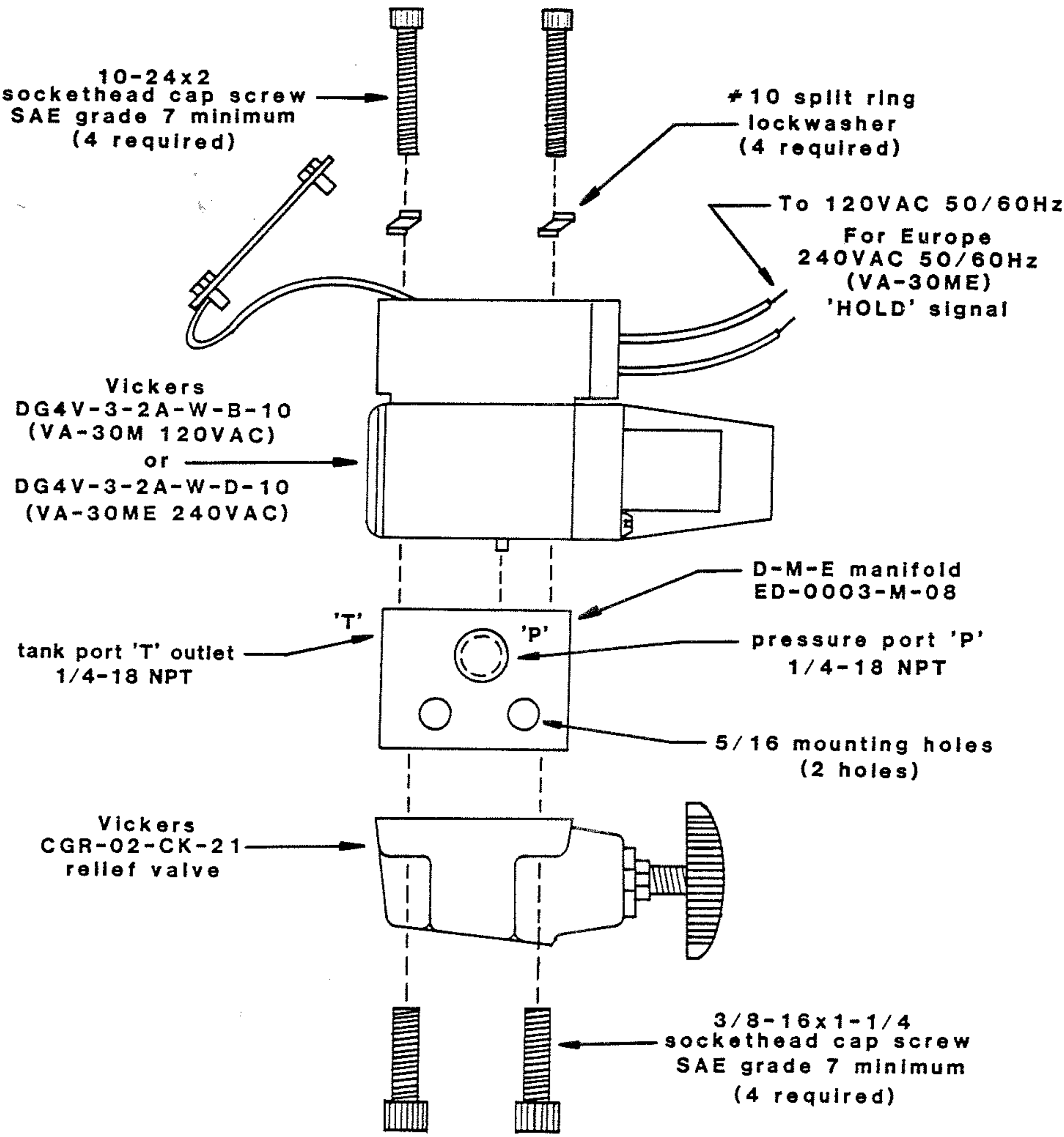
The Third-Stage* or Hold Pressure Valve should be installed in the pilot circuit of the main injection relief valve. If the machine has two separate main injection relief valves for First-Stage and Second-Stage, then install VA-30M on Second-Stage main relief valve. (Refer to the next page for a schematic representation of this installation.) This pilot pressure is generally available on the main or Second-Stage relief valves, through a vent port on the valve, opposite the adjustment knob. This pressure is connected to the "P" pressure port on the VA-30M. The valve is drained to tank through the "T" port. This line should be direct to tank, since any pressure at this point will be added to the pressure setting.

For operator convenience, the VA-30M should be mounted close to existing machine hydraulic controls. Plumbing to the "P" pressure port should be done through 1/4-inch (minimum) high pressure steel tubing. High pressure flexible hose can be used but may result in pressure oscillations. If this occurs, addition of a 0.040-inch orifice at the main relief valve should help reduce the oscillations. The tank line may be low pressure hose of 1/4-inch minimum diameter.

*If your machine is already equipped with Third-Stage Injection, check with your D-M-E Technical Service Representative for installation information.



3-STAGE HYDRAULIC INTERFACE



3rd STAGE VALVE ASSEMBLY
(VA-30M and VA-30ME)

IV. Power Interface Machine Connections

PI-930 POWER INTERFACE BOX
COLORED WIRING AND TERMINAL NUMBER INFORMATION

DME-4000

1) Black (10): The black wire is to be connected to a 120 VAC signal that is "ON" from the beginning of injection forward to the end of injection forward. The black wire must be installed on the signal side of the injection forward solenoid circuit where the signal normally comes from, usually at the same point where the yellow wire from ABORT is also installed, including almost all cases that involve machines with 120 VAC solenoid.

2) White (11): The white wire is always connected to 120 VAC COMMON.

3) Red (17), Green (18) & Violet (16): These wires are used to duplicate the function of the Boost Cut-Off Limit Switch or Timer. Use the red and green wires to parallel a normally open contact of either the Boost Cut-Off Timer or Limit Switch. Use the red and violet wires in series with a "boost solenoid" or relay input for Boost Cut-Off (transfer to pack).

> NOTE: The red, green and violet wires are to be wired into the machine such that when the DME-4000 is in control, the machine shifts to second stage when: the Fill setpoint is reached, the booster timer times out or a limit switch for that function is made, whichever occurs first.

6) Yellow (27) & Blue (26): The yellow and blue wire is the ALARM/ABORT injection forward circuit. It represents a set of contacts that are normally open but held closed. When Abort or Incomplete Cycle occur these contacts open. When opened by an alarm condition they remain open until the beginning of the next injection forward signal.

> NOTE: The blue wire must be spliced to the wire from the terminal strip in the machine control panel that physically goes to the injection forward solenoid. The yellow wire is to be installed at the location on the terminal strip where we removed the injection forward solenoid wire, which is now connected to the blue wire.

7) Tan (30), Grey (29) & Pink (31): These wires are used to duplicate the function of a Screw Return Limit Switch. Use the tan and pink wires to parallel a normally open limit switch. Use the tan and grey wires to open a solenoid. These contacts trip when the Screwback setpoint is reached.

8) Red/Black (36), Red/Green (35) & Red/Yellow (37): These wires are used to duplicate the function of a Suckback or Decompress Limit Switch or Timer. Use the red/black and red/yellow wires to parallel a normally open limit switch. Use the red/black and red/green wires to open a solenoid. These contacts trip when the Decompress setpoint is reached.

NOTE: Use only for rear decompress, after screw recovery.

9) Brown (14) & Orange (13): The brown and orange cable wires are used as an optional alarm contact. These can be used to ring a bell or turn on a lamp. These contacts trip when the ALARM/ABORT setpoint is reached.

TERMINAL STRIP:

10) Black (24) & White (23): These wires power the third stage holding valve when the Pack setpoint is reached. They supply 120 VAC directly to the valve.

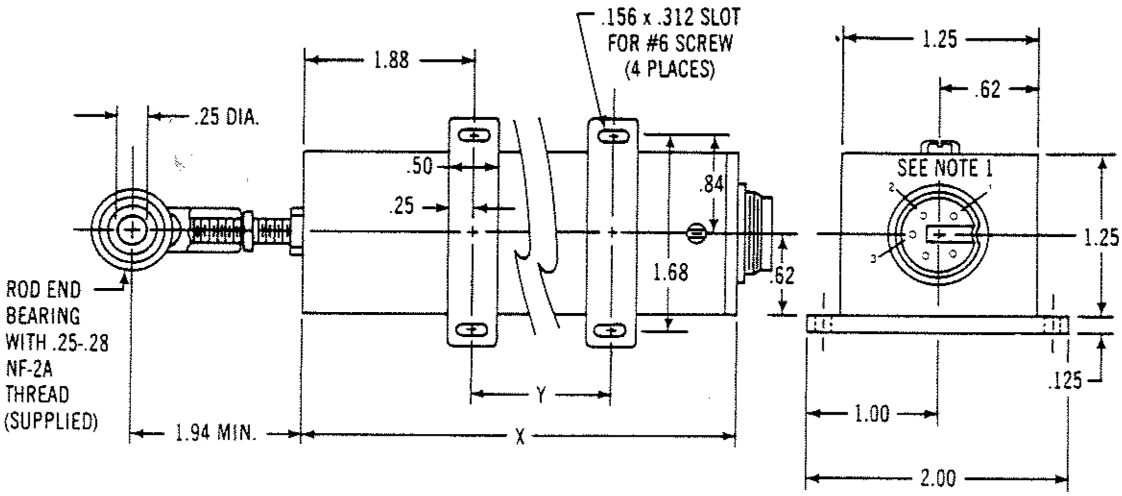
11) Red (21) & Red (22): The pack auxiliary contacts are normally open contacts which can be used to energize an extra relay or solenoid if necessary, such as a second stage flow control valve. This contact trips when the Fill setpoint is reached.

16 GAGE, SEPARATE WIRES:

12) Brown (16g) & Orange (16g): The brown and orange wires are connected to 440 VAC or 220 VAC for the Power Interface Transformer. If you connect on 220 VAC, the terminal strip on the transformer in the PI-930 box must be changed accordingly. (See chart on transformer.)

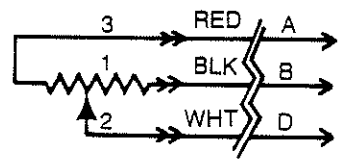
13) Green (16g): This green wire should be connected to a machine ground point. (NOTE: Frame ground, not AC COMMON.)

SCREW TRAVEL POTENTIOMETERS



CATALOG NUMBER	X	Y
STP-471	11.64″	7.875″
STP-472	14.78″	11.000″
STP-473	20.78″	17.000″
STP-474	26.78″	23.000″

NOTE 1: ELECTRICAL SCHEMATIC:



INSTALLATION

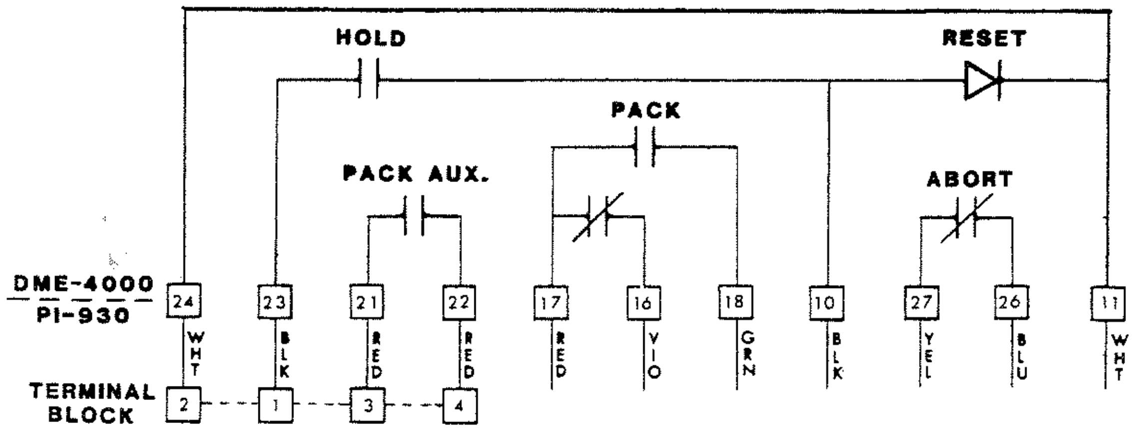
Select measuring range based on maximum screw travel + 1 inch.
Potentiometers with a maximum measuring range of 36 inches are available on special order.

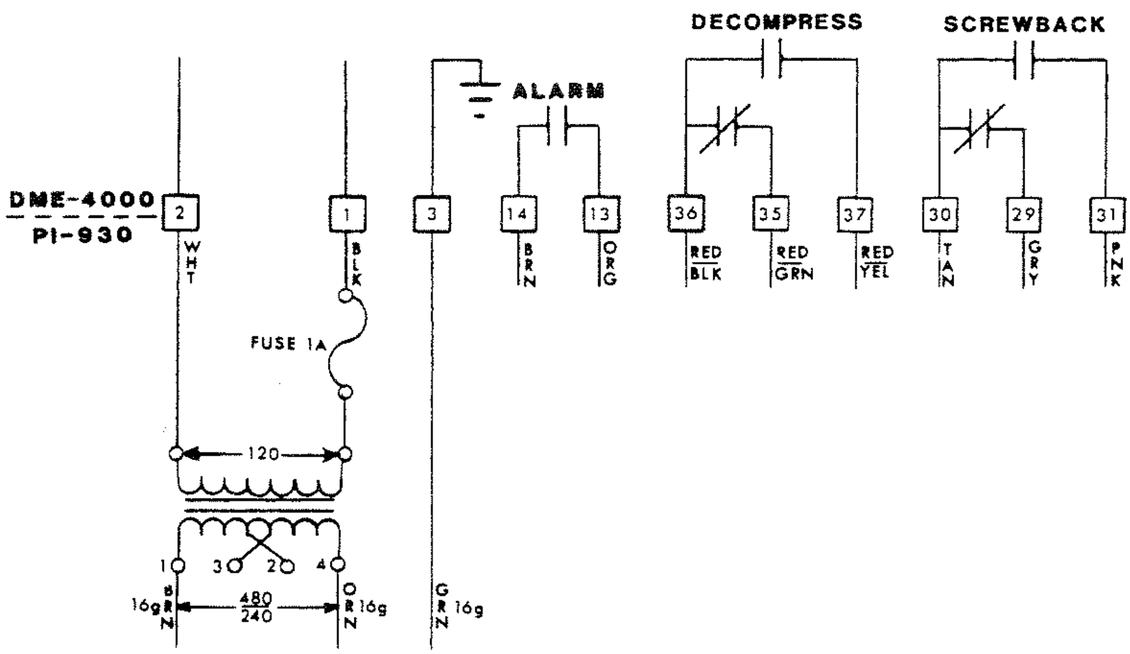
CATALOG NUMBER	MEASURING RANGE*
STP-471	0-9″
STP-472	0-12″
STP-473	0-18″
STP-474	0-24″

SPECIFICATIONS

MEASURING RANGE	0 TO 9, 12, 18 OR 24 INCHES*
INPUT	24VDC
POWER RATING	0.75 WATTS/STROKE INCH
CYCLE LIFE	10 MILLION CYCLES
REPEATABILITY	0.005 INCHES
ACCURACY (LINEARITY)	±1.0%
CABLE LENGTH	15 FEET
CABLE ELECTRICAL CONNECTORS:	
POTENTIOMETER END	BINDER 681.09-0114-56-05
INSTRUMENT END	BT06J-10-6P

DME-4000 / PI-930 INTERFACE





CUSTOMER ______________________ MACH. TYPE ______________________

CONTACT ______________________ REF. DWG. ______________________

TELEPHONE ______________________ DRAWN BY ______________________

SALESMAN ______________________ DATE ______________________

S E C T I O N 6

MOLD SET-UP SHEETS

customer__________ date__________ part # and name__________

machine #__________ material__________ mold #__________ cavities__________

CONTROLLER SETTINGS

Sensor Model	__________
Ejector Pin Size	__________
Fill Setpoint	__________
Fill on	stroke ☐ pressure ☐
Pack Setpoint	__________
Pack on	stroke ☐ pressure ☐
Hi-Alarm Setpoint	__________
Peak Cavity	__________
Pressure Reading	__________
Fill Time Reading	__________
Pack Time Reading	__________
Screwback Setpoint	__________
Decompress Setpoint	__________

MACHINE SETTINGS

Barrel Temp.
- Nozzle __________
- Front __________
- Center __________
- Rear __________
- Melt __________

Timers
- 1st Stage __________
- 2nd Stage __________
- Overall Inj. __________
- Cooling __________
- Mold Open __________

Std. Cycle __________

Mold Temp.
- Movable __________
- Stationary __________
- Middle Plate __________

Pressure
- 1st Inj. __________
- 2nd Inj. __________
- 3rd Inj. __________
- Back __________
- Clamp __________

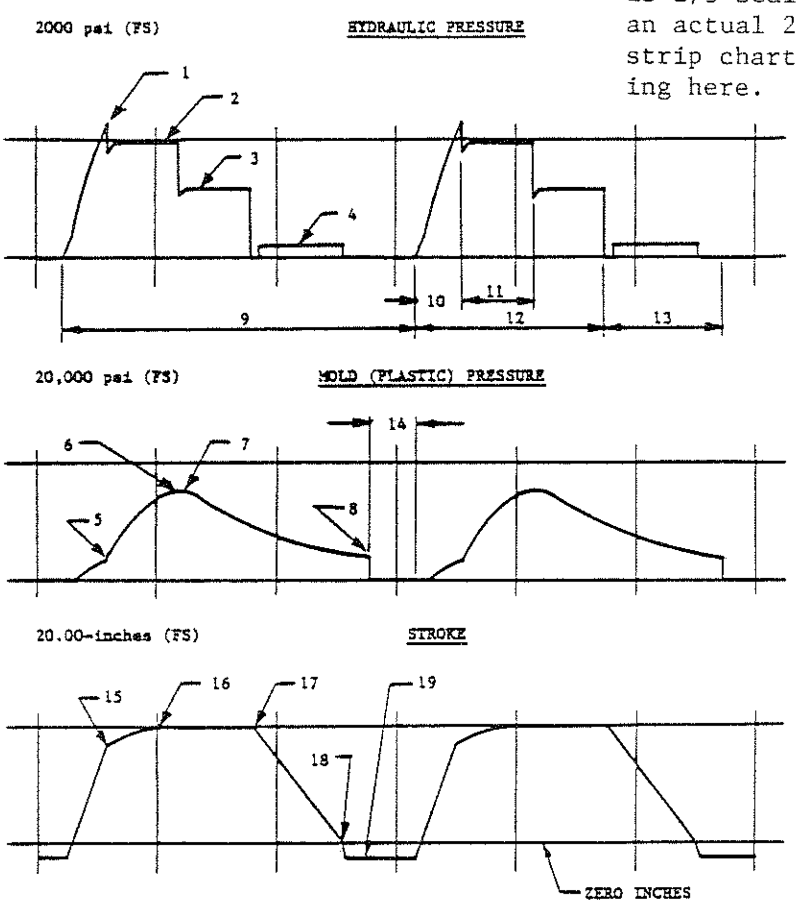
Screw Displacement
- Stroke __________
- Decompress __________
- Cushion __________

Flow Control Setting __________

NOTES:

CHART ANALYSIS

NOTE: This example is 2/3 scale. Tape an actual 2 channel strip chart recording here.



PRESSURES
1) 1st __________
2) 2nd __________
3) 3rd __________
4) Back __________
5) Fill __________
6) Pack __________
7) Peak __________
8) Residual __________

TIMES
9) Cycle __________
10) Fill __________
11) Pack __________
12) Overall Inj __________
13) Cool __________
14) Mold Open __________

STROKE
15) Fill __________
16) Pack __________
17) Max Stroke __________
18) Screwback __________
19) Decompress __________

Chart Speed: __________
(normally 5mm/second)

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

customer ____________ date ____________ part # and name ____________

machine # ____________ material ____________ mold # ____________ cavities ____________

CONTROLLER SETTINGS

Sensor Model ____________
Ejector Pin Size ____________
Fill Setpoint ____________
Fill on stroke ☐ pressure ☐
Pack Setpoint ____________
Pack on stroke ☐ pressure ☐
Hi-Alarm Setpoint ____________
Peak Cavity ____________
Pressure Reading ____________
Fill Time Reading ____________
Pack Time Reading ____________
Screwback Setpoint ____________
Decompress Setpoint ____________

MACHINE SETTINGS

Barrel Temp.
Nozzle ____________
Front ____________
Center ____________
Rear ____________
Melt ____________

Timers
1st Stage ____________
2nd Stage ____________
Overall Inj. ____________
Cooling ____________
Mold Open ____________

Std. Cycle ____________

Mold Temp.
Movable ____________
Stationary ____________
Middle Plate ____________

Pressure
1st Inj. ____________
2nd Inj. ____________
3rd Inj. ____________
Back ____________
Clamp ____________

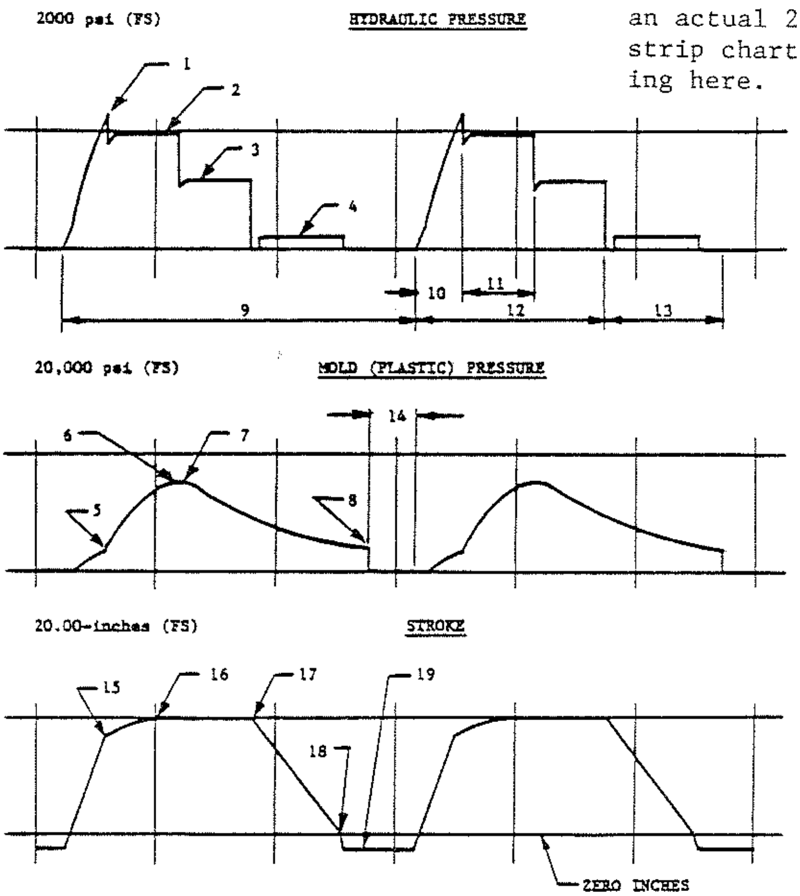
Screw Displacement
Stroke ____________
Decompress ____________
Cushion ____________

Flow Control Setting ____________

NOTES:

CHART ANALYSIS

NOTE: This example is 2/3 scale. Tape an actual 2 channel strip chart recording here.



PRESSURES

1)1st ____________
2)2nd ____________
3)3rd ____________
4)Back ____________
5)Fill ____________
6)Pack ____________
7)Peak ____________
8)Residual ____________

TIMES

9)Cycle ____________
10)Fill ____________
11)Pack ____________
12)Overall Inj ____________
13)Cool ____________
14)Mold Open ____________

STROKE

15)Fill ____________
16)Pack ____________
17)Max Stroke ____________
18)Screwback ____________
19)Decompress ____________

Chart Speed: ____________
(normally 5mm/second)

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

customer ____________ date ____________ part # and name ____________

machine # ____________ material ____________ mold # ____________ cavities ____________

CONTROLLER SETTINGS

Sensor Model	________
Ejector Pin Size	________
Fill Setpoint	________
Fill on	stroke ☐ pressure ☐
Pack Setpoint	________
Pack on	stroke ☐ pressure ☐
Hi-Alarm Setpoint	________
Peak Cavity	________
Pressure Reading	________
Fill Time Reading	________
Pack Time Reading	________
Screwback Setpoint	________
Decompress Setpoint	________

MACHINE SETTINGS

Barrel Temp.

Nozzle	________
Front	________
Center	________
Rear	________
Melt	________

Timers

1st Stage	________
2nd Stage	________
Overall Inj.	________
Cooling	________
Mold Open	________

Std. Cycle ________

Mold Temp.

Movable	________
Stationary	________
Middle Plate	________

Screw Displacement

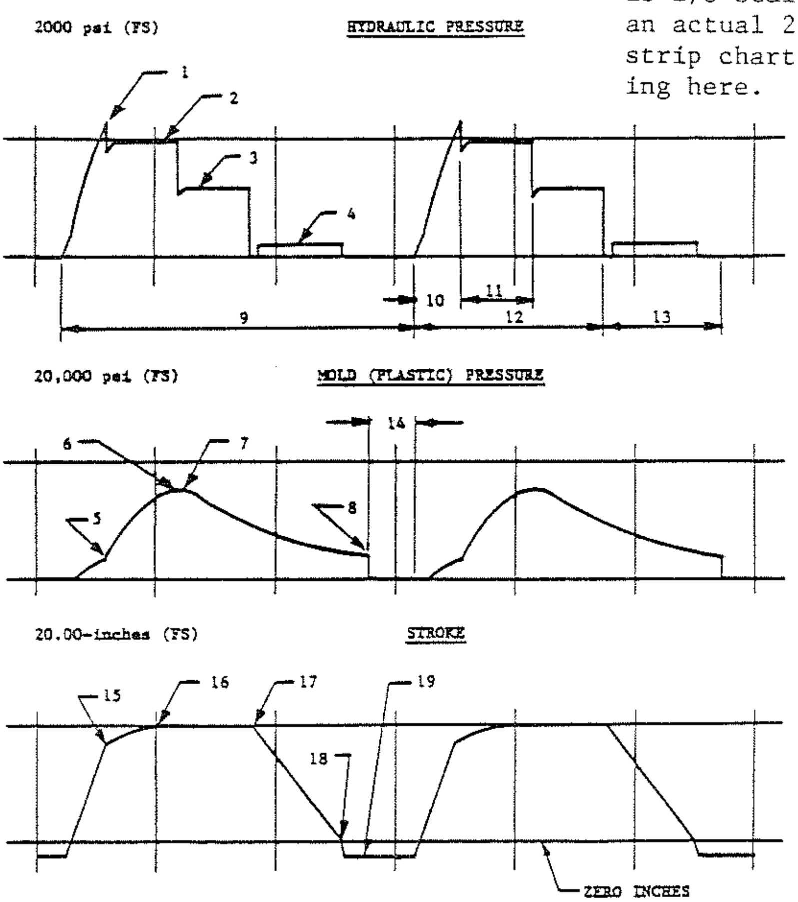
Stroke	________
Decompress	________
Cushion	________

Pressure

1st Inj.	________
2nd Inj.	________
3rd Inj.	________
Back	________
Clamp	________
Flow Control Setting	________

NOTES:

CHART ANALYSIS



NOTE: This example is 2/3 scale. Tape an actual 2 channel strip chart recording here.

PRESSURES

1) 1st	________
2) 2nd	________
3) 3rd	________
4) Back	________
5) Fill	________
6) Pack	________
7) Peak	________
8) Residual	________

TIMES

9) Cycle	________
10) Fill	________
11) Pack	________
12) Overall Inj	________
13) Cool	________
14) Mold Open	________

STROKE

15) Fill	________
16) Pack	________
17) Max Stroke	________
18) Screwback	________
19) Decompress	________

Chart Speed: ________
(normally 5mm/second)

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

customer ______ date ______ part # and name ______

machine # ______ material ______ mold # ______ cavities ______

CONTROLLER SETTINGS

Sensor Model	______
Ejector Pin Size	______
Fill Setpoint	______
Fill on	stroke ☐ pressure ☐
Pack Setpoint	______
Pack on	stroke ☐ pressure ☐
Hi-Alarm Setpoint	______
Peak Cavity	______
Pressure Reading	______
Fill Time Reading	______
Pack Time Reading	______
Screwback Setpoint	______
Decompress Setpoint	______

MACHINE SETTINGS

Barrel Temp.

Nozzle	______
Front	______
Center	______
Rear	______
Melt	______

Mold Temp.

Movable	______
Stationary	______
Middle Plate	______

Screw Displacement

Stroke	______
Decompress	______
Cushion	______

Timers

1st Stage	______
2nd Stage	______
Overall Inj.	______
Cooling	______
Mold Open	______

Std. Cycle ______

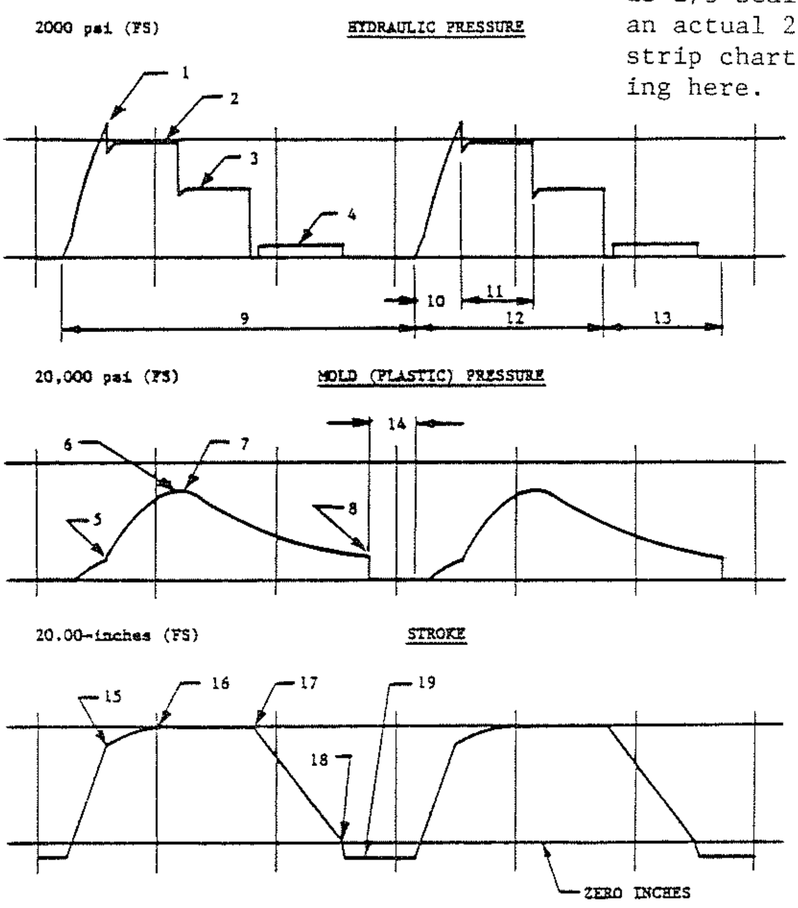
Pressure

1st Inj.	______
2nd Inj.	______
3rd Inj.	______
Back	______
Clamp	______
Flow Control Setting	______

NOTES:

CHART ANALYSIS

NOTE: This example is 2/3 scale. Tape an actual 2 channel strip chart recording here.



PRESSURES

1) 1st	______
2) 2nd	______
3) 3rd	______
4) Back	______
5) Fill	______
6) Pack	______
7) Peak	______
8) Residual	______

TIMES

9) Cycle	______
10) Fill	______
11) Pack	______
12) Overall Inj	______
13) Cool	______
14) Mold Open	______

STROKE

15) Fill	______
16) Pack	______
17) Max Stroke	______
18) Screwback	______
19) Decompress	______

Chart Speed: ______
(normally 5mm/second)

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

customer__________________ date______________ part # and name__________________

machine #______________ material______________ mold #_________ cavities_________

CONTROLLER SETTINGS

Sensor Model	______________
Ejector Pin Size	______________
Fill Setpoint	______________
Fill on	stroke ☐ pressure ☐
Pack Setpoint	______________
Pack on	stroke ☐ pressure ☐
Hi-Alarm Setpoint	______________
Peak Cavity Pressure Reading	______________
Fill Time Reading	______________
Pack Time Reading	______________
Screwback Setpoint	______________
Decompress Setpoint	______________

MACHINE SETTINGS

Barrel Temp.

Nozzle	________
Front	________
Center	________
Rear	________
Melt	________

Timers

1st Stage	________
2nd Stage	________
Overall Inj.	________
Cooling	________
Mold Open	________

Std. Cycle ________

Mold Temp.

Movable	________
Stationary	________
Middle Plate	________

Screw Displacement

Stroke	________
Decompress	________
Cushion	________

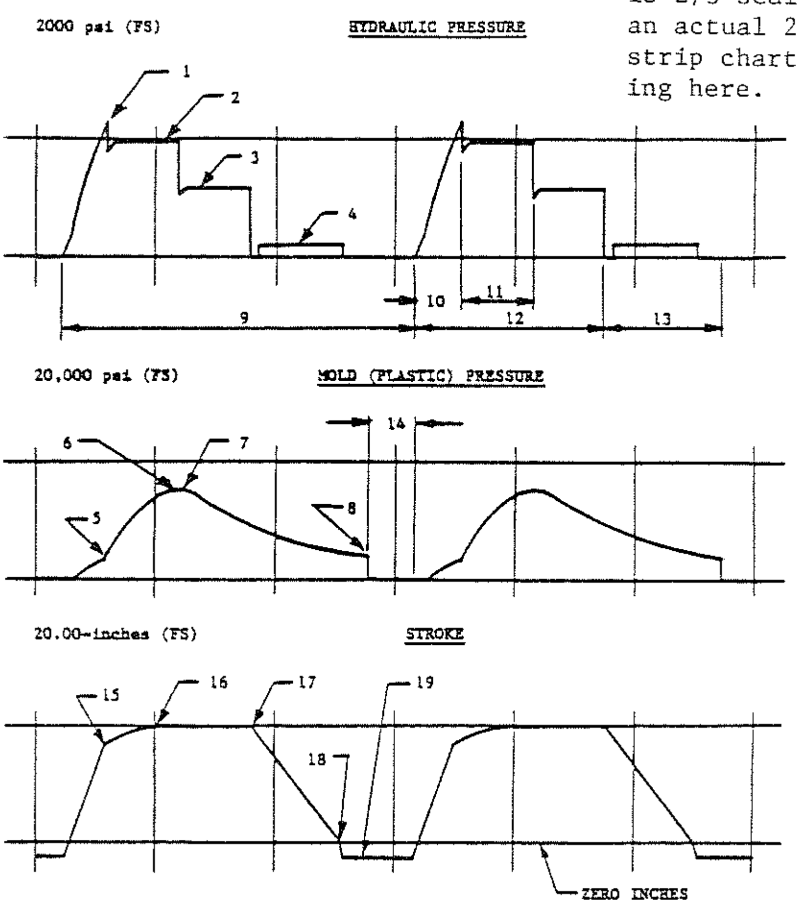
Pressure

1st Inj.	________
2nd Inj.	________
3rd Inj.	________
Back	________
Clamp	________
Flow Control Setting	________

NOTES:

CHART ANALYSIS

NOTE: This example is 2/3 scale. Tape an actual 2 channel strip chart recording here.



PRESSURES

1) 1st	________
2) 2nd	________
3) 3rd	________
4) Back	________
5) Fill	________
6) Pack	________
7) Peak	________
8) Residual	________

TIMES

9) Cycle	________
10) Fill	________
11) Pack	________
12) Overall Inj	________
13) Cool	________
14) Mold Open	________

STROKE

15) Fill	________
16) Pack	________
17) Max Stroke	________
18) Screwback	________
19) Decompress	________

Chart Speed: ________
(normally 5mm/second)

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

USA

Phone Orders (Toll Free)
1-800-626-6653

Mail Orders
D-M-E Company
(World Headquarters)
29111 Stephenson Hwy.
Madison Heights, MI 48071
Attn: Order Dept.

(313) 398-6000
Telex 230670

D-M-E COMPANY
A FAIRCHILD INDUSTRIES COMPANY

ADDITIONAL SERVICE CENTERS (USA)

2376 John Glenn Dr. N.E.
ATLANTA, GA 30341

502 Brookpark Road
CLEVELAND, OH 44109

2143 Joe Field Road
Suite 200
DALLAS, TX 75229

558 Leo Street
DAYTON, OH 45404

1551 N.W. 69th Street
FORT LAUDERDALE, FL 33309

1217 Central Avenue
HILLSIDE, NJ 07205

83 Keystone Drive
LEOMINSTER, MA 01453

1975 N. 17th Avenue
MELROSE PARK, IL 60160

6116 Wayzata Blvd.
MINNEAPOLIS, MN 55416

1101 Monterey Pass Road
MONTEREY PARK, CA 91754

11839 Westline Industrial Dr.
ST. LOUIS, MO 63146

4263 Clyde Park
WYOMING, MI 49509

Canada

Phone Orders
(416) 677-6370

Mail Orders
D-M-E of Canada, Ltd.
6210 Northwest Drive
Mississauga, Ontario L4V1J6

Operations also in Europe
Mexico, South America,
Australia, Japan
and the Far East.

DME-4/OM-1C-884

LITHO IN USA