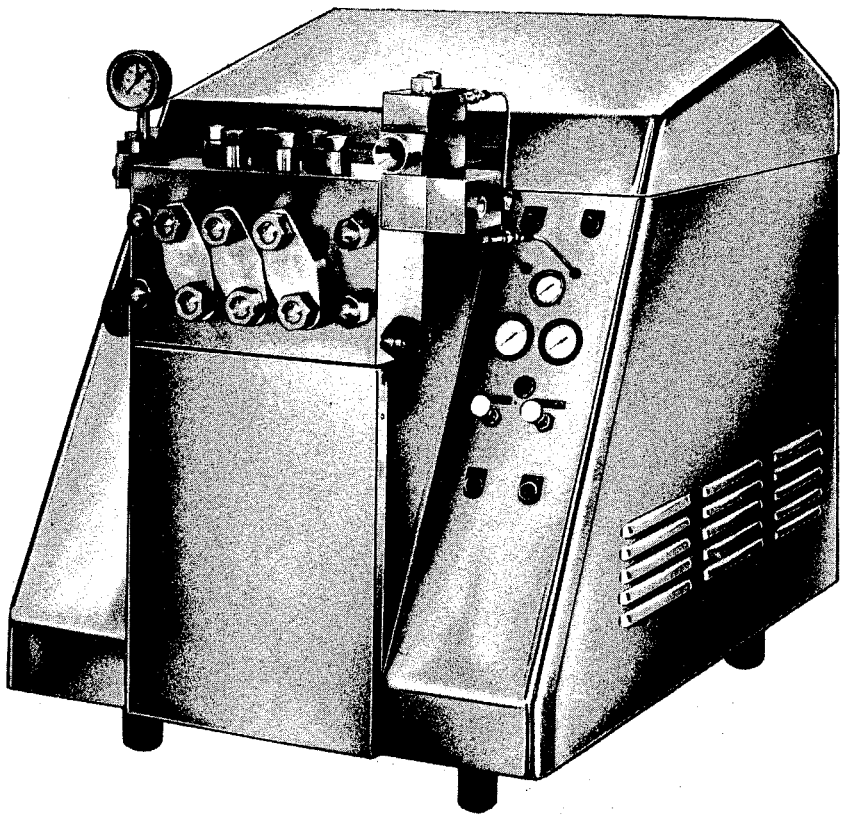
STOCKNR 3091

GAULIN MC 45

OPERATION & SERVICE MANUAL

GAULIN HOMOGENIZERS

MODELS: MC18 - MC45 - MC75



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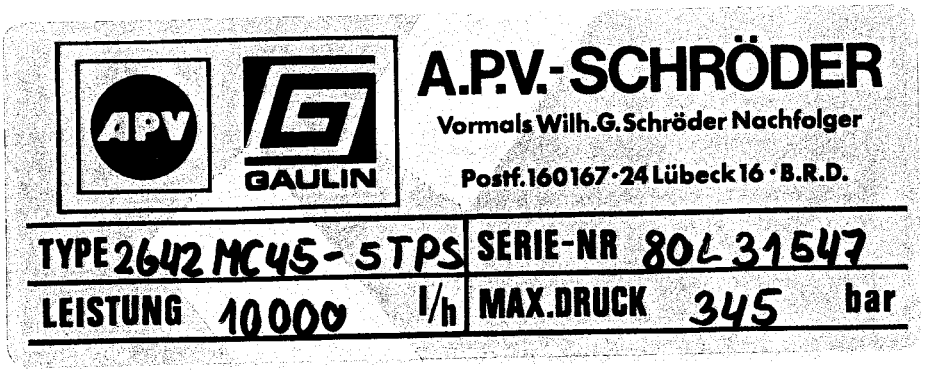
APV
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TYPE 2642 MC45-5TPS
SERIE-NR 80L31547
LEISTUNG 10000 l/h
MAX.DRUCK 345 bar

GAULIN WARRANTY

Gaulin warrants to the original Purchaser that Machinery of its own manufacture is free from defects of material and workmanship. Equipment or accessories manufactured by others, but purchased from Gaulin, are warranted to the extent of the Warranty of the original manufacturer.

Gaulin guarantees to repair or replace at its option, f.o.b. Point of Shipment, any component or part of its own manufacture found to be defective within one year after date of shipment. Such repair or replacement is subject to the following provisions:

a. Prior to the Machinery being placed in operation, a Gaulin Warranty Registration Data Sheet must be submitted to and be approved by Gaulin.
b. Operation of the Machinery must be determined by Gaulin to have been at all times in conformance with the information specified and approved on the Warranty Registration Data Sheet.
c. Machinery or material claimed to be defective must be shipped to Gaulin, transportation prepaid.
d. Damages from ordinary wear and tear, deterioration during periods of storage by the Purchaser prior to installation and operation, erosion or corrosion, misuse, abuse or improper application of the equipment by the Purchaser or any third party are specifically excluded from this Warranty.

GAULIN MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OR OTHERWISE, OTHER THAN STATED ABOVE NOR WILL GAULIN BE RESPONSIBLE FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES, OR FOR ANY OTHER CLAIM ARISING OUT OF THE SALE OF ITS EQUIPMENT BEYOND THE REMEDY STATED ABOVE.

HOW TO RETURN MATERIALS

Materials or equipment cannot be returned without first obtaining Gaulin's written permission. Materials and/or equipment accepted for credit are subject to a service charge plus all transportation charges. Materials or equipment built to order are not subject to return for credit under any circumstances. Any materials or equipment authorized for return must be securely packed to reach Gaulin Corp. without damage.

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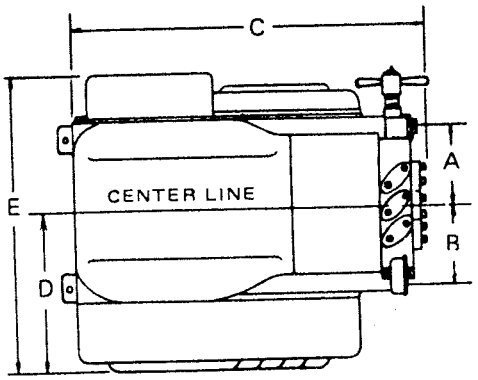
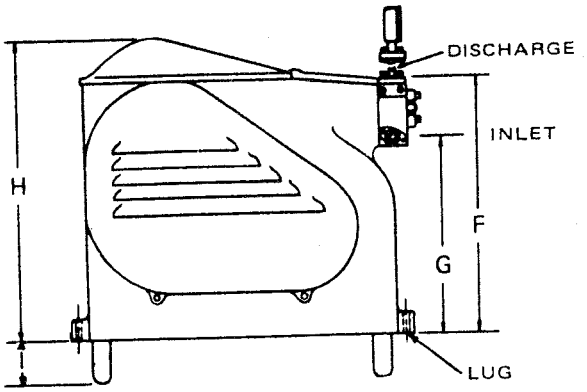
MACHINE WEIGHT AND DIMENSIONS

MODEL M3 & M6 HOMOGENIZERS

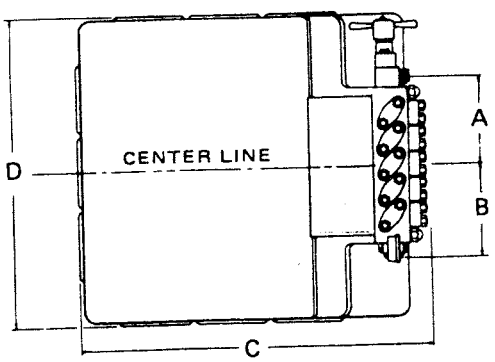


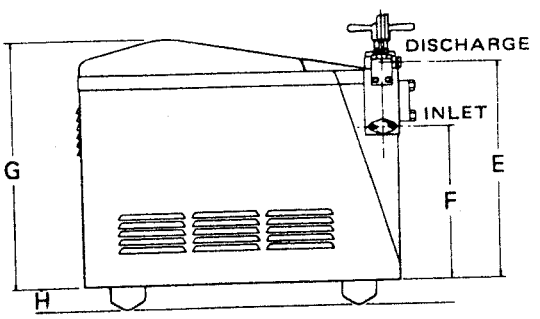


Frame Size	A	B	C	D	E	F	G	H	I	Gross Wt. (less motor)
M3	7"	8"	33"	15"	29"	34"	27½"	37¼"	5"	1500 lbs.
M6	10"	11½"	45"	21"	39"	34½"	28	41½"	6"	3400 lbs.

NOTE: Lug extends 2½" beyond base. Cast lug base optional.

MODEL M12 & MC HOMOGENIZERS





Frame Size	A	B	C	D	E	F	G	H	Gross Wt. (less motor)
M12	10¾"	12½"	46 13/16"	40"	37 13/16"	29¼"	42¾"	7½"	3,600 lbs.
MC18	11⅛"	12¼"	65"	46½"	38½"	27"	43¾"	4¼"	5,400 lbs.
MC45	12¾"	14⅞"	83"	50"	50¼"	35¾"	56¾"	4¼"	9,000 lbs.
MC75	18¾"	20½"	83"	61"	51⅜"	35¾"	56¾"	4¼"	10,500 lbs.
MC100	18¾"	20½"	83"	61"	51⅜"	35¾"	56¾"	4¼"	13,000 lbs.
MC140	31 1/16"	34 31/32"	96"	101"	67"	44"	62½"	4¼"	21,000 lbs.

NOTE: Dimensions and weights are correct – exceptions are A and E dimensions (suction and discharge connections) which will vary depending on customer specifications. Dimension H is minimum adjustment to one inch.

Figure 1

PRIMARY INSTRUCTION DATA

Complete familiarity with your Gaulin Homogenizer and its working parts will give you an increased awareness of its superior construction and wide range of capabilities.

Study this manual carefully. It will help you to install the machine correctly, operate it safely and efficiently, and maintain it properly.

DAMAGE IN TRANSIT

Occasionally, a machine inadvertently suffers damage during transit or unloading procedures. Inspect the exterior of the unit carefully. If any damage is evident, file a claim with the carrier immediately and notify Gaulin.

MOVEMENT TO INSTALLATION LOCATION

The machine is mounted on skids to facilitate movement to your installation location. In order to prevent damage to the unit when moved, be sure to see that fork lifts or slings are positioned under the skids.

IF START-UP IS DELAYED MORE THAN ONE MONTH

Often, Gaulin Homogenizers are not installed and placed in operation immediately after their arrival at the job-site. The machine has been shipped in a suitable crate to prevent damage while in transit. As soon as possible after its arrival at the plant, the unit should be uncrated per instructions. After spare parts and tools have been checked against the packing list, we suggest that they be stored in a suitable place to prevent loss or damage.

There are many removable parts to the cylinder assembly as shown on the applicable drawing. If the start up is to be delayed for more than one month, it is suggested that all cylinder metal parts and gaskets be removed and stored with spare parts and tools. When a homogenizer or relief valve is supplied, it should also be disassembled and parts stored with above. All parts should be wrapped or separated to prevent damage.

When the cylinder block is supplied of material other than stainless steel, it should be protected against rust by thoroughly coating with a corrosion proof grease.

Parts in the drive compartment have been cleaned and lightly coated with a lubricant prior to shipping as a temporary precaution against rust. On a delayed start-up, it is essential that these parts be thoroughly coated with a corrosion proof grease or sprayed with a vapor phase inhibitor.

The complete machine should then be covered with a plastic sheet or other suitable cover to protect it against weather, dirt, dampness, etc.

When the machine is installed on location, the Gaulin factory agent in your area should be contacted and advised of approximate date of initial start-up so that assistance and correct reassembling instructions can be offered.

After the drive compartment has been filled with oil to the correct level, and prior to assembling the plungers and other cylinder parts, the machine should be run for approximately thirty minutes to assure proper lubrication of parts and correct adjustment of oil pressure. Instructions for these procedures are found in this manual.

SPECIAL TOOLS FOR GAULIN HOMOGENIZERS

Illustrated on next page are some of the special tools for use with Gaulin equipment. The list will help you identify those particular tools furnished with your machine. Please consult the Packing List in this manual for the complete description of tools applicable to your machine.

HOW TO RETURN MATERIALS

Materials or equipment cannot be returned without first obtaining Gaulin's written permission. Materials and/or equipment accepted for credit are subject to a service charge plus all transportation charges. Materials or equipment built to order are not subject to return for credit under any circumstances. Any materials or equipment authorized for return must be securely packed to reach Gaulin Corp. without damage.

HOW TO ORDER PARTS

Help us to help you by following this procedure:

1. Identify your machine by MODEL and SERIAL NUMBER.

2. Identify parts from exploded view illustrations by CORRECT NAME only. Use item numbers where applicable.

NOTE: Your specific machine identification data is located at the front of this manual. Model and serial number will be found on the Packing List, also at the front of the manual. The serial number will be found on a nameplate at the rear of the well section.

LIST OF TOOLS

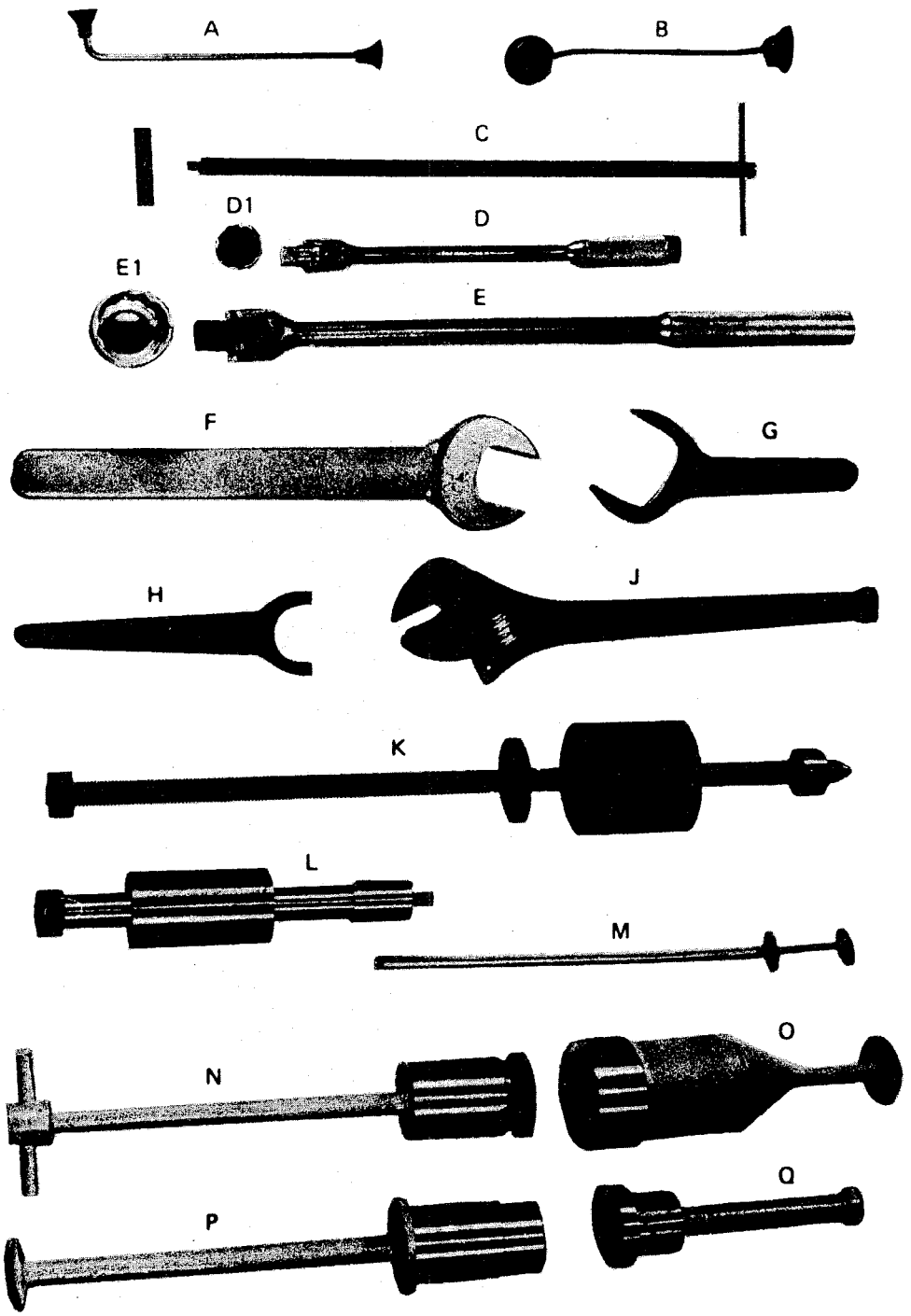


Figure 2

A. Ball Valve Removing Tool
B. Poppet Valve Removing Tool
C. Ball Valve Guide Removing Tool
D. 1/2 Drive Handle
D1. 1/2 Drive Socket Inlet, Gauge & Gauge Block Valve Body
E. 3/4 Drive Handle
E1. 3/4 Drive Socket, Front & Upper Cap
F. Plunger Adapter & Valve Body Stud Nut Wrench
G. Baffle Gland & Packing Adj. Screw Wrench
H. Crosshead Bearing Wrench
J. Miscellaneous Adjustable Wrench
K. Valve Seat Removing Tool Assy.
L. Discharge & Suction Valve Stop Retainer, Removing Tool
M. Valve & Stop Removing Tool
N. Packing Removing Tool Assy.
O. Packing Assembly Tool
P. Rear Packing Assembly Tool (Sterile)
Q. Packing Removing Tool (Pkg. Adj Screw Type)

INSTALLATION

UNCRATING INSTRUCTIONS

Instructions for uncrating your machine are attached to the shipping crate. The top and sides of the crate can be removed either at the area selected for installation or at a convenient place prior to moving the machine to the installation area on the skids provided. Uncrating at the installation area is preferable. Reasonable care must be exercised to avoid damage to the unit during the removal of the case. The Operation and Service Manual, with Packing List and Identification Sheet, will be found with spare parts in the motor compartment.

LOCATION

Your Gaulin machine is an integral part of your processing system and its location as a system component should be carefully planned and selected. Ease and efficiency of operation, as well as proper maintenance,depends largely upon the thought given to final location, before the machine is actually placed in position.

WEIGHT

The machine weight and specification information is found on Page 8 of this manual. The floor which is to support the machine should be capable of 150% of the stated weight.

FLOOR SPACE

The floor space occupied by the machine itself is also shown on the Weight and Specification sheet. Allow a minimum of 24" of space at the rear of the machine for oil changing and other maintenance. Facing the cylinder block from the front of the machine, allow extra space around the unit as indicated on the chart below:

Machine Model	Space on Left Side	Space on Right Side
M3	30"	24"
M6	24"	40"
M12	24"	40"
MC18	24"	46"
MC45	24"	50"
MC75	24"	61"
MC100	24"	61"
MC140	24"	61"

Figure 3

REMOVAL FROM SKIDS

On removing the machine from the skids, exercise extreme care to avoid damage to base or stainless steel skin. The machine must be jacked up, on the skids, to a height sufficient to permit removal of bolts going through the skid from the bottom. Before removing them, however, safe practice dictates that the base be rested firmly on wooden blocks, rather than on jacks, while the bolts are removed.

BOLTING TO FLOOR (Lug Mounted Units)

It is not necessary to bolt the machine to the floor unless an external drive is used. On units with cast lug base, before setting anchor bolts, check actual dimensions between bolt holes as a preliminary checking procedure, and make sure anchor bolts are securely mounted in floor to accurately maintain unit in desired location.

ADJUSTABLE FEET

Mount the adjustable feet. Make sure the threads are clean and cover them with a graphite paste or water resistant grease to prevent rust. Screw them up into the tapped holes under the base. There is approximatley 1" total adjustment.

MACHINE LEVELING

The unit should be approximately level for best operation. Use the machined surface of the cylinder block for leveling, side-to-side and front-to-back.

IMPORTANT – PLUNGER AND PACKING REMOVAL

The plunger packing was removed from the machine prior to shipment to prevent electrolysis, and was attached to the drip tube in the well area outside of the machine. In order to assure that the plunger and packing assemblies are not damaged during the procedure for testing proper motor rotation, it is *absolutely* necessary to remove the plungers from the machine at this time. Refer to appropriate Cylinder Instructions pages as identified on "This is your Machine" page.

COOLING OR LUBRICATION WATER

Bring water supply to the Water Connection Inlet, as shown on page 13. It is recommended that a valve be installed in the water line to regulate the flow of cooling water. It is also good practice to mount a solenoid shut-off valve in the water line so that the water will be automatically turned on when the main motor is started, and will be turned off when the machine is shut down. When a hand operated valve is located in the line supplying water to the plungers, it is used to adjust the flow to the plungers.

The machine will require from three to five gallons per minute, depending upon the temperature of the water, machine size and capacity. If the machine has a separate Hydraulic Valve Actuator box unit, a separate water line must be run to that assembly (See HVA Section, page 22).

WATER PIPING

M3 Models use water for plunger lubrication and oil cooling. (See page 13 for connection location. Inlet nipple to be furnished by customer.)

The M6 Model uses water for plunger lubrication only. (See page 13.) Inlet nipple (to be furnished by customer) connects to hole where Item #48 (Water Swing Joint) is located. If the oil cooler is supplied (option on M6 only) water connection is made similar to water connection for MC Models.

Water connections for Models M12, MC18, MC45, MC75, MC100 and MC140 are illustrated on page 13 and 14 showing a single connection for oil cooler and plunger lubrication.

DRAIN LINE

The cooling or lubricating waste water must be connected to a line leading to the floor or to a drain. Drain piping location is shown on Lubrication System drawing, pages 13 and 14.

OIL LUBRICATION

All oil was drained from the crankcase after a run-in period at plant. It is necessary to clean and flush crankcase. Fill the crankcase to visual oil gauge level with specified oil. After the machine has been operated, it will be noted that the oil level drops. This drop in level corresponds to the amount of oil required to fill the entire oil lubrication system. Add additional oil until level reaches center mark on visual oil gauge level. The oil pressure gauge should indicate a pressure between 20 and 40 p.s.i.g. The minimum safe pressure is 20 p.s.i.g. Oil pressure will decrease as oil temperature rises. There is a relief valve built into the discharge side of the oil pump, or a separate relief valve is located in the motor compartment. These can be adjusted to give required pressure. When an external oil pump is furnished (for eccentric shaft operation below 60 rpm) the pump and relief valve are factory installed. For oil change scheduling, see page 13.

PRESSURE LUBRICATION SYSTEM

WARNING: Do not use oil other than that specified for your particular machine. The M3, M6 and M12 Models utilize sleeve bearings on the eccentric and drive shafts. The entire MC Model series uses roller bearings on the driveshaft, and sleeve bearings on the eccentric shaft. A combination oil-splash and mist-lubrication system is used on gears and anti-friction bearings. Positive pressure lubrication is used for the sleeve bearings, eccentric cams and crossheads.

Correct crankcase oil may be purchased from the Gaulin Corporation, and the initial quantity is normally furnished with the machine when purchased. The correct oil is available in 5 gallon cans or in 54 gallon drums.

There are two types of oil used; one for Gaulin machines when operating at an eccentric shaft speed *below* 150 revolutions per minute, and another for speeds *above* 150 revolutions per minute. They are identified, as follows:

(Eccentric shaft RPM is the same as the number of strokes per minute made by one plunger. Gaulin will furnish, on request, the speed of a given machine, and the specific oil recommendation for your machine.)

Eccentric speed *below* 150 RPM – 5 Gallon Cans #811100.

SPECIFICATION: A premium grade industrial lubricating oil (not automotive), paraffinic base with a defoaming agent, oxidation and corrosion inhibitors, viscosity of 1000 to 1500 SSU at 100°F viscosity of 95 - 105 SSU at 210°F, with a minimum viscosity index of 85, pour max. †10°F, carbon max. .03%, flash open cup 450°F minimum.

Eccentric speed *above* 150 RPM – 5 Gallon Cans #811800.

SPECIFICATION: A premium grade industrial lubricating oil (not automotive), paraffinic base with a defoaming agent, oxidation and corrosion inhibitors, viscosity of 396 SSU at 100°F, viscosity of 59.3 SSU at 210°F with a minimum viscosity index of 105, pour max. +15°F, carbon max. .03%, flash open cup 465°F minimum.

OIL CAPACITY CHART

FRAME SIZE	OIL CAPACITY
M3	3 Gallons
M6-M12	6 Gallons
MC18	4 Gallons
MC45	9 Gallons
MC75-MC100	13 Gallons
MC-140	25 Gallons

Figure 4

The rear frame, housing the eccentric shaft, the drive shaft and the crossheads are gasketed and tightly covered. Although this cavity is vented to allow the escape of heat and moisture, a certain amount of condensation is unavoidable. To avoid oxidation of machined surfaces, and emulsification of oil under pressure, the following procedure is recommended. After machine has been shut down overnight, to permit the water to separate from the oil, open the petcock at the lower rear frame and drain the flow into a container until the flow of water stops and the flow of oil begins. Close the petcock. Discard the contents of the container. Check the oil level and add fresh oil, if needed.

OIL CHANGING

The frequency of oil change depends upon the type of service. On intermittent service, oil should be changed every 500 hours or 6 months. On continuous duty, if free of contamination and moisture, the oil may be used for 2,000 hours. Whenever oil is changed, clean oil compartment with steam, kerosene, etc. On MC models, clean the primary strainer at the bottom of the oil sump and replace filter cartridge.

LUBRICATION AND WATER PIPING DIAGRAMS

A.P.V.-SCHRÖDER GmbH
Vormals Wilh.G.Schröder Nachfolger GmbH
Tel. (0451) 691018 · Postf. 160167 · 24 Lübeck 16

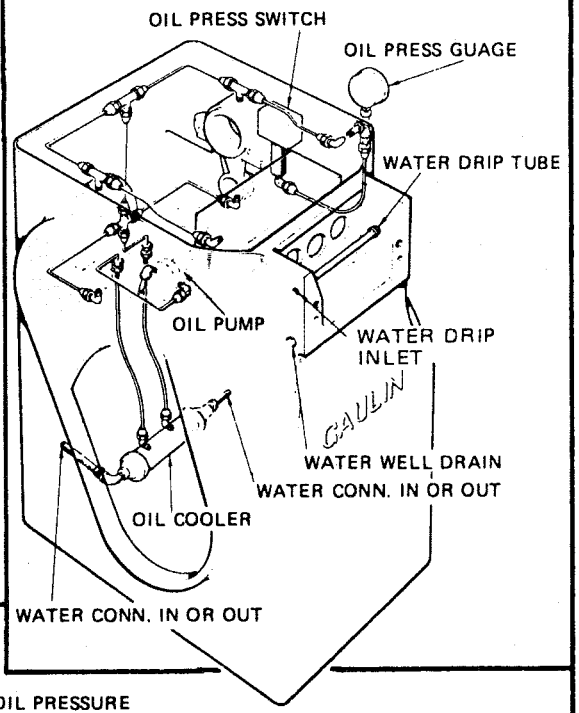
Folgende oder gleichwertige Ölsorten sind zur Getriebeschmierung der Homogenisiermaschine geeignet:

Following or equivalent lubricants are suitable for homogenizer gear lubrication:

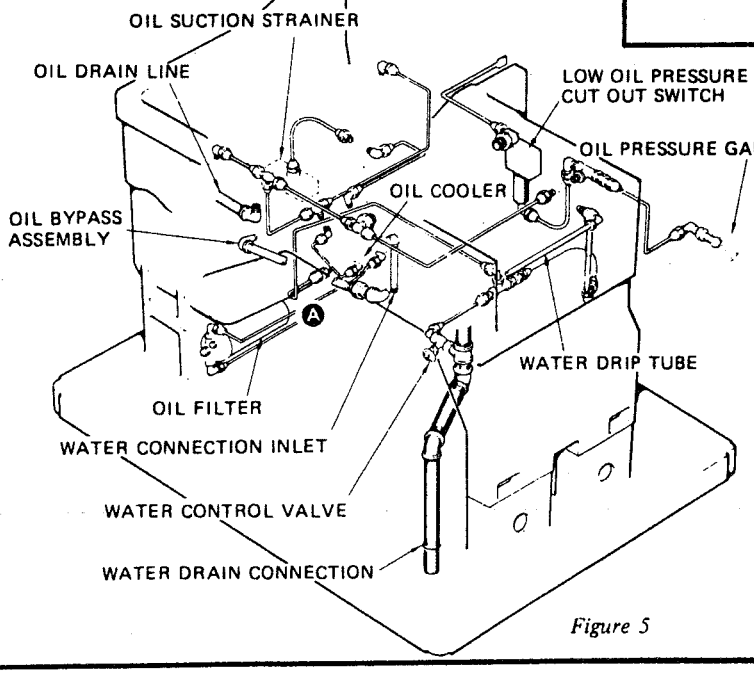
79

ARAL	DEGOL TU 220
BP	ENERGOL GR-XP 220
ESSO	SPARTAN EP 220
FINA	GIRAN 220
FUCHS	RENEP COMPOUND 106
SHELL	OMALA OEL 220
TEXACO	URSA OIL P-220/MEROPA 220

M 3



MC 18
MC 45
MC 75
MC 100



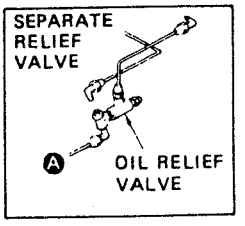


Figure 5

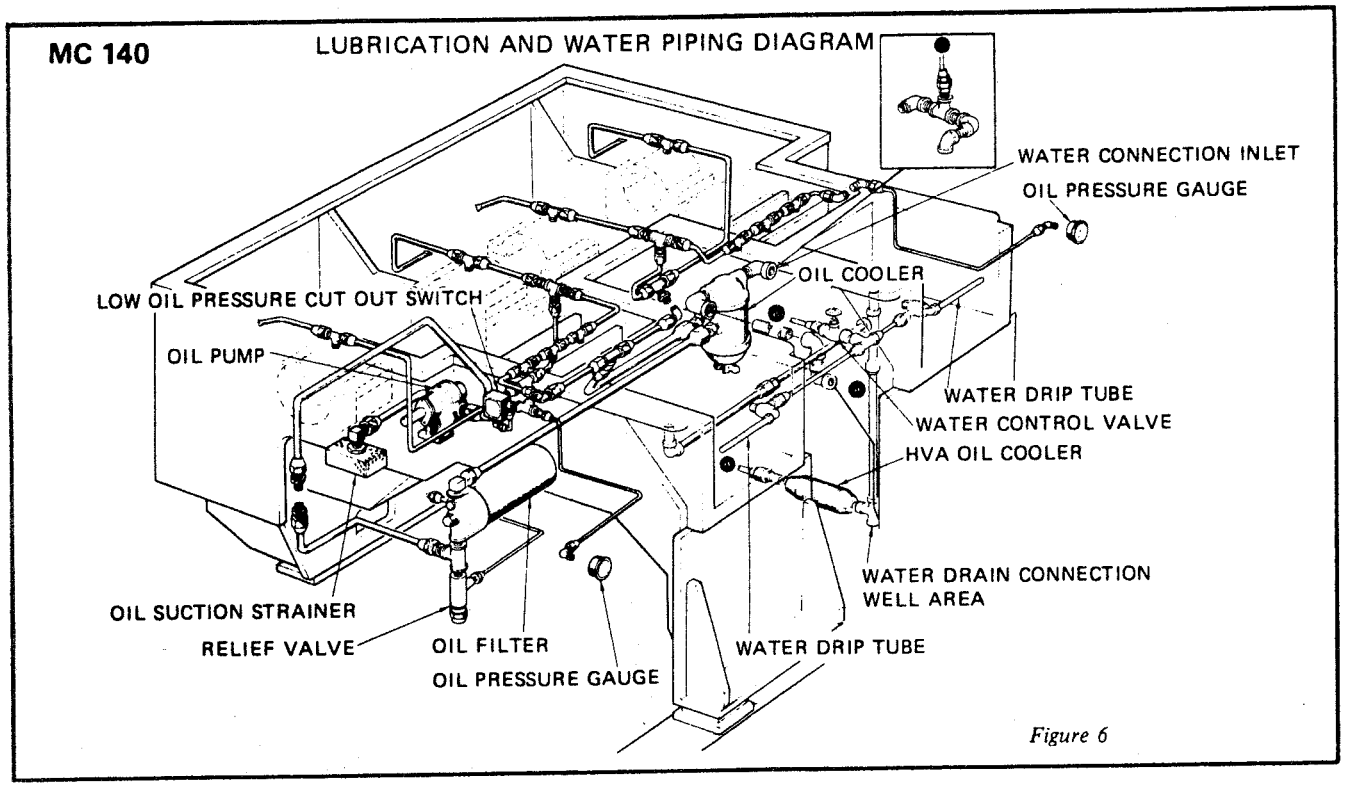


Figure 6

ELECTRICAL CONNECTIONS

WARNING Before connecting motor, be sure that the Plunger and Packing Assemblies have been removed from the cylinder block, as described on page (9).

The services of a competent industrial electrician are recommended for the installation of wiring and for making certain of correct motor rotation. Directional arrow will be found on the motor, or driveshaft for external drives.

After the wiring has been completed, remove the belt guard cover and check the sheaves and belts. These may have been loosened in transit. Adjust if necessary.

On M12 and all MC models, plastic start/stop switch covers are furnished with the machine. Upon completion of wiring install the switch covers.

MULTI-PURPOSE LOW OIL PRESSURE CUT-OUT SWITCH

This switch will prevent operation of the machine under an inadequate lubrication condition. (See figure 8, page 15 for installation instructions.)

When starting the machine, the START button must be held in until the oil pressure reaches the minimum set point.

Correct operation of the low pressure cut-out switch should be checked, as follows: Loosen the oil line connection at the switch to decrease the oil flow. If the switch is wired correctly the machine will stop.

If, during operation, the oil pressure drops below the minimum safety setting, the flow of electrical current to the motor is interrupted and remains so until the deficiency is corrected. Failure of the oil pressure gauge to register may be traceable to improper gauge connections, inadequate oil supply in the reservoir, the presence in the oil of excessive moisture, or the reversing of motor connections causing the oil pump to operate in reverse.

CORRECT BELT TENSION

In order to check for correct belt tension, place a bar across the face of all belts and apply hand pressure at a central point between the sheaves. A deflection of 1/64 per inch of span is correct. (See drawing below).

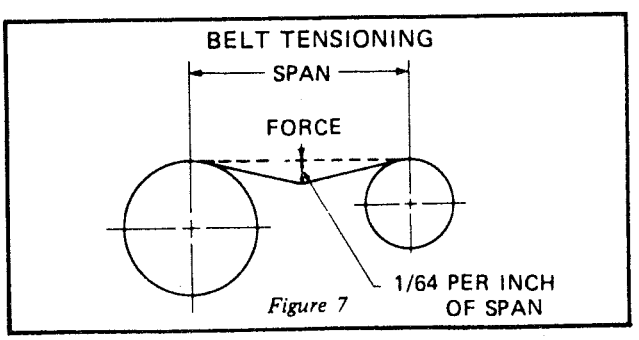
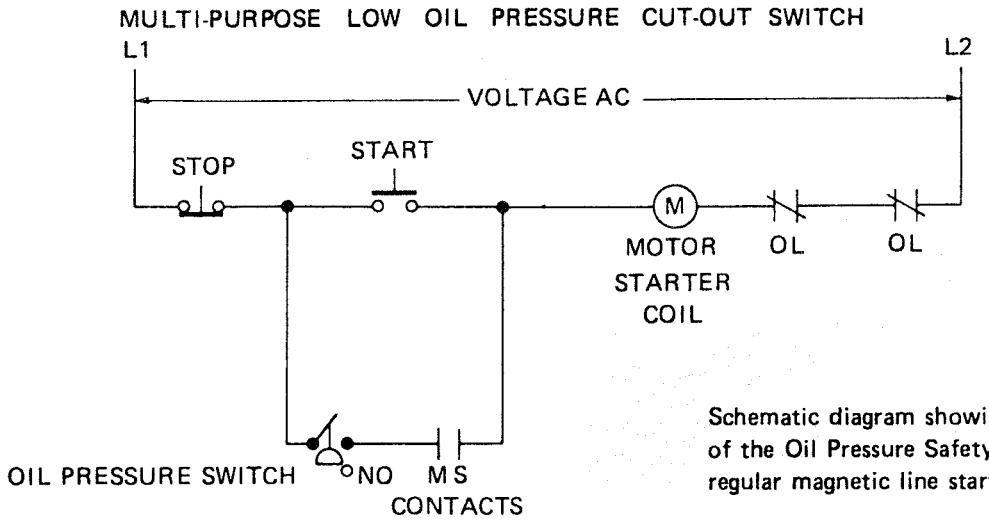


Figure 7

MOTOR LUBRICATION

The motor, if provided, with the machine has been selected to meet load requirements, and is covered by the warranty issued by the motor manufacturer. The motor should be lubricated in accordance with manufacturers

recommendations. Although unlikely, should difficulty arise, immediately contact the local representative of the motor manufacturer, our representative or factory. If modification or repair, not authorized by the MOTOR MANUFACTURER, is undertaken, the warranty is automatically waived.



Schematic diagram showing connection of the Oil Pressure Safety Switch to a regular magnetic line starter.

The Safety Switch is rated at 440 volts and may be used on single, two or three phase circuits as only two line wires are used in any case.

NOTE: When used in connection with manually operated compensators the safety switch should be wired into the existing control circuit as a low pressure cut-out.

Figure 8

MOTOR TEMPERATURE

If the motor appears to run hot, attach a thermocouple or thermometer to the very top of the motor. ADD 10°F to the reading to determine the actual temperature of the motor.

NOTE: NEMA motor specifications do not include a temperature rise factor. Motor manufacturer's limitation on temperature rise is air temperature surrounding motor. This should not exceed 40°C, unless special motors are supplied.

Model MC45, MC75 and MC100 machines are equipped with a fan attached to the end of the drive shaft inside the driven sheave. In hot climates or areas of high temperature (above 40°C.), a fan might be required on the smaller Gaulin machines. Please contact the factory if this question arises.

HYDRAULIC VALVE ACTUATOR (HVA) SYSTEM

If your machine is furnished with an integral or box type HVA System, the procedures below should be followed:

1. Wire the motor. It can be wired independently of the machine, or can be tied in with the unit's starter. If it is tied in with the starting circuit, a time delay switch should be provided to permit the machine to commence pumping prior to the application of HVA pressure to the valve assembly.
2. Clean the inside of the actuator oil reservoir sump before filling with oil.
3. Fill the HVA oil reservoir with hydraulic oil. Type of oil used must be the same as specified for machines operating in excess of 150 R.P.M. (See page 12.) Fill the box unit reservoir, if supplied, to the center of the oil level sight glass. On the integral reservoir type, fill approximately three-quarters full (1½ gallons.)
4. On factory-installed HVA Systems, all water and hydraulic connections have been completed. A common water supply line has been furnished for both the HVA and the machine oil coolers, as well as the plunger packing cooling system.
5. On separate box units, install (customer furnished) fittings, and pipe from the water supply to the oil cooler and from the oil cooler to the water drain.

PRELIMINARY MACHINE CHECKOUT

Now that all electrical, cooling, and lubrication requirements have been completed, and prior to assembling the plungers and other cylinder parts, the machine should be run for at least thirty minutes to assure proper lubrication of parts and correct adjustment of oil pressure.

CYLINDER REASSEMBLY

If the machine is to be operated within a two-week period, the plunger assembly parts should be assembled with plunger packing.

If the machine is not to be operated within two-weeks, the plunger assembly should be reinstalled, but without the plunger packing.

Refer to the appropriate Cylinder Instructions pages for your machine.

PRODUCT PIPING CONNECTIONS

IMPORTANT: A shut-off valve or other device for restricting discharge must *never* be placed in the discharge line, unless a suitable relief valve is placed between the shut-off valve and the machine.

WARNING: It is essential that proper product piping to the machine be provided. Piping size will be governed by the product and the process. The suction pipe size must *never* be smaller than the suction inlet connection.

When processing viscous materials, the suction pipe should be considerably larger than the suction inlet connection, and, a suitable feed pump should be provided to ensure positive and adequate feed to the suction side of the machine.

The product infeed pressure should always be greater than the vapor pressure.

Gaulin recommends a pressure gauge be installed at the suction inlet connection.

A test for correct suction feed pressure is accomplished as follows: Operate the machine on water. Determine the capacity. Operate the unit on the product at the same pressure and capacity. If the product capacity is 3% or more lower than the water capacity, the machine is being starved and the suction head must be increased.

If a suction strainer is to be used, it can be installed either in the suction manifold of the cylinder block or as close as feasible to the suction inlet connection, with a pressure gauge installed between the strainer and cylinder. The discharge piping should be the same size or larger than the discharge fitting.

When the machine is furnished with sanitary fittings, the connections may be larger than the pipe size shown for a specific model. In these cases, a reducer may be used to equal the discharge pipe size. See charts shown below for correct pipe sizes.

Back pressures in the discharge line, up to 500 p.s.i.g., will not affect processing efficiency of the machine. On units furnished with sanitary discharge fittings, back pressure is limited to 100 p.s.i.g. due to the pressure rating of the fittings.

STANDARD INDUSTRIAL PIPING CONNECTIONS

MODEL	SUCTION CONNECTIONS	DISCHARGE CONNECTIONS
M3	1" or 1¼" NPT Male	½" Female
M6-M12	1" or 1¼" NPT Male	½" Female
MC18	2" NPT Male	1" Female
MC45	2½" NPT Male	2" Female
MC75-MC100	2½" NPT Male	2" Female
MC-140	3" NPT Male	2½" Female

STANDARD SANITARY PIPING CONNECTIONS

MODEL	SUCTION CONNECTIONS	DISCHARGE CONNECTIONS
M3	1½"	1½"
M6-M12	1½"	1½"
MC18	2"	1½"
MC45	3"	2"
MC75-MC100	3"	2"
MC-140	3"	2½"

Figure 9

PRE-OPERATIONAL INFORMATION

GENERAL INSTRUCTIONS

To help you understand the following instructions, please refer to these drawings:
Plate C213 - Cylinders and Parts
Plate V216 - Single Stage Homogenizer or SMD Assemblies
Plate V217 - Two stage Homogenizer or SMD Assemblies

NOTE: The Pressure Gauge (#41) shipped with your machine is a delicate instrument and is easily subject to damage through careless handling.

PRESSURE GAUGE RANGE – Gauges are supplied in four standard ranges:

0 to 1000 p.s.i.g. - for operation up to 600 p.s.i.g.

0 to 5000 p.s.i.g. - for operation up to 3000 p.s.i.g.

0 to 10,000 p.s.i.g. - for operation up to 5000 or 8000 p.s.i.g.

0 to 15,000 p.s.i.g. - for operation up to 10,000 p.s.i.g.

NOTE: The Red Pointer (#45) on gauge is preset at the factory and indicates maximum allowable operating pressure for which your machine was designed.

The actual operating pressure of the machine must be accurately known in order to produce a satisfactory product and to avoid over-loading the motor or the unit. Serious machine breakdowns have occurred due to overloading of the unit, because gauge does not record actual operational pressure. To avoid trouble in this respect, it is advisable to have a spare gauge which would be used *only for testing* the gauge used for production.

An alternative method is to check the gauge furnished with the unit, during the initial installation of the new machine, and record actual gauge pressures and corresponding ampere readings of the motor while operating at three or more different operating gauge pressures. Then, draw a pressure-versus-amperage curve for use in the event of suspected gauge failure. The amperage reading will be sufficiently accurate for operation of the machine and processing in the event of gauge failure. In addition, it is an excellent future check on the gauge to determine the accuracy of the instrument.

To prevent the possible occurrence of electrolytic action or breakage during transit, Plunger Packing (#25) was removed from the machine. Packing assemblies must be installed properly (see Cylinder Reassembly, Plate C213) before any attempt is made to operate the machine.

Visible leakage of product from the rear of the cylinder indicates the need for adjusting or replacing the plunger packing.

WARNING: Continued operation with leaking packing will cause rapid and serious damage to the inside diameter of the Packing Adjusting Ring (#27) which, in turn, will markedly reduce the life of both the packing and the plungers.

The power-end section (see Plates B-164-176), housing the eccentric shaft, the drive shaft, and the crossheads, is lubricated by oil under pressure. The well area, located directly behind the cylinder, houses the plungers, which are cooled and lubricated by a water spray. The cylinder block accommodates the product being processed under high pressure.

The proper packing or gaskets for use in each area can be identified by comparing size and shape with the opening to be packed, and by referring to Plates C213, V216 and V217 in the manual.

The insertion of packing or gasket seals presents an excellent opportunity to become familiar with the nomenclature and construction of the unit. The manual clearly identifies each component by name and item number, thus providing useful information for the maintenance of the unit and for ordering replacements.

To aid in identification and to assure availability when needed, it is wise to clearly tape and label all spare parts with name and item number, and keep them neatly stored near the unit.

When the need for a replacement part arises, it is wise to order an extra for future needs.

All personnel who will operate or maintain the unit should be given an opportunity to disassemble, clean and reassemble the machine several times for initial familiarity.

In the cylinder block (Plate C213) and homogenizing or SMD valve assembly (Plates V216, V217) components have been precision machined. Care must be taken not to damage parts by rough handling. If a part does not go into place under gentle pressure, remove it and check the manual rather than attempt force.

NOTE: Your specific machine identification data is located at the front of this manual. Model and serial number will be found on the Packing List, also at the front of the manual. The serial number will be found on a nameplate at the rear of the well section.

Note that the cylinder block (Plate C213) is precision-machined from a single piece of stainless steel as standard construction, or special cylinder block material when specified. The cylinder ports are bored horizontally and closed with plunger packing assemblies at the rear, and gasketed caps at the front. The valve ports, bored vertically through the cylinders, contain pump valve assemblies and are closed on top by gasketed caps. The suction manifold, bored horizontally through the lower part of the cylinder block, is closed at one end by a gasketed cap and is fitted at the other end with an inlet connection (#17). These are interchangeable. The discharge manifold, bored horizontally through the upper part of the cylinder block, is of smaller diameter than the suction manifold and is fitted at one end for the homogenizer or SMD assembly (Plates V216 or Plates V217) and at the other end for the product gauge assembly or recorder assembly, or both.

All caps and assemblies on the cylinder block must be carefully secured with the special tools provided, due to the high product pressures developed in the block.

NOTE: The cylinder caps are machined to assure self-centering. In assembling the stud nuts which secure the cylinder caps, the pressure gauge block, the homogenizing valve or SMD assembly, and the suction manifold fittings, be sure to hand-tighten before applying a wrench. Then, use the special wrenches provided to complete tightening, being careful to tighten alternately in order to obtain uniform tension.

NOTE: A 3-way valve, designated for continuous open position is recommended for altering the flow-direction of processed material discharged directly from the unit. Never use a flow-control valve. The flow of processed material must never be restricted or stopped while the machine is in operation. The processed material can be flowed directly to shipping containers or storage tanks.

Avoid the introduction of excess air in the material being supplied to the unit.

NOTE: The presence of excess air will cause loud knocking, in both the cylinder and the homogenizing valve or SMD assembly, as well as erratic fluctuation of the pressure gauge indicator. Continued operation of the unit with gauge fluctuation will shorten gauge life and, if continued, may damage the cylinder and cause fatigue to other metal parts due to shock-loading. Pressure feed is necessary for high viscosity material. Gravity feed for some low viscosity materials may be satisfactory if the temperature is below 150°F.

CYLINDER DISASSEMBLY, CLEANING, REASSEMBLY

In order to facilitate this function, complete instructions for cylinder disassembly, cleaning and reassembly are contained in Plates C213, Cylinders and Parts.

HOMOGENIZER VALVE DISASSEMBLY, CLEANING, REASSEMBLY

In order to facilitate these functions, complete instructions for disassembly, cleaning and reassembly of manually operated homogenizer valve parts are contained on Plates V216 (Single-Stage Valves) and V217 (Two-Stage Valves).

NOTE: If the pressure drop downstream from the discharge is higher than 20 psi, it usually is necessary to install a tightly capped air stand pipe or commercially available hydraulic accumulator to minimize the line vibration. (This may become necessary on the suction line side of machines running at high capacities or when long and complex suction lines are used.)

GENERAL OPERATION

TEST OPERATIONS

All foreign matter in piping or supply system must be flushed out and removed from system before machine is put into operation. Turn on water for plunger lubrication, adjusting flow by control valve. After checking the entire unit for tight assembly, test operation can begin.

Note: Clean water should be used for initial testing of the homogenizer, closely observing for leakage and loss of operating pressure. If leakage does occur, correction can be easily accomplished. During the water test run, a capacity check should be made to determine if the machine is operating at its rated flow.

Manually controlled single or two-stage Homogenizing Valve – Slowly turn second-stage handwheel clockwise until product pressure gauge reads desired pressure. Then, turn first-stage handwheel clockwise until it reaches the maximum rated pressure for the machine. As the pressure rises, check cylinder caps, etc. for leaks. If any leaks occur, tighten nuts. With cold water, it is sometimes difficult to completely stop leakage around nylon gaskets, but they will quickly seat themselves when hot product is run, or, tighten further.

Hydraulic Valve Actuator (HVA) Homogenizing Valve – Complete instructions for operation of HVA machines is contained on pages 23-25.

Recommended: This is the opportune time to construct a Pressure/Amperage Curve to facilitate future occasional checkout of gauge accuracy or when gauge fails. It is a simple procedure. Merely record on the graph furnished below, three or four pressure gauge readings, up to the maximum for the machine, as well as the corresponding amperage reading determined by your electrician as each of the pressures is reached. Future amperage readings should correspond with the pressures indicated by the gauge.

PRODUCT OPERATION

Start feed pump, if one is in use. Adjust flow of cooling water and check oil level. Before starting the machine, make certain the Handwheel (#9) on the valve assembly (Plate V216 or V217) is turned counter clockwise to the open position, permitting the product to flow through the valve assembly without pressure. Start machine motor. Open product supply valve. After the product is pumping smoothly through the machine, gradually turn the valve Handwheel (#9) clockwise toward the closed position until the desired pressure is indicated on the Gauge (#41) (Plate C213). At this point, the unit will be functioning as intended. With the exception of listening for abnormal noises and checking the Gauge (#41) for excessive pressure or fluctuation, no further attention is needed. If operation is not smooth, immediately turn the valve Handwheel (#9) counterclockwise to the open position. Repeat the procedure followed initially. This will permit complete removal of air from the system. Before starting, and during operations for the first several days, additional tightening of the Upper and Front Stud Nuts (#1 and #30) (Plate C213) is strongly advised. This procedure should properly seat the Upper Cylinder Gaskets (#3) and Front Cap Gasket (#28) (Plate C213).

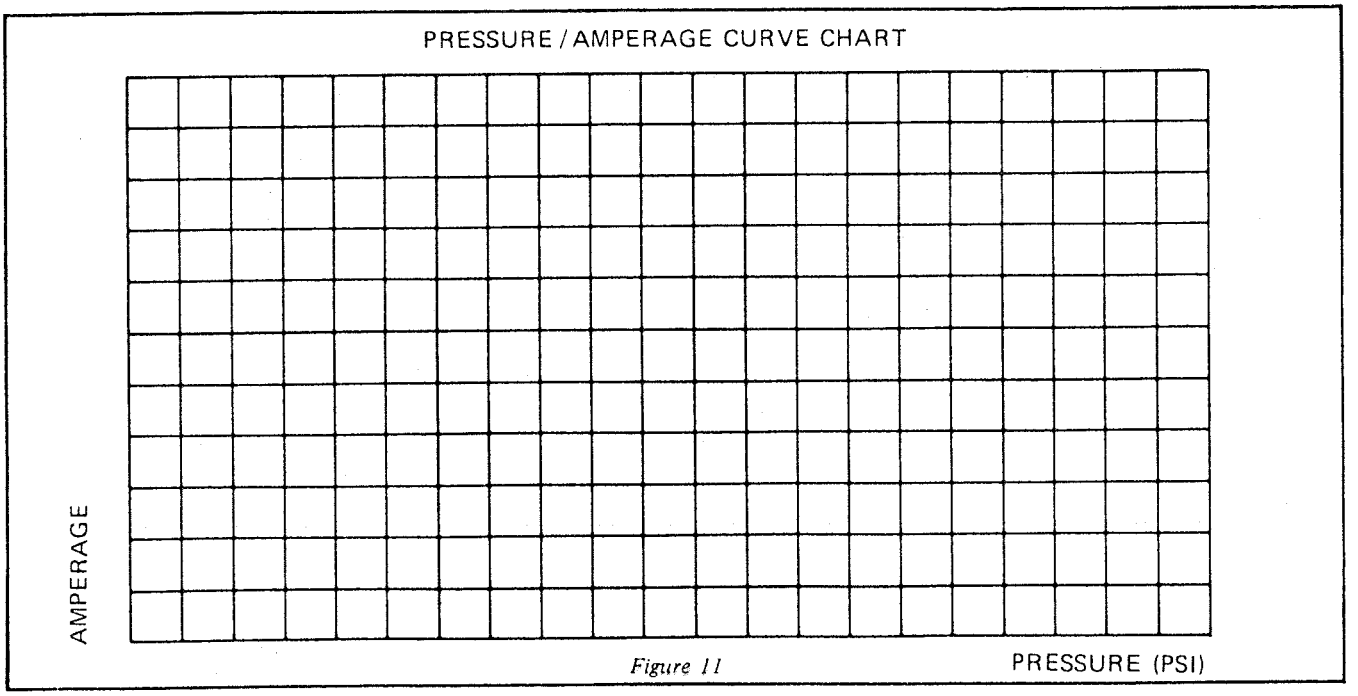
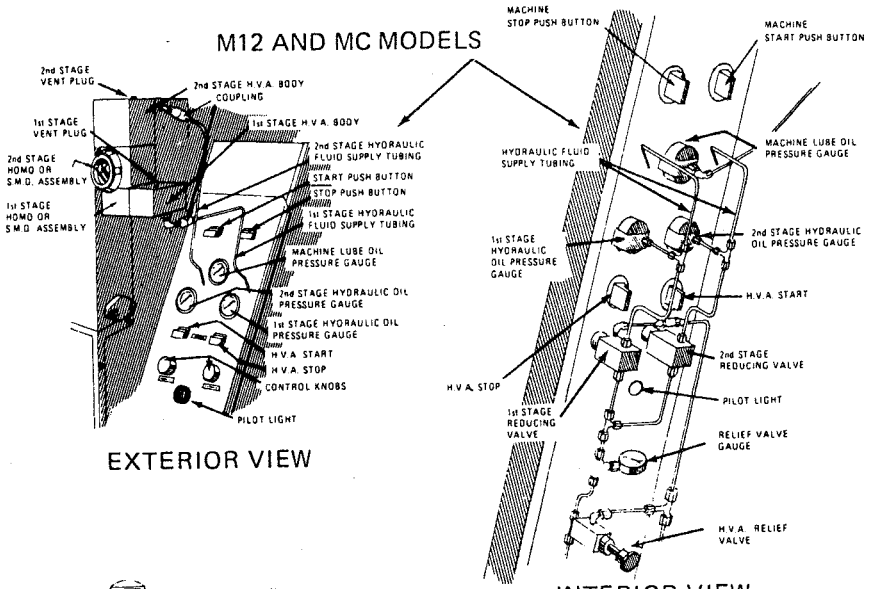
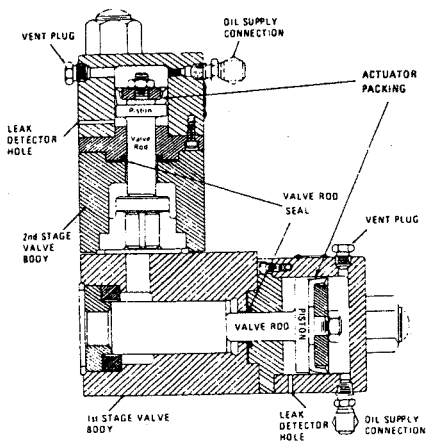


Figure 11

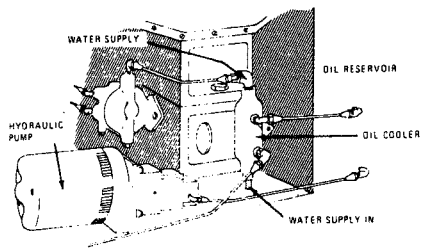
PLATE V221

HVA Hydraulic Actuator - Piping



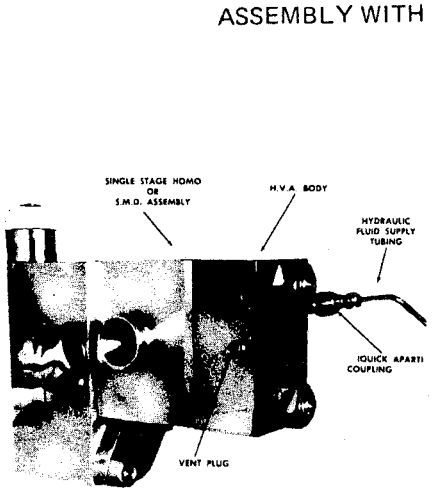


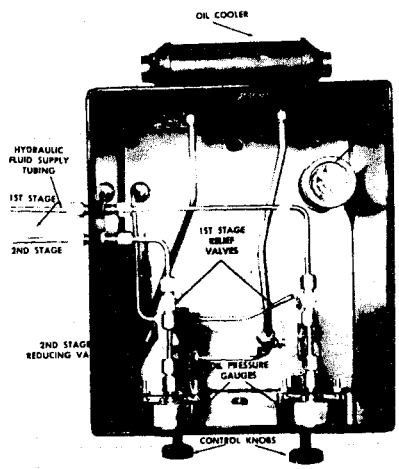
TYPICAL TWO-STAGE VALVE ASSEMBLY WITH HVA

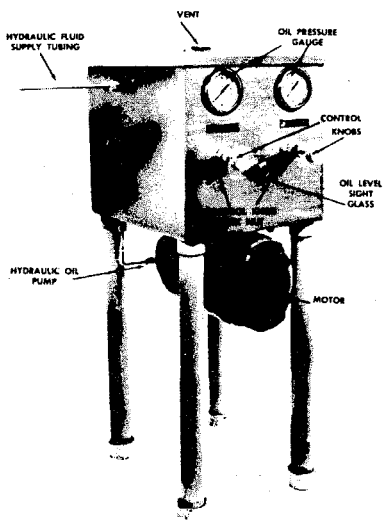


INTEGRAL UNIT

*Patent applied for.







REMOTE HVA UNIT

Figure 12

HVA OPERATION

The Hydraulic Valve Actuated (HVA) System includes a hydraulic relief valve which has been carefully set to control the maximum desired homogenizing pressure, or the maximum safe operating pressure of the machine.

Each stage of a two-stage homogenizing valve is controlled by a separate pressure reducing valve permitting independent control of each stage.

The relief valve and reducing valves in a two-stage machine are piped in series. Therefore, pressure must be created by the relief valve before the reducing valves can be operated.

On initial start-up after installation of the Hydraulic Valve Actuator, the system will be empty of hydraulic oil. The oil filter supplied as part of the unit is of good quality in order to insure clean oil to the HVA pump and mechanism. However, the HVA is intended for use with oil, not a mixture of oil and water, making it essential that excess condensation or water leakage into the HVA box (or sump in the integral HVA systems) be avoided.

The model M3 and M6 machines use HVA remote box units. The M12 and MC models, if factory equipped with HVA, will have a 2-gallon oil reservoir mounted in the base of the unit. When HVA is field installed, it must be a remote box unit identical to the M3 and M6 units.

Installation instructions for two-stage HVA system

1. Clean and wipe out inside of actuator oil reservoir sump before filling with oil.

2. Fill HVA oil reservoir with hydraulic oil. Type of oil used must be same specifications as the oil recommended for machines operating in excess of 150 r.p.m. (See page 12). On box units, fill to center of oil level sight glass. On integral reservoir units, fill three quarters full (approximately 1-½ gallons).

3. On factory installed HVA units, all water and hydraulic connections have been completed. A common water supply line has been furnished for both HVA oil cooler and machine oil cooler, and plunger packing cooling system.

4. On remote box units, install customer furnished fittings and pipe from water supply to oil cooler and from oil cooler to water drain.

5. Wire motor. Motor may be wired independent of homogenizer or tied in with homogenizer starter. If it is tied in with the starting circuit of the homogenizer, a time delay switch should be provided to permit the homogenizer to commence pumping prior to the application of HVA pressure to the homogenizing valve.

6. The HVA remote box unit may be located anywhere adjacent to the machine, within limits of the length of hydraulic tubing supplied.

7. If remote panel operation is desired, additional tubing may be purchased.

8. The HVA remote box units are supplied with the necessary tubing and fittings. It is necessary, however, to cut tubing to the required length and install fittings. The tubing fittings are installed by:

   a. Cut tubing off square.

   b. Slip nut over end of tubing.

   c. Slip ferrule over end of tubing, slotted end first.

   d. Using a tube flaring tool, slightly flare end of tubing to prevent ferrule from sliding off.

   e. Screw nut onto male fitting on HVA box and tighten.

   f. Repeat same procedure on opposite end of tubing using Quick-Apart connector. Mating piece to Quick-Apart connector is attached to HVA unit mounted on homogenizing valve.

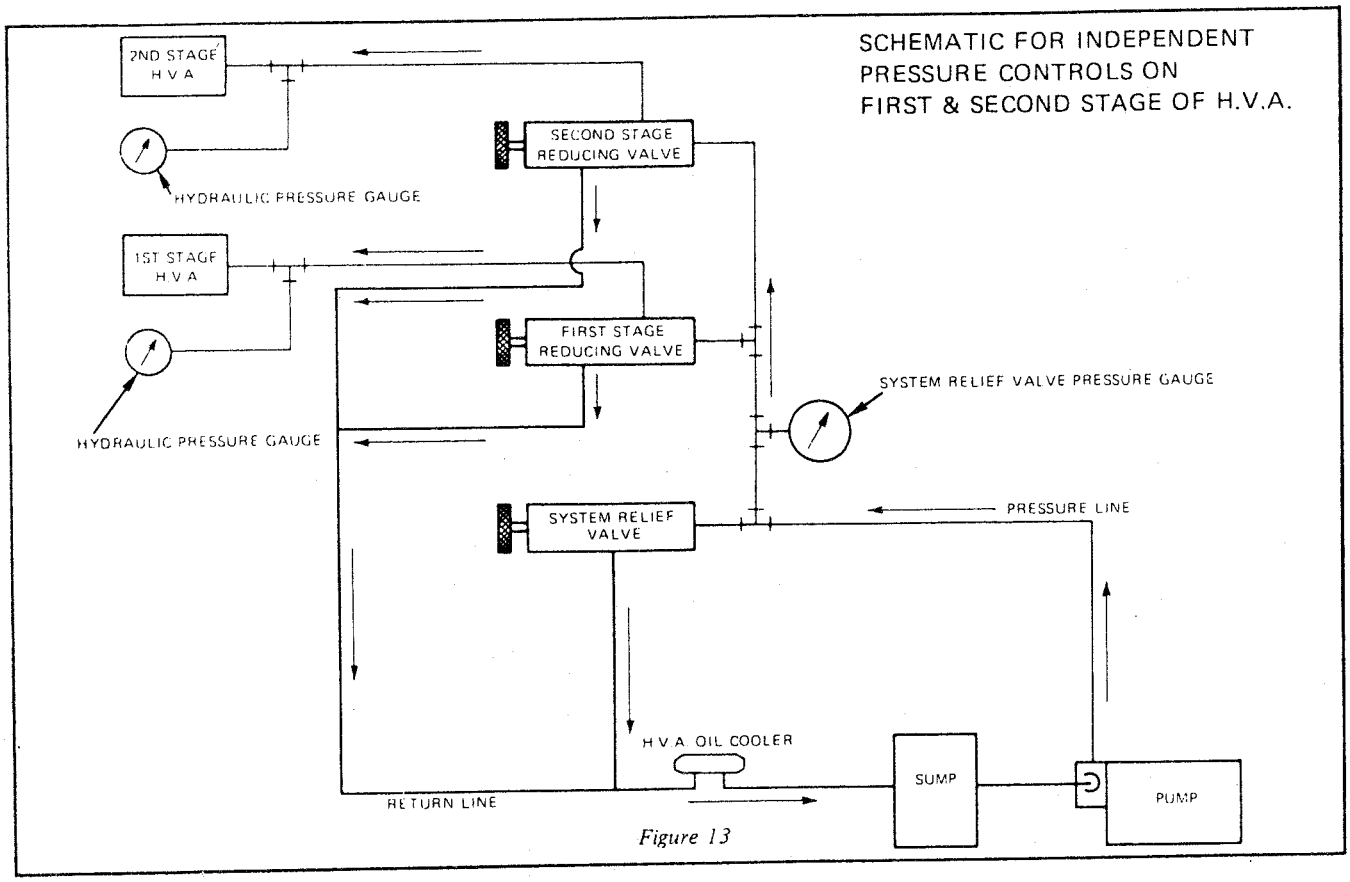


Figure 13

Initial start-up of HVA two-stage Homogenizing Valve Assembly – When starting and calibrating machines equipped with two stage homogenizing valve assembly, proceed as outlined below:

1. Loosen, but do not remove vent plugs on top of first and second-stage actuator bodies.

2. Turn first and second-stage reducing valve control knobs counter clockwise several turns to relieve possible pressure build up in system.

3. Start the HVA pump motor and allow to run for a few moments to fill the system with hydraulic oil

4. The relief valve, located inside the base of MC machines or in the oil reservoir on box units, has been preset for operation. If it becomes necessary to readjust the relief valve, turn the control knob clockwise until 800 to 1000 p.s.i.g. registers on the relief valve pressure gauge located on the pressure line leading to the reducing valves.

5. Turn first and second-stage reducing valve control knobs clockwise several turns to create a slight pressure on the system to speed up the air bleeding process through the vent plugs.

6. Allow HVA pump and motor to operate for this limited time period until all air is expelled from the actuator bodies, as indicated by air-free fluid escaping through the loosened vent plugs.

7. Tighten the vent plugs.

8. Turn first and second-stage reducing valve control knobs counterclockwise until hydraulic pressure gauges come to rest at the minimum point. This reading should not exceed 20 to 30 p.s.i.g. on either gauge.

9. Stop HVA pump and motor.

10. Start homogenizer on water and allow the machine to run until full flow has been reached.

    CAUTION: Do not start the HVA pump until full flow has been obtained and all air has been removed from the system. Failure to observe this precaution can cause serious damage to the homogenizer by shock loading.

11. On the two-stage homogenizing valve assembly, the second-stage processing pressure should be adjusted first. Turn the second-stage reducing valve control knob clockwise until the desired second-stage pressure is indicated on the product pressure gauge.

12. Turn the first-stage reducing valve control knob clockwise until total desired processing pressure is indicated on the product pressure gauge.

13. If the desired product processing pressure cannot be obtained, there may not be sufficient hydraulic pressure available. Proceed as follows:

    Turn first stage reducing valve control knob counter-clockwise until product pressure gauge reaches the minimum point or setting of second-stage pressure. Slowly turn the relief valve control knob clockwise to increase the pressure created by the relief valve. This should be increased about 200 p.s.i.g. at a time Turn the first-stage reducing valve control knob clockwise and observe pressure on the product pressure gauge. Repeat these steps until desired product processing pressure is obtained.

14. Read hydraulic pressure gauge and record the pressure. Tighten the control knob locknut on the relief valve control knob. When properly set, the relief valve will prevent the homogenizer from operating at pressures higher than desired or in excess of the safe operating pressure of the machine. Turn reducing valve control knobs on first and second-stage reducing valves counter-clockwise until hydraulic pressure gauges come back to minimum position.

15. Repeat steps 11 and 12. Record the hydraulic pressure indicated on the gauges for the desired product operating pressure. The pressures should remain constant for the product operating pressure.

16. Tighten the control knob locknuts on the first and second-stage reducing valves to maintain a constant valve setting. Subsequent and similar operating pressures can be achieved by starting the HVA pump motor. Daily settings are not required.

17. When homogenizers are operated on more than one product, requiring different pressure combinations, steps 11 and 12 should be repeated for each product. Manual adjustment of the reducing valve control knobs will be required when product changes are made.

SPECIAL INSTRUCTIONS FOR DAIRY OPERATION

HOMOGENIZER IN AN HTST SYSTEM

The homogenizer can be operated in many different locations in an HTST or UHT system, such as: between the raw regenerator and heating sections, midway through regenerator section, after the heating section, after the holding tube, after a vacuum treatment unit, after a centrifugal pump, after a positive displacement metering pump, after a centrifugal pump in a standardizing separator.

Each location changes the temperature, infeed and discharge pressure conditions, thus changing the piping hook-up requirements. Accordingly, there is no single right way to start up and operate the machine.

CONSTANT REQUIREMENTS

No matter where the homogenizer is located, efficient, safe operation demands the following:

1. Homogenizing temperature above 140°F., (except evap.).

2. Maintain minimum infeed pressure above 10 p.s.i.g. or greater as dictated by product temperature, viscosity, and flow rates.

3. Air entrainment in product must be kept to absolute minimum possible (2% or less) to avoid serious damage from shock loading.

4. Do not start machine under pressure.

5. Do not apply pressure until machine is pumping smoothly, with air expelled from cylinder and infeed lines.

6. Uninterrupted supply required so machine cannot operate with pressure applied while product runs out.

HOMOGENIZER IN A BATCH SYSTEM

The same constant requirements as described above are in order. Because such systems are usually not designed for continuous operation, more care is required in operation. If system allows, it should be automated to re-cycle instead of running out of product. At the very least, a low-level alarm system should be installed to signal the operator when the time has come to remove pressure. Proceed as follows:

1. Turn on cooling water for plungers and oil cooler.
2. Check oil level gauge at back of machine. It should show a level in the center of the gauge glass.
3. Before starting the homogenizer every day, make a practice of opening the petcock at the back of the oil sump to drain off any condensation which has separated from the oil while machine was shut down.
4. Back off (counter-clockwise) handwheel(s) or HVA control knob(s) several full turns.
5. Open re-cycle valve (if one is in system) so product can flow back to homogenizer infeed line (while pressure is being applied.)
6. Open product valve, start feed pump and homogenizer.
7. When air is expelled and machine is pumping smoothly, turn clockwise, second-stage hand-wheel or control knob bringing pressure up to desired setting (see table of suggested pressures below.)

NOTE: The second-stage handwheel is the wheel located next to the discharge fitting.

8. Turn the first-stage handwheel or control knob down for required total gauge pressure.
9. For the first several days, additional tightening of the upper and front cylinder cap nuts is advised. This will help to seat the upper and front cap gaskets.

HOMOGENIZING PRESSURE

The pressure required will depend on: product temperature, nature of product, shelf life desired, amount of air in product, heat history of product, homogenizing valve condition & type and even the condition of pump valves & seats. Accordingly, the following table lists only the normal range. Actual pressures will be determined by trial and error for the optimum efficiency possible, with the product, the machine, and the system involved.

In order to shut down the homogenizer, back off handwheel(s) or turn off HVA switch. Usually, machine and piping system is flushed out before stopping the homogenizer.

MAXIMUM OPERATING PRESSURE FOR YOUR MACHINE

This point cannot be emphasized too strongly because of the serious consequences which will result if the warnings are not understood and observed. See name plate and sheet, "This is Your Machine", for your machine maximum pressure.

The controlling factors which limit the operating pressure of the machine are in either the cylinder end, the power drive end, or the motor. Plunger diameter (area) will determine the loading on the power drive end. Cylinder block design limits its loading to a specific value. The available motor horsepower in the machine will limit the pressure even if the power drive end and cylinder are capable of higher pressure. The coding on the name plate will give the maximum pressure allowed by the cylinder or the power drive end, whichever is lower. The red pointer setting on the product pressure gauge attached to the cylinder will give the maximum safe pressure.

SUGGESTED OPERATING PRESSURES FOR DAIRY PRODUCTS

PRODUCT	2ND STAGE	1ST STAGE/TOTAL GAUGE READING
Fluid Milk	300 to 500 psi	1500 to 2500 psi
Half and Half Milk	500	1800 to 3000 psi
Coffee Cream	(Use pressure on 1st stage only)	500 to 1000 psi
Soured Cream	optional	none
Evaporated Milk	300 to 500 psi	1500 to 2500 psi
Soft Serve Mix	300 to 500 psi	2000 to 3000 psi
10–12% I.C. Mix	300 to 500 psi	2000 to 3000 psi
16% I.C. Mix	300 to 500 psi	2000 to 3000 psi
Sterile Milk	300 to 500 psi	1500 to 2500 psi
		2500 to 5000 psi

Figure 14

If the machine capacity is increased to a point where the motor horsepower limits the pressure below the red pointer setting, the red pointer can be easily changed. In no case, however, should it ever be moved above the name plate designation.

Homogenizers are designed and manufactured for maximum operating pressures up to and including 10,000 psi. When your machine was ordered, it was designed and built to allow operating pressures to the top limit specified on your order. If a future need arises which requires a higher operating pressure, the machine can often be converted to operate at higher pressure. When this is possible, it usually requires smaller diameter plungers and associated parts. In other cases it might require a complete new cylinder assembly designed for the higher pressure.

Never attempt to operate beyond the present limits of your machine without consulting the factory or a factory representative or authorized dealer.

ASEPTIC HOMOGENIZER CYLINDER DESIGNS

Aseptic homogenizer construction consists primarily of a means of confining the plungers in an atmosphere where sterility is maintained (usually by means of steam.)

The cylinder is constructed with one steam fitting which supplies steam to each sterilizing chamber through one common steam cavity connecting all plunger bores. The steam is directed into each plunger bore and confined between sets of primary and secondary high temperature plunger packing.

The primary packing assembly is spring loaded and is used to seal the product being pumped in the pumping chamber. It is also used to form a part of the steam sterilizing chamber.

The secondary packing assembly is also spring loaded and helps to complete the individual steam chamber around each plunger.

The depth of the cylinder is designed to prevent any part of the plunger, normally in contact with the product, from being withdrawn from the sterile chamber.

The customer should supply the steam line, including pressure reducing valve, check valve, globe valve, pressure gauge, and strainer to the ¼" N.P.T. fitting supplied in the top of the cylinder. Condensate piping and trap are included with the machine and are factory connected to drain line.

For sterilizing the cylinder, wet steam or hot water at temperatures up to 300°F. is normally used. Because of the high temperatures and the lack of lubricity behind the product plunger packing, the best high temperature plunger packings available will not give service approaching that of standard plunger packing used in processing food products. Accordingly, these machines are supplied with hard chrome-plated plungers which are highly polished for best packing life.

In operation, steam at 10 to 15 psig is fed into the top of cylinder and the condensate is removed through the built-in steam trap. Never allow steam pressure to exceed product infeed pressure while processing.

In order to help prolong packing life, steam feeding to plunger seals must be stopped during in-place cleaning cycles.

STEAM SUPPLY AND ASEPTIC CYLINDER ASSEMBLY DETAIL

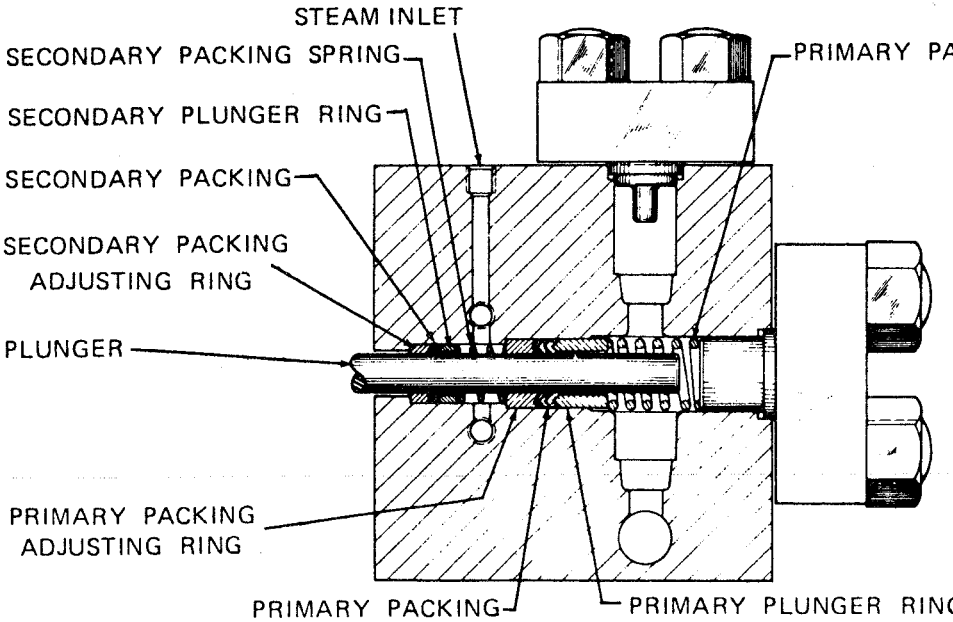


Figure 15

RECOMMENDED REGULAR MAINTENANCE SCHEDULE

DAILY INSPECTION

1. Check oil level, visible through oil level sight glass on back of machine, and add oil if required.
2. Drain condensate from oil sump through petcock on back of machine.
3. Check oil pressure (20 - 40 PSI) and adjust, if necessary. See page 12.
4. Check water lubrication and cooling system.
5. Check for any leaks from cylinder or base.
6. With machine running, listen for any abnormal sound.

MONTHLY INSPECTION

1. Check tightness of all bolts, nuts and fittings.
2. Check oil pressure and adjust if necessary. See page 12.
3. Check for oil leaks.
4. Check water lubrication and cooling system.
5. Check belt tightness and adjust if necessary. See page 14.
6. Disassemble and inspect all homogenizing valve and cylinder parts for wear and damage.
7. Inspect seals or packing around plunger adapters and replace if necessary. On adjustable type, tighten adjusting nut.
8. Replace all gaskets and packing.
9. Inspect all gasket counterbores and repair if needed.

SIX MONTH OR YEARLY INSPECTION

1. Drain oil, clean crankcase, gear case, and oil level sight glass. If machine uses oil filter, replace cartridge. Fill with oil to proper level. See page 13 for frequency of oil change.
2. Repeat all monthly checks.
3. Lubricate motor bearings according to manufacturer's instructions.
4. Inspect connecting rod bearing inserts for possible wear or damage. Replace if necessary. See pages 41, 46 . M3 models are not equipped with replaceable inserts.
5. On all MC Model machines, inspect and adjust crosshead ball joints. See page 47.
6. Re-torque front cylinder cap studs. See page 31 for procedure.
7. Re-torque crosshead bearing ball into connecting rod. See page 47 for correct torque.
8. Tighten cylinder to base.
9. Check operation of low-oil pressure switch.
10. Report mishandling of parts to supervisor.

MAINTENANCE PROCEDURES

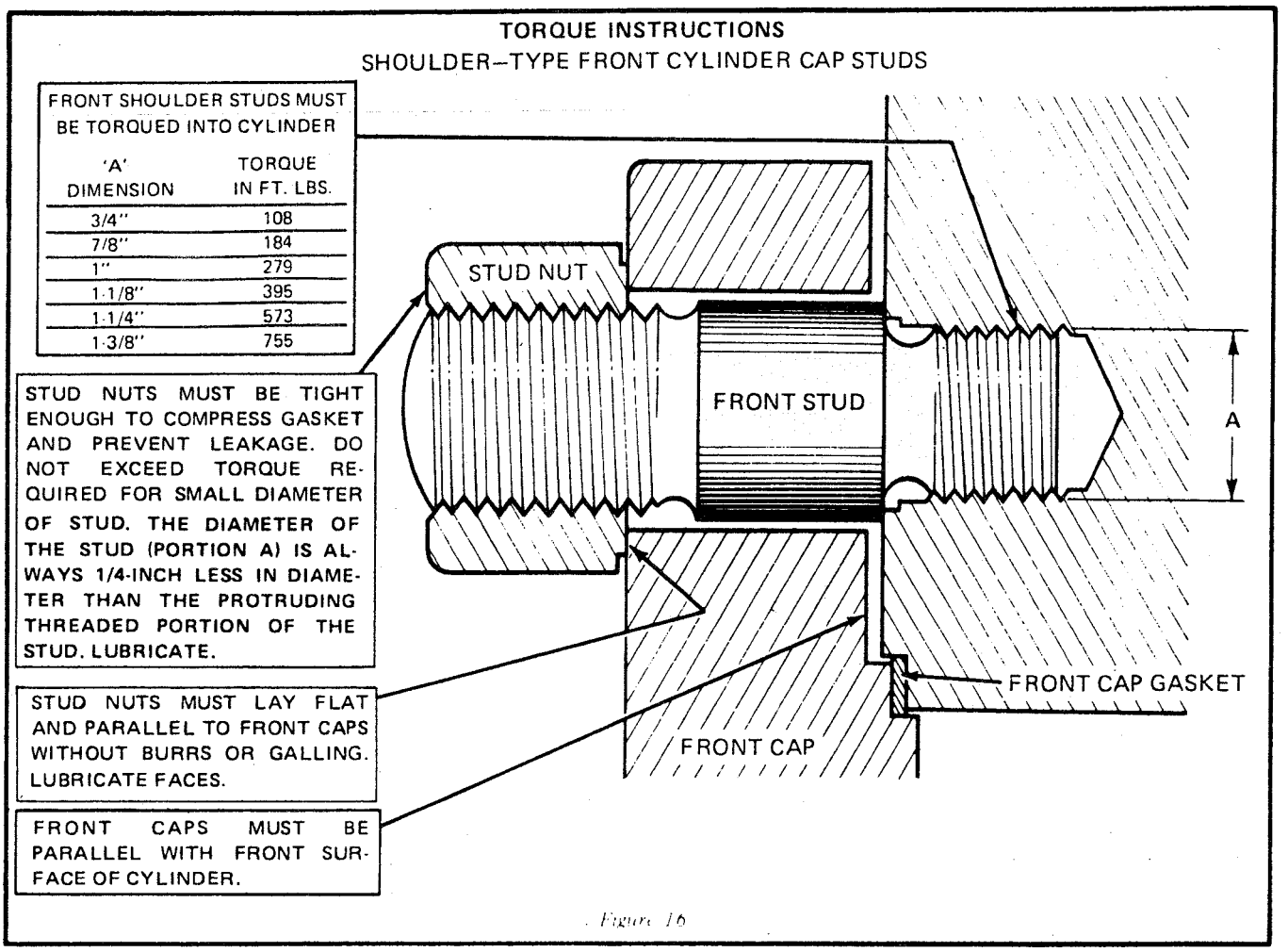


Figure 16

FLUID-END MAINTENANCE - ALL MODELS

TORQUE INSTRUCTIONS

All current machines are furnished with shoulder-type front cylinder cap studs which have been properly torqued at time of factory assembly. It is important to re-torque each stud every six months. Correct installation and torque data is illustrated above.

PLUNGER PACKING MAINTENANCE

Leakage through the plunger packing is the result of worn packing, usually caused by the following: worn packing adjusting rings, worn or misaligned plungers, packing material unsatisfactory for high temperature or highly abrasive conditions, insufficient compression of the packing. Even new packing blows out from shock loading.

1. Packing adjusting rings are made of nylon, nickel alloy, or bronze, depending on the duty required. Any type of ring should wear faster than the plunger. Plunger rings are always of stainless steel with a minimum clearance of .040" over the plunger. No metal contact between sliding members, when both are made of stainless steel, can be permitted without immediate damage.

2. Plungers are available in 18-8 S.S., hardened 17-4 PH S.S., hard chrome plated S.S., Colmonoy coated, solid ceramic as standard construction, and of special materials as well, depending on the duty requirements. For liquid, non-abrasive product 18-8 S.S., which is relatively soft, is completely satisfactory. Abrasive products require harder materials. High temperature packings demand highly polished, hard surfaced plungers.

When new, clearance between the plunger and metal packing adjusting rings is .002". When this total clearance reaches .010", one or both parts should be replaced. A split in the center of the "V" or the inner lip of a nylon ring worn over 1/32" below the outer lip, will require immediate replacement.

When plungers show lengthwise scoring which is cutting out the packing, mount them in a lathe or drill press chuck and polish for several minutes with 180 grit emery cloth.

3. Standard "V" rubber or cotton duck and styrene rubber packings are recommended for use only up to 185°F. Operation at 200°F. will greatly reduce their useful life. Other packing materials are needed to withstand chemical action, or abrasive materials. Consult factory for availability of materials for unusual duties.

4. The packing spring is self-adjusting, but in time it can take a permanent set. If the packing is allowed to move back and forth with the plunger it will fail quickly and the packing spring must be replaced.

NOTE: The Tapered Ball Valve Seat Cylinder (TBA) features a packing adjustment screw. For proper adjustment, refer to plate C213D, Pages 71-73.

5. Although plungers are interchangeable, it is best practice to maintain the same assemblies in each location. Lubricate threads prior to assembling and avoid denting shoulders of plungers as this creates misalignment.

PUMP VALVE SEATS

The seats for the suction and discharge valves in the cylinder are of three types:

1. "PS" cylinder construction indicates that the seats are integral with the stainless steel cylinder. They will develop small pits on seating areas during the work hardening process. This will continue for the first 1,000 hours or so. They can also show indentations from undissolved particles in the product. When lapping of valves to their seats is necessary, use automotive, medium-grit, water-soluble valve grinding compound.

2. "TPS" cylinder construction uses Rexalloy (stellite) field removable valve seats with 17-4 PH hardened poppet valves. If erosion grooves form across the seating surface, use tool item (K) , to remove seats. Remove round nut on bottom, insert rod down through seat, hold round nut with (M), screw rod into nut, slide rubber cushion ring over rod, follow with metal spacer block and top nut. Tighten upper nut until seat is pulled out of taper. If loose for any reason, they will create a pounding sound. For regrinding, Gaulin recommends that seats be returned to factory.

   In replacing seats make certain that tapers on seats and cylinder bores are clean. Pack seats in dry ice or immerse in an alcohol dry-ice mixture for 20-30 minutes. Install in cylinder by tapping into place with a piece of wood or brass. Since any leakage between the seats and the cylinder bores will create serious damage, extreme care should be used in assembling the seats.

3. "TBS" cylinder construction uses field removable valve seats with Rexalloy (stellite) ball valves. Except for sizes and shape, they are the same and should be treated as described above. Sub Micron Disperser (SMD) units use tungsten carbide seats.

For valve seat refacing in the field, Rexalloy seats may be refaced on a lathe using carbide tool kit, and that Carbide seats should be refaced by special grinding shops.

PUMP VALVES

These are of several materials and designs:

1. 18-8 stainless steel valves are standard in "PS" cylinders only. Pitting which develops across seating surfaces, as described above, will usually not affect pumping operation, unless they become linked to form a by-pass across the seat area. If this occurs, valve and seat must be refaced. Grinding kits are available for purchase, and valve seat refacing tools are available on a rental basis. If used, the valves will have to be lathe turned to a true 45° angle and then lapped to the seats.

   If poppet valves hang up or stick, the cause is either product build-up or a burr at the bottom of the 45° angle cylinder valve seat.

2. 17-4 PH hardened stainless steel valves are standard in "TPS" cylinders. They will withstand much more abrasion than 18-8 valves. If problems develop, treat them the same as 18-8 S.S. valves.

3. Rexalloy (stellite) ball valves, used in "TBS" construction only, should be inspected regularly. Pits, dents or surface cracking will quickly lead to erosion of the valve seats and the ball valves should, therefore, be replaced promptly. Sticking or hanging up usually indicates product build up or insufficient clearance between ball valves and ball valve guides for the viscosity of the product being handled. Abnormal noise, pressure gauge fluctuation and uneven pumping are associated with valves sticking.

CAPACITY CHECK

Capacity measurements should be made with cold water only. They should be made with the machine disconnected from the normal processing system. Any by-pass lines should be removed. The suction line should be dropped in a tank from which an adequate supply of water can be made available. All water should be discharged through the valve system and piped in such a way that a vessel of known capacity will collect all of it. The suction line should be gasketed at each joint.

1. Start the machine and run until all air is expelled from the infeed pipe and cylinder.

2. With all pressure off, direct the discharge into the measuring vessel and time the fill with a stop watch. 2000 gph or lower can be measured successfully in a 10 gallon can. Divide 36,000 by the number of seconds for U.S.G.P.H.

3. Repeat at maximum pressure. If more than a 3% difference occurs, the problem may lie in the condition of pump valves and seats, or belt slippage. (Use 5% for TBS.) In addition, product compressibility may be a factor, or there may be gas in the product.

PRODUCT PRESSURE GAUGE

Gauge problems are primarily due to improper care in handling the gauge, or severe shock loading caused by operating either with air in the product or with inadequate infeed pressure.

1. A pressure/amperage curve (see page 21) is useful for rechecking gauge accuracy. Many users permanently install an anmeter in the motor line as a double check on the gauge.

2. Repeated gauge failures indicate possible abnormal operating conditions which should be checked out. If no abnormal conditions can be found, improved gauge life (up to 5 times) has been obtained by installing a remotely mounted gauge. These units come equipped with a five fast long capillary tube with a sensing bulb which fits the standard gauge block on the machine.

HOMOGENIZING VALVE PARTS

VALVE ROD – Whether the valve rod is used with either manually or HVA controlled valves, it must be kept straight and free from burrs, so it can move freely within the valve body. If it binds, pressure cannot be properly controlled. If burrs develop, polish rod with 180 grit emery cloth and also polish the holes through which it travels. Always lubricate rod prior to assembly.

VALVE ROD PACKING – This packing serves two purposes. The first is to seal against product leakage. The second is to dampen down the motion of the valve rod. When the packing becomes worn, it allows rapid oscillation of the valve rod, accelerating wear and affecting pressure control.

VALVE SPRING – Valve springs can take a set, break, and although they are plated, can corrode and weaken. They should always be heavily lubricated with grease upon assembly and the valve rod washer must be installed between the spring and the handwheel.

HANDWHEEL AND HANDWHEEL SUPPORT – Other than an occasional check on the condition of the threads, and lubrication prior to assembly, no maintenance is usually required.

VALVE AND VALVE SEAT – The valves will be of Rexalloy (stellite), tungsten carbide, or similar very hard materials. The wear patterns shown on page 34 will apply to all materials and all configurations. Valves and valve seats must always have a continuous contact area around the full circumference on valve and seat. If this contact is broken at any point, as illustrated on figure 19, item 5 the valve and seat require relapping or regrinding.

1. Rexalloy (stellite) valves can be lapped in your plant using a standard oil mixed grinding compound, medium grit. Piloted valves (ones in which there is a 3 or 4 sided pilot which enters the hole in the valve seat to keep the valve face parallel with the seat) are ground to each other. Apply a small dab of compound at three places on the seating surface. Either hold the parts in your hands and rotate them together or secure them in a lathe chuck, turning at slow speed. Caution: keep the compound away from the wings of the valve pilot to avoid increasing the diameter of the valve seat hole. Repeat process, adding compound as required until seating surfaces are restored to approximately the Number 2 pattern shown in the Wear Pattern Guide (next page.)

2. For valves and seats of the unpiloted type, apply the same type of automotive valve grinding compound. Lap each piece separately by rotating them in a circular motion against a smooth, flat, hard surface such as a piece of heavy plate glass.

3. Tungsten Carbide or Kennemetal valves and seats are the hardest metal available and require a diamond lapping compound which is available from Gaulin in 2-gram tubes. A small amount of this compound on the seats will show a mirror finish at the contact areas after lapping. Any break in the mirror finish indicates that the valve and seat will require regrinding.

4. When seating surfaces are permitted to develop erosion channels, as shown on pattern number 5, they cannot be corrected by lapping and Factory regrinding will be required.

IMPACT RINGS – These are available in Rexalloy (stellite) and other materials and are designed for one or both of two purposes. They help prevent the high-speed stream, upon leaving the faces of the valve and seat, from cutting deep grooves in the stainless steel valve bodies. In the homogenizing process, the impact ring plays an important role in helping to further break up the product particles striking it. When the groove or grooves on the inside of the ring are worn to a depth of approximately 1/32" to 1/16", the part should be replaced to maintain efficient homogenization.

VALVE SEAT GASKETS – These, as well as all other gaskets in the fluid end of the machine, are available in several materials to handle the specific duty required. Replacement is only required when leakage develops.

TYPICAL TWO-STAGE HOMOGENIZING VALVE ASSEMBLY

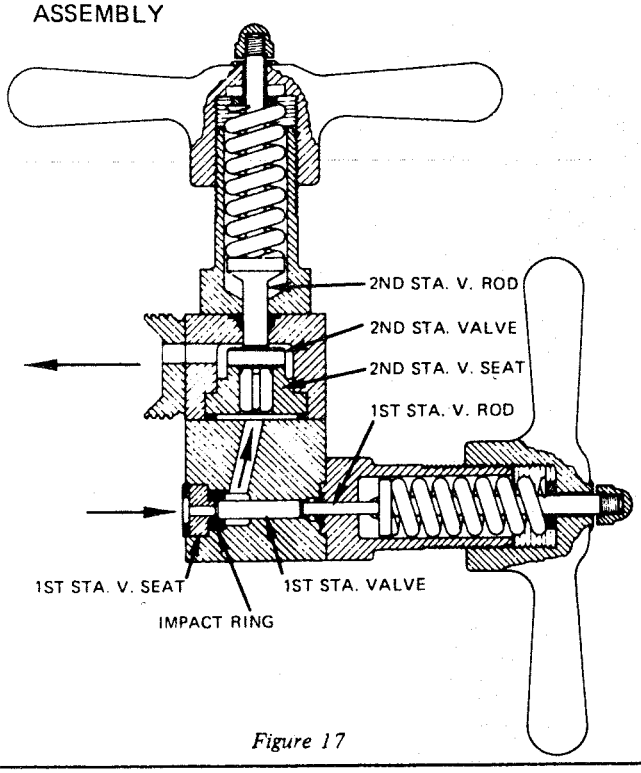
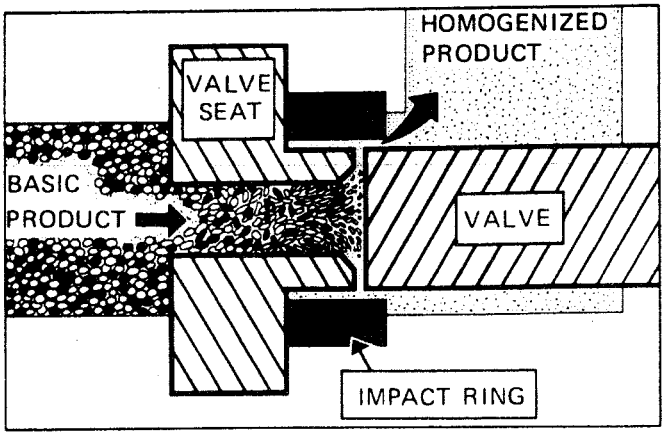


Figure 17

THE GAULIN HOMOGENIZING VALVE EXPLAINED

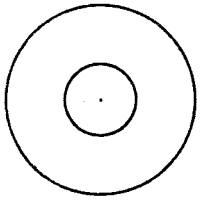


A Gaulin homogenizing valve section as basic product enters the area at high pressure. The pressure forces open the pre-loaded adjustable valve and the product passes through the aperture where an instantaneous pressure drop to less than atmospheric occurs, causing shearing action and cavitation bubbles. The product then strikes the impact ring at a velocity of 57,000 ft./min., further shattering the particles by impact and implosion of the bubbles. The homogenized product is discharged at a pressure sufficient for movement to the next processing stage.

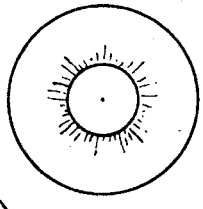
Figure 18

HOMOGENIZING VALVE WEAR PATTERN GUIDE

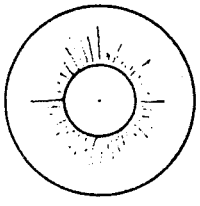
Standard commercial finish is satin in appearance. Where required, valves can be factory mirror finished as an optional extra.



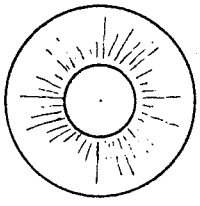
1. NEW VALVE – Complete bearing across whole face



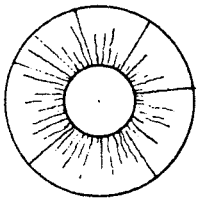
2. USED VALVE – 1/2 of face still bearing – no channels
   – in excellent condition



3. USED VALVE – 3/4 of face gone – no erosion
   – still good but watch for channels



4. VALVE READY FOR REGRINDING – Approx. 7/8 of face gone
   – failure of valve can occur at any moment



5. EROSION GROOVES – Radial grooves due to erosion at any stage of wear – valve must be reground for proper operation regardless of other face conditions

Figure 19

OIL CHANGING

Frequency of oil changing depends on the type of service required. (Oil specifications are found on page 12).

On intermittent service, change oil every 500 operating hours or 6 months, whichever comes sooner. Always change oil if it has become emulsified with water.

On continuous service, if oil is free of contamination and emulsification with condensate, it can be used for 2000 hours.

After draining oil alway clean oil compartment (use steam, kerosene, etc.). Change oil filter cartridge and clean the primary strainer on bottom of pump inlet pipe (if three items are supplied.)

NOTE: Excessive water on oil sump is caused by: leaking oil cooler, worn baffle seals or packing, defective top cover gasket, or excessive humidity.

1. Check oil cooler by disconnecting one oil line fitting and turning on the cooling water. If cooler leaks, water will come out oil connection.

2. Check baffle seal or packing by removing top covers, stand at side of machine, and direct a stream of water from a hose at the baffle seal area toward the back of the machine. Observe if water comes through into the oil compartment. Adjust or replace as necessary.

3. Check top cover gasket visually and replace if needed.

4. Excessive condensation can develop if cooling water is very cold. It will be seen as puddles of water standing on flat surfaces when top cover is removed and as drops hanging from underside of top cover. Raising water temperature and/or insulating under top cover are methods of correction.

MOTOR LUBRICATION

Motor bearings should be lubricated only as instructed by the motor manufacturer. Too much lubrication is more damaging than too little. With the manufacturer's recommended grease, remove plugs on top and bottom of both bearings. Pump grease into bottom and allow old grease to flow out top. Install bottom plugs but leave top ones out until motor has run long enough to be at maximum operating temperature. Excess grease will have then expanded and run out top opening. Reinstall top plugs.

OIL PUMP AND RELIEF VALVE ADJUSTMENT

The lubrication oil pump is mounted on a pad in the drive compartment and is driven by a gear on the driveshaft. The relief valve is either built- in, attached to the pump or mounted in the oil pump's discharge piping. The assembly consists of a poppet valve held against an integral valve seat by a spring, an adjustment screw, a copper washer and a hex-sided cap.

1. Oil pressure is raised by removing the cap and turning down (clockwise) on the screw to increase spring tension against the poppet valve.

2. If pressure cannot be increased, remove the adjusting screw, the spring and the valve. Check the seating surfaces of the valve and seat.

3. If the problem still persists, check all oil line fittings for tightness and cracks, all lubricated points for excess oil loss due to wear, and packing gland on oil pump shaft for tightness. Replace oil pump only as a last resort.

OIL PUMP GEARS

If pump drive gears fail, split oil pump driven gears are available for MC models as replacement parts. This eliminates the need to remove the driveshaft and driveshaft bearing.

LOW OIL PRESSURE SAFETY SWITCH

This switch is connected to the lubrication system and is electrically connected to the motor starter. (See pages 14 and 15). Its function is to shut the machine down if the oil pressure drops below the set point. The machine will not restart until the oil pressure rises above the set point. To adjust:

1. Remove the switch cover plate which is held on by four screws.

2. Adjustment is made by turning the knurled nut up or down.

3. The point at which the oil pressure will stop the machine should be checked at least every six months. Remove top covers from the machine and install a cardboard or sheet metal guard over the gears to stop oil splash. Start machine and loosen an oil fitting to allow the oil pressure to drop gradually. As it drops, observe the point on the gauge at which the machine shuts down.

OIL TEMPERATURE

In continuous operation the oil temperature can safely run as high as 155°F. When a question arises regarding oil temperature, measure the actual oil temperature before contacting the factory. Do not guess. Unless the room temperature is very high, oil temperature during normal plant operation will be under 140°F.

1. If oil temperature is abnormally high, the first question to be resolved is whether the heat is coming from the motor or from friction in the drive end. If the motor compartment temperature is below the oil temperature, the problem can be assumed to be in the oil compartment drive components.

2. High oil temperature can be caused by: high oil pressure, too tight or too rough bearing surfaces, incorrect oil.

3. Check (page 12) for oil information and the following pages for information on the drive parts.

MODEL M3 ONLY

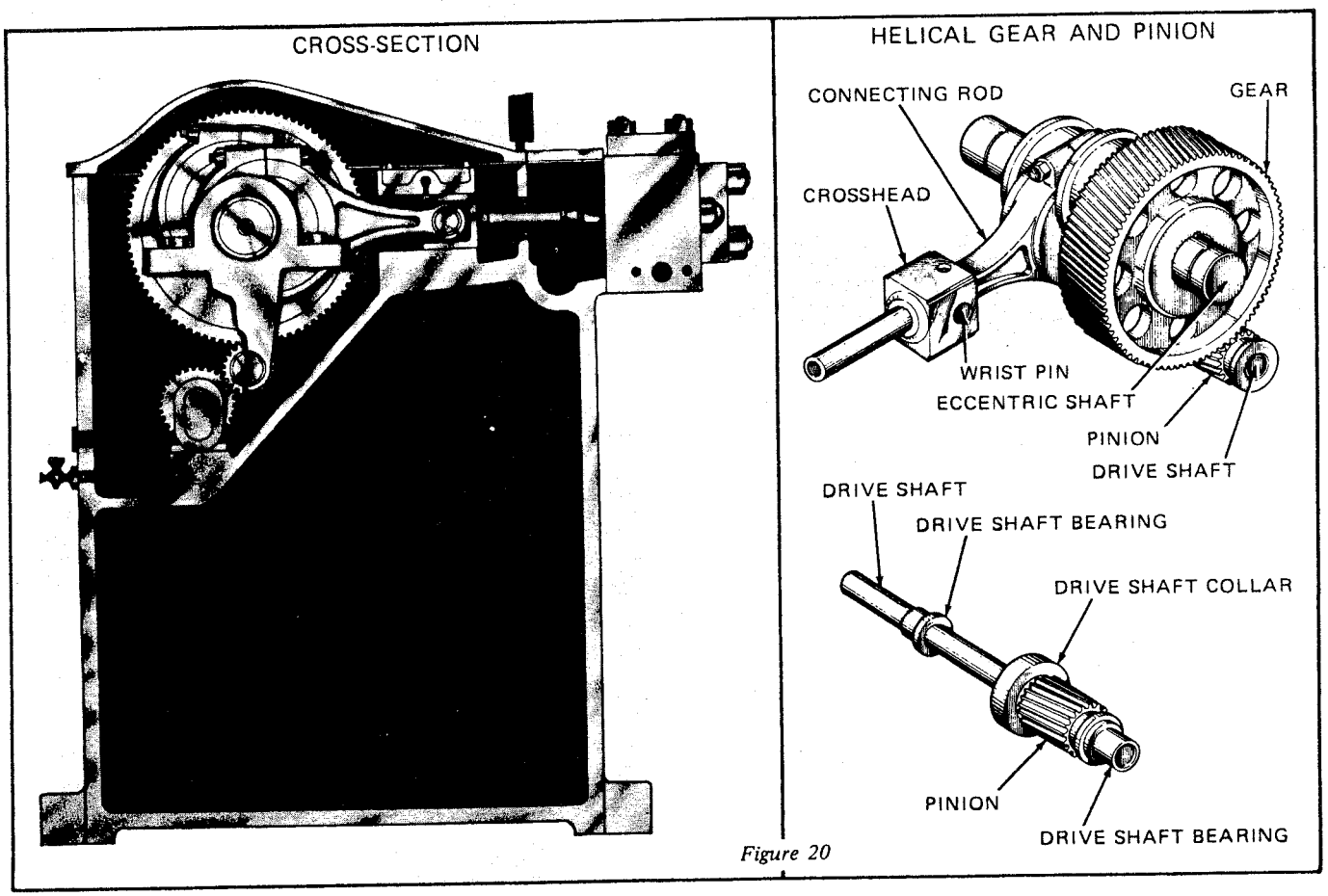


Figure 20

HELICAL GEAR & PINION (Figure 20, Plates B164, B165)

1. Normal rotation of the large gear is counter-clockwise, when observed from the gear side (right side) of the machine.

2. It may become necessary, because of wear or excessive gear noise, to replace the gears. Do not attempt to reverse rotation without contacting the factory. Helical gears create an end-thrust and are designed to take this thrust in only one direction.

3. Gear wear will occur naturally over a long period of usage. It usually takes the form of a developing series of small pit marks on the working side of the gear teeth. Obviously, this wear will be greatly accelerated by using the wrong oil, failure to drain condensate and water from the oil, or overloading the machine.

4. Overloading will occur if maximum operating pressure is exceeded, if product contains entrained air, or if the machine is partially starved through lack of sufficient infeed pressure. A "knock" in the machine usually indicates the presence of air or insufficient infeed pressure, but only when there is a serious amount of air or starvation. Serious trouble can still be caused by, air or poor infeed pressure when the knocking sound is only faintly audible.

5. Gear noise will develop with gear wear. It will appear as a "growl" or "rumbling" sound and will be synchronous with one revolution of the large gear (one full stroke of one plunger). It usually becomes louder when pressure is applied to the machine.

   a. Clearance between the gear, driveshaft bearing and pinion gear is determined as follows:

      1. Remove top cover and belt guard cover.

      2. By hand turn large driven sheave, on end of driveshaft, back and forth pushing sheave and driveshaft in as far as it can go.

      3. Remove Allen Set Screw (item #13) in Driveshaft Collar (item #12) and slide collar to the right against end thrust bearing in the pillow block. Lock set screw. Be sure that there is approximately 1/32" of end play in the driveshaft.

      4. If the position of the driveshaft was moved to any significant extent, recheck the alignment of the drive and driven sheaves, correcting if necessary.

   b. If there is no significant gear wear evident, check clearance in the eccentric shaft bearing on gear side as follows:

      1. Using a crow bar attempt to force gear upwards, away from pinion. Since the normal total oil firm clearance in the eccentric shaft bearings is .001" per inch of diameter, it can now be determined if there is excessive lift (indicating excessive bearing wear, rather than gear wear).

6. If gear teeth are worn, the gears can be replaced. Because it is never good practice to replace only one half of a set of gears which have run together for any length of time, it is strongly recommended that both the pinion and large helical gear be replaced at the same time.

   a. Removal of large gear can be accomplished as follows:

      1. After top cover, belt guard and motor compartment door are removed, loosen and remove "V" belts by loosening motor Adjustment Screw Check Nut (item 48).

      2. Loosen driveshaft collar and pinion gear by removing set screws.

      3. Remove Driven Sheave (item 26) and Key (item 23).

      4. Pull drive shaft out, being careful to remove pinion key.

      5. Remove the three Connecting Rod Caps (item 73) being careful to keep the shims with each cap in order, so that they can be replaced in exactly the same location.

      6. Remove the gear oil-guard and slide the connecting rod assemblies toward the front of the machine away from the eccentric shaft.

      7. By means of a chain fall, lift clear of the machine the entire assembly, consisting of the eccentric shaft, eccentric gear and the two pillow blocks. CAUTION: The pillow blocks, containing the eccentric shaft and driveshaft sleeve bearings, are free to slide off and should be held in place until the assembly is placed on a table or floor.

      8. The large gear is a press fit and can be removed with an arbor press or gear puller.

DRIVESHAFT ASSEMBLY (Figure 20, Plates B164, B165)

The driveshaft assembly consists of the Driveshaft (item # 11) a Driveshaft Collar (item # 12) and the Pinion Gear (item # 61). The collar and pinion gear are removable and are held in place by means of Allen set screws.

1. The driveshaft is supported in two bronze, flanged, Sleeve Bearings (# item 83) which are held in removable Pillow Blocks (item 80).

2. Shaft removal can only be made toward the V-belt sheave side of the machine.

3. The oil pump is mounted on a pad and turned by the oil pump Driven Gear (item 7) which meshes with the driveshaft pinion.

4. The bronze sleeve bearings are a press fit in pillow blocks. They can be installed after drilling oil holes by shrinking in dry ice. Alternatively, they can be installed with an arbor press, but the oil hole should be drilled after installation. Bearings are prevented from turning by means of an Allen set screw tightened in a tapped hole between the bearing and the bearing housing.

ECCENTRIC SHAFT & BEARINGS (Plate B165)

The eccentric shaft is made from a heavy, one-piece high-strength alloy casting.

1. The shaft runs in two full, bronze sleeve-type bearings. The bearings are prevented from turning by means of an Allen set screw tightened in a tapped hole between the bearing and the bearing housing. They can be installed as described above.

2. The shaft is gun drilled and oil is pumped through the center of the shaft and out to each cam so that the connecting rod bearings ride on a cushion of oil under pressure. There is a plug in the end of the shaft.

3. If bearing replacement is ever required after installation, in order to obtain the necessary oil film clearance (about .003" minimum) they probably should be reamed or honed.

4. In the event of damage to bearing surfaces on the cams or end journals, do not turn them undersize in a lathe. This would require specially sized bearings, which are not available.

   a. If surfaces are only slightly grooved, the roughness can be removed using strips of emery cloth.

   b. Even though they still show light grooving, they can be safely used because the grooves merely trap oil, just as does an oil groove in a sleeve bearing. The important thing to remember is that elevated ridges of metal, thrown up when the groove developed, must be removed by emery cloth or draw filing.

   c. If surfaces are severly damaged or undersized, the best method of repair is to have them metalized and remachined to original size.

CONNECTING ROD & CROSSHEADS (Figure 20, Plate B165)

The connecting rod sub-assembly consists of the two halves of the Connecting Rod (items 73 & 85) two bolts with Lock Nuts (items 84 & 72) two sets of Laminated Shims (.003" thick) (item 74) and the Wrist Pin Bearing (item 86). The crosshead is a single piece with the plunger adapter integral to it. The wrist pin is separate and must be ordered as an individual item.

1. The connecting rods are of cast iron with adjustment for oil film clearance being made by means of the laminated shims. The proper clearance is .001" per inch of diameter. When connecting rods or crossheads are removed, always be sure to install them with the oil hole on top. The oil hole in the connecting rod is drilled through the wrist pin bearing.

2. After connecting rod bolt lock nuts are removed & replaced a number times, the lock nuts will begin to slip and loosen up. When annual or semi-annual inspection reveals this, replace promptly with new ones.

3. The crosshead clearance for oil film is .002" to .003" between each surface (measured dry). The pressure lubrication system pumps oil down through the crosshead cover plate, through the hole in the top of the crosshead and into the hole in the connecting rod to lubricate the wrist pin and bearing.

4. Wrist pins are a press fit in the crossheads. When assembling them, some crosshead metal, around the wrist pin hole, is sometimes upset and should be cleaned up with a few strokes of a fine mill file.

PLUNGER ADAPTER & BAFFLE SEAL PACKING (Plate B165)

The plunger adapter on this model is part of the crosshead and cannot be removed or replaced separately. The very critical plunger alignment starts with the crosshead. It is, therefore, important that the adapter not be bent and the threaded end be square and undamaged.

1. The shoulder of the plunger, tightened against the shoulder of the threaded end of the adapter, extends the alignment from the crosshead.

2. Damage to the threads of the relatively soft nickel alloy should generally be repaired by cutting away the damaged thread. A tap can be used to correct the thread.

3. The baffle packing consists of an oil seal with the lips facing toward the plunger well to stop the entrance of water. These can be installed without damage by using the Packing Assembly Tool (Page 10), item 0 after the cylinder block is removed.

4. To remove the connecting rods from this model, after the connecting rod caps have been removed, it will be necessary to loosen up the acorn nuts holding the cylinder block to the frame and either totally remove cylinder or move it away from the frame about two inches.

MODEL M6, M12 CROSS-SECTION

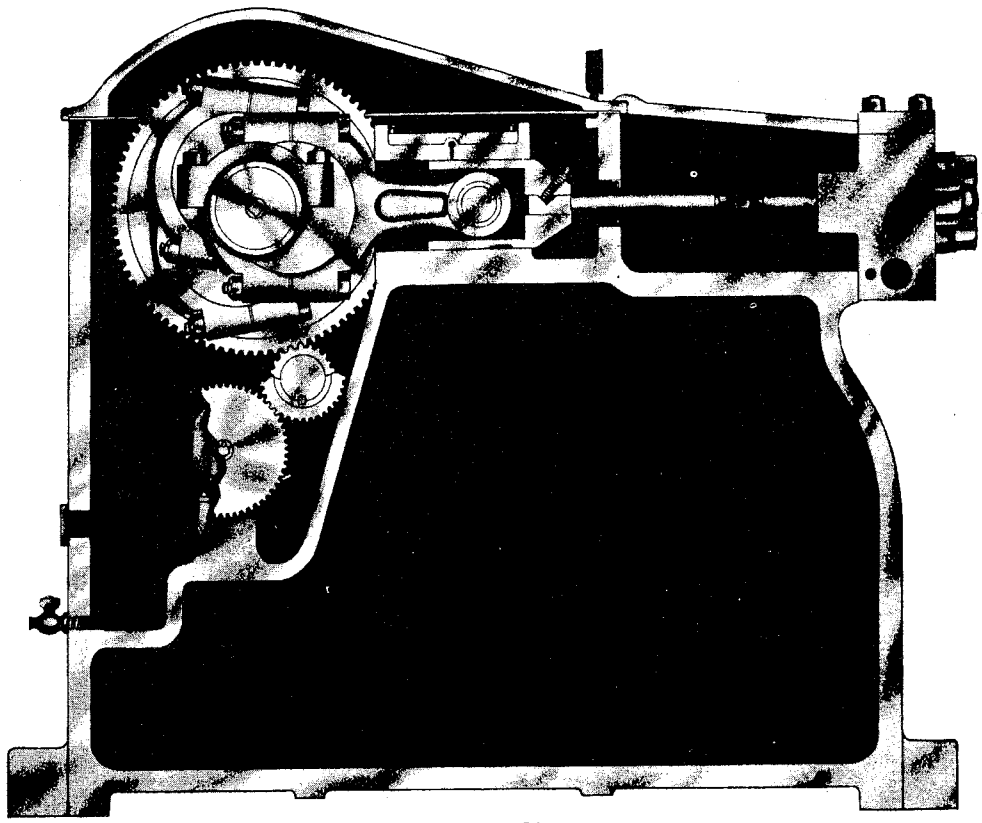


Figure 21

HERRINGBONE GEAR & PINION – MODELS M6, M12

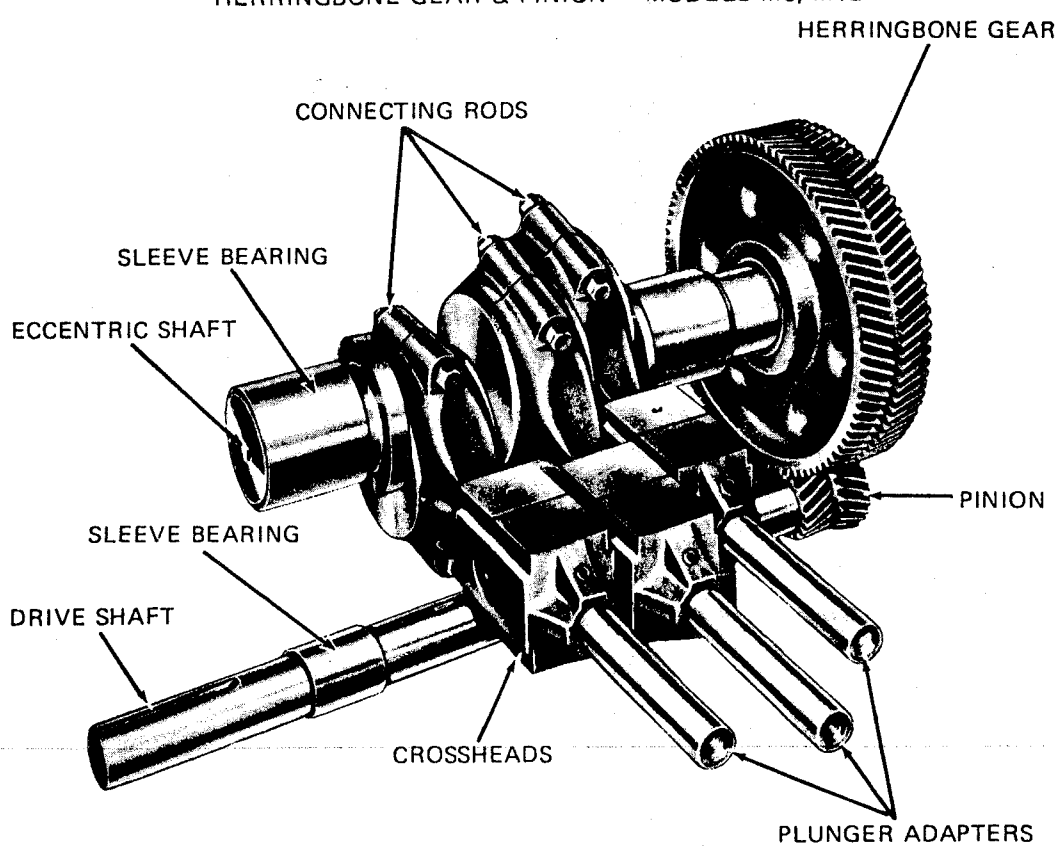


Figure 22

MODELS M6 & M12 HERRINGBONE GEAR & PINION (Figure 22, Plates B166, B167)

1. Normal rotation of the large gear is counter-clockwise, when observed from the gear side (right side) of the machine.

2. If it becomes necessary because of wear or excessive gear noise, rotation can be reversed so that the new, undamaged side of the gear teeth will carry the load. To reverse rotation, change any two motor leads (in a three-phase circuit) thus, changing motor direction. Also, interchange suction and discharge line connections at the lubrication pump. The relief value must always be located on the discharge side.

3. Gear wear will occur over a long period of useage. It usually takes the form of a developing series of small pit marks on the working side of the gear teeth. Obviously, this wear will be greatly accelerated by using the wrong oil, failure to drain condensate and water from the oil, or overloading the machine.

4. Overloading will occur if maximum operating pressure is exceeded, if product contains entrained air or if the machine is partially starved through lack of sufficient infeed pressure. A "knock" in the machine usually indicates the presence of air or insufficient infeed pressure — but only when there is an extremely serious amount of air or starvation. Serious trouble can still be caused by these factors when the knocking sound is only faintly audible.

5. Gear noise will develop with gear wear. It will appear as a "growl" or "rumbling" sound and will be synchronous with one revolution of the large gear (one full stroke of one plunger). It usually becomes lounder when pressure is applied to the machine.
   a. Clearance between gear and pinion should be checked by measuring driveshaft end-play as follows:
      1. Remove cover on belt drive side.
      2. By hand, turn large driven sheave, on end of drive shaft, back and forth while pushing sheave and driveshaft in as far as it can go.
      3. With a pencil, mark the driveshaft against the drive shaft oil drain cover plate.
      4. Pull the sheave and driveshaft back, out away from the base as far as it can go, turning it back and forth at the same time.
      5. Again mark the shaft.
      6. Measure the distance between the two marks. The minimum should be 1/32", with 3/32" the maximum before excess gear or bearing wear is indicated.
   b. If drive shaft end-play is excessive, even though gears do not appear worn, check clearance in eccentric shaft bearing on gear side as follows:
      1. Remove covers to expose large gear.
      2. With a crow bar, attempt to force gear upwards, away from pinion. Since the normal total oil film clearance in the eccentric shaft bearings is .001" per inch of diameter, it can be now determined if there is excessive lift (indicating excessive bearing wear — rather than gear wear.)

6. The pinion gear is heat shrunk on the driveshaft and is not removable. Because it is never good practice to replace only one half of a pair of gears which have run together for any length of time, it, therefore, means that the gear, pinion and driveshaft should be replaced, when one part requires it.

7. Herringbone gear removal is best accomplished with a hydraulic puller and pusher. The end of the eccentric shaft on the gear side is drilled and tapped to accept a threaded rod to aid in pushing gear on. A 30-ton unit is satisfactory. An alternate method is to take the shaft to a shop where the gear can be removed and replaced in a large arbor press.

8. If pinion and driveshaft assembly is also to be removed when the driven sheave, (item 18) has been removed, the driveshaft assembly will slide out with the large gear as the gear puller moves the gear out.

DRIVESHAFT ASSEMBLY (Figure 22, Plates B166, B167)

The driveshaft assembly consists of the driveshaft with a pinion gear heat-shrunk in place. It is supported in two babbitt-lined full bronze sleave bearings.

1. The assembly can only be removed and replaced from the gear side.
2. The driveshaft floats to find its own position, dictated by the mesh of the herringbone gears.
3. The sleave bearings are a drive fit in the housings and are secured against turning by a set screw in a hole which is drilled and tapped, half in the bearing and half in the bearing housing, parallel with the bearing.
4. Remove old bearings (after removing set screws) with a puller made with a threaded rod, washers

and nuts, to serve as a jack screw. They can also be removed with a block of hard wood and a sledge hammer.

5. Make sure oil holes are located properly in new bearings. Shrink them in dry ice for 30 minutes. Bearings can be then installed quickly with oil holes lined up. Drill, tap and install new set screws.

6. Babbitt-lined bearings must be scraped rather than honed. The oil film clearance is the standard "rule of thumb", .001" per inch of diameter.

7. When finally installing driveshaft, make sure that the gear is lined up properly with the oil pump driven gear.

8. To remove driveshaft and pinion only, loosen or remove eccentric cap bearing screws and lift, with a chain fall or bar, eccentric gear up out of mesh with pinion. After driven sheave is removed and oil pump driving gear set screw is loosened, the assembly then can be pulled out toward pinion side.

ECCENTRIC SHAFT & BEARINGS (Figure 22, Plate B167)

The eccentric shaft is a heavy, one piece, high strength alloy casting.

1. The shaft runs in two babbitt lined, full, bronze sleeve bearings. The bearings are located in place by means of dowels in the bottom of the bearing housings.

2. The shaft is gun-drilled and oil is pumped through the center of the shaft and out to each cam so that the connecting rod bearings ride on a cushion of oil under pressure. There is a plug on one end of the shaft.

3. If bearing replacement is ever required, note that the fit of the bearings in their housings requires a slight squeeze when bearing caps are pulled down tight. This requires careful checking of oil film clearance which should be .001" per one inch of diameter minimum. NOTE: babbitted bearings must be scraped, not honed.

4. In the event of damage to bearing surfaces on the cams or end journals, do not turn them undersize in a lathe. This would require specially sized bearings which are not available.

   a. If surfaces are only slightly grooved, the roughness can be removed using strips of emery cloth.

   b. Even though they still show light grooving, they can be safely used because the grooves merely trap oil, just as does an oil groove in a sleeve bearing. The important thing to remember is that elevated ridges of metal, thrown up when groove developed, must be removed by emery cloth or draw filing.

   c. If surfaces are severly damaged or undersized, the best method or repair is to have them metalized and remachined to original size.

CONNECTING ROD AND CROSSHEADS (Figure 22, Plate B167)

The connecting rod sub-assembly consists of two halves of the Connecting Rod (Items 74 & 89), a set of two steel backed, babbitted Bearing Halves (Item 81) two Bolts with lock nuts (90 & 75) and a Wrist Pin Bushing with set screw. The crosshead sub assembly consists of the Crosshead (Item 86) two Wrist Pin Set Screws (91) and one Adapter Set Screw (Item 93). The wrist pin is not part of the sub-assembly and must be ordered separately.

1. Connecting rod bearing halves must be used as a set, but they can be interchanged in the same connecting rod. They are automatically located by dowels. *Caution:* make sure dowels are bottomed in holes in connecting rod. Oil film clearance should be approximately .001" per inch of diameter when bolts are pulled up tight. There are no shim spacers so if wear develops to the point where a bearing slap occurs, bearing liners must be shimmed out or replaced.

2. After connecting rod bolt lock nuts are removed and replaced a number of times, the lock nuts will begin to slip and loosen up. When annual or semi-annual inspection reveals this, replace promptly with new ones.

3. The crosshead clearance for oil film is .002" to .003" between each surface (measured dry).

PLUNGER ADAPTER & BAFFLE SEAL PACKING (Plate B167)

Because the very critical alignment of the plunger starts at the crosshead, it is important that the shoulders of the adapters remain square and undamaged from mishandling.

1. Tightening the Set Screw (item 93) pulls adapter back against square end of crosshead, holding adapters in alignment.

2. The shoulder of the plunger, tightened against the shoulder on the threaded end of the adapter, maintains and extends the alignment to the plunger.

3. Damage to threads in the stainless steel adapter generally should only be repaired by grinding or cutting away the damaged thread. A tap can be used to correct the threads.

4. Baffle packing consists of one oil seal facing in towards the oil and another one facing out toward the plunger well and the water. They can be installed without damage by using the Packing Assembly Tool (item O).

MC MODELS CROSS-SECTION

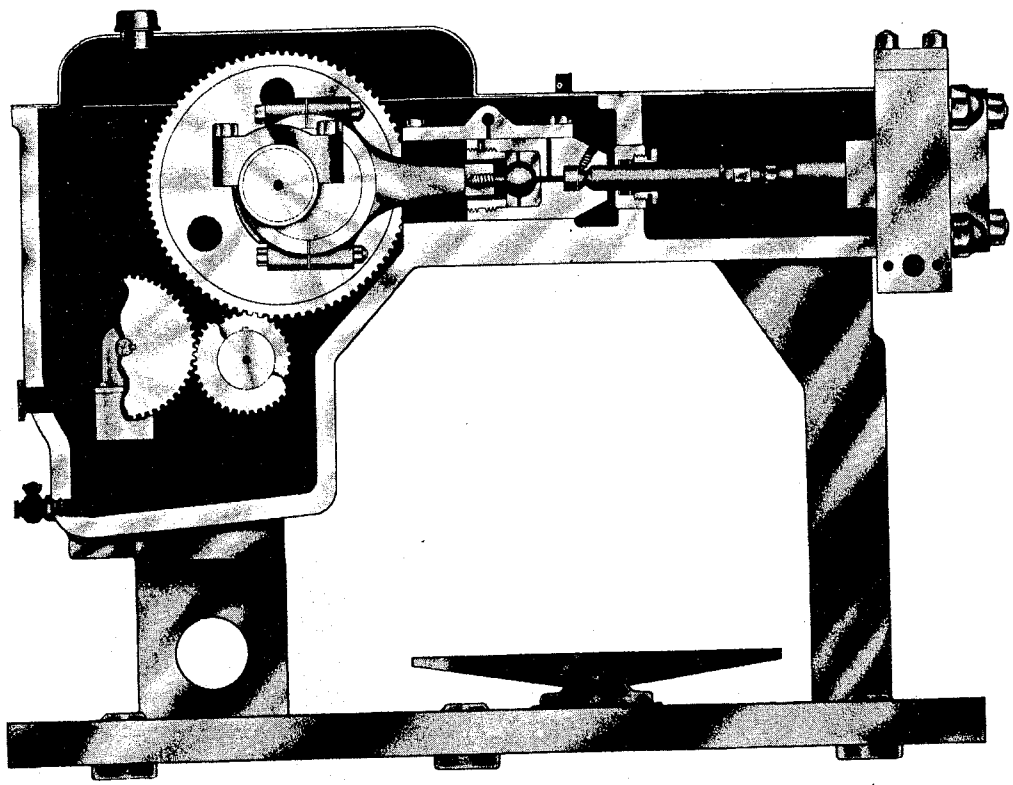


Figure 23

HERRINGBONE GEAR & PINION (Figure 24, Plates B168, B169)

1. Normal rotation of the large gear is counter-clockwise, when observed from the gear side (right side) of the machine.

2. If it becomes necessary because of wear or excessive gear noise, rotation can be reversed so that the new, undamaged side of the gear teeth will carry the load. To reverse rotation, change any two motor leads (in a three phase circuit) thus changing motor direction, also, interchange suction and discharge line connections at the lubrication oil pump. The relief valve must always be located on the discharge side.

3. Gear wear will occur over a long period of useage. It usually takes the form of a developing of small pit marks on the working side of the gear teeth. Obviously, this wear will be greatly accelerated by using the wrong oil, failure to drain condensate and water from the oil or overloading the machine.

4. Overloading will occur if maximum operating pressure is exceeded, if product contains entrained air or if the machine is partially starved through lack of sufficient infeed pressure. A "knock" in the machine usually indicates the presence of air or insufficient infeed pressure — but only when there is an extremely serious amount of air or starvation. Serious trouble can still be caused by these factors when the knocking sound is only faintly audible.

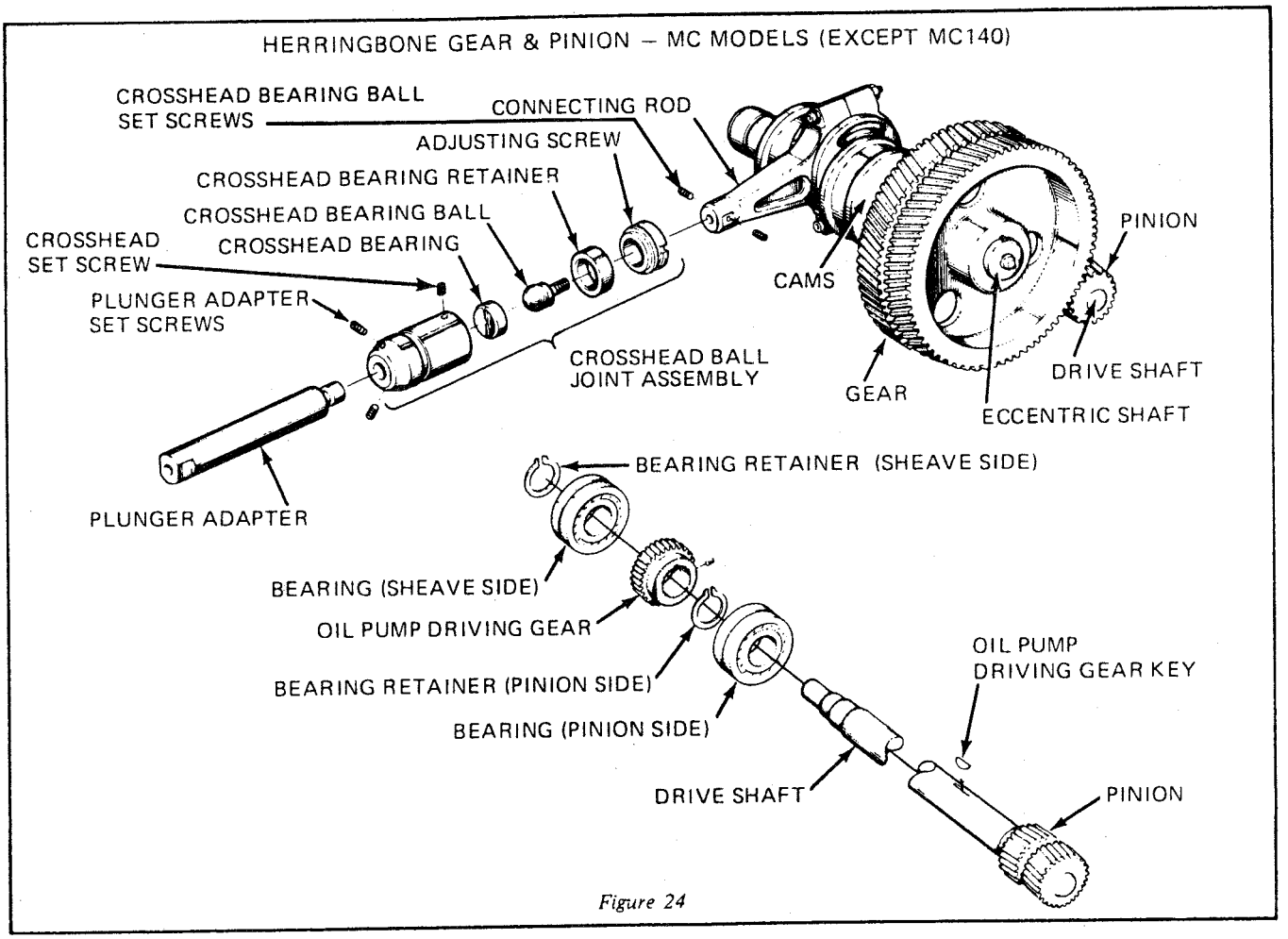


Figure 24

5. Gear noise will develop with gear wear. It will appear as a "growl" or "rumbling" sound and will be synchronous with one revolution of the large gear (one full stroke of one plunger). It usually becomes louder when pressure is applied to the machine.

   a. Clearance between gear and pinion should be checked by measuring driveshaft end play as follows: (*Note:* applies to Models MC 18, 45, 75 and 100 only.)

      1. Remove cover on belt drive side.

      2. By hand, turn large driven sheave, on end of drive shaft, back and forth while pushing sheave and driveshaft in as far as it can go. If it will not slide in or out by hand, use a block of hard wood or soft metal and a sledge hammer to tap it in as far as the mesh of the gears will allow.

      3. With a pencil, mark the driveshaft against the seal retainer plate.

      4. With a large bar, force the sheave and driveshaft back out away from the base, as far as it can go

      5. Again mark the shaft.

      6. Measure the distance between the two marks. The minimum should be 1/32", with 3/32" the maximum before excess gear or bearing wear is indicated.

   b. Gear and pinion clearance for Model MC 140: Because the machine uses two separate eccentric shafts and gears, it is difficucult to check clearance between the gears and pinions as can be done with the smaller machines. Therefore, instead of checking drive shaft end play, it will be necessary to use a feeler gauge as follows:

      1. Remove cover on belt drive side, stainless steel top cover and splash cover.

      2. By hand, turn large driven sheave clockwise so that pinion teeth are in contact with teeth of large herringbone gears.

      3. The clearance between the teeth will now be toward the back side of the machine.

      4. With feeler gauge, measure the clearance by inserting the gauge from the sides between the pinion gear teeth and the large gear teeth. It should measure

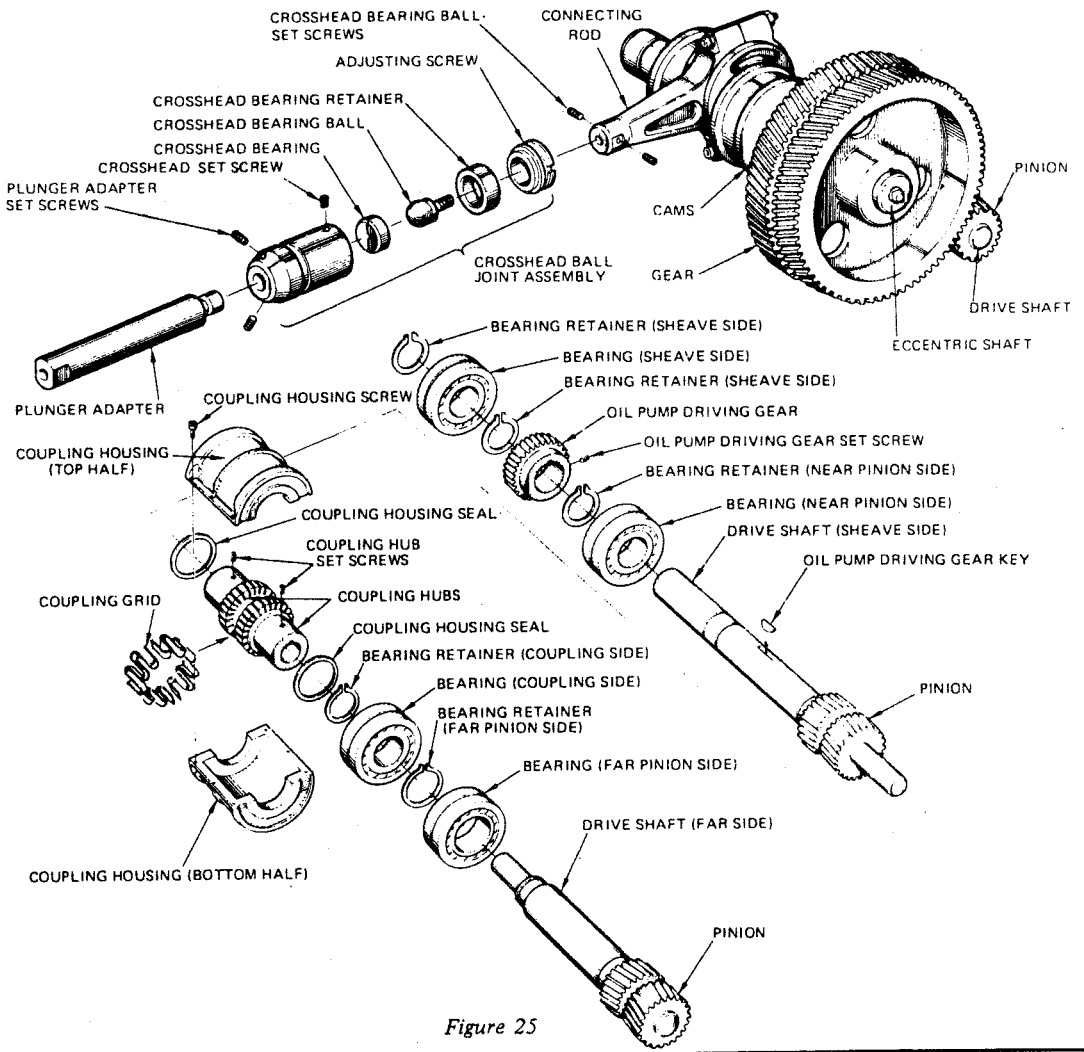


Figure 25

between .008" and .010" on the outboard edge.

5. If clearance is excessive, even though gears do not appear worn, check clearance in eccentric shaft bearings next to gears as follows:

6. One gear at a time, using a crow bar, attempt to force gear upwards, away from pinion. Since the normal total oil film clearance in the eccentric shaft bearings is .001" per inch of diameter, it can now be determined if there is excessive lift (indicating excessive bearing wear rather than gear wear.

c. If driveshaft end-play is excessive, even though gears do not appear worn, check clearance in eccentric shaft bearing on gear side as follows: (*Note:* applies to Models MC 18, 45, 75 and 100 only.)

1. Remove covers to expose large gear.

With a crow bar, attempt to force gear upwards, away from pinion. Since the normal total oil film clearance in the eccentric shaft bearings is .001" per inch of diameter, it can now be determined if there is excessive lift (indicating excessive bearing wear rather than gear wear.).

6. The pinion gear is heat shrunk on the driveshaft and is not removable. Because it is never good practice to replace only one half of a pair of gears which have run together for any length of time, the gear, pinion and driveshaft should be replaced if one part requires replacement.

7. Herringbone gear removal is best accomplished with a hydraulic puller and pusher or, alternatively a large arbor press. In any case, each eccentric shaft and gear assembly will have to be lifted out of the machine as a unit. In preparation for this, remove the bearing caps, remove the back half of the connecting rods and slide the connecting rods toward the front end of the machine to clear the eccentric cams:

DRIVESHAFT ASSEMBLY (Figure 24, Plate B168) (MODELS MC 18, 45, 75, 100)

The drive shaft assembly consists of the shaft with a pinion gear heat shrunk in place, two self-aligning roller bearings (these are not the same size), two bearing lock rings, oil pump driving gear, and drive shaft oil seal.

1. The assembly can only be removed and replaced from the gear side.

2. The pinion end bearing is slightly larger on the O.D. than the bearing for the opposite end. The outer races have only a slight interference fit in the bearing housings so the shaft can float to be self aligning. The mesh of the herringbone gear and pinion will move it into alignment.

3. New bearings are installed on the drive shaft by heating them in oil to 250°F.

4. Slide pinion end bearing into place on shaft against shoulder and install lock ring.

5. Slide oil pump driving gear into place and lock set screw against key securely.

6. Slide opposite end-bearing into place and install lock ring.

7. To remove driveshaft and pinion only, loosen or remove eccentric cap bearing screws and lift, with a chain fall or bar, eccentric gear up out of mesh with pinion. After driven sheave and seal retainer are removed, the assembly then can be driven out toward pinion side.

DRIVE SHAFT ASSEMBLY (Figure 25, Plate B171)

Note: applies to Model MC140 only.

The drive shaft assembly consists of two separate shafts, each with its own pinion gear heat shrunk in place, two self-aligning roller bearings on each shaft (these are not the same size), bearing lock rings for each bearing, one oil pump driving gear and one drive shaft oil seal. The two shafts are connected with a mechanical coupling.

1. For purposes of identification, the shaft on which the driven sheave is located will be called the "belt side shaft" and the opposite one is the "far side shaft." Each one may be removed only through its own side.

2. The O.D. of the outboard bearing on each side is slightly larger than that of the inboard bearing. The outer bearing races have only a slight interference in the bearing housings so that the shafts can float to be self aligning. The mesh of the gears will move the shafts into alignment.

3. New bearings are installed on the shafts by heating them in oil to 250°F.

4. To assemble the "belt side shaft" bearings, slide the correct bearing (the smaller O.D.) from the sheave end of the shaft all the way to the shoulder next to the pinion gear. Place correct bearing lock ring in groove next to bearing.

5. Slide oil pump driving gear in place over key and lock set screw.

6. Install correct bearing lock ring in inner groove and slide outboard bearing up against it. Install second bearing lock ring it its groove.

7. "Far side shaft" bearings have different I.D.'s as well as O.D.'s so the bearing with the larger I.D. is mounted first up against the shoulder next to the pinion gear. Then install bearing lock ring. Slide inboard bearing against shoulder and install bearing lock ring.

8. Mount each half of the coupling over shafts with keys in place and tighten set screws against keys securely.

9. Each drive shaft assembly can now be installed in place from its own side.

10. See page 46 for instructions for properly synchronizing shafts.

ECCENTRIC SHAFT & BEARINGS (Plate B169).

(Note - The Model MC140 uses two eccentric shafts.)

The eccentric shaft is made of a heavy, high-strength alloy steel center shaft on which are installed ductile iron cams. The cams are located by means of keyways and dowels and are installed using a high temperature shrink-fit procedure. The driving load is taken by the interference fit, not the dowels. Because of this construction, successful removal and replacement of cams is not feasible from a practical or economic standpoint. Some shafts are also welded between cams for further stiffening.

1. The shaft runs in two babbit lined, full bronze-sleeve bearings. The bearings are located in place by means of dowels in the bottom of the bearing housings. A fiber thrust washer is mounted on each end of the shaft between the outside cam and the eccentric shaft bearings, making the total end play of the shaft between 1/32" and 1/16".

2. The shaft is gun drilled and oil is pumped through the center of the shaft out to each cam so that the connecting rod bearings ride on a cushion of oil under pressure. There are plugs in both ends of shaft.

3. If bearing replacement is ever required, note that the fit of the bearings in their housings requires a slight squeeze when bearing caps are pulled down tight. This requires careful checking of oil film clearance which should be .001" per one inch of diameter minimum. *Note:* Babbitted bearings must be scraped – not honed.

Note: on MC18 models the shaft bearing housing must be assembled with the 1/8" indicator hole at the 12 o'clock position.

4. In the event of damage to bearing surfaces on the cams or end journals, do not turn them undersize in a lathe. This would require specially sized bearings which are not available.

   a. If surfaces are only slightly grooved, the roughness can be removed using strips of emery cloth.

   b. Even though they still show light grooving, they can be safely used because the grooves merely trap oil, just as does an oil groove in a sleeve bearing. The important thing to remember is that elevated ridges of metal, thrown up when the groove developed, must be removed with emery cloth or by draw filing.

   c. If surfaces are severely damaged or undersized, the best method of repair is to have them metallized and remachined to original size.

METHOD OF SYNCHRONIZING MC140 ECCENTRIC SHAFTS

Because the Model MC140 uses two separate eccentric shafts, each with three cams spaced at 120°, it might be assumed that correct synchronization would require the two shafts to be set so that the cams would by 60° apart (6 plungers/360°). The optimum setting, however, is one which will produce the least pulsation and the lowest rate of vibration.

Through exhaustive testing and calculations the angle which has been found best in order to achieve the smoothest operation is 37° rather than 60°. If, for any reason, it is necessary to disconnect the coupling which fastens the two driveshafts together or to lift the gear (#101) up and out of mesh from the Driveshaft and Pinion (#25 & #26), the shafts must be carefully re-positioned as follows:

NOTE: When reference is made to the left or the right side of the machine or to a certain plunger assembly, stand in front of the cylinder assemblies and identify from left to right.

a. The drive parts of both sections of the machine must be assembled.

b. Each half of the coupling with the cover and seal must be loosely assembled to each respective drive shaft.

c. The coupling gap between each half, as well as alignment, must be carefully set. Contact factory for detailed instructions.

d. Once the gap and alignment are determined, the positioning of the shafts can be accomplished to best synchronize both assemblies.

e. See "Note" above. Rotate eccentric shafts until number one and six Crosshead assemblies are at their maximum forward positions.

f. Facing the righthand side of the machine, at the eccentric gear, rest the base of a machinist's or carpenter's square on the top edge of the base casting. Sight up the side of the square and locate the gear tooth which is positioned at top dead center (12 o'clock).

g. Rotate the gear assembly backward (clockwise) approximately 18 teeth.

h. The two grooves of the coupling halves are then aligned for installation of the grids.

i. Make certain the grids and covers are fixed firmly to avoid vibration.

For further installation and maintenance instructions regarding the MC140 Drive Shaft Coupling, refer to the attached sheet.

CONNECTING ROD & CROSSHEAD ASSEMBLIES (Figures 24, 25 and Plate B169).

On all MC Models except the MC140, connecting rod sub-assembly consists of the two halves of the Connecting Rod, (Items 72 & 76) a set of two steel-backed, babbitted Bearing Halves (Item 74), two Bolts with Lock Nuts (73) and (77), a Crosshead Bearing Retainer Nut (81), Bearing Retainer (82) and Ball (83). The crosshead sub-assembly includes only the Crosshead (86) and Set Screws (85) and (87). The Crosshead Bearing (84) must be ordered as a separate part.

On the Model MC140 (Figure 25, Plate B172) the connecting rod sub-assemblies consist of the two halves of the Connecting Rod, (Items 92 & 107) a set of two steel-backed, babbitted Bearing Halves (Item 95), two

Bolts with Lock Nuts (Items 93 & 106), a Crosshead Bearing Retainer Nut (Item 88), Bearing Retainer (Item 87) and Ball (Item 86). The Crosshead Sub-Assembly includes only the Crosshead (Item 83) and Set Screws (Items 82 & 84). The Crosshead Bearing (Item 85) must be ordered as a separate part.

1. Connecting-rod bearing halves must be used as a set, but they can be interchanged in the same connecting rod. They are automatically located by dowels. *Caution:* Make sure dowels are bottomed in holes in connecting rod. Oil film clearance should be approximately .001" per one inch of diameter when bolts are pulled up tight. There are no shim spacers so if wear develops to the point where a bearing slap occurs, bearing liners must be shimmed out or replaced.

2. After connecting rod-bolt locknuts are removed and replaced a number of times, the locknuts will begin to slip and loosen up. When annual or semi-annual inspection reveals this, replace them promptly with new ones.

3. On Model MC 18 machines, the torque requirement for tightening the crosshead bearing ball into the connecting rod is 130 foot pounds, unlubricated. (Loosen set screws before tightening.)

   On all other Model MC machines, the torque requirement is 370 foot pounds, unlubricated. (Loosen set screws before tightening.)

4. The crosshead ball and socket adjustment should be kept properly adjusted since wear increases rapidly if they are allowed to slap. Adjust as follows:

   a. Remove oil line and crosshead cover.

   b. On MC Models, turn crosshead by means of Plunger Adapter Item (88) until Crosshead Set Screw (85) is exposed.

   c. On MC140, turn crosshead by means of Plunger Adapter (Item 77) until Crosshead Set Screw (Item 84) is exposed.

   d. Loosen set screw.

   e. Hold Bearing Retainer Nut Item (81) (Item 88 on MC140) with spanner wrench while slowly turning plunger adapter with its wrench, until a slight drag is noticed on plunger adapter.

   f. Lock set screw at that point.

   g. Repeat with others and replace cover plate and oil lines.

PLUNGER ADAPTER & BAFFLE SEAL PACKING (Plates B169, B172)

Because the very critical plunger alignment starts at the crosshead, it is important that the shoulders of the adapters remain square and undamaged by mishandling.

1. Tighten the two Plunger Adapter Set Screws to pull adapter back against square end of crosshead, holding adapter in alignment.

POWER END MODEL MC 140

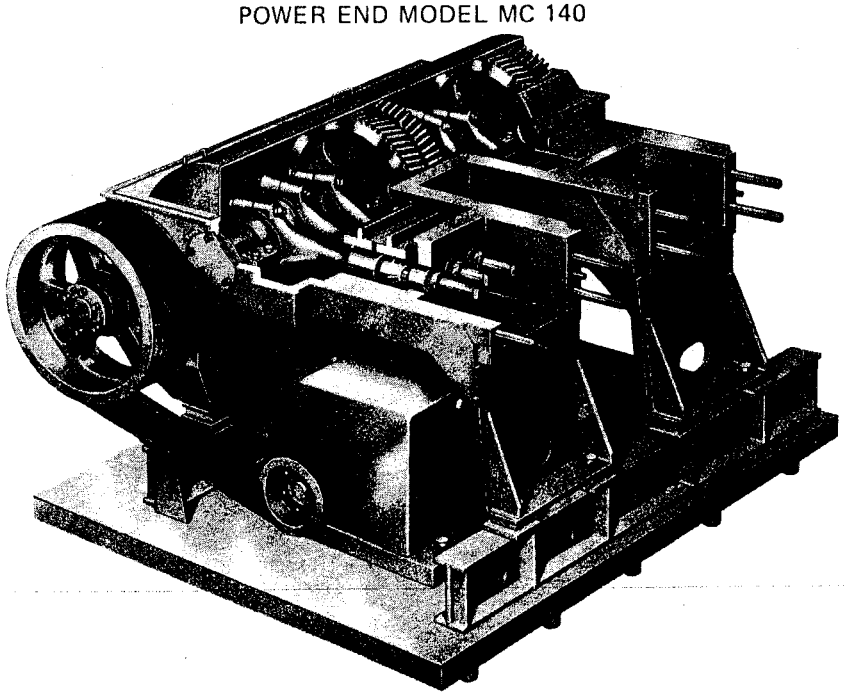


Figure 26

2. The shoulder of the plunger, tightened against the shoulder on the threaded end of the adapter, maintains and extends the alignment to the plunger.
3. Damage to threads in the stainless-steel adapter generally should only be repaired by grinding or cutting away the damaged thread. A tap can be used to correct the thread.
4. Baffle packing consists of one teflon washer, two pieces of square braided packing and one more teflon washer, in that order. With the adapter in place, install parts in the baffle gland being careful that they go completely into place. Tighten adjusting nut firmly while machine is running.

TROUBLE SHOOTING GUIDE

CAUSE	CORRECTION	PAGE
ABNORMAL NOISE		
Knocking sound		
1. Air in product		18
2. Starved inlet		16
3. Pump valve sticking		32
4. Air lock		24, 25, 26
5. Loose ball joints		47
6. Connecting rod bearings		38, 41, 46
7. Loose valve seat		32
8. Loose plunger		38, 41, 47
9. Loose plunger adapter		38, 41, 47
Growling sound		
1. Gear teeth pitted		36, 40, 42
Squealing sound		
1. Tight ball joints		47
2. Valve squeal	Eliminate air from product	
3. Motor bearings		14, 35
4. Loose belts		14
5. Plunger adapters dry through baffle seals	Lubricate	
Scraping sound		
1. Driving sheaves loose	Realign & tighten	
2. Gear oil guard loose	Tighten	
Machine labors or slows down		
1. Overload on machine		17
2. Loose belts		14
CAPACITY		
Too low		
1. Pump valves & seat need grinding		32
2. Loose belts		14
3. Infeed pressure too low		16
4. Air in product		18
5. To change capacity	Contact factory for details	
Varies		
1. Motor not up to speed	Check with tachometer & check amperage draw against name plate	21
CYLINDER LEAKAGE		
From front caps	Check gasket and gasket seat areas for grooves, scores, etc.	31, 32
From upper caps		
1. Bad gasket	Replace	
2. Damaged gasket seat	Smooth up scratches	
From valve assembly		
1. Valve seat gasket	Replace	
2. Valve rod gasket	Replace	
Around plungers		
1. Plunger packing failure		31

CAUSE	CORRECTION	PAGE
CYLINDER STUD FAILURE		
Front studs moving in operation		
1. Front caps misassembled		31
2. Front stud nuts out of square	Smooth contact surface until nut bears all around the circumference. If not possible, replace.	31
3. Shoulder studs (two diameter) break	New studs must be torqued into cylinder.	31
4. Any cylinder stud failure	New studs must be torqued into cylinder.	31
PRODUCT PRESSURE GAUGE		
Gauge hand oscillates		
1. Air in product		18, 33
2. Starved inlet		16
3. Pump valve sticking		32
4. Air lock		24, 25, 26
5. Pump valves leaking		32
Premature gauge failure		
1. Product pressure gauge		33
Pressure drops		
1. Thermal expansion	When valve assembly temperature becomes stable, pressure should remain constant.	
Pressure wanders up & down		
1. Product lodged between pump valve and seat	Clear valve by changing adjustment up and down or by disassembling to clean.	
2. Build up, making pump valve bind	Disassemble and clean.	
Gauge does not return to 0		
1. Defective gauge	Replace	
Cannot obtain required pressure		
1. Homogenizing valve and seat worn		33, 34
2. Air in product		18, 33
3. Starved inlet		16
4. Air lock		24, 25, 26
5. Valve rod binding	Remove any burrs with emery cloth. If rod is bent, replace.	
6. Homogenizing Valve binding	Clean product build up and polish off any burrs.	
HEAT EXCESSIVE		
Power end (drive compartment)		
1. Eccentric shaft bearings damaged		38, 41, 45, 46
2. Drive shaft bearings		37, 40, 45
3. Connecting rod bearings		38, 41, 46
4. Wrong oil		12
5. Insufficient oil		12
Motor compartment		
1. Motor overloaded	Check gauge, check voltage & amperage.	
2. Insufficient air circulation		15, 36
3. Defective insulation or windings		15
HVA pump hot & pressure drops		
1. Incorrect oil		12, 23
2. Worn pump builds heat from slippage	Run cold water stream on pump to prevent cavitation until pump can be replaced	

CAUSE	CORRECTION	PAGE
HOMOGENIZING EFFICIENCY		
Gradually becomes worse over period of weeks		
1. Valve & seat wearing	1st stage of 2 stage assembly only	33, 34
2. Valve or valve rod developing galling or burrs	Clean up parts with emery cloth	
Varies up and down from day to day or hour to hour		
1. Symptom of intermittant air incorporation	Entrained air in product destroys efficiency and must be eliminated	18, 33
2. If product high pressure gauge wanders, valve is not remaining stable	Check for product build up in valve	
Efficiency drops suddenly and does not improve		
1. Valve or valve seat damaged		33, 34
2. Gauge defective		21, 33
3. Ingredients in a manufactured product have changed or are from a new lot.	Formulation may be different. If new batch of one or more ingredients is involved, pressure change may be required.	26
4. Change in process system	Evaluate possible new machine requirements.	26
5. Damage to pump valve or seat affecting pumping	Replace or regrind faulty pump valve and seat.	32
LUBRICATION OIL		
Pressure gauge shows drop in pressure		
1. Pressure always drops as oil heats up and thins	It should level off to a pressure of 20-40 psi. in several hours.	
2. Relief valve adjustment sticking	Disassemble relief valve in oil pump and free it if needed.	
3. Oil filter cartridge clogging or collapsing	Replace cartridge	
4. Oil line fitting has become loose, or tubing cracked	Check all lines and tighten or replace as necessary.	
Oil becomes milky colored		
1. Water in the oil		13
Gauge fluctuates		
1. Air in lube system	Loosen gauge with machine running to bleed off air.	
2. Connecting rod bearings damaged	Replace	
3. Ball joint loose		47
4. Dampener screw in gauge inlet not in place	Screws sometimes back out due to vibration. Tighten	
5. Gauge defective	Replace	
Oil level drops too fast.		
1. Leaking through baffle packing		38, 41, 47
2 Leaking into oil cooler if water pressure is low	Indicates cooler is defective. Replace.	
3. Too much oil being drained when petcock is open to drain water	Caution operator	
Oil temperature too high.		
1. Wear in drive parts		12, 13
2. Oil pressure set too high		35, 36
3. Cooling water temperature too high	Water temperature above 85°F. requires that larger cooler or refrigerated water should be used.	

CAUSE	CORRECTION	PAGE
VIBRATION		
Machine vibrates		
1. Legs not all tight to the floor	Relevel machine.	
2. Balance weights missing from sheaves	If mark of missing weight is visible, sheave must be balanced.	
3. Air in product or starved inlet		16, 18, 33
Suction or discharge lines vibrate		
1. Pressure too high in lines		18

CYLINDER DISASSEMBLY

1. Remove the Gauge Stud Nuts (#43) and remove Gauge (#41).
2. Remove the Gauge Block Stud Nuts (#40) and remove Gauge Block (#37).
3. Remove Inlet Stud Nuts (#18) from Inlet Connection (#17) and from Cylinder Inlet Cap (#31) on the opposite end of the cylinder.
4. Remove Inlet Connection (#17), Inlet Cap (#31) and Inlet Gaskets (#16).
5. Remove Upper Cylinder Cap Nuts (#1), Upper Cylinder Caps (#2) and Upper Cylinder Cap Gaskets (#3).
6. Remove Discharge Valve Springs (#5).
7. Remove Front Cylinder Cap Nuts (#30).
8. Remove Front Cylinder Caps (#29) and Front Cylinder Cap Gaskets (#28).
9. Remove Packing Adjusting Springs (#24).
10. With wrench provided, attach to the flats of each Plunger Adapter (#88) (see Plate B169 for MC Models only, not necessary on M3, M6 or M12 Models.) Loosen and remove Plungers (#11) with plunger wrench.
11. Remove Packings (#25) by using Packing Removal Tool (N) (see drawing below). First, remove knurled nut from tool. Next, slide tool through packing assembly. Replace knurled nut and remove each packing assembly, consisting of Plunger Ring (#26) and Packing (#25) if previously inserted, and Packing Adjusting Ring (#27).
12. With Valve Removing Tool (B), lift and remove Suction Valves (#20) and Discharge Valves (#8).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

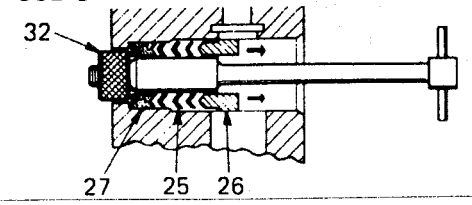
CYLINDER REASSEMBLY

After cleaning all cylinder parts, please perform the following reassembly procedures:

1. With tool provided, install Suction and Discharge Valves.
2. Install Discharge Valve Springs (#5) on center of Discharge Valves (#8).
3. Attach Upper Cylinder Cap Gaskets (#3) onto Upper Cylinder Caps (#2).
4. Install Upper Cylinder Caps (#2) with Gaskets (#3), making sure that stems on the underside of caps enter Discharge Valve Springs (#5).
5. Install and hand tighten Upper Cylinder Cap Nuts (#1).
6. Assemble plunger and packing assemblies as follows:

(Note: Before assembly these parts should be coated with a lubricant which is compatible with the product to be processed. Also, all threads and nut faces should be coated with an acceptable lubricant.)

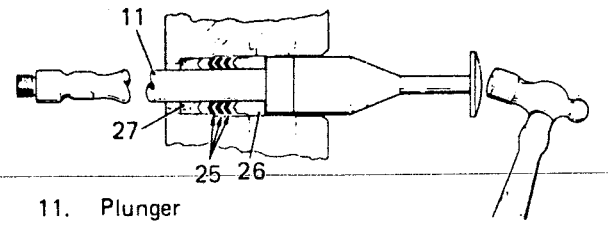
USE OF PACKING REMOVAL TOOL



25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring
32. Knurled Nut

Figure 27

USE OF PACKING ASSEMBLY TOOL



11. Plunger
25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring

Figure 28

CYLINDER DISASSEMBLY

1. Remove the Gauge Stud Nuts (#43) and remove Gauge (#41).

2. Remove the Gauge Block Stud Nuts (#40) and remove Gauge Block (#37).

3. Remove Inlet Stud Nuts (#18) from Inlet Connection (#17) and from Cylinder Inlet Cap (#31) on the opposite end of the cylinder.

4. Remove Inlet Connection (#17), Inlet Cap (#31) and Inlet Gaskets (#16).

5. Remove Upper Cylinder Cap Nuts (#1), Upper Cylinder Caps (#2) and Upper Cylinder Cap Gaskets (#3).

6. Remove Discharge Valve Springs (#5).

7. Remove Front Cylinder Cap Nuts (#30).

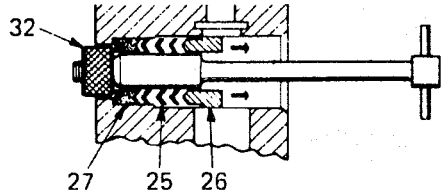
8. Remove Front Cylinder Caps (#29) and Front Cylinder Cap Gaskets (#28).

9. Remove Packing Adjusting Springs (#24).

10. With wrench provided, attach to the flats of each Plunger Adapter (#88) (see Plate B169 for MC Models only, not necessary on M3, M6 or M12 Models.) Loosen and remove Plungers (#11) with plunger wrench.

11. Remove Packings (#25) by using Packing Removal Tool (N) (see drawing below). First remove knurled nut from tool. Next, slide tool through packing assembly. Replace knurled nut and remove each packing assembly, consisting of Plunger Ring (#26) and Packing (#25) if previously inserted, and Packing Adjusting Ring (#27).

USE OF PACKING REMOVAL TOOL



25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring
32. Knurled Nut

Figure 30

12. With Valve Removing Tool (B), lift and remove Suction Valves (#20) and Discharge Valves (#8).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

CYLINDER REASSEMBLY

After cleaning all cylinder parts, please perform the following reassembly procedures:

1. With tool provided, install Suction and Discharge Valves.

2. Install Discharge Valve Springs (#5) on center of Discharge Valves (#8).

3. Attach Upper Cylinder Cap Gaskets (#3) onto Upper Cylinder Caps (#2).

4. Install Upper Cylinder Caps (#2) with Gaskets (#3), making sure that stems on the underside of caps enter Discharge Valve Springs (#5).

5. Install and hand tighten Upper Cylinder Cap Nuts (#1).

6. Assemble plunger and packing assemblies as follows:

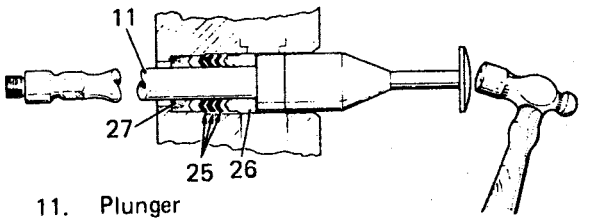
(Note: Before assembly, these parts should be coated with a lubricant which is compatible with the product to be processed. Also, all threads and nut faces should be coated with an acceptable lubricant.)

As a unit, assemble Packing Adjusting Ring (#27), Plunger Packing (#25) (please refer to Packing List or Machine Identification Sheet to determine number of pieces of plunger packing required for your machine), and Plunger Ring (#26) onto Plunger (#11). Repeat with all plungers.

PLATE C213 (C)

8. Slide front end of plunger (#11) through the packing assembly, starting from the packing adjusting ring side, through the plunger packing and plunger ring.
9. Carefully insert plunger (#11) with the packing assembled, into the cylinder port from the front and securely tighten plungers (#11) to plunger adapters (#88) with wrenches provided. Repeat with all plungers.

USE OF PACKING ASSEMBLY TOOL



11. Plunger
25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring

Figure 34

10. Using packing assembly tool (O) drive packing assemblies home as far as they will go into cylinder bores. Refer to sketch. Repeat with all assemblies.
11. Install packing adjusting springs (#24).
12. Install front cylinder cap gaskets (#28) into gasket recesses and place front cylinder caps (#29) on the front cylinder cap studs (#23).
13. Lubricate all threads and flat faces on nuts and install front cylinder cap nuts (#30) to studs (#23) upper cylinder cap nuts (#1) to studs (#14). Tighten firmly and evenly by hand and then securely with wrench. Be sure that nuts are tight and that caps are NOT TIPPED. THEY MUST BE PARALLEL TO FACE OF CYLINDER. If they are not square with the cylinder, the studs can bend in operation and they will fail from metal fatigue.
14. Install cylinder inlet gaskets (#16) on inlet connection (#17) and inlet cap (#31) and install on inlet studs (#15).
15. Install inlet stud nuts (#18) on inlet studs (#15) and tighten evenly and firmly.
16. Install gauge block gasket (#39) into gasket recess and assemble gauge block (#37) onto gauge block studs (#46).
17. Install gauge block nuts (#40) onto gauge block studs (#46) and tighten evenly and firmly.
18. Install gauge gasket (#42) into gasket recess and assemble gauge and flange to gauge studs (#38).
19. Install gauge stud nuts (#43) and tighten evenly and firmly.

NOTE: Inlet gaskets, connection and caps can be installed on either left or right side of cylinder.

TBS CYLINDER PARTS LIST

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
1	Upper Cap Stud Nut	6	23	Front Cap Stud	6
2	Upper Cap	3	24	Suction Valve Stop Retainer	3
3	Upper Cap Gasket	3	25	Plunger Packing (See Machine Identification Sheet)	Varies
4	Discharge Valve Guide Retaining Spring	3			
5	Discharge Valve Spring	3	26	Plunger Ring	3
6	Discharge Valve Spring Button	3	27	Packing Adjusting Ring	3
7	Discharge Valve Guide	3	28	Front Cap Gasket	3
8	Discharge Ball Valve	3	29	Front Cap	3
9	Tapered Discharge Valve Seat	3	30	Front Cap Stud Nut	6
10	Cylinder	1	31	Inlet Cap	1
11	Plunger	3	37	Gauge Block	1
14	Upper Cap Stud	6	38	Gauge Stud	2
15	Inlet Connection Stud	4	39	Gauge Block Gasket	1
16	Inlet Connection Gasket	2	40	Gauge Block Stud Nut	2
17	Inlet Connection	1	41	Gauge with Flange	1
18	Inlet Connection Stud Nut	4	42	Gauge Gasket	1
19	Tapered Suction Valve Seat	3	43	Gauge Stud Nut	2
20	Suction Ball Valve	3	45	Pressure Limiting Pointer	1
21	Suction Valve Guide	3	46	Gauge Block Stud	2
22	Suction Valve Stop	3			

When ordering Parts, specify Model No., Serial No., Part Name, and Quantity

CYLINDER DISASSEMBLY

1. Remove the Gauge Stud Nuts (#43) and remove Gauge (#41).

2. Remove the Gauge Block Stud Nuts (#40) and remove Gauge Block (#37).

3. Remove Inlet Stud Nuts (#18) from Inlet Connection (#17) and from Cylinder Inlet Cap (#31) on the opposite end of the cylinder.

4. Remove Inlet Connection (#17), Inlet Cap (#31) and Inlet Gaskets (#16).

5. Remove Upper Cylinder Cap Nuts (#1), Upper Cylinder Caps (#2) and Upper Cylinder Cap Gaskets (#3).

6. Remove Front Cylinder Cap Nuts (#30).

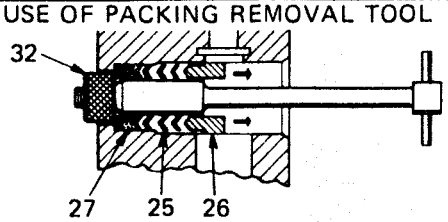
7. Remove Front Cylinder Caps (#29) and Front Cylinder Cap Gaskets (#28).

8. Remove Packing Adjusting Springs (#24).

9. With wrench provided, attach to the flats of each Plunger Adapter (#88) (see Plate B169 for MC Models only, not necessary on M3, M6 or M12 Models.) Loosen and remove Plungers (#11) with plunger wrench.

10. Remove Packings (#25) by using Packing Removal Tool (N) (see drawing below). First, remove knurled nut from tool. Next, slide tool through packing assembly. Replace knurled nut and remove each packing assembly, consisting of Plunger Ring (#26) and Packing (#25) if previously inserted, and Packing Adjusting Ring (#27).

USE OF PACKING REMOVAL TOOL



25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring
32. Knurled Nut

Figure 33

11. Remove discharge valve springs (#5), spring buttons (#6).

12. Remove discharge valve guide retaining springs (#4).

13. With valve stop removing tool (M), remove suction valve stops (#22).

14. With valve removing tool (A), lift and remove suction valves (#20) and discharge valves (#8).

15. With valve guide removing tool (C) remove suction valve guides (#21) and discharge valve guides (#7).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

CYLINDER REASSEMBLY

After cleaning cylinder and parts please perform the following reassembly procedure.

1. With tool provided install suction valves (#20) and discharge valves (#8).

2. Install suction valve guides (#21) and discharge valve guides (#7).

3. Install suction valve stops (#22) with valve stop removing tool (M).

4. Install discharge valve guide retaining springs (#4).

5. Attach discharge valve springs (#5) to spring buttons (#6) and assemble to top of discharge valves (#8).

6. Install upper cylinder cap gaskets (#3) into gasket recesses and install upper cylinder caps (#2) making sure that stems on the underside of caps enter discharge valve springs (#5).

7. When possible use an acceptable lubricant on packing assembly parts, plunger ring (#26) plunger packing (#25) and packing adjusting ring (#27) and assemble as a unit on to plunger (#11).

TAPERED SEAT POPPET VALVE CYLINDER (TPS)

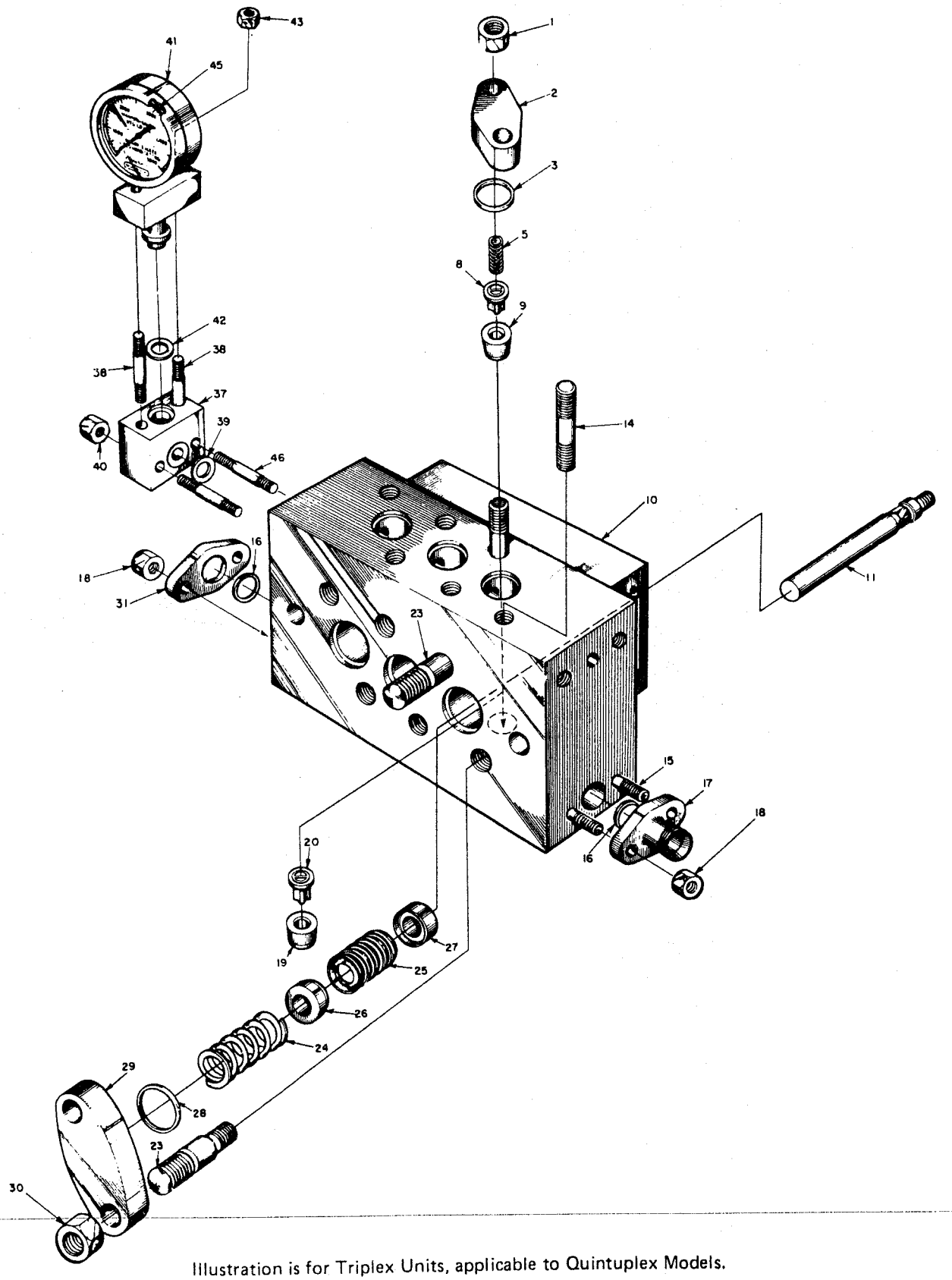


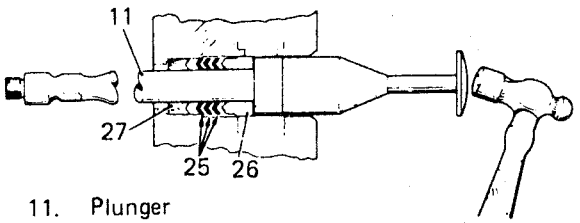
Illustration is for Triplex Units, applicable to Quintuplex Models.

Figure 32

PLATE C213 (B)

7. Carefully insert plunger and packing assemblies through the front of the cylinder ports and thread and tighten Plunger (#11), into Plunger Adapters (#88). (See attached drawing for correct positioning of parts.)

USE OF PACKING ASSEMBLY TOOL



11. Plunger
25. Plunger Packing
26. Plunger Ring
27. Packing Adjusting Ring

Figure 31

8. Using Packing Assembly Tool (0) and hammer, gently tap packing assemblies into cylinder bores until solid seating is obtained.

9. Install Packing Adjusting Springs (#24).

10. Install Front Cylinder Cap Gaskets (#28), on Caps (#29) and on Cap Studs (#23), and replace Front Cylinder Cap Nuts (#30). Tighten firmly and evenly by hand before securing with a wrench. Be sure that front caps are not tipped. They must be parallel with the front of the cylinder, or the studs may bend in operation and fail from metal fatigue. Cap Nuts (#30) must be sufficiently tight to compress the gasket and prevent leakage. (This procedure must be followed, double-checking the tightness of the nuts on the cylinder, gauge and homogenizer valve assemblies.

11. Install Gauge Block Gasket (#39) and assemble Gauge Block (#37) to Cylinder (#10). Tighten securely.

12. Install Gauge Gasket (#42) and Gauge (#41) to Gauge Block (#37). Tighten nuts uniformly.

13. Replace Inlet Gaskets (#16) on Inlet Connection (#17) and Inlet Cap (#31).

14. Install and tighten Inlet connection and inlet Cap Stud Nuts (#18).

NOTE: Inlet gaskets, connection and caps can be installed on either left or right side of cylinder.

TPS CYLINDER PARTS LIST

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
1	Upper Cap Stud Nut	6	25	Plunger Packing (See Machine	Varies
2	Upper Cap	3		Identification Sheet)	
3	Upper Cap Gasket	3	26	Plunger Ring	3
5	Discharge Valve Spring	3	27	Packing Adjusting Ring	3
8	Discharge Poppet Valve	3	28	Front Cap Gasket	3
9	Tapered Discharge Valve Seat	3	29	Front Cap	3
10	Cylinder	1	30	Front Cap Stud Nut	6
11	Plunger	3	31	Inlet Cap	1
14	Upper Cap Stud	6	37	Gauge Block	1
15	Inlet Connection Stud	4	38	Gauge Stud	2
16	Inlet Connection Gasket	2	39	Gauge Block Gasket	1
17	Inlet Connection	1	40	Gauge Block Stud Nut	2
18	Inlet Connection Stud Nut	4	41	Gauge with Flange	1
19	Tapered Suction Valve Seat	3	42	Gauge Gasket	1
20	Suction Poppet Valve	3	43	Gauge Stud Nut	2
23	Front Cap Stud	6	45	Pressure Limiting Pointer	1
24	Packing Spring	3	46	Gauge Block Stud	2

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

TAPERED BALL VALVE SEAT CYLINDER (SPRING-LOADED PACKING) (TBS)

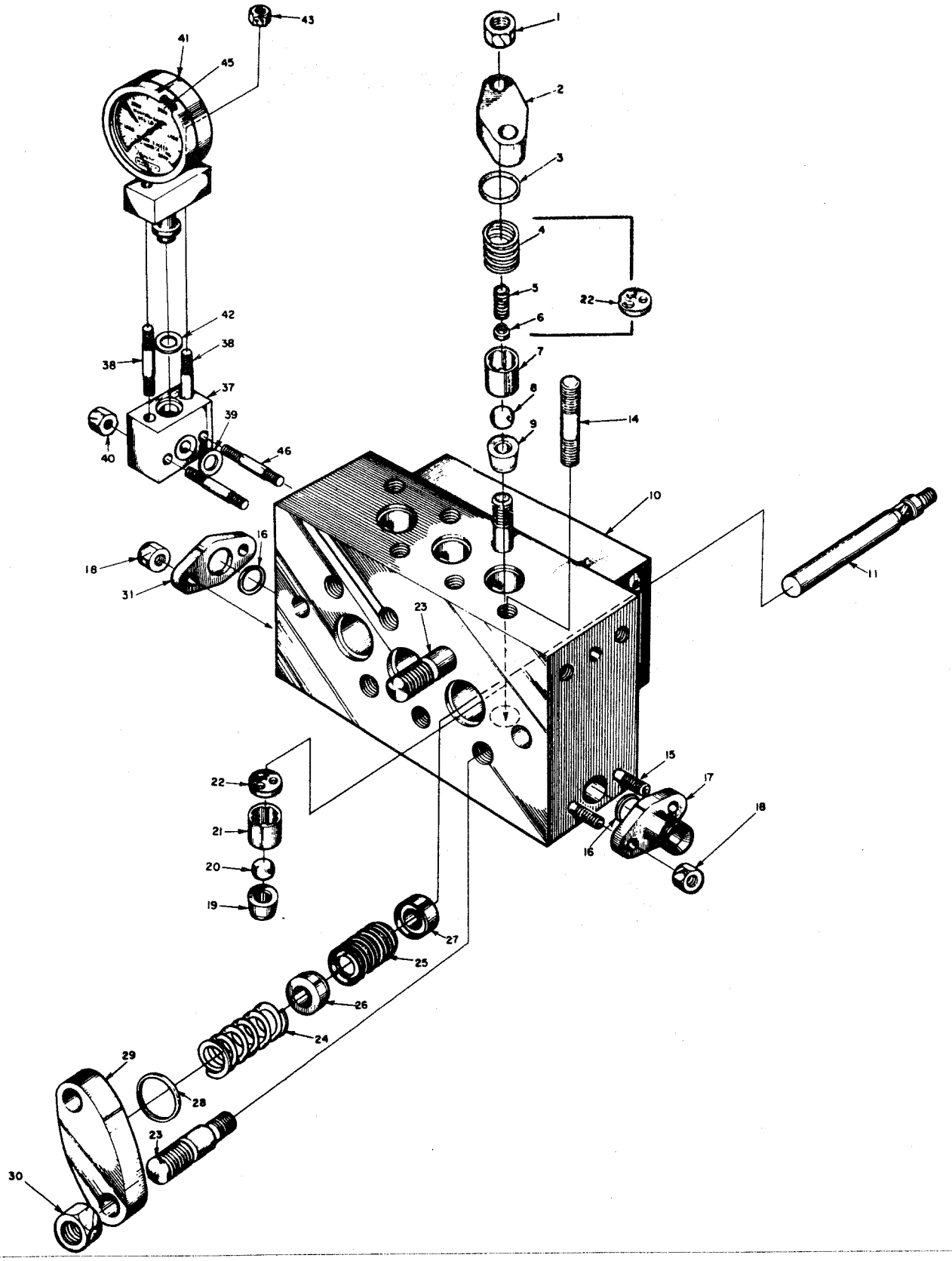


Illustration is for Triplex Units, applicable to Quintuplex Models.

Figure 35

FOLDOUT FOR
PLATE C213 (C)

PLATE V216 (C)

SINGLE-STAGE HOMOGENIZING VALVE ASSEMBLY INSTRUCTIONS AND PARTS LIST (FLUTED TYPE)

VALVE DISASSEMBLY

1. Remove single-stage Valve Body Stud Nuts (#5), single-stage Handwheel (#9) and Handwheel Support assembly (#4).
2. Remove single-stage Valve Body (#2) assembly, being careful not to drop valve components.
3. Remove Valve Seat Gasket (#14), Valve Seat (#13), Impact Ring (#12), Valve Guide (#15) with Gasket (#16), and Valve (#11) with Valve Gaskets (#17), if used.

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

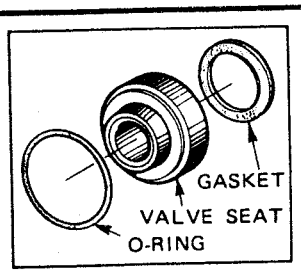
Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

VALVE REASSEMBLY

1. Lubricate Valve (#11) with an acceptable lubricant and insert into Valve Guide (#15), if used, making sure that the valve moves freely.
2. Reinstall Valve Guide Gasket (#16), if used.
3. Insert this assembly into Valve Body (#2).
4. Reinstall Impact Ring (#12), Valve Seat (#13), and Valve Seat Gasket (#14).
5. Slide valve body assembly over Studs (#1).
6. Reassemble Handwheel (#9) and Handwheel Support (#4) assembly on studs.
7. Replace Stud Nuts (#5) and tighten evenly and securely.



Valve Seat Used On Some Assemblies

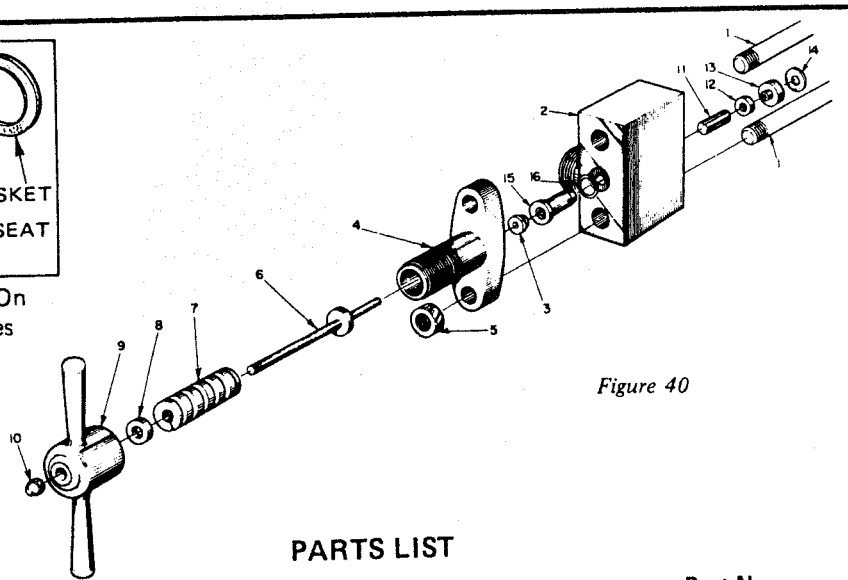


Figure 40

PARTS LIST

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
1	Valve Body Stud	2	9	Hand Wheel	1
2	Valve Body	1	10	Valve Rod Cap Nut	1
3	Valve Rod Packing	1	11	Homo Valve	1
4	Hand Wheel Support	1	12	Impact Ring	1
5	Valve Body Stud Nut	2	13	Homo Valve Seat	1
6	Valve Rod	1	14	Homo Valve Seat Gasket	1
7	Valve Spring	1	15	Homo Valve Guide	1
8	Valve Rod Washer	1	16	Homo Valve Guide Gasket	1

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

PLATE V216 (D)

SINGLE-STAGE SUB-MICRON DISPERSER (SMD) VALVE ASSEMBLY INSTRUCTIONS AND PARTS LIST

VALVE DISASSEMBLY

1. Remove single-stage Valve Body Stud Nuts (#5), single-stage Handwheel (#9), and Handwheel Support assembly (#4).
2. Remove single-stage Valve Body (#2) assembly, being careful not to drop valve components.
3. Remove Valve Seat Gasket (#14), Valve Seat Assembly (#19), Impact Ring (#12), Valve Insert (#11), Valve Guide (#15) with Gasket (#16), Valve Holder (#18) and Valve Gaskets (#17).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

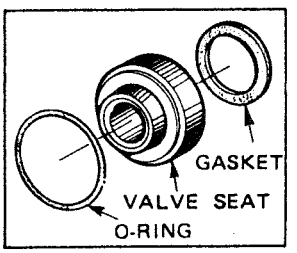
Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

VALVE REASSEMBLY

1. Lubricate Valve (#11) and Gaskets (#17) with an acceptable lubricant and insert into Valve Guide (#15), if used, making sure that valve moves freely.
2. Reinstall Valve Guide Gasket (#16), if used.
3. Replace Valve Insert (#11) into Valve Holder (#18).
4. Reinstall Gaskets (#17).
5. Lubricate Valve Holder (#18) and Valve Holder Gaskets (#17) with an acceptable lubricant, making sure that Valve Holder (#18) moves freely.
6. Insert assembly into Valve Body (#2) or Valve Guide (#15), if used.
7. Install Impact Ring (#12), Valve Seat Assembly (#19), and Valve Seat Gasket (#14).
8. Slide valve body assembly over Studs (#1).
9. Reassemble Handwheel (#9) and Handwheel Support (#4) assembly on studs.
10. Replace Stud Nuts (#5) and tighten evenly and securely.



Valve Seat Used On Some Assemblies

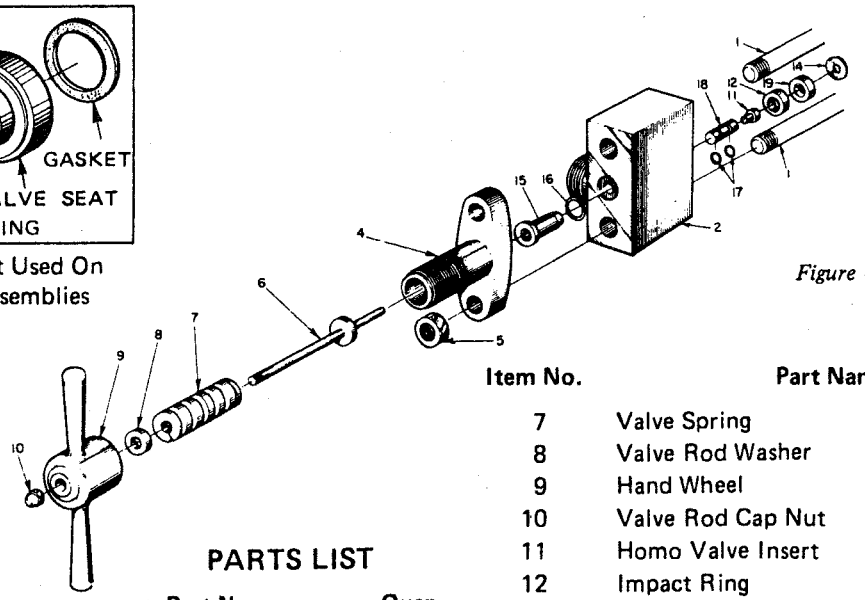


Figure 41

PARTS LIST

Item No.	Part Name	Quan.
1	Valve Body Stud	2
2	Valve Body	1
4	Hand Wheel Support	1
5	Valve Body Stud Nut	2
6	Valve Rod	1
7	Valve Spring	1
8	Valve Rod Washer	1
9	Hand Wheel	1
10	Valve Rod Cap Nut	1
11	Homo Valve Insert	1
12	Impact Ring	1
14	Homo Valve Seat Gasket	1
15	Homo Valve Guide	1
16	Homo Valve Guide Gasket	1
17	Homo Valve Gasket	2
18	Homo Valve Holder	1
19	Homo Valve Seat Assembly	1

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

PLATE V216 (E)

SINGLE-STAGE HOMOGENIZING VALVE ASSEMBLY INSTRUCTIONS AND PARTS LIST

VALVE DISASSEMBLY

1. Remove single-stage Value Body Stud Nuts (#5), single-stage Handwheel (#9) and Handwheel Support assembly (#4).
2. Remove single-stage Valve Body (#2) assembly, being careful not to drop valve components.
3. Remove Valve Seat Gasket (#14), Valve Seat (#13) and Valve (#11), and Impact Ring (#12).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

Note If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

VALVE REASSEMBLY

1. Install Impact Ring (#12) into Valve Body (#2).
2. Install Valve Seat (#13) and Valve (#11), as an assembly, into Valve Body (#2).

   NOTE: To guard against possible valve steam breakage, be certain that Valve (#11) remains inserted into Valve Seat (#13) after assembly is placed into position in valve body.
3. Install Valve Seat Gasket (#14).
4. Slide Valve Body (# 2) over Studs (#1).
5. Reassemble Handwheel (#9), and Handwheel Support (#4) assembly on studs.
6. Replace Stud Nuts (#5) and tighten evenly and securely.

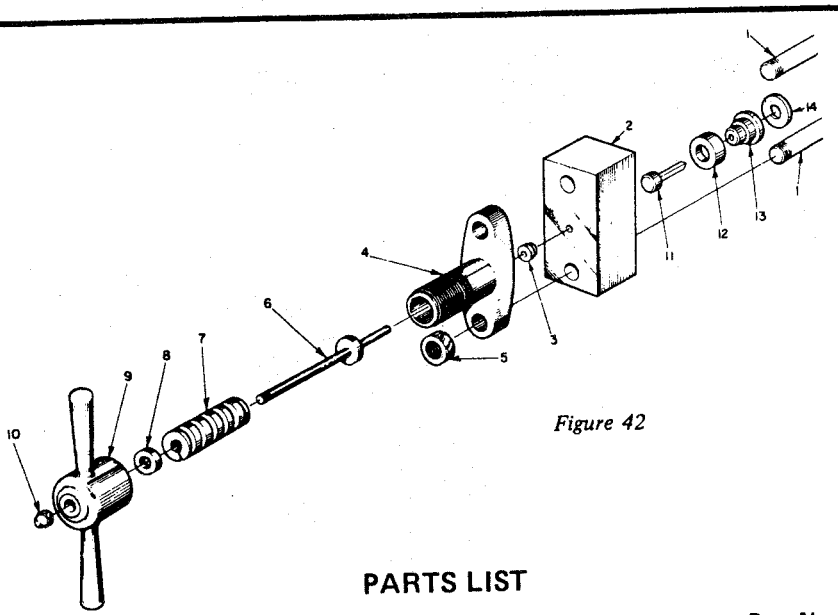


Figure 42

PARTS LIST

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
1	Valve Body Stud	2	8	Valve Rod Washer	1
2	Valve Body	1	9	Hand Wheel	1
3	Valve Rod Packing	1	10	Valve Rod Cap Nut	1
4	Hand Wheel Support	1	11	Homo Valve	1
5	Valve Body Stud Nut	2	12	Impact Ring	1
6	Valve Rod	1	13	Homo Valve Seat	1
7	Valve Spring	1	14	Homo Valve Seat Gasket	1

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

PLATE V216 (F)

MANUALLY OPERATED RELIEF VALVE AND HIGH PRESSURE DISCHARGE BLOCK ASSEMBLY INSTRUCTIONS AND PARTS LIST

VALVE DISASSEMBLY

1. Remove Valve Body Stud Nuts (#5), Handwheel (#9), Handwheel Support assembly (#4).
2. Remove Valve Body (#2), being careful not to drop the valve, seat and impact ring.
3. Remove Valve (#11), Seat (#13), Impact Ring (#12) and Valve Seat Gasket (#14) from Valve Body (#2).
4. Remove Discharge Block (#15) and Discharge Block Gasket (#16).

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

VALVE REASSEMBLY

1. Install Discharge Block Gasket (#16) into Discharge Block (#15) and assemble, as a unit, onto Studs (#1).
2. Insert Impact Ring (#12) into Valve Body (#2).
3. Insert Valve (#11) into Valve Seat (#13) and assemble, as a unit, into Valve Body (#2).

NOTE: To guard against possible valve stem breakage, be certain that Valve (#11) remains inserted into Valve Seat (#13) after assembly has been placed into position in valve body.

4. Install Valve Seat Gasket (#14).
5. Reassembly Handwheel (#9) and Handwheel Support assembly (#4) onto Studs (#1).
6. Replace Valve Body Stud Nuts (#5) and tighten evenly and securely.

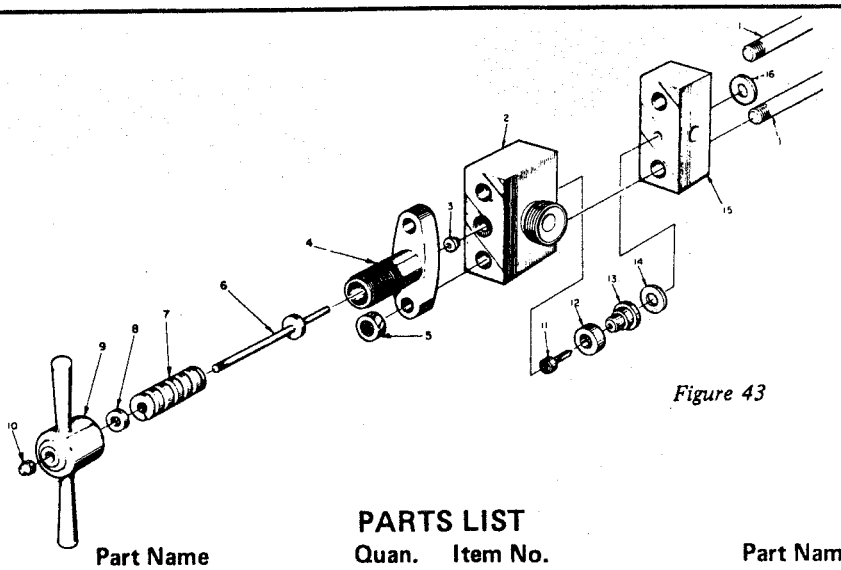


Figure 43

PARTS LIST

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
1	Valve Body Stud	2	9	Hand Wheel	1
2	Valve Body	1	10	Valve Rod Cap Nut	1
3	Valve Rod Packing	1	11	Homo Valve	1
4	Hand Wheel Support	1	12	Impact Ring	1
5	Valve Body Stud Nut	2	13	Homo Valve Seat	1
6	Valve Rod	1	14	Homo Valve Seat Gasket	2
7	Valve Spring	1	15	Discharge Block	1
8	Valve Rod Washer	1	16	Discharge Block Gasket	1

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

PLATE V 217 (C)

HOMOGENIZING VALVE INSTRUCTIONS

VALVE DISASSEMBLY

1. Remove second-stage Valve Body Stud Nuts (#27), second-stage Handwheel (#31) and Handwheel Support assembly (#26).

2. Remove the second-stage Valve Body (#24) being careful not to drop the valve and seat.

3. Remove Valve (#23) and Seat (#22) from second-stage Body (#24).

4. Remove first-stage Valve Body Stud Nuts (#5), first-stage Handwheel (#9) and Handwheel Support (#4).

5. Remove first-stage Valve Body (#2) assembly being careful not to drop valve components.

6. Remove Valve Seat Gasket (#14), Valve Seat (#13), Impact Ring (#12) Valve Guide (#15) with Gasket (#16), and Valve (#11) with Valve Gaskets (#17), if used.

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

VALVE REASSEMBLY

1. Lubricate Valve (#11) with an acceptable lubricant and insert into Valve Guide (#15), if used, making sure that the valve moves freely.

NOTE When installing Valve (#11) the solid end of the valve must be located against the seat.

2. Reinstall Valve Guide Gasket (#16).

3. Insert this assembly into Valve Body (#2).

4. Reinstall Impact Ring (#12), Valve Seat (#13), and Valve Seat Gasket (#14).

5. Slide valve body assembly over Studs (#1).

6. Reassemble Handwheel (#9) and Handwheel Support (#4) assembly on studs.

7. Replace Stud Nuts (#5) and tighten evenly and securely.

8. Insert second-stage Valve (#23) into Valve Seat (#22), and install as an assembly into second-stage Valve Body (#24).

NOTE To guard against possible valve stem breakage, be certain that Valve (#11) remains inserted into Valve Seat (#13) after assembly has been placed into position in valve body.

9. Install Valve Seat Gasket (#21).

10. Assemble second-stage valve body to first-stage valve assembly on Studs (#20).

11. Assemble Handwheel Support (#26) and Handwheel (#31) as a unit onto Valve Body Studs (#20).

12. Replace Stud Nuts (#27) and tighten evenly and securely.

PLATE V 217 (C)

TWO-STAGE HOMOGENIZING VALVE ASSEMBLY
(First-Stage is Fluted Plug Valve, Second-Stage is Piloted Valve)

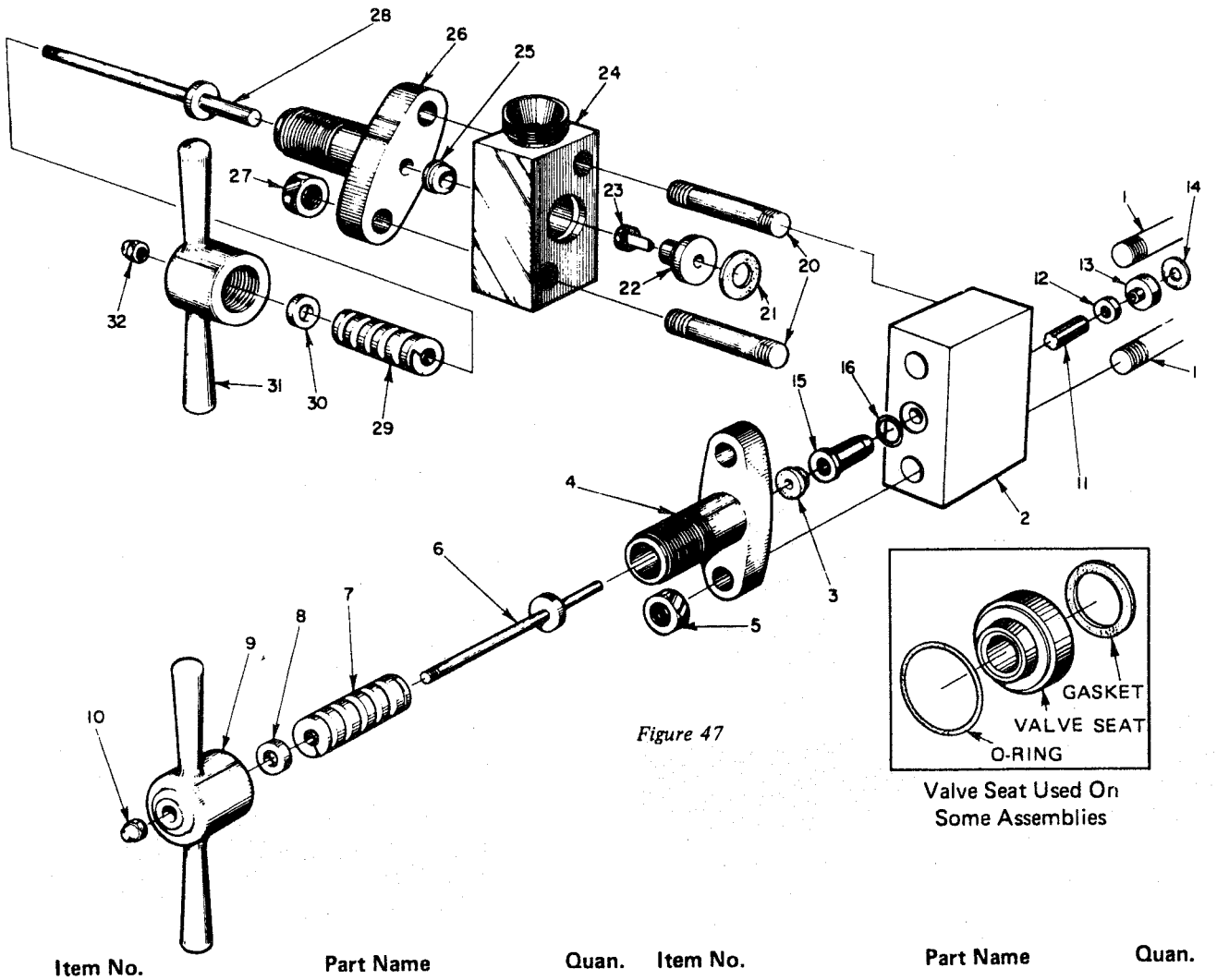


Figure 47

Valve Seat Used On Some Assemblies

Item No.	Part Name	Quan.
FIRST STAGE		
1	Valve Body Stud	2
2	Valve Body	1
3	Valve Rod Packing	1
4	Hand Wheel Support	1
5	Valve Body Stud Nut	2
6	Valve Rod	1
7	Valve Spring	1
8	Valve Rod Washer	1
9	Hand Wheel	1
10	Valve Rod Cap Nut	1
11	Homo Valve	1
12	Impact Ring	1
13	Homo Valve Seat	1
14	Homo Valve Seat Gasket	1
15	Homo Valve Guide	1
16	Homo Valve Guide Gasket	1

Item No.	Part Name	Quan.
SECOND STAGE		
20	Valve Body Stud	2
21	Valve Seat Gasket	1
22	Valve Seat	1
23	Valve	1
24	Valve Body	1
25	Valve Rod Packing	1
26	Hand Wheel Support	1
27	Valve Body Stud Nut	2
28	Valve Rod	1
29	Homo Valve Spring	1
30	Valve Rod Washer	1
31	Hand Wheel	1
32	Valve Rod Cap Nut	1

When ordering Parts, specify Model No., Serial No., Part Name and Quantity

PLATE V 217 (D)

SUB-MICRON DISPERSER VALVE INSTRUCTIONS

VALVE DISASSEMBLY

1. Remove second-stage Valve Body Stud Nuts (#27), second-stage Handwheel (#31) and Handwheel Support assembly (#26).
2. Remove second-stage Valve Body (#24) being careful not to drop the valve and seat.
3. Remove Valve (#23) and Seat (#22) from second-stage Body (#24).
4. Remove first-stage Valve Body Stud Nuts (#5), first-stage Handwheel (#9) and Handwheel Support (#4).
5. Remove first-stage Valve Body (#2) assembly being careful not to drop valve components.
6. Remove Valve Seat Gasket (#14), Valve Seat Assembly (#13), Impact Ring (#12), Valve Insert (#11), Valve Guide (#15) with Gasket (#16), Valve Holder (#18) and Valve Gaskets (#17).

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

VALVE REASSEMBLY

1. Lubricate Valve Holder (#18) and Gaskets (#17) with an acceptable lubricant and insert into Valve Guide (#15), making sure that valve holder moves freely.
2. Reinstall Valve Guide Gasket (#16).
3. Insert this assembly into Valve Body (#2).
4. Replace Valve Insert (#11) into Valve Holder (#18).
5. Install Impact Ring (#12), Valve Seat Assembly (#13), and Valve Seat Gasket (#14).
6. Slide valve body assembly over Studs (#1).
7. Reassemble Handwheel (#9) and Handwheel Support (#4) assembly on studs.
8. Replace Stud Nuts (#5) and tighten evenly and securely.
9. Insert second-stage Valve (#23) into Valve Seat (#22) and install as an assembly into second-stage Valve Body (#24).

NOTE: To guard against possible valve stem breakage, be certain that Valve (#23) remains inserted into Valve Seat (#22) after assembly has been placed into position in valve body.

10. Install Valve Seat Gasket (#21).
11. Assemble second-stage valve body to first-stage valve assembly on Studs (#20).
12. Assemble Handwheel Support (#26) and Handwheel (#31) as a unit onto Valve Body Studs (#20).
13. Replace Stud Nuts (#27) and tighten evenly and securely.

PLATE V 217 (D)

TWO-STAGE SUB-MICRON DISPERSER (SMD) VALVE ASSEMBLY
(First-Stage is O-Ring Plug Valve, Second-Stage is Piloted Valve)

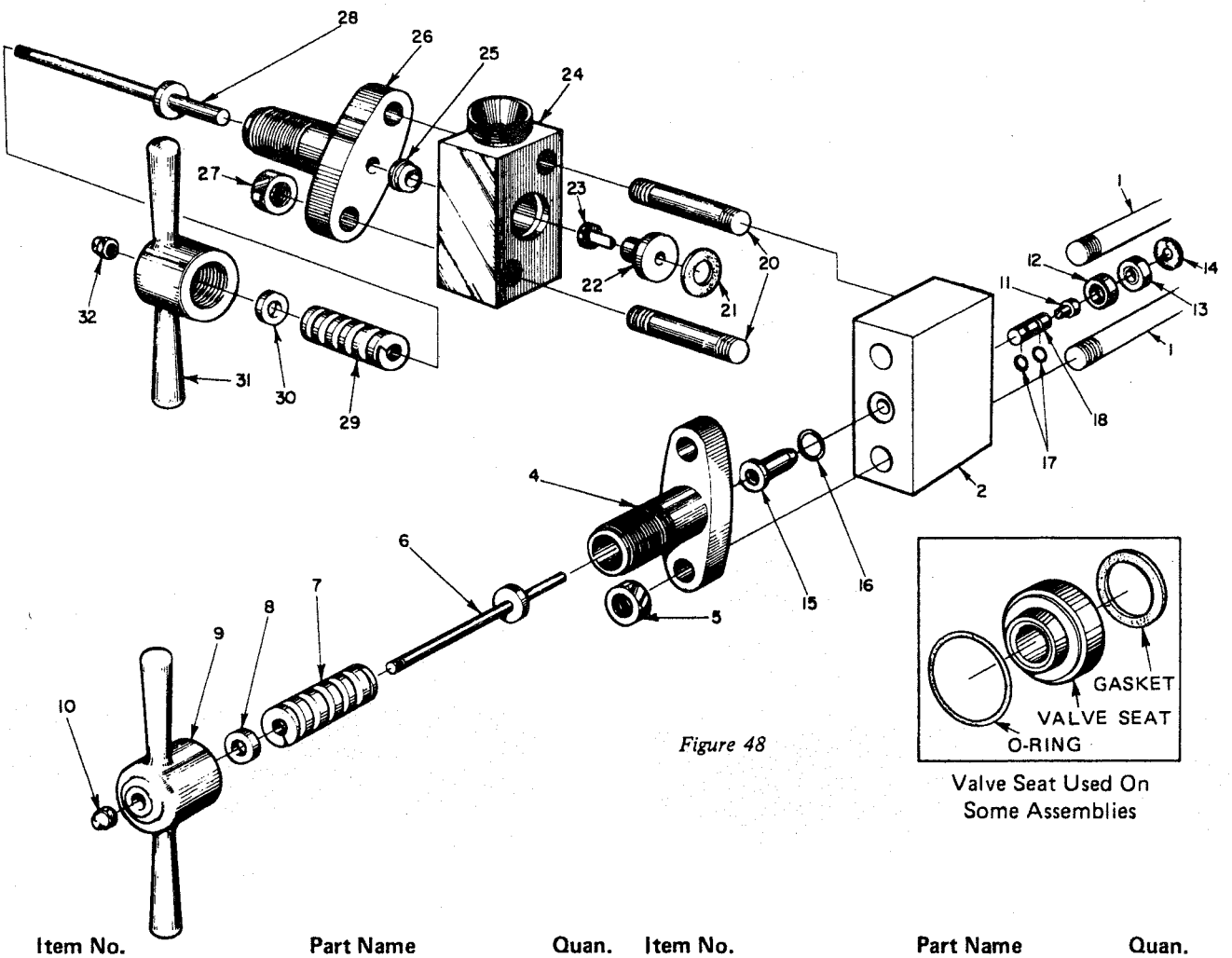


Figure 48

Valve Seat Used On Some Assemblies

Item No.	Part Name	Quan.
FIRST STAGE		
1	Valve Body Stud	2
2	Valve Body	1
4	Hand Wheel Support	1
5	Valve Body Stud Nut	2
6	Valve Rod	1
7	Valve Spring	1
8	Valve Rod Washer	1
9	Hand Wheel	1
10	Valve Rod Cap Nut	1
11	Homo Valve Insert	1
12	Impact Ring	1
13	Homo Valve Seat Assembly	1
14	Homo Valve Seat Gasket	1
15	Homo Valve Guide	1
16	Homo Valve Guide Gasket	1
17	Homo Valve Gasket	2
18	Homo Valve Holder	1

Item No.	Part Name	Quan.
SECOND STAGE		
20	Valve Body Stud	2
21	Valve Seat Gasket	1
22	Valve Seat	1
23	Valve	1
24	Valve Body	1
25	Valve Rod Packing	1
26	Hand Wheel Support	1
27	Valve Body Stud Nut	2
28	Valve Rod	1
29	Homo Valve Spring	1
30	Valve Rod Washer	1
31	Hand Wheel	1
32	Valve Rod Cap Nut	1

When ordering Parts, specify Model No., Serial No., Part Name, and Quantity.

PLATE V 217 (E)

HOMOGENIZING VALVE INSTRUCTIONS

VALVE DISASSEMBLY

1. Remove second-stage Valve Body Stud Nuts (#27), second-stage Handwheel (#31) and Handwheel Support assembly (#26).
2. Remove second-stage Valve Body (#24) being careful not to drop the valve and seat.
3. Remove Valve (#23) and Seat (#22) from second-stage Body (#24).
4. Remove first-stage Valve Body Stud Nuts (#5), first-stage Handwheel (#9) and Handwheel Support (#4).
5. Remove first-stage Valve Body (#2) assembly being careful not to drop valve components.
6. Remove Valve Seat Gasket (#14), Valve Seat (#13), Impact Ring (#12) and Valve (#11).

Note: If your machine is furnished with a Hydraulically Actuated Homogenizing Valve Assembly (HVA) also see Plate V220 for complete reassembly instructions

CLEANING – Clean all parts thoroughly. Use brushes. Do not use metal brushes, sponges or other abrasive aids on parts.

Be careful to prevent metal parts from striking each other or other metal objects.

Lubricate all external threads with an acceptable lubricant before reassembling. Repeat this procedure on disassembly for at least one month to allow the threaded parts to become work hardened.

VALVE REASSEMBLY

1. Install impact ring (#12) into first stage valve body (#2).
2. Insert first stage valve (#11) into valve seat (#13) and assemble as a unit into valve body (#2).
3. Install valve seat gasket (#14).
4. Assembly first stage valve body (#2) on studs (#1).
5. Reassemble handwheel (#9) and handwheel support (#4) assembly on studs.
6. Replace stud nuts (#5) and tighten envenly and securily.
7. Insert second stage valve (#23) into valve seat (#22) and install as an assembly into second stage valve body (#24).

NOTE: To guard against possible valve stem breakage, be certain that valve (#23) remains inserted into valve seat (#22) after assembly has been placed into position in valve body.

8. Insert valve seat gasket (#21).
9. Assemble second-stage valve body to first stage valve assembly on studs (#20).
10. Assemble Handwheel Support (#26) and Handwheel (#31) as a unit onto valve Body Studs (#20).
11. Replace stud nuts (#27) and tighten evenly and securely.

PLATE V 217 (E)

TWO-STAGE HOMOGENIZING VALVE ASSEMBLY
(Both Valve Stages are Piloted Type Valve)

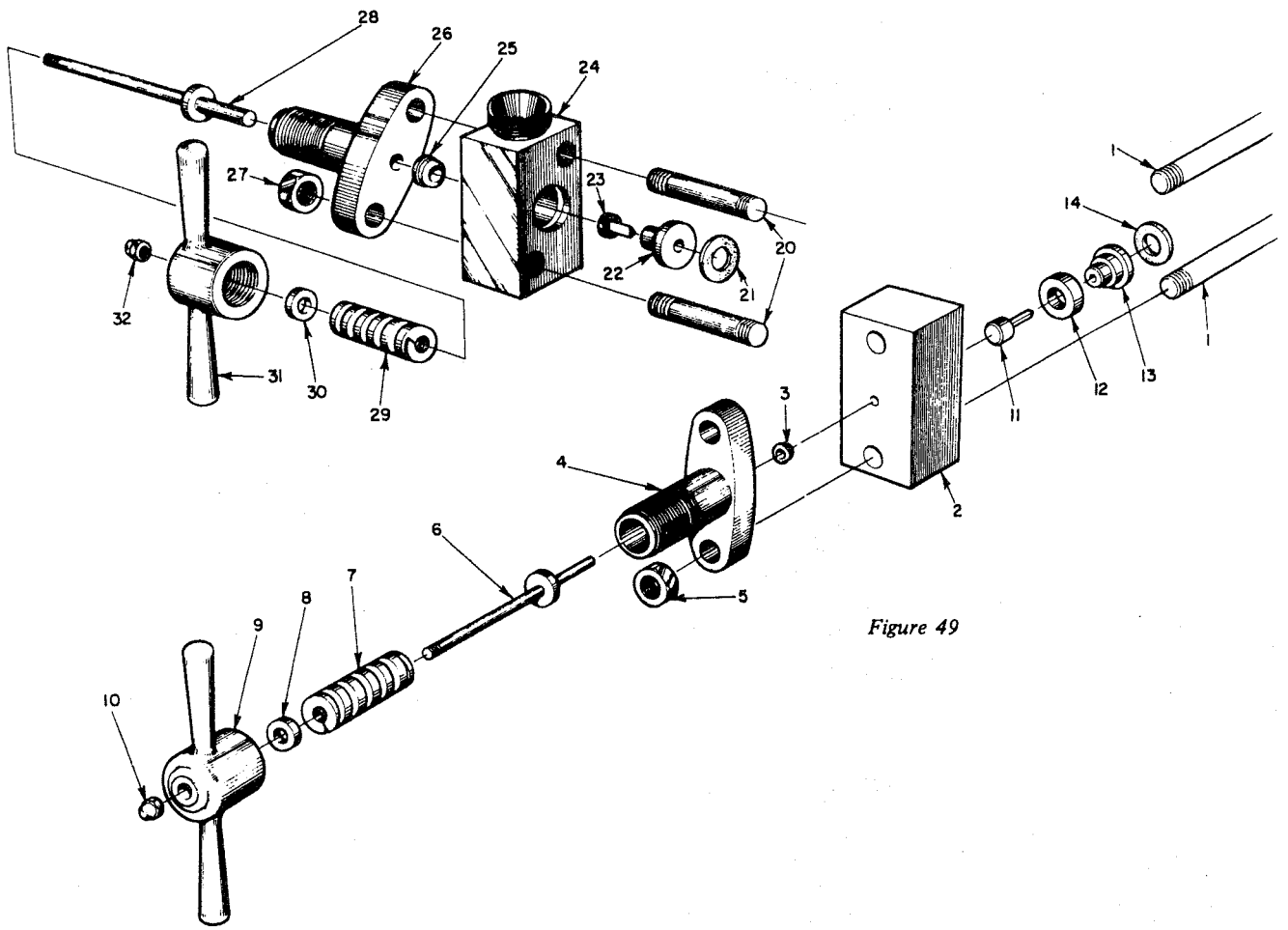


Figure 49

Item No.	Part Name	Quan.	Item No.	Part Name	Quan.
FIRST STAGE			**SECOND STAGE**		
1	Valve Body Stud	2	20	Valve Body Stud	2
2	Valve Body	1	21	Valve Seat Gasket	1
3	Valve Rod Packing	1	22	Valve Seat	1
4	Hand Wheel Support	1	23	Valve	1
5	Valve Body Stud Nut	2	24	Valve Body	1
6	Valve Rod	1	25	Valve Rod Packing	1
7	Valve Spring	1	26	Hand Wheel Support	1
8	Valve Rod Washer	1	27	Valve Body Stud Nut	2
9	Hand Wheel	1	28	Valve Rod	1
10	Valve Rod Cap Nut	1	29	Homo Valve Spring	1
11	Homo Valve	1	30	Valve Rod Washer	1
12	Impact Ring	1	31	Hand Wheel	1
13	Homo Valve Seat	1	32	Valve Rod Cap Nut	1
14	Homo Valve Seat Gasket	1			

When ordering Parts, specify Model No., Serial No., Part Name and Quantity.

PARTS LIST FOR PLATES B168, B169 AND B170

Item No.	Part Name	Quan.
1	Top Plate Screws	*
2	Top Plate Sealing Washer	*
3	Top Plate Gasket	
4	Oil Pump Mounting Cap Screw	4
5	Oil Pump	1
6	Gear Case Cap Screw	*
7	Top Plate Assembly	1
8	Bearing Lock Ring (Pinion Side)	1
9	Drive Shaft Bearing (Pinion Side)	1
10	Oil Filter Mounting Bracket	1
11	Drive Shaft	1
12	Pinion Key	1
13	Air Inlet Nipple	2
14	Base	1
15	Cylinder Dowel	2
16	Cylinder Gasket	1
17	Base Mounting Cap Screw	4
18	Base Mounting Lockwasher	4
19	Sub Base	1
20	Motor Rail Shaft Set Screw	2
21	Motor Rail Collar	2
22	Motor Rail	2
23	Motor Rail Shaft	1
24	Motor Rail Adjusting Screw	4
25	Motor Rail Shaft Support	2
26	Motor Rail Shaft Support Lockwasher	4
27	Motor Rail Shaft Support Cap Screw	4
28	Driven Sheave Assembly (Includes 29, 30, 31)	
29	Driven Sheave Lockwasher	3
30	Driven Sheave Cap Screw	3
31	Driven Sheave Bushing	1
32	Driven Sheave Key	1
33	Driving Sheave Assembly (Includes 34, 35, 36)	
34	Driving Sheave Lockwasher	3
35	Driving Sheave Cap Screw	3
36	Driving Sheave Bushing	1
37	VEE Belt	
38	Motor Rail Shaft Set Screw	2
39	Motor Mounting Screw Lockwazher	4
40	Motor Mounting Screw	4
41	Driving Sheave Key	1
42	Motor	1
43	Drive Shaft Bearing (Drive Side)	1
44	Bearing Lock Ring (Drive Side)	1
45	Base Foot	4-6
46	Drive Shaft Seal	1
47	Seal Retainer Cap Screw	6
48	Seal Retainer	1
49	Seal Retainer Gasket	1
50	Oil Pump Driving Gear Key	1
51	Oil Pump Driven Gear Key	1
52	Oil Pump Driven Gear	1
53	Oil Pump Driving Gear	1
55	Gear Case Gasket	1
56	Gear Case	1
57	Cylinder Stud	4*
58	Relief Valve	1
59	Oil Filter Mounting Brkt. Cap Screw	2
60	Oil Filter Mounting Brkt. Cap Screw Lockwasher	2
61	Pinion	1
62	Crosshead Cover Cap Screw	
63	Crosshead Cover Cap Screw	4*

Item No.	Part Name	Quan.
64	Crosshead Cover	1
65	Crosshead Cover Dowels	2
66	Gear	1
67	Eccentric Shaft Thrust Washer	2
68	Eccentric Shaft Plug	2
69	Gear Key	1
70	Eccentric Shaft Assembly	1
71	Connecting Rod Dowel	6*
72	Connecting Rod Cap	3*
73	Connecting Rod Bolt	6*
74	Connecting Rod Bearing	6*
75	Connecting Rod Bearing Dowel	6*
76	Connecting Rod	3*
77	Connecting Rod Nut	6*
78	Eccentric Bearing Cap	2
79	Eccentric Shaft Bearing	2
80	Crosshead Bearing Ball Set Screw	6*
81	Crosshead Bearing Retainer Nut	3*
82	Crosshead Bearing Retainer	3*
83	Crosshead Bearing Ball	3*
84	Crosshead Bearing	3*
85	Crosshead Set Screw	3*
86	Crosshead	3*
87	Plunger Adapter Set Screw	6*
88	Plunger Adapter	3*
89	Packing Adjusting Screw	3*
90	Baffle Seal Packing	6*
90A	Baffle Wiper Ring	6*
91	Baffle Stuffing Box	3*
92	Eccentric Shaft Bearing Dowel	2
93	Eccentric Shaft Cover Plate Gasket	1
94	Eccentric Shaft Cover Plate	1
95	Eccentric Shaft Cover Plate Cap Screw	6
96	Bearing Cap Screw	8
97	Top Cover	1
98	Handle	2
99	Handle Screw	4
100	Oil Splash Guard	1
101	Panel Screw	Varies
102	Rear Panel	1
103	Oil Splash Guard Gasket	Varies
104	Panel Support Left	2
105	Side Panel Left	1
106	Well Strip	1
107	Tinnerman Nut	Varies
108	Oil Pressure Gauge Gasket	1
109	Front Side Panel Left	1
110	Contact Block	2
111	Front Panel Center	1
112	Front Side Panel Right	1
113	Panel Support Right	2
114	Side Panel Right	1
115	Oil Pressure Gauge	1
116	Start Switch	1
117	Stop Switch	1
122	Well Cover	1
126	Well Lining	1
127	Name Plate – Serial Number	1
129	Fan Mounting Spacer	1
130	Fan	1
131	Fan Mounting Bolt Lockwasher	1
132	Fan Mounting Bolt	1
133	Air Inlet Vent Nipple	2
134	Oil Filter	1

PLATE B168

MC MODELS BASE, DRIVE COMPONENTS

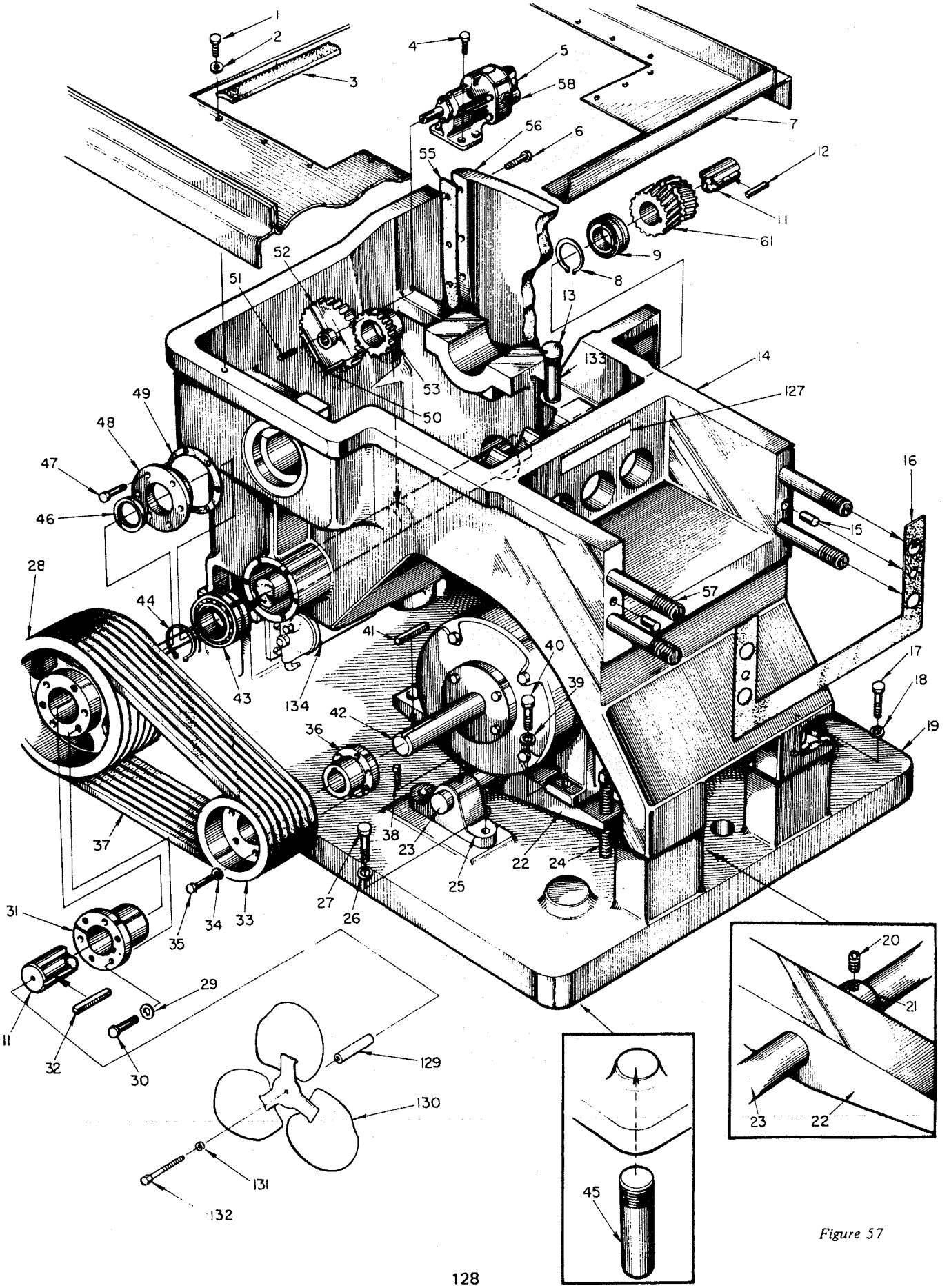


Figure 57

PLATE B169

MC MODELS BASE, DRIVE COMPONENTS

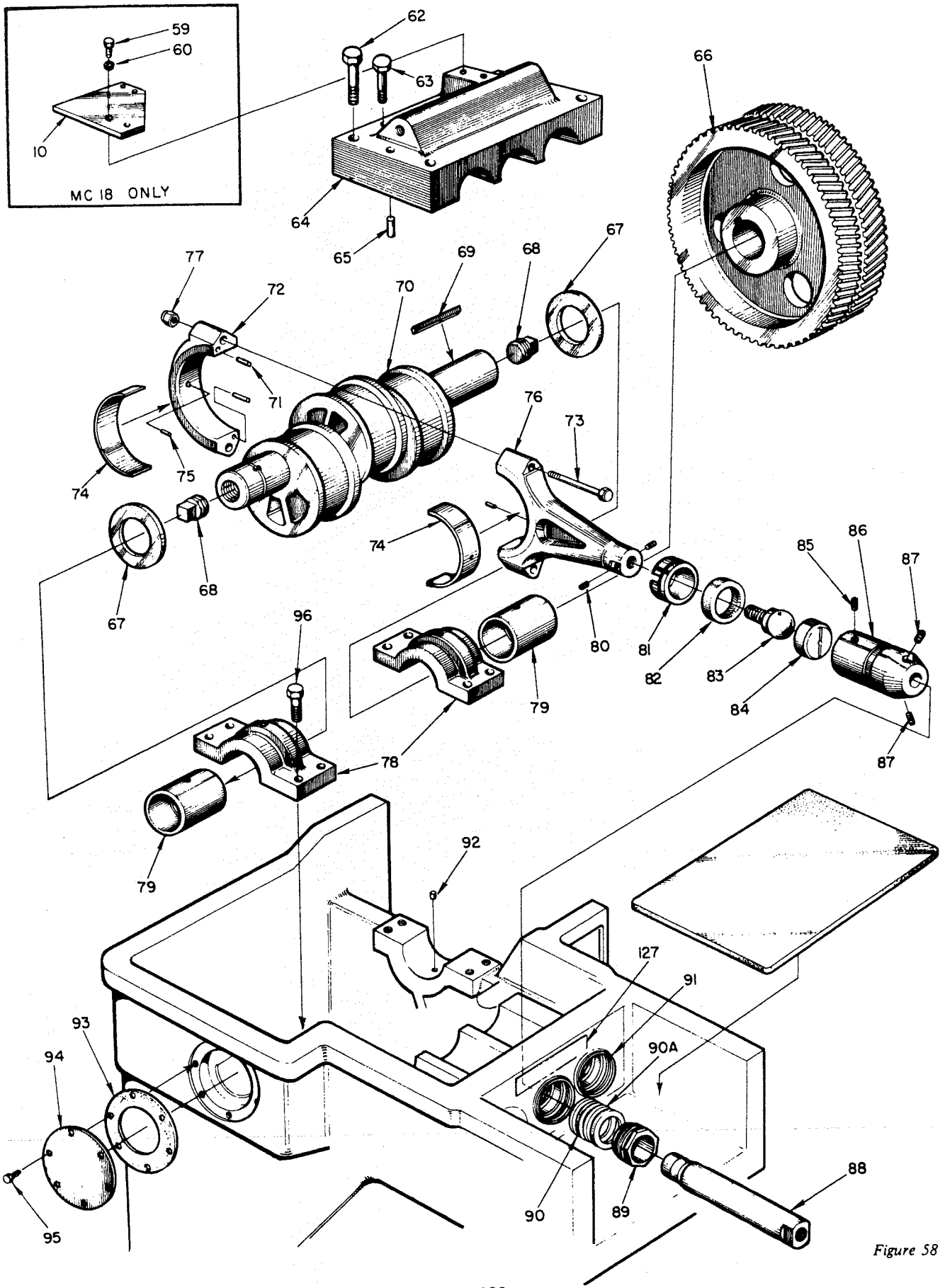


Figure 58

PLATE B170

MC MODELS STAINLESS STEEL SKIN

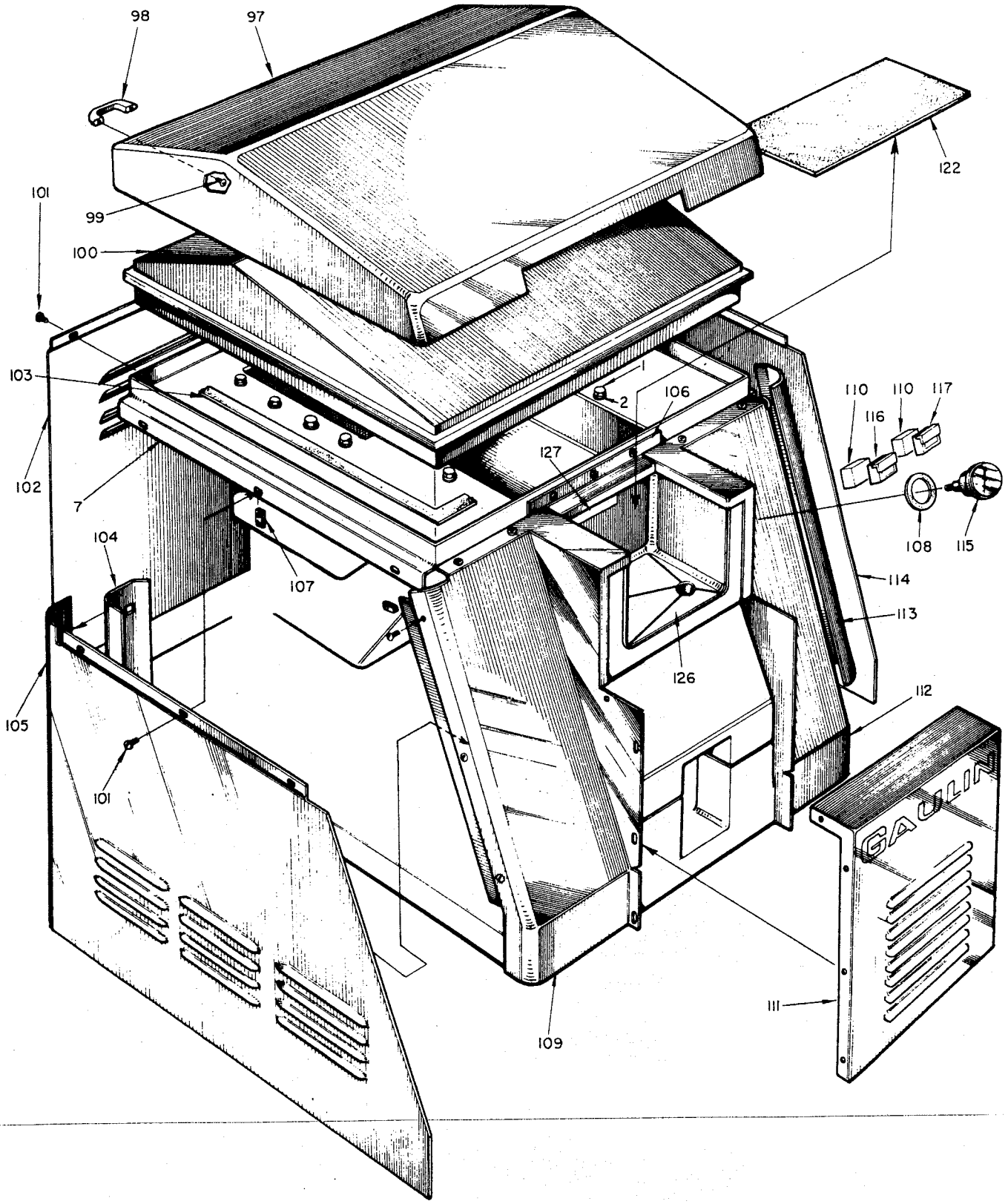
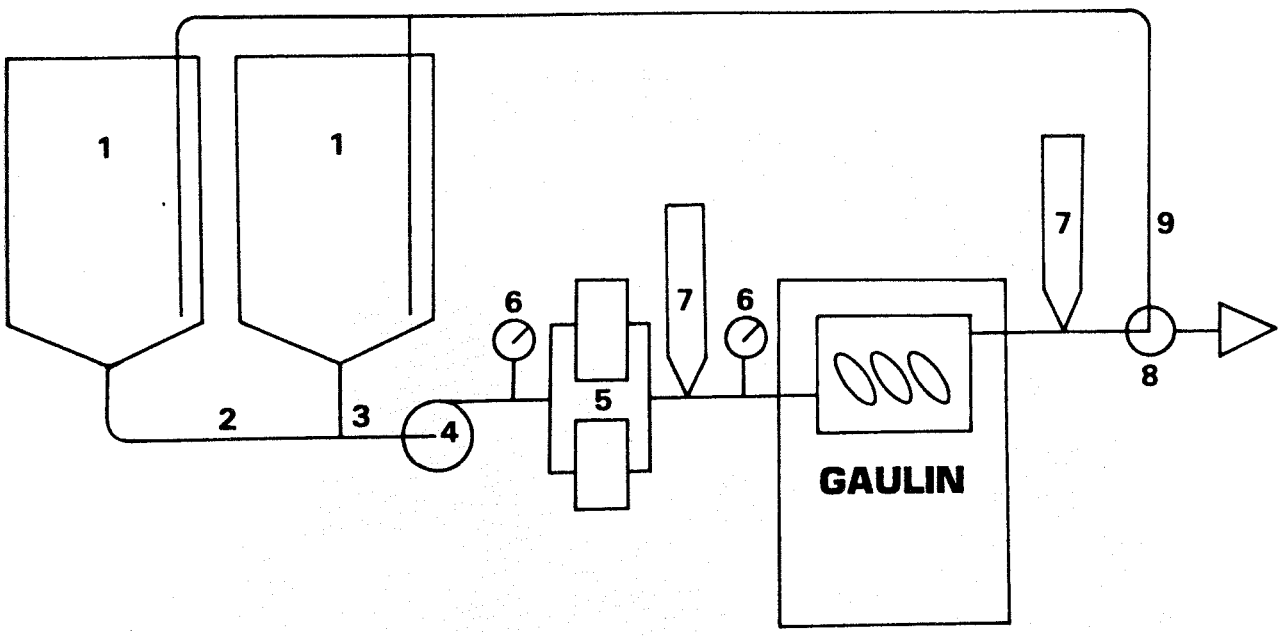


Figure59

RECOMMENDED LAY-OUT OF
GAULIN
HOMOGENIZER/PUMP INSTALLATION



1 **Feed Tank.** Tank design with agitator (if used) to be such as to avoid early drawing of vortex, resulting in air entrapment. Low level detector may be installed to sound alarm or automatically stop homogenizer/pump and/or lower homogenizing pressure prior to the time that feed tank is completely emptied.

2 **Suction & Discharge Piping.** Avoid long lines and sharp elbows as far as practical and select pipe line diameters not less than those specified for the homogenizer/pump suction and discharge respectively.

3 **Change-over to another feed tank.** The valve arrangement in the suction piping should be such that the change-over from one feed tank to another will be gradual, allowing stagnant product in the line to accelerate to normal flow velocity before the feed from the first tank is cut completely.

4 **Feed Pump.** To be dimensioned such as to ensure positive feed pressure, preferably not less than 1 bar over the vapor pressure of the product, immediately at the homogenizer inlet. Heavy bodied products may require an even higher pressure.

5 **Suction Strainer.** Recommended for protection of homogenizer/pump cylinder parts. Preferably duplex arrangement for easy maintenance without interruption of product flow.

6 **Suction Pressure Gauges.** One to be installed upstream of filter and one immediately at homogenizer inlet to register the inlet pressure and the pressure drop across the suction strainer to indicate strainer fouling.

7 **Hydraulic Accumulators or Vibration Dampeners.** Recommended to be mounted in homogenizer in and outlet line, if pipe line vibration excessive which often due to excessively long tubing, high pipe line velocities etc.

8 **Valve in Homogenizer/Pump Discharge Line.** Under no circumstances do install shut-off valves in discharge line. To divert product flow, use threeway valve or similar which keeps discharge open in at least one of several directions.

9 **Return Line.** If installed, returnflow to discharge preferably under level of product in feed tank to prevent incorporation of air.

Attention. Perfect feed conditions are of paramount importance. Also it should be borne in mind that the homogenizer/pump uses a positive volume pumping system which is capable of an unlimited pressure build-up in case of flow restrictions in the discharge line. Any possible restrictions in the discharge system therefore warrant the installation of protective devices.

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Telefon (0451) 69 10 18 · Telex 02 6 355

GAULIN HOMOGENIZERS & PUMPS

IMPORTANT

chart to be mounted on wall or on machine in full view of operator

To avoid mechanical damage and inadequate homogenizing efficiency (homogenizers only) it is imperative that the SERVICE MANUAL is thoroughly studied prior to the initial machine start-up and that it is kept available to the operator at all times. The following instructions even though not to the exclusion of others, may, if not strictly adhered to, lead to major damage and deficiencies.

1 Upon initial start-up the unit is to be operated at full product flow but zero pressure for a minimum of one hour in order to remove dirt and pipe scale from the entire system without causing extreme wear and tear to the homogenizing valve parts.

2 Do not operate the unit for any extended period of time without product or any other liquid medium passing through.

3 Do not under any circumstances start the unit with the homogenizing valve loaded.

4 Never empty feed tank and/or allow a vortex to develop at the feed tank outlet when the unit is operating under pressure.

5 Avoid incorporation of air in product.

6 Make sure that pressure in feed line at cylinder inlet is never less than 1 atm over the vapor pressure of the product at the operating temperature. When handling heavy bodied products, a further increase of feed pressure may be required to prevent starvation from occurring.

7 If feed pressure insufficient at any time during operation, turn homogenizing pressure down to zero immediately. No harm is done in continuing pumping operation as long as no homogenizing pressure is applied.

8 Discontinue operation as soon as feasible, when noticing heavy pressure fluctuations on product pressure gauge excessive vibration in machine or pipe lines or a metallic knocking sound or any other abnormal noise in cylinder and/or drive end. Check pump valves and seats, packings and gaskets, product pressure gauge and feed conditions.

9 Low lub oil pressure safety switch should remain wired into motor circuit and correctly adjusted at all times. Check regularly for correct functioning which done by loosening the oil line connection at the switch to bring pressure down to zero. If impracticable, turn micro-switch up until unit stops; then reset.

10 Check lub oil regularly and drain water condensate if necessary. Replace lub oil as instructed.

11 Check homogenizing valve and seat regularly and regrind or replace, if and when radial grooves have developed across three quarter of working surfaces. Replace impact ring, if worn (Applies to homogenizers only).

12 Check belt tension regularly to avoid slippage and resulting drop in capacity and belt breakage.

13 Adjust valve in line to plunger drip tube to minimum flow such as to still ensure that entire circumference of plunger wetted at all times.

14 Never tighten front cylinder cap nuts during operation under pressure.

A.P.V.-SCHRÖDER GmbH

Vormals Wilh. G. Schröder Nachfolger GmbH

2400 LÜBECK 16 · Mecklenburger Straße 223 · Postfach 160 167

Telefon (0451) 69 10 18 · Telex 02 6 355

Your Machine is

CUSTOMER'S NAME SIMILAC
ADDRESS _____
P. O. # M-24428/01374

(1) **MODEL** 2642 MC 45 - 5 TPS

(2) Your Serial Number - 80L31547

(3) Your Maximum Operating Capacity is _____ G.P.H. - 10.000 L/h

(4) Your Maximum Operating Pressure is _____ P.S.I. - 345 bar
(As indicated by red marker on pressure gauge.)

(5) Your Model and Frame Size is MC 45 - 5 TPS
Your Plates for Power End are

B168, 169, 170, Page 330.48

(6) Your *Cylinder is _____
Heading See Data Chart on Plate C213, page 330.43
Correct components consist of Group I and Section Plate C 213, Page 61, Group B.
* (Triplex illustrations are shown on Plate C213 only - Quintuplex or others are applicable to those Plates).

(7) Your Machine is furnished with a single stage Homogenizer ~~or SMD Assembly.~~
Heading ~~See Data Chart on Plate V216,~~ page 330.44
~~Correct components~~ consist of Group I and Section Plate V 216, Page ..., Group ...

(8) Your Machine is furnished with a two stage Homogenizer or SMD Assembly.
Heading See Data Chart on Plate V217, page 330.45
Correct components consist of Group I and Section Plate V 217, Page 96, Group C..

(9) Your HVA Assembly consists of a Box Unit or Integral Unit - See Pages 330.37-41 for details

(10) Your Motor H.P. is _____ / ./. kW

(11) Your Gear Ratio is ~~5.0, 5.18, 5.23, 5.37~~ 5,35

(12) Your Plunger Diameter is 2-1/8 inches

(13) Your Plunger Stroke is 6 inches

(14) The number of pieces of Packing per Plunger is 3 (504023)

(15) Your Suction Connection is NW 65 DIN 11851

(16) Your Discharge Connection is NW 40 DIN 11851

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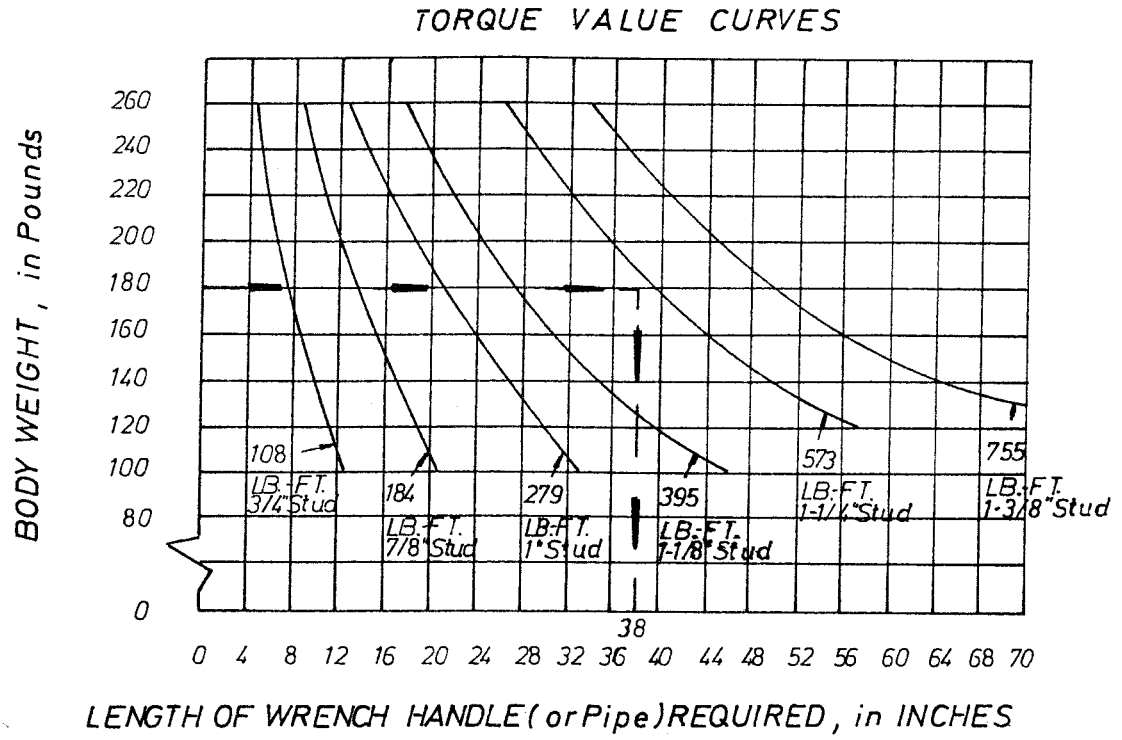
TORQUE VALUE FOR SHOULDERED STUDS

Metric dimensions for 1m handle

Stud dimens.	Torque in Nm
3/4"	146
7/8"	250
1 "	378
1-1/8"	536
1-1/4"	913
1-3/8"	1024

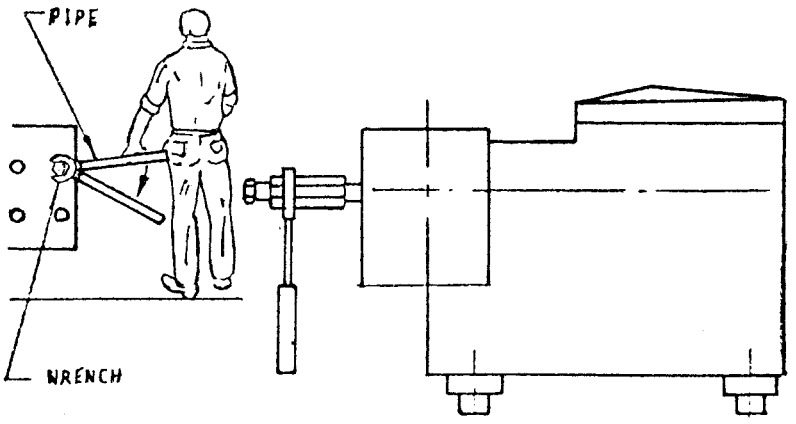


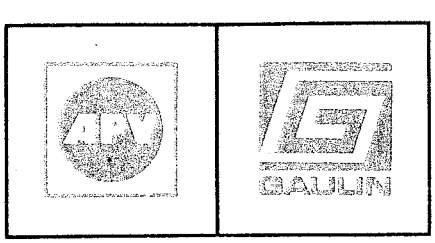
HOW TO USE TORQUE CURVES

1. The torque value curves shown above represent calculated value based on dead body weight. The use of additional body force or push on the wrench or pipe handle end (such as jumping on the handle) will produce an over-torque on the stud.
2. (Example of usage) Refer to the arrow-line shown. If a 180-pound person wants to torque a 1-1/4" stud, he should use a 38" long wrench or pipe extension, as measured from the center of the stud.

TORQUING THE SHOULDER-TYPE STUD

To properly install studs a torque wrench is normally required. However, if none is available, it is necessary to install studs with the use of a socket wrench, adjustable wrench or open-end wrench and a piece of pipe of a length as specified in the table attached. (It is very important to use exactly the length of the pipe indicated.) When using the specified length of pipe, slide the pipe over the wrench handle all the way up to the wrench end. Do not permit the pipe to slip off of the end of the wrench. Now, using your body weight, grip the pipe at the very end, so that both your hands are next to each other. Lean on the pipe, forcing the hex stock to turn. When you cannot turn any further, this will have produced a torque equal to or greater than the maximum torque required.





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