CHEMICAL INSTRUMENTATION SYSTEMS

Serial # 87252

Cap 28 GPH

Type 1-35-113

Model-A.

MILROYAL

CONTROLLED VOLUME PUMPS

MODEL A-1&B-1

MANUAL 35.307

INSTRUCTION MANUAL

FOR MILROYAL

MOTOR DRIVEN CONTROLLED VOLUME PUMPS

MODELS A-1 & B-1

NOTE

IMPORTANT

Place this manual in the hands of personnel responsible for the installation, operation, and maintenance of the equipment

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MILTON ROY COMPANY

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INTRODUCTION

GENERAL DESCRIPTION

A controlled volume pump is a reciprocating, positive displacement pump designed to meter liquids in measured volumes against a positive differential pressure (or head) between pump suction and discharge. (Discharge pressure must be greater than suction pressure.) Precision built, the pump performs this metering function with an accuracy within plus or minus one percent.

Basically, the pump consists of a drive unit, a plunger, and a displacement chamber or liquid end in which the plunger reciprocates. The pump delivers a controlled volume of liquid with each discharge stroke.

Pump capacity is adjustable by changing plunger stroke length and/or plunger stroking speed. Such adjustments can be made manually, or automatically by signal from remote process control instruments. Selection of capacity control methods is determined by the nature of the application.

PURPOSE OF THIS MANUAL

The Milton Roy Controlled Volume Pump is a rugged, precision-built unit designed for years of trouble-free service. This instruction manual is intended to help you get this service.

The manual is divided into four main sections: installation, operation, maintenance and stroke adjustment. Tips on tracing and correcting some of the more common troubles are given at the back of this manual, together with parts drawings and parts lists.

Trouble-free performance begins with proper pump selection and application. If you change your pump from its original service and are in doubt about the specifications or the application, contact your local Milton Roy engineering representative, or the factory, for assistance and advice. *It may save you costly downtime.*

WARRANTY

The Milton Roy Company guarantees its products against defects in workmanship or material under normal use and service for a period of one year from date of shipment from originating plant at Wyndmoor, Montgomery County, Pennsylvania, or St. Petersburg, Florida. All obligations and liabilities under this guarantee are limited to repairing or replacing at our option, f.o.b. plant of shipping origin, of such allegedly defective units as are returned, carrier charges prepaid. All repairs or replacements are made subject to factory inspection of returned parts at company plant. No liability is accepted for consequential damages or reinstallation labor.

Defects as defined in the above paragraph shall not include decomposition by chemical action (corrosion). The materials of construction offered are recommendations based on many years experience; however, these recommendations are not to be considered guarantees against wear and/or corrosion and are subject in all cases to verification and acceptance by the Purchaser.

Guarantee on equipment and accessories furnished by outside manufacturers shall be limited to the guarantee of the respective equipment and/or accessory manufacturer for such units.

The Milton Roy Company will not assume responsibility for contingent liability through alleged failure or failures of any of its products of their accessories.

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A. LOCATION

Locate the pump so that suction and discharge piping are as short and free of bends as possible. A long suction line is not desirable.

If possible, locate the pump below the liquid level in the reagent storage vessel. A flooded suction line helps avoid vapor binding of the pump.

Allow enough space around each pump to perform routine maintenance and operating adjustments. When locating the pump out of doors, or in a dusty or wet area, install a cover over the unit. Allow adequate ventilation in the cover to remove heat.

B. REMOVAL OF PUMP FROM CRATE

1. *The crate should be carefully examined on receipt from carrier to be sure there is no obvious damage to contents.* Open crate carefully, as there sometimes are accessory items fastened to the inside of crate which may be damaged or lost by carelessness. Examine all material inside crate, check against packing list to be sure that all items are accounted for, and that they are undamaged.

2. All pumps are given a thorough test under simulated operating conditions before they leave the factory. This test includes a test to verify the pump capacity, and a check on the drive motor under actual pumping load. This test insures that the pump meets specifications as covered by your order.

3. a. Wipe off the outside of pump casing to be sure that no dirt gets into drive mechanism when cover is removed. Fill the gear case with the special "MILROYAL" oil. The oil should be slowly poured down over the gear housing and shaft bearings.

b. If pump is of the packed plunger design, it probably requires a special lubricant for the packing. Refer to data face sheet in front of this manual for this special lubricant. The packing should be lubricated sparingly with the special lubricant.

NOTE: that data face sheet may indicate either:

(1) Flush stream connections or;

(2) Internal flush instead of a packing lubricant. Refer to Section 1–F–3.

4. If pump is to be stored, or will not be used for sometime, it is suggested that the packing be removed and stored in an airtight container to prevent deterioration.

NOTE that this precaution is not necessary with teflon packing.

C. FOUNDATION

Support the pump firmly on a concrete foundation, preferably with its level two inches or more above the floor level to protect it from wash-downs and to provide easier access for service. All pumps are provided with at least four holes to accommodate anchor bolts.

Install the pump in a level position and draw the anchoring bolts up firmly.

D. PIPING

1. General Information

a. Use piping of materials resistant to corrosion by the liquid being pumped. Exercise care in selection of materials to avoid galvanic corrosion at points of connection to the pump liquid end.

b. Both suction and discharge piping must be adequate to handle peak instantaneous flow. The flow follows an approximate sine curve due to the reciprocating motion of the plunger and peak instantaneous flow is approximately pi (3.14) times the average. Therefore, the piping must be designed to handle a flow of pi times the pump capacity. For example, a Milroyal with a rated capacity of 88 gallons per hour must have piping designed for 88 x 3.14 (or 276) gph. Refer to Section 1–G, "Net Positive Suction Head" before designing suction piping.

c. When making up joints, be sure inside diameters match perfectly. Remove burrs and sharp edges, and avoid possibility of welding shot or spelter entering lines. Blow out all lines before making final connections to pump.

d. Provide for pipe expansion when hot fluids are to be pumped. Support piping so that strain is not placed on the pump. Never spring piping to make connections.

e. Make suction and discharge piping as straight and short as possible, avoiding unnecessary elbows. Where necessary, use 45 degree or long sweep 90 degree fittings. Piping should be sloped, if necessary, in a direction to eliminate vapor pockets.

f. Use flexible connections for both suction and discharge on pumps with plastic liquid ends. Never use rigid pipe, whether plastic or metal, on these units.

g. When handling liquids which form deposits in pipelines, use plugged crosses at points where lines change direction 90 degrees. This will permit cleaning without dismantling the piping.

h. Install suitable corrosion-resistant piping to drain stuffing box leakage to waste. Keep this pipe open at all times.

i. Use concentric bushings in vertical lines only, unless the piping arrangement provides natural venting of horizontal lines.

j. Install expansion loops, valves, and similar equipment in positions (valve stems pointing horizontally or downward, for example) to prevent formation of vapor pockets.

k. Safety considerations are most important when liquids handled may be hazardous to personnel or property. Adequate strength, corrosion resistance and location of piping must be considered. An approved safety valve (or rupture disc) is mandatory to protect the pump, associated piping and other equipment from over-pressure.

2. Suction Piping

a. If possible, use either metal or plastic tubing for the suction line because it has a smooth inner surface and is easily formed into sweep bends.

b. Suction piping must be absolutely tight. After installation, test suction piping with air and soap solutions for leaks.

c. When pumping liquids at temperatures near the boiling point, or when pumping from a vacuum, provide sufficient suction head to prevent "flashing" of the liquid into vapor when it enters the pump displacement chamber on suction stroke. Refer to Section 1–G, Special Pumping Problems for Instructions for determining net positive suction head available.

d. Tight joints, sufficient net positive suction head, and properly adjusted packing are absolutely necessary for efficient and nonerratic pump operation. Failure to meet these requirements may allow formation of vapor bubbles in the displacement chamber which will cause erratic pumping or even pump failure.

3. Discharge Piping

a. Install adequately sized pipe to prevent excessive pressure losses on the discharge stroke of the pump.

b. Be sure pipe pressure rating is in excess of the safety valve setting (see item below).

c. Discharge pressure greater than suction head is necessary for a controlled volume pump to function accurately. If discharge pressure is less than suction head, an artificial pressure head must be supplied. Refer to Category G, Item 3, Special Pumping Problems.

4. Safety Valves

Motor driven positive displacement pumps can build up tremendous discharge pressures in one or two strokes, long before thermal over-load protection or similar devices in the motor starter circuit become effective. Very serious damage to the pump, discharge line, or process equipment can occur if the discharge line is obstructed. To prevent this, equip the discharge line with a properly designed safety valve, sized to handle system pressures safely and to carry the maximum pump flow rate and of a material corrosion-resistant to the pumped liquid.

Proper location of the safety valve is on the discharge line between the pump and any shut-off valve. Pipe outlet of the safety valve back to the suction tank, or to drain, with the open end of the pipe visible at all times. In this way, safety valve leakage may be easily detected. *The Milton Roy Diaphragm-Type Safety Valve must be installed so that absolutely no back pressure is applied to the outlet.*

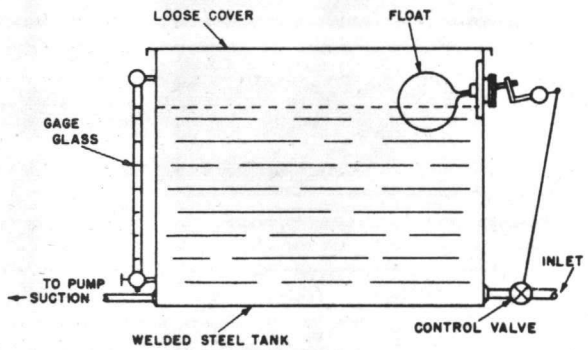


Figure 1. Typical Float Box Illustration

e. Negative suction pressure conditions (suction lift) should be avoided whenever possible, particularly with diaphragm type pumps, if maximum metering accuracy is to be obtained. Applications requiring operation under negative suction pressure should be referred to factory for engineering analysis and specific installation and operating recommendations.

f. If long suction lines are unavoidable, use a float box or auxiliary feed tank (stand pipe) close to the suction side of the pump. A typical float box is shown in Figure 1. The float box may be calibrated and used to check pump capacity by measuring the time required to pump a specific quantity of fluid from the box.

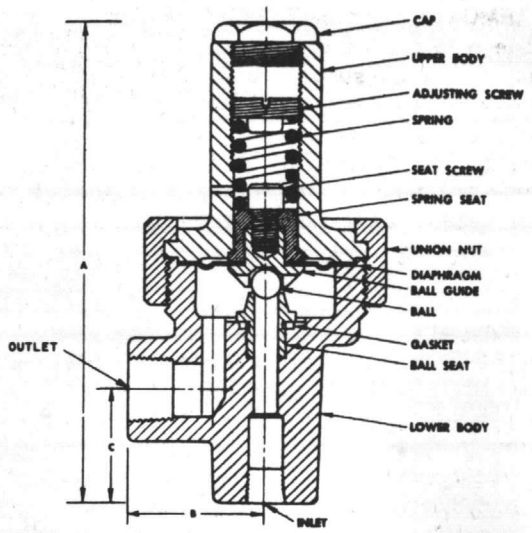


Figure 2. Milton Roy Safety Valve

5. Check Valves

For safety reasons, a check valve should be installed in the discharge line near the point where the line enters a boiler or other high pressure process vessel.

6. Shut-Off Valves

Provide shut-off valves, adjacent to the pump, in both suction and discharge lines. *Locate valve after the safety valve in the discharge line.* Pipe unions in these lines (on the pump side of the shut-off valves) will facilitate servicing the liquid end in those cases where it must be removed from the pump frame.

E. POWER CONNECTIONS

1. Check the nameplate rating of the motor and any auxiliary electrical equipment against the available power supply before making connections.

2. The motors furnished on motor-driven Controlled Volume Pumps are usually squirrel cage induction motors. Consequently, they have high starting torques and high starting currents (normally in the range of 300 to 350 percent of maximum running current). If the motors are connected to light duty power lines, make sure that on starting they will not overload the circuits. Be sure they are protected with correctly sized thermal overload devices.

3. Approved wiring and conduit piping practice should be followed throughout.

F. SERVICES

Check the complete installation to determine the services necessary for proper operation of the system. Some of the more common services required are noted below.

1. Drains

Provide drains convenient to the pump so that any leakage may be easily removed, particularly when handling corrosive materials.

2. Catchall

The catchall is tapped to receive a 1–inch pipe through which stuffing box seepage is led to a container alongside the pump base or to a drain. A nipple and a 90–degree elbow should be fitted into the bot-

tom of the catchall. A plastic funnel is also supplied with each Milroyal packed plunger pump to help direct corrosive fluid away from metallic catchall surfaces.

3. Stuffing Box Flushing

In many applications, flush stream connections are furnished to keep the packing clear of solid particles. Details are covered under Category G, Item 4, Special Pumping Problems.

4. Heating and Cooling Facilities

When abnormally hot or cold materials are pumped, the pump liquid end may be jacketed to circulate either a heating agent or coolant around the pumping chamber. Normally, the jackets are furnished with two 1/4-inch pipe taps for connection to heating or cooling medium lines.

5. Auxiliary Air and Electrical Circuits

Auxiliary or accessory electrical equipment (other than the pump driver) is normally furnished for single phase, 115 volt, 60 cycle wiring and, in general, can operate from standard lighting circuits.

Proper connections are indicated on equipment nameplates or wiring diagrams supplied with auxiliary equipment.

Air operated equipment will normally require two sources of air supply. A standard sixty-pound (80-100 psi at compressor) plant air supply will normally be satisfactory for the power elements. A standard thirty-pound (30 psi) instrument air supply is required for control instruments.

G. SPECIAL PUMPING PROBLEMS

1. NET POSITIVE SUCTION HEAD

In installations requiring suction lifts, long suction lines, pumping liquids near the boiling point, and pumping from vacuums, the net positive suction head (NPSH) conditions must be reviewed to make sure that the system will function satisfactorily.

Net positive suction head is the head available, above the vapor pressure of liquid being pumped, to push liquid into the pump suction port. Minimum net positive suction head (NPSHmin) is the head below which cavitation (vapor formation) occurs in the pump. Both values are calculated at the suction port of the pump.

In Controlled Volume Pump applications, two conditions are tested to determine the required minimum NPSH. At the *start* of the suction stroke the fluid has no velocity and the minimum NPSH (here called *static* NPSH), depends on the force necessary to accelerate the fluid in the pipeline. At the *peak* of the suction stroke there is no acceleration factor and the minimum NPSH (here called *dynamic* NPSH), depends on friction losses as calculated from standard flow equations.

a. Static NPSH:

The following formulae are used to calculate NPSH and minimum NPSH (in pounds per square inch) for Controlled Volume Pumps at the start of the suction stroke.

$$NPSH = Pa \pm Ph - Pv \quad (1)$$

$$NPSHmin = \frac{(Sp.\ Gr.)\ Lp\ LN^2D^2}{120{,}000\ Dp^2} \quad (2)$$

Where
- D = Plunger diameter (inches)
- D_p = Pipeline I.D. (inches)
- L = Pump stroke length (inches)
- L_p = Actual length of pipe (feet)
- P_a = Absolute ambient pressure above liquid (psia)
- P_h = Head of liquid column above (+) or below (–) center line of pump (psig)
- P_v = Vapor pressure of liquid (psia)
- N = Pump speed (strokes per minute)
- Sp. Gr. = Specific gravity of liquid

Following is a typical example showing calculation of NPSH available, and minimum NPSH required to determine whether cavitation will occur.

Sample Problem

Determine the limiting NPSH conditions of a Milroyal Controlled Volume Pumping System with 1 psig static suction head handling 70 gph water at 20°C. (Model MR1–38–113).

Operating Conditions

The suction storage tank is open to atmosphere. There are 25 feet of standard 1" pipe on suction line, including 1 globe valve, one tee, and two elbows. The pump has a plunger diameter of 1-1/2", a 1-1/2" stroke, and operates at 113 strokes per minute.

- D = 1.5 inches
- D_p = 1.049 inches
- L = 1.5 inches
- L_p = 25 feet (only actual length of pipe including fittings is considered)
- Pa = 14.7 psia
- Ph = 1.0 psig
- Pv = 0.5 psia (Vapor pressure of water @ 20°C)
- N = 113 strokes per minute
- Sp.= Gr. – 1.0

Solution

From equation (1) above:

NPSH (available) = $Pa \pm Ph - Pv$ =

14.7 + 1.0 – 0.5 = 15.2 psi available NPSH

From equation (2) above:

$$NPSH\ (Minimum) = \frac{(Sp.\ Gr.)\ LpLN^2D^2.}{120{,}000\ Dp^2} =$$

$$\frac{1.0 \times 25\ ¼\ 1.5 \times 113^2 \times 1.5^2}{120{,}000 \times 1.049^2} = 8.16 \text{ psi minimum NPSH required}$$

Since the NPSH available (15.2 psi) is greater than the minimum NPSH required (8.16 psi) the pump will operate without cavitation.

Sometimes it is impractical to locate pumps and associated tanks so as to avoid long suction lines. If in the above example, the suction line would be 75 feet long, the NPSH required would be 24.5 psi and the pump would cavitate in operation – resulting in unsatisfactory performance – however, increasing the pipe size to 1-1/2" (1.6" ID) will reduce the required minimum NPSH to 10.5 psi and pump will operate without cavitation.

b. Dynamic NPSH

In contrast, NPSH based on friction losses at the peak of the suction stroke is calculated from the following formula:

NPSH (available) = Pa ± Ph – Pv – (Pf) (Le) (3)

NPSH (Minimum) = 25 (Dps) (Pf) (4)

Where Dps = Standard pump suction connection I.D. (in inches)

Le = Equivalent length of pipe (feet)

Pf = Friction loss per foot of suction pipe calculated from standard hydraulic tables (in psia)

NOTE: It is important to use pi (3.1416) times average flow (Maximum pump capacity in *gallons per minute*) when determining friction loss in piping. This allows for the sinusoidal displacement curve of the Milroyal pump (e.g. the MR1–38–113) used in the previous example has a rated capacity of 70 gph. Pi (3.1416) x 70 = 220 gph, divided by 60 = 3.67 gpm. Friction loss tables for piping are usually set up for even increments in gpm flow. So, when calculated peak flow falls between increments, use *next larger* increment in table – i.e. use 4 gpm to determine loss from table.

Sample Problem

Determine the limiting NPSH condition for the system used in previous example.

Operating Conditions

Dps = 0.824" (3/4" standard pipe)

Le = 62 feet

Pa = 14.7 psia

Ph = 1.0 psig

Pf = .03 psi/ft.

Pv = 0.5 psia

Solution

From equation (3):

available NPSH = Pa ± Ph – Pv – (Pf)(Le)

= 14.7 + 1.0 – 0.5 – (.03 x 62)

= 13.34 psia

From equation (4)

NPSH (Minimum) = 25 Dps x Pf

= 25 x 0.824 x .03 = 0.618 psia

The available NPSH exceeds the minimum NPSH required, so pump will operate without cavitation.

Usually with water and fluids with similar kinematic viscosity the first pair of equations (1 and 2) applies. In pilot plants and other places where unusual numbers of fittings and valves are sometimes necessary, the second pair of equations (3 and 4) may apply.

Note that the installation of a hold up tower or supply vessel, on the suction line near the pump can greatly reduce the peak flow in the line, bringing it to nearly average flow. This is especially important with large pumps, operating at high stroking rates, as it may be more economical to provide these accessory items than to provide a long, expensive alloy suction line from storage tank to pump.
Consult factory for design assistance on such applications giving complete layout of proposed installation.

2. Divided Flow Applications

Controlled Volume Pumps are frequently used to inject water treating chemicals directly into boiler drums. Use one liquid end assembly for each individual boiler drum. It is not recommended practice to discharge into a manifold connected to several points under pressure, if metering accuracy to each point is desired. If any point is under slightly less pressure than the other it will take the major share of additive.

3. Discharge Pressure Less Than Suction Pressure

Milton Roy Motor driven Controlled Pumps are designed to operate against a positive pressure differential. Discharge pressure must be greater than suction pressure or the ball checks will not seat properly. When it is necessary to pump from higher to lower pressure, an artificial positive head, in the form of a vented riser or a back pressure valve, must be provided. However, if the condition exists in metering slurries (milk of lime for example) please consult the factory for the proper arrangement of back pressure devices.

a. A vented riser (Figure 3), which prevents siphoning action, is simply a vertical extension of the discharge pipe into an open tee. The other side of the tee goes to the process. This device provides an artificial discharge head and is practically maintenance-free.

b. A back pressure valve is a spring-loaded diaphragm valve especially designed for back pressure service. It is designed to open on each pumping stroke, rather than only for emergency relief of pressure surges. A diaphragm protects the spring from the corrosive action of the liquid being pumped and prevents particles from clogging the spring. A typical back pressure valve is shown in Figure 4.

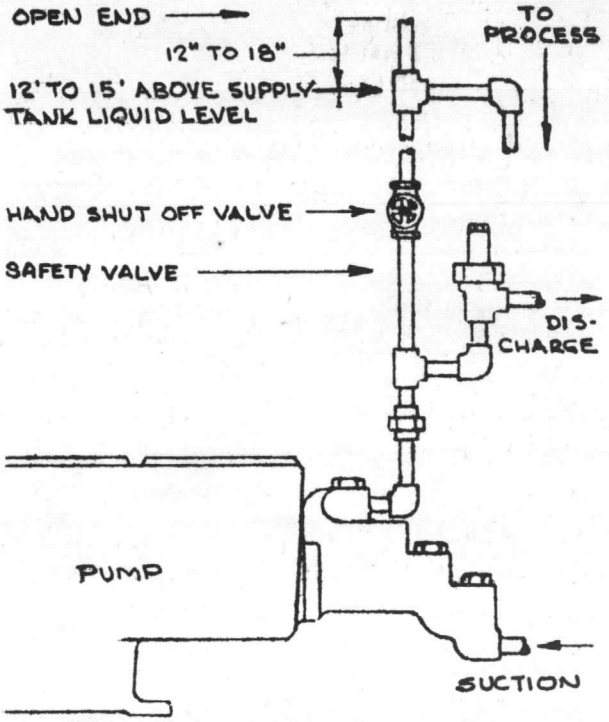


Figure 3. Vented Riser Installation

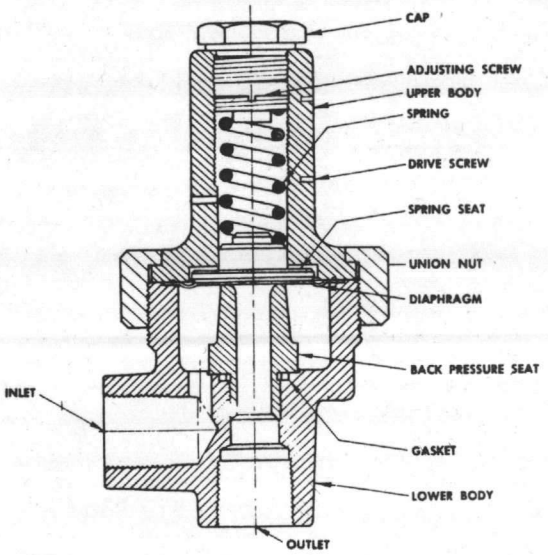


Figure 4. Milton Roy Back Pressure Valve

4. Slurry Applications

When pumping certain phosphate solutions, slurries, or solutions of limited solubility, packing and plunger life will be considerably increased if an internal flushing connection is used, with a "V" or "Chevron" type of packing. These solutions tend to concentrate in the packing and to precipitate abrasive crystals which score the plunger and result in rapid packing wear. The internal flush connection prevents these accumulations by continuously flushing the stuffing box with water in the following manner.

On the discharge stroke of the plunger, some of the liquid that is being pumped is forced back into the packing. On the suction stroke, as the "V" packing "relaxes," a little of the water introduced by the internal flush connection flows from the lantern ring along the plunger into the displacement chamber, flushing out the abrasive slurry particles or preventing the precipitation of crystals from the solution. The flow of flushing water amounts to only a few drops per minute.

The internal flush connection is made by removing the grease lubrication fitting over the pump stuffing box, and connecting the stuffing box to a source of water (or other compatible liquid) under pressure (25 to 50 psi above suction pressure). Since only a few drops per minute are required, small diameter tubing can be used to make this connection. A suitable check valve (1/8" or 1/4" NPT aircraft hydraulic system check in stainless steel) should be used on the flush line immediately adjacent to the stuffing box connection to prevent back-up of the chemical thru the flush line in case of packing failure. A small 1/8" or 1/4" needle valve should be included to facilitate adjustment of the flush water flow rate.

In some applications it is desirable to have a through flush connection to remove toxic or dangerous fluids from the stuffing box area. In these installations, flushing liquid is brought in on one side of the lantern ring and carried away from the other to a suitable drain or point of safe disposal.

Through flush connections are usually provided for at the factory by proper drilling and tapping of the pump stuffing box. Through flush connection can be added in the field, when deemed necessary. Consult the factory for specific instructions for your pump. Be sure to provide full details of the applications.

5. Pumping Viscous Liquids

When pumping viscous liquids, it is advisable to use piping whose diameter is larger than the pump port size. With liquids of high viscosities, it may be necessary to increase as much as 3 or 4 pipe sizes.

6. Pumping Concentrated Sulfuric Acid

a. Quantities greater than 20 gallons per hour (all plunger sizes 5/8" in diameter and greater):

The standard Controlled Volume Pump furnished for this capacity will easily handle the sludge normally present in commercial grade sulfuric acids.

b. Quantities less than 20 gallons per hour:

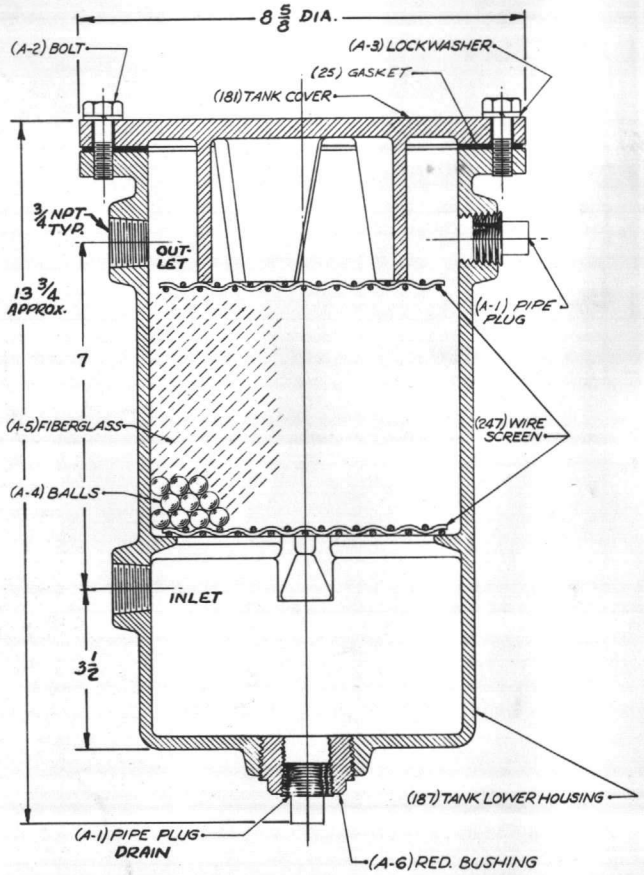
The standard Controlled Volume Pump furnished for these capacities normally has a liquid end too small to adequately handle the sludge present in commercial acids. However, commercial acid can be handled in small quantities by using the procedures given below.

i. Use a sulfuric acid tank provided with a heel (unused tank capacity below the tank outlet openings) in which the sludge can collect without getting into the pumping system.

ii. Make every effort to provide the pump with a flooded suction.

iii. Use piping of the same material of construction as the pump liquid end. If the pump liquid end is cast steel, use standard steel pipe. Under no circumstances mix iron and steel construction; serious galvanic corrosion will result.

iv. Use a glass wool filter or a Milton Roy sludge trap similar to that shown in Figure 5 to prevent sludge from entering the acid system.



Milton Roy Drawing 3021 Sludge Trap

Figure 5. Sludge Trap Construction

7. Accumulator (Surge Chamber)

When back pressure valves are used to provide an artificial discharge head, it is desirable to also use an accumulator or surge chamber on the pump discharge line. The accumulator or surge tank will smooth out the flow from the pump to the back pressure valve by absorbing the peaks of flow from the pump. This will allow the valve opening in the back pressure valve to oscillate about a partially open position instead of being required to snap open and closed on each stroke. This will prolong the life of

the valve operating parts. The use of the surge chamber (or accumulator) in this setup also provides a smoother flow of the pumped liquid to process.

The internal volume of a surge chamber should be approximately 12 to 15 times the single stroke displacement of the pump. For instance, an MR1-21 has a single stroke displacement of 1-1/2 cubic inches, so the internal volume of the surge chamber should be somewhere between 18 and 22-1/2 cubic inches. A piece of 1-1/2 inch pipe 10 inches long fitted with a tight cap (must be air tight) and reducers to bring it down to discharge pipe size would have an internal volume of about 20 cubic inches, which would be well within above specifications.

It is essential that a surge chamber (or accumulator) be installed vertically directly on the discharge line as close as possible to the pump. Full size pipe (same size as discharge line) should be used for connecting the surge chamber (or accumulator) to the discharge line. Since the flow smoothing function depends on a cushion of air trapped in the upper part of the chamber, it is necessary to provide for refilling the chamber with air, as air will be gradually absorbed by most liquids.

This can be most easily done by putting a suitable shut-off valve in the connection from the discharge line to the chamber with a union between the valve and the chamber. By closing the valve, and breaking the union, the chamber can be emptied of liquid and re-installed. Opening the shut-off valve puts the chamber back on the line.

Note that all parts used to make up the chamber must be of suitable materials to resist corrosion and they must be able to withstand maximum (system) discharge pressures with a reasonable factor of safety.

H. INSTALLATION AND START-UP OF THE MILROYAL PUMP

1. Packed Plunger Design

For convenience in shipping and subsequent handling of the unit, some Milroyal pumps are shipped with the motor dismounted. Before attaching the motor, it is recommended that the pump case be anchored in its desired location because of the motor overhang.

A small ring magnet is shipped with each pump. After the pump has been installed and the motor attached, the magnet must be placed in the correct location inside the pump. Center the magnet over the oil pump intake hole located in the underside of the crosshead guide section of the pump casing. See The Assembly and Parts Drawing furnished with this manual for magnet (part #406) location. Check the inside of the pump case for foreign matter. Blow out with compressed air. Then pour the gear lubricant furnished with the pump, *into the pump casing* over the gears and bearings and replace pump cover.

Make the necessary electrical connections to the pump motor. The motor must rotate counter-clockwise facing the shaft end.

Make the necessary piping connections as required by the process application. The pump is now ready for start-up.

CAUTION: Do not operate without oil in the casing and do not raise the cover of the gear section while pump is running.

SECTION 2 – OPERATING INSTRUCTIONS

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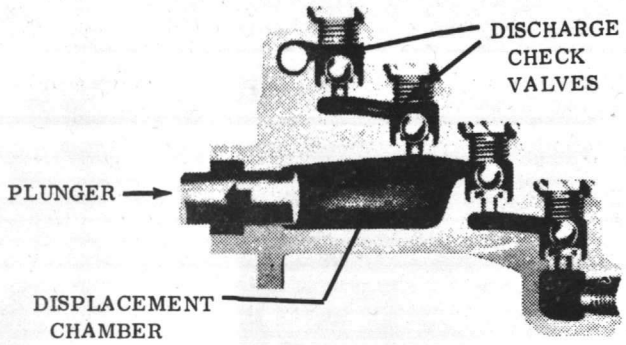
F. Capacity Variation by Speed Adjustment
G. Lubricants

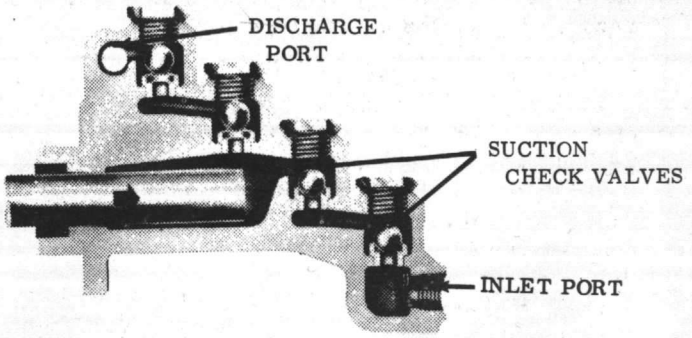
A. PRINCIPLE OF OPERATION

NOTE: For purposes of explanation, the standard step-valve liquid end is illustrated.

1. Suction Stroke

The suction stroke of the pump plunger draws the liquid in through the inlet port, around the double ball checks in the inlet side and into the displacement chamber. The partial vacuum created causes the inlet double ball checks to rise from their seats to admit the liquid, while the outlet double ball checks are seated by system back pressure, preventing back flow from the discharge line. Refer to Figure 6 and 7.





2. Discharge Stroke

The discharge stroke of the pump plunger exerts pressure on the liquid, seating the inlet double ball checks and preventing escape to suction. The outlet double ball checks rise from their seats and permit liquid to flow from the outlet port.

3. Capacity Calculations

The method for determining controlled volume pumping capacity is indicated by the general equation:

$$Q = \frac{D^2LNE}{K}$$

Where
- Q = Pump capacity (See Table Below)
- D = Plunger diameter (inches)
- L = Plunger stroke length (inches)
- N = Number of strokes per minute
- E = Volumetric efficiency
- K = Dimensional constant

If D and L are in inches and N is in strokes per minute as indicated, the table below shows the value of K for obtaining Q in various flow units.

Q	Gallons Per hour	Gallons per minute	Milliliter per hour
K	4.92	295	0.0013

The general equation shows the effect of the three major variables which influence controlled volume pumping capacity. Plunger diameter (D) is fixed for each specific installation. However, capacity varies nearly linearly with changes in either stroke length or stroking speed.

Data accumulated from thousands of pump installations indicate that the volumetric efficiency (E) of any specific pump is predictable. A value of 0.9 for E is satisfactory for preliminary calculations. At very high pressures, because of liquid compressibility, this value is lower. The repetitive accuracy of a Controlled Volume Pump is relatively unaffected by wide variations in viscosity, density, and pressure drop in the system. Therefore, the volumetric efficiency, once established for a specific system, remains relatively constant.

B. PRE-OPERATIONAL INSPECTION

After the pump is installed, but before it is started for the first time, a number of checks should be made.

1. Bolts

Be sure all bolts are tight.

2. Lubrication

Be sure all lubrication fittings are serviced with the recommended grease. Check the pump case and fill to the correct level with the recommended oil. (See Section 3, Category B, Lubrication Schedule, for details.)

3. Packing

If inspection shows packing to be dried out, replace it with new packing. Instructions for breaking in packing are given under Item C, Test Runs and Break-In Period, below.

C. TEST RUNS AND BREAK-IN PERIOD

1. *Packing* (Non-Special Types) – *Applicable only to packed plunger pumps.*

"Break-in" packing before actual pumping load is applied. To do this, release the packing gland and then tighten just 1/4 turn more than finger tight Using the specific packing lubricant recommended on the pump Data Face Sheet, inject packing lubricant into the fitting provided. Then pull the packing gland up one full turn to "set" the packing in the stuffing box and keep the packing loaded for several minutes to allow it to "flow" into position. Release the packing gland and then tighten 1/4 turn more than finger tight. Operate the pump dry (without pumping fluid) at full stroke for about 1/2 hour, occasionally applying a few drops of light oil to the plunger where it enters the stuffing box. The system should then be placed in operation, and the pump adjusted for proper chemical feed. If there is leakage at the gland, tighten the packing just a little at a time (wait for at least five minutes between adjustments) until leakage is stopped.

The first 24 hours of operation are very critical, as far as packing life is concerned. If the packing is pulled up too tightly, it will overheat and decompose rapidly. If it is very carefully adjusted during this critical period, it will develop a good running surface, thereby greatly extending its life. (Sometimes, especially when operating at high pressures, the packing will expand from heat generated by friction and it will be necessary to actually loosen the gland during initial operation.)

2. Capacity Calibration

After the initial break-in period (12 hours or more), test runs may be made to determine the exact capacity of the controlled volume pump under specific operating conditions.

Usually, it is only necessary to calibrate the pump at three stroke length settings in order to determine its characteristics throughout the entire range. The settings normally used are full stroke length, 50 percent stroke length, and 10 percent stroke length.

Two methods of measuring the capacity in a given time limit can be used. These methods are:

a. Measure the drop in liquid level from a calibrated tank.

b. Measure the quantity collected from the discharge side of the pump on the low pressure side of the safety valve.

For dangerous materials it is recommended that the first method be used, since the operator does not come in contact with fluid being handled.

D. LOW CAPACITY–HIGH PRESSURE OPERATION

It is essential that the suction and discharge lines of pumps operating at high pressures be free of entrained air. In order to fill the complete system with liquid, operate the pump under no discharge pressure for a short time before starting pressure tests.

After the unit has been idle for some time, there is a possibility that air will enter the system because of changes in the temperature of the liquid. The system can be purged by installing a valve in the discharge line which will allow liquid to be pumped to atmosphere when starting up the pump.

E. MICROMETER CAPACITY ADJUSTMENT

The pump capacity is adjusted simply by turning the micrometer type handwheel in either a clockwise or counter-clockwise direction to decrease or increase the capacity as desired. The indicator on the handwheel is accurately calibrated in percent of full stroke, with calibration marks at intervals of 0.5 percent of full stroke.

Early models were not equipped with locking devices on the capacity adjustment but later models have this device incorporated in the adjustment handwheel. Should your pump be equipped with the locking device, it will be necessary to release the locking set screw with a suitable socket wrench before changing the adjustment, and relocking the set screw when adjustment is completed.

F. CAPACITY VARIATION BY SPEED ADJUSTMENT

Capacity of motor driven pumps may be adjusted by some form of variable speed drive, either mechanical or electrical. Control may be manual or by remote signal from an instrument controller.

G. MILROYAL LUBRICANTS

Due to the increase in viscosity of the gear oil in the Milroyal pumps as the ambient temperature decreases, it is necessary to dilute the oil to prevent overloading of the pump motor as ambient temperature changes.

The required dilution for various ranges of ambient temperatures are listed in the "Gear Lubricant Chart:"

Gear Lubricant Chart

Minimum Ambient Temp. Expected	Type Oil	*Dilution
60°F and above	AGMA #8 Compounded	Undiluted
40°F to 70°F	AGMA #8 Compounded	10%
20°F to 50°F	AGMA #8 Compounded	20%
0°F to 30°F	AGMA #8 Compounded	30%
–20°F to 10°F	AGMA #8 Compounded	40%

*See "Dilution Schedule" Below

The nominal capacity of the gear section of the Milroyal Models A & B casing is 10 qts.

To lower the allowable operational ambient temperature of the gear oil, dilute with clean kerosene as directed below. After adding the required amount of kerosene, operate the pump for a period of five minutes to provide adequate mixing. Remove oil level plug and drain to proper level.

Dilution Schedule (Kerosene Diluent)

Oil Mixture in Pump	Dilution Desired*			
	10%	20%	30%	40%
Undiluted	2 pts.	4 pts.	6 pts.	8 pts.
10%	–	2 pts.	3-1/2 pts	4-1/2 pts.
20%	–	–	1-1/2 pts	3 pts.
30%	–	–	–	1-1/2 pts.

* The above mixtures are for use with ambient temperature ranges listed in the "Gear Lubricant Chart". CAUTION: Do not operate the pump with dilutions greater than recommended above or serious damage to drive can result.

SECTION 3 – MAINTENANCE INSTRUCTIONS

CONTENTS

A. Packing
   1. Replacing Packing
B. Lubrication Schedule
   1. Pump Packing
   2. Oil Level in Milroyal Housing
   3. Motor Lubrication
C. Spare Parts Data
   1. Recommended List of Spare Parts
   2. Instructions for Ordering Spare Parts
D. Replacing Spare Parts
   1. Replacing Plunger
   2. Replacing Valve Balls and Seats
E. Drive Service Instructions
F. Trouble Shooting Chart

If the pump has been properly installed and checked, the actual maintenance that is required is essentially routine repacking, lubrication and replacement of worn parts.

A. PACKING (Packed Plunger Type Liquid Ends Only)

There are two general types of packing used in these pumps: (a) automatic, self-sealing "V" or "Chevron" types, and (b) compression types. Substitution of one type of automatic packing for another will usually cause no trouble, but an automatic packing set should not ordinarily be replaced with a compression set, or vice versa, without consulting the factory. Packing included as original equipment is carefully selected from many available types as the best for the particular application.

Packings of square or round cross sections, which must be firmly compressed in the stuffing box are known as compression types. These are made of many compositions, each suited for use with a definite group of chemicals. They depend for their proper functioning on compression in the stuffing box, but if too tightly compressed, they will overheat and disintegrate rapidly. Plungers in these pumps are usually one of the austenitic stainless steels and if operated with a packing that is excessively tight, the plungers will become scored. Overly tight packing also places an excessive load on the motor and gears.

Automatic packings, "V" or "Chevron" shaped, depend for their operation on hydraulic pressures in the displacement chamber which act on their special shape. Their design causes the sealing edges to expand into close contact with the plunger and the inside surface of the stuffing box on the pressure stroke of the pump, thereby effecting a seal. When the pressure in the displacement chamber drops on the suction stroke, the packing relaxes, easing the load on the operating mechanism. Automatic packing must never be operated so tightly that it cannot properly flex. All desirable operating characteristics will be lost and wear will be accelerated. It is seldom necessary to operate "V" packing more than finger tight, except under extreme pressure conditions.

1. Replacing Packing

a. Thoroughly clean the stuffing box of old packing and grease. Check the plunger for scoring or pitting by corrosion. Install new plunger, if inspection shows this to be necessary.

b. Thoroughly cover each piece of packing with the lubricant recommended by the factory. Place one packing section at a time in the stuffing box. If required, be sure to locate adapters at the bottom and top of the packing and on both sides of the lantern ring (if a lantern ring is used). Tamp each piece of packing firmly in place before adding the next piece. If the rings are split, stagger the joints so that they will not be in line. Locate the lantern ring carefully, preferably with the face on the pressure side just under the lubrication fitting. It will move up as the packing is "set" and adjusted. Fill the stuffing box with packing to about 1/4 inch of the end. This will allow the gland to enter sufficiently to be properly guided.

c. Follow the packing break-in instructions previously described in Section 2, Item C, Paragraph 1.

B. LUBRICATION SCHEDULE

1. Pump Packing (Daily)

Once each day, lubricate the packing lightly with the special lubricant recommended on the pump data face sheet (front of manual). An Alemite fitting located above the stuffing box at the forward end of the pump frame is provided for this purpose. Under no circumstances change the type of lubricant used for this service, since it has been carefully selected for its compatibility with the packing material and its resistance to corrosive attack by the fluid being pumped. (NOTE: Some pumps equipped with plastic liquid ends do not have provision for packing lubrication.)

2. Oil Level in Milroyal Housing (check monthly)

Fill gear section of unit with Gear Lubricant to oil level plug hole. Use only quality AGMA Compounded Oil, quantity as specified in Section 2 – Catagory G, Milroyal Lubricants. Oil should be changed every 2500 hours of operation or every 6 months, whichever occurs first. Magnetic Filter below crosshead chamber should be cleaned and replaced at this time.

Ambient Temp.	Gear Lubricant AGMA Type
50 – 125°F*	#8

*Refer to Page 2.05 for dilution ratios for low temperature operation.

3. Motor Lubrication (Yearly)

Once each year (check motor manufacturers' recommendations) lubricate drive motor bearings and other points with a suitable grease.

C. SPARE PARTS DATA – Packed Plunger Design

1. Recommended List of Spare Parts

It is recommended that a standard spare parts group be kept on hand at all times to prevent serious delay in repairs. As many Controlled Volume Pumps are tailored to specific applications, it is almost impossible to set up general lists of recommended spare parts for inclusion in this manual. It is suggested that you request a list of recommended spare parts for your specific pump (give exact serial number) from your Milton Roy representative or directly from the Parts Department, Milton Roy Company.

For standard MILROYAL pumps, packed plunger design, the recommended spare parts consist of the following for each liquid end, or pumping cylinder:

Packed Plunger Type

Two sets of packing
One plunger
Four ball checks
Four seats
*Four valve caps
*Four valve cap gaskets
One drive rod assembly
One worm gear and shaft
Two worm shaft bearings
Two conical sleeve bearings
Two trunnion nylon thread
Lock inserts
One Tool Kit

*These parts not applicable to column valve liquid ends

This is considered the minimum spare parts group for this pump, and as parts are used for service they should be replaced immediately. If the pump is an essential unit in a process that would stop production if it were shut down, it is obvious that sufficient spare parts should be carried in maintenance stock to prevent long costly delays.

2. Instructions for Ordering Replacement Parts

a. Motor Parts – Spare parts for motors furnished with Milton Roy controlled pumps can be ordered through Milton Roy Company. However, in order to save time, inquiries and orders for spare *motor* parts may be sent directly to the motor manufacturer. When sending your inquiries to these manufacturers, be sure to include full motor nameplate data from the unit or units involved.

b. Pump Parts – When ordering spare parts or writing about your pump, refer to the *Serial Number* and give complete data from the Milton Roy nameplate. Please specify the exact quantity of each part by name and number (refer to parts list and drawings). Also, please specify which (if any) parts are to be assembled. Note that Part No. 21 is the machined liquid end casting only. No seats, balls, caps, or other fittings are included when Part No. 21 alone is specified. The complete liquid end assembly will be furnished only if it is specifically ordered.

Terms are Net 30 days, F.O.B. Factory, Philadelphia, Pa., or St. Petersburg, Fla.

Transportation charges Parcel Post Prepaid, unless otherwise stated.

All shipments are made at Purchaser's risk, and any claims for damage or non-delivery should be filed with the Carrier at Destination. We shall gladly provide shipping information. When obsolete parts are ordered, we reserve the right to furnish latest interchangeable part.

No credit for returned material will be allowed unless authorization has first been obtained from Milton Roy's home office. Shipments of returned parts must be prepaid and include a Milton Roy Return Material Tag.

Direct inquiries for prices, delivery, and purchase orders to your Milton Roy District Representative or to:

Parts Department
Milton Roy Company
1300 E. Mermaid Lane
Philadelphia 18, Pa.

D. REPLACING PARTS

1. Replacing Plunger
(See Disassembly Instructions, Item E, Pg. 3.07.)

2. Replacing Valve Balls and Seats

a. Step Valve Liquid Ends – all valve seats are pressed into the step valve body. Seats should be removed very carefully to avoid damage to the liquid end body. It is preferable to (1) tap the old seat, (2) use a suitable bolt and washer to act as a "puller" to remove the seat. Seats can also be removed by sue of an "Ezy-Out" tool, but there is more chance of damaging the liquid end body.

When installing new seats, tap gently into place until they find their center, and then tap sharply on top of seats to drive them home. The seat driver should be of a design that does not touch the edge of the seat where the ball rests.

After installing new seats, place a few drops of light machine oil on each seat and place the old balls on the new seats (providing old balls are not pitted). Place a soft brass rod over one ball at a time, and being sure to hold rod absolutely vertical, tap rod with one sharp blow of a hammer. (One blow is sufficient, since the purpose of this operation is only to break any sharp corner of the seat face. In operation, the ball should rest on a relatively sharp corner, not a beveled surface. Repeated blows will make a bevel on the seat). After this seating operation, remove old balls, install new balls, and replace caps and gaskets.

Ref. Drawing B-102-0054-000

(1) Remove cartridge assembly 221-N from pump body.
(2) Push out limit pin (292) with drift pin.
(3) Remove top ball check.
(4) Screw upper end of cartridge into pipe coupling of proper size.
(5) Set assembly down on coupling end and press out seats with bar of a diameter suitable to fit freely through bottom hole.

(6) Check inside walls of cartridge for scored or marred surfaces or pick up. Discard if corroded or marred in any way.

(7) Insert seat having shoulder into bottom of cartridge taper.

(8) Place a soft brass rod of a diameter slightly smaller than the hole in the cartridge on top of the seat and drive it into the taper in the bottom of the cartridge.

(9) Place a few drops of light machine oil on the seat and place a hardened ball on the seat.

(10) Place a soft brass rod over the ball and holding the rod firmly and vertical, tap the end of the rod lightly with one blow by use of a hammer. The cartridge should be sitting on a solid, flat surface.

NOTE: The purpose of this one blow operation is only to break the very sharp edge machined on the seat face. In operation, the ball should rest on a relatively sharp edge, not a beveled surface. More than one blow will tend to bevel the edge.

(11) Drop a new ball on the bottom seat and lay into place, over the top of the seat, the limit pin 292A on the shoulder machined in the bore of the cartridge. (Note: In certain sizes the lower limit pin is welded to top seat.)

(12) Repeat operations #9 and #10 on the top seat #224–D.

(13) Start seat into top of cartridge by tapping lightly with small hammer using a soft brass rod or plate across top edge of seat.

(14) Using the same brass rod that pressed in the seat in operation #8, press the seat #224-D in until

seated against limit pin #292–A.

(15) Drop a new ball on the seat, and press in limit pin #292 through hole on top of cartridge. Be sure pin is pressed slightly below outside diameter of cartridge on both ends.

(16) Install cartridge assembly in liquid end body and connect piping.

E. DRIVE SERVICE INSTRUCTIONS

Disassembly and Assembly Procedures for Milroyal Pump

1. DISASSEMBLY FOR REMOVAL OF CROSSHEAD

a) SPECIAL TOOLS

Wrench for tension bearing #211-0022-006

b) ORDER OF DISASSEMBLY

(1) Remove liquid end (part 221)

(2) Loosen Plunger (part 212) by unscrewing plunger adapter (part 272-B) several turns. Remove plunger.

(3) Remove gland cap (part 208)

(4) Drain oil from pump below level of crosshead (part 210).

(5) Remove tension bearing (part 237-E) from crank (part 216) as follows:

a. With stroke set at 20%, rotate worm until crank is in the horizontal position.

b. Loosen tension bearing locking set screws (405-A)

c. Remove tension bearing by rotating counter-clockwise (R.H. thread). Use special wrench #211-0022-006.

(6) Unlock nut (part 405-D) on crosshead key retaining screw (part 405-H) and remove retaining screw.

(7) Remove crosshead slowly thru opening for liquid end in front of pump casing.

CAUTION: Do not lose crosshead key (part 261) in crosshead keyway or steel ball (part 407-A) in crosshead bore. The ball may follow the crosshead if crosshead is removed too rapidly.

2. DISASSEMBLY FOR REMOVAL OF GEAR HOUSING

a) SPECIAL TOOLS

Wrench for tension bearing #211-0022-006

Wrench for trunnion #5411-003-002

Wrench for bearing adjuster #5411-002-002

b) ORDER OF DISASSEMBLY

(1) Drain oil from pump.

(2) Remove motor and motor adaptor (part 272-A).

(3) Remove crosshead (part 210). Refer to "Disassembly for Removal of Crosshead." Item 1 this section.

(4) Remove the bearing adjuster (part 237-D) using special wrench #5411-002-002.

(5) Loosen set screws (part 405-C) which lock the two trunnions (parts 237-A & 237-B).

(6) Remove the trunnion on the motor side using special wrench #5411-003-002.

(7) Press roller bearing cup from this trunnion.

(8) Remove the drive worm (part 252-A).

(9) Remove the remaining trunnion using special wrench #5411-003-002.

(10) Remove nylon thread lock inserts (part 243) by tightening the trunnion set screws until inserts fall thru. Remove set screws.

(11) Remove the gear housing (part 281-A).

CAUTION: Do not lose the two lead screw keys (part 211-A) from the lower end of the gear housing.

3. ASSEMBLY OF CROSSHEAD IN PUMP

If gear housing has been removed, install per assembly instructions for gear housing (Steps 1-13, Pgs. 3.12 thru 3.14) before assembly of crosshead in pump.

a) SPECIAL TOOLS

Wrench for tension bearing, #211-0022-006

b) ORDER OF ASSEMBLY

(1) Make certain ball is in place in oil pump suction port (bottom of crosshead bore).

(2) Crosshead (part 210) and connecting rod (part 214) must be assembled prior to installing in pump. Refer to instructions 7, 8 & 9 (Pg. 3.10) for method of connecting socket bearings.

(3) With key (part 261) in crosshead keyway, slide crosshead thru crosshead bore, keeping key in line with key retaining screw hole until hole in key is in line with retaining screw holes. The tension bearing on the crank end of the connecting rod must be clear of the crosshead bore before continuing.

(4) Insert key retaining screw (part 405-H) until dog point on screw enters hole in crosshead key and locks against the crosshead.

(5) Back out key retaining screw sufficiently to free crosshead and lock the screw in this position with the screw lock nut (part 405-D).

(6) With the stroke adjustment set at 20% and the crank in the horizontal position, move the crosshead back until the connecting rod ball can be seated in the crank bearing.

(7) Tighten the tension bearing in the crank (part 216) sufficiently to completely seat the ball using tool #211-0022-006.

(8) Loosen the tension bearing and re-tighten until connecting rod is just free enough to rotate with fingers.

(9) Tighten the two tension bearing locking screws (405-A).

(10) Install plunger, gland cap, and liquid end as follows:

a. Insert plunger thru gland cap into plunger adapter until plunger is seated against bottom of hole in crosshead. Tighten adapter carefully until plunger is locked in crosshead.

Model A and B units incorporate the feature of adjusting the packing gland from the outside. These bolts are inserted through holes located on either side of the liquid end flange and threaded into the packing gland yoke. Take up on gland evenly and set packing in accordance with instructions in section 2-C-1.

4. ASSEMBLY OF WORM GEAR IN GEAR HOUSING

a) MODEL A UNITS –
(Refer to Drawing #D-102-0148-000)

b) MODEL B UNITS

All gear housings and cranks for Model B Units are stamped when inspected with critical dimensions necessary for assembling the worm wheel in its gear housing. The crank is stamped on one of its rough cast sides with the actual dimension, to three decimal places, showing its machined hub length. The gear housing is stamped on its rear rough cast face with the actual dimension, to three decimal places, between its machined crank bearing face and the parallel centerline through the conical taper bored holes. All worm gears are machined to a close tolerance between the center of their cut teeth and the face of one hub. On Model B units the marked hub side is the one which is held close. The dimension to be used for centering the gear is .8725. This dimension should be added to the dimension found stamped on the side of the crank and then subtracted from the dimension stamped on the gear housing. The difference is the shim thickness to be inserted between the crank hub and the worm gear hub. After assembling the crank and the worm gear with the proper thickness of shims between them, an excessive number of shim thicknesses should be assembled over the crankshaft against the other worm gear hub. The rear crankshaft bearing (237-K) and nut (405-E) should be clamped up tight. This assembly should be placed so that all weight forces the crank against its rubbing face and a measurement be taken with feeler gages of the clearance between the rear machined face of the gear housing and the flange of rear bearing (237-K). After determining this clearance around the circumference of the flange, enough shims should be removed to allow only .002 – .003 end float of the crank assembly in the gear housing. Assembly is now ready for insertion into main casing.

5. ASSEMBLY OF GEAR HOUSING IN PUMP

a) SPECIAL TOOLS AND MATERIAL

Centering Tool #211-0021-006.

Wrench for tension bearing #211-0022-006.

Wrench for trunnion #5411-003-002.

Wrench for bearing adjuster #5411-002-002.

Torque Wrench (0-50 Ft.–Lbs.) not furnished by Milton Roy Company.

Torque Wrench adapter #5411-001-002.

Loctite*, grade HV

Dial Indicator & Magnetic Base Stand.

b) PREPARATION OF PARTS

Before assembly, several of the parts require special preparation. The trunnion threads, the mating threads in the pump casing, the bearing adjuster thread, the mating thread in the open trunnion, the I.D. of the open trunnion, and the O.D. of the roller bearing cup must be thoroughly cleaned and free of oil and foreign matter. This will require scraping of the parts to remove the original film of hardened Loctite* and use of clean solvent for degreasing.

* Registered trademark – American Sealants Co.

c) ORDER OF ASSEMBLY
(Refer to appropriate drawing of Drive Assembly) (Model B) Drawing #D-102-0092-000, (Model A) Drawing #D-102-0148-000.

(1) Apply a heavy coating of grease to the inside and outside surfaces of the conical sleeve bearings (part #237H). Push sleeve bearings into gear housing bores until retained in place by coating of grease.

(2) With the adjusting screw keys, part #211-A, in position (chamfered ends downward) lower the gear housing into the pump casing, taking care that the two adjusting screw keys slide into the grooves in the adjusting screw (256-A).

(3) Hold the gear housing in approximate assembled position and install the two trunnions (237 B), after applying Loc-tite Grade HV to outside threads of trunnions, (8–10 drops). Take up on the trunnions evenly until they engage the sleeve bearings sufficiently to retain them in the gear housing.

(4) Install the gear housing centering tool, part #211-0021-010 in the crosshead bore with the point of the tool as close as possible to the gear housing.

(5) Adjust the stroke adjusting screw (256A) and the two trunnions (237B) until the center hole in the crank is in line with the point on the centering tool.

(6) Using the trunnion wrench, part #5411-003-002, and torque wrench adaptor, part #5411-001-002, apply a 35 ft. lb. torque load to the trunnions. It is essential that each trunnion be tightened a little at a time in order to keep the gear housing in line with the centering tool.

(7) Insert new nylon thread lock inserts (part 243A) and the lock screws in the trunnion lock screw holes and tighten the set screws to lock the trunnions in place. Remove centering tool.

(8) Install the drive worm.

(9) Apply 2–3 drops of Loctite* (Grade HV) to O. D. of roller bearing cup and install in the open trunnion.

(10) Apply Loctite* Grade HV to thread of bearing adjuster, (part #237-D) 2–3 drops.

(11) Assemble the bearing adjuster (237D) using special tool, part #5411-002-002. Before tightening, make certain that worm is properly mated with worm gear and that roller bearings are properly seated. This can be accomplished by rotating worm while turning bearing adjuster to snug position.

NOTE: Care must be taken to see that oil seal (408B) is not damaged when installing bearing adjuster over worm shaft.

(12) Tighten bearing adjuster sufficiently to seat the bearing cups then loosen 1/2 turn. Re-tighten to allow 0.001" axial movement of worm shaft. Check axial movement with dial indicator by tapping worm shaft lightly.

(13) Before continuing with gearhousing assembly, the pump must remain undisturbed for a period of 6 hours at 70°F., to allow sufficient time for the Loctite* to harden.

(14) Install crosshead and connecting rod in pump. Refer to "Assembly of Crosshead in Pump."

(15) With the stroke set at 20% and the crank in the downward position, insert the connecting rod ball in the crank socket. Rotate the worm until the crank is in the horizontal position.

(16) Tighten the tension bearing (237E) in the crank sufficiently to completely seat the ball using special wrench #211-0022-002.

(17) Loosen the tension bearing and re-tighten until connecting rod is just free enough to rotate with fingers.

(18) Tighten the two tension bearing locking screws (405A).

(19) Replace the motor and motor adapter.

(20) Fill to proper level with new gear oil.

*Registered trademark – American Sealants Co.

F. TROUBLE SHOOTING CHART

TROUBLE	CAUSE	REMEDY
1. Pump won't operate	A. Blown fuse	A. Replace blown fuse
	B. Open thermal overload device in starter	B. Reset
	C. Low liquid level (where low level cutoff is used)	C. Fill tank
	D. Broken wire	D. Locate and repair
	E. Low voltage	E. Determine reason (wiring may be too light)
	F. Discharge line blocked	F. Remove block
	G. Liquid "frozen" in pump	G. Thaw out
2. Pump doesn't deliver rated capacity	A. Starved suction	A. Replace suction piping with larger size, or increase suction head
	B. Leaky suction piping	B. Repair or replace defective piping
	C. Excessive suction lift	C. Rearrange equipment location to reduce suction lift.
	D. Liquid too close to boiling point	D. Lower temperature or increase suction pressure
	E. Capacity adjustment incorrectly set	E. Adjust properly
	F. Leaky packing	F. Adjust or replace packing
	G. Pump operating at incorrect speed	G. Check line voltage and frequency against motor nameplate
	H. Worn or dirty valve seats, or both	H. Clean or replace
	I. Viscosity of liquid too high	I. (1) Reduce viscosity by heating or other means; (2) Increase size of suction piping; (3) Increase suction pressure

TROUBLE	CAUSE	REMEDY
3. Pump delivers erratically	A. Leaky suction line	A. Repair or replace piping
	B. Leaky packing	B. Repair or replace packing
	C. Worn or dirty valve seats, or both	C. Clean or replace
	D. Excessive excursion of ball valves from seats	D. Limit excursion to manufacturer's tolerance
	E. Insufficient suction pressure	E. Increase suction pressure: (1) Raise tank level (2) Pressurize suction tank
	F. Liquid too close to boiling point	F. Reduce temperature or raise suction pressure
	G. Leaky safety valve	G. Repair or replace safety valve.
4. Motor overheats	A. Power supply does not match motor characteristics	A. Check power supply against motor nameplate data
NOTE: Totally enclosed and explosion proof motors operate at higher temperatures than open motors	B. Insufficient quantity or improper type of lubricant in gear case	B. Check level and type of lubricant. Replace if doubt exists
	C. Overload caused by operating pump beyond rated capacity	C. Check operating conditions against pump manufacturer's specs
	D. Packing too tight, or improperly lubricated	D. Readjust packing and lubricate if necessary
	E. Pump operating mechanism improperly lubricated	E. Check all lubricating points
	F. Mechanical misalignment	F. Check alignment of all working parts.
5. Noisy operation	A. Pump valves	A. Valves must move to open and close, and they will make a clicking noise as they operate. In larger sized pumps, the ball valves may roll in their cages causing rattling noises, these noises are sometimes amplified by natural resonances in the piping system. They are usually indications of normal valve functioning.
(1) in Pump		
(2) in Gear	A. Excessive backlash in gears	A. Replace gears
	B. End play in high speed shaft	B. Readjust per instructions
	C. Worn bearings	C. Replace bearings
	D. Lack of or wrong type of lubricant	D. Drain and refill gearcase with proper quantity and type of lubricant
6. Pump is not on zero stroke when stroke adjustment dial reads zero	A. Stroke adjusting handwheel is not properly adjusted	A. Set pump to zero stroke. Loosen set screw on stroke adjusting hand wheel. Set handwheel dial to zero and retighten set screw.
7. Pump cannot be set on zero stroke	A. Gear housing is not on center	A. Pump must be disassembled and re-aligned as per assembly and reassembly instructions

TROUBLE	CAUSE	REMEDY
8. Crosshead rotates in crosshead bore	A. Crosshead locking set screw is not seated in crosshead key.	A. Remove crosshead and examine for possible scoring marks. If the crosshead is scored, polish with fine emery cloth and replace per crosshead assembly instructions.
9. Leakage of oil around trunnion	A. Insufficient Loctite used when assembling pump	A. Disassemble pump and reassemble per assembly instructions.
10. Leakage of oil around pump drive shaft	A. Oil seal damaged or worn	A. Disassemble pump replace seal and reassemble per assembly instructions.
11. High pitched screeching noise – and excessive heat on gear housing.	A. Too high preload on roller bearing or lack of lubrication on bearings	A. Remove bearing adjuster and remove Loctite from threads. Reassemble to correct preload torque per assembly instructions. Re-Loctite with proper number of drops of Grade "HV". Pour gear case oil over both bearings.
12. Repeated knocking noise with each stroke	A. A slight knock is permissible. Unusually loud knocking is due to excessive wear of worm and worm gear	A. Disassemble pump and replace worm and worm gear. Reassemble per pump assembly instruction.
13. Excessive rocking of gear housing at each stroke	A. Stroke adjusting screw or keys are worn	A. Disassemble pump replace screw and/or keys and reassemble per pump assembly instructions.
14. Hesitation of crosshead motion at either end of stroke or connecting rod knock	A. Loose tension bearing	A. Remove connecting rod and examine ball for wear. If wear is not excessive reassemble connecting rod per pump assembly instructions.
15. Excessive wear on connecting rod bearings	A. (1) Gear oil not changed at regular intervals as recommended in operating instructions (2) Oil Pump not functioning properly due to faulty relief valve or plugged hole in connecting rod.	A. (1) Replace all parts showing excessive wear. Maintain recommended oil change interval (2) Check connecting rod. If connecting rod is not plugged replace relief valve.
16. Leakage of oil around crosshead	A. Worn or damaged crosshead seal	A. Remove crosshead, replace seal. Inspect crosshead for longitudinal grooves caused by foreign particles becoming embedded in seal. Polish O.D. if required. Reassemble per crosshead assembly instructions.

SECTION 4 MICROMETER CAPACITY ADJUSTMENT

Refer to drawing #102-0148-000 – ("A")

#102-0092-000 – ("B")

A. Standard micrometer capacity adjustment permits accurate repeatable resetting to 1/2 of 1% of scale, by calibrated division marks. Setting to 1/4 of 1% can easily be done by estimate. A lock is provided to prevent accidental change in the setting.

1. Replacement of the capacity adjustment screw (256-A)

Screw with Gear Housing Assembled

(a) MILROYAL – MODEL A–1

(1) Drain oil from pump.

(2) Unscrew and back out set screws (405-AL) shown on drawing #D-102-0148-000

(3) Place hand under gear housing and remove lead screw key (211-A) by pulling with fingers. If keys are tight, and cannot be removed easily, a screw driver may be used as a lever by inserting its end into the slot machined near the end of each key and prying against the gear hub.

(4) After the keys have been removed the capacity adjustment screw may be turned out of the casing.

(5) Replace capacity adjustment screw in reverse order.
NOTE: Always replace the "O" ring seal (408.A) with a new one if the screw is removed for any reason.

(b) MILROYAL – MODEL B – 1

(1) Drain oil from pump.

(2) Adjust gear housing into most advantageous position to allow for socket type wrench clearance when loosening bolts (405-X).

(3) Remove bolts and clevis (#203) being careful not to lose the two lead screw keys (#211-A).

(4) After clevis and keys have been removed the capacity adjustment screw may be turned out of the casing.

2. Replacement of capacity indicator plate.

(a) Remove part 255-A hand knob assembly by releasing set screw (s) 405-J.

(b) Remove old indicator plate and clean off mounting area.

(c) Activate the adhesive on the new indicator plate by dipping plate in TOLUDL.

(d) Place plate in proper position on mounting, with markings in readable position.

(e) Tie in place with wire, cord string, or with a hose clamp until adhesive sets. (about half an hour).

(f) Remove wire, string or clamp.

(g) Install handwheel (255-A) – Tighten screw (s) 405-J just lightly.

(h) Remove cover over catchall (281-D) so crosshead can be observed. Start up pump.

(i) Adjust handwheel (255-A) until there is no perceptible motion of the crosshead.

(j) Release set screw (s) 405-J and set handwheel to indicate "zero-zero" on indicator plate (and on handwheel scale. Recheck for zero motion of crosshead. Stop pump.

(k) Lock screw (s) 405-J firmly.

(l) Set to desired capacity – Start pump on stream.

NOTE: Later models are equipped with a set screw located axially in handwheel to permit locking the handwheel so that adjustment cannot be changed accidently.

3. Replacement of handwheel (255-A)

(a) Remove cover 281-D over catchall area so crosshead can be observed. Start pump.

(b) Adjust handwheel (255-A) until there is no perceptible motion of the crosshead (zero stroke).

(c) Release set screw (s) 405-J and remove handwheel.

(d) Install new handwheel on capacity adjustment screw. Line it up on indicator plate to read "zero-zero". Lock screw (s) 405-J firmly.

(e) Set to desired capacity.

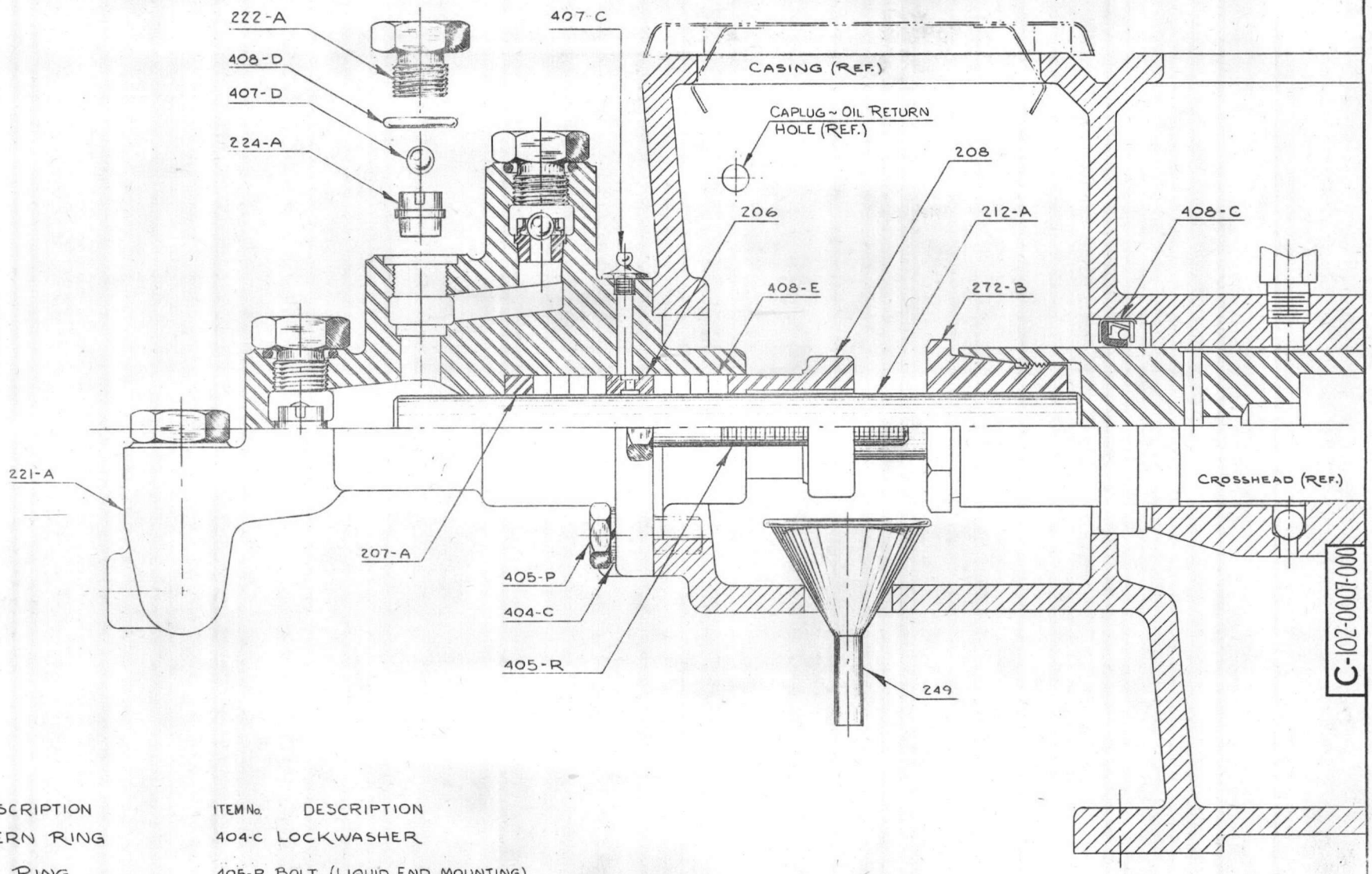
SECTION 4 – CAPACITY ADJUSTMENT

CONTENTS

A. Micrometer Adjustment

B. Variable Input Speed Adjustment of Capacity.

All Milroyal pump models are available with several types of variable speed input drivers. Since numerous types of both electronic and mechanical drives can be furnished and possibly have autopneumatic control of speed, it is not possible to list in this manual the instructions and service information for each. Therefore, supplied with each unit, having such a drive, are separate instruction, operating and maintenance sheets covering the particular drive furnished.



ITEM No.	DESCRIPTION
206	LANTERN RING
207-A	NECK RING
208	GLAND CAP
212-A	PLUNGER
221-A	LIQUID END
222-A	CAP
224-A	SEAT
249	FUNNEL (CATCHALL)
272-B	ADAPTER (PLUNGER)

ITEM No.	DESCRIPTION
404-C	LOCKWASHER
405-P	BOLT (LIQUID END MOUNTING)
405-R	BOLT (GLAND CAP)
407-C	GREASE FITTING
407-D	BALL CHECK
408-C	SHAFT SEAL (CROSSHEAD)
408-D	SEAL (LIQUID END CAP)
408-E	PACKING

CHG NO.	DATE	BY	CHANGE
A	7-10-61	JGG	ITEM 249 WAS 407-E. ASSY REF. 102-0027-000 ADD.

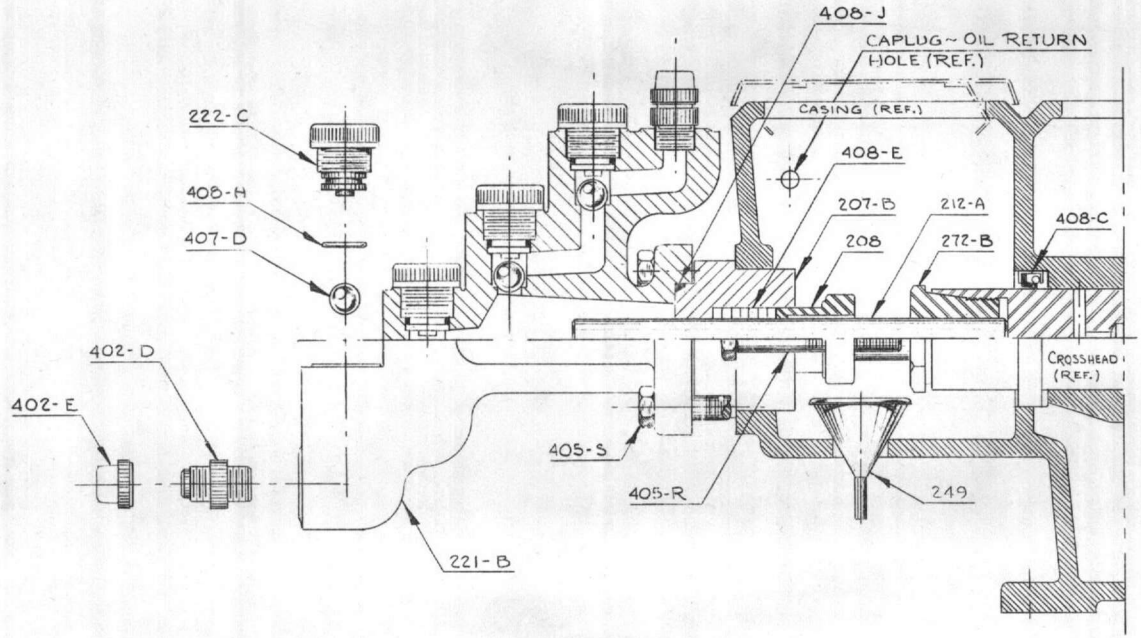
DESCRIPTION MILROYAL PUMP MOD. "A" OR "B"
SUPERSEDES DWG.
MAT'L
DWN BY JGG | DATE 3-22-61 | APPROVED | SCALE ~

MILTON ROY COMPANY
1300 E. MERMAID LANE
PHILADELPHIA 18, PA.

TITLE STEP TYPE LIQUID END ASSEMBLY

PATTERN CODE

DWG. NO. C-102-0007-000



ITEM No.	DESCRIPTION
207-B	GLAND
208	GLAND CAP
212-A	PLUNGER
221-B	LIQUID END
222-C	CAP
249	FUNNEL (CATCHALL)
272-B	ADAPTER (PLUNGER)
402-D	HALF UNION COUPLING
402-E	COUPLING NUT

ITEM No.	DESCRIPTION
405-R	BOLT (GLAND CAP)
405-S	BOLT (LIQUID END MOUNTING)
407-D	BALL CHECK
408-C	SHAFT SEAL (CROSSHEAD)
408-E	PACKING
408-H	SEAL (LIQUID END CAP)
408-J	SEAL (GLAND)

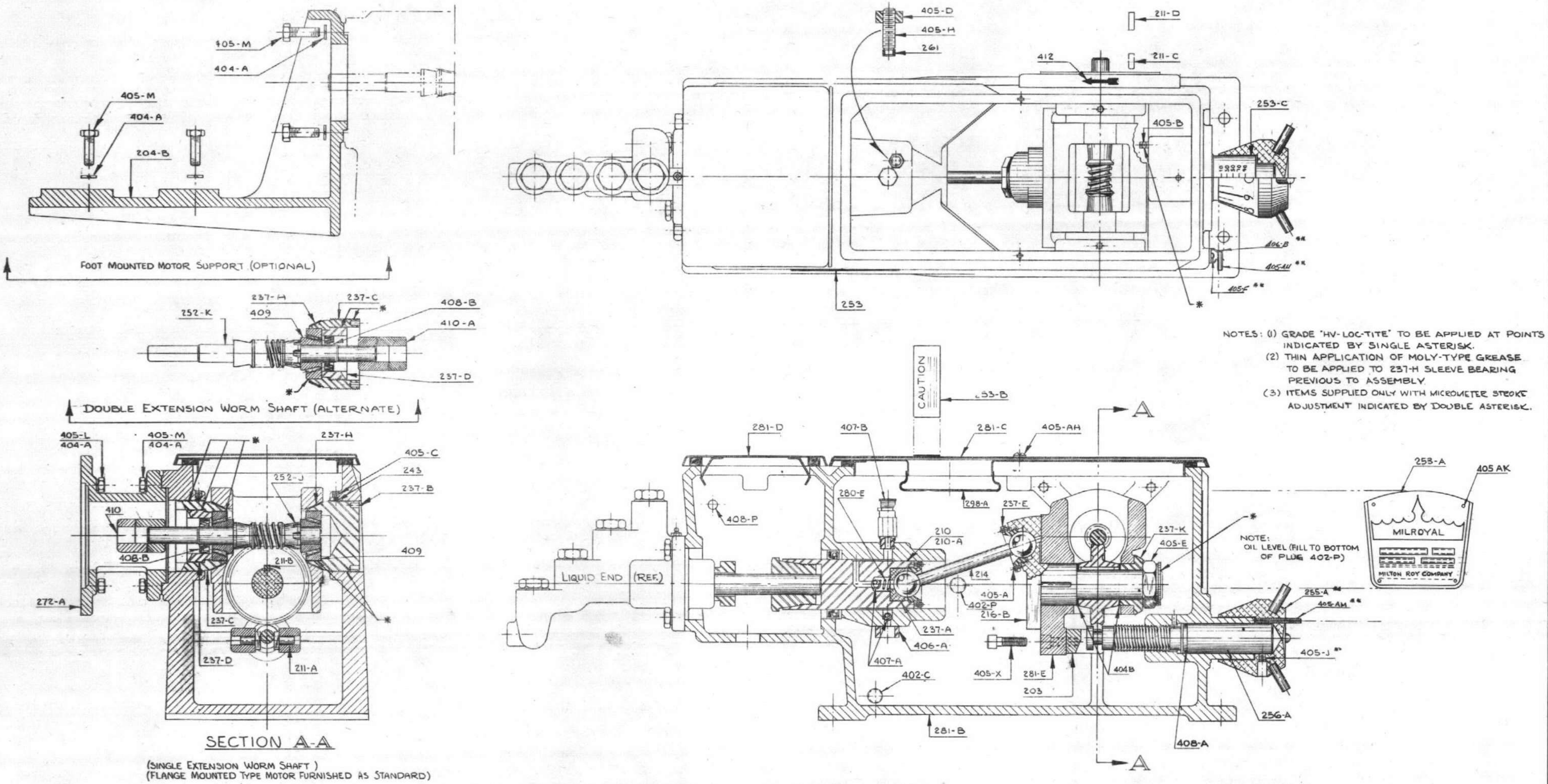
CHG NO	DATE	BY	CHANGE
B	2-27-67	J.E.M.	ITEM 408-E WAS PREVIOUSLY CALLED PACKING
A	7-10-61	JGG	ITEM 249 WAS 407-E

DESCRIPTION MILROYAL PUMP 1½ HP SIZE MOD A,B
SUPERSEDES DWG.
MAT'L
DWN BY JGG | DATE 3-23-61 | APPROVED | SCALE

MILTON ROY COMPANY
1300 E. MERMAID LANE
PHILADELPHIA 18, PA.

TITLE PLASTIC LIQUID END ASSEMBLY
PATTERN CODE
DWG. NO. C-102-0008-000

C-102-0008-000



NOTES: (1) GRADE "HV-LOC-TITE" TO BE APPLIED AT POINTS INDICATED BY SINGLE ASTERISK.
(2) THIN APPLICATION OF MOLY-TYPE GREASE TO BE APPLIED TO 237-H SLEEVE BEARING PREVIOUS TO ASSEMBLY.
(3) ITEMS SUPPLIED ONLY WITH MICROMETER STROKE ADJUSTMENT INDICATED BY DOUBLE ASTERISK.

SECTION A-A

(SINGLE EXTENSION WORM SHAFT)
(FLANGE MOUNTED TYPE MOTOR FURNISHED AS STANDARD)

ITEM No.	DESCRIPTION	ITEM No.	DESCRIPTION	ITEM No.	DESCRIPTION	ITEM No.	DESCRIPTION	ITEM No.	DESCRIPTION
				272-A	ADAPTOR (FLANGE MOTOR)	405-A	SET SCREW (CONN. ROD)	408-A	"O" RING (STROKE ADJUSTMENT SCREW)
203	CLEVIS	243	INSERT (THREAD LOCK)			405-B	SET SCREW (STROKE STOP)	408-B	SHAFT SEAL (WORM SHAFT)
204-B	MOTOR SUPP. BRKT. (FOOT MTD. MOTOR)	252-J	WORM SHAFT (SINGLE EXTENSION)			405-C	SET SCREW (THREAD LOCK)	408-P	CAPLUG ~ OIL RETURN HOLE
210	CROSSHEAD	252-K	WORM SHAFT (DOUBLE EXTENSION)	280-E	SPRING-CROSSHEAD	405-D	NUT (SLIDING SHOE)	409	BEARING (WORM SHAFT)
210-A	CROSSHEAD ASSEMBLY					405-E	NUT (CRANK)		
211-A	KEY (LEAD SCREW)	253	M.R. LOGO (IDENTIFICATION PLATE)	281-B	CASING	405-H	SET SCREW (SLIDING SHOE)	410	COUPLING (MOTOR)
211-B	KEY (CRANK)	253-A	NAMEPLATE	281-C	COVER	405-J	SET SCREW (HAND KNOB-MICRO ADJ.)	410-A	COUPLING (CONNECTING)
211-C	KEY (WORM SHAFT)	253-B	CAUTION STICKER	281-D	COVER (CATCHALL)	405-AH	SOCKET WRENCH		
211-D	KEY (MOTOR)	253-C	STROKE INDICATOR PLATE (MICRO ADJ.)	281-E	HOUSING (GEAR)	405-L	MOUNTING BOLT (FLANGE MOTOR)		
216-B	CRANK					405-M	MOUNTING BOLT (MOTOR, SUPPORT & ADAPTOR)		
237-B	TRUNNION (CLOSED)			298-A	BELLOW	405-X	MOUNTING BOLT (CLEVIS)		
237-A	BEARING (CROSSHEAD)	255-A	HAND KNOB ASSEMBLY (MICRO ADJ.)			405-AH	MOUNTING SCREW (COVER)	412	ARROW~MOTOR ROTATION
237-C	TRUNNION (OPEN)					405 AK	DRIVE SCREW		
237-D	BEARING ADJUSTER (OPEN)					406-A	MAGNET (FILTER)		
237-E	BEARING-TENSION	256-A	STROKE ADJUSTMENT. SCREW (STD. ADJ.)	402-C	PLUG-DRAIN	406-B	AUGAT CLIP		
237-H	CONICAL SLEEVE BEARING-TRUNNION			402-P	PLUG-OIL LEVEL	407-A	BALL CHECK (CROSSHEAD)	405AM	STROKE LOCKING SCREW
		261	SHOE (SLIDING)			407-B	FITTING RELIEF		
237-K	C[illegible]BEARING ~ REAR			404-A	LOCKWASHER	405-F	DRIVE SCREW		
				404-B	SHIMS				

CHG. NO.	DATE	BY	CHANGE
D	12-3-65	J.E.M.	ADDED ITEM NO. 243, INSERT (THREAD LOCK)
C	10-26-64	J.P.B.	STROKE LOCK PLATE PART NO. 253-F DELETED
B	6-22-64	J.P.B.	405-AJ & 243 DELETED. 253-E, 405-AH, 405-F, 406-B, 405AM ADDED
A	11-22-63	W.G.D.	NOTES ON LOC-TITE AND GREASE ADDED.

DESCRIPTION: MODEL "B-1" REF SP 335-0090-0XX, ETC

SUPERSEDES DWG.

MAT'L

DWN. BY: SGM | DATE: 10-22-62 | APPROVED | SCALE: ~

MILTON ROY COMPANY
1300 E. MERMAID LANE
PHILADELPHIA 18, PA.

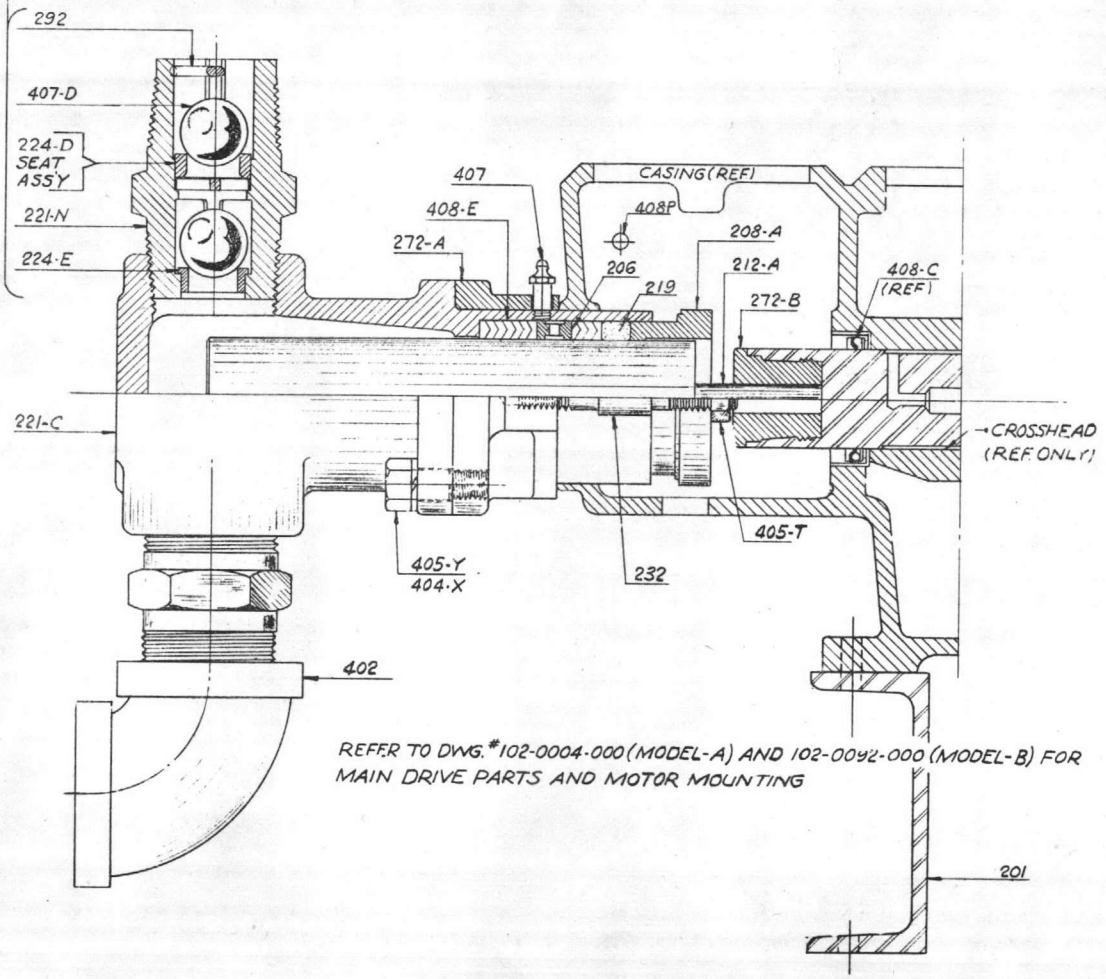
TITLE: MILROYAL MODEL "B-1" PUMP ASS'Y LESS LIQUID END, PARTS

PATTERN CODE

DWG. NO. D-102-0092-000

221-J COLUMN VALVE ASSEMBLY

ITEM	DESCRIPTION	ITEM	DESCRIPTION
201	BASE	272-A	ADAPTOR-LIQUID END
206	LANTERN RING	272-B	ADAPTOR-PLUNGER
208-A	GLAND	292	BALL LIMIT PIN
212-A	PLUNGER		
219	SPACER-PACKING	402	ELBOW-SUCTION
221-C	LIQUID END		
		404-X	WASHER-LIQUID END
221-J	COLUMN VALVE ASSY		
221-N	COLUMN VALVE	405-T	NUT-GLAND
		405-Y	BOLT-LIQUID END
224-D	SEAT-UPPER	407	GREASE FITTING
224-E	SEAT-LOWER		
		407-D	BALL CHECK
232	STUD-GLAND	408-C	SEAL-CROSSHEAD
		408-E	PACKING
		408-P	CAPLUG



REFER TO DWG. #102-0004-000 (MODEL-A) AND 102-0092-000 (MODEL-B) FOR MAIN DRIVE PARTS AND MOTOR MOUNTING

C-102-0104-000

CHG.	DATE	BY	APPR.	REVISION
B	6-18-65	SGM		ADDED ITEM NO. 219 (NO. 1. REDUCED 6" SPACER ADDED)
A	4-4-63	J.E.M.		ADDED WELD ASSY (BALL LIMIT STOP WELDED TO UPPER SEAT)

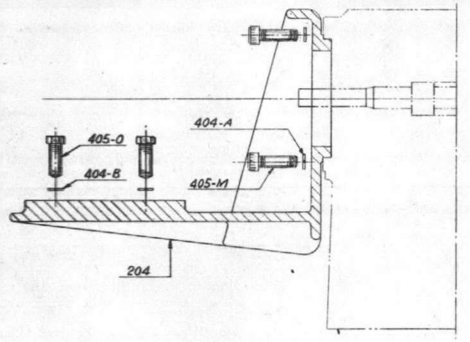
DESCRIPTION: MILROYAL MODEL A & B 2½ DIA. PLUNGER.
B/M (REF.) 235-0112-XXY
SUPERSEDES
MAT'L=YY

DWN.	APPR.	DATE	SCALE	PATT. CODE
J.E.M.		12-4-62	HALF	

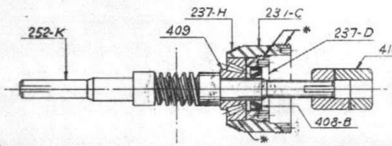
MILTON ROY COMPANY
PHILADELPHIA 18, PA.
ST. PETERSBURG 33, FLA.

TITLE: COLUMN VALVE LIQUID END ASSEMBLY

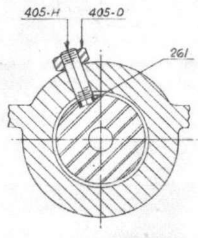
DWG. NO. C-102-0104-000



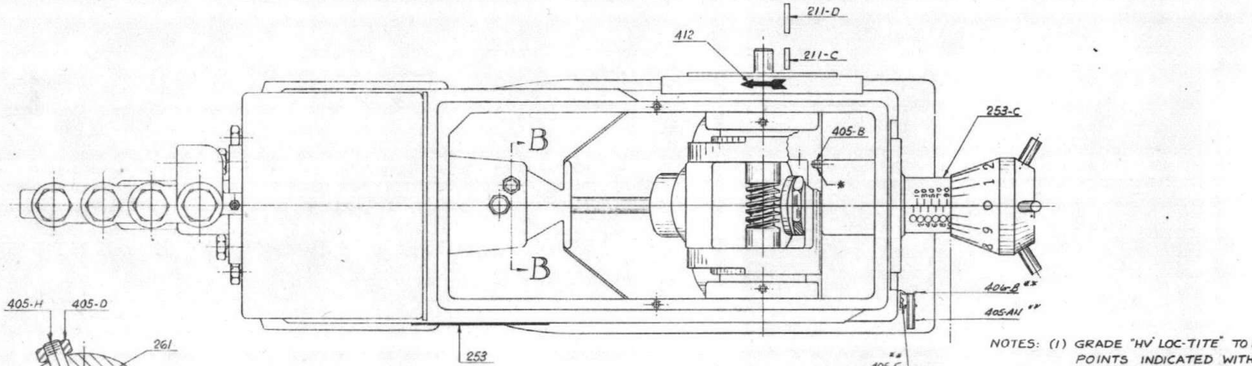
FOOT MOUNTED MOTOR SUPPORT (OPTIONAL)



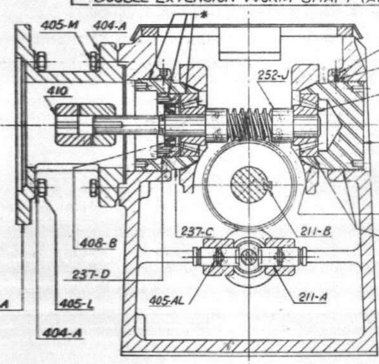
DOUBLE EXTENSION WORM SHAFT (ALTERNATE)

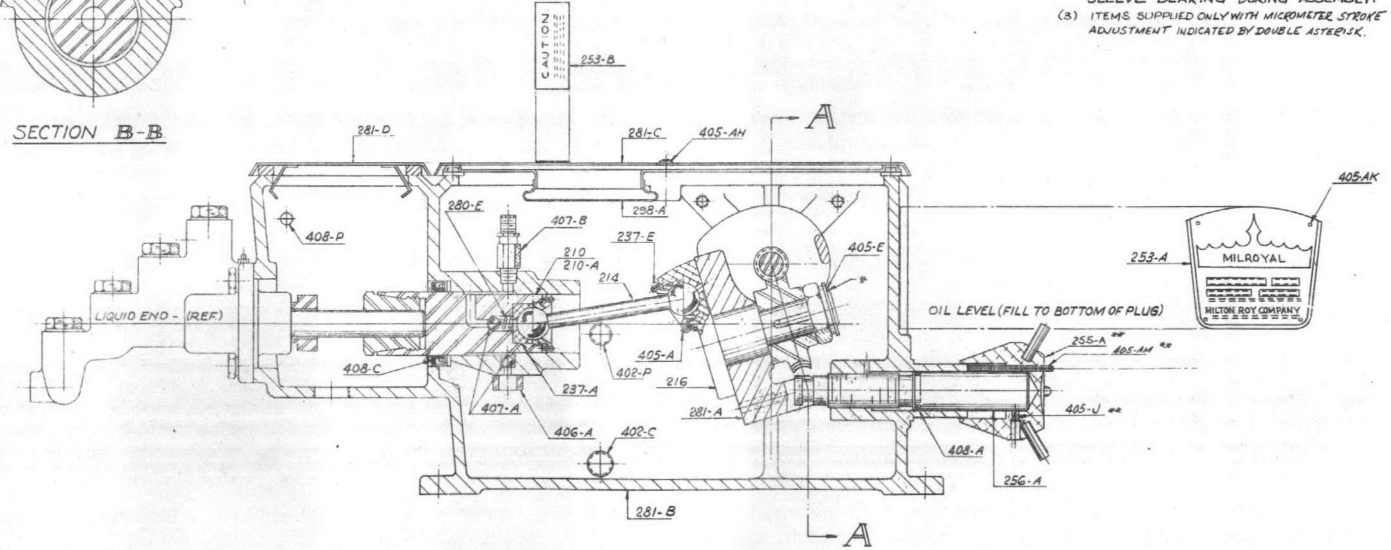


SECTION B-B



NOTES: (1) GRADE "HV" LOC-TITE TO BE APPLIED AT POINTS INDICATED WITH SINGLE ASTERISK
(2) THIN APPLICATION OF MOLY-TYPE GREASE TO BE APPLIED TO 237-H SLEEVE BEARING DURING ASSEMBLY.
(3) ITEMS SUPPLIED ONLY WITH MICROMETER STROKE ADJUSTMENT INDICATED BY DOUBLE ASTERISK.





SECTION A-A

(SINGLE EXTENSION WORM SHAFT ASSEMBLY)
(FLANGE MOUNTED TYPE MOTOR FURNISHED AS STD.)

ITEM NO.	DESCRIPTION
204	MOTOR SUPP. BRKT. (FOOT MTD. MTR)
210	CROSSHEAD
210-A	CROSSHEAD ASSEMBLY
211-A	KEY (LEAD SCREW)
211-B	KEY (CRANK)
211-C	KEY (WORM SHAFT)
211-D	KEY (MOTOR)
214	CONNECTING ROD ASSEMBLY
216	CRANK
237-A	BEARING (CROSSHEAD)

ITEM NO.	DESCRIPTION
237-B	TRUNNION (CLOSED)
237-C	TRUNNION (OPEN)
237-D	BEARING ADJUSTER
237-E	BEARING-TENSION
237-H	CONICAL SLEEVE BEARING-TRUNNION
243	INSERT (THREAD LOCK)
252-J	GEAR SET (SINGLE EXT. WORM SHAFT)
252-K	GEAR SET (DOUBLE EXT. WORM SHAFT)
253	M. R. LOGO.
253-A	NAME PLATE
253-B	CAUTION STICKER
253-C	STROKE INDICATOR PLATE (MICRO. ADJ.)
255-A	HAND KNOB ASSEMBLY (MICRO. ADJ.)

ITEM NO.	DESCRIPTION
256-A	STROKE ADJUSTMENT SCREW (STD. ADJ.)
261	SHOE (SLIDING)
272-A	ADAPTOR (FLANGE MOTOR)
280-E	SPRING-CROSSHEAD
298-A	BELLOWS
281-A	HOUSING (GEAR)
281-B	CASING
281-C	COVER
281-D	COVER (CATCHALL)
402-C	PLUG - DRAIN

ITEM NO.	DESCRIPTION
402-P	PLUG-OIL LEVEL
404-A	LOCKWASHER (MTR. FLANGE & ADAPTOR)
404-B	LOCKWASHER (MOTOR-FOOT MOUNTED)
405-AK	DRIVE SCREW
405-A	SET SCREW (CONN. ROD)
405-B	SET SCREW (STROKE STOP)
405-C	SET SCREW (THREAD LOCK)
405-D	NUT (SLIDING SHOE)
405-E	NUT (CRANK)
405-H	SET SCREW (SLIDING SHOE)
405-J	SET SCREW (HAND KNOB-MICRO. ADJ.)
405-F	DRIVE SCREW
405-L	MOUNTING BOLT (FLANGE MOTOR)
405-M	MOUNTING BOLT (MTR ADAPTOR FLANGE)
405-AN	SOCKET WRENCH
405-O	MOUNTING BOLT (FOOT MTD. MOTOR)
405-AL	SET SCREW (LEAD SCREW KEY LOCK)

ITEM NO.	DESCRIPTION
405-AH	MOUNTING SCREW (COVER)
406-A	MAGNET
406-B	AUGAT CLIP
407-A	BALL CHECK (CROSSHEAD)
407-B	FITTING - RELIEF
408-A	'O' RING (STROKE ADJUSTMENT SCREW)
408-B	SHAFT SEAL (WORM SHAFT)
408-P	CAPLUG-OIL RETURN HOLE
408-C	CROSSHEAD SEAL
409	BEARING
410	COUPLING (MOTOR)
410-A	COUPLING (CONNECTING)
412	ARROW - MOTOR ROTATION
405AM	STROKE LOCKING SCREW.

CHG.	DATE	BY	APPR.	REVISION
E	12-9-65	J.E.M.		ADDED ITEM NO. 243, INSERT (THREAD LOCK)
D	10-26-64	J.P.B.		STROKE LOCK PLATE PART NO. 253-E DELETED
C	7-7-64	J.P.B.		243 & 405-AJ DELETED. 253-E, 405-AH, 405-F, 406-B, 405AM ADDED
B	2-11-64	W.G.D.		LOC-TITE NOTES ADDED
A	7-9-63	J.E.M.		REDRAWN

DESCRIPTION MODEL - A-1

B/M (REF.)

SUPERSEDES

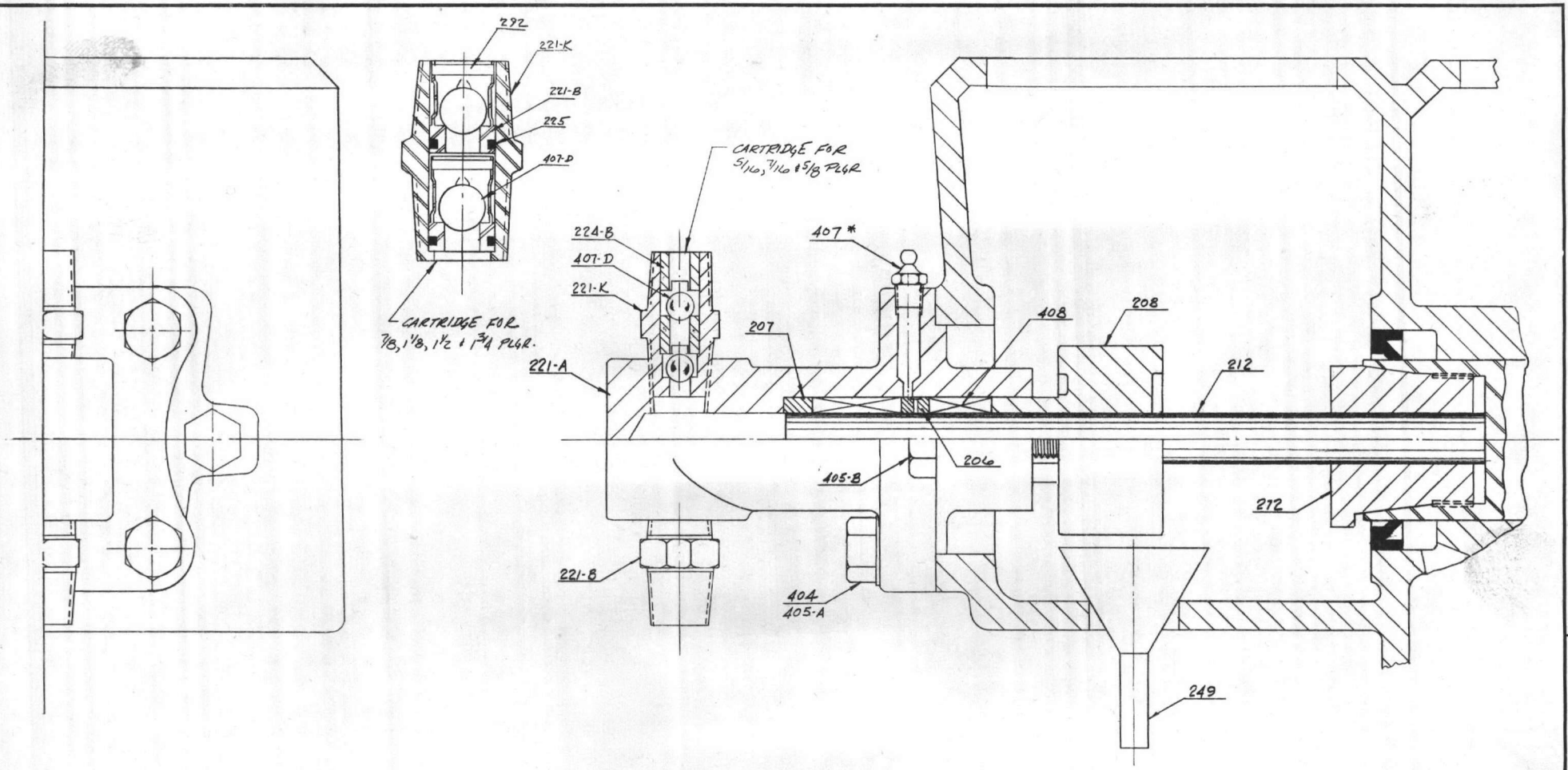
MAT'L - YY

DWN.	APPR.	DATE	SCALE	PATT. CODE
J.E.M.	[illegible]	7-9-63	~	

MILTON ROY COMPANY
PHILADELPHIA 18, PA.
ST. PETERSBURG 33, FLA.

TITLE MILROYAL PUMP DRIVE ASS'Y. LESS LIQUID END PARTS

DWG. NO. D-102-0148-000



* FOR INTERNAL FLUSH REMOVE GREASE FITTING (407)

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
206	LANTERN RING	253	CAUTION STICKER (NOT SHOWN)
207	NECK RING		
208	GLAND CAP	272	PLUNGER ADAPTER
		292	LIMIT PIN
212	PLUNGER	404	LOCKWASHER
		405-A	BOLT-LIQUID END.
221-A	LIQUID END	405-B	BOLT-GLAND CAP
221-B	BALL CHECK CARTRIDGE ASS'Y	292	LIMIT PIN. (B)
221-K	CARTRIDGE BODY	407	GREASE FITTING
224-B	SEAT		
407-D	BALL CHECK	408	PACKING.
225	"O" RING.		
249	FUNNEL		

CHG.	DATE	BY	APPR.	REVISION
B	9-12-66	J.P.B.		CARTRIDGE DETAIL ADDED FOR 5/16, 7/16, 1/2, 3/4 PLGR.
A	6-6-66	J.E.M.		ADDED 5/8, 1 1/8, 1 1/2 & 1 3/4 PLGRS. IN DESCRIPTION BLOCK.

DESCRIPTION: 5/16, 7/16, 5/8, 7/8, 1 1/8, 1 1/2 & 1 3/4 PLGRS. MILROYAL MODEL A & B 1000 PSI MAX.
B/M (REF.) 335-0432-XXY TO 335-0434-XYY.
SUPERSEDES
MAT'L=YY

DWN.	APPR.	DATE	SCALE	PATT. CODE
JRB		9-23-65	NONE	

MILTON ROY COMPANY
PHILADELPHIA 18, PA.
ST. PETERSBURG 33, FLA.

TITLE: PARTS & ASSEMBLY. COL VALVE MILROYAL

DWG. NO. C-102-0489-000

C-102-0489-000