# TABLE OF CONTENTS

## 250R1 EXTRUDER

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA</td>
<td>1</td>
</tr>
<tr>
<td>SAFETY</td>
<td>1</td>
</tr>
<tr>
<td>WARNING</td>
<td>2</td>
</tr>
<tr>
<td>GENERAL SPECIFICATIONS</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>RESIN HANDLING</td>
<td>3</td>
</tr>
<tr>
<td>Colored Resin Handling System</td>
<td>4</td>
</tr>
<tr>
<td>Colored Resin System Parts List</td>
<td>4</td>
</tr>
<tr>
<td>Colored Resin System Illustration</td>
<td>5</td>
</tr>
<tr>
<td>Natural (Uncolored) Resin Handling System</td>
<td>5</td>
</tr>
<tr>
<td>Natural Resin System Parts List</td>
<td>5</td>
</tr>
<tr>
<td>Natural Resin System Illustration</td>
<td>5</td>
</tr>
<tr>
<td>BLOWMOLDING MACHINE</td>
<td>6</td>
</tr>
<tr>
<td>The Blowmolding Machine</td>
<td>6</td>
</tr>
<tr>
<td>The Extruder</td>
<td>7</td>
</tr>
<tr>
<td>Extruder Parts List</td>
<td>7</td>
</tr>
<tr>
<td>Extruder Illustration</td>
<td>7</td>
</tr>
<tr>
<td>Hopper</td>
<td>7</td>
</tr>
<tr>
<td>Screw and Barrel</td>
<td>7</td>
</tr>
<tr>
<td>Screw and Barrel Parts list</td>
<td>8</td>
</tr>
<tr>
<td>Screw and Barrel Illustration</td>
<td>8</td>
</tr>
<tr>
<td>Barrel Temperature Control</td>
<td>9</td>
</tr>
<tr>
<td>Barrel Cooling</td>
<td>9</td>
</tr>
<tr>
<td>Barrel Cooling Parts List</td>
<td>9</td>
</tr>
<tr>
<td>Barrel Cooling Illustration</td>
<td>9</td>
</tr>
<tr>
<td>Barrel Cooling Schematic</td>
<td>9</td>
</tr>
<tr>
<td>Temperature Controllers</td>
<td>10</td>
</tr>
<tr>
<td>Reciprocation</td>
<td>10</td>
</tr>
<tr>
<td>Screw Position Indicator Parts List</td>
<td>11</td>
</tr>
<tr>
<td>Screw Position Indicator Illustration</td>
<td>11</td>
</tr>
<tr>
<td>Linear Position Transducer Parts List</td>
<td>11</td>
</tr>
<tr>
<td>Linear Position Transducer Illustration</td>
<td>11</td>
</tr>
<tr>
<td>Reducer and Drive</td>
<td>12</td>
</tr>
<tr>
<td>Reducer and Drive Parts List</td>
<td>12</td>
</tr>
<tr>
<td>Reducer and Drive Illustration</td>
<td>12</td>
</tr>
<tr>
<td>The Ball Spline</td>
<td>13</td>
</tr>
<tr>
<td>Sheave and Drive Belt</td>
<td>13</td>
</tr>
<tr>
<td>Variable Speed Drive</td>
<td>13</td>
</tr>
<tr>
<td>DIE HEAD</td>
<td>13</td>
</tr>
<tr>
<td>Die Head Manifold</td>
<td>14</td>
</tr>
<tr>
<td>Die Head 4 x 8 - 1 Parts List</td>
<td>14</td>
</tr>
<tr>
<td>Die Head 4 x 8 - 1 Illustration</td>
<td>14</td>
</tr>
<tr>
<td>Die Head 4 x 8 - 4 Parts List</td>
<td>15</td>
</tr>
<tr>
<td>Die Head 4 x 8 - 4 Illustration</td>
<td>15</td>
</tr>
<tr>
<td>Die and Mandrel</td>
<td>15</td>
</tr>
<tr>
<td>Diverging Tooling Illustration</td>
<td>15</td>
</tr>
<tr>
<td>Converging Tooling Illustration</td>
<td>15</td>
</tr>
<tr>
<td>The Stripper</td>
<td>16</td>
</tr>
<tr>
<td>Stripper Parts List</td>
<td>16</td>
</tr>
<tr>
<td>Stripper Illustration</td>
<td>16</td>
</tr>
<tr>
<td>Section</td>
<td>Pages</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Clamp</td>
<td>16, 17, 18</td>
</tr>
<tr>
<td>Clamp Parts List 15 x 34 - 3</td>
<td>17</td>
</tr>
<tr>
<td>Clamp 15 x 34 - 3 Illustration</td>
<td>17</td>
</tr>
<tr>
<td>Clamp Limit Switch Parts List</td>
<td>18</td>
</tr>
<tr>
<td>Clamp Limit Switch Illustration</td>
<td>18</td>
</tr>
<tr>
<td>Clamp Safety Doors</td>
<td>19</td>
</tr>
<tr>
<td>Molds</td>
<td>18</td>
</tr>
<tr>
<td>Handleless Container Illustration</td>
<td>19</td>
</tr>
<tr>
<td>Neck Rings</td>
<td>20</td>
</tr>
<tr>
<td>Neck Ring Types (and Pre-Finish Systems)</td>
<td>20</td>
</tr>
<tr>
<td>Plain—&quot;Inside the Neck&quot;</td>
<td>20</td>
</tr>
<tr>
<td>Plain—&quot;Inside the Neck&quot; Illustration Figure 1</td>
<td>20</td>
</tr>
<tr>
<td>Domes</td>
<td>20</td>
</tr>
<tr>
<td>Dome Illustration Figure 2</td>
<td>20</td>
</tr>
<tr>
<td>Dome Illustration Figure 3</td>
<td>20</td>
</tr>
<tr>
<td>Dome Illustration Figure 4</td>
<td>21</td>
</tr>
<tr>
<td>Dome Illustration Figure 5</td>
<td>21</td>
</tr>
<tr>
<td>Ram Down Interference Pre-Finish</td>
<td>21</td>
</tr>
<tr>
<td>Ram Down Interference Illustration Figure 6</td>
<td>21</td>
</tr>
<tr>
<td>Compacting Pre-Finish</td>
<td>21</td>
</tr>
<tr>
<td>Compacting Pre-Finish Illustration Figure 7</td>
<td>22</td>
</tr>
<tr>
<td>Pull-Up Pre-Finish</td>
<td>22</td>
</tr>
<tr>
<td>Pull-Up Illustration Figure 8</td>
<td>22</td>
</tr>
<tr>
<td>Water System</td>
<td>22</td>
</tr>
<tr>
<td>The Water System</td>
<td>22</td>
</tr>
<tr>
<td>Mold Cooling</td>
<td>23</td>
</tr>
<tr>
<td>Air System</td>
<td>23</td>
</tr>
<tr>
<td>Air System</td>
<td>23</td>
</tr>
<tr>
<td>Air Schematic Parts List</td>
<td>24</td>
</tr>
<tr>
<td>Air Schematic Illustration</td>
<td>24</td>
</tr>
<tr>
<td>High and Low Pressure Blow</td>
<td>24</td>
</tr>
<tr>
<td>Stripper</td>
<td>24</td>
</tr>
<tr>
<td>Safety Door Interlocks</td>
<td>25</td>
</tr>
<tr>
<td>Air Filtration</td>
<td>25</td>
</tr>
<tr>
<td>Hydraulic System</td>
<td>25</td>
</tr>
<tr>
<td>Hydraulic System</td>
<td>25</td>
</tr>
<tr>
<td>Hydraulic Schematic Parts List</td>
<td>26</td>
</tr>
<tr>
<td>Hydraulic Schematic Illustration</td>
<td>26</td>
</tr>
<tr>
<td>Hydraulic Power Unit Parts List</td>
<td>26</td>
</tr>
<tr>
<td>Hydraulic Power Unit Illustration</td>
<td>26</td>
</tr>
<tr>
<td>Platen Actuation</td>
<td>27</td>
</tr>
<tr>
<td>Extruder Screw Reciprocation</td>
<td>27</td>
</tr>
<tr>
<td>Electrical System</td>
<td>28</td>
</tr>
<tr>
<td>The Electrical System</td>
<td>28</td>
</tr>
<tr>
<td>Control Panel Components</td>
<td>29</td>
</tr>
<tr>
<td>The Electrical Schematic</td>
<td>32</td>
</tr>
<tr>
<td>Sample Circuit Diagram</td>
<td>33</td>
</tr>
<tr>
<td>Motor Control</td>
<td>37</td>
</tr>
<tr>
<td>Motor Control Diagram</td>
<td>37</td>
</tr>
</tbody>
</table>
STATEMENT OF POLICY CONCERNING OCCUPATIONAL SAFETY AND HEALTH ACT

THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970 (OSHA) PLACES THE RESPONSIBILITY UPON EACH EMPLOYER TO PROVIDE THEIR EMPLOYEES A PLACE IN WHICH TO WORK FREE FROM RECOGNIZED SAFETY AND HEALTH HAZARDS.

THE PLASTICS MACHINERY DIVISION OF HOOVER UNIVERSAL, INC. INTERPRETS OSHA STANDARDS AS THEY APPEAR TO APPLY TO ITS PRODUCTS AND DESIGNS AND BUILDS THOSE SAFETY FEATURES WHICH ARE REQUIRED. HOWEVER, SINCE THESE STANDARDS ARE CONTINUALLY REVIEWED AND REVISED AND ARE SUBJECT TO DIFFERING INTERPRETATIONS BY THE OFFICIALS IMPLEMENTING AND ENFORCING THE ACT, HOOVER IS NOT IN A POSITION TO GUARANTEE COMPLIANCE.

SAFETY

All precautions have been taken to assure the safety of personnel with your Uniloy blowmolder. The operator must practice safety operating procedures at all times on and around the machine. Warning, Danger, and Safety plaques are placed in conspicuous areas that may be potentially hazardous to personnel.

Uniloy has built into its blowmolder a system of safety devices to help assure safe operation of the machine.

EMERGENCY STOP

HYDRAULIC DUMP VALVE
PNEUMATIC AND ELECTRICAL
SAFETY DOOR INTERLOCKS
LOW PRESSURE CLOSE
SHOT CYLINDER OVERFILL SAFETY
MAIN ELECTRICAL PANEL DOOR

STOCK TEMPERATURE GAGE
TORQUE LIMIT CONTROL

IF YOU DESIRE TO INCORPORATE INTO YOUR HOOVER EQUIPMENT ADDITIONAL OR SUBSTITUTE HEALTH OR SAFETY FEATURES, HOOVER WILL BE PLEASED TO DISCUSS THE DESIGN ALTERNATIVES WITH YOU AND TO FURNISH QUOTATIONS COVERING THEM FOR YOUR CONSIDERATION.

BECAUSE OF THE VARIABLE INTERPRETATION OF OSHA STANDARDS AND OUR INABILITY TO ASSURE YOU OF COMPLIANCE THEREWITH, WE HEREBY ADVISE YOU THAT HOOVER ASSUMES NO LIABILITY FOR DIRECT OR CONSEQUENTIAL DAMAGES WHICH MAY ARISE OUT OF ANY FAILURE OF HOOVER EQUIPMENT TO COMPLY WITH OCCUPATIONAL SAFETY AND HEALTH ACT, AS AMENDED FROM TIME TO TIME, OR ANY STATE EQUIVALENT THEREOF, WHICH LIABILITY IS HEREBY EXPRESSLY DENIED.
INSTANTANEOUS OVERLOAD

CLUTCH

HYDRAULIC RESERVOIR TEMPERATURE SWITCH

GUARDS

BARREL COOLING TYPE

All safety devices installed on your blowmolder are intended for protection, health, and welfare of personnel. For no reason should they be removed or the system overridden.

The operator or maintenance personnel should assure themselves of the proper operation of these devices prior to operation of the machine.

Safety instruction plates are fastened in conspicuous areas of the machine. Under no circumstance should these be removed. They must be maintained so that they are easily readable. Operating and maintenance personnel must understand the safety instructions before they are permitted to work on the machine.

Safety inspection

Certain precautions should be taken to insure the safe operation of any blowmolding machine. The following listing covers preventative safety procedures which maintain the safe operating conditions of the machine.

WARNING

Do not operate the machine if safety gate and interlocks are not functioning properly.

This system is a safety override of the torque limit control. When the torque limit is either out of adjustment or if failure occurs, Thermo switch protection for operating at pre-set temperature. If clutch reaches temperatures above pre-set temperature drive will shut down. Reset is automatic once the clutch cools to normal running temperature. This would generally indicate that clutch RPM is too slow.

Hydraulic system will stop if oil temperature reaches above its set point. If this occurs check system for leak at valves, rotacs, and fittings. When it has been established that no fluid is leaking, open the by-pass manatrol valve located between the discharge side of the hydraulic pump and heat exchanger and restart pump motor(s) to lower the temperature.

Drive belt (shroud), Hydraulic compartment (expanded metal), Safety doors (expanded metal), Clamp (expanded metal), Barrel (shroud).

U’ Con heat transfer fluid

Inspect all heat instruments for proper control of respective heat zones. This check is important for protection of plant personnel from injury. Loss of heat control in some plastic materials could result in an explosion.

Check tightness of tie rod nuts.

Check all hydraulic pressure lines and fittings for loose joints or loose piping that could result in an oil blow out. Such blow outs could cause direct injury or possibly a fire if it were to come in contact with heater bands.

Check electrical grounding to prevent possibility of an accidental or unauthorized disconnect.

Check all electrical wiring for loose connections or short circuits. Use only fuse size specified on the electrical schematic supplied with the machine.

Before working on screw or head heater bands, pull the main disconnect switch to OFF. Failure to pull disconnect could result in electrical shocks.
GENERAL SPECIFICATIONS

Screw Diameter—Inches  
L/D Ratio  
Compression Ratio  
Drive HP  
Drive Type  
Plasticizing Capacity—LBS/HR. HDPE  
Shot Capacity—grams HDPE  
Number of Barrel Heating Zones  
Shot Cylinder—Bore X Stroke  
Barrel Cooling Type  
Hydraulic Pump GPM  
Hydraulic Pump Motor HP  
Hydraulic Reservoir Capacity—Gal.  
Hydraulic Pressure—Max. PSI  
Nitrogen Accumulator Capacity—Gal.  
Electrical Power—AMPS  
460 V 60 CY 3PH  
230 V 60 CY 3PH  

MODEL 250R1  
2.50  
24:1  
3:1  
40 AC  
Eddy Current  
220  
450  
3  
6 x 8  
U’Con  
15.0  
10.0  
55.0  
1500  
10.0  
103  
205

INTRODUCTION

Blowmolding is a process by which plastic resin is transformed from the raw material into a thin walled hollow container. This process is divided into three separate steps: i.e., resin handling system, blowmolder, and bottle finishing and handling equipment.

The following material describes the standard process and equipment in the Uniloy line. Special variations can be made to suit an individual customer’s requirements, but care should be taken to insure a workable and compatible system throughout.

RESIN HANDLING

The first step in the process is the system by which the plastic resin is fed to the blowmolder. Depending on the type of container to be made, this system may have to supply resin in its natural state or blended with color concentrate. Bleach, detergent, etc., usually require a colored container; whereas, milk, water, juice, etc., use the resin in its natural color. These two systems are described separately in the following sections.

Colored resin handling system

This system includes the equipment to store, blend, and convey virgin resin, color concentrate, and reground scrap to the blowmolder in the proper proportions. To simplify the explanation, we shall follow the material through the system.

Initially we start with virgin resin and color concentrate. The virgin is stored in a TOTE* Bin from which it is fed to the duo-screw blender by a material feeder, which is a motor driven vacuum device. The material feeder is mounted on the virgin hopper of the blender and is connected to the TOTE* Bin by steel tubing. The color concentrate is put into the color hopper of the blender by hand. Color concentrate is used in small enough quantities that it usually is not automated.

The blender is a duo-screw auger type blender which has variable speed adjustments by which the desired proportions may be obtained.

After the virgin and color are blended, they are deposited in a storage area in the base of
the unit. From there they are conveyed to the blowmolding machine hopper on demand by a material feeder which is mounted on top of the hopper.

If the system is equipped with a Uniloy bottle finishing line, it will also have a scrap reprocessing system. This system collects the scrap flash trimmed from the container and conveys it to a scrap grinder. Since the airveyor is moving a large volume of air in order to entrain the scrap, the scrap grinder is equipped with a cyclone separator. This unit allows the air to escape while the scrap settles down into the grindare inserted between this cyclone and the TOTE* Bin to prevent metal contamination beyond this point. These magnets are accessible through a hinged door and they should be cleaned periodically.

**TOTE*—is a registered Hoover trademark**

This TOTE* Bin is a major storage area for regrind just as the first TOTE* Bin was for virgin resin. From here the regrind is conveyed to the blowmolding machine hopper in the same manner as the virgin resin was.

The ratio loader, therefore, conveys both virgin and regrind to the machine hopper. It is not a blender in the strict sense, but it will deliver the two materials in variable proportions and satisfactorily mixed.

In the case of large blowmolding machine operations, a central resin handling system may be employed serving a group of machines. This type of system, although larger, involves the same general kinds of equipment.

When installing a resin handling system, it must be taken into account that the normal scrap grinder used in such a system will generate more noise then is allowed by the Walsh-Healy Act. The grinder must, therefore, be housed in a room separate from all work areas.

**Colored resin handling system**

**ITEM PART NAME**

- A Virgin Tote Bin
- B Duo-Screw Blender
- C Blended Resin Line to Blowmolder
  - 1-1/4 EMT Tubing
- D Blended Resin Storage Bin Suction
  - Ports
- E Regrind Tote Bin
- F 2" EMT Tubing
- G Scrap Return, 10" Duct
- H 1-1/4 EMT Tubing
- I Material Feeders
- J 1-1/4 EMT Tubing
- K Regrind Cyclone
- L Scrap Separator
- M Scrap Grinder
Natural (uncolored) resin handling system

This system includes the equipment to store, blend, and convey virgin resin and regrind scrap to the blowmolding machine in proper proportions. As before, the following explanation will follow the material as it passes through the system.

The virgin resin is stored in a TOTE* Bin from which it is fed directly to the blowmolding machine hopper by means of a ratio loader, which is a motor driven vacuum device. The ratio loader operates intermittently and is controlled by a level switch in the machine hopper.

If the system is equipped with a Uniloy bottle finishing line it will also have a scrap reprocessing system. This system collects the scrap flash trimmed from the container and airveys it to the scrap grinder. Since the airveyor is moving a large volume of air in order to entrain the scrap, the scrap grinder is equipped with a cyclone separator. The cyclone allows the air to escape while the scrap settles down into the grinder. If the air was forced directly into the cutting chamber of the grinder, ground plastic and dust would be blown all over the area. It might also create enough back pressure in the airveyor to prevent proper conveying and cause plugging in the airveyor duct work.

As plastic scrap enters the grinder it encounters several rotating and fixed blades between which it is sheared over and over again until it is approximately pellet size at which time it may pass through the perforated screen below the cutting chamber. The scrap, which is now called regrind, then falls into a small storage bin that funnels it into an impeller type fan. This fan airveys the regrind through steel tubing to a regrind storage TOTE* Bin. Again, since we are airveying, an air dissipating cyclone is mounted on top of the TOTE* Bin. Several permanent magnets are inserted between this cyclone and the TOTE Bin to prevent metal contamination beyond this point. These magnets are accessible through a hinged door and should be cleaned periodically.

This TOTE Bin is the major storage area for regrind just as the first TOTE Bin was for virgin. From here the regrind is conveyed to the blender by a material feeder in the same manner as the virgin was.

The blender, therefore, mixes the color, virgin, and regrind together in adjustable proportions.

In the case of the large blowmolding operations, a central resin handling system may be employed serving a group of machines.

Natural (uncolored) resin handling system

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Virgin Line to Blowmolder</td>
<td>1-¼ EMT Tubing</td>
</tr>
<tr>
<td>B</td>
<td>Re grind Line to Blowmolder</td>
<td>1-¼ Tubing</td>
</tr>
<tr>
<td>C</td>
<td>Re grind Tote Bin</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Scrap Return</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Virgin Tote Bin</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Re grind Cyclone</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>2’ EMT Tubing</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Scrap Separator</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Scrap Grinder</td>
<td></td>
</tr>
</tbody>
</table>
All machines operating on a single system must, naturally, use the same color and type of resin. This type of system, although larger, involves the same general kinds of equipment.

When installing a resin handling system, it must be taken into account that the normal scrap grinder used in such a system will generate more noise than is allowed by the Walsh-Healy Act. The grinder must, therefore, be housed in a room separate from all work areas.

THE BLOWMOLDING MACHINE

The blowmolding machine is a processing machine which takes the plastic resin as supplied by the resin handling system and transforms it into a plastic container. This is accomplished in several steps which will be explained individually and in the order that they occur as the plastic passes through the machine.

In general, the resin enters the extruder section which melts it, compresses it, and mixes it into a semi-fluid condition. It is then forced through an extrusion die which forms it into a uniform walled tube which is called "parison". Mold halves are then brought together around the parison, closing it at both ends. Compressed air is then pumped into the parison, forcing it to expand out to the contour of the mold. The blown parison is held under pressure in this manner long enough to allow the liquid cooled mold to lower its temperature well below the melting point. The mold then opens and the container is ejected and transported to the finishing line for deflashing.

A blowmolding machine consists, therefore, of three major parts: the extruder, the die head, and the mold clamp. These three parts are made in various sizes and arrangements so that each individual customer's container size and production rate may be accommodated. This manual has been written to include the extruder and variations in the clamp and head combinations which may be used with them.

The extruder will be designated by a number such as 250R1. The model number 250R1 means a 2.50 inch diameter reciprocating screw extruder of design series 1.

Clamps will have meaningful model numbers also. A clamp model number 15 x 34-3 means 15 inch tall platens, 34 inch between tie bars of design series 3.

Die heads are described by model numbers such as 4 x 6-1 which indicates a 4 die head on 6 inch centers. A 4 x 8-1 is a 4 die head on 8 inch centers. The -1 means a design series 1 in both cases.

Once the above system is understood, it becomes very easy to describe each unit of the Blowmolding machine without reference to any catalog or other information.

The Extruder

The extruder is that part of the blowmolding machine which heats and compresses the resin into a molten, air free mass, and delivers it to the extrusion head at the temperature and pressure required to produce a parison.

Since this extruder is a reciprocating type, it may be considered to have two separate functions. First, it transforms the solid pellet resin into a thoroughly mixed extrudable melt. Secondly, it is equipped with a hydraulic cylinder and other components by which the screw may be rapidly moved forward forcing the melt into the extrusion head with sufficient pressure to properly form a parison.

The extruder consists of the following components which will be covered in the sequence listed:

- Hopper
- Screw and Barrel
- Barrel Temperature Control
- Barrel Cooling Assembly
- Temperature Controllers
- Reciprocation
- Reducer
- Ball Spline
- Sheave and Belt Reduction
- Variable Speed Drive
The extruder

ITEM PART NAME
A Nitrogen Accumulator
B Shot Cylinder
C Thrust Bearing
D Reducer
E Hopper
F Barrel and Screw Assembly
G Barrel Cooling Assembly
H Reducer Cooling Unit
I Hydraulic Power Unit
J Variable Speed Drive

Hopper

The hopper is a funnel shaped resin reservoir which is mounted directly to the feed throat of the extruder barrel. The resin supplied to the hopper by the resin handling system drops by gravity directly into the feed section of the extruder screw. A plexiglass window is built into the lower part of the hopper so that the operator can see when the resin level becomes low. The hopper is supplied with a drain port for discharge of resins in case of contamination or resin changes.

Screw and barrel

The screw and barrel assembly consists of an auger type conveying screw, which rotates within a heavy walled cylindrical barrel. The screw has stellited and ground flights for long wear resistance. The barrel is made of seamless steel tubing with Xaloy lining. Around the outside of the barrel are electric heater bands which are separated into different zones along the length of the barrel. The purpose of these zones is to allow for localized temperature control. The heater bands also include cooling tubes. Thus, with both heating and cooling capability, the temperature of the barrel can be maintained very closely in each zone. A complete explanation of the temperature system will be found on Page 10.

The resin enters the barrel through the feed throat into the section of the screw called the feed section. The screw in this area is merely a conveyor which moves the pellets forward toward the middle section of the screw known as the transition or compression section. As the pellets move through the feed section of the screw they absorb heat from the barrel walls which is generated by the heater bands in this zone.

By the time the pellets have moved through the feed section and reach the beginning of the transition, they have picked up enough heat to reach, or nearly reach, the melting point. The plastic is still pretty much in pellet form at this point, even if it is melted, because nothing has acted on it to compress it or to squeeze out the air entrapped between the pellets. The root diameter of the screw through the feed section is constant, as is the pitch or distance between flights. So, as was stated earlier, the feed section is strictly a conveying section with the addition of heat to the moving resin.

In the transition section the root diameter of the screw gradually increases, thereby reducing the area in which the molten plastic may flow. The resulting compression forces the molten pellets together and causes the air between the pellets to remain in a relatively open feed section. Therefore, by the time the plastic resin reaches the end of the transition section, it has become a solid molten mass called the melt. The melt should be completely molten at this point because as it becomes compressed it rubs more heavily on the wall of the barrel creating frictional heat in addition to picking up heat from the barrel.

The melt, as it leaves the transition section and enters the metering section, should be a solid mass of molten material. It is not mixed very well, however, and that is the purpose of the metering section. The root diameter of the screw in the metering section is again constant and equal to the exit diameter of the transition section. The melt is not compressed any further, but the action of the screw flights and the rubbing of the plastic on the barrel walls mixes the melt thoroughly until it emerges
from the end of the screw as a homogeneous flow. The heater bands in the metering zone are used mainly to insure uniformity of temperature of the melt and, of course, to melt the material in the barrel during the warm up period when starting the machine.

Leaving the metering zone, the plastic enters the mixing tip. This is a fluted section which has a series of deep grooves spaced between a close fitting ridge (same OD as the screw flights) and a ridge with approximately .020 clearance. The melt is forced over these thin channels producing further mixing and preventing unmelted particles from passing through.

Various kinds and grades of resins require different temperature settings in the various zones to produce a uniform melt. It is impossible in this manual to cover all of them. But, in general, if the extruder melt contains partially unmelted pellets or other indications of improper melt, it is usually a sign of improper temperature settings or the screw is turning at too fast a rate, or a combination of both.

Do not attempt to run an extruder too cold. Using the barrel cooling to reduce the temperature of any zone more than 30° can result in excessive barrel shrinkage at the same time that the screw is expanding due to increased frictional heat. This can cause damage to both the screw and the barrel.

It can be seen in the illustration that the barrel is sufficiently longer than the screw to provide a storage space for the melt as it is produced and retracts the screw. This involves the reciprocation feature of the machine which is explained in a later section. As the melt is produced it forces the screw to move away from the nozzle and when a shot is made the screw is driven forward, forcing the melt through the nozzle. The nozzle itself serves only as a connector between the barrel and the extrusion head. The screw is constantly rotating, whether retracting or making the shot.

### Screw and barrel

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Name (Quant.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Barrel Heater (6)</td>
</tr>
<tr>
<td>B</td>
<td>Retainer Ring (1)</td>
</tr>
<tr>
<td>C</td>
<td>Nozzle (1)</td>
</tr>
<tr>
<td>D</td>
<td>Nozzle Heater</td>
</tr>
<tr>
<td>E</td>
<td>Split Ring (1)</td>
</tr>
<tr>
<td>F</td>
<td>Barrel Support (1)</td>
</tr>
<tr>
<td>G</td>
<td>Barrel (1)</td>
</tr>
<tr>
<td>H</td>
<td>Feed Throat (1)</td>
</tr>
<tr>
<td>I</td>
<td>Screw (1)</td>
</tr>
<tr>
<td>J</td>
<td>Split Ring (1)</td>
</tr>
</tbody>
</table>

![Screw and barrel diagram]

---

8
Barrel temperature control

The various sections of the extruder screw have their own individual influence on the plastic, therefore, the heating requirement of each is usually different. This requires that each section have its own temperature control system which is independent from the rest.

Clamped tightly to the outside of the barrel is a series of aluminum heater bands which also contain cast-in cooling tubes. There are several of these heater bands in each of the three zones. Within each zone, the heaters are wired to a common temperature controller and piped in series, to a coolant control valve. The coolant control valve is, in turn, operated by the temperature controller for that zone. Therefore, the temperature controller for each zone controls both heating and cooling.

The three zones are the feed zone, the transition zone, and the metering zone. These zones approximate the corresponding sections of the screw. All zones have a two-fold purpose; namely, to heat up a cold extruder and to maintain proper running temperature. During continuous operation the various zones will call for heating and cooling at various intervals while maintaining the temperature set on the controller within close limits. It is common, however, that the frictional heat developed by some resins within the transition and metering sections is more than adequate to maintain the temperature desired. In this case, occasional cooling is all that will be required.

directly from the reservoir to the heat exchanger and back again. This serves to keep the coolant temperature more consistent and increases pump life by preventing dead heading.

Chilled water is supplied to the heat exchanger from the main supply headers in the machine base through small copper tubes. Both supply and return lines are equipped with thermometers and the return line has a flow

---

Barrel cooling

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Valve</td>
</tr>
<tr>
<td>B</td>
<td>Pump &amp; Motor</td>
</tr>
<tr>
<td>C</td>
<td>Pressure Gage</td>
</tr>
<tr>
<td>D</td>
<td>Thermometer</td>
</tr>
<tr>
<td>E</td>
<td>Heat Exchanger</td>
</tr>
<tr>
<td>F</td>
<td>Level Gage</td>
</tr>
<tr>
<td>G</td>
<td>Thermometer</td>
</tr>
<tr>
<td>H</td>
<td>Flow Control</td>
</tr>
<tr>
<td>I</td>
<td>Thermometer</td>
</tr>
</tbody>
</table>

---

An individual solenoid valve controls the flow of coolant to each zone on command of the appropriate temperature control instrument. When no zone requires cooling and all valves are closed, a recirculating valve is opened which allows the pump to move the coolant
control valve. Flow of chilled water can thereby be controlled to obtain maximum efficiency. When properly adjusted, the maximum temperature of the reservoir should not exceed 200°F. A system operating below 150° would indicate that the flow control valve is opened too far and is wasting water. Adjustment of this valve should not be attempted until after the machine has been running in automatic cycle long enough to stabilize the barrel heating conditions.

The coolant used in this system is 100% Union Carbide Heat Transfer Fluid #50-HB-280X. If replenishing is required, do not attempt to mix this fluid with any other type. Care should be taken when handling this fluid because it dissolves paint. Also, avoid leaving the heat on the barrel with the chiller off. This allows the fluid to overheat. Then if the chiller is started, the resultant thermal shock will cause the heat exchanger gaskets to fail.

Temperature controllers

Temperature control instruments are located in the main control panel and serve to maintain the pre-set temperature in the various zones of the extruder and die head, within narrow limits. The instruments are similar to each other in many respects: they look alike, they all have a “Press To Set” knob that is used to adjust set point, they all have a red arrow that indicates the set point for the desired temperature; and they have a green arrow that indicates the actual temperature of the sensing probes (thermocouples) to which they are dependent on the relationship between the desired temperature and the indicated temperature. The manner in which these outputs are controlled is determined by the type of instrument used for each zone. The various types used on this extruder are listed below.

Love model 49-814

This type is used to control the die head where the only requirement is for heating. When the green pointer is well below the red arrow, the heat is full on. As the green pointer approaches the desired temperature, the controller begins cycling off and on to reduce the amount of heat output. The amount of "off" time will increase and the amount of "on" time will decrease as the green pointer approaches the red set point. The instrument will automatically adjust its output as required to maintain stability at the desired temperature. The status of the output is indicated by two pilot lights. The red indicating when the heat is "on" and the green indicating when the heat is "off".

Love model 58-814

This type is used to control the transition section, feed section, and metering section of the barrel where it is sometimes necessary to cool rather than heat. The control action is the same as described above for the Model 49-814 except that in addition to the heating control, the inverse relationships occur in the cooling output; that is, as the green pointer indicates actual temperature rising above the desired point, the cooling output will increase in proportion to the difference. The instrument will automatically adjust to increase the heating or cooling output as required to stabilize the controlled temperature at the desired point. The output states are indicated by pilot lights as follows:

<table>
<thead>
<tr>
<th></th>
<th>RED</th>
<th>GREEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>Cooling</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Power Off</td>
<td>Off</td>
<td>Off</td>
</tr>
</tbody>
</table>

Love model 50

This instrument does not control temperature, but continuously indicates the temperature of a thermocouple inserted directly into the plastic. It therefore displays stock temperature. Its output takes the form of a contact which is open when the stock temperature is below the set point, closed when above. This contact is connected in the extruder drive motor circuit, preventing the operation of this motor until the plastic is warm enough to extrude. A flashing amber light indicates that the temperature is, or has been lower, than the set point. Once the temperature rises above the set point, depressing the small pushbutton on the face of the instrument will cause the flashing light to go off. This is the normal condition, and the extruder motor may be operated.

Reciprocation

Because the extruder screw is rotating continuously, the production of melted plastic is continuous. During the time when the molds are closed the plastic produced must be stored to await the next shot. This storage takes place in the barrel.
During a shot, the hydraulic valve controlling the shot cylinder applies high pressure to the cylinder which moves the screw forward rapidly, forcing the molten plastic ahead of it through the nozzle and into the die head manifold. When the screw reaches the full forward position, the hydraulic valve shifts, connecting the shot cylinder to an adjustable relief valve which is usually set at 100 to 175 PSI. At this point the plastic has an easier task moving the screw to the rear than it has going through the die head. The plastic being produced thus accumulates in the barrel at the end of the screw and forces it to retract during the time the mold is closed.

When the next shot is required, the hydraulic valve again shifts to high pressure, moving the screw forward, and forcing the stored plastic out through the die head.

Although the hydraulic pressure reading during a shot may vary from machine to machine due to many factors, such as, type of plastic resin, size and type of extrusion tooling, temperature. Shot pressure adjustments are made through a flow control valve and pressure gage located at the rear of the machine.

The position of the screw in the barrel, as it moves back and forth, is shown on a meter on the operator’s control panel. This meter reads directly in inches with “0” being the full forward position and “8” being the extreme rear position of the screw. Incorporated in the meter arrangement are two electrical switches. The switch at the forward end of the stroke is adjustable and may be used for several purposes as described in the Electrical section of this manual. The adjusting knob and read-out dial indicate the point in the stroke at which this switch is tripped (on the forward motion only). If the screw retracts the full 8 inches the second switch is tripped. This rear switch activates the safety circuit of the machine and shuts it off.

The screw position meter is controlled by a linear position transducer located near the thrust bearing assembly inside the base. The transducer shaft is attached to a yoke which is mounted on the thrust bearing housing and moves with it. Care must be taken when working in this area of the machine to prevent damaging this device. It is rather fragile.

**Screw position indicator**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Screw Position Meter</td>
</tr>
<tr>
<td>B</td>
<td>Set Point Adjusting Knob</td>
</tr>
</tbody>
</table>

**Linear position transducer**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Trip Knob</td>
</tr>
<tr>
<td>B</td>
<td>Clamp</td>
</tr>
<tr>
<td>C</td>
<td>Limit Switch</td>
</tr>
<tr>
<td>D</td>
<td>Trip Knob</td>
</tr>
<tr>
<td>E</td>
<td>Limit Switch Bracket</td>
</tr>
<tr>
<td>F</td>
<td>Limit Switch Trip Rod</td>
</tr>
<tr>
<td>G</td>
<td>Yoke</td>
</tr>
<tr>
<td>H</td>
<td>Mounting Bracket</td>
</tr>
<tr>
<td>I</td>
<td>Bracket</td>
</tr>
<tr>
<td>J</td>
<td>Linear Position Transducer (12&quot;)</td>
</tr>
<tr>
<td>K</td>
<td>Limit Switch</td>
</tr>
<tr>
<td>L</td>
<td>Limit Switch Bracket</td>
</tr>
</tbody>
</table>

**Reducer and drive**

The reducer unit is a double reduction helical gear drive which is designed for quiet, trouble free service. It is a self-contained hollow shaft, foot mounted unit.

Since the gear box is self-contained, it can be removed intact from the machine if major servicing is ever required. It is shipped properly filled with the appropriate lubricant, but the oil level should be inspected prior to initial
start-up and weekly thereafter. A dip stick is located at the top of the unit for this purpose. After every 2500 hours of running, the gear box should be drained and refilled. Check the manufacturers recommendations for the proper lubricant which is printed on a name plate attached to the unit. See lubrication instructions at the back of this manual for further instructions.

The temperature of the reducer should not be allowed to rise over 140°F. A cooling system designed to remove excess heat is located in the hydraulic compartment of the rear bulk head. A small pump circulates the gear lube from the bottom of the reducer case through a heat exchanger and then back to the reducer. Thermometers are provided so that adjustments can be made without guessing. Running the reducer too cold, that is below 100°F, wastes chilled water and may result in decreased efficiency of the reducer.

Reducer and drive

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME (QTY.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Bushing</td>
</tr>
<tr>
<td>B</td>
<td>Ball Spline</td>
</tr>
<tr>
<td>C</td>
<td>Key (4)</td>
</tr>
<tr>
<td>D</td>
<td>Seal</td>
</tr>
<tr>
<td>E</td>
<td>Reducer</td>
</tr>
<tr>
<td>F</td>
<td>Seal</td>
</tr>
<tr>
<td>G</td>
<td>Thrust Bearing</td>
</tr>
<tr>
<td>H</td>
<td>Bearing</td>
</tr>
<tr>
<td>I</td>
<td>Seal</td>
</tr>
<tr>
<td>J</td>
<td>Tie Bar (8)</td>
</tr>
<tr>
<td>K</td>
<td>Hydraulic Cylinder</td>
</tr>
<tr>
<td>L</td>
<td>Housing</td>
</tr>
<tr>
<td>M</td>
<td>Adapter</td>
</tr>
<tr>
<td>N</td>
<td>3 Groove “C” Section Sheave 9.0 P.D.</td>
</tr>
<tr>
<td>O</td>
<td>Matched Set of 3 Steel V-belts</td>
</tr>
<tr>
<td>P</td>
<td>Taper Lock Sheave Taper Lock Bushing 1-7/8” Bore-½” Keyway</td>
</tr>
<tr>
<td>Q</td>
<td>Drive Motor (Eaton) Drive Motor (Louis Allis)</td>
</tr>
</tbody>
</table>
The ball spline

Contained within the hollow shaft of the reducer is a ball spline which is used to transmit the drive torque to the rotating and reciprocating screw. The reason for the ball spline is to reduce the drag created by reciprocating the screw while it is being rotated under full torque.

The ball spline is secured to the hollow shaft by 8 socket head cap screws. In the event that this assembly is ever removed from the reducer, these screws should be tightened with a torque of 580 in-lbs.

In the opposite end of the hollow shaft is a bronze bushing and a wiper seal which rides on the inner member of the ball spline. For adequate lubrication, the space remaining within the hollow shaft would be greased with All Purpose Grease. A grease zerk is located at the rear of the ball spline and should be lubricated monthly (6-7 pumps with standard grease gun).

If for any reason the ball spline must be removed from the reducer, the inner and outer members must be removed together. Under no circumstances should the ball spline be taken apart.

Sheave and belt drive

Power is transmitted from the motor to the reducer by means of three C section V-belts. These belts are a matched set to insure uniform loading on each belt. Replacement belts should be purchased as a matched set.

Variations on the drive pulleys are acceptable as long as they do not exceed 100% load on the drive motor. Adjust reducer cooling to remove any additional heat load.

Improperly tensioned belts can result in bearing failure and shaft failure. Tension on new belts should be adjusted to the following specification:

The force required at the middle of the belt span to deflect a belt 5/16” should be between 5.5 and 8.5 pounds.

Variable speed drive

This machine is equipped with a variable speed drive arrangement as listed below. Since the various drive manufacturers supply adequate operation and instruction literature with each unit, the drive motor will not be covered further in this manual. The literature concerning your particular drive will be included in the service package supplied with the machine.

The drive motor is mounted on a vertically adjustable plate. The adjustment is accomplished by four threaded posts and nuts. The motor plate resting on the nuts is leveled to obtain parallelism between the motor shaft and the reducer input shaft by adjusting the nuts individually. A roller chain is then wrapped around the sprockets attached to each nut. The nuts will then move together which allows the motor to travel vertically while maintaining the parallel relationship to the gear reducer. This movement is used thereafter to apply the power tension to the V-Belts.

MODEL NUMBER  STD. DRIVE TYPE
250R1 A.C. Eddy Current Coupling
*Eaton
*Louis Allis

*Motor units are not electrically interchangeable.

Die head manifold

After the plastic leaves the extruder it passes into the die head manifold (also known as the extrusion manifold). It is in this part of the machine that the molten plastic is formed into the proper shape and thickness suitable for blowmolding a container. The shape required is that of a thin walled tube called "parison". Each container design requires a parison of a definite diameter and wall thickness and it is the function of the die head manifold to transform the molten plastic mass it receives from the extruder into precisely the right parison. Adjustments are available for producing a straight, round parison of uniform wall and proper wall thickness.

Plastic flowing into the die block from the extruder is split into several paths which direct it to each of the head assemblies. Depending on the particular design used, these flow paths may be proportioned in diameter to maintain the same resistance to flow for all heads, or the flow channels may all be the same diameter with adjustable choke screws used to maintain equal resistance. The purpose of either method is to insure that during the shot, each head assembly is furnished identical amounts of plastic. This is necessary in order to maintain uniform parison lengths. Failure to maintain
reasonably equal parison lengths will create 
problems in many types of automated 
trimming equipment as well as creating 
excessive flash which must be reground.

As the plastic enters each die head assembly 
it is forced to split into two streams and flow 
around the mandrel sleeve. As these two 
streams meet on the opposite side, they 
"weld" together again. With the proper 
conditions of pressure and temperature the 
weld will be complete and unnoticeable fusion. 
The actual shape of the mandrel sleeve in the 
area of the weld is very important for another 
reason. Improper shaping will result in dead 
spots or areas of zero flow velocity which cause 
plastic degradation. This burnt plastic will then 
slowly be washed out removing spots or streaks 
in the parison. Since this is an extremely 
critical area, some small burning may take 
place. It is not too uncommon, therefore, to 
develop this condition after long production 
runs. In the event that this happens, it is 
necessary to disassemble the head and clean it.

The plastic flows down over the mandrel 
sleeve in a tubular form. The lower end of the 
sleeve forms an orifice with the surrounding 
adjusting ring. This orifice produces back 
pressure which is useful in aiding the welding 
process. This ring is adjustable eccentrically 
which can be used to correct a curling 
parison. Plastic, being a rather viscous material, 
tends to flow easier down the weld line side of 
the head. This can sometimes cause the 
parison to flow faster in that area resulting in a 
banana shaped parison. By shifting the 
adjusting ring so as to snub off the flow 
through the orifice on the weld line side, the 
parison can be made to drop straight.

The die head block and the lower feed throats 
are heated with electric heater bands which 
are controlled by a temperature instrument. 
Page 10. The die head block is also fitted with 
a melt thermocouple with a direct reading 
temperature indicator. This instrument 
continuously monitors the plastic temperature as 
it enters from the extruder.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Retainer Ring Mandrel Adjusting Nut</td>
</tr>
<tr>
<td>B</td>
<td>Adjusting Nut Sleeve</td>
</tr>
<tr>
<td>C</td>
<td>Die Head Block</td>
</tr>
<tr>
<td>D</td>
<td>Upper Mandrel Sleeve</td>
</tr>
<tr>
<td>E</td>
<td>Lower Mandrel Sleeve</td>
</tr>
<tr>
<td>F</td>
<td>Feed Throat Heater Band (2)</td>
</tr>
<tr>
<td>G</td>
<td>Adjusting Ring</td>
</tr>
<tr>
<td>H</td>
<td>Ferry Head Cap Screw</td>
</tr>
<tr>
<td>I</td>
<td>Clamp Ring</td>
</tr>
<tr>
<td>J</td>
<td>Mandrel Adjusting Nut</td>
</tr>
<tr>
<td>K</td>
<td>Choke Screw</td>
</tr>
<tr>
<td>L</td>
<td>Seal Ring</td>
</tr>
<tr>
<td>M</td>
<td>Feed Throat</td>
</tr>
<tr>
<td>N</td>
<td>Die Heater</td>
</tr>
<tr>
<td>O</td>
<td>Die</td>
</tr>
<tr>
<td>P</td>
<td>Mandrel</td>
</tr>
</tbody>
</table>

4 × 8 – 1 DIE HEAD: FOR 1 GALLON 
CONTAINER ONLY. HALF GALLON DESIGN 
IS COMMON BUT PART NUMBER MAY DIFFER.
Die head 4 × 8 – 4
6” (MINIMUM HEAD CENTERS
DIE DIAMETER 2.50

ITEM PART NAME
A Mandrel Adjusting Nut
B Mandrel Sleeve
C Die Block
D Adjusting Ring
E Feed Throat
F Feed Throat Heater (2)
G Bushing
H Die Clamp
I Die
J Set Screw
K Choke Screw
L Die Adjusting Screw
M Die Heater
N Mandrel

4 × 8 – 4 DIE HEAD: FOR HALF GALLON CONTAINER ONLY. GALLON CONTAINER IS OF COMMON DESIGN BUT PART NUMBER MAY DIFFER.

Die and mandrel

Plastic flowing past the mandrel sleeve, as previously described, enters the die and mandrel which is the final shaping orifice. This orifice determines the diameter and wall thickness of the parison. The pressure drop across this orifice is rather large and therefore, the geometry of these two parts is quite critical. Slight changes in either the die or the mandrel can sometimes cause drastic changes in the parison. Therefore, the die and mandrel are very accurately made and should be cared for and handled like any precision tooling. Never attempt to clean or scrape plastic from a die or mandrel with anything sharp. Use a copper bar sharpened for the purpose or a wire brush (by hand—not motor driven).

Actual die and mandrel design is determined by many factors such as container size (width across parting line), container weight, type of neck finish desired, resin type, etc. The most common problem in the design of dies and mandrels today is due to the large variety of resins available, many of which require drastically different designs to produce the same container. So if you are contemplating a resin change, obtain a sample and run it to determine any necessary changes before committing your entire production to it.
Two adjustments are provided to obtain the proper parison desired. The mandrel adjusting nut is used to vary the wall thickness and therefore the container weight. The die may be adjusted eccentrically to produce a uniform wall around the parison.

There is no means whereby the diameter of the parison can be changed significantly, except when using certain high swell resins. These materials expand considerably upon exiting from the die at high pressure. In this case, the hydraulic shot pressure can sometimes be manipulated to increase or decrease the amount of swell and therefore the resulting parison diameter.

Each die is surrounded by an electric heater band which is controlled by individual variacs mounted on the control cabinet. These variacs are manually set variable transformers which supply power to the heater band continuously.

The stripper

The stripper plate, which is actuated by an air cylinder, ejects the formed container downward from the mold area after the molds have opened far enough for clearance.

The timing of the stripper action is important. The molds must be opened far enough to allow the stripper and the container to move downward without interference. A delay here only serves to increase cycle time, so it must occur as soon as possible.

The velocity of the stripper movement should be kept at a reasonable rate. Excessive speed will only serve to shorten the life of the unit. Too slow a speed will not effectively strip the container away from the die and mandrel with a clean break.

Care should be taken in adjusting the lower limit switch cam to insure that the stripper plate is all the way up when the switch is tripped. If the cam trips too soon, the molds may hit the stripper plate as they are closing.

For description of the air circuitry and control of the stripper turn to Page 23, 24.

The clamp

The purpose of the clamp mechanism is to locate and hold the molds together securely while the container is being blown. The clamp consists primarily of two platens upon which the molds are mounted, guide bars, and platen rails which locate and support the platens and a toggle mechanism which moves and locks the platens. It will be noted that there are actually three platens, but the third, or rear platen, serves no function as far as the molds are concerned. It is a necessary part of the clamping assembly in that it serves to connect the front platen through the guide bars to the toggle mechanism.

Page 17 shows the clamp in the closed or locked position. The toggle linkage has been rotated into a straight line configuration. When the guide bars are adjusted properly, they will have been stretched approximately .010 inches in order for the linkage to reach this straight line position. This puts a pre-load on the molds which is greater than the force developed by the air pressure within the molds. This pre-load plus the straight line linkage, eliminates any possibility of the molds being blown open.
The motivating force behind the toggle linkage is a hydraulic rotary actuator. This device has a rotary motion of about 100°. From the close position as shown the rotary actuator can rotate counter clockwise 100°. This results in a linear motion of the center and rear platens of approximately 5.5 inches each. Both platens move toward the rotary actuator simultaneously. Since the rear platen is tied directly to the front platen by means of the four guide bars, they must both move together. The center and front platens move in opposite directions at the same speed and for the same distance. This remains true whether the platens are opening or closing.

A clamping cycle begins with the mold platens open and the rotary actuator rotated counter clockwise 100° from that shown. As the rotary actuator rotates clockwise, closing the molds, the initial velocity of movement is large. However, as the linkage begins to straighten out and the molds approach each other, the velocity decreases (much the same as when a piston approaches top dead center in an automotive engine). As the molds actually touch, the velocity of the platens has been reduced to zero. This smooth reduction in speed increases mold life by eliminating all of the impact forces common to many other types of machines.

The hydraulic system operating the rotary actuator produces a low pressure close but a high pressure lock up. This system moves the platens to within a very short distance of being closed (.020 - .060 inches) under low hydraulic pressure. This feature prevents mold damage if some object happens to be between the molds. Or, if a parison clings to the blow pin and creates a mass of plastic rather than a parison, the low pressure will not squeeze it into the mold. Under such circumstances as these, the platen movement will be stalled, and after a short time delay the clamp will open and automatic cycling will stop.

There are several adjustments required to position the molds under the die head. First of all, the platens should be parallel to each other and square to the direction of their movement. This may be accomplished with the tie bar adjusting nuts at the rear aligned platens. These nuts are also used to obtain the proper lock up tension on the molds. Since the distance between the center and rear platens is fixed, in the lock up or closed

**CLAMP**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>L.H. Rotac Adapter</td>
</tr>
<tr>
<td>B</td>
<td>Clevis</td>
</tr>
<tr>
<td>C</td>
<td>Rear Platen</td>
</tr>
<tr>
<td>D</td>
<td>Rotac Adjusting Screw</td>
</tr>
<tr>
<td>E</td>
<td>Front Platen</td>
</tr>
<tr>
<td>F</td>
<td>Center Platen</td>
</tr>
<tr>
<td>G</td>
<td>R.H. Rotac Adapter</td>
</tr>
<tr>
<td>H</td>
<td>Hex Nut</td>
</tr>
<tr>
<td>I</td>
<td>Tie Bar Bushing</td>
</tr>
<tr>
<td>J</td>
<td>Tie Bar</td>
</tr>
<tr>
<td>K</td>
<td>Bushing Retainer</td>
</tr>
<tr>
<td>L</td>
<td>Bushing</td>
</tr>
<tr>
<td>M</td>
<td>Rotac</td>
</tr>
<tr>
<td>N</td>
<td>Toggle Pin</td>
</tr>
<tr>
<td>O</td>
<td>Toggle Link</td>
</tr>
<tr>
<td>P</td>
<td>Bearing</td>
</tr>
<tr>
<td>Q</td>
<td>Split Tie Bar Nut</td>
</tr>
<tr>
<td>R</td>
<td>Platen Rail</td>
</tr>
<tr>
<td>S</td>
<td>Platen Shoe</td>
</tr>
<tr>
<td>T</td>
<td>Guide</td>
</tr>
</tbody>
</table>

REFER BY PART NAME AND CLAMP
MODEL NUMBER
EXAMPLE: 15 × 34 - 3
position, adjusting these nuts will control the
distance between the center and front platens.
Proper adjustment of this distance will stall the
rotary actuator at low pressure but not at the
high lock up pressure available. A simple
check for uniformity of tie bar nut adjustment is
to place a single thickness of this paper
between the top and bottom of the two outside
molds and close the platens until they are
locked. All four pieces should be tight.

Once the platens have been oriented to
each other, the next step is to bring the entire
platen assembly into the proper relationship to
the die head assembly. This may be done with
either the rotary actuator adjusting screws as
required.

There are several points in the clamp
assembly which should be lubricated daily.
These include the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toggle Pins</td>
<td>Grease</td>
</tr>
<tr>
<td>Platen Shoes</td>
<td>Grease</td>
</tr>
<tr>
<td>Tie Bar Bushings</td>
<td>Oil</td>
</tr>
</tbody>
</table>

**Clamp limit switch arrangement**

**ITEM PART NAME**

| A | Cam Bracket               |
| B | Limit Switch Cams         |
| C | Limit Switch Trip Rods    |
| D | Rotac Adapter             |
| E | Limit Switch 802TK        |

**Clamp safety doors**

The entire clamp area of the machine is
guarded by expanded metal sliding safety
doors. Also a fixed guard is placed over the
front and center platens to prevent reaching
over the sliding doors. This fixed guard is
positioned beneath the die head adjustments so
that changes can be made without removal of
the guards. Under no circumstances should a
machine be operated with any of the safety
guards or devices removed or rendered
inoperative.

Each section of the safety doors operate both
a three way air valve and a limit switch. The
air valve controls a hydraulic valve in the clamp
closing circuit which in turn will not allow the
clamp to operate if the safety guard is open.
The limit switch controls the electrical control
of the clamp. In other words, if any of the safety
doors are left open, the clamp pushbuttons
are rendered inoperative.

These safety interlocks are in effect at all
times, whether in manual or automatic cycle.
They should be checked periodically to insure
that they are functioning properly. To check,
merely open any one of the doors and attempt
to open or close the platens. They should be
completely inoperative.

**The molds**

The molds perform the last major operation
in blowing a plastic container. Each mold half
is mounted on a moveable platen, which when
closed, centers the mold directly under the die
and mandrel. This machine will accept any
number of molds, depending on the size and
type of clamp.

Each mold half is made up of three parts: the
neck ring, the mold body, and the bottom
insert. These parts are attached to a back plate
which in turn is mounted by means of screws
to the platen.

The mold has two basic functions to
perform; namely, to form the container and to
cool it sufficiently. While the platens are open,
the parison is extruded between the mold
halves. When the parison reaches the proper
length, the molds close and air pressure
supplied through the die head assembly
inflates the parison to the shape of the cavity.
When the blown container has cooled, the air
is exhausted, and the platens open to allow the
stripper to eject the container.

The cavity in the mold which forms the
contour of the container is usually machined
from the solid, although casting methods are
sometimes used. The cavity is made slightly
larger than the finished container to allow for
shrinkage which occurs during the cooling of
the plastic.
Pinch-off is required at any point around the cavity where there is flash. This is a depressed area adjacent to the cavity and separated from it by a sharp edge. This sharp edge severs the flash from the container except for a very thin film and facilitates the trimming of the flash. The depth of the pinch-off area is important because if it is too shallow, the molds will be held open, and if it is too deep, the flash will not be properly cooled. Caution must be exercised when changing either container weight or type of resin. Either of these can cause a change in the depth of pinch-off required.

Because the extruded parison is usually about 350°F, the molds are water cooled. Normally this is done by passing chilled water through a series of drilled passages in all three parts of the mold. The size and number of these passages is determined by the container design. The cooling of the container in the mold is of the utmost importance because it is by far the greatest single factor in cycle time. In general, the cooling water should be as cold as existing ambient humidity conditions will allow. Molds will sweat when the temperature of the coolant is below the dew point and condensed water drops inside the mold cavity will mar the appearance of the container. However, the mold open time is so short on these machines that mold temperatures can usually be well below the dew point.

Molds are built to exacting dimensions and must be treated as precision tooling. Damage can occur through misuse which results in expensive repair and loss of production. The paring line which includes the pinch-off is very easily damaged. Care should be exercised not only when the mold is in production, but also when in storage.

Molds for handleless containers
- A Bottom Insert
- B Locating Dowel
- C Mold Body
- D Coolant Lines
- E Neck Ring
- F Tail Grabber Slot
- G Pinch-Off
- H Backing Plate

Molds for handled containers
- A Bottom Insert
- B Locating Dowel
- C Mold Body
- D Coolant Lines
- E Neck Ring
- F Tail Grabber Slot
- G Pinch-Off
- H Backing Plate
NECK RING TYPES (and PRE-FINISH SYSTEMS)

There are five general types of neck ring designs used on Uniloy molds; namely, plain—inside the neck—type, dome, pull-up, compacting, and ram down interference. In most cases, the choice depends on the bottle design, type of finish, and container weight. The descriptions in the following sections are intended to be typical rather than specific because there are many ramifications and limitations to each of these general categories.

Plain - “inside the neck”

Some container designs allow this, the simplest of systems, to be used. It must be a container without a handle, preferably round or square, and having a centered neck which permits both an internal lip and an “as blown” wall thickness (Figure 1). The neck ring in this case is machined from aluminum and water cooled when practical. A blow pin is not usually required, but the neck ring is located quite close to the die face in order to effect a seal for the blow air. An advantage of this system is the absence of flash at the top of the container. In the case of a screw finish it also eliminates the pinch-off which occurs whenever there is flash and can sometimes be troublesome.

Domes

Until Uniloy developed the pre-finish and compacting system, this was the most common type of neck ring design used. Presently its use is limited almost exclusively to containers with off-center necks (Figure 2 and Figure 3).

In order to obtain the best wall thickness uniformity, the center of the container (off-center neck finishes and on-center neck finishes) should be in line with the die and mandrel. This requires a neck ring which forms an air passage between the neck and blow pin which is supported by the die and mandrel system. In the upper position of this neck ring, the air passage is enlarged into a dome type shape. Plastic blown into this area forms a dome which is subsequently acted upon by the stripper to remove the container from the blow pin and eject it from the machine.

The off-center neck container is trimmed to remove flash in a guillotine system and is conveyed to a facing station (fly cutter) which removes the dome and finishes the neck of the container.

In the case of the on-center neck finish containers (Figures 4 and 5) there are two configurations. Figure 4 depicts the type where a facing station is used to remove the dome and finish the neck by means of a fly cutter system. And the other, Figure 5, is a spin-off type system where the container is conveyed through a trimming station revolving against a stationary knife edge thus removing the dome and finishing the container.
**Ram down interference prefinish**

Although this arrangement is very similar to the compacting system it will eliminate the need to convey the container through a facing station to finish the neck.

It is applicable only to container necks whose finishes do not require internal lips or grooves. This I.D. of the finish must be straight and smooth. The main purpose of this system is to produce a heavy walled neck finish.

The pre-finish system is composed of a neck ring, insert, blow pin, and a cylinder arrangement for moving the blow pin up and down. In Figure 6-1 the mold is closed, and the blow pin is extended below the top surface of the insert. Figure 6-2, the blow pin is down, forcing plastic into the neck finish. The blow pin stroke is determined by the stroke of the pre-finish cylinder. To increase shearing action of the blow pin, adjust it downward so that greater pressure will be applied at the point of interference, or where the blow pin shear sleeve insert and the shear steel meet.

Because the parison must freely pass over the blow pin, this system is limited as far as size combinations are concerned. In general, a half gallon is limited to a 38mm or smaller and a gallon is limited to 48mm or smaller.

The neck ring is usually made of aluminum and is water cooled. The insert (shear steel) and blow pin are hardened and ground tool steel. Both the neck ring and insert are provided with pinch-off, therefore, the container is produced with top flash and will need trimming by means of a die action trimmer.

---

**Compacting pre-finish**

Although this arrangement is very similar to the pre-finish system it operates in reverse with totally different results. It is applicable only to centered neck containers whose finishes do not require internal lips or grooves. The I.D. of the finish must be straight and smooth. The main purpose of this system is to produce heavy walled neck finishes.

It is composed of a neck ring, insert, blow pin, and a cylinder arrangement for moving the blow pin up and down. Figure 7-1. As shown in diagram Figure 7-2, the blow pin is rapped down forcing the plastic trapped in front of it into the neck ring cavity. The undercut or “dam” traps the material underneath preventing it from being pushed into the mold cavity below the finish.

---

**CAUTION:** IF BLOW PIN IS SET TOO LOW, DAMAGE TO SHEAR STEELS, BLOW PINS, OR BOTH WILL OCCUR. IF SET TOO HIGH, NO SHEARING ACTION WILL OCCUR AND NECK FINISH WILL NOT BE COMPLETE.
The clearance between the blow pin and the insert must be held quite close to prevent the plastic from flashing up around the pin. It is very difficult to completely prevent flashing around the blow pin, but it should be held to a minimum in order to simplify the trimming operation. With a few exceptions, most finishes will require a facing operation on this type of neck.

Because the parison must freely pass over the blow pin, this system is limited as far as size combinations are concerned. In general, a half gallon container is limited to 38mm finish or smaller and a gallon is limited to 48mm or smaller.

The neck ring is usually made of aluminum and is water cooled. The insert and blow pin are hardened and ground tool steel. Both the neck ring and insert are provided with pinch-off and, therefore, the container is produced with top flash.

**Pull-up pre-finish**

Used exclusively with center fill container (with or without handles) having an as blown wall thickness and internal lip with a calibrated I.D. as determined by blow pin size.

In the initial cycle the blow pin is in the up position, the parison is dropped and the blow pin extends to the down position as the mold closes, Figure 8-1, shear diameter of shear steel insert in mold (bottom diameter of shear steel) will align to the mid-point of the groove on the blow pin. Blow cycle starts and blows the container, then exhausts. Figure 8-2 illustrates the blow pin being retracted demonstrating the shearing action (Figure 8-3). Blow pin rises to the full up position and gives shearing action of the blow pin diameter through the shear steel, forming the I.D. of the neck finish.

**CAUTION:** IF BLOW PIN IS SET TOO LOW, DAMAGE TO SHEAR STEELS, BLOW PINS, OR BOTH WILL OCCUR. IF SET TOO HIGH, NO SHEARING ACTION WILL OCCUR AND NECK FINISH WILL NOT BE COMPLETE.

**The water system**

Cooling water is required by a blowmolding machine to remove excess heat from the molds and various mechanical elements. Usually a commercial, air cooled, portable water chiller is used in a closed loop system to supply the total needs of the machine. In some large multi-machine installations two systems may be used such as a chiller and a cooling tower. This is done to improve efficiency because the molds require much colder water than mechanical units.

The closed system water chiller is not the only method available, but it does satisfy the needs of the equipment very well. All elements require clean water to prevent mineral deposit
build-up, and the closed system prevents contamination of this type. Also, the chiller is the only system which can supply a very low temperature coolant such as O°F which is required on some molds. Therefore, this system is about the most simple and economical for the majority of installations.

In some cases, such as a dairy where a "sweet water" or similar system exists, the chiller would not be required except when extremely low temperatures are needed. In considering other systems, pay close attention to mineral content and other forms of contamination.

Cooling water is piped to the machine at the rear of the extruder base. This connection supplies water to the hydraulic, reducer cooling and barrel cooling heat exchanger on all machines. The flow of water to each of these units is controlled by a flow control valve and it should be carefully set to minimize the usage of water.

Approximate running temperatures for the various units are as follows:

- Hydraulic reservoir: 110°F
- Reducer: 130°F
- Barrel cooling reservoir: 175°F

If it is desired to supply the mechanical elements from a second source, such as a cooling tower, it may be as warm as 60°F with a minimum pressure of 35 PSI when supplying 20 GPM.

**Mold cooling**

This is a major requirement of chilled water both in quantity and heat load. The greatest single portion of cycle time is cooling time. Plastic enters the mold at approximately 350°F and must be reduced to about 180°F as rapidly as possible. This requires molds to be as cold as possible, which is usually determined by the relative humidity and the mold open time. Since the molds are open in automatic cycle only a very short time, mold temperatures below the dew point can often be used without ill effects. Molds operating too cold for existing ambient condition will "sweat" on the cavity walls during the mold open time causing water spots on the finished container.

There are two general types of molds as far as water cooling connections are concerned. Larger, handled container molds usually are cooled individually with separate connections while small, non-handled container molds are usually manifolded together with common connections. In the case of individual molds, they are fed from a common supply which is piped through the platens for convenience and minimum tubing length. Each mold half is piped with one inlet and one outlet. The outlets are connected to a water return manifold mounted on the side of the clamp. Each connection to the manifold is equipped with a thermometer. The exit temperature from each mold half can therefore be monitored.

Small container molds which are manifolded together usually have only one or two inlets and outlets. These are connected directly to the main coolant supply lines in the base for the sake of convenience.

The chiller should be located as close to the blowmolding machine as is practical and the pipe or hose connections between the chiller and machine should be insulated to prevent heat pick-up.

**The air system**

Compressed air is used for several purposes on this machine:

1. To form the container.
2. To eject or strip the container.
3. To operate the safety door interlock system.
4. To power the cylinder operated blow pins.

The air supply should not be less than 100 PSI at the machine. Because blow pressure can drastically affect the volume of any blown plastic container, it must be maintained above the 100 PSI level. A regulator (C) is supplied with the machine, as noted below, which may be set at the desired blow pressure. This regulator will reduce plant pressure to the set value and will not allow pressure fluctuations above that point to enter the system. In the event that other plant demands on the air system may cause the pressure supplied to the blowmolding machine to drop below this value, some remedial action must be taken, such as a completely separate compressor or a sufficiently large surge tank located near the machine. Remember, a drop in air pressure will result in a container which is under volume.
The flow of air supplied to the machine is divided in two paths. One path is through a lubricator (B) to the manifold supplying lubricated, but un-regulated, air to the various cylinders and for use as pilot air. The second path goes through a pressure regulator (C) and then to the manifold and is not lubricated. This dry air is used to blow the container. It may also be used as a source of dry air for some accessory equipment where air comes into direct contact with the container.

On the rear face of the manifold are mounted four valves. The function of these valves are as follows:

A  PRE-FINISH CONTROL VALVE
   Operates pre-finish cylinders up or down position.

E  BLOW-EXHAUST SELECTOR SWITCH
   This valve is a pilot valve controlling the Blow-Exhaust valves (D) mounted beneath the manifold.

F  LOW PRESSURE REGULATOR
   This controls the amount of low pressure.

G  HIGH/LOW PRESSURE SELECTOR VALVE
   This solenoid valve determines whether the container is being blown with high or low pressure air.

I  STRIPPER CYLINDER DIRECTIONAL CONTROL VALVE
   Actuates stripper cylinder up and down.

Most of the exhaust ports of these air valves are equipped with silencers to meet, or exceed, the requirements of the Walsh Healy Act. Removal of these devices may result in violation of this law.

**High and low pressure blow**

The Blow-Exhaust valve (D) is an On-Off valve which controls the time when air is allowed to blow the container. The High/Low Pressure selector valve controls whether high or low air pressure is used to blow the container. In most cases only high pressure air is used. However, it is sometimes desirable to inflate the parison slowly with low pressure prior to the high pressure blast.

The main air regulator (C) is the high pressure control and should be adjusted to approximately 80 PSI. The low pressure may be set as required (usually 10-20 PSI) by regulator (F).

The Blow-Exhaust valves (D) are pilot operated and are all controlled by a single solenoid valve Blow/Exhaust selector valve (E) regardless of the number of heads. When the solenoid is energized, blow air is allowed to pass through to inflate the parison. When it is de-energized, the blow air is shut off and the pressurized container is allowed to quickly exhaust.

**Stripper**

The stripper is an air cylinder operated device which ejects the blown container from

**Air schematic**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre-Finish Control Valve</td>
</tr>
<tr>
<td>B</td>
<td>Lubricator</td>
</tr>
<tr>
<td>C</td>
<td>High Pressure Regulator</td>
</tr>
<tr>
<td>D</td>
<td>Blow/Exhaust Valve</td>
</tr>
<tr>
<td>E</td>
<td>Blow/Exhaust Selector Valve</td>
</tr>
<tr>
<td>F</td>
<td>Low Pressure Regulator</td>
</tr>
<tr>
<td>G</td>
<td>High/Low Pressure Selector</td>
</tr>
<tr>
<td>H</td>
<td>Stripper Speed Control</td>
</tr>
<tr>
<td>I</td>
<td>Stripper Directional Control Valve</td>
</tr>
<tr>
<td></td>
<td><strong>Not</strong></td>
</tr>
<tr>
<td></td>
<td>Shown*Sanitary Filter</td>
</tr>
<tr>
<td></td>
<td><strong>Not</strong></td>
</tr>
<tr>
<td></td>
<td>Shown*Mufflers</td>
</tr>
<tr>
<td></td>
<td>Pre-Finish Cylinder</td>
</tr>
</tbody>
</table>

*Optional Item
(Usually used on machines making food product containers).
the machine after the molds open. It is controlled by a solenoid operated directional valve (I). In the de-energized position, this valve maintains the stripper in the UP position. When the molds are open sufficiently to permit the ejection of the container, a limit switch on the clamp mechanism is tripped which energizes the valve, sending the stripper down. A limit switch on the stripper frame is tripped in the down position which de-energizes the valve and returns the stripper to the UP position. Flow control valves are mounted on each port of the stripper cylinder by which the speed in each direction may be adjusted.

**Safety door interlocks**

The safety doors when closed, trip four cam operated air valves. Air pressure is supplied from the manifold through all four valves in series to two different devices. First, the air pressure is supplied to the hydraulic power unit where an air pilot operated valve supplies hydraulic pressure to the mold closing rotary actuator. Second this same air supply operates an electrical pressure switch which supplies the electricity by which the solenoid directional valve is operated that controls the hydraulic rotary actuator.

Therefore, if any one of the clamp safety doors in opened, the air valve operated by that door will exhaust the air pressure in this system, resulting in a complete loss of hydraulic pressure to the rotary actuator as well as the removal of all electrical power from the solenoids of the hydraulic valve which controls it.

A pressure regulator is used to cut down the air supplied to this system in order to make it react more quickly when a door is opened. Although the system functions satisfactorily at line pressure, it is more sensitive at about 30 PSI and should be adjusted to that level whenever possible.

It is extremely important, for the safety of the operator, that these safety doors and their interlocking systems are kept in good working order. Each day they should be inspected and checked to insure proper operation. Each of the four doors should be checked separately as follows:

With one door open, attempt to close the molds with the Mold Close pushbutton. They should not move. Next, manually shift the Rotac directional control valve and while holding the valve in first one shifted position and then the other, observe the clamp for motion. There should be none. Repeat this procedure on all doors.

**Air filtration**

An air filter may be added as an accessory when required, such as in dairies, in order to insure clean air. This filter is mounted separately on the machine bridge near the air manifold. When included on the machine, this becomes the point to which plant air is supplied rather than to the manifold directly.

This filter contains a cartridge element for removing dirt particles and a cooling coil for condensing moisture. It, therefore, must be connected to the chilled water system. When purchased with the blowmolding machine, this connection is made at the factory.

**The hydraulic system**

The hydraulic system of this machine serves two distinct purposes, namely, to operate the rotary actuator which closes and opens the molds and to drive the extruder screw forward to make a shot. These two functions require very different hydraulic outputs, as described below.

Hydraulic pressure is produced by a 15 GPM variable volume, pressure compensated, vane pump (C) which is driven by an electric motor (B) (see hydraulic schematic). The normal rating of this pump is up to 1500 PSI. The pressure compensator on the end of the pump may be set at any desired pressure and full volume will be produced up to within 50 PSI of that setting. As the pressure rises through the last 50 PSI, the volume is gradually diminished until the set pressure is reached at which time no volume is produced at all. This prevents heat build-up which commonly occurs in circuits employing fixed displacement pumps which must dump over a relief valve during dead heading conditions.

A filter (A) is located in the suction line of the pump to prevent dirt from entering the pump. This filter has a 74 micron cartridge and it contains magnets for the removal of fine ferrous particles. The filter should be cleaned whenever the indicator shows the need for it. As the filter becomes dirty, the pores of the cartridge become clogged. When this condition becomes acute, an automatic by-pass in the filter opens to prevent cavitation and eventual destruction to the pump. However, when this
happens, the filter is useless and may be contaminating the entire system with dirty oil.

Only a high grade of hydraulic oil with a viscosity of 150-250 SSU and with rust, oxidation, anti-foam and anti-wear inhibitors should be used. After two weeks of initial running, and every three months thereafter, the system should be drained and refilled with new oil. An alternate method of maintenance may be employed by obtaining one of the small, portable filtration units which are available for this purpose. A unit of this type will remove oil from the machine, filter it, and return it to the reservoir.

Hydraulic power unit

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART</th>
<th>NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Shot Cylinder 4-Way</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Low Pressure Relief</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>10 HP Motor</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Option:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swinging Arms Valve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shift Clamp Valve</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Rotac Pressure Reducing Valve</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Check Valve</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Safety Door Valve</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Low Pressure 2-way Valve</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Filler Cap &amp; Screen</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Thermometer</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Oil Temperature Switch</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Suction Filter</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Accumulator Dump Valve</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Rotac 4-way Valve</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>15 GPM Pump</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Pump Pressure Compensator Valve</td>
<td></td>
</tr>
<tr>
<td></td>
<td>System Pressure Adjustment</td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Pressure Gage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oil Level Should be filled to a Depth of 1” in Filler Cap Screen</td>
<td></td>
</tr>
</tbody>
</table>
Platen actuation

All denotations within ( ) relate to hydraulic schematic page 26. The movement of the platen and the locking force required for the molds is obtained by means of a rotary actuator. This device is composed of a housing containing a shaft which carries a flat vane. Hydraulic pressure applied to either side of the vane produces rotary motion in one direction or the other. This rotary motion imparts movement and force to the platen through a toggle linkage. The direction of rotation of the rotary actuator is controlled by the 4-way valve (P) in the same manner as a double acting cylinder.

For mold protection and safety reasons, this system is designed with two pressures available. During the closing of the molds, it is desirable to have a low pressure available to prevent mold damage, in case some object happens to be between the mold halves. It is also necessary to have a high pressure to produce the final lock-up of the molds.

The setting of the pump compensator is the adjustment for obtaining the high pressure. This becomes the highest pressure obtainable in the system and is usually set at about 1400–1500 PSI.

The solenoid operated 2 way valve (R), together with the remote relief valve (S), are used to obtain the low pressure. When the solenoid of valve (R) is de-energized, system pressure is controlled by the setting of (S). And when the solenoid is energized, valve (R) is closed and the pressure of the system is controlled only by the pump compensator. The low pressure setting of valve (S) should be just high enough to move the platen at a reasonable rate of speed. This setting is normally about 250 PSI.

When the mold area closes to within .020 - .060 inches, a limit switch is tripped by the clamp mechanism which energized the solenoid of valve (R), removing the low pressure relief valve (S) from control. The pressure then rises to the pump setting for the final lock-up. It is therefore necessary to energize or de-energize solenoid valve (R) to obtain either high or low pressure.

If anything is between the molds which prevents closing to the limit switch setting mentioned in the previous paragraph, the low pressure close timer will time out, the molds will reopen and automatic cycling will stop.

Therefore, if an object happens to get caught between the molds, it will be squeezed by low pressure only and will be released after a few seconds.

Inserted between the solenoid section and the slave section of valve (P) is a pressure reducing valve (O). This valve limits the pressure that can be applied to the rotary actuator. Because the rotary actuator is rated at 1000 PSI, operation at higher pressures only serves to reduce the life of the unit. Since system pressure is usually above 1000 PSI, the pressure reducing valve when set at a maximum of 900 PSI, effectively safeguards the unit.

Extruder screw reciprocation

The shot cylinder is controlled by the single solenoid 4-way valve (K). This is a two position valve. Energizing the solenoid of valve (K) will apply pressure on the shot cylinder piston, causing a shot to be made. De-energizing the solenoid will exhaust the shot cylinder through the back pressure relief valve (L). Thus the plastic pressure in the extruder barrel can be controlled as plastic is being produced and stored by adjusting valve (L).

Valve (H) is a pressure compensated flow control which regulates the speed at which the shot cylinder may travel during a shot. In any given instance the resistance to plastic flow during a shot created by the die head assembly is constant, therefore, controlling the speed at which plastic flows out of the heads. Also as the speed of the flow increases, the pressure exerted on the plastic must increase. Therefore plastic shot pressure is directly controllable by valve (H) within the limits of the hydraulic system pressure.

The heat exchanger (M) is used for protection of the system. High ambient temperatures or other conditions may tend to overheat the hydraulic oil, causing several operation and maintenance problems such as sticking valves and non-uniform movements. Care should be taken by proper adjustment of the water control valve to maintain 110°-130°F oil temperature in the reservoir.

The nitrogen bottle (F) is used in the circuit as a pressure storage vessel. It consists of a steel tank containing a heavy BUNA-N bag connected at one end of the tank by an external fitting. Nitrogen gas enters the bag through this fitting and oil is pumped into the opposite end of the tank. Thus the BUNA-N bag
separates the gas from the oil.

Before any oil is introduced into the bag, the tank is pre-charged with nitrogen at a pressure between 1/2 and 3/4 of system pressure.

As oil is pumped into the bag, the nitrogen is compressed further so that the gas pressure always equals the oil pressure. When valve (K) is shifted with the resulting demand for oil by the shot cylinder, both the nitrogen bottle and the pump furnish this demand. The nitrogen bottle may be compared to a spring which is compressed until its force is needed and then released to perform some useful work.

The charge of gas can be checked with the appropriate adapter and gage only when the bottle is empty of oil. The oil may be removed by opening valve (E) which dumps it directly to the reservoir. This must be done with the hydraulic pump turned off. If recharging is required, only pure nitrogen may be used. No other gas may be substituted.

CAUTION: ANY TIME THAT IT IS
NECESSARY TO WORK ON THE
HYDRAULIC SYSTEM, ALWAYS OPEN
VALVE (E) AND DUMP THE ACCUMULATOR
BEFORE REMOVING A VALVE, HOSE,
TUBE, CYLINDER, ETC.

Check valve (D) is used to prevent the oil stored in the accumulator from flowing back through the pump when it is shut off. This check valve also prevents accumulator pressure from operating the clamp portion of the machine.

The electrical system

The electrical system for this machine consists of components ranging from a simple pilot light to complex servo mechanisms such as the temperature controllers and the variable speed extruder drive. In between lies an array of devices designed and interconnected to change, monitor, protect, or control the process of converting resin into a formed container. Fuses provide overload and short circuit protection for various parts of the system. Transformers are used to provide lower, safer voltage levels in some areas. Motor starters give us a means of remotely controlling the motors as well as protecting them against undervoltage and overload. Control relays from the brain of the cycle control, responding to various inputs from limit switches, timers, pushbutton, etc., and controlling the outputs accordingly.

All of these items are pre-wired to a single main circuit breaker, the point at which the customer makes his connection to his power supply. This circuit breaker is interlocked with the control panel door, so that the door can not be opened with the breaker turned on, and the breaker can not be turned on when the door is open.

The major loads in the system are shown in the schematic diagram in a way that is largely self-explanatory. The temperature controls and the variable speed extruder drive are both covered thoroughly by instruction manuals prepared by their respective manufacturers. Therefore these items are not covered in detail in this manual, which will be directed toward helping the operator and maintenance man to understand the controls and the logic employed to make the machine run.

The electrical controls for a machine of this type are a complex assortment of interdependent devices which may be best understood by breaking up the system into sections. Each section of the circuit, while related to other sections, may still be considered as a separate circuit in itself. Each diagram in the manual is a direct reproduction of a portion of the overall schematic, which shows all the various sections of the circuit together. There may be minor additions to accommodate a special function that is not required on a standard machine, but the basic circuit is the same.

The nameplate affixed to the panel door of each machine bears the drawing number of the schematic that fits any given machine exactly. It is suggested that the reader refer to this drawing when reviewing the sectional diagrams shown in the manual in order to understand how each section fits the overall picture, and also to detect any additional circuitry that may be peculiar to this machine.

All wiring is color coded to aid in identification, as well as having a number tag on each end of each wire. Power wires are black, AC control wiring is red, DC control wires are blue, and equipment ground conductors are green. Yellow identifies control wires used for interconnection between machines or those with power supplied from a source outside the control panel.

Wire numbers are assigned as follows:

1-150  Blowmolder control circuit
151-200  Temperature Control
201-300 Blowmolder power circuits
301-400 Extruder drive control
401-500 Interconnection between machines
501-600 Control circuits for auxiliary equipment such as trimmers and conveyors.

All devices such as relays, timers, solenoids, and limit switches are labeled with an engraved nameplate bearing the device designation as shown in the schematic diagram. Numbers are assigned to these devices in the following manner:

1-100 Blowmolder devices
101-200 Trimmer devices
201-300 Bottle take-off devices
301-400 Conveyors

**Control panel components**

The double door panel attached to the machine base encloses all the components required for machine control and is designed to be oiltight and dust tight to exclude contaminants which may interfere with the operation of the enclosed control. For this reason, as well as to protect personnel from accidental contact with “live” parts, the doors must be kept tightly closed at all times. All components are designed to operate at temperatures up to 150°F., which is about the same as the hot water temperature in a home. A cooling fan is provided to keep the panel at a moderate temperature.

Each device in the panel is identified with a nameplate which relates it to the schematic diagram and to this manual. The following description will help to identify each component and to understand its intended purpose.

**A. TEMPERATURE INDICATING CONTROLLER**

The function and purpose of the temperature control instruments is covered in other sections of this manual. See page 10 for information.

**B. METERS**

1. **MACHINES EQUIPPED WITH EDDY-CURRENT COUPLINGS**

   a. **EXTRUDER MOTOR LOAD METER**: This meter is calibrated to the motor and indicates the percent of full load.

   b. **TACHOMETER**: This meter is calibrated to the extruder drive and indicates the speed of the output shaft in revolutions per minute. Screw RPM is the product obtained by multiplying the meter reading by the sheave ratio and the gear reducer ratio. For example, if the gear reducer nameplate indicates a ratio of 14.7:1 and the driving sheave has a pitch diameter of 9.0 inches (9.40 O.D.), the drive sheave P.D. is 10.0 inches (10.40 O.D.), and the meter indicates 1600 RPM screw speed is determined as follows:

   \[
   \frac{9.0}{10.0} \times 14.7 = 97.9 \text{ RPM}
   \]

2. **MACHINES EQUIPPED WITH D.C. DRIVES**

   a. **EXTRUDER MOTOR LOAD METER**: This meter reads directly in amperes and must be related to the full load current given on the motor nameplate.

   b. **TACHOMETER**: This meter is driven by a tachometer generator, coupled to provide a fixed ratio between the meter reads directly in screw RPM.

3. **ELAPSED TIME HOUR METER**: This digital clock indicates the total hours the extruder has been operated, therefore provides a record for scheduling maintenance.

   4. **CYCLE COUNTER**: This meter is equipped with a reset knob and indicates the number of machine cycles made since the last reset.

**C. TIME DELAY RELAYS**

1 TD: **“CHARGE-DELAY” TIMER**: provides a time lag after the screw reaches its forward limit, before it starts to retract; energized when LS-1 is closed, indicating that the screw is forward; resets when LS-1 opens, indicating that the screw has began retracting.

   2 TD: **“EXHAUST” TIMER**: determines length of exhaust time; energized when “BLOW” TIMER times out; resets when molds start to open.

   3 TD: **“BLOW DELAY” TIMER**: provides a delay after the molds close, before full pressure air blow; energized when LS-3 is actuated; resets when molds open and release LS-3.
4 TD: “BLOW” TIMER: determines length of full pressure blow time; energized when LS-3 actuated; resets when molds open and release LS-3.

5 TD: “LOW PRESSURE CLOSE” SAFETY TIMER: determines length of time molds are allowed to close without de-energizing SAFETY TIMER normally energized, off delay; delay period begins when molds start to close, timer is again energized when molds are locked up.

6 TD: “BLOW PIN DELAY” TIMER: when used, this timer provides an adjustable delay between the time the molds start closed and the point at which the blow pins drive down.

8 TD: PRE BLOW DELAY TIMER: this delay provides one of the most important controls available to the operator, also one of the most delicate. Adjustment of 1.100 second up or down will often make the difference between success or failure in blowing good containers. These adjustments must be related to Pre-Blow air pressure adjustments. These two factors, when properly tuned, provide the proper rate of flow at the proper time to permit the desired shaping of the parisons prior to the final closing of the mold at the beginning of high pressure blow.

In most applications, the PRE-BLOW SELECTOR SWITCH will be in position 1 and the timer will begin its pre-set delay period when the extruder screw reaches its forward position. Usually, this signal also starts the molds closed (see MOLD SEQUENCE SELECTOR). When the timer times out, the PRE-BLOW SOLENOID valve is energized. If the PRE-BLOW SELECTOR is in position 2, the timer starts when the screw starts forward. It can then be adjusted to begin Pre-Blow at any point during the discharge of parisons. This is sometimes desirable in the molding of heavy walled containers.

In either case, when 8 TD times out, Pre-Blow will begin. If too much delay is set on the timer, LS-3 will override the signal and complete the actuation of Pre-Blow air as soon as the molds are closed.

No matter which of these methods is employed, Pre-Blow air will remain energized until the Blow Time has timed out, de-energizing both the PRE-BLOW and the BLOW SOLENOID VALVES.

D. PUSHBUTTONS AND SELECTOR SWITCHES:

- HEAT ON: Depressing this button energizes all heaters. Care must be taken to re-energize heaters after using “EMERGENCY STOP” pushbutton.
- HEAT OFF: Depressing this button de-energizes all heaters.
- EXTRUDER MOTOR START: Depressing this button will start the extruder motor. Motor cannot be started if pilot light on stock temperature controller is on.
- EXTRUDER MOTOR STOP: Depressing this button will de-energize the motor.
- CLUTCH START (not used with D.C. drives): Depressing this button will energize the eddy current coupling.
- CLUTCH STOP (not used with D.C. drives): Depressing this button de-energizes the eddy current coupling only.
- HYDRAULIC PUMP START: Depressing this button will energize the hydraulic pump motors irrespective of the condition of the safety devices.
- HYDRAULIC PUMP STOP: Depressing this button de-energizes the hydraulic pump motors.
- SPEED CONTROL: This is a potentiometer which controls the speed of the drive output. This legend plate calibrated in percent of max. RPM. At the counter-clockwise or “0” setting, no rotation will be obtained. The speed is infinitely variable over the complete range to the maximum clockwise or “100” setting which will give full speed operation.
- EMERGENCY STOP: Depressing this button will de-energize all motors, heaters, and controls.
- MOLD SEQUENCE SELECTOR: This switch determines the time at which the molds start to close.
- PRE-BLOW SELECTOR: This is a key operated switch which selects the point in the cycle at which the pre-blow operation is initiated.
- BLOW PIN SELECTOR: This three position switch determines whether the blow pins will be held down (MANUAL), operated automatically (AUTO), or not used (OFF).
- SAFETY RESET: Depressing this button energizes the SAFETY RELAY, allowing the machine to be operated.
POWER ON: This is a pilot light only and indicates the main circuit breaker is on.

EXTERNAL CIRCUIT ON: Depressing this button supplies power to accessory equipment (Trimmer, conveyor, etc.).

EXTERNAL CIRCUIT OFF: Depressing this button de-energizes the accessory equipment.

E. SAFETY SIGNAL LIGHT:
A safety circuit is provided to prevent mold closing or further machine operation in case of operational casualties. A red signal light and an alarm bell indicates that the machine is out of order. A safety reset pushbutton is provided at the control panel to restore machine operation after the problem has been corrected.

F. TRANSFORMER T2:
A transformer is located in the base of the machine to provide a source of 120 volt power to operate the die heaters, hopper feeder, work light, and convenience receptacles. If power for the machine is supplied from a 440-480 volt source, this transformer is large enough to provide power to the head heaters at 220-240 volts, 3 phase, in addition to the loads mentioned above at 120 volts.

G. SUB-PANEL:
The sub-panel is mounted inside the main power control cabinet and supports all control components to which the machine components and equipment are connected.

CONTROL TRANSFORMER T1:
This is the transformer which supplied 115 volts to the control circuit of the machine, its rating is 1.5 KVA.

T3: (not used with D.C. drives)
Due to the large amount of power required by the drive motor, this current transformer monitors the motor current and transmits a proportionate amount to the load meter.

MOTOR STARTERS:
1M: Magnetic motor starter; supplies hydraulic pump motors with power and overload protection.
2M: Magnetic motor starter; supplies extruder drive motor with power and overload protection. When a D.C. drive is used, the 2M starter is replaced by the D.C. controller.
3M: Magnetic motor starter; supplies barrel coolant pump with power and overload protection.

I.O.L. (not used with D.C. drives):
The instantaneous overload relay is a current-responsive devise designed to actuate at a pre-determined current level, in this case, 140% of full load. When actuated, it de-energizes the eddy current coupling, thus removing the load.

CONTACTORS:
1PC: Energizes all temperature controllers.
2PC: Controlled by temperature indicating controller (TIC) #1, energizes heaters on rear section of the barrel (feed zone).
3PC: Controlled by TIC-2; energizes heaters on transition zone of the barrel (center section).
4PC: Controlled by TIC-3; energizes heaters on rearward metering section of the barrel (metering section I).
5PC: Controlled by TIC-4; energizes the heaters on the forward metering section (metering section II).
6PC: Controlled by TIC-5; energizes heaters on extrusion die head. When a double head is used, 6PC controls the die block only.
7PC: (Used only with a double head) controlled by TIC-6; energizes heaters on the feed throats of the head.

CONTROL RELAYS:
1CR: SCREW FOREWARD RELAY, and
2CR: SCREW RETRACT RELAY; these two relays are controlled by LS-1 and LS-1A respectively and are required to provide additional points in the circuit that may be affected by these switches. 1CR is energized when LS-1 is actuated at the forward end of the screw travel, and 2CR is energized when LS-1A is actuated at the rear end.

3CR: CHARGE RELAY; energizes solenoid valve #1 reducing hydraulic pressure on rear of shot cylinder, allowing screw to move backwards or "CHARGE".

4CR: AUTOMATIC CYCLE RELAY; energized by "CYCLE START" pushbutton provided that all safety doors are closed. Energizes mold cooling solenoid valves #8 to allow cooling water to flow through the molds.

5CR: PRE-BLOW RELAY; energizes solenoid valve #5 (5L and 5R) which introduces air into the parisons at reduced pressure.
6CR: PRE-BLOW SHUT-OFF RELAY; de-energizes PRE-BLOW AND BLOW RELAYS and energizes EXHAUST TIMER.
7CR: HIGH PRESSURE RELAY; energizes solenoid #2 to apply high pressure to the mold traversing mechanism; energized at all times except as molds are moving closed.
8CR: BLOW RELAY; energizes solenoid #6 (6L and 6R) to start full pressure blow; energized when molds are closed and BLOW DELAY TIMER times out; de-energized when "Blow" timer times out.
9CR: MOLD CLOSE RELAY; energizes solenoid #4 to close molds.
10CR: MOLD OPEN RELAY; energizes solenoid #4 to open molds.
11CR: BLOW PIN RELAY; energizes solenoid valve #9 (9L and 9R) to drive blow pins down.
12CR: AUXILIARY STRIPPER RELAY; sets up the stripper control circuit; energized when molds start to open, de-energizes when stripper is in a downward position, actuating LS-6.
13CR: STRIPPER RELAY; energizes solenoid #7 (7L and 7R) to operate the stripper(s).
14CR: CYCLE AUXILIARY RELAY; ties beginning of successive cycle to end of preceding cycle, energized when stripper is in the downward position, actuating LS-6; de-energized by LS-1 when screw reaches forward position.
15CR: SAFETY RELAY; shuts down the machine and sounds an alarm in the event of a failure or mal-function; energized by depressing "Safety Reset" pushbutton; de-energized when (1) any "EMERGENCY STOP" pushbutton is depressed, (2) "LOW PRESSURE close" TIMER is allowed to time out before molds are closed, (3) "MOLD close" relay becomes energized while LS-6 (LS-6L or LS-6R) indicates the stripper is between the molds, (4) the screw fails to produce material while the machine is cycling, (5) temperature of Hydraulic Oil reaches over 130°F.
16CR, 17CR, 18CR, 19CR: These are cooling control relays for the extruder barrel zones, controlled by the temperature indicating controller for each zone. Each relay energizes a solenoid valve which allows the cooling medium to flow through the cast-in tubes in each heater.
16CR Controls the transition section;
17CR Controls the metering section I;
18CR Controls the metering section II;
19CR Controls the feed section.
101CR: EXTERNAL SIGNAL RELAY: Synchronizes accessory equipment operation with blowmolding cycle.
H. 120 Volt—15 amp Service Outlet
A service outlet is provided just below the material hopper inside the barrel shroud on the left to supply power to the hopper feeder.

The electrical schematic

Page 33 shows a simple electrical circuit in which most of the common circuit elements are employed. A study of this sample is useful to help one become familiar with the various elements, their symbols, and also the interpretation of an electrical schematic. All Uniloy schematics follow the form and symbology prescribed by J.I.C. standards.

The following descriptions and explanatory notes are given with reference to the sample diagram:

1. The VERTICAL row of numbers at the left side are line numbers. They provide reference points within the diagram which bear no relationship to wire numbers, terminal number, or any points within the control panel or on the machine.
2. Numbers shown in PARENTHESES are terminal designations provided on a piece of control apparatus by its manufacturer and are not to be confused with wire numbers or terminal numbers assigned to the machine as a whole.
3. RELAYS:
   A relay is an electrically operated switch. It is similar to an ordinary household toggle switch in function, except that it is operated by an electromagnet rather than a manual lever, and may have many contacts.
   Each relay may be divided into two classes of electrical components, coils, and contacts. It is rare to find a relay with more than one coil, but it may have any number of contacts, in various types. In Uniloy equipment, you will not find more than eight contacts on any given relay, but they may be in any combination of
normally open and normally closed.

When power is applied to the relay coil, it is said to be energized; when power is off, the relay is de-energized.

Energizing the relay transfers all its contacts simultaneously, closing those which are normally open (N.O.) and opening all those which are normally closed (N.C.). When a contact is closed, current can flow through it.

Schematically, relay coils are designated by circles, the relay designation being inscribed therein. (See ICR shown in line 2 of sample diagram). N.O. contacts are shown as two short vertical parallel lines, N.C. contacts have a diagonal line intersecting them. Each contact has the relay designation directly above it. To the right of each relay coil is a series of numbers indicating the lines in the diagram in which contacts on this relay may be found. Underscored numbers indicate N.C. contacts.

Referring again to the sample circuit, you will see 3, 5, 7, 7 to the right of ICR coil, indicating that a N.O. contact is to be found in line 3, two N.O. contacts in line 7 and a N.C. contact in line 5.

4. LIMIT SWITCHES:

These mechanically actuated devices usually contain two sets of contacts, one set normally open and one set normally closed. When actuated, both sets of contacts transfer simultaneously to the opposite condition, remaining there until the actuator is released.

Schematically limit switches are designated as LS and are shown N.O. or N.C. by their symbols. If both contacts are used, they will be connected by a broken line which indicates that they are both part of the same switch. Either contact may be used and the other omitted, depending on the requirements of the circuit. In this case, only that portion of the switch (N.O. or N.C.) will be shown on the diagram.

Referring to the sample diagram, LS-1 is shown N.C. in line 2, and N.O. in line 5. Actuation may be thought of as the application of a force to the pressure pad which is a part of each symbol. Therefore, it is apparent that force applied to LS-1 will cause its contact in line 2 to open and its contact in line 5 to close. It is important to note that Uniloy schematics show limit switches in the "START CYCLE" or idle position. Therefore, N.O. contacts may be shown held closed or actuated and N.C. contacts may be shown held open.
There are limit switches which do not obey all of these rules. One such type is the neutral position switch used on the stripper. This switch has two N.O. contacts which we can call "A" and "B" for the purpose of discussion. When the actuating lever is moved clockwise, contact "A" closes, but "B" remains open. Releasing the lever allows "A" to open again. Moving the lever counterclockwise causes "B" to close, but "A" remains open. Because the contacts are independent of each other, they can provide signals at different times, or indicate different positions, eliminating the need for a second switch.

5. SELECTOR SWITCHES:

These are similar to pushbuttons, both in appearance and in their schematic symbols, the difference being that a selector symbol has an arrow to indicate the position in which it is shown. Physically, a selector has a knob or key that must be rotated to switch from one position to another. They may have any number of positions, but those in Uniloy equipment do not usually have more than three.

In the sample diagram, an "OFF-ON" selector is shown in line 2, its arrow indicating it is in the "OFF" position and its contact is open. Switching to the "ON" position will reverse this condition.

Some selectors have more contacts as well as more positions. To help interpret the symbols, X's and O's are placed beside each contact to show its condition in all positions. X denotes closed and O denotes open.

6. TIME DELAY RELAYS:

These are relatively complex solid state electronic devices that transfer electrical contacts to switch parts or the external circuit on or off. In this function it is exactly the same as a control relay; energizing the transfers contacts, de-energizing it restores the contacts to their N.C. or N.O. condition, as the case may be. As the Timer times, it actuates the time delay contacts.

An analysis of this will show that the timer experiences three conditions during each cycle:
1. POWER OFF
2. TIMING
3. TIMED-OUT

To help identify contact conditions, a series of X's and O's are shown by each contact in a diagram, X denoting normally closed and O denoting normally open. The N.O. instantaneous contact operated by the timer may then be described as OXX which means that in condition "1" (POWER OFF) the contact is open and will be closed when power is applied to the coil; it remains closed during the time delay period (condition "2"); it remains closed in condition "3" (timed-out); and it will return to its normal state (open) only when the power to the Timer coil is turned off. An N.C. contact is the direct opposite, XOO. The first time delay contact is shown OOX or XOX.

When the timer is de-energized, the timer resets and is then ready for the next cycle.

These timers are of the plug-in type, and they may be removed from their cases without disturbing the wiring. This facilitates inspection, range changes, and trouble shooting. If a malfunction is suspected, it is a simple matter to remove the timer and substitute another one.

7. PRESSURE SWITCHES:

Pressure switches are similar in function to limit switches. They usually have N.O. and N.C. contacts which transfer to the opposite condition when the switch is actuated. The difference is that a pressure switch is actuated when air on hydraulic pressure is applied to the self-contained piston or diaphragm. This piston type is usually used for high pressure applications, and the diaphragm type is low pressure applications.

Schematically, they are designated as PS. Refer to PS-1 in the sample diagram which is shown N.O. in line 2 and will close when sufficient pressure is applied to actuate it.
8. THERMAL SWITCHES:
   These are temperature operated devices but differ from a temperature controller in that they serve as a protective limit device rather than as a controller which regulates temperature to a pre-set value.

   Schematically they are designated as TS-. In line 2 of the sample diagram, TS-1 is shown N.C. and will open when its sensor is overheated.

9. PLUGS AND RECEPTACLES:
   These are used wherever it is necessary to disconnect some portion of the equipment for shipping, service, or because it may not be required at all times.

   Schematically, each plug pin and receptacle socket are shown as adjoining arrows, and designated by a “P” with both a numerical prefix and a numerical suffix. The prefix denotes the plug number, and the suffix denotes the pin number within the plug. Thus, 3P5 would indicate pin #5 in plug #3 socket #5 receptacle #3. See IP1 and IP2 in line 7 of the sample.

   Note: In some cases, the plug and its mating receptacle may be on different machines so that one machine may receive either power or control signals or both from the second machine. In these cases, the pins and sockets will be shown on different diagrams. Where this situation occurs, the socket will be designated by “S” as in 3S7. This will mate with pin #3P7 on another machine.

   The plugs and receptacles in Uniloy equipment are so keyed that you cannot mismatch them. They appear to be identical, but if they do not connect together easily, they do not belong together.

10. SOLENOIDS:
    Solenoids, generally speaking, are devices which convert electrical energy into mechanical energy. When current flows through a solenoid coil a magnet is created which causes the movable portion (armature) to shift, usually compressing a spring which will return the armature to its normal position when the coil is de-energized. Most solenoids are used to shift the spool of a valve, which in turns allows fluid to flow, thus controlling a cylinder or other fluid power device. Now let us assume a set of conditions which must be satisfied to enable a machine to run:

    A. 460 VAC power is available, but for safety and uniformity, it is desired to operate our control circuit at 115 volts AC.

    B. An “OFF” switch is required so the machine may not be started inadvertently.

    C. Power is provided from a central hydraulic system, so no pump is required.

    D. No action is to be permitted if no hydraulic pressure is available, or if the fluid is too hot.

    E. The desired sequence of operations is as follows:

       1. When started by an operator, cylinder is required to advance to a stop.

       2. The cylinder retracts.

       3. After an adjustable time delay, the cylinder repeats steps 1 and 2 automatically.

       4. Steps 1, 2, and 3 are to repeat until the operator commands it to stop or there is a power failure, such as a blown fuse.

       5. In the event of a power failure, the machine must be re-started by the operator, not automatically.

    F. The assembly that contains the solenoid valve must be easily removed for service.

    Referring again to the sample circuit, you will see that all these requirements are met. Even though AC power alternates its direction of flow periodically, it is convenient, when interpreting a schematic, to think of current flow in terms of D.C., i.e. unidirectional current; flowing out the left side of the transformer, down the main line on the left, from where it always seeks the shortest route to the main line up the right side, then back into the transformer. Small directional arrows in the sample circuit show this D.C. flow analogy.
Electricity, being rather lazy, always follows the path of least resistance, but its urge to get back to the transformer is so strong that it is willing to do some work along the way. This is the thing we take advantage of. By opening and closing contacts at the right point in the circuit at the right time, we can control the current flow to make it perform any desired task at any desired time.

To satisfy the first requirement, we must use a transformer. The primary side is now shown in the diagram, but we will assume it is connected to a 460 volt source. The output (secondary) of the transformer will then be our control circuit power supply at 115 volts. In order to prevent overloading, a fuse is installed in the line leading away from the transformer. This is the “hot” side of the line, #1. The other side of the secondary winding is then connected to wire #2 as shown. This now becomes what may be referred to as the neutral, common, or return side of the line.

We now have voltage present at any point along #1 wire. This is connected to two devices, the selector switch and a NO contact on 1 CR. Since both devices are open, a voltage detector (light bulb) will show voltage between #1 and #2 only.

Turning the selector switch to its “On” position closes its contact, so that voltage is now present at wire #3 and since both the “STOP” pushbutton and the 1CR NC contact are closed, voltage will also be present at wire nos. 4 and 9.

Depressing the “START” pushbutton will close its contact, making voltage present at wire #5. If the hydraulic pressure is low, PS-1 will be open as shown, and we can go no further until this condition has been corrected.

Once the hydraulic pressure problem has been corrected (this may have required opening a valve, or connected a hose), the pressure will be applied to PS-1, closing it. Voltage is now preset at wire #6. Assuming that the thermal switch does not indicate overheating, TS-1 is closed so we have voltage at wire #7.

LS-1 is located so that it will be actuated when the cylinder is extended. Since the cylinder has not yet extended, LS-1 is closed, we have voltage at wire #8.

Now there is nothing blocking the voltage between wires 1 and 3 so current will flow through the circuit and through the coil of 1CR. This energizes the relay and, as described previously, its contacts will transfer, closing those in line 3 and 7 and opening in line 5.

Closing the contact in line 3 provides a second path between wire nos. 4 and 5, allowing us to release the “START” pushbutton and still have a continuous circuit through 1CR coil.

Closing the contacts in line 7 sets up a second path for current flow, if the solenoid is plugged in; this one passing through the solenoid valve coil. Energizing Sol. 1 shifts the valve spool, causing the cylinder piston to extend.

When the piston rod is fully extended, LS-1 is actuated, opening its contact in line 2, thus interrupting the current flow through 1CR, which now drops out, transferring all its contacts to their normal state.

Opening 1CR contacts in line 7 interrupts the current flow to this solenoid valve, de-energizing it, and allowing the valve spring to return the spool to its normal position. This reverses the direction of oil flow, causing the piston rod to retract.

Closing the 1CR contact in line 5 applied voltage to wire #9 again, and since LS-1 is actuated, its NO contact is now closed and we will now have voltage at wire nos. 10 and 11. allowing current to flow through both the timer clutch coil and the timer motor. The timer is now energized and timing, so its contacts will be as indicated by the second position (see timer description). That is, the time delay contact in line 4 remains open, the time delay contact in line 6 remains closed, and the instantaneous contact in line 5 has transferred and is now closed, providing a second path between wire nos. 9 and 10.

As the piston rod retracts, LS-1 is released, allowing its contacts to transfer to their normal condition, but has no effect at this time.

After a pre-set time delay, the timer is “timed-out”, the third condition described previously, at this point, the contact in line 4 will close and if PS-1 and TS-1 are still closed, 1CR will be energized.

When 1CR is energized the circuit reaction is the same as before, except that when its NC contact opens in line 5, the circuit to the timer is interrupted and the time is de-energized, allowing it to reset.
Motor control

Depressing the "START" pushbutton allows current to flow from one side of the line through the "STOP" button, the "START" button, the operating coil of the motor starter "M", and the overload contacts, to the other side of the line. This magnetizes the operating coil, causing it to pull its contacts closed. One contact closes a circuit around the "START" button so the circuit is maintained after the button is released. Three other contacts close, applying power to the motor.

The motor may be stopped by interrupting the current flow to the operating coil. Depressing one of the "EMERGENCY STOP" pushbuttons will stop all motors. The hydraulic pump may also be stopped at any time by depressing its "STOP" button. The extruder motor will be stopped if its "STOP" button is depressed or if the "SAFETY" relay drops out for any reason. The coolant pump is controlled only by the main heat contactor. When the heat is turned on, the pump runs continuously. It should be noted that all overload contacts (3 for each motor) are connected in series, so that opening any one will stop all motors. When this occurs, it is necessary to allow a few minutes for the element to cool before resetting it. Resetting is accomplished by depressing the white buttons located on each motor starter. When the tripped element is reset, a definite ratcheting action will be felt.

You can then determine which motor is being overloaded from the nameplate affixed adjacent to the starter and the identification provided in the schematic diagram for your machine.

The most common overload problem is due to excessive pressure or flow rate in the hydraulic section of this manual for proper settings.

Temperature control

All heaters on the machine are controlled by a single contactor, either directly through its power contacts or indirectly through auxiliary contacts in the control circuit. This contactor is energized by depressing the "HEAT ON" pushbutton and is normally de-energized by depressing the "HEAT OFF" pushbutton. However, it will also be de-energized if any "EMERGENCY STOP" button is depressed. This is a safety measure employed to assure that all power to the accessible areas of the machine is switched off in an emergency. The operator must remember to turn the heaters on again after using an "EMERGENCY STOP" button if he does not want the machine to cool off.

When the main heat contactor is energized, power is made available to the head heaters and the die heaters through a transformer. Auxiliary contacts mounted on the main heat contactor energize the coolant pump and also the temperature controllers. From this point, the temperature controller for each zone then controls the heat input and, in some cases, the cooling input to the area or zone that it is connected to.

Page 38, 39 show schematically the elements required for the control of a typical heating-cooling zone. When power is applied to the temperature controller at terminals L1 and L2, the controller will then compare the
temperature asked for by the red setting pointer to the temperature indicated by the green pointer and respond as required to bring the two pointers in line. The green pointer receives its power from the heat sensor or thermocouple located in the object that is to be controlled. If the green pointer is below the red pointer, an internal contact in the controller closes to energize PC, the power contactor, which in turn closes contacts to energize the heaters for its zone. As the temperature rises, the thermocouple output is increased, driving the green pointer toward the set point. When the two pointers coincide, the controller will de-energize the PC coil, allowing the PC contacts to open the circuit to the heaters.

The controller used for the head heaters and the feed zone heaters are only capable of the action described above. In other areas, however, there is sometimes enough heat generated in the extrusion process that it becomes necessary to provide cooling capability. This is accomplished in a similar manner, except that the cooling control relay CR is energized only when the green pointer is above the red pointer. The CR contacts close, energizing a solenoid valve. The valve opens, allowing cooling fluid to circulate through the controlled zone. As the temperature drops, the green pointer moves down toward the set point and as it approaches the point of coincidence, the relay is de-energized, opening the circuit to the solenoid valve, allowing it to close.

To prevent a cyclic condition, there is an adjustable differential provided in the controller, which permits a deadband setting of 1% full scale, maximum.

When none of the zones requires cooling, an optional by-pass valve can be employed to energized which permits the cooling fluid to re-circulate. This maintains a constant temperature in the coolant and prevents the pump from dead heading.
Control circuit power supply

Except in isolated cases where deviation from Uniloy standards is specifically requested by the purchaser, all controls operate at 115 volts. This lower voltage level is not only safer, but also more convenient to work with. In addition, the use of a transformer to reduce the voltage level also provides a buffer which diminishes the effect of line voltage variations and transients on the control devices. This transformer is sized to supply only the control requirements for the machine and will not permit the use of portable hand tools or work lights. There is a receptacle provided on the control panel that is fed from another source and can be used for these purposes.

Power is supplied to the primary side at line voltage, usually 230 or 460 volts. The transformer then converts this to 115 volts for use in the control circuit. This control power is then fed into a group of fuses. F1 is sized to protect the transformer, F2 and F3 are sized to carry the load in the solenoid circuit, and F4 and F5 are selected to carry the balance of the controls. A pilot light indicates when the power is on and three EMERGENCY STOP pushbuttons are provided, one in the control panel and one on each side of the machine. As the diagram shows, all circuit elements are supplied through the EMERGENCY STOP button so that depressing any of them will
interrupt the power being supplied to any device. Since all action devices such as motors, heaters, and solenoids are controlled by magnetically operated devices in the control circuit, opening this circuit by any means will disconnect all devices from their source of power.

**Reciprocation control**

Since a general description of the screw reciprocation appears in another section of this manual, discussion here will be limited to the electrical controls and it will be assumed that the reader is familiar with the sections titled "EXTRUDER: RECIPROCAITION" and "SCREW FORWARD LIMIT SWITCH".

The diagram shows schematically all the circuit elements involved in controlling screw reciprocation. The safety relay must be energized before power is available to any part of this circuit.

**MANUAL CONTROL:**

There is a pushbutton "A" labeled "CHARGE" on each side of the machine. Depressing either of these buttons will energize the CHARGE RELAY "B" which, in turn, closes its contacts B2 in the solenoid circuit to energize the "CHARGE" SOLENOID valve "D". Solenoid "D" shifts the spool in a hydraulic valve, connecting the shot cylinder through a relief valve to tank. The relief valve is set low, so that the plastic being produced by screw rotation forces the screw to retract against this low pressure.

When the "CHARGE" button is released, the CHARGE RELAY and therefore the charge solenoid are de-energized, and the valve spool returns to its spring offset position shifting the valve spool to the opposite side, which connects the shot cylinder to the hydraulic pump at high pressure so that oil can flow into the cylinder with sufficient force to drive the piston, and therefore the screw, forward to discharge the stored plastic out through the extrusion dies.

**AUTOMATIC OPERATION:**

When the shot has been completed, that is, the screw is forward, the SCREW FORWARD LIMIT SWITCH LS-1 will be actuated, energizing the SCREW FORWARD RELAY and closing its contact "K". If the AUTOMATIC CYCLE RELAY is energized, its contact "J" will be closed and the CHARGE DELAY TIMER "C" becomes energized and begins timing. Contact "C1" opens instantly to prevent limit switch "H" from completing its circuit if the molds close before the charge delay timer period ends. When the time delay is complete, contact "C2" closes, energizing the CHARGE RELAY "B", contacts "B2" close energizing solenoid "D", contact "B1" also closes, and since "E", "F", and "G" are closed, a path is closed around "C2". The screw begins retracting and "K" is released to de-energize the timer "C", allowing "C2" to open and "C1" to close, but no action occurs at this time. This condition remains until the molds close, time out, and open. As they are opening, contact "F" opens and then "E" opens. Since timer contact "C1" is closed, charge relay "B" is now dependent on the limit switch contact "H" which is actuated as the molds are opening.
Opening "H" causes relay "B" to drop out, de-energizing valve "D", returning it to the spring offset position which drives the screw forward as described above. When forward, the Screw Forward relay is energized, closing contact "K" and the cycle repeats.

TO SUMMARIZE:
1. The "SCREW FORWARD LIMIT SWITCH" LS-1 energizes the "CHARGE DELAY" TIMER.
2. AFTER A TIME DELAY, THE "CHARGE RELAY" is energized, allowing the screw to retract.
3. The "shot" begins when the DISCHARGE LIMIT SWITCH LS-5 is actuated as the molds are opening.

Platen actuation

In the interest of clarity, the description presented in this section will be limited to the directional control of the platen movement. For further details regarding Low Pressure Closing, Safety Door Interlock, and Safety Circuit Operation, refer to those specific sections.

Page 42 shows schematically all circuit elements required for mold closing and opening. Before power is made available to any part of this circuit, the safety doors must both be closed, actuating the air pressure switch "C". No manual control or automatic cycling can be achieved unless the safety relay is energized, closing its contacts "D1" and "D2".

MANUAL OPERATION:
Assuming that the above mentioned conditions are satisfactory, with the auto cycle relay de-energized, contact "E1" is open, preventing automatic cycling, and contact "E2" is closed making power available to the four manual control buttons. A MOLD CLOSE and a MOLD OPEN pushbutton is located on each side of the platen area.

Depressing either MOLD CLOSE pushbutton will energize the MOLD CLOSE RELAY "A", since the stripper auxiliary relay contact "I" and the MOLD OPEN RELAY contact "B1" must be closed at this time.

When relay "A" becomes energized it opens the interlock contact "A1" to prevent the actuation of the MOLD OPEN RELAY "B", and closes contacts "A2" in the solenoid circuit to energize the MOLD CLOSE SOLENOID "Q". Energizing "Q" shifts the spool of a four-way hydraulic valve, allowing oil to flow to the rotary actuator, closing the molds.

Releasing the MOLD CLOSE pushbutton de-energizes relay "A" and solenoid "Q" and the mold movement stops.

Depressing either MOLD OPEN pushbutton will energize the MOLD OPEN RELAY "B", except that if the MOLD OPEN LIMIT SWITCH is actuated, its contact "P" will be open and relay "B" will not be energized. When relay "B" pulls in, the interlock contact "B1" opens to prevent the actuation of the MOLD CLOSE RELAY "A", and contacts "B3" close in the solenoid circuit to energize the MOLD OPEN SOLENOID "R", allowing oil to flow to the opposite side of the rotary actuator mentioned above and the molds open until either the pushbutton is released or the MOLD OPEN limit switch is actuated.

AUTOMATIC OPERATION:
If the AUTO CYCLE RELAY is energized, contact "E2" will be open, interrupting the manual control, and "E1" will be closed, making power available to those elements required for automatic sequencing. The MOLD SEQUENCE SELECTOR SWITCH provides a choice of two points in the machine cycle at which the molds begin closing. In position 2, contact "K" is closed so that MOLD CLOSE RELAY "A" becomes energized as soon as the shot is completed, closing contact "J". If the selector is in position 1, contact "K" is open and relay "A" is not energized until the charge relay pulls in, closing contact "F". All other contacts in the "A" relay circuit, "G", "H1", "I", and "B1" are closed at this time, so the mold closing actuation is dependent solely upon the choice between contacts "F" and "J". The difference is that "J" always close before "F", the interval between them being determined by the CHARGE DELAY TIMER. A more detailed description of the timer circuit will be found in the section "Reciprocation Control."

When relay "A" becomes energized, it allows direct power to solenoid "Q" and the molds just as was described in manual operation. Unless an abnormal condition arises, such as safety circuit drop-out or a safety door opening, the molds will remain closed until the EXHAUST TIMER times out opening contact "H1" and closing contact "H2". The Blow-Air Control section describes the Exhaust Timer Control in detail.

Opening "H1" de-energizes relay "A" and it drops out, de-energizing solenoid "Q" and closing contact "A1". Since "H2" closed when
“H1” opened, closing “A1” energizes the MOLD OPEN RELAY “B”, which in turn energizes solenoid “R” as described under manual operation. As the molds are opening, and the MOLD CLOSED LIMIT SWITCH is released de-energizing the EXHAUST TIMER, it resets and transfers contacts “H1” and “H2” to their normal state. In other words, “H1” is now closed and “H2” is now open, but since MOLD OPEN RELAY contact “B2” also closed when the relay was energized, the circuit is maintained and the molds continue to open until the MOLD OPEN LIMIT SWITCH is actuated, opening contact “P”, at which time relay “B” and solenoid “R” are both de-energized.

As the molds are opening, other limit switches are actuated to initiate the stripper action and to start the discharge or shot stroke. When the shot is completed, the SCREW FORWARD LIMIT SWITCH is actuated, energizing the SCREW FORWARD RELAY, closing contact “J” end the mold closing sequence repeats.

Two contacts, “G” and “I” are required to prevent relay “A” from being energized prematurely. Contact “I” opens when the molds start to open and remain open until the stripper reaches bottom of its stroke. Contact “G” opens when the stripper is down and remains open until the shot has been completed.

In the event the safety circuit is de-energized while the molds are not open and the pressure switch “C” indicates all safety doors are closed, the AUTO CYCLE RELAY contact “E2” and the Safety Relay Contact “D3” will be closed energizing the MOLD OPEN RELAY “B” and the molds will open.

**TO SUMMARIZE:**
1. With the MOLD SEQUENCE selector switch in position 2, the molds start to close as soon as the shot is completed, actuating the SCREW FORWARD LIMIT SWITCH.
2. In position 1, the molds wait until the CHARGE DELAY TIMER has timed out, then begin closing.
3. The molds remain closed for the sum of two time delays: Blow Time and Exhaust Time.
4. The molds open when the EXHAUST TIMER times out.
5. As the molds open, the SHOT LIMIT SWITCH IS ACTUATED, starting the next shot.
6. When the shot is completed, the molds close as in step 1 or step 2 above.
7. If the safety circuit is tripped while all safety doors are closed, the molds will open automatically.

**Stripper control**

The stripper control solenoid valve and its related circuitry are shown on page 43. A manual switch is located on each side of the machine to permit the operator to extend the stripper down where it will remain until the switch is returned to the “AUTO” position. This permits cleaning or removal of molten plastic.
that may have accumulated on the stripper plate. Both switches are normally in the “AUTO” position.

**MANUAL OPERATION:**

Turning a selector switch to the “MAN” position will close contacts “G1” or “H1” and open contacts “G2” or “H2” to prevent a feedback into the automatic controls. When relay “B” pulls in, contacts “B1” in the solenoid circuit will close, energizing the Stripper solenoid “M” to shift the spool of a 4-way air valve, directing air into the cylinder that drives the stripper down. When both switches are in the “AUTO” position, relay “B” and solenoid “M” are both de-energized, and a spring in the valve will return the spool to its normal position, directing air to the opposite end of the cylinder, driving the stripper up to its normal position.

**AUTOMATIC OPERATION:**

When the machine is in automatic cycle, the AUTO CYCLE RELAY contact “E” will be closed, making power available to the Stripper control circuit. As soon as the molds start to open, the MOLD OPEN RELAY contact “F” closes energizing the STRIPPER AUXILIARY RELAY “A”, which closes its contact “A1” to hold the relay energized until the stripping function is completed. This relay sets up the stripper circuit and holds it as long as required, thus making its action independent of the other circuits, assuring that the stripper can still operate even if the MOLD OPEN RELAY drops out first. As the molds are opening, the Stripper Start limit switch LS-4 is actuated, energizing the STRIPPER RELAY “B” and solenoid “M” to drive the stripper down as described above. As the stripper moves downward, the Stripper limit switch LS-6 is released, opening contact “J2” in the safety circuit. This contact is held closed only when the stripper is up and must be adjusted carefully so it will not be closed at any time when the stripper plate is not clear of the neck rings in the molds. If the molds attempt to close at any time when this contact “J2” is not closed, the MOLD CLOSE RELAY contact “L” will open and the Safety relay will be de-energized, stopping the machine. Refer to the section titled “Safeties” for further details.

When the stripper reaches the bottom of its stroke, the limit switch LS-6 is actuated to close contact “J1”, energizing the CYCLE AUXILIARY RELAY “C”, which opens its contact “C1”. By this time, the MOLD OPEN RELAY will have dropped out and its contact “F” will be open, so opening “C1” de-energizes the STRIPPER AUXILIARY RELAY “A” and the STRIPPER RELAY “B”, which in turn, de-energizes solenoid “M” as described above, and the stripper starts to return upward. As it moves up, LS-6 is released, opening contact “J1”, but since the CYCLE AUXILIARY CONTACT “C2” closed when relay “C” was energized and the SCREW FORWARD RELAY contact “K” is closed, relay “C” does not drop out, but will remain energized until the shot is completed. The effect of this relay may be seen in the “Reciprocation Control” and “Platen Actuation” sections of this manual.

When the stripper reaches the upward limit of its stroke, the “Up” contact of LS-6 will be closed again so that the molds may be closed without tripping the safety circuit.

**TO SUMMARIZE:**

1. The stripper starts down the LS-4 is actuated as the molds are opening.
2. The stripper returns upward as soon as LS-6 is actuated downward.
3. LS-6 must be actuated upward or the molds cannot be closed without tripping the safety.
**Cylinder operated blow pins**

As indicated in other sections of this manual, the use of cylinder operated blow pins is optional, and not all machines are equipped with this feature. The electrical controls are simple and inexpensive enough that they are included in all machines as standard equipment. An exception to this is the BLOW PIN DELAY TIMER. The timer is only used with a compacting system, therefore it is not installed unless required as indicated below.

**MANUAL BLOW PIN OPERATION:** a three position selector switch is provided in the control panel. In the center position, both of its contacts “F1” and “F2” are open and the system cannot be operated either manually or automatically. Turning the selector clockwise closes its contact “F2”, energizing the BLOW PIN RELAY “B”. Relay “B” pulls in, closing contacts “B1” in the solenoid circuit to energize BLOW PIN SOLENOID “H1”. Energizing the solenoid shifts the valve spool, directing air into all of the cylinders simultaneously, driving the blow pins down, where they will remain until the switch is returned to the center position, de-energizing the BLOW PIN RELAY “B” and the solenoid, allowing a spring in the valve to return the spool to its normal position, thus directing air to the opposite side of the cylinders, and the blow pins pull upward.

**AUTOMATIC BLOW PIN OPERATION:** If the selector is turned counter-clockwise contact “F1” will close. If the machine is in automatic cycle, relay contact “C” will be closed, and as soon as the molds start to close, contact “D” will close, allowing power to flow through contacts “C”, “D”, “E”, “F1”, and the jumper “G” to the relay coil “B,” energizing the BLOW PIN RELAY and the solenoid valve as described above, driving the blow pins down.

The molds close while the blow pins are down, and they remain down until the BLOW TIMER times out and energizes the PRE-BLOW SHUT-OFF RELAY, opening its contact “E”. When “E” opens, the BLOW PIN RELAY and solenoid “H” are both de-energized, forcing the blow pins to pull forward.

When a time delay is required, the BLOW PIN DELAY TIMER must be added and jumper “G” is removed. Now, when contact “D” closes and the molds start to close, the BLOW PIN DELAY TIMER becomes energized and begins timing. When its time delay period expires, contact “A1” closes, energizing the BLOW PIN RELAY and solenoid “H”. The remaining sequence is the same as it was without the timer.
TO SUMMARIZE THE BLOW PIN OPERATION:

1. Without the timer, the blow pins drive down as soon as the molds start to close. This is the “shear” or PULL-UP type of operation.

2. When the timer is used, the blow pins drive down when the timer times out, usually shortly after the molds are closed. This is the “COMPACTING” or “RAM-DOWN” type of operation.

3. In either case, the blow pins pull up at the time air begins exhausting from the blown containers.

**Blow air control**

The air system for blowing containers is a two pressure system, using low pressure initially (Pre-Blow) and then switching to high pressure (Blow). A selector switch provides a choice as to whether or not the Pre-Blow air is used during the time the molds are moving closed. Although there are valves provided for each individual die head, they are controlled by pilot air pressure which in turn, is controlled by solenoid valves. In this way, air is controlled to each die head, but only two electrical outputs are required. In describing the electrical controls, it will be assumed that the reader is familiar with the section of this manual entitled “THE AIR SYSTEM—BLOW AND PRE-BLOW.”

Below shows schematically all of the elements required for blow air control. The AUTO CYCLE RELAY must be energized before power is available to any portion of this circuit. With the PRE-BLOW SELECTOR SWITCH in position 1, contact “H” will be closed and contact “I” will be open. In this condition the PRE-BLOW RELAY “A” is energized when the shot is completed, that is, the extruder screw reaches its forward position, trips a limit switch LS-1, energizing the SCREW FORWARD RELAY, and closes its contact “G”. Relay “A” pulls in, closing its contacts and closes its contacts “A1” and “A2”. The “A1” contact provides an alternate path for the flow of current to the coil “A”, so that it remains energized after the “G” contact opens. Closing the “A2” contacts in the solenoid circuit energizes the PRE-BLOW SOLENOID “K”, shifting its spool to allow pilot air pressure to open the “ON-OFF” valve at each die head and low pressure air flows into each parison as the molds are moving closed.

If the PRE-BLOW SELECTOR SWITCH is in position 2, the most commonly used position, contact “H” will be open, contact “I” will be closed and relay “A” will be energized until the molds are closing and tripped the MOLD LIMIT SWITCH LS-3, closing its contact “J”. From this point, all conditions are the same as in position 1, and the remaining sequence is identical in either case. It should be noted that the PRE-BLOW SOLENOID valves must remain energized, maintaining the “ON-OFF” valves...
in the open position to allow either low pressure or high pressure air to pass through.

At the time the MOLD CLOSING LIMIT SWITCH is actuated closing contact “J”, two time delay relays become energized. These are the BLOW DELAY TIMER “D” and the BLOW TIMER “F”, and they both begin timing at this point. When the BLOW DELAY TIMER rings out, its contact “D1” closes, energizing the BLOW RELAY “E” which in turn closes its contacts “E1” in the solenoid circuit to energize the BLOW SOLENOID “L”. This applies pilot air pressure to the pilot operated selector valves on each die head and they shift from the low-pressure supply to the high-pressure supply. This condition remains for the duration of the blow time setting.

When the BLOW TIMER “F” reaches the end of its delay period, it switches two contact “F1” and “F2”. When “F2” opens, the BLOW RELAY “E” is de-energized, opening contacts “E1” to de-energize solenoid “L”. When “F1” closes, the PRE-BLOW SHUT-OFF RELAY “B” becomes energized, opening contact “B1” to de-energize the PRE-BLOW RELAY “A”, and closing contact “B2” to energize the EXHAUST TIMER “C”.

Relay “A” drops out, opening contacts “A1” to de-energize solenoid “K”. Since both solenoids are now de-energized, the air which has been trapped in the blown container now exhausts to the atmosphere.

When the EXHAUST TIMER times out, its contacts, which are not shown in this diagram, signal the molds to open. As they open, the MOLD CLOSED LIMIT SWITCH is released, opening contact “J”, and all timers reset.

TO SUMMARIZE:
1. PRE-BLOW begins either before the molds close (position 1) or after the molds start closing (position 2). The point at which pre blow begins in position #2 depends on the length of the cam that actuates LS-3.
2. The BLOW DELAY TIMER determines the length of the low pressure blow, and starts the high pressure blow.
3. The BLOW TIMER determines the cooling time for the container.
4. The EXHAUST TIMER determines the interval between Blow shut-off and mold opening.
5. The timers reset when the molds start to open, releasing the MOLD CLOSING LIMIT SWITCH LS-3.

BLOW AIR CONTROL—For machines provided with a “Pre-Blow Delay” timer

The valving functions of this system are identical to those used without the PRE-BLOW DELAY TIMER. The same pneumatic schematic diagram applies. There is added flexibility provided through the use of this timer and a third position in the selector switch, “PRE-BLOW 1-2-3”. Reference to the description of 8 TD in another section of this manual may be helpful. Even though selector switch positions 1 and 2 provide the same function in this system, it was thought advisable to add the third position to call attention to the new and totally different function that it controls.

The diagram which follows shows schematically all of the elements required for blow air control. The AUTO CYCLE RELAY must be energized before power is available to any portion of this circuit. With the PRE-BLOW SELECTOR SWITCH in either position 1 or 2, contact “P” will be open. In this condition the PRE-BLOW DELAY TIMER “M” is energized when the shot is completed, that is, the extruder screw reaches its forward position, trips a limit switch LS-1, energizing the SCREW FORWARD RELAY, and closes its contact “G1.”

If the PRE-BLOW SELECTOR SWITCH is set to position 3, contact “P” is closed and the timer “M” is energized earlier in the cycle, as soon as parison discharge begins. This occurs because the charge relay drops out closing its contact “N”, and the screw forward relay has not yet been activated, therefore its contact “G2” is closed.

In either case, whether timer “M” becomes energized at the beginning of discharge or at the end, the instantaneous timer contact “M”, closes immediately to provide an alternate path for the flow of current to the timer “M” so that it remains energized after the “G1”, “G2”, and “N” contacts open. When the time which has been pre-set on “M” expires, its delayed contact “M2” closes, energizing the PRE-BLOW RELAY, “A”, closing its contacts “A”, in the solenoid circuit, energizing the PRE-BLOW SOLENOID “K”, shifting its spool to allow pilot air pressure to open the “On-Off” valve at each die head and low pressure air flows into each parison.

From this point, the remaining sequence is identical, whether position 1, 2, or 3 is selected. It should be noted that the PRE-BLOW SOLENOID valve must remain energized,
maintaining the On-Off" valves in the open position to allow either low pressure or high pressure air to pass through.

At the time the mold closed limit switch is actuated closing contact "J", two time delay relays become energized. These are the BLOW DELAY TIMER "D", and the BLOW TIMER "F", and they both begin timing at this point. When the BLOW DELAY TIMER times out, its contact "D1" closes, energizing the BLOW RELAY "E" which in turn closes its contacts "E1" in the solenoid circuit to energize the BLOW SOLENOID "L". This applies pilot air pressure to the pilot operated selector valves on each die head and they shift from the low-pressure supply to the high-pressure supply. This condition remains for the duration of the blow time setting.

When the BLOW TIMER "F" reaches the end of its delay period, it switches two contacts "F1" and "F2". When "F2" opens, the BLOW RELAY "E" is de-energized, opening contacts "E1" to de-energize solenoid "L". When "F1" closes, the PRE-BLOW SHUT-OFF RELAY "B" becomes energized, opening contact "B1" and "B3" to de-energize the PRE-BLOW RELAY "A", the PRE-BLOW DELAY TIMER "M", and closing contact "B2" to energize the EXHAUST TIMER "C".

Relay "A" drops out, opening contacts "A2" to de-energize solenoid "K". Since both solenoids are now de-energized, the air which has been trapped in the blown container now exhausts to the atmosphere.

When the EXHAUST TIMER times out, its contacts, which are not shown in this diagram, signal the molds to open. As they open, the mold closed limit switch is released, opening contact "J", and all timers reset.

TO SUMMARIZE:
1. The PRE-BLOW DELAY TIMER starts either at the beginning of parison discharge (position 3) or at the end of discharge (position 1 or 2).
2. The PRE-BLOW DELAY TIMER always starts low pressure blow.
3. The BLOW DELAY TIMER determines the length of the low pressure blow, and starts the high pressure blow.
4. The BLOW TIMER determines the cooling time for the container.
5. The EXHAUST TIMER determines the interval between Blow shut-off and mold opening.

6. The timers reset when the molds start to open, releasing the MOLD CLOSE LIMIT SWITCH LS-3.

Low pressure closing

All Union blowmolding machines are provided with a protective feature which allows the molds to close at reduced hydraulic pressure, greatly reducing the force exerted upon the closing mechanism which in turn serves to protect the molds and tooling as well as the machine operator from serious injury. This feature also serves to sense obstructions and malfunctions, and react to them by interrupting the cycle and sounding an alarm. In addition, this system is designed to fail safe, that is, all components are used in such a way that any failure that is likely to occur, will result in the hydraulic system being limited to low pressure only, therefore the machine cannot be operated unless deliberate steps are taken to defeat the system.

The low pressure closing control functions exactly the same when closing the molds manually as when in automatic cycle.
When the MOLD CLOSE RELAY is energized to close the molds, a normally closed contact "D" is opened interrupting the flow of current through the HIGH PRESSURE RELAY coil "A", allowing it to drop out. This opens the HIGH PRESSURE RELAY contacts "A2" in the solenoid circuit, de-energizing the HIGH PRESSURE SOLENOID valve "F". When this valve is de-energized, the hydraulic pressure available to move the molds is limited to the setting of the LOW PRESSURE CLOSE RELIEF VALVE, which should be set at about 250-300 PSI, or just high enough to move the molds at a normal rate.

When the HIGH PRESSURE RELAY dropped out, it also opened its contact "A1" which controls the LOW PRESSURE CLOSE TIMER, de-energizing it. This timer now begins its time delay period, and a race is begun between the timer and the mold closing mechanism. Normally, the race is won by the molds, which actuate the HIGH PRESSURE LIMIT SWITCH "E" when they are nearly closed. Closing this switch energizes the HIGH PRESSURE RELAY "A" and its contacts "A1" and "A2" close to energize the HIGH PRESSURE SOLENOID "F" and the LOW PRESSURE CLOSE TIMER "B". When the timer is energized, it stops timing and begins recharging for the next cycle. Energizing the solenoid valve transfers pressure control to the high pressure setting, thus applying the added force necessary to lock up the molds and hold them closed against the air pressure which will be exerted within the molded containers.

If there should be a malfunction or obstruction in the mold closing mechanism, the molds will be slow in closing and the timer will win the race. When this occurs, the timer contact opens, de-energizing the SAFETY RELAY, which shuts down the machine.

**TO SUMMARIZE:**
1. The machine operates at the high pressure setting at all times except as the molds are moving closed.
2. When the molds start to close, the available pressure is dropped to the low setting, and the time delay period begins.
3. When the molds are nearly closed, the pressure is increased to the high setting for lock-up, and the timer resets.
4. The timer does not control the pressure, but provides a signal in the event the molds do not close properly.

**Signal to auxiliary equipment**

Most machine lines use auxiliary equipment such as a trimmer, a conveyor, or some other form of take-off which must be synchronized with the blowmolding cycle. A relay is provided in the panel to facilitate this correlation with other equipment. The relay coil may be connected to two different points in the blowmolding cycle, depending on the type of signal required. An isolated contact is connected to a plug-in socket located underneath the clamp support arm. The contact is not connected to any blowmolder circuitry but is operated by it, as shown on page 49.
When the blowmolder is in automatic cycle the AUTO CYCLE RELAY contact “B” closes making power available to this circuit. When the molds are closed or closing, the MOLD CLOSE RELAY contact “E” is closed. As soon as the MOLD CLOSED LIMIT SWITCH LS-3 is actuated, closing contact “D”, power is applied to both points 75 and 77 through the BLOW TIMER and BLOW DELAY TIMER contacts “F” and “G”. These two points, 75 and 77, will be found as terminals located top center above the relay panel. Both points are pre-wired as shown and the coil of the relay may be connected to either point.

The BLOW DELAY TIMER starts timing when LS-3 was actuated and when it times out, its contact “G” opens, de-energizing point 77. If the relay coil were connected to this point, it would drop out at this time and its contact “A2” would open. If the coil “A” were connected to 75, it would remain energized because both “D” and “E” are still closed. When “A” is energized, its contact “A1” closes to hold the circuit closed after “D” and “E” open. As the molds open, the STRIPPER RELAY is energized to drive the stripper down. At this time, contact “C” opens and the EXTERNAL SIGNAL RELAY is de-energized, opening its contact “A2”.

The EXTERNAL SIGNAL CONTACT “A2” is provided with an adjustable time delay, so that its closure may be delayed after the relay is energized.

Usually a trimmer or conveyor should start at about the time the molds close. In this case, the coil connection should be to point 77 and the signal will be just a brief pulse, one second or less, at the time the MOLD CLOSED LIMIT SWITCH is actuated.

Swinging arms are used when gripping and holding of the bottles are required as they are removed from the molds. This movement must be synchronized with the stripper, and point 75 is used. The time delay on 101CR is adjusted so the device grips the bottles just before the molds open, to prevent the gripping fingers from being in contact with the hot plastic for too long a time so they do not overheat.

**Screw forward limit switch**

When the extruder reaches its forward position at the end of a shot, a limit switch, LS-1 is actuated. The actuation point is adjustable, so the switch may be tripped earlier or later in the stroke as desired. This section will describe the variations that may be employed through the adjustment of this switch and other related devices, the MOLD SEQUENCE SELECTOR SWITCH and the CHARGE DELAY TIMER.

Parison wall thickness is affected somewhat by the extrusion rate. The highest rate and therefore the heaviest wall will be experienced while the shot is being made. Once the screw is all the way forward, if it is not returned immediately, the output is reduced to the rate of
flow that is produced by screw rotation only, hence a thinner parison wall will be observed. If the parisons are allowed to hang, the molten plastic cannot support its own weight and will stretch or "DRAW DOWN" and further thinning of the wall around the top of the parisons will be experienced.

If a slightly larger parison is required, careful adjustment of the controls can achieve a "BOUNCE" effect, in which the screw is rammed forward at the high extrusion rate, then returned immediately, before the molds are closed. The sudden relaxation of pressure allows the parisons to expand slightly in diameter, which shortens their length slightly, creating the illusion of "BOUNCING". However, this condition exists for only a short time after which the effect of draw-down overcomes the bounce effect, and the parison diameter decreases.

A third method can be used, that of closing the molds on moving parisons. This method results in the shortest cycle time, so it is advantageous where it can be used. If the molds close before the screw starts retracting, neither draw-down nor bounce will be experienced. In addition, the screw retraction may be delayed for an instant after mold lock-up, extruding a ring or washer at the top of the neck rings, forming a seal against air escaping, and also providing a barrier between the hot die and mandrel and the cold neck ring.

**DRAW-DOWN MACHINE SETTINGS:**
1. MOLD SEQUENCE SELECTOR SWITCH should be in position 1.
2. The SCREW FORWARD LIMIT SWITCH LS-1 should be set so that it is tripped at the very end of the forward stroke.
3. The CHARGE DELAY TIMER should be set short, possibly at zero.

The draw-down effect can now be controlled by adjusting the timer. With the timer at zero, the screw will begin retracting as soon as LS-1 is actuated, stopping the extrusion. The molds also start closing when LS-1 is tripped because there is no time delay. The parisons hang, supporting their own weight or "drawing down" while the molds are closing.

If the timer is set at .5 seconds, the screw will come forward, tripping LS-1 which starts the time delay period. The screw will remain in the forward position for .5 seconds during which time the plastic output results only from straight extrusion and a noticeable step will appear in the parison wall. After the time delay, the screw begins retracting, shutting off the flow of plastic and the molds begin to close, draw-down, or further thinning of the parisons will be experienced during the time the molds are closing.

**BOUNCE MACHINE SETTINGS:**
1. MOLD SEQUENCE SELECTOR SWITCH should be in position 2.
2. LS-1—set to trip near the end of the screw travel.
3. CHARGE DELAY TIMER—set equal to or less than time elapsed between the tripping of LS-1 and the end of the screw stroke.

When LS-1 is tripped, the molds start to close immediately and the time delay begins. At the end of the time delay, extrusion stops and the screw begins retracting. The point at which the molds start to close is adjusted by LS-1 and the bounce point is adjusted by the timer.

**SHORT CYCLE SETTINGS:**
1. MOLD SEQUENCE SELECTOR SWITCH should be in position 2.
2. LS-1—set to trip well ahead of the end of screw travel.
3. CHARGE DELAY TIMER—set at least equal to the mold close time.

The molds start closing immediately when LS-1 is tripped and the time delay begins. At the time the molds lockup, or shortly thereafter, the timer should time out, retracting the screw.

**External power supply**
Whenever any accessory equipment such as a trimmer or conveyor is provided by Uniloy, a plug-in connection is provided to supply power to this equipment. This plug-in is fed from a separate set of fuses in the panel, and these fuses are in turn fed through a magnetically operated contactor as shown on page 51. Also, a set of control circuit fuses isolate the external accessory circuit from the internal blowmolder circuit. The control circuit is also provided with a plug-in connection so that any piece of accessory equipment may be unplugged and removed if required.

The contactor is energized by depressing the pushbutton labeled EXTERNAL CIRCUIT ON,
which is located on the control panel. The holding circuit for the contactor runs out through the plug 3S, as wire no. 408, through the emergency stop buttons on the accessory equipment, and back through 3S, as wire no. 403, to the contactor, 101 PC. A pilot light indicates whether or not the circuit is energized. The circuit cannot be energized unless all accessory equipment is plugged in. The interconnection diagram supplied with the equipment shows the proper arrangement for a particular installation.

**Limit switches**

Limit switches are position indicators used in various places to provide an electrical signal when its actuator is in the desired position. If reasonable care is taken in their application, actuation, and adjustment, they will give millions of trouble-free operations. One of the most frequent causes of a cycle failure is that a limit switch is not properly adjusted and is not being tripped by its actuator. Careful adjustment avoids this problem. Any limit switch should be adjusted so that its plunger or arm moves far enough to trip the switch, but not so far that there is no over-travel left.

**DESCRIPTION OF LIMIT SWITCHES:**

Following is an itemized list of limit switches used in the control circuit and a description of their individual functions.

**LS-1:** This switch is mounted on top of the machine base, at the rear of the machine. It is a position switch, providing a contact closure when the screw is forward. Its effect is covered in another section of the manual, "Screw Forward Limit Switch."

**LS-2:** Mounted on clamp base near Rotac unit; indicates molds are closed but not locked; energizes "HIGH PRESSURE RELAY" and energizes "LOW PRESSURE CLOSING" timer 5 TD.

**LS-3:** Mounted on clamp base near Rotac unit; indicates Toggle system is locked in position; energizes "BLOW DELAY TIMER" 3 TD and BLOW TIMER" 4 TD.

**LS-4:** Mounted on clamp base near Rotac unit; operates as molds are opening; initiates "STRIPPER" action.

**LS-5:** Mounted on clamp base near Rotac unit; operates as molds are opening; causes screw to move forward, discharging stores plastic.
LS-7: Mounted on clamp base near Rotac unit; indicates molds are completely open: de-energizes “MOLD OPEN RELAY”.

LS-1A: Mounted on top of machine base at the rear of machine and is actuated when the screw has traveled almost to “shot size”. During a normal machine cycle, it is necessary that LS-1A be actuated. If it is not tripped, the SAFETY RELAY will de-energize indicating that material is not being fed at a normal rate. Or the Material Hopper may be empty altogether.

On the other hand, if LS-1A stays actuated for longer than 10 seconds, the SAFETY RELAY will de-energize also.

TO SUMMARIZE:
1. LS-1A must be actuated every cycle but for not as long or longer than 10 seconds.

Safeties
1. SCREW TRAVEL LIMIT:
   If the screw should be retracted to its maximum stroke, either because of a malfunction of the lack of synchronism between cycle time and extruder output, LS-1A will be actuated for more than 10 seconds and de-energize the Safety Relay.

2. If the screw does not actuate LS-1A, as it travels rearward, indicating that material is low or machine cycle is not matched to extruder output, the Safety Relay will de-energize.

3. STRIPPER FAILURE
   To prevent damage to the molds, the stripper must be retracted before the molds can close. A limit switch, LS-6 has been provided to indicate this condition, guarding against failures caused by.
   a. Lack of air pressure due to broken or pinched line, valve failure, or compressor failure.
   b. Mechanical interference caused by an obstruction, misalignment, or breakage.
   d. Electrical malfunction in relay, limit switch or wiring. If LS-6 is open at any time during mold close portion of the cycle, the Safety Relay will be de-energized.

4. MOLD OBSTRUCTION:
   In order to minimize damage to molds and injury to personnel, the molds close with hydraulic pressure reduced to a level just great enough to provide sufficient speed. A pressure setting of 250-350 PSI will close the molds from the maximum open position in about 1 second or less. As the molds start to close, a timer is de-energized and begins timing out. When the molds reach the closed position, a limit switch, LS-2, is actuated, energizing the timer and energizing a valve to boost the hydraulic pressure, increasing the locking force. In the event the molds do not reach the closed position before the timer times out, the safety relay will be de-energized. This condition may be caused by an obstruction in the molds, excessive friction or lack of lubrication in the mold traverse mechanism, or low hydraulic pressure.
5. MATERIAL HOPPER EMPTY:
Should the extruder fail to produce material while cycling, either because the hopper is empty or the screw is not turning, the machine will complete one cycle and shut down. Since there is not any material produced, the screw does not retract and LS-1 remains actuated. Because of the incomplete cycle, the molds attempt to close as soon as the stripper starts to return to its normal position, but since it has not had time to retract and actuate LS-6 and the molds are trying to close, the Safety Relay is de-energized.

6. SAFETY RELAY, PAGE 52:
To energize the Safety Relay, depress the Reset pushbutton “E” and when the relay picks up, its contact “A1” closes to hold the relay in after the pushbutton is released. This condition remains until interrupted by one of the items listed above, or a power failure.

When de-energized, the relay drops out closing contact “A2” which energizes the bell and the warning lights.

350R-250R1 BLOWMOLDER
START-UP PROCEDURES

1. Start the following equipment:
   A. Chiller
   B. Air Compressor
   C. Grinder
   D. Conveyor
   E. Plastic Vacuum System

2. Turn main power supply on.

3. Reset safety circuit.

4. Push heat start button.

5. Set barrel and head heat instruments as indicated below:
   A. Feed Zone 250°F
   B. Transition Zone 250°F
   C. Metering Zone 1 250°F
   D. Metering Zone 2 250°F
   E. Left Head 340°F
   F. Right Head 340°F
   G. Stock Temperature 340°F

6. Constantly monitor these instruments as the heat increases in each zone. Make sure that all zones rise in temperature.

7. The die head instruments will be the slowest in temperature rise due to the head block being the largest single piece of steel, thus requiring longer to heat up.

8. Make the following instrument changes when the head heats reach 310°F:
   A. Feed Zone 300°F
   B. Transition Zone 340°F
   C. Metering Zone 1 340°F
   D. Metering Zone 2 340°F
   E. Left-Right Head(s) Unchanged

NOTE: LEAVE HEAD ZONE(S) AND STOCK TEMPERATURE AT 340°F.

9. Let zone(s) reach these temperatures for at least thirty (30) minutes.

10. Set all die variacs (heaters) to 60% approximately ten (10) minutes before start-up.

11. You are now ready to start the machine.
    So far the time consumed will be close to one and one-half (1½) hours after the power and heats have been turned on.

12. Turn on hydraulic pump. System pressure should be 1500 PSI.

13. Push reset button on stock temperature instrument. The flashing yellow light will go off and the red light will appear if the stock temperature is above 340°F. This is a temperature safety device and must be not moved below its set point 340°F.


15. Start clutch with clutch speed pot at “0”.

16. Gradually turn speed pot clockwise and observe the flow of plastic from die head(s).
    Do not increase the pot too fast. It is best to start the flow of material very slowly as you watch the percentage (%) of load on the extruder motor. Continue to increase the R.P.M.’s of the clutch until you reach the desired running speed.

17. Turn die heater(s) (variac) to “0”.

18. You are now ready to start blowing bottles if you previously have checked the following:
    A. All switches must be in “automatic” on the blowmolder.
    B. All switches on the eight-foot cooling conveyor and trimmer are on “automatic” and “run” and the external circuit pushbutton depressed with the (yellow) reset button lit.

19. Trip the bottle chute rearward. Hold the charge button in until the crew position meter (inch meter) reaches 5-½”.

20. Push the blue charge button. The parison(s) will fall off the die(s).
21. Release charge button and push in cycle start button.
22. Push the charge button in again just before the molds open the first time.
23. Continue to hold the button in for 2 seconds after the molds are all the way open.
24. Release the charge button and the next shot will come from the head(s).
25. The holding in of the charge button is important as it insures you of a longer start-up parison until the flow of the plastic is continuous and uniform.
26. Repeat this procedure of holding in of the charge button for at least 4 or 5 mold closures, or until the parison lengths are long enough for the swinging arm fingers to grasp the container from the mold(s) and extract them.
27. Put all bottles in the grinder until the tails are centered in the container and the handles are formed properly.
SEQUENCE OF OPERATION 250R1

LIFT ACTUATED WHEN SCRUB IS FORWARD

LOW PRESSURE CLOSE TIMER 5 TO TIMING

LS-2 ACTUATED AS MOLDS ARE CLOSING

LS-3 ACTUATED WHEN MOLDS LOCK UP

BLOW TIMER IS TIMING

EXHAUST TIMER IS TIMING

LS-4 EITHER SWITCH MAY BE ACTUATED FIRST DURING MOLD OPENING

LS-5 ACTUATED WHEN MOLDS ARE FULLY OPEN

WHEN SCRUB IS FORWARD, LOT IS ACTUATED AND THE CYCLE REPEATS
GENERAL LUBRICATION & MAINTENANCE INSTRUCTIONS

DAILY LUBRICATION & MAINTENANCE
LUBRICATION ITEMS
Hydraulic Oil
  Mobil D.T.E. 26
Stripper Guide Rods
  Mobil D.T.E. 26
Air Lubricator
  Mobil D.T.E. 26
Grease as follows
Ball Spline
  Thrust Bearing Shoes
  Clamp-Toggle Pins
    -Platen Shoes
    -Tie Bar Bushings

MAINTENANCE ITEMS
Safety Doors
Stripper Speed Control

WEEKLY LUBRICATION & MAINTENANCE
LUBRICATION ITEMS
Reducer
  Mobilgear 630 or Mobil D.T.E. Oil BB
MAINTENANCE ITEMS
Barrel Cooling Fluid
  U'CON 50 HB-280X

Drive Sheaves

MONTHLY LUBRICATION
Hydraulic Reservoir
  Mobil D.T.E.

THREE MONTH LUBRICATION & MAINTENANCE
Thrust Bearing
  Mobilux EP 2
Hydraulic Pump Strainer
YEARLY MAINTENANCE
Temperature Controls

Barrel cooling fluid

SPECIAL GEAR REDUCER REQUIREMENTS
Check the reducer case temperature carefully in several spots after at least eight hours of constant running. If the temperature is:
Below 150°F.
Between 150°F. and 180°F.
Above 180°F.

-Check to maintain proper oil level
-Check water flow to heat exchanger to maintain 100°F. to 130°F. oil temperature
-Oil lightly

-Oil lightly

-Automatic Lubricator—Mobilux EP 1
-Grease Gun—Mobilux EP 2
-Grease
-Grease
-Grease
-Grease
-Oil with Mobil D.T.E. 24

-Check to insure proper cam valve actuation
-Check adjustment and readjust as required

-Check to maintain proper oil level

-Check level and add U'CON fluid as required
-Adjust water flow to heat exchanger to maintain normal running reservoir temperature at 150°F. to 200°F.
-Check tension 5.5-8.5 lbs. to deflect 5/16 inches

-Flush and clean suction filters. If damaged replace

-Remove and repack each three months
-Remove and thoroughly clean

-Recalibrate and check pivots and jewels—See Manual for local authorized service
-Clean reservoir and replace fluid with U'CON 50HB—280X

When changing reducer oil, be sure to drain the unit completely. Flush the case with new oil for a few minutes. Then refill to the proper level with new oil.
LUBRICANT CHARACTERISTICS
Mobil D.T.E. 24
Mobile D.T.E. 26
Mobile D.T.E. Oil BB
Mobilgear 630
Mobilux EP 1 and 2

155 SUS at 100°F. premium antiwear hydraulic and circulating oil. Also has the properties needed for an air line oil.
335 SUS at 100°F. premium antiwear hydraulic and circulating oil.
1100 SUS at 100°F. premium double inhibited oil for use in multifunctional reuse application.
1100 SUS at 100°F. premium quality, heavy duty industrial gear lubricant. This is formulated with the new sulfur-phosphorus-extreme pressure additives which provide improved antiwear and friction reducing characteristics.
These are NLGI No. 1 and No. 2 consistency extreme pressure unleaded lithium soap greases. They are multipurpose products for both antifriction and plain bearings under wet and dry conditions, and for use in the temperature range of -20°F. to 250°F.

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>SAE 10-20 WITH ADDITIVES</th>
<th>SAE 50-110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic Richfield Co.</td>
<td>Duro AW-21</td>
<td>Rubilene Extra Heavy</td>
</tr>
<tr>
<td>Standard Oil Co. (Calif.)</td>
<td>Chevron EP Hyd. 11</td>
<td>Chevron Mach. Oil 50</td>
</tr>
<tr>
<td>Cities Service Oil Co.</td>
<td>Citgo XD 20</td>
<td>Pacemaker Oil 110</td>
</tr>
<tr>
<td>Continental Oil Co.</td>
<td>Super HD 21</td>
<td>Conoco Dectal 92 R&amp;O</td>
</tr>
<tr>
<td>Mobil Oil Corp.</td>
<td>DTE 24</td>
<td>DTE BB</td>
</tr>
<tr>
<td></td>
<td>DTE 26</td>
<td>Mobilgear 630</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GREASE LITHIUM TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATLANTIC RICHFIELD CO.</td>
</tr>
<tr>
<td>MOBIL OIL CORP.</td>
</tr>
</tbody>
</table>
250R1 BLOWMOLDER

<table>
<thead>
<tr>
<th>CLAMP SIZE</th>
<th>W</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 X 15</td>
<td>37&quot;</td>
<td>33</td>
</tr>
<tr>
<td>34 X 15</td>
<td>45.5&quot;</td>
<td>33</td>
</tr>
<tr>
<td>38 X 15</td>
<td>49.5&quot;</td>
<td>33</td>
</tr>
</tbody>
</table>

A. 3 - 4 - 10 TAP THRU - 10 HOLES
B. 2" N.P.T. WATER INLET
C. 2" N.P.T. WATER OUTLET
D. 1" N.P.T. AIR INLET (W/O FILTER)
E. ELECTRICAL CONNECTION ACCESS

EXTRUDER LUBRICATION GUIDE

1. Grease - Mobilux #EP2 on a daily basis
2. Grease - Mobilux #EP2 Remove, clean, and repack 1/2 - 2/3 full on a quarterly basis
3. Grease - Mobilux #EP2 with grease gun 2 - 3 pumps every 2 - 3 weeks
4. Gear Lube - Mobil DTE-20 or Mobilgear 630 Check dipstick daily, drain and refill every 1200 Hours
5. Nitrogen Pressure - 70% of system pressure, Check on a monthly basis
6. Heat Transfer Fluid - Union Carbide 50#380X Check on a weekly basis, Replace annually
7. Drive Motor - See vendor specifications
8. Hydraulic Fluid - Mobil DTE 26 Check weekly, drain, clean and refill every 1200 Hours

* FLUID CAPACITIES IN GALLONS
EXTRUDER TEMPERATURES AND PRESSURES

SHOT PRESSURE 1100 - 1200 PSI
(Depending on application)

U'CON BARREL COOLING FLUID 18 - 20 PSI

ACCUMULATOR 70% OF SYSTEM PRESSURE

BARREL COOLING 175 - 200 F

REDUCER COOLING 175 - 195 F

HYDRAULIC SYSTEM PRESSURE 1500 PSI

HYDRAULIC RESERVOIR 110 - 120 F

CLAMP LUBRICATION POINTS

1. Tie bar bushing—Four lubrication points on a single rotor. Six lubrication points on a double rotor. Lubricate each shift with Mobil Oil DTE #26
2. Toggle link bushing—Eight lubrication points on a single rotor. Sixteen lubrication points on a double rotor. Lubricate each shift with Mobil Oil EP #2
3. Platen shoes—Six lubrication points. Lubricate each shift with Mobil Oil EP #2.
COOLING CONVEYOR LUBRICATION GUIDE

Mobilux EP  Mobil Oil DTE BB Gear Box Fill Plug
+2

Gear Box
Fill Level Plug
<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>LUBRICANT</th>
<th>LUBRICATION FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SIGHT GAGE FILL TO TOP OF GAGE</td>
<td>SAE 60</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>FILLER TUBE - GEAR BOX</td>
<td>ALL-PURPOSE GREASE</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>BUCKET GUIDE CHAIN</td>
<td>ZERK PTG.</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>FLANGE BEARING W//ZERK PTG.</td>
<td>ALL-PURPOSE GREASE</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>IDLER SPROCKET</td>
<td>LIGHT WEIGHT MACH.</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>STRIPPER TIE ROD BUSHINGS (2 PLACES)</td>
<td>ALL-PURPOSE GREASE</td>
<td>X</td>
</tr>
<tr>
<td>7</td>
<td>PLATEN TIE ROD BEARING (4 PLACES)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8-9</td>
<td>CRANK SHAFT PIN (6 PLACES)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>TAKE-UP SPROCKET</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BLOW MOLDING TROUBLESHOOTING GUIDE
FOR INTERMITTENT EXTRUSION MACHINES
PARISON FORMATION

PROBLEM
1. Upper handle webbing, neck laps, Chevrons on shoulder of bottle, occasional missed handle, and lower handle webs
2. Lower handle webs; missed handles only
3. Parison sag
4. Parison hooking
5. Die line(s)
6. Tail lengths not uniform
7. Melt fracture (sharkskin)

CAUSE
1. pleating (draping)
2. a) low flare
   b) mold position
   c) hooking parison
3. a) melt temperature too high
   b) drop time too long
   c) mold closing too slowly
4. a) die gap out of adjustment
   b) air flowing on parison
   c) warped die or mandrel
   d) adjusting ring out of adjustment
   e) die temperature not uniform
5. a) damaged die or mandrel
   b) contamination in die gap
   c) degraded resin on die or mandrel
6. a) manifold chokes out of adjustment
   b) bottle weights not uniform
   c) non-uniform head heats
   d) head chokes out of adjustment
7. a) melt flow is unstable

SOLUTION
1. see preblow adjustments
2. a) lower stock temperature; increase shot pressure
   b) shift mold into parison and realign blow pins
   c) adjust parison drop
   d) see preblow section
3. a) decrease melt temperature
   b) reduce drop time
   c) increase low pressure close; lubricate tie bar bushings
4. a) adjust die around mandrel
   b) shield parisons from moving air
   c) replace damaged component
   d) recenter the adjusting ring
   e) check for stripper plate contact
5. a) replace damaged component
   b) open die gap and purge
   c) disassemble and clean the tooling
6. a) adjust manifold chokes, make short tails longer first
   b) adjust bottle weights to ± 1 gm of target weight
   c) check heaters
   d) reset head chokes
7. a) increase or decrease stock temperature; increase or decrease drop time; check to insure that the head choke and manifold chokes are open as much as possible; clean the tooling
<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 8. Air bubbles | 8. a) moisture in material  
b) low fill pressure | 8. a) raise feed zone temp. to 335°F; switch to back up material  
b) increase fill pressure |
| 9. Stringing or drooling | 9. a) high fill pressure  
b) high melt temperature | 9. a) reduce fill pressure until weeping stops: Approx 150 psi - 4-head  
200 psi - 6-head  
b) decrease melt temperature |
| 10. Cuffing parison | 10. a) tooling mismatch  
b) temperature differential on tooling  
c) degraded material on die face  
d) melt temp. too hot or cold  
e) fill pressure too high or too low | 10. a) set proper bottle weight for tooling design; recut die for 0.015" mandrel extension below die face  
b) check head temperature setting and heater band function; shut off die variacs  
c) clean die face  
d) reduce or increase melt temp.  
e) adjust fill pressure |
| 11. Bottle weight too high or too low | 11. a) mandrel down or up too far | 11. a) turn mandrel adjusting nut clockwise to decrease or counterclockwise to increase bottle weight, making sure the mandrel does not turn. |
| 12. Holes in parisons and bottles | 12. a) contamination  
b) moisture | 12. a) check regrind quality  
b) see section on contamination investigation |
| 13. Tail length variations | 13. a) see attached | 13. a) adjust parison drop  
b) adjust swing arms  
c) adjust mold open stop LS-7  
d) adjust LS-4 and/or pneumatic flow control valves  
e) adjust screw rpm higher or increase blow time 4TD  
f) switch to auto mode  
g) check mold cooling system  
h) increase exhaust time |
| 14. Bottle sticking in mold | 14. a) parison hooking  
b) swing arm out of adjustment  
c) molds not opening far enough  
d) stripper plate timing  
e) tail too short  
f) blow pin in manual (down) position  
g) molds too hot  
h) insufficient exhaust time |
### DURING MOLDING

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 1. Bottom or volume adjusting insert inversion | 1. a) insufficient exhaust time  
b) bottle weight too low | 1. a) increase exhaust time  
b) increase bottle weight |
| 2. Poor weld or hole at the pinchoff | 1. a) pinchoff too sharp  
b) molds too hot  
c) stock temp too high  
d) excessive preblow  
e) molds closing too fast  
f) high pressure air coming on too soon | 2. a) roll pinchoff slightly  
b) increase mold cooling or cycle time  
c) reduce stock temperature  
d) reduce preblow pressure or timings  
e) slow down mold closing speed  
f) delay high blow air |
| 3. Incomplete blowing of the bottle | 3. a) blow air restricted  
b) hole in parison (contamination)  
c) pinchoff too sharp  
d) incomplete venting | 3. a) check blow air system  
b) drop mandrel and purge; check regrind quality  
c) roll pinchoff slightly  
d) repair vent |
| 4. Bottle too hot | 4. a) mold temp too high  
b) blow air pressure too low  
c) cycle time too short  
d) incomplete venting  
e) melt temp too high | 4. a) reduce mold temperature  
b) increase blow air pressure (to 80 psi minimum)  
c) increase cycle time  
d) repair vent  
e) decrease melt temperature |
| 5. Excessive exhaust time | 5. a) air channels plugged in exhaust system  
b) blow air pressure too high  
c) defective timer  
d) defective solenoid air valve | 5. a) open air channels in exhaust system  
b) lower blow air pressure  
c) replace timer  
d) repair valve |

### AFTER MOLDING

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
</table>
| 1. Trimming problems | 1. a) hooking parison  
b) mold damage  
c) mold alignment (mismatch)  
d) worn pinchoffs  
e) tie bar adjustments  
f) mold shimming  
g) flash too hot  
h) rotac seals leaking  
i) rotac high pressure too low  
j) trimmer conveyor bucket bent | 1. a) straighten parison drop  
b) repair mold  
c) replace guide pins and bushings  
d) rebuild mold  
e) adjust tie bars  
f) shim mold  
g) reduce mold temperature  
h) rebuild or replace rotac  
i) increase to 1000 psi max  
j) straighten buckets |
<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>k) trimmer to conveyor bucket indexing off</td>
<td>k) adjust drive chain</td>
</tr>
<tr>
<td></td>
<td>l) trimmer damaged</td>
<td>l) repair trimmer</td>
</tr>
<tr>
<td></td>
<td>m) blow pin alignment</td>
<td>m) align blow pins or replace blow pin</td>
</tr>
<tr>
<td></td>
<td>n) shear steel damage</td>
<td>n) replace shear steel; check for mold mismatch</td>
</tr>
<tr>
<td></td>
<td>o) high flare material</td>
<td>o) increase drop time, increase stock temp., recheck preblow</td>
</tr>
<tr>
<td></td>
<td>p) plugged dowel pin holes</td>
<td>p) clean dowel pin holes</td>
</tr>
<tr>
<td></td>
<td>q) plugged vents</td>
<td>q) clean vents</td>
</tr>
<tr>
<td></td>
<td>r) obstruction in mold</td>
<td>r) remove obstruction</td>
</tr>
<tr>
<td></td>
<td>s) molds too hot</td>
<td>s) decrease mold temperature</td>
</tr>
<tr>
<td></td>
<td>t) cycle too short</td>
<td>t) increase blow time</td>
</tr>
<tr>
<td></td>
<td>u) toggle linkage pins worn</td>
<td>u) replace linkage pins</td>
</tr>
<tr>
<td></td>
<td>v) incorrect bottle weights</td>
<td>v) reset bottle weights</td>
</tr>
<tr>
<td>2. Cap leakage</td>
<td>2. a) worn or damaged blow pin or shear steel</td>
<td>2. a) replace blow pin and/or shear steel</td>
</tr>
<tr>
<td></td>
<td>b) blow pin alignment</td>
<td>b) align blow pin</td>
</tr>
<tr>
<td></td>
<td>c) mold alignment (mismatch)</td>
<td>c) replace guide pins and bushings</td>
</tr>
<tr>
<td></td>
<td>d) blow pin and shear steel dimensions wrong</td>
<td>d) replace with correct size blow pin and steel</td>
</tr>
<tr>
<td></td>
<td>e) neck plate dimensions wrong</td>
<td>e) replace neck plates</td>
</tr>
<tr>
<td></td>
<td>f) cap dimensions wrong</td>
<td>f) change to new lot of caps or call cap manufacturer</td>
</tr>
<tr>
<td></td>
<td>g) trimmer damage due to difficult flash removal</td>
<td>g) see 1 (trimming problems)</td>
</tr>
<tr>
<td></td>
<td>h) vertical web inside neck (pleating)</td>
<td>h) adjust preblow system</td>
</tr>
<tr>
<td></td>
<td>i) capper tongue too high or too low</td>
<td>i) adjust capper tongue</td>
</tr>
<tr>
<td>3. Poor bottle surface (orange peel)</td>
<td>3. a) moisture on molds</td>
<td>3. a) aircondition or dehumidify blow mold room; dry inside of molds; increase mold temp.</td>
</tr>
<tr>
<td></td>
<td>b) low blow pressure</td>
<td>b) increase blow pressure</td>
</tr>
<tr>
<td></td>
<td>c) melt temp. too low</td>
<td>c) increase melt temperature</td>
</tr>
<tr>
<td></td>
<td>d) mold finish</td>
<td>d) mold surface may be too rough or too smooth</td>
</tr>
<tr>
<td></td>
<td>e) insufficient venting or plugged vents</td>
<td>e) clean vents with solvent</td>
</tr>
<tr>
<td>4. Bottle warpage</td>
<td>4. a) insufficient cooling time</td>
<td>4. a) increase blow time (4TD)</td>
</tr>
<tr>
<td></td>
<td>b) molds too hot</td>
<td>b) reduce mold temperature</td>
</tr>
<tr>
<td>5. Bottle volume too high</td>
<td>5. a) bottle weight too low</td>
<td>5. a) increase bottle weight</td>
</tr>
<tr>
<td></td>
<td>b) molds too cold</td>
<td>b) increase mold temperature</td>
</tr>
<tr>
<td></td>
<td>c) cycle too long</td>
<td>c) reduce cycle time</td>
</tr>
<tr>
<td></td>
<td>d) mold volume wrong</td>
<td>d) resize molds</td>
</tr>
<tr>
<td>PROBLEM</td>
<td>CAUSE</td>
<td>SOLUTION</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>6. Bottle volume too low</td>
<td>6. a) bottle weight too high</td>
<td>6. a) reduce bottle weight</td>
</tr>
<tr>
<td></td>
<td>b) mold too hot</td>
<td>b) reduce mold temp.</td>
</tr>
<tr>
<td></td>
<td>c) cycle time too short</td>
<td>c) increase cycle time</td>
</tr>
<tr>
<td></td>
<td>d) mold volume incorrect</td>
<td>d) resize mold</td>
</tr>
<tr>
<td></td>
<td>e) volume reducing inserts not used</td>
<td>e) remove inserts for packed bottles only</td>
</tr>
<tr>
<td></td>
<td>f) blow air pressure too low</td>
<td>f) increase blow air pressure</td>
</tr>
<tr>
<td></td>
<td>g) bottle storage area too cold</td>
<td>g) reduce storage area temp. or dwell time</td>
</tr>
<tr>
<td></td>
<td>h) melt temp. too high</td>
<td>h) reduce melt temperature</td>
</tr>
<tr>
<td>7.Indented parting line</td>
<td>7. a) blow air pressure too low</td>
<td>7. a) increase blow air pressure</td>
</tr>
<tr>
<td></td>
<td>b) air entrapment</td>
<td>b) improve (clean) mold venting</td>
</tr>
<tr>
<td>8. Parison tail sticking in bottle</td>
<td>8. a) tail too long</td>
<td>8. a) if all tails are long-</td>
</tr>
<tr>
<td>bottom</td>
<td>b) mold pinchoff too sharp</td>
<td>-reduce screw speed</td>
</tr>
<tr>
<td></td>
<td>c) mold closing too tight at bottom</td>
<td>-reduce blow time 4TD</td>
</tr>
<tr>
<td></td>
<td>d) swing arm out of adjustment</td>
<td>if one tail is long-</td>
</tr>
<tr>
<td></td>
<td>e) insufficient cooling</td>
<td>-adjust manifold choke</td>
</tr>
<tr>
<td>9. Cold spots, or marbelizing</td>
<td>9. a) melt too cold</td>
<td>9. a) increase melt temperature</td>
</tr>
<tr>
<td></td>
<td>b) cycle too fast</td>
<td>b) increase blow time (4TD)</td>
</tr>
<tr>
<td></td>
<td>c) insufficient back pressure (fill pressure)</td>
<td>c) increase fill pressure</td>
</tr>
</tbody>
</table>

**GENERAL OPERATION**

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Machine rings out while the</td>
<td>1. a) foreign object between molds</td>
<td>1. a) remove object and inspect for mold</td>
</tr>
<tr>
<td>molds are closing or molds fail to</td>
<td>b) lack of lubrication on tie bars, platen ways and</td>
<td>damage</td>
</tr>
<tr>
<td>lock up</td>
<td>toggle linkage</td>
<td>b) lubricate clamp assembly</td>
</tr>
</tbody>
</table>
### PROBLEM

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) tie bars adjusted too tight or out of square</td>
<td>c) loosen tie bar adjustments</td>
<td>d) increase low pressure to 350 psi by adjusting the pressure reducing valve</td>
</tr>
<tr>
<td>d) mold close low pressure too low</td>
<td></td>
<td>e) adjust or replace 5 TD timer</td>
</tr>
<tr>
<td>e) low pressure close safety timer 5 TD malfunctions</td>
<td></td>
<td>f) adjust LS-2 cam or replace LS-2 switch</td>
</tr>
<tr>
<td>f) LS-2 not making</td>
<td></td>
<td>g) increase high pressure to 950 psi max</td>
</tr>
<tr>
<td>g) high pressure set too low</td>
<td></td>
<td>h) rebuild or replace rotac</td>
</tr>
<tr>
<td>h) rotac seals worn</td>
<td></td>
<td>i) inspect and repair Safety door regulator should be 30 psi</td>
</tr>
<tr>
<td>i) air operated safety door malfunction</td>
<td></td>
<td>j) adjust LS-6 cams</td>
</tr>
<tr>
<td>j) stripper plate limit switch (LS-6) not actuated</td>
<td></td>
<td>k) replace solenoid #5</td>
</tr>
<tr>
<td>k) high pressure hydraulic valve solenoid defective</td>
<td></td>
<td>i) clean and restart</td>
</tr>
<tr>
<td>l) double shot in mold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Molds fail to close automatically but close manually</td>
<td>2. a) LS-1 not actuated</td>
<td>2. a) replace LS-1 switch</td>
</tr>
<tr>
<td></td>
<td>b) charge delay timer not timing out</td>
<td>b) replace timer 1 TD</td>
</tr>
<tr>
<td></td>
<td>c) exhaust timer not timing out</td>
<td>c) replace timer 2 TD</td>
</tr>
<tr>
<td>3. Machine rings out while molds are closed or as they are opening</td>
<td>3. a) LS-1A not made or defective</td>
<td>3. a) advance LS-1A or replace if made mechanically but not electrically</td>
</tr>
<tr>
<td></td>
<td>b) LS-1A made too soon or defective</td>
<td>b) retard LS-1A or replace</td>
</tr>
<tr>
<td></td>
<td>c) 7 TD timer timing out too soon or defective</td>
<td>c) add more time or replace</td>
</tr>
<tr>
<td></td>
<td>d) screw speed much too fast for cycle time</td>
<td>d) reduce screw speed or cycle time</td>
</tr>
<tr>
<td>4. Machine rings out when molds reach full open position</td>
<td>4. a) resin hopper empty</td>
<td>4. a) check hopper loader; fill hopper</td>
</tr>
<tr>
<td></td>
<td>b) extruder motor not running</td>
<td>b) restart extruder drive</td>
</tr>
<tr>
<td>5. Machine rings out when mold fails to open</td>
<td>5. a) exhaust timer failed to time out</td>
<td>5. a) replace exhaust timer TD-2</td>
</tr>
<tr>
<td></td>
<td>b) exhaust timer was not energized</td>
<td>b) replace blow timer TD-4</td>
</tr>
<tr>
<td></td>
<td>c) mold open solenoid valve defective</td>
<td>c) replace hydraulic solenoid SOL-6</td>
</tr>
<tr>
<td>6. Machine rings out when screw drive stops</td>
<td>6. a) clutch coolant hot</td>
<td>6. a) increase coolant flow or reduce temperature to clutch heat exchanger</td>
</tr>
<tr>
<td>PROBLEM</td>
<td>CAUSE</td>
<td>SOLUTION</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>7. Screw drive will not start</td>
<td>7. a) stock temperature safety tripped</td>
<td>7. a) reset stock temp. reset button</td>
</tr>
<tr>
<td></td>
<td>b) blown fuse (F-9, F-10, F-11)</td>
<td>b) replace fuse</td>
</tr>
<tr>
<td>8. Hydraulic pump stops</td>
<td>8. a) hydraulic oil too hot</td>
<td>8. a) open oil cooler bypass valve to cool it</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) jump out oil temp. sensor until oil temp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) add additional heat exchanger</td>
</tr>
</tbody>
</table>

**HYDRAULIC SYSTEM**

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No shot</td>
<td>1. a) LS-5 not actuated</td>
<td>1. a) adjust or replace LS-5</td>
</tr>
<tr>
<td></td>
<td>b) discharge solenoid defective</td>
<td>b) replace or repair SOL 3</td>
</tr>
<tr>
<td>2. Shot slows noticeably</td>
<td>2. a) nitrogen percharge pressure in</td>
<td>2. a) with bottle empty of oil,</td>
</tr>
<tr>
<td>during stroke</td>
<td>accumulator too high or low</td>
<td>charge with nitrogen to 1000-1100 psi</td>
</tr>
<tr>
<td>3. Slow parison drop time</td>
<td>3. a) ruptured nitrogen bladder in</td>
<td>3. a) replace bladder</td>
</tr>
<tr>
<td>(greater than 2 seconds)</td>
<td>accumulator</td>
<td>b) should be 1500 psi</td>
</tr>
<tr>
<td></td>
<td>b) pump pressure too low</td>
<td>c) open manitrol valve</td>
</tr>
<tr>
<td></td>
<td>c) manitrol valve closed</td>
<td>d) open manifold chokes and rebalance</td>
</tr>
<tr>
<td></td>
<td>d) manifold chokes closed</td>
<td>e) open head chokes</td>
</tr>
<tr>
<td></td>
<td>e) head chokes down</td>
<td>f) repair</td>
</tr>
<tr>
<td></td>
<td>f) shot cylinder piston rings worn</td>
<td></td>
</tr>
<tr>
<td>4. Noisy hydraulic pump</td>
<td>4. a) cavitation</td>
<td>4. a) clean or replace suction filter</td>
</tr>
<tr>
<td></td>
<td>-restricted intake</td>
<td>-change oil</td>
</tr>
<tr>
<td></td>
<td>-wrong oil viscosity</td>
<td>-add oil</td>
</tr>
<tr>
<td></td>
<td>-worn pump seals</td>
<td>-repair or replace pump seals</td>
</tr>
<tr>
<td></td>
<td>b) worn pump</td>
<td>b) repair or replace pump</td>
</tr>
<tr>
<td>5. Fluctuating pressure</td>
<td>5. a) worn pump(s)</td>
<td>5. a) repair or replace</td>
</tr>
<tr>
<td>(hydraulic pump)</td>
<td>b) compensator malfunctioning</td>
<td>b) repair or replace</td>
</tr>
<tr>
<td></td>
<td>c) clogged filter</td>
<td>c) clean or replace</td>
</tr>
<tr>
<td>shifting</td>
<td>sticking</td>
<td>If valve operates, replace solenoid</td>
</tr>
<tr>
<td></td>
<td>b) slave spool sticking or</td>
<td>b) repair or replace valve</td>
</tr>
<tr>
<td></td>
<td>main spool sticking</td>
<td></td>
</tr>
<tr>
<td>7. Hydraulic oil too hot</td>
<td>7. a) oil cooler malfunction</td>
<td>7. a) adjust coolant flow rate or temperature</td>
</tr>
</tbody>
</table>
**PROBLEM**

PROBLEM

1. No blow air
2. Blow air fails to shut off
3. Stripper plate fails to operate automatically but functions manually
4. Stripper plate fails to operate manually
5. Stripper cylinder functions but is erratic
6. Stripper action is too hard, slams down and up
7. Parison sticking to stripper plate
8. Molds open, then close immediately without making shot

**CAUSE**

b) pump on for an extended period with machine not cycling

**SOLUTION**

b) shut down pump when machine is down

---

**PNEUMATIC SYSTEM PROBLEMS**

1. a) LS-3 not actuated
   b) blow solenoid valve defective
   c) blow timer defective
   d) main air valve closed
   e) air compressor down
2. a) blow air selector valve stuck
   b) blow air timer fails to time out
3. a) LS-4 limit switch not actuated
4. a) no air pressure
5. a) no air cylinder lubrication
   b) stripper guide rod bearing not lubricated
6. a) air flow controls improperly adjusted
7. a) stripper not returning up soon enough
   b) stripper plate misalignment
8. a) stripper failed to operate

1. a) adjust LS-3 cam or replace LS-3
   b) repair or replace Sol. 8
2. a) repair or replace selector valve
   b) replace 4-TD
3. a) adjust or replace LS-4
4. a) check air sources ie: hoses, shut off valve, air compressor
   b) replace or repair SOL 9
5. a) fill or adjust air oiler
   b) lubricate guide bar bearings
6. a) adjust as required
7. a) increase stripper speed with flow control valve
   - advance LS-4 trip rod
   - adjust LS-6 cams
   b) center stripper plate to dies
8. a) adjust LS-4

---

**HEATER PROBLEMS**

1. Any heater zone fails to heat properly; red pilot light on
2. Pilot light out
3. Thermostat fails

1. a) blown fuse in heater circuit
   b) defective controller
   c) defective heater
2. a) check fuses, replace as required
   b) check controller
   c) check zone amp draw; replace heater as required

69
### PROBLEM

2. Any zone fails to heat properly; red pilot light off

3. Any heater zone overheat

4. Metering or transition zone overheat

### CAUSE

2. a) burned out pilot light  
   b) defective photocell in controller

3. a) thermocouple circuit open  
   b) defective indicator in controller

4. a) barrel cooling system not functioning properly  
   b) defective SKINNER valve

### SOLUTION

2. a) replace pilot light  
   b) consult instrument manufacturer

3. a) repair or replace broken thermocouple  
   b) replace controller

4. a) clean SKINNER valves  
   - check pump pressure  
   - check fluid level indicator  
   - check coolant temp. if high, increase coolant flow to heat exchanger  
   b) repair or replace Skinner valve #12, 13, 14 or 15 as required.

### SWING ARMS

1. Swing arms not gripping tail properly

1. a) clearance between fingers not adjusted properly  
   b) swing arms not going up high enough  
   c) tails too short  
   d) swing arms not getting up soon enough  
   e) fingers closing too soon  
   f) swing arm not going evenly

1. a) set finger clearance at 0  
   b) move swing arm attachment on swing arm pivot shaft  
   c) lengthen tails  
   d) adjust "up" speed swing arm with flow control valve  
   e) insufficient hydraulic pressure  
   f) rotac seals bad; adjust CR-101; adjust LS-201 finger close paddle; also see (b), above

2. Swing arms not placing bottles on cooling bed properly

2. a) fingers opening too soon  
   b) swing arm speed too fast or too slow  
   c) tail lengths too short or too long  
   d) cooling bed misaligned  
   e) worn rotac spline

2. adjust LS-201 paddles  
   b) adjust speed flow control valves  
   c) adjust tail lengths  
   d) align as necessary  
   e) replace