DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

PLUNGER LIQUID END

This manual should be made available to the person responsible for installation, operating and maintenance.

**TEXT VOLUME**

**Date : 01/97** **O / Ref : T.160.0801.001.Rev. A**

For better understanding, use this volume together with the ILLUSTRATIONS VOLUME.

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**GUARANTEE**

**TECHNICAL CHARACTERISTICS**

(see last page of illustrations fascicle)

**LIST OF « TECHNICAL ASSISTANCE » AND « SPARE PARTS » DEPARTMENTS**

# HOW TO USE THIS MANUAL ?

**IMPORTANT**: You should read the following paragraphs carefully in order to understand how to use this manual efficiently.

This manual corresponds to the type of pumps mentioned on the cover page.

There may be several different construction versions for each type of pump, however, and this manual takes those differences into account.

## TEXT FASCICLE

The paragraphs or lines specific to a given construction are:

- indented compared to the main text body,
- marked by a vertical line indicating the specific text,
- marked by a rectangle specifying the corresponding code.

If a paragraph is identified by means of two adjoining « boxes » , this means that both codes are required at the same time (« and » relation). If, however, the « boxes » are separated, this means that only one of the codes is required (« or » relation).

## ILLUSTRATIONS FASCICLE

The figures specific to a given construction version are marked by means of a box specifying the corresponding code.

**Note**: When first reading this document, you are advised to highlight the « boxes » corresponding to the construction of your equipment so the manual will be easier to read in future.

## MARKING USED IN THE MANUAL

You will find the list of the various possibilities and the corresponding markings, at the end of the illustrations manual.

The « cross » in the « Done » column in the table indicates the specific construction of your pump.

# PART I - DESCRIPTION

## I - 1. UNPACKING AND STORAGE

### *UNPACKING*

The packaging must be carefully examined on receipt in order to ensure that the contents have not sustained any obvious damage. Precautions must be taken when opening the packaging in order to avoid damaging accessories which may be secured inside the packaging. Examine the contents and check them off against the delivery note.

### *STORAGE PRECAUTIONS*

**Storage for less than six months**

Equipment shall preferably be stored in its original packaging and protected from adverse weather conditions.

**Storage for more than six months**

- Grease all visible unpainted sections. Rubber parts (such as semi-flexible couplings) must be protected from sunlight and sudden temperature changes.
- Store the pump in its original packaging. In addition, packaging in heat-sealing plastic cover and dessicant bags must be provided for. The quantity of dessicant bags should be adapted to the storage period and to the packaging volume.
- Store protected from adverse weather conditions.

## I - 2. DESCRIPTION

The MILROYAL Pump is a compact electro-mechanical metering pump, oil-lubricated with a sealed housing, allowing adjustment of its capacity when stopped or in operation.

It is designed for industrial operation in continuous mode.

It is made up of the following items (Fig. 1.2a):

- a driving device consisting of a motor [1],
- a mechanical assembly [2],
- a liquid end [3].

Capacity adjustment is controlled either manually (by a graduated hand-knob [4] or automatically (such as by a servomotor [5]).

Various components of the mechanical assembly are shown in Figure 1.2a.

## I - 3. OPERATING PRINCIPLE OF THE MECHANICAL ASSEMBLY

See Figure 1.3a.

The mechanical assembly works on the principle of the inclinable crank.

The rotational motion of the motor is transmitted by the worm [1] to the tangential gear [2] which is linked to the inclinable crank [3]. A connecting rod and crank system [4] converts the rotary driving motion into a reciprocating linear motion with adjustable stroke. The stroke depends upon the angle of inclination of the crank, which is determined by the position of a micrometer screw [5]. Figure 1.3a illustrates manual adjustment of the position of the micrometer screw [5] using the hand-knob [7].

When the angle is zero, the connecting rod describes a cone of revolution. The mechanical system turns but there is no longitudinal movement of the crosshead [6] (zero stroke).

Figure 1.3b shows the functional diagram at zero stroke.

Figure 1.3c shows the functional diagram at maximum stroke.

## I - 4. OPERATING PRINCIPLE OF THE PACKED PLUNGER LIQUID END

See Figure 1.4a.

The plunger [2] is connected to the crosshead [1] of the mechanical assembly and has the same reciprocating linear motion.

In the suction phase, the displacement of the plunger [2] creates a negative pressure and allows the suction of a given volume (swept volume) through the valve assembly [4], while valve assembly [5] closes the discharge circuit.

During the discharge phase, the process is reversed. The plunger expels the fluid from the process through valve assembly [5], while valve assembly [4] closes the suction circuit.

## 1 - 5. OPTION FOR PLUNGER-TYPE LIQUID END

### *RINSING OPTION*

See Figure 1.5a.

R

This option consists in fitting the liquid end body with:

- a rinsing ring [10],
- a union for the inlet of rinsing product [11],
- a union for the outlet of rinsing product [12].

## 1 - 6. SAFETY AND HEALTH INSTRUCTIONS

The personnel responsible for installing, operating and maintaining this equipment must become acquainted with, assimilate and comply with the contents of this manual in order to:

- avoid any possible risk to themselves or to third parties,
- ensure the reliability of the equipment,
- avoid any error or pollution due to incorrect operation.

Any servicing on this equipment must be carried out when it is stopped. Any accidental start-up must be prevented (either by locking the switch or removing the fuse on the power supply line).

A notice must be attached to the location of the switch to warn that servicing is being carried out on the equipment.

During oil changing operations, the waste oil must be collected in a suitable receptacle. Any overflow of oil which may result must be removed using a degreasing agent suitable for the operating conditions.

Soiled cleaning cloths must be stored in suitable receptacles. The oil, degreasing agent and cleaning cloths must be stored in accordance with the rules on pollution.

Switch off the power supply as soon as any fault is detected during operation: abnormal heating or unusual noise.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

# PART II - INSTALLATION

## II - 1. HYDRAULIC INSTALLATION

All the information concerning the hydraulic installation of a metering pump is detailed in a volume, « Generalities about metering pumps installation ». You should consult that manual to determine the installation required for your application.

Certain essential points are, however, also briefly covered in this document.

### *GENERAL*

- Piping layout

There must be no swan-necks or stagnant volumes which are liable to trap air or gas.

Stresses due to incorrect alignment of piping with respect to the centreline of valves must be avoided as far as possible.

- Remove burrs and clean the piping before fitting.
- It is advisable to provide for a calibrating chamber in order to calibrate the pump in service conditions.

### *PIPING ON THE SUCTION CIRCUIT*

- Provide for a filter with suitable mesh size upstream of the pump.
- Check whether the diameter and length of pipe are compatible with the pump's maximum capacity.

### *PIPING ON THE DISCHARGE CIRCUIT*

- Provide for a safety valve on the discharge pipe, designed to protect the installation.
- Check whether it is necessary to install a pulsation dampener, according to the width and diameter of the tubing.
- It is advisable to install a priming valve on the discharge circuit in order to make starting and maintenance of the pump easier.

Figure 2.1a is a schematic representation of a calibrating chamber, a priming valve and a safety valve in ideal conditions.

## II - 2. DRIP COLLECTION

Provide for outlets so that any leak or drips can be easily drained off without any danger. This is especially important in the case of harmful liquids.

See Figure 1.2a.

Position a tray under the plain hole at the bottom of the spacer [8] to recover leaks from the stuffing box.

## II - 3. HANDLING

Choose lifting equipment that is compatible with the weight of the pump. (See TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

See Figure 2.3a.

Handling requires the following precautions :

Fit one sling under the motor and install the other under the pump mechanical assembly or assemblies.

Check that the assembly is correctly balanced before starting to move it.

Secure the pump as soon as it is positioned in its required location (see Chapter II - 4. Setting up).

## II - 4. SETTING UP

Secure the pump to a correctly dimensioned, horizontal support by its attaching holes. Leave enough clear space around the pump to be able to carry out servicing operations and adjustments.

Pumps installed outdoors must be protected by a shelter (according to the climatic conditions).

MX

Note: the pumps are « aligned » in the factory on their frames. Before securing the frame, check that the supporting surface is flat (and use shims, for example, to ensure that it is horizontal).

# II - 5. ELECTRICAL INSTALLATION

## *CONNECTING THE MOTOR*

Check the specifications of the motor and compare them with the voltage available on your installation before making connections. Connect up the motor in accordance with the instructions in the terminal box (Fig. 2.5a).

SX

A delta connection is required to connect up to a 230 V 3-phase power supply (Fig. 2.5b).

M1

A star connection is required to connect up to a 400 V 3-phase power supply (Fig. 2.5c).

**CAUTION** : Do not forget to connect the earth terminal on the motor [PE] (Fig. 2.5a) to the equipment earth conductor.

The electrical protection installed for the motor (fuse or thermal protection) must be suitable for the motor's rated current.

# PART III - START UP

## III - 1. PROCEDURES BEFORE START UP

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

See Figure 1.2a.

- Check that the pump is secured to its support (Chapter II - 4. Setting up).
- Remove the cover from the housing [7] and fill the housing with the lubricating oil supplied up to the middle of the level indicator [12]. Reinstall the cover on the housing.
- Check the opening of all the isolating valves installed on the suction and discharge circuits. If the discharge circuit is equipped with an injection nozzle or a back-pressure valve, open the priming valve for discharge (if there is no priming valve, disconnect the discharge pipe). This makes it possible to verify that there is liquid present if the pump is installed in flooded suction, or to prime the pump if it is installed in suction lift.

D

- Check that the pump capacity is set to "0%" (hand-knob [4]).

SX

**Checking the electrical connection of the motor**

M1

Start up the pump to check the motor's direction of rotation. It must comply with that indicated by the arrow marked on the pump housing. To reverse the motor's direction of rotation, invert A and B or A and C (See Figure 2.5b or 2.5c). Stop the pump.

## III - 2. START UP

- Once all the checks and procedures described in the previous section have been carried out, start up the pump.
- Check visually and by listening. (In particular, check that there are no suspicious noises).

D

- Make sure that the hand-knob is unlocked.

- Adjust the pump capacity gradually from 0 % to 100% and control the liquid output at priming valve or discharge check valve.
- As soon as the liquid to be pumped flows out of the priming valve or the discharge valve, priming on the process side has been achieved. Close the priming valve or reconnect the discharge pipe, as applicable.
- Once the priming is obtained, adjust the pump to the desired capacity.

D

- Lock the hand-knob with the locking screw [9] (Fig. 1.2a).

## III - 3. FAILURES ON START UP

### *PROBLEMS WITH MOTOR*

**The motor runs with difficulty and heats up**

SX

- One phase is incorrectly connected.
- The characteristics of the electrical power supply do not match the specifications of the motor.

M1

- The electrical connection used is not suitable.

**The motor overheats**

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

### *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

SX

M1

- The direction of rotation of the motor is incorrect. (Check using the arrow marked on the housing). Reverse the direction of rotation (see Chapter III - 1. Procedures before start up, Checking the electrical connection of motor).

### *PROBLEMS WITH FLOW RATE*

**The flow rate is lower than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The suction power is insufficient (pipe cross-section too small or pipe too long): replace the pipe with ones that have a larger cross-section or install the pump in flooded suction.
- The leak-tightness of suction pipe is unsatisfactory.
- The viscosity of the liquid is incompatible with the pump's capabilities.

**The capacity is greater than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- A syphoning phenomenon is observed: check that the suction pressure is not greater than the discharge pressure. Install a back-pressure valve on the discharge side.
- Too many flow pulsations : a pulsation dampener is required, or the pulsation dampener installed is of the wrong size, or the pressurization of the pulsation dampener is incorrect.

**The capacity is variable**

- This problem may be due to particles from the piping which interfere with the operation of the valve assemblies: clean the piping (if there is an abnormal presence of particles) and the valve assemblies (by checking the assembly sequence of different components, or by referring to table 5.2c, chapter V - 2.).

## III - 4. OPERATION - SCHEDULE FOR CHECKS AND MAINTENANCE OPERATIONS

The programme of checks and maintenance operations depends on the conditions in which the equipment is used. For this reason, the following frequencies are given as an example only. Individual users should adapt these frequencies to their own specific operating conditions.

| When | Check | Maintenance | See |
|---|---|---|---|
| Start up | Check tight sealing and temperature of plunger | Adjust sealing | Chapter IV-2 |
| After 250 hours | | Change lubricating oil | Chapter IV-1 |
| Every month | Check oil level in the housing<br>- if incorrect -> | Trace lubricating oil leak | Chapter IV-2 |
| Every 750 hours | Check tight sealing of plunger<br>- if incorrect -> | Adjust sealing:<br>if adjustment impossible -> change packings | Chapter IV-2<br>Table 5.2b |
| Every 3 months | Check the oil temperature (max : Chapter IV-1)<br>if incorrect -> | Verify<br>- the date of the last oil change<br>- the extent of contamination of the oil<br>- the equipment operating conditions | |
| Every 6 months or 2,500 hours | | Change lubricating oil | Chapter IV-1 |
| Frequency to be defined according to process (2,500 hours approx.) | Check conformity of capacity | Check capacity | Chapter IV-2 |
| Every year | | ** Annual overhaul | Part V |

** Our Technical Assistance Department staff is available for any maintenance matters on site (see DOSAPRO adress at the end of this manual).

A model maintenance sheet is shown in Figure 3.4a to help you ensure follow-up of your servicing actions (checking or maintenance).

# PART IV - ROUTINE MAINTENANCE

## IV - 1. OIL CHANGE

### *LUBRICATING OIL*

- Perform the first housing oil change after 250 hours' operation. Subsequent oil changes will be carried out every 2,500 hours' operation or every six months.
- Disconnect the pump electrically, check that the equipment cannot be switched on accidentally. Position a notice at the location of the switch.

**Note**

To avoid any risk of burning by the hot oil, protective gloves should be worn.

See Figure 1.2a.

- Unscrew the plug [11] and drain the oil into a tray. Degrease the plug, apply a little Loctite 221 adhesive on the threads and screw the plug into place.
- Remove the cover from the housing [7] and fill the housing up to the middle of the level indicator [12] with an oil suitable for service conditions.
- Quantity: see TECHNICAL CHARACTERISTICS at the end of the illustrations manual.
- Remove any overflow of oil immediately with a suitable degreasing agent for the operating conditions.

**Recommendations**

- Standard conditions: standard oil

Ref.: 437 0013 021N, Ref.: 437 0013 024N (COFRAN Mecanep 220) or equivalent (see below).

- Ambient temperature: > - 5°
- Max. oil temperature: + 90°

Table of equivalencies:

| | |
|---|---|
| FUCHS | RENEP 220 |
| B.P. | GR XP 220 |
| CASTROL | ALPHA SP 220 |
| ELF | REDUCTELF SP 220 |
| FINA | GIRAN 220 |
| IGOL | DYNAM SP 220 |
| MOBIL OIL | MOBILGEAR 630 |
| SHELL | OMALA 220 |
| TOTAL | CARTER EP 220 |
| ESSO | SPARTAN EP 220 |

- Special conditions: for example, low-temperature oil: temperature range: -35°C to +46°C.

Ref: Sintofluid (FUCHS)

# IV - 2. OTHER MAINTENANCE OPERATIONS

## *TRACING A LUBRICATING OIL LEAK*

See Figure 1.2a.

- Check that the drain plug [11] is correctly tightened.
- Check for leakage on the shaft on the motor side or on the protective cap side. If a leak is found, change the seals on the worm shaft (see Table 5.2f).
- Check for any flow of fluid through the hole at the bottom of the spacer [8]. If there is, change the crosshead oil seals (see Table 5.2e).

## *CHECKING AND ADJUSTING THE PLUNGER'S TIGHT SEALING*

Remove the cover from the spacer [8] (Fig. 1.2a) and check for leakage on part [A] (Fig. 1.4a).

The leak is acceptable if it is no more than about one drop per minute.

If the leak is greater than that :

- Gradually tighten part [A] with a pin wrench (if part [A] is fitted with holes). Wait five minutes before repeating the operation (checking and adjustment).
- Check this adjustment after two hours' operation. Also check the temperature of the liquid end body.

If overheating occurs, repeat the previous adjustment but gradually loosen the part [A].

## *CHECKING THE PUMP CAPACITY*

This is a question of determining the straight line representing the pump's capacity according to its adjustment.

Four measurements are sufficient (adjustment at 100%, 75%, 50% and 25%).

There are two possible methods:

- If the pump is installed in pressurizing mode (Fig. 2.1a), measure the volume of pumped liquid in a calibrating chamber for a given period of time. It may be necessary to reproduce actual operating conditions (suction pressure).
- If the pump is installed in suction mode, measure the volume of discharged liquid. It may be necessary to reduce actual operating conditions (discharge pressure).

The first method is recommended. In addition, this method avoids placing the operator in contact with the liquid, which is important if the pumped liquid is hazardous.

For a precise check, which cannot be performed using the two methods described above, it may be necessary to use an electromagnetic flowmeter.

# IV - 3. TRACING CAUSES OF FAILURE

## *PROBLEMS WITH MOTOR*

### The motor does not run

SX

The thermal relay has been tripped.

- The motor is defective.
- Wiring is defective.

M1

- Check the parts of the mechanical assembly.

### The motor heats up abnormally

- The quantity of lubricating oil is incorrect: trace the leak (see Chapter IV - 2.)
- The quality of the lubricating oil is incorrect. Check the date of the last oil change and the specifications of the oil used.
- The pump is used in conditions it was not designed for.

## *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The tangential gear is worn. Replace it.
- The " bearings " are worn. Replace them.
- The half-coupling attaching screws are loose or the shock absorber is worn.

## *PROBLEMS WITH FLOW RATE*

### The pump produces no flow

The crosshead and the plunger do not move :

D

- The pump capacity is adjusted to « 0 % » : Adjust the capacity to the desired value and lock the hand-knob.

- The connecting rod is broken,
- The tangential gear is worn.

The crosshead and plunger move :

- The liquid end is unprimed: release the pressure on the discharge pipe and prime the liquid end, or check the leak-tightness of the suction circuit.
- The balls of the valve assemblies are blocked by particles: clean or replace the valve assemblies. First, check whether the presence of these particles is normal and take corrective action if necessary.

**The pump does not provide the required flow rate**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The ball seats and/or the balls are dirty or worn: clean or replace the ball seats and the balls or the valve assemblies.
- The leak-tightness of the suction circuit is unsatisfactory: repair or replace the piping.

## IV - 4. ORDERING SPARE PARTS

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).

- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

# PART V - PREVENTIVE MAINTENANCE

*ANNUAL OVERHAUL*

This consists in replacing the wear parts included in a "spare parts kit" (see below). The corresponding action is detailed in Part VII : Servicing of the liquid end, and in Part VIII : Servicing of the mechanical assembly.

This servicing is conducted by carrying out the following procedures :

- removing the liquid end,
- removing the mechanical assembly,
- reinstalling the mechanical assembly,
- reinstalling the liquid end.

The tables (Chapter V - 2.) show the sequential action into individual servicing actions.

## V - 1. SPARE PARTS CONSTITUTING THE "SPARE PARTS KIT"

### For packed plunger liquid end

- packings (Table 5.2b).
- seat and ball assemblies (with seals) or valve assemblies (Table 5.2c).

### For mechanical assembly

- crosshead oil seal(s) (Table 5.2e)
- worm shaft seals (Table 5.2f)

SX
M1

- shock absorbers for motor coupling (Table 5.2g)

Mi
Mn

- shock absorbers for pump coupling (Table 5.2g)

Certain products will be necessary to carry out these servicing actions, such as the following:

- a degreasing agent (e.g. Loctite super clean 7063),
- a lockwire adhesive (e.g. Loctite self-locking compound 221),
- a tight sealing adhesive (e.g. Loctite 566).

It is advisable to conduct the annual overhaul at the same time as changing the oil in the housing (see Chapter IV - 1. Oil change).

### *OTHER SPARE PARTS*

Other spare parts are available. You will find the list in Chapter VI - 1. List of other spare parts.

### *ORDERING SPARE PARTS*

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).
- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

## V - 2. SEQUENTIAL ACTIONS

**REPLACING THE PACKINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

N

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the plunger mounting assembly | VII - 2 | K1 |
| • Removing the cartridge | VII - 2 | J1 |
| • Reinstalling the plunger mounting assembly | VII - 3 | K2 |
| • Reinstalling the cartridge | VII - 3 | J2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 5.2b : Sequential action.**

**REPLACING THE PACKINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

U

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the packings | VII - 2 | J1 |
| • Reinstalling the packings | VII - 3 | J2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 5.2b : Sequential action.**

**REPLACING THE VALVE ASSEMBLIES**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1-3) |
| • Removing the valve assembly | VII - 2 | B1 |
| • Reinstalling the valve assembly | VII - 3 | B2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2c : Sequential action.**

**REPLACING THE CROSSHEAD SEALS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2e : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

SX

**Table 5.2f : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the half-coupling | VIII - 2 | AN1 |
| MX • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2f : Sequential action.**

SX

M1

**REPLACING THE SHOCK ABSORBER FOR MOTOR COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Removing the motor | VIII - 2 | M1 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

Mi

Mn

**REPLACING THE SHOCK ABSORBER FOR PUMP COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

# PART VI - CORRECTIVE MAINTENANCE

## VI - 1. LIST OF OTHER SPARE PARTS

This list completes the list given in Chapter V - 1. which covers the set of replacement parts required for annual overhaul of the pump.

**For packed plunger liquid end**

U

- plunger (see Table 6.2a)
- plunger mounting assembly (see Table 6.2a)

N

- plunger mounting assembly (see Table 6.2b)

**For mechanical assembly**

- crosshead + pin axis assembly (see Table 6.2d)
- connecting rod + crank (see Table 6.2e)
- bearing screw (see Table 6.2f)
- bearings (see Table 5.2f)
- « gear + worm » assembly (see Table 6.2i)

## VI - 2. SEQUENTIAL ACTIONS

U

**REPLACING THE PLUNGER**
**REPLACING THE PLUNGER MOUNTING ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Replacing the plunger mounting assembly | VII - 4 | K1 |
| • Reinstalling the plunger mounting assembly | VII - 4 | K2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 6.2a : Sequential action.**

**REPLACING THE PLUNGER MOUNTING ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

N

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Replacing the plunger mounting assembly | VII - 2 | K1 |
| • Reinstalling the plunger mounting assembly | VII - 3 | K2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 6.2b : Sequential action.**

**REPLACING THE « CROSSHEAD + PIN AXIS » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end
and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 6.2d : Sequential action.**

**REPLACING THE CONNECTING ROD/CRANK ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 (1;2:5) |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the crank | VIII - 4 | T1 |
| • Reinstalling the crank | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Restarting | VII - 3 & VIII - 3 | A2 (as per A1) |

**Table 6.2e : Sequential action.**

**REPLACING THE BEARING SCREW**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the bearing screw | VIII - 2 | Q1 (1) |
| • Reinstalling the bearing screw | VIII - 3 | Q2 (2 - 5) |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2h : Sequential action.**

**REPLACING THE « GEAR + WORM » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the half-coupling | VIII - 2 | AN1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the tangential gear | VIII - 4 | T1 |
| • Reinstalling the tangential gear | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 4 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2i : Sequential action.**

# PART VII - SERVICING THE LIQUID END

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x) in the case of partial servicing operation.

## VII - 1. GENERAL

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

## VII - 2. REMOVING THE LIQUID END

### A1. Preliminary operations

Before carrying out any servicing action on the liquid end or tubes, take the necessary steps to ensure that any harmful liquid they may contain is not spilt and does not touch personnel. Provide for the rinsing of the liquid end, if necessary, and provide for appropriate protective equipment. Check that there is no pressure and the temperature of components before starting to dismantle.

1. Position the pump capacity adjustment on "0%".
2. Disconnect the pump electrically. Check that the equipment cannot be started up accidentally. Place a notice at the location of the switch.
3. Disconnect the pump hydraulically.
4. Remove the cover from the spacer.

R | Disconnect the liquid end from the rinsing system.

2
4
5

### B1. Removing the valve assemblies

See Figure 7.2a.

1. Unscrew the valve assemblies [221].
2. Clean the tapped holes in the liquid end body [3].

3

### B1. Removing the valve assemblies

See Figure 7.2a.

1. Unscrew the valve assemblies [221] and [221A].
2. Clean the tapped holes in the liquid end body [3].

### F1. Removing the liquid end

See Figure 7.2c.

1. Unscrew nut [A] by one turn.
2. Unscrew the two screws (liquid end/spacer junction) from the inside of the spacer and extract the liquid end body [221A].
3. Unscrew the mounting screw [272A] and extract the plunger. Make sure that one of the two washers [439] has not been left in the bore in the crosshead.

### J1. Removing the packings

See Figure 7.2c.

1. Remove the nut [A]. Remove the bushing [244] and cylinder [237].
2. Extract the packings [438A], rinsing spacer [006] and guide bushing [007]. If necessary, use a hook, taking care to avoid scratching the liquid end body [221A]. Clean the liquid end body with a degreasing agent and compressed air in order to remove all the particles of braid.

## VII - 3. REINSTALLING THE LIQUID END

### J2. Reinstalling the packings

See Figure 7.2c.

1. Fit the guide bushing [007], packings [438A] and rinsing spacer [006] in the liquid end body [221A].
2. Fit the cylinder [237] in the bushing [244].
3. Fit the bushing [244] in the liquid end body and tighten the nut [A] by one turn.

### F2. Reinstalling the liquid end

See Figure 7.2c.

1. Grease the washer [439] and position it on the nut [272]. Screw the mounting screw [272A] into the crosshead, making sure that the second washer [439] is correctly positioned. Lock the mounting screw (torque of 1 m.daN).
2. Reinstall the liquid end body [221A] on the plunger [212] and attach it onto the spacer by means of two screws (tightening to a torque 0.5 m.daN).
3. Screw on the nut [A] without torquing.

2

4

5

### B2. Reinstalling the valve assemblies

See Figure 7.2a.

1. Apply Teflon on the threads on the valve assemblies [221]. Apply tallow.
2. Screw the valve assemblies onto the liquid end body [3], taking into account the arrow indicating the direction of flow of the liquid.

2

3. Tighten to a torque of 5 m.daN.

### B2. Reinstalling the valve assemblies

See Figure 7.2a.

3

1. Apply Teflon on the threads of the valve assemblies [221] and [221A]. Apply tallow.
2. Screw the valve assemblies onto the liquid end [3], taking into account the arrow indicating the liquid flow direction.
3. Tighten the valve assembly of the suction system to a torque of 12 m.daN.
4. Tighten the valve assembly of the discharge system to a torque of 5 m.daN.

### A2. Restarting

2. Make the hydraulic connections on the pump.
3. Make the electric connections on the pump.
4. Check that the capacity adjustment is set to the "0%" position.
5. Check that there is no suspicious noise on starting up.
6. Adjust the pump capacity to "100%" to allow quicker priming on the process side.
7. Once priming on the process side has been achieved, carry out sealing adjustment (see below).
8. Reinstall the spacer cover (replacing the cover seal, if necessary).

D

9. Adjust the pump to the desired capacity and lock the hand-knob.

DA

9. Adjust the pump to the desired capacity.

### *SEALING ADJUSTMENT*

This consists in checking leakage on part [A].

The leak is acceptable if it is no more than about one drop per minute.

If the leak is greater than that :

- Gradually tighten part [A] with a pin wrench (if part [A] is fitted with holes). Wait five minutes before repeating the operation (checking and adjustment).
- Check this adjustment after two hours' operation. Also check the temperature of the liquid end body.

If the pump becomes hot, check that it has been primed. If the pump has been properly primed, repeat the previous adjustment procedure while gradually loosening the part [A].

# VII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

## K1. Removing the plunger mounting assembly

See Figure 7.2c.

1. Unscrew the nut [272] (part bonded with Loctite 221 adhesive) and remove washer [439], mounting screw [272A], washer [019] and the plunger [212].

## K2. Reinstalling the plunger mounting assembly

See Figure 7.2c.

1. Engage the washer [019] and mounting screw [272A] on the plunger [212].
2. Grease the first washer [439] and fit it on the nut [272].
3. Apply a little Loctite 221 adhesive on the beginning of the thread of nut [272]. Screw the nut onto the plunger [212].

# PART VIII - SERVICING THE MECHANICAL ASSEMBLY

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x), in the case of partial servicing operation.

## VIII - 1. GENERAL

A view of the mechanical assembly is shown in Figure 8.1a.

MX

**Note concerning multiplexed pumps**

When carrying out servicing on all the pumps, start with the last pump, then move on to the one adjacent to it, and so on until reaching the driving pump.

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.
- Clean the recess for O-rings when they are removed. Apply tallow in the recess before reinstalling the new O-ring.

## VIII - 2. DISMANTLING THE MECHANICAL ASSEMBLY

### A1. Preliminary operations

The relevant recommendations and procedures are described in section A1, Chapter VII - 2. REINSTALLING THE LIQUID END.

MX

If necessary, prepare lifting equipment compatible with the weight of the mechanical assembly (see TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

5. Drain the oil from the housing and remove the cover from the housing.

### F1. Removing the liquid end

The relevant procedures are described in section F1 of Chapter VII - 2. REMOVING THE LIQUID END.

### M1. Removing the motor

SX

See Figure 8.2a.

M1

1. Shim the mechanical assembly, if necessary, as the motor mount [072] which supports the pump will have to be dismantled.
2. Remove the screws attaching the motor mount [072] onto the housing and take out the motor, the motor mount and the half-coupling [052A].
3. If the shock absorber [440] must be replaced, remove it and remove dust from the two half-couplings.

### N1. Removing the half-coupling

SX

See Figure 8.2a.

M1

1. Measure dimension [D].
2. Remove the screw [435A] through the hole [E] in the housing in order to remove the half-coupling [052].

### AN1. Removing the half-coupling

Mi

See Figure 8.2a.

Mn

1. Measure dimension [D2].
2. Remove screw [R1] through the hole [E] in the housing to remove the half-coupling [052].

### O1 - 1. Removing the connecting rod

See Figure 8.2b.

1. Remove the connecting rod [014] from the crank [216]: unscrew the nut [435J] and withdraw the pin axis [068].

### P1. Removing the crosshead

See Figure 8.2c.

1. Remove the plug [432A] and screw [435A].
2. Extract the liner [072], crosshead [010] and connecting rod [014] through the bore in the spacer.
3. Withdraw the crosshead.[010] from the liner [072], mark the direction of fitting of the lip seal [408] and O-ring [438].

### V1. Removing the attaching lug

SX

See Figure 8.2b.

Mn

1. Remove the four screws securing the attaching lug [N] to the housing, after shimming the mechanical assembly, if necessary.

### AV1. Uncoupling the pumps

M1

See Figure 8.2e.

Start by working on the “last” MD pump.

Mi

1. Unscrew the screws linking the two pumps as well as the attaching screws (pump - frame). Remove the pump. Remove the spacer [019], if one is fitted.
2. Measure dimension [D1].
3. Remove screw [R1] to remove the half-coupling [052A].

### Q1. Removing the worm

See Figure 8.2b.

1. Unscrew the bearing screw [237]. If any difficulty is encountered, heat the housing with a blowtorch to soften the adhesive applied in the thread tapped in the housing and on the threads of the bearing screw. Remove the bearing screw, the lip seal [408A] and bearing [409]. If a blowtorch is used, the bearing [409] must be replaced.
2. Remove the worm.

### R1. Removing the crank support

See Figure 8.2b.

1. Remove the two locking rings [404A]. Push on the adjusting dies [211] to free the micrometer screw [256].
2. Remove the two screws [435B]. Unscrew the micrometer screw [256] using the hand-knob [255] in order to free the crank support [281A].
3. Remove the crank support [281A] with the bearing [409].
4. Remove the lip seal [408A] from the housing, if it has to be replaced.

D

VF

See Figure 8.2d.

5. If the lock insert [043] has to be replaced, completely unscrew the micrometer screw. Remove screw [008A] and extract the lock insert by making it fall out.

## VIII - 3. REINSTALLING THE MECHANICAL ASSEMBLY

### R2. Reinstalling the crank support

See Figure 8.2b.

1. If necessary, proceed with the replacement of the bearing [409]: apply Loctite 221 adhesive on the outside of the bearing and install it in its recess in the housing.
2. Position the crank support [281A] in the housing.

### Q2. Reinstall the worm

See Figure 8.2b.

1. Fit the worm into the housing. (There is no specific direction of fitting).
2. Apply tallow on the seal [408A] and fit the seal into the housing.
3. Apply tallow on the seal [408A] and fit it into the bearing screw [237], (taking care to comply with the direction of fitting).
4. If necessary, replace the bearing [409]: apply a little Loctite 221 on the bearing screw [237] and fit the bearing on the bearing screw.
5. Apply Loctite 566 on the tapping in the housing and on the threads on the bearing screw. Screw in the bearing screw. Wait for the adhesive to dry (about 3 hours at 18°C) before continuing with the fitting procedure.

### S2. Reinstalling the micrometer screw

See Figures 8.2d and 8.2b.

D

1. If the lock insert [043] was removed, screw the micrometer screw [256], fit the insert in the bore and install the screw [008A] without torquing it. Reinstalling the stop collar [018].
2. Screw the micrometer screw [256] in order to engage the adjusting dies [211] in the groove in the micrometer screw.

VF

3. Position the adjusting dies using the two stop rings [404A].
4. Unscrew the micrometer screw until reaching the "98%" graduation.
5. Place the stop collar [018] fully home against the housing and moderately tighten the two screws [435B].
6. Adjust the micrometer screw to the "100%" graduation and lock the two screws [435B].

### P2. Reinstalling the crosshead

See Figure 8.2c.

1. Proceed with the replacement of the lip seal [408] and O-ring [438], if necessary: apply a little tallow in the liner, fit a seal in the liner. Take care to avoid damaging the lip on the seal during reinstallation.
2. Fit the crosshead [010] in the liner [072]. Replace the O-ring [438].
3. Fit the assembly comprising the liner [072] and crosshead [010] in its recess through the bore in the spacer.
4. Position this assembly with screw [435A] (tightening to a torque of 0.5 m.daN). Reinstall the plug [432A].

### O2 - 1. Reinstalling the connecting rod

See Figure 8.2b.

1.Reinstall the connecting rod [014] on the crank [216]. Fit the pin axis [068] and screw on the nut [435J].

### N2. Reinstalling the half-coupling

SX

See Figure 8.2a.

M1

1. Reinstall the half-coupling [052] on the worm shaft, allowing for the measurement conducted during dismantling (dimension [D]).
2. Screw in the screw [435A] via the hole [E] in the housing.

### AN2. Reinstalling the half-coupling

Mi

See Figure 8.2a.

Mn

1. Reinstall the half-coupling [052] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D2]).
2. Install the screw [R1] through the hole [E] in the housing.

### M2. Reinstalling the motor

SX

See Figure 8.2a.

M1

1. Proceed with the replacement of the shock absorber [440], if necessary.
2. Fit the two half-couplings and, at the same time, engage the motor mount [072] in the centring fitting in the housing. The mount must be fully home on the housing and the shock absorber [440] must be fitted without forcing between the two half-couplings.
3. Secure the mount [072] with screws.

M1

### AW2. Positioning the pump

See Figure 8.2e.

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D1]). Install the screw [R1].
2. Position the crank in the high position.

Mi

### AW2. Coupling the pumps

See Figure 8.2e

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (code [D1]). Install the screw [R1].
2. Position the crank in the high position.
3. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
4. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted between the two half-couplings without being placed under stress.
5. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

Mn

### AW2. Coupling the pumps

See Figure 8.2a.

1. Position the crank in the high position.
2. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
3. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted without being placed under stress between the two half-couplings .
4. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

SX

Mn

### V2. Reinstalling the attaching lug

See Figure 8.2b.

1. Secure the attaching lug [N] with four screws.

## F2. Reinstalling the liquid end

The relevant procedures are described in section F2 of Chapter VII - 3. REINSTALLING THE LIQUID END.

## A2. Restarting

1. Fill the housing with oil and reinstall the housing cover (replacing the cover seal, if necessary).

The other relevant procedures are described in section A2, Chapter VII - 3.REINSTALLING THE LIQUID END.

# VIII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

## O1 - 2. Removing the connecting rod

See Figure 8.2c.

1. Remove the connecting rod [014] from the crosshead [010]: unscrew the screw [435E] and withdraw the pin [011] (parts bonded with Loctite 221 adhesive).

## T1. Removing the tangential gear

See Figure 8.2b.

1. Unscrew the nut [405] while holding the crank [216] (parts bonded with Loctite 221.
2. Drive out the crank.

## T2. Reinstalling the tangential gear

See Figure 8.2b.

1. If necessary, adjust the groove in the tangential gear to fit with the key on the crank [216] (in the event of replacement of the worm / tangential gear pair or replacement of the crank).
2. Apply a little adhesive on the thread on the crank. Engage the crank in the crank support [281A], fit the tangential gear (taking care with the direction of fitting) and screw on the nut [405].

## O2 - 2. Reinstalling the connecting rod

See Figure 8.2c.

1. Reinstall the connecting rod [014] on the crosshead [010]: fit the connecting rod on the pin [011] by means of screw [435E] (part bonded with Loctite 221).

# GUARANTEE

The vendor guarantees his products according to the D.M.R. general conditions of sale.

The guarantee for components and sub-assemblies not fabricated by the vendor is limited tothat given by the supplier.

The vendor's guarantee only covers the replacement or the repair, at his cost and in his factory, of all parts acknowledged by his technical services as being defective due to an error in conception, of material or of execution.

It is the purchasers responsability to prove the said defects. The guarantee does not cover the replacement of wear parts mentioned in part V - Preventive Maintenance.

The vendor reserves the right to modify all or part of his products in order to satisfy the guarantee. The guarantee does not cover charges arising from dismantling, assembly, transport and movements.

The replacement of one or several parts, for whatever reason, does not prolong the period of guarantee.

The guarantee is not applicable notably in the following cases :

- installation not in accordance with standard current practice.
- deterioration or accident resulting from negligence.
- lack of surveillance or maintenance.
- modifications to conditions of use.
- chemical corrosive or erosive attack. The proposed materials of construction are recommendations subject in all cases to verification and acceptance by the client. The recommendations, based on the experience of the vendor and the best available information, do not guarantee against wear or chemical action.

The guarantee ceases :

- if the storage of the material, outwith the vendors factory, does not conform to his recommendations or to current standard practices.
- in case of work or dismantling of the material by someone who does not respect written recommendations of the instruction manual (when replacing wear parts).
- if parts from another origin are substituted for the original parts supplied by the manufacturer.

The purchaser cannot call on guarantee claims to justify differing payments.

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DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

PLUNGER LIQUID END

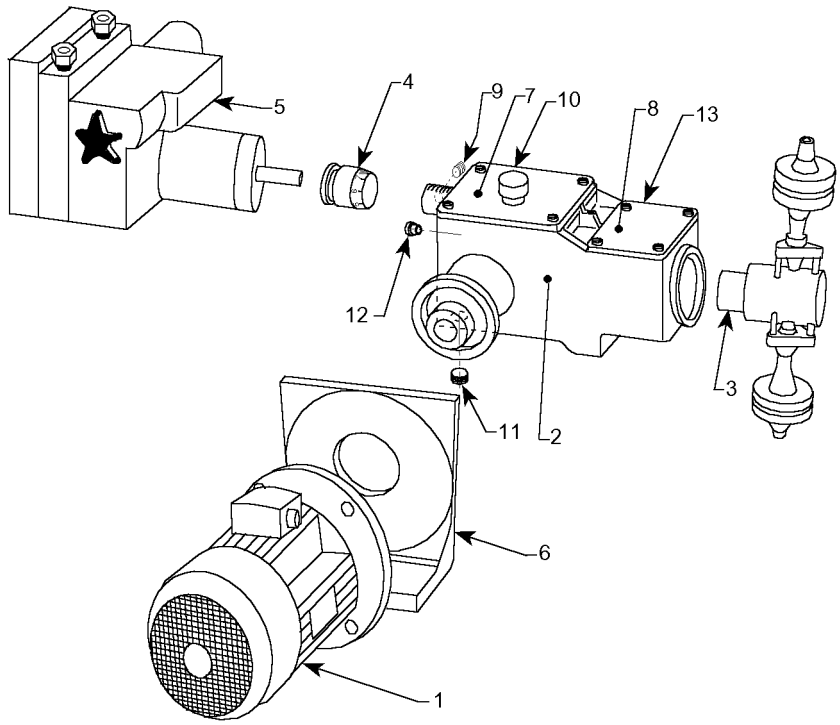
This manual should be made available to the person responsible for installation, operating and maintenance.

**ILLUSTRATIONS VOLUME**

**Date : 01/97** **O / Ref : I.160.0801.001.Rev. A**

For better understanding, use this volume together with the TEXT VOLUME.

# LIST OF ILLUSTRATIONS




| | | | |
|---|---|---|---|
| 1 | Motor | 7 | Housing |
| 2 | Mechanical assembly | 8 | Mechanical assembly spacer |
| 3 | Liquid end | 9 | Stroke adjustment knob locking screw |
| 4 | Stroke adjustment knob | 10 | Housing filler plug |
| 5 | Servo-motor | 11 | Housing drain plug |
| 6 | Motor support | 12 | Oil gauge (housing) |

**Fig. 1.2a: Milroyal D pump fitted with plunger-type liquid end**

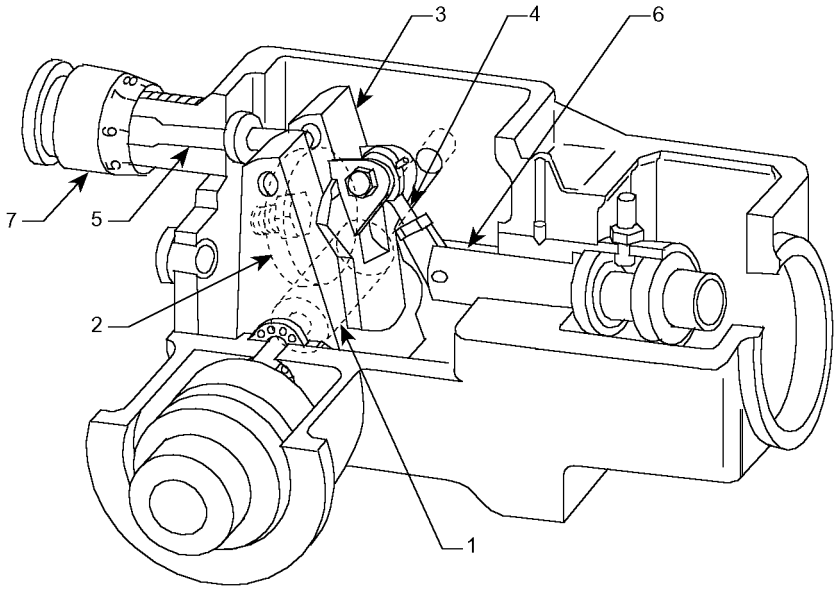



**Fig. 1.3a : Mechanical assembly**

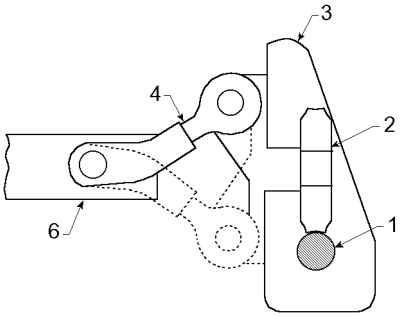



**Fig. 1.3b : Setting to zero stroke**

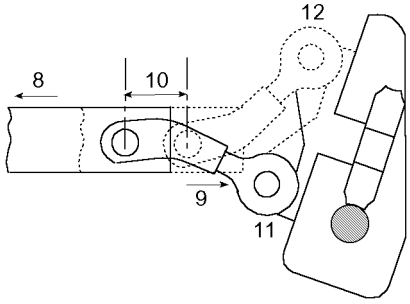
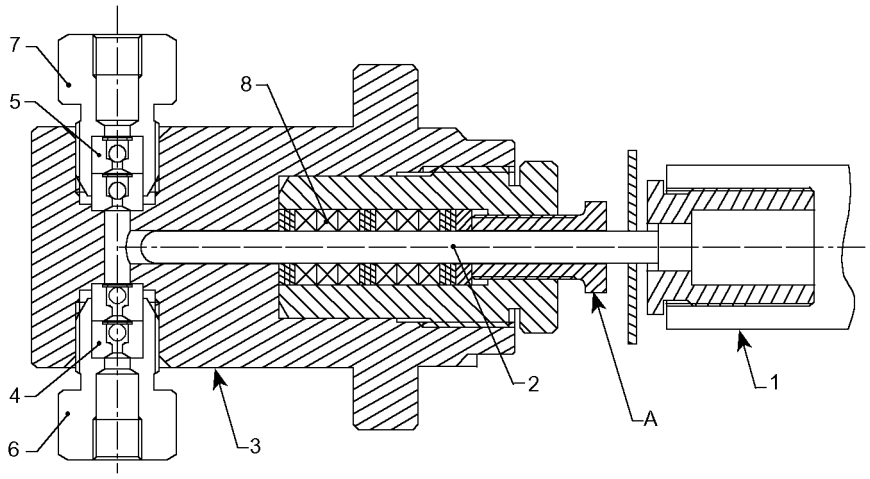



**Fig. 1.3c : Setting to maximum stroke**

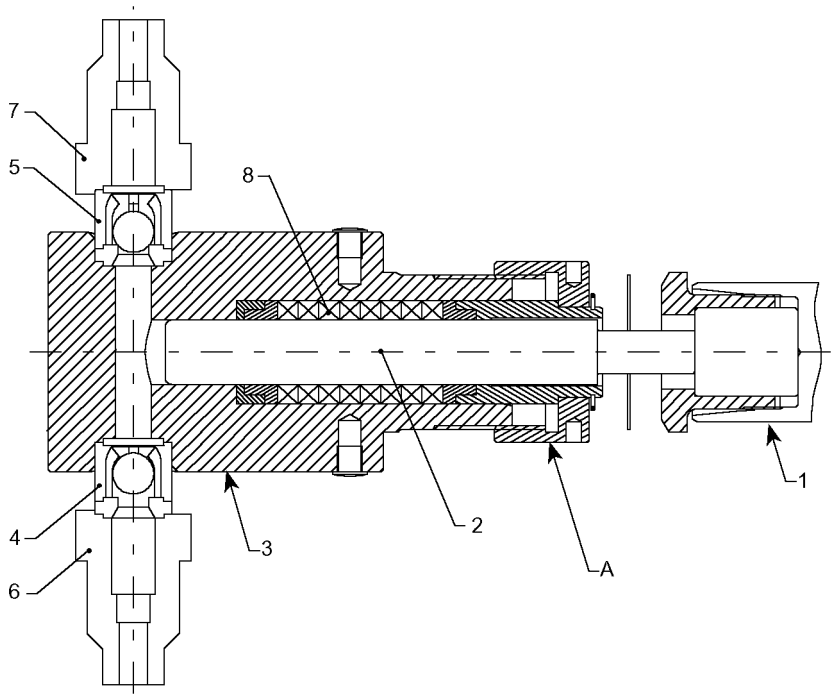
| | | | |
|---|---|---|---|
| 1 | Worm | 7 | Stroke adjustment knob |
| 2 | Tangential gear | 8 | Discharge |
| 3 | Inclinable crank | 9 | Suction |
| 4 | Connecting rod | 10 | Stroke |
| 5 | Micrometer screw | 11 | Position discharge |
| 6 | Crosshead | 12 | Position suction |




N

| | | | |
|---|---|---|---|
| 1 | Crosshead | 6 | Connection assembly (suction) |
| 2 | Plunger | 7 | Connection assembly (discharge) |
| 3 | Liquid end body | 8 | Packing |
| 4 | Valve assembly (suction) | A | Screw gland |
| 5 | Valve assembly (discharge) | | |

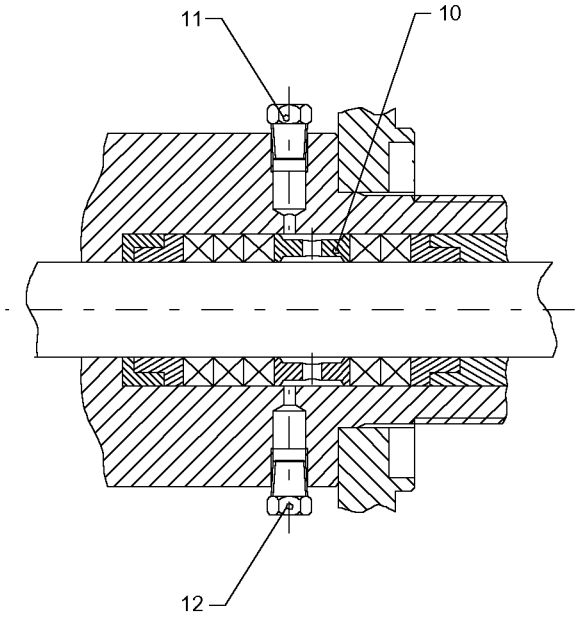
**Fig. 1.4a: operating principle of the plunger-type liquid end**




U

| | | | |
|---|---|---|---|
| 1 | Crosshead | 6 | Connection assembly (suction) |
| 2 | Plunger | 7 | Connection assembly (discharge) |
| 3 | Liquid end body | 8 | Packing |
| 4 | Valve assembly (suction) | A | Clamping nut |
| 5 | Valve assembly (discharge) | | |

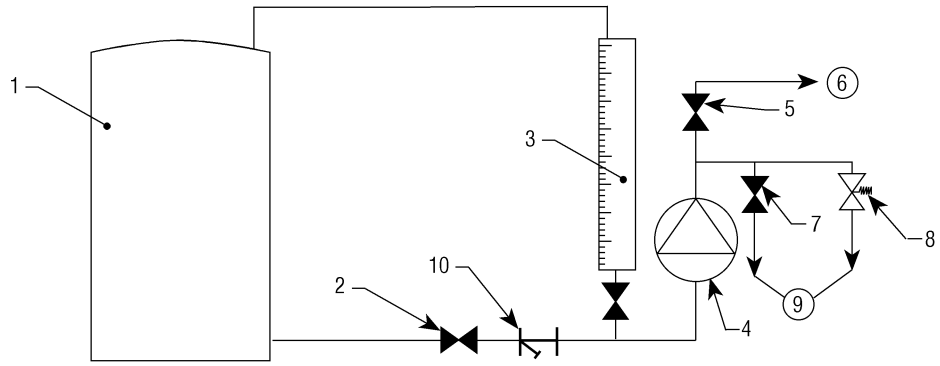
**Fig. 1.4a: operating principle of the plunger-type liquid end**




R

| | |
|---|---|
| 10 | Rinsing ring |
| 11 | Union for the inlet of rinsing product |
| 12 | Union for the outlet of rinsing product |

**Fig. 1.5a : Rinsing option.**




| | | | |
|---|---|---|---|
| 1 | Tank | 6 | Utilization |
| 2 | Suction circuit isolating valve | 7 | Priming valve |
| 3 | Calibrating chamber | 8 | Safety valve |
| 4 | Pump | 9 | Return |
| 5 | Discharge circuit isolating valve | 10 | Filter |

**Fig. 2.1a : Diagram of an installation**

SX

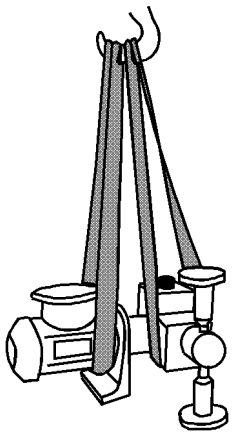


**Fig. 2.3a : Handling**

MX

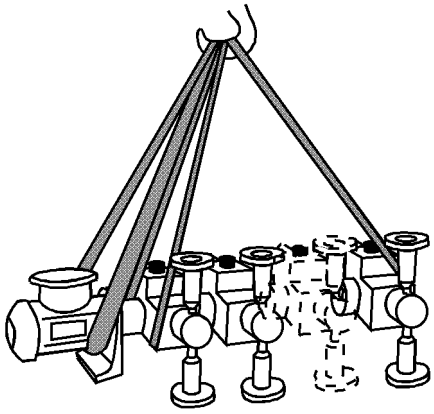
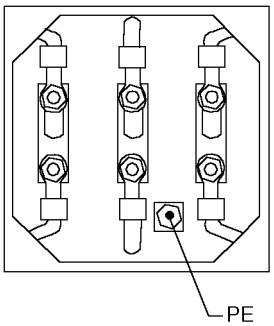


**Fig. 2.3a : Handling**

SX



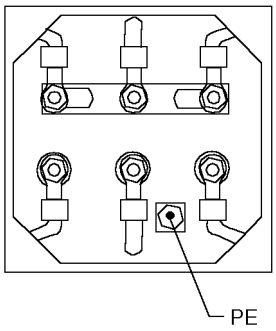




**Fig. 2.5a : Motor terminal box**

M1

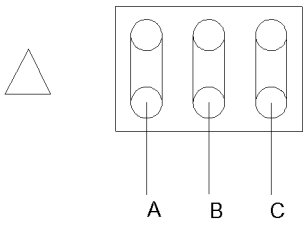



**Fig. 2.5b :**
**230 V delta connection**

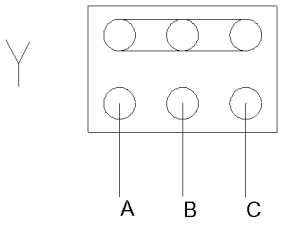



**Fig. 2.5c :**
**400 V star connection**

## MAINTENANCE SHEET

Pump code : Contract No :
Liquid pumped :

| Service Operation | Date | Hours | Remarks |
|---|---|---|---|
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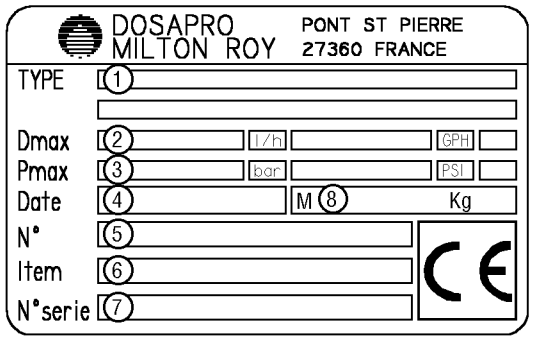
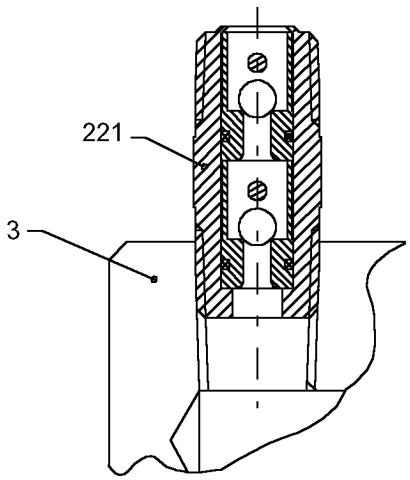
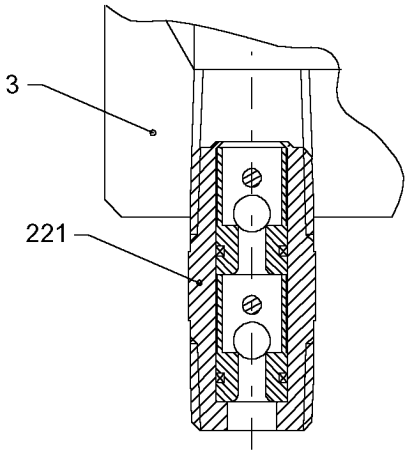
**Fig. 3.4a : Model Maintenance Sheet**




| | |
|---|---|
| **1** | **Type : Pump code** |
| 2 | Dmax : maximum capacity |
| 3 | Pmax : maximun pressure |
| 4 | Date: date of manufacture |
| **5** | **N° : Contract No** |
| 6 | Item : your reference |
| 7 | N° série.: Dmr internal no |

**Fig. 4.4a : Identification plate**



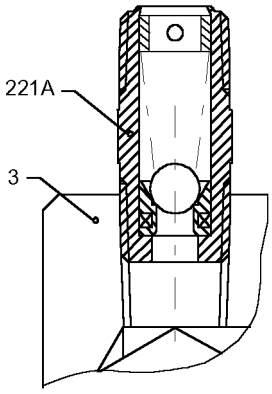

**Discharge** **Suction**

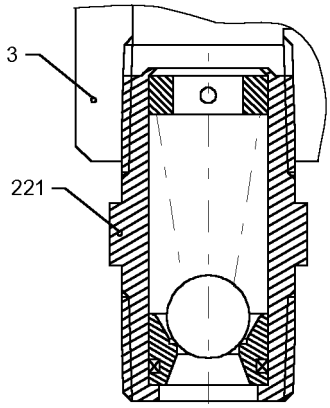
| | |
|---|---|
| 221 | Valve assembly |
| 3 | Liquid end body |

2

4

**Fig. 7.2a : Sectional drawing of valve assemblies**



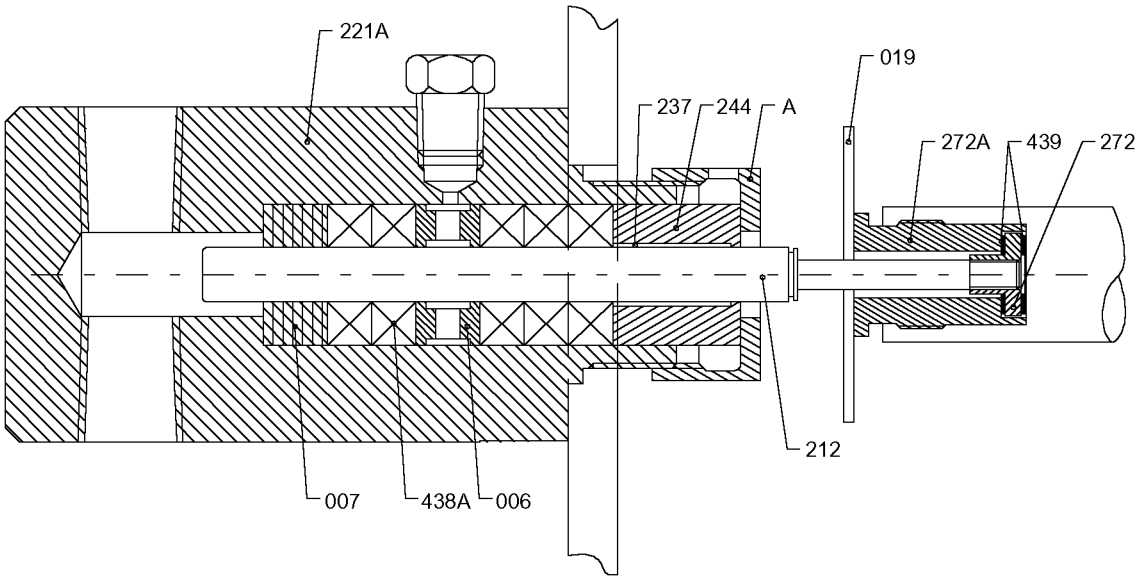




**Discharge** **Suction**

| | |
|---|---|
| 221 | Valve assembly (suction) |
| 221A | Valve assembly (discharge) |
| 3 | Liquid end body |

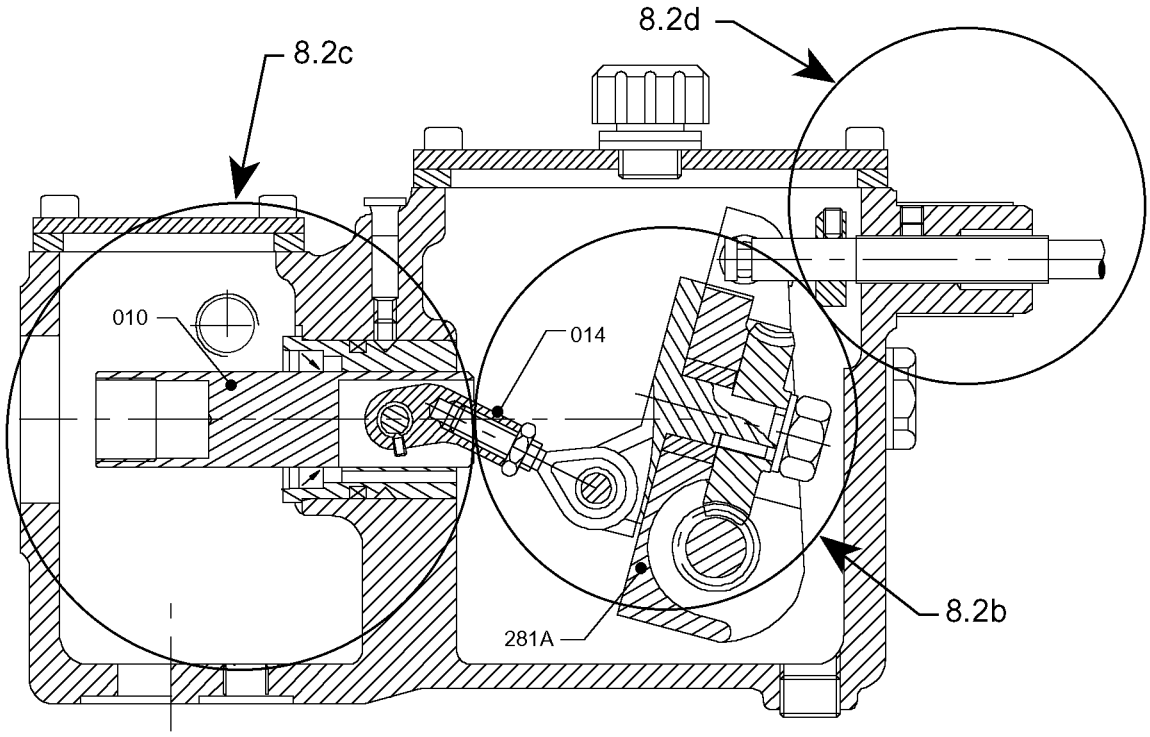
3

**Fig. 7.2a : Sectional drawing of valve assemblies**



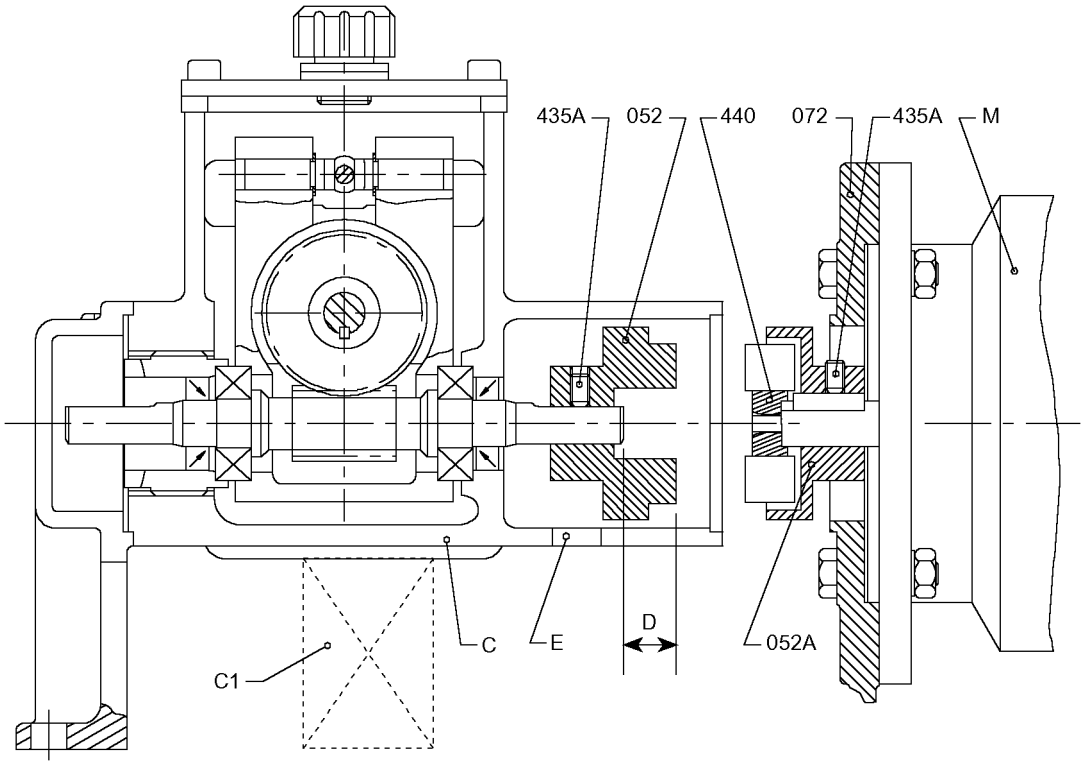

| | | | |
|---|---|---|---|
| 006 | Rinsing spacer | 244 | Bushing |
| 007 | Guide bushing | 272 | Nut |
| 019 | Washer | 272A | Mounting screw |
| 212 | Plunger | 438A | Packing |
| 221A | Liquid end body | 439 | Washer |
| 237 | Cylinder | A | Nut |

**Fig. 7.2c : Sectional drawing of the plunger-type liquid end**




| | | | |
|---|---|---|---|
| 010 | Crosshead | 281A | Crank support |
| 014 | Connecting rod | | |

**Fig. 8.1a : Diagram of mechanical assembly (Milroyal D)**

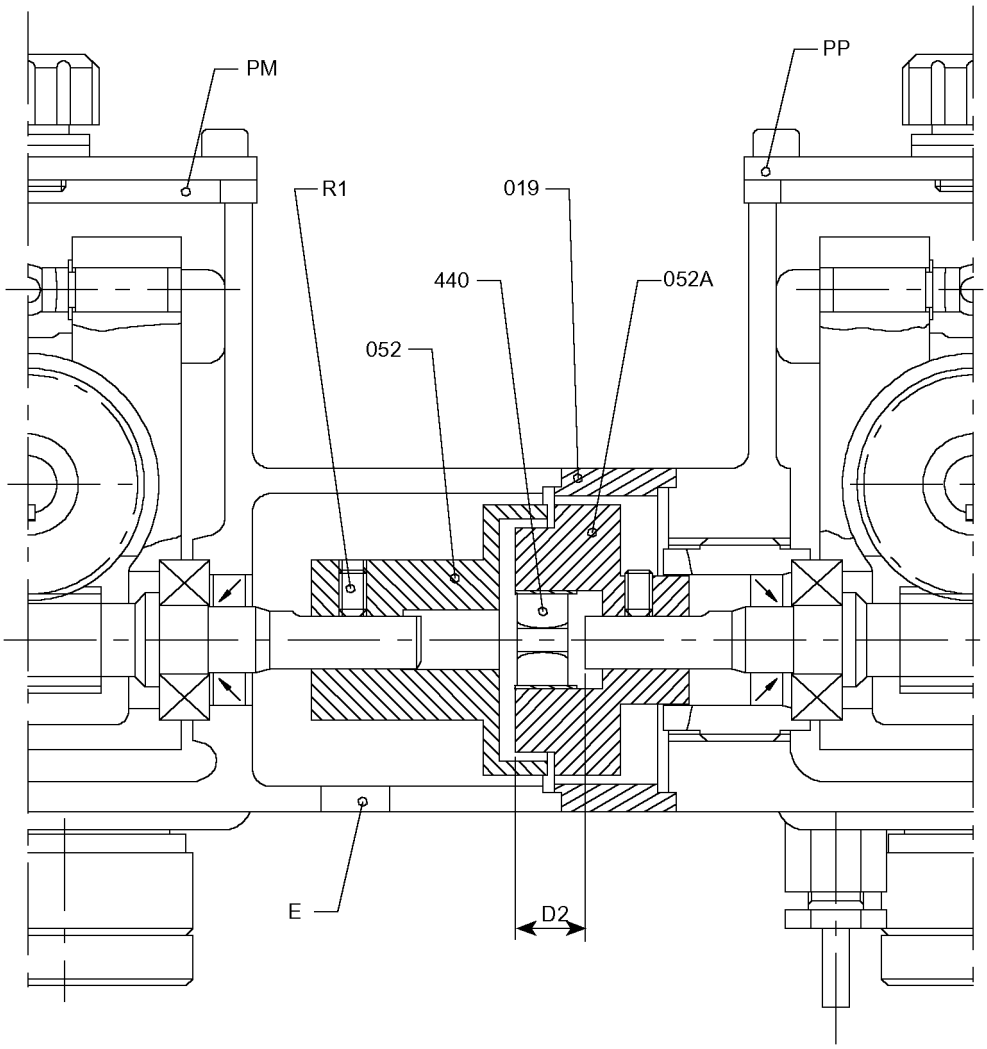



| | | | |
|---|---|---|---|
| C | Housing | 052A | Half coupling on housing side |
| C1 | Wedges | 072 | Motor support |
| M | Motor | 435A | Screw |
| 052 | Half coupling on motor side | 440 | Shock absorber |

SX

M1

**Fig. 8.2a : Fitting the motor**

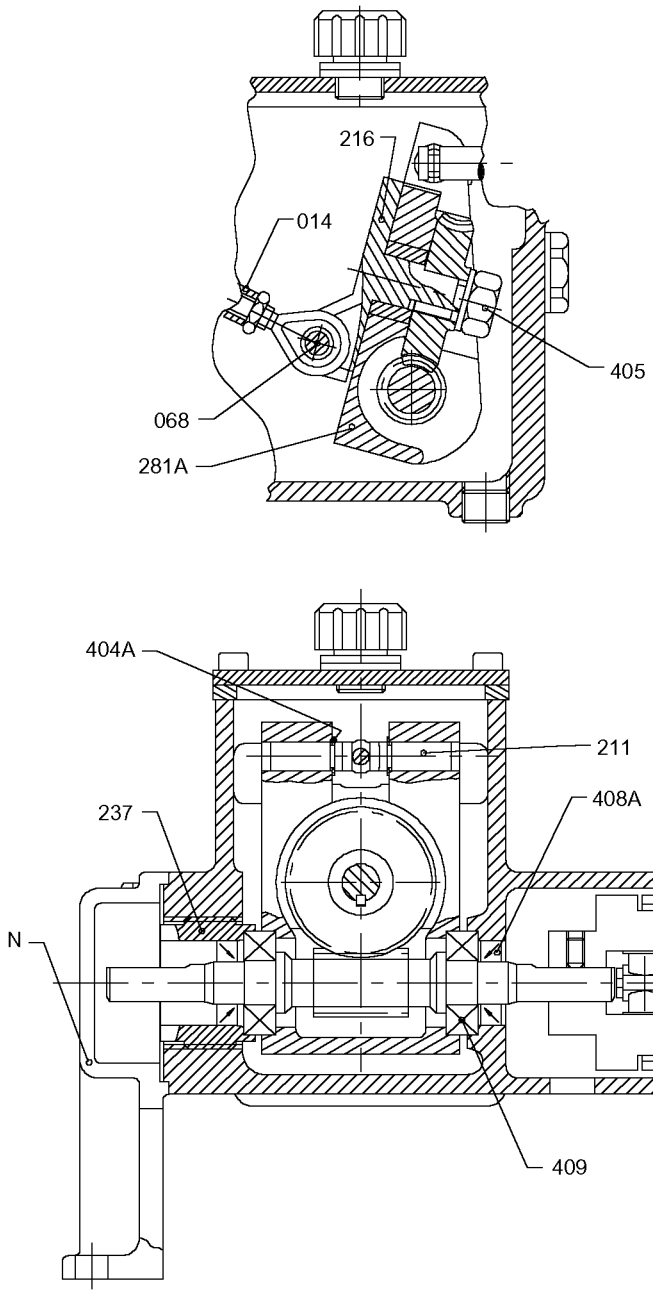



| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.P. | previous pump |
| 052A | Half coupling | R1 | Screw |
| 440 | Shock absorber | | |

Mi

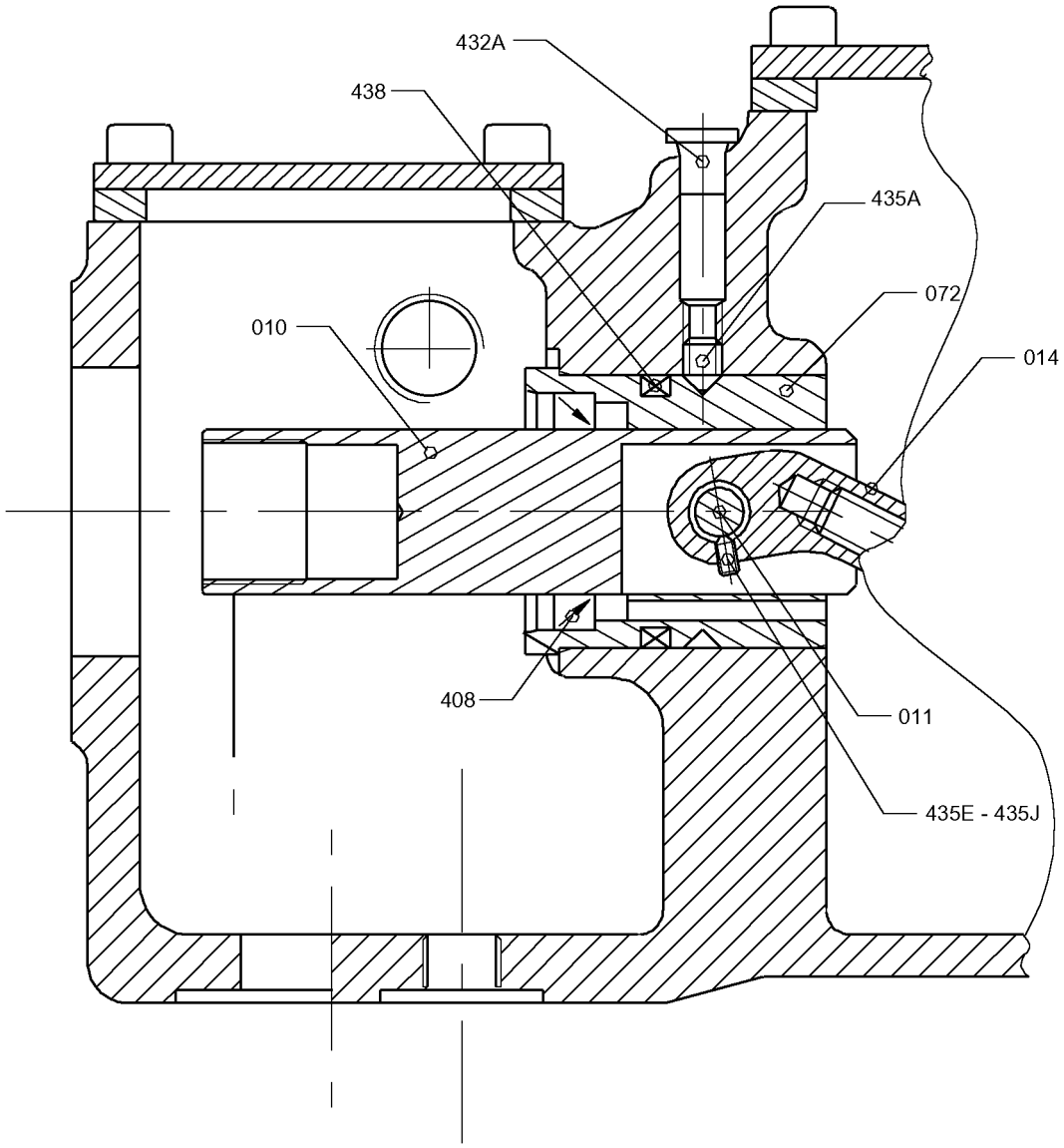
Mn

**Fig. 8.2 a : Multiplexing coupling (previous pump)**



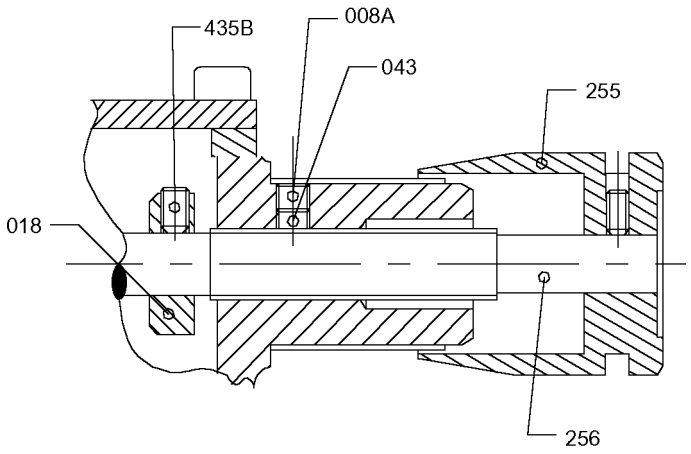

| | | | |
|---|---|---|---|
| 014 | Connecting rod | 405 | Nut |
| 068 | Pin axis | 408A | Worm shaft seal |
| 211 | Adjusting die | 409 | Ball bearing |
| 237 | Bearing screw | 435J | Nut |
| 281A | Crank support | N | Attaching lug |
| 404A | Stop ring | | |

**Fig. 8.2b : Sectional drawing of housing (Milroyal D)**




| | | | |
|---|---|---|---|
| 010 | Crosshead | 432A | Plug |
| 011 | Axis | 435A | Screw |
| 014 | Connecting rod | 435E | Screw |
| 072 | Liner | 435J | Nut |
| 408 | Crosshead oil seal | 438 | O-ring |

**Fig. 8.2c : Sectional drawing of spacer (Milroyal D)**

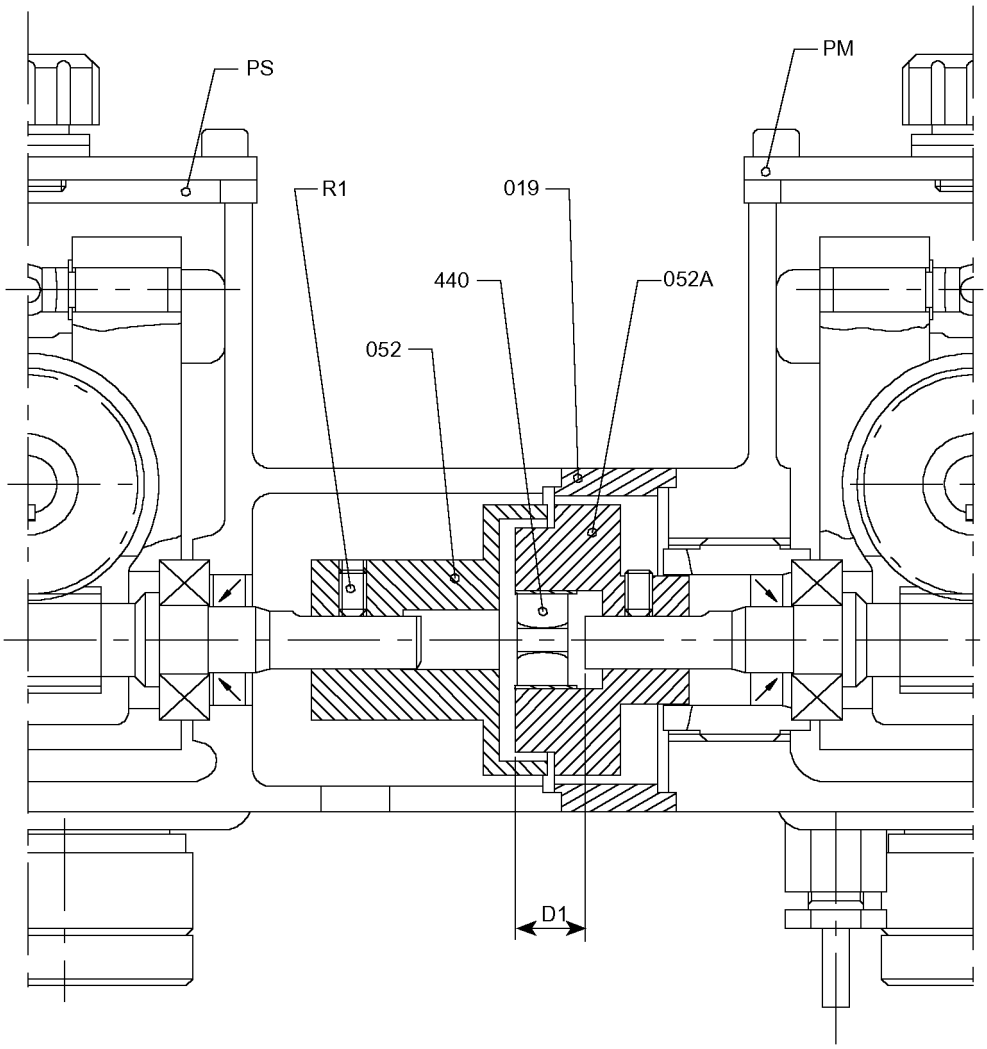



D

VF

| | | | |
|---|---|---|---|
| 018 | Stop collar | 256 | Micrometer screw |
| 043 | Lock insert | 435B | Screw |
| 255 | Stroke adjustment knob | 008A | Screw |

**Fig. 8.2d : Sectional drawing of the flow adjustment (Milroyal D)**




M1

Mi

| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.S. | Next pump |
| 052A | Half coupling | R1 | Vis |
| 440 | Shock absorber | | |

**Fig. 8.2e : Multiplexing coupling (Next pump)**

DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

M/X/V DIAPHRAGM-TYPE LIQUID END

This manual should be made available to the person responsible for installation, operating and maintenance.

**TEXT VOLUME**

**Date : 12/99** **O / Ref : T.160.0813.001.Rev. B**

For better understanding, use this volume together with the ILLUSTRATIONS VOLUME.

# CONTENTS

# HOW TO USE THIS MANUAL ?

**IMPORTANT**: You should read the following paragraphs carefully in order to understand how to use this manual efficiently.

This manual corresponds to the type of pumps mentioned on the cover page.

There may be several different construction versions for each type of pump, however, and this manual takes those differences into account.

## TEXT FASCICLE

The paragraphs or lines specific to a given construction are:

- indented compared to the main text body,
- marked by a vertical line indicating the specific text,
- marked by a rectangle specifying the corresponding code.

If a paragraph is identified by means of two adjoining « boxes » , this means that both codes are required at the same time (« and » relation). If, however, the « boxes » are separated, this means that only one of the codes is required (« or » relation).

## ILLUSTRATIONS FASCICLE

The figures specific to a given construction version are marked by means of a box specifying the corresponding code.

**Note**: When first reading this document, you are advised to highlight the « boxes » corresponding to the construction of your equipment so the manual will be easier to read in future.

## MARKING USED IN THE MANUAL

You will find the list of the various possibilities and the corresponding markings, at the end of the illustrations manual.

The « cross » in the « Done » column in the table indicates the specific construction of your pump.

# PART I - DESCRIPTION

## I - 1. UNPACKING AND STORAGE

### *UNPACKING*

The packaging must be carefully examined on receipt in order to ensure that the contents have not sustained any obvious damage. Precautions must be taken when opening the packaging in order to avoid damaging accessories which may be secured inside the packaging. Examine the contents and check them off against the delivery note.

### *STORAGE PRECAUTIONS*

**Storage for less than six months**

Equipment shall preferably be stored in its original packaging and protected from adverse weather conditions.

**Storage for more than six months**

- Grease all visible unpainted sections. Rubber parts (such as semi-flexible couplings) must be protected from sunlight and sudden temperature changes.
- Store the pump in its original packaging. In addition, packaging in heat-sealing plastic cover and dessicant bags must be provided for. The quantity of dessicant bags should be adapted to the storage period and to the packaging volume.
- Store protected from adverse weather conditions.

## I - 2. DESCRIPTION

The MILROYAL Pump is a compact electro-mechanical metering pump, oil-lubricated with a sealed housing, allowing adjustment of its capacity when stopped or in operation.

It is designed for industrial operation in continuous mode.

It is made up of the following items (Fig. 1.2a):

- a driving device consisting of a motor [1],
- a mechanical assembly [2],
- a liquid end [3].

Capacity adjustment is controlled either manually (by a graduated hand-knob [4] or automatically (such as by a servomotor [5]).

Various components of the mechanical assembly are shown in Figure 1.2a.

## I - 3. OPERATING PRINCIPLE OF THE MECHANICAL ASSEMBLY

See Figure 1.3a.

The mechanical assembly works on the principle of the inclinable crank.

The rotational motion of the motor is transmitted by the worm [1] to the tangential gear [2] which is linked to the inclinable crank [3]. A connecting rod and crank system [4] converts the rotary driving motion into a reciprocating linear motion with adjustable stroke. The stroke depends upon the angle of inclination of the crank, which is determined by the position of a micrometer screw [5]. Figure 1.3a illustrates manual adjustment of the position of the micrometer screw [5] using the hand-knob [7].

When the angle is zero, the connecting rod describes a cone of revolution. The mechanical system turns but there is no longitudinal movement of the crosshead [6] (zero stroke).

Figure 1.3b shows the functional diagram at zero stroke.

Figure 1.3c shows the functional diagram at maximum stroke.

## I - 4. OPERATING PRINCIPLE OF THE METAL DISC OR PTFE DIAPHRAGM LIQUID END

### *SINGLE DIAPHRAGM*

See Figure 1.4a.

The plunger [2] is connected to the crosshead [1] of the mechanical assembly.

0

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The diaphragm [11] which is hydraulically coupled with the plunger [2], sucks in a given volume (swept volume) of fluid in the liquid end body [3], through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the diaphragm [11], which has the effect of discharging the liquid through the valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

The diaphragm [11] moves between two extreme positions defined by the contour plates [12] and [14].

## *DOUBLE DIAPHRAGM ON METAL DISC DIAPHRAGM LIQUID END*

M
C

See Figure 1.4a.

An intermediate diaphragm [18] allows a vacuum to be created between the two metallic diaphragms [11] and [15].

The plunger [2] is connected to the crosshead [1] of the mechanical assembly.

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The first diaphragm [11] is hydraulically coupled with the plunger [2], the second diaphragm [15] "bonded" to the first diaphragm [11] sucks in a given volume (swept volume) of fluid in the liquid end body [3], through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the two "bonded" diaphragms [11], [18] and [15], which has the effect of discharging the fluid through valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

The diaphragms move between two extreme positions defined by the contour plates [12] and [17].

## *DOUBLE DIAPHRAGM ON PTFE DIAPHRAGM LIQUID END*

X
C

See Figure 1.4a.

A vacuum is created between the two diaphragms.

The plunger [2] is connected to the crosshead [1] of the mechanical assembly.

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The first diaphragm [11] is hydraulically coupled with the plunger [2], the second diaphragm [15] "bonded" to the first diaphragm [11] sucks in a given volume (swept volume) of fluid in the liquid end body [3], through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the two "bonded" diaphragms, which has the effect of discharging the fluid through valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

The diaphragms move between two extreme positions defined by the contour plates [12] and [17].

If the pressure exerted by the hydraulic fluid on the diaphragm becomes greater than normal operating pressure during the discharge phase, the safety valve [9] evacuates the hydraulic fluid to the spacer [10] in order to protect the pump. This safety valve also includes an air bleed acting continuously on the hydraulic circuit.

An admission valve [13] regulates the inlet of hydraulic fluid into the displacement chamber [8] in order to maintain a constant volume of hydraulic fluid between the plunger [2] and the diaphragm [11].

## 1 - 5. OPTIONS FOR DIAPHRAGM-TYPE LIQUID END

### *HEATING OR COOLING SHELL OPTION*

The heating or cooling product flows from the upper section of the liquid end to its lower section.

J

**Safety note for users**

The technician has to take in account all usual precautions regarding heat echangint fluids (boiling or freezing).

### *OPTION RUPTURE DETECTION BY PRESSURE GAUGE*

A detection system [16] (Fig. 1.4a) is fitted on the double diaphragm body [14] (Fig. 1.4a).

C5

See Figure 1.4b.

When the two diaphragms are in perfect condition, the vacuum that exists between them is indicated by the indication "0" on the pressure gauge.

When one of the two diaphragms ruptures, pressure is exerted between the two diaphragms and is indicated on the pressure gauge.

### *OPTION RUPTURE DETECTION BY PRESSURE SWITCH*

A detection system [16] (Fig. 1.4a) is fitted on the double diaphragm body [14] (Fig. 1.4a).

C6

See Figure 1.4b.

When the two diaphragms are in perfect condition, there is a vacuum between the two diaphragms. The given indication is equal to zero.

When one of the two diaphragms ruptures, the pressure increases and exceeds the pressure switch detection threshold which causes a change in state of the output contact on the pressure switch.

You then use this electrical signal as you wish (audio alarm, indicator light, shutdown of the pump, etc.).

## 1 - 6. SAFETY AND HEALTH INSTRUCTIONS

The personnel responsible for installing, operating and maintaining this equipment must become acquainted with, assimilate and comply with the contents of this manual in order to:

- avoid any possible risk to themselves or to third parties,
- ensure the reliability of the equipment,
- avoid any error or pollution due to incorrect operation.

Any servicing on this equipment must be carried out when it is stopped. Any accidental start-up must be prevented (either by locking the switch or removing the fuse on the power supply line).

A notice must be attached to the location of the switch to warn that servicing is being carried out on the equipment.

During oil changing operations, the waste oil must be collected in a suitable receptacle. Any overflow of oil which may result must be removed using a degreasing agent suitable for the operating conditions.

Soiled cleaning cloths must be stored in suitable receptacles. The oil, degreasing agent and cleaning cloths must be stored in accordance with the rules on pollution.

Switch off the power supply as soon as any fault is detected during operation: abnormal heating or unusual noise.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

# PART II - INSTALLATION

## II - 1. HYDRAULIC INSTALLATION

All the information concerning the hydraulic installation of a metering pump is detailed in a volume, « Generalities about metering pumps installation ». You should consult that manual to determine the installation required for your application.

Certain essential points are, however, also briefly covered in this document.

### *GENERAL*

- Piping layout

There must be no swan-necks or stagnant volumes which are liable to trap air or gas.

Stresses due to incorrect alignment of piping with respect to the centreline of valves must be avoided as far as possible.

- Remove burrs and clean the piping before fitting.
- It is advisable to provide for a calibrating chamber in order to calibrate the pump in service conditions.

### *PIPING ON THE SUCTION CIRCUIT*

- Provide for a filter with suitable mesh size upstream of the pump.
- Check whether the diameter and length of pipe are compatible with the pump's maximum capacity.

### *PIPING ON THE DISCHARGE CIRCUIT*

- Provide for a safety valve on the discharge pipe, designed to protect the installation. (The pump is protected by its own internal safety system).
- Check whether it is necessary to install a pulsation dampener, according to the width and diameter of the tubing.
- It is advisable to install a priming valve on the discharge circuit in order to make starting and maintenance of the pump easier.

Figure 2.1a is a schematic representation of a calibrating chamber, a priming valve and a safety valve in ideal conditions.

## II - 2. DRIP COLLECTION

Provide for outlets so that any leak or drips can be easily drained off without any danger. This is especially important in the case of harmful liquids.

See Figure 1.2a.

Leak detector [15] allows leaks of hydraulic fluid or lubricating oil to be checked and drained off.

## II - 3. HANDLING

Choose lifting equipment that is compatible with the weight of the pump. (See TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

See Figure 2.3a.

Handling requires the following precautions :

Fit one sling under the motor and install the other under the pump mechanical assembly or assemblies.

Check that the assembly is correctly balanced before starting to move it.

Secure the pump as soon as it is positioned in its required location (see Chapter II - 4. Setting up).

## II - 4. SETTING UP

Secure the pump to a correctly dimensioned, horizontal support by its attaching holes. Leave enough clear space around the pump to be able to carry out servicing operations and adjustments.

Pumps installed outdoors must be protected by a shelter (according to the climatic conditions).

MX

Note: the pumps are « aligned » in the factory on their frames. Before securing the frame, check that the supporting surface is flat (and use shims, for example, to ensure that it is horizontal).

## II - 5. ELECTRICAL INSTALLATION

### *CONNECTING THE MOTOR*

Check the specifications of the motor and compare them with the voltage available on your installation before making connections. Connect up the motor in

SX

accordance with the instructions in the terminal box (Fig. 2.5a).

A delta connection is required to connect up to a 230 V 3-phase power supply (Fig. 2.5b).

M1

A star connection is required to connect up to a 400 V 3-phase power supply (Fig. 2.5c).

**CAUTION** : Do not forget to connect the earth terminal on the motor [PE] (Fig. 2.5a) to the equipment earth conductor.

The electrical protection installed for the motor (fuse or thermal protection) must be suitable for the motor's rated current.

### *CONNECTING THE PRESSURE SWITCH DETECTION SYSTEM*

C6

See Figure 1.5a.

Connect a two-conductor cable to the « normally closed » contact of the pressure switch (230 V maxi, 10 A maxi).

Tighten the stuffing box and check that it is leaktight.

# PART III - START UP

## III - 1. PROCEDURES BEFORE START UP

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

- Remove the cover from the housing [7] and fill the housing with the lubricating oil supplied up to the middle of the level indicator [12]. Reinstall the cover on the housing.
- Remove the cover from the spacer [8] and fill the spacer with the hydraulic fluid supplied up to the middle of the valve reject connection. Reinstall the cover on the spacer.
- Check the opening of all the isolating valves installed on the suction and discharge circuits. If the discharge circuit is equipped with an injection nozzle or a back-pressure valve, open the priming valve for discharge (if there is no priming valve, disconnect the discharge pipe). This makes it possible to verify that there is liquid present if the pump is installed in flooded suction, or to prime the pump if it is installed in suction lift.

D

- Check that the pump capacity is set to "0%" (hand-knob [4]).

SX

**Checking the electrical connection of the motor**

M1

Start up the pump to check the motor's direction of rotation. It must comply with that indicated by the arrow marked on the pump housing. To reverse the motor's direction of rotation, invert A and B or A and C (See Figure 2.5b or 2.5c). Stop the pump.

## III - 2. START UP

- Once all the checks and procedures described in the previous section have been carried out, start up the pump.
- Check visually and by listening. (In particular, check that there are no suspicious noises).

D

- Make sure that the hand-knob is unlocked.

- Adjust the pump capacity gradually from 0 % to 100% and control the liquid output at priming valve or discharge check valve.
- As soon as the liquid to be pumped flows out of the priming valve or the discharge valve, priming on the process side has been achieved. Close the priming valve or reconnect the discharge pipe, as applicable.
- Then check the level of hydraulic fluid in the spacer and top it up, if necessary.

- Once the priming is obtained, adjust the pump to the desired capacity.

D

- Lock the hand-knob with the locking screw [9] (Fig. 1.2a).

## III - 3. FAILURES ON START UP

### *PROBLEMS WITH MOTOR*

**The motor runs with difficulty and heats up**

SX

- One phase is incorrectly connected.
- The characteristics of the electrical power supply do not match the specifications of the motor.

M1

- The electrical connection used is not suitable.

**The motor overheats**

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

### *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

SX

M1

- The direction of rotation of the motor is incorrect. (Check using the arrow marked on the housing). Reverse the direction of rotation (see Chapter III - 1. Procedures before start up, Checking the electrical connection of motor).

### *PROBLEMS WITH FLOW RATE*

**The flow rate is lower than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The suction power is insufficient (pipe cross-section too small or pipe too long): replace the pipe with ones that have a larger cross-section or install the pump in flooded suction.
- The leak-tightness of suction pipe is unsatisfactory.
- The viscosity of the liquid is incompatible with the pump's capabilities.
- Degassing of the displacement chamber is incorrect: proceed with degassing of the displacement chamber (See Chapter IV - 2.).

**The capacity is greater than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- A syphoning phenomenon is observed: check that the suction pressure is not greater than the discharge pressure. Install a back-pressure valve on the discharge side.
- Too many flow pulsations : a pulsation dampener is required, or the pulsation dampener installed is of the wrong size, or the pressurization of the pulsation dampener is incorrect.

**The capacity is variable**

- This problem may be due to particles from the piping which interfere with the operation of the valve assemblies: clean the piping (if there is an abnormal presence of particles) and the valve assemblies (by checking the assembly sequence of different components, or by referring to table 5.2c, chapter V - 2.).

## III - 4. OPERATION - SCHEDULE FOR CHECKS AND MAINTENANCE OPERATIONS

The programme of checks and maintenance operations depends on the conditions in which the equipment is used. For this reason, the following frequencies are given as an example only. Individual users should adapt these frequencies to their own specific operating conditions.

| When | Check | Maintenance | See |
|---|---|---|---|
| After 250 hours | | Change lubricating oil | Chapter IV-1 |
| Every month | Check oil level in the housing<br>- if incorrect -> | Trace lubricating oil leak | Chapter IV-2 |
| | Check hydraulic fluid level in spacer<br>- if incorrect -> | Trace hydraulic fluid leak | Chapter IV-2 |
| | Check for the appearance of any leak on the leak detector<br>- if a leak appears -> | Trace leak | Chapitre IV-2 |
| Every 3 months | Check the oil temperature (max : Chapter IV-1)<br>if incorrect -> | Verify<br>- the date of the last oil change<br>- the extent of contamination of the oil<br>- the equipment operating conditions | |
| Every 6 months or 2,500 hours | | Change lubricating oil | Chapter IV-1 |
| | | Change hydraulic fluid | Chapter IV-1 |
| Frequency to be defined according to process (2,500 hours approx.) | Check conformity of capacity | Check capacity | Chapter IV-2 |
| Every year | | ** Annual overhaul | Part V |

** Our Technical Assistance Department staff is available for any maintenance matters on site (see DOSAPRO adress at the end of this manual).

A model maintenance sheet is shown in Figure 3.4a to help you ensure follow-up of your servicing actions (checking or maintenance).

# PART IV - ROUTINE MAINTENANCE

## IV - 1. OIL CHANGE

### *LUBRICATING OIL*

- Perform the first housing oil change after 250 hours' operation. Subsequent oil changes will be carried out every 2,500 hours' operation or every six months.
- Disconnect the pump electrically, check that the equipment cannot be switched on accidentally. Position a notice at the location of the switch.

**Note**

To avoid any risk of burning by the hot oil, protective gloves should be worn.

See Figure 1.2a.

- Unscrew the plug [11] and drain the oil into a tray. Degrease the plug, apply a little Loctite 221 adhesive on the threads and screw the plug into place.
- Remove the cover from the housing [7] and fill the housing up to the middle of the level indicator [12] with an oil suitable for service conditions.
- Quantity: see TECHNICAL CHARACTERISTICS at the end of the illustrations manual.
- Remove any overflow of oil immediately with a suitable degreasing agent for the operating conditions.

**Recommendations**

- Standard conditions: standard oil

Ref.: 437 0013 021N, Ref.: 437 0013 024N (COFRAN Mecanep 220) or equivalent (see below).

- Ambient temperature: > - 5°
- Max. oil temperature: + 90°

Table of equivalencies:

| | |
|---|---|
| FUCHS | RENEP 220 |
| B.P. | GR XP 220 |
| CASTROL | ALPHA SP 220 |
| ELF | REDUCTELF SP 220 |
| FINA | GIRAN 220 |
| IGOL | DYNAM SP 220 |
| MOBIL OIL | MOBILGEAR 630 |
| SHELL | OMALA 220 |
| TOTAL | CARTER EP 220 |
| ESSO | SPARTAN EP 220 |

- Special conditions: for example, low-temperature oil: temperature range: -35°C to +46°C.

Ref: Sintofluid (FUCHS)

## *HYDRAULIC FLUID*

- Change the hydraulic fluid in the spacer every 2,500 hours' operation or every six months.
- Disconnect the pump electrically, check that the equipment cannot be switched on accidentally. Position a notice at the location of the switch.

**Note**

To avoid any risk of burning by the hot oil, protective gloves should be worn.

See Figure 1.2a.

- As the spacer is of a small volume, draw out the hydraulic fluid through the plug [13] with a syringe.
- Fill the spacer up to the middle of the valve reject connection with a hydraulic fluid suitable for service conditions.
- Quantity: see TECHNICAL CHARACTERISTICS at the end of the illustrations manual.
- Remove any overflow of oil immediately with a suitable degreasing agent for the operating conditions.

**Recommendations**

- Standard conditions: standard oil

Ref.: 437 0013 031N, Ref.: 437 0013 033N (COFRAN Cofraline Extra 32S) or equivalent (see below).

- Ambient temperature: > - 12°
- Max. oil temperature: + 80°

Table of equivalencies:

| | |
|---|---|
| FUCHS | RENOLIN EXTRA 32S |
| BP | HLPD 32 |
| CASTROL | HYSPIN VG 32 |
| ELF | OLNA 32 |
| FINA | CIRKAN 32 |
| IGOL | SONHYDRO 32 |
| MOBIL | DTE 24 |
| SHELL | TELLUS 32 |
| TOTAL | AZOLLAS ZS 32 |
| ESSO | NUTO H 32 |

- Special conditions: for example, low-temperature oil: temperature range: -40°C to +60°C.

Ref: Hydrofrima 15 (FUCHS)

# IV - 2. OTHER MAINTENANCE OPERATIONS

## *TRACING A LUBRICATING OIL LEAK*

See Figure 1.2a.

- Check that the drain plug [11] is correctly tightened.
- Check for leakage on the shaft on the motor side or on the protective cap side. If a leak is found, change the seals on the worm shaft (see Table 5.2f).
- Check for the appearance of an oil leak on the leak detector [15]. If there is leakage, change the crosshead oil seals (see Table 5.2e).

## *TRACING A HYDRAULIC FLUID LEAK*

- Check the leak-tightness of the strainer plug [14] (Fig. 1.2a). If there is a leak, change the relevant seal.
- Check the leak-tightness of the connection and the base of the safety valve [9] (Fig. 1.4a). Check the leak-tightness of the spacer connection. If there is a leak, change the relevant seals.

## *TRACING A LEAK ON THE LEAK DETECTOR*

Check whether the leak appears on the inside of the tubing or outside.

- If the leak appears outside the piping, check the leak-tightness of the connection and the stuffing box of the leak detector [15]( Fig. 1.2a). If there is a leak, replace the relevant seals.
- If the leak appears inside the piping, check the level of hydraulic fluid. If it is higher than it should be, adjust the hydraulic fluid level to the middle of the valve reject connection. Also check if the piping is correctly snapped into place in its connection. If these two checks prove satisfactory, replace the crosshead points (see Table 5.2e).

## *CHECKING THE PUMP CAPACITY*

This is a question of determining the straight line representing the pump's capacity according to its adjustment.

Four measurements are sufficient (adjustment at 100%, 75%, 50% and 25%).

There are two possible methods:

- If the pump is installed in pressurizing mode (Fig. 2.1a), measure the volume of pumped liquid in a calibrating chamber for a given period of time. It may be necessary to reproduce actual operating conditions (suction pressure).
- If the pump is installed in suction mode, measure the volume of discharged liquid. It may be necessary to reduce actual operating conditions (discharge pressure).

The first method is recommended. In addition, this method avoids placing the operator in contact with the liquid, which is important if the pumped liquid is hazardous.

For a precise check, which cannot be performed using the two methods described above, it may be necessary to use an electromagnetic flowmeter.

### *DEGASSING THE DISPLACEMENT CHAMBER*

See Figure 1.4a.

1. Adjust the pump capacity to 100 %.
2. Unscrew the cap nut [9.1] from the safety valve.
3. Tighten the screw [9.2], noting the number of turns made (so that you can return to the initial position), until it bears on the calibrating screw [9.3]. Tighten by a further 3/4 turn. This forces hydraulic fluid towards the spacer so that the displacement chamber can be degassed.
4. Leave to run for five or six minutes and adjust the pump to the desired capacity.
5. Loosen the screw [9.2] to return to its initial position.
6. Retighten the cap nut [9.1].

## IV - 3. TRACING CAUSES OF FAILURE

### *PROBLEMS WITH MOTOR*

**The motor does not run**

SX

The thermal relay has been tripped.

- The motor is defective.
- Wiring is defective.

M1

- Check the parts of the mechanical assembly.

**The motor heats up abnormally**

- The quantity of lubricating oil is incorrect: trace the leak (see Chapter IV - 2.)
- The quality of the lubricating oil is incorrect. Check the date of the last oil change and the specifications of the oil used.
- The pump is used in conditions it was not designed for.

### *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The tangential gear is worn. Replace it.
- The " bearings " are worn. Replace them.
- The half-coupling attaching screws are loose or the shock absorber is worn.

## *PROBLEMS WITH FLOW RATE*

### The pump produces no flow

The crosshead and the plunger do not move :

D

- The pump capacity is adjusted to « 0 % » : Adjust the capacity to the desired value and lock the hand-knob.

- The connecting rod is broken,
- The tangential gear is worn.

The crosshead and plunger move :

- The liquid end is unprimed: release the pressure on the discharge pipe and prime the liquid end, or check the leak-tightness of the suction circuit.
- The balls of the valve assemblies are blocked by particles: clean or replace the valve assemblies. First, check whether the presence of these particles is normal and take corrective action if necessary.

### The pump does not provide the required flow rate

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The level of hydraulic fluid in the spacer is incorrect: trace the leak (see Chapter IV - 2. : Others maintenance operations).
- The safety valve (for the installation) releases pressure: the discharge pipe is partially or completely obstructed.
- The safety valve (internal to the pump) continuously releases pressure: the discharge or suction pipe are partially or completely obstructed.
- The disk / ball stop assembly of the refill valve [13] (Fig. 1.4a) is defective: proceed with its replacement (see Part VII, sections H1 and H2, on Removing and Reinstalling the refill valve).
- The refill valve is defective: proceed with its replacement (see Part VII - Servicing the liquid end, sections H1 and H2, on Removing and reinstalling the refill valve).
- The air bleed built into the safety valve is blocked by particles: clean the bleed element (see Part VII - Servicing the liquid end, on Cleaning the air purge built into the safety valve).

C

- Check the leaktightness of the unions on the detection assembly and the dual diaphragm body. If necessary, carry out the degassing procedure on the dual diaphragm (see Chapter VII - Servicing on the liquid end, sections on Reinstalling the detection system and Degassing the dual diaphragm).

- The ball seats and/or the balls are dirty or worn: clean or replace the ball seats and the balls or the valve assemblies.
- The leak-tightness of the suction circuit is unsatisfactory: repair or replace the piping.

## IV - 4. ORDERING SPARE PARTS

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).

- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

# PART V - PREVENTIVE MAINTENANCE

*ANNUAL OVERHAUL*

This consists in replacing the wear parts included in a "spare parts kit" (see below). The corresponding action is detailed in Part VII : Servicing of the liquid end, and in Part VIII : Servicing of the mechanical assembly.

This servicing is conducted by carrying out the following procedures :

- removing the liquid end,
- removing the mechanical assembly,
- reinstalling the mechanical assembly,
- reinstalling the liquid end.

The tables (Chapter V - 2.) show the sequential action into individual servicing actions.

## V - 1. SPARE PARTS CONSTITUTING THE "SPARE PARTS KIT"

**For metall disc or PTFE diaphragm liquid end**

- diaphragm(s) (Table 5.2a)
- valve assemblies (Table 5.2c)
- kit for refill valve
- kit for safety valve
- miscellaneous seals

**For mechanical assembly**

- crosshead oil seals (Table 5.2e)
- worm shaft seals (Table 5.2f)
- cover seals (for housing and spacer)
- tubing, washer, packing for leak detector
- O-ring for strainer

SX
M1

- shock absorbers for motor coupling (Table 5.2g)

Mi
Mn

- shock absorbers for pump coupling (Table 5.2g)

Certain products will be necessary to carry out these servicing actions, such as the following:

- a degreasing agent (e.g. Loctite super clean 7063),
- a lockwire adhesive (e.g. Loctite self-locking compound 221),
- a tight sealing adhesive (e.g. Loctite 566).

It is advisable to conduct the annual overhaul at the same time as changing the oil in the housing and the hydraulic fluid in the spacer (see Chapter IV - 1. Oil change).

### *OTHER SPARE PARTS*

Other spare parts are available. You will find the list in Chapter VI - 1. List of other spare parts.

### *ORDERING SPARE PARTS*

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).

- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

## V - 2. SEQUENTIAL ACTIONS

**REPLACING THE DIAPHRAGM(S)**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| | Operation | Chapter | Section |
|---|---|---|---|
| | • Preliminary operations | VII - 2 | A1(1-3) |
| C | • Removing the detection assembly | VII - 2 | L1 |
| | • Removing the diaphragm(s) | VII - 2 | C1 |
| | • Reinstalling the diaphragm(s) | VII - 3 | C2 |
| C | • Reinstalling the detection assembly | VII - 3 | L2 |
| | • Restarting | VII - 3 | A2(as per A1) |

**Table 5. 2a : Sequential action.**

**REPLACING THE VALVE ASSEMBLIES**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1-3) |
| • Removing the valve assembly | VII - 2 | B1 |
| • Reinstalling the valve assembly | VII - 3 | B2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2c : Sequential action.**

**REPLACING THE CROSSHEAD SEALS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2e : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

SX

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 5.2f : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

MX

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the half-coupling | VIII - 2 | AN1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2f : Sequential action.**

SX

M1

**REPLACING THE SHOCK ABSORBER FOR MOTOR COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Removing the motor | VIII - 2 | M1 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

Mi

Mn

**REPLACING THE SHOCK ABSORBER FOR PUMP COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

# PART VI - CORRECTIVE MAINTENANCE

## VI - 1. LIST OF OTHER SPARE PARTS

This list completes the list given in Chapter V - 1. which covers the set of replacement parts required for annual overhaul of the pump.

**For metall disc or PTFE diaphragm liquid end**

- plunger cylinder assembly (see Table 6.2a)
- plunger mounting assembly (see Table 6.2b)
- refill valve
- safety valve

**For mechanical assembly**

- crosshead + pin axis assembly (see Table 6.2d)
- connecting rod + crank (see Table 6.2e)
- bearing screw (see Table 6.2f)
- bearings (see Table 5.2f)
- « gear + worm » assembly (see Table 6.2i)

## VI - 2. SEQUENTIAL ACTIONS

**REPLACING THE PLUNGER-CYLINDER ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Replacing the cylinder | VII - 4 | I1 |
| • Replacing the plunger mounting assembly | VII - 4 | K1 |
| • Reinstalling the plunger mounting assembly | VII - 4 | K2 |
| • Reinstalling the cylinder | VII - 4 | I2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 6.2a : Sequential action.**

**REPLACING THE PLUNGER MOUNTING ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Removing the plunger | VII - 4 | I1 (1) |
| • Replacing the plunger mounting assembly | VII - 4 | K1 |
| • Reinstalling the plunger mounting assembly | VII - 4 | K2 |
| • Reinstalling the plunger | VII - 4 | I2 (2) |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2 |

**Table 6.2b : Sequential action.**

**REPLACING THE « CROSSHEAD + PIN AXIS » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 6.2d : Sequential action.**

**REPLACING THE CONNECTING ROD/CRANK ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 (1;2:5) |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the crank | VIII - 4 | T1 |
| • Reinstalling the crank | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Restarting | VII - 3 & VIII - 3 | A2 (as per A1) |

**Table 6.2e : Sequential action.**

**REPLACING THE BEARING SCREW**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the bearing screw | VIII - 2 | Q1 (1) |
| • Reinstalling the bearing screw | VIII - 3 | Q2 (2 - 5) |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2h : Sequential action.**

**REPLACING THE « GEAR + WORM » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the half-coupling | VIII - 2 | AN1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the tangential gear | VIII - 4 | T1 |
| • Reinstalling the tangential gear | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 4 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2i : Sequential action.**

# PART VII - SERVICING THE LIQUID END

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x) in the case of partial servicing operation.

## VII - 1. GENERAL

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.
- Clean the recess for O-rings when they are removed. Apply tallow in the recess before reinstalling the new O-ring.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

## VII - 2. REMOVING THE LIQUID END

### A1. Preliminary operations

Before carrying out any servicing action on the liquid end or tubes, take the necessary steps to ensure that any harmful liquid they may contain is not spilt and does not touch personnel. Provide for the rinsing of the liquid end, if necessary, and provide for appropriate protective equipment. Check that there is no pressure and the temperature of components before starting to dismantle.

1. Position the pump capacity adjustment on "0%".
2. Disconnect the pump electrically. Check that the equipment cannot be started up accidentally. Place a notice at the location of the switch.
3. Disconnect the pump hydraulically.
4. Drain the spacer and remove its cover. Disconnect the tube connected to the safety valve.

C6 | Disconnect the pipe [584] (Fig. 1.5a) from the union [432].

J | Disconnect the liquid end from the cooling or heating system.

1

**B1. Removing the valve assemblies**

See Figure 7.2a.

1. Unscrew the valve assembly bodies [021] and remove the valve assemblies to replace them.
2. Clean the tapped holes in the liquid end body [3].

C5

**L1. Removing the detection system**

See Figure 1.5a.

1. Unscrew the union [432] to separate the detection assembly from the valve assembly body [045]. Remove the screw [W] and remove the detection assembly.
2. Unscrew the valve assembly body and remove the valve set and the seal [438].
3. Clean the valve set.

C6

**L1. Removing the detection system**

See Figure 1.5a.

1. Unscrew the union [432] to separate the detection assembly from the valve assembly body.
2. Unscrew the valve assembly body [045].
3. Remove the valve set and the seal [438]. Clean the valve set.

S

**C1. Removing the diaphragms**

See Figure 7.2b.

1. Remove the screws [435] to remove the liquid end body [021], the first diaphragm [098], the dual diaphragm body [098B], the intermediate diaphragm [098A] and the second diaphragm [098].
2. Clean the mating faces for fitting of the diaphragms on the liquid end body, the dual diaphragm body and the displacement chamber. Check that there is no scoring on these surfaces and take care handlings do not score on them.

J

**C1. Removing the diaphragms**

See Figures 7.2b and 7.2d.

1. Remove the screws [435] to remove the heating shell [067], the seal [438], the liquid end body [021], the first diaphragm [098], the dual diaphragm body [098B], the intermediate diaphragm [098A] and the second diaphragm [098].
2. Clean the mating faces for fitting of the diaphragms on the liquid end body, the dual diaphragm body and the displacement chamber. Check that there is no scoring on these surfaces and take care handlings do not score on them.

**E1. Removing the safety valve**

See Figure 7.2c.

1. Unscrew the cap [9.4] to gain access to the attaching screws [9.5].
2. Remove the attaching screws.
3. Remove the seals [438A] and [438B], ball stop [092] and ball [437A].

### H1. Removing the refill valve

See Figure 7.2c.

1. Unscrew the refill valve [13] from the displacement chamber [072].
2. Remove the seal [438] and the disk/ball stop assembly [092A].

### F1. Removing the displacement chamber

If required, the whole liquid end can be removed when carrying out this procedure.

See Figure 7.2c.

1. Unscrew the mounting screws [B].
2. From the inside of the spacer, unscrew the two screws [F] (liquid end/spacer junction) and take out the displacement chamber with the plunger.
3. If necessary, remove the O-ring [438E] (if it has to be replaced).

## VII - 3. REINSTALLING THE LIQUID END

### F2. Reinstalling the displacement chamber

See Figure 7.2c.

1. Position the crosshead at the rear neutral point (flow rate at the "100%" position and the crank upwards).
2. Install the plunger mounting screw [B] in the crosshead and tighten to a torque of 1 m.daN.
3. Apply tallow in the recess for the seal [438E] and fit the seal on the displacement chamber [072].
4. Fit the displacement chamber on the plunger [012] and position it in the spacer.
5. Secure the displacement chamber onto the spacer with two screws [F], replacing the two seals [438D]. Tighten to a torque of 0.5 m.daN.

S

**C2. Reinstalling the diaphragms**

See Figure 7.2b.

1. Fit the intermediate diaphragm [098A] on the dual diaphragm body [098B]. Take care with positioning: the ports in the two parts must be aligned. If necessary, a very fine metal wire can be used to check their positioning, in which case the wire should not be withdrawn until after carrying out step 3. Fit a diaphragm on each side of the intermediate diaphragm and fit this assembly on the liquid end body [021].
2. Position this assembly on the displacement chamber. Tighten the screws [435] without torquing and check the position of the dual diaphragm body: the detection system must be in line with the valve assemblies. Tighten the screws [435] evenly in opposite pairs (applying a torque of 0.2 m.daN).

J

**C2. Reinstalling the diaphragms**

See Figures 7.2b and 7.2d.

1. Fit the heating shell [067], the seal [438] and the liquid end body [021]. Fit the intermediate diaphragm [098A] on the dual diaphragm body [098B]. Caution with positioning: the ports in the two parts must be aligned. If necessary, a very fine metal wire can be used to check their positioning, in which case the wire should not be withdrawn until after carrying out step 3. Fit a diaphragm on each side of the intermediate diaphragm and fit this assembly on the liquid end body [021].
2. Position this assembly on the displacement chamber. Tighten the screws [435] without torquing and check the position of the dual diaphragm body: the detection system must be in line with the valve assemblies. Tighten the screws [435] evenly in opposite pairs (applying a torque of 0.2 m.daN).

d1 p1

3. Lock the screws [435] by tightening to a torque of 4 m.daN.

d1 p2

d2 p1

3. Lock the screws [435] by tightening to a torque of 5 m.daN.

d1 p3

d2 p2

3. Lock the screws [435] by tightening to a torque of 6 m.daN.

d2 p3

3. Lock the screws [435] by tightening to a torque of 8 m.daN.

d3 p1

3. Lock the screws [435], tightening to a torque of 10 m.daN.

d3
p2

3. Lock the screws [435], tightening to a torque of 12 m.daN.

d3
p3

3. Lock the screws [435], tightening to a torque of 15 m.daN.

**H2. Reinstalling the refill valve**

See Figure 7.2c.

1. Fit the seal [438] and the lenticular piece / ball stop assembly [092A] on the refill valve [13].
2. Screw the refill valve on the displacement chamber [072] (tightening to a torque of 5 m.daN).

**E2. Reinstalling the safety valve**

See Figure 7.2c.

1. Fit the ball [437A], ball stop [092] and seal [438B] in the displacement chamber [072].
2. Attach the safety valve [9] on the displacement chamber with screws [9.5] (tightening to a torque of 2 m.daN).
3. Fit the seal [438A] on the safety valve and screw the cap [9.4] in place.

**L2. Reinstalling the detection system**

See Figure 7.2b.

1. Install the seal [438] in its recess.
2. Screw the syringe (tool [10]) in place of the valve assembly body [045].
3. Extract the plunger [10.1] from the syringe. Pour in a liquid compatible with the pumped fluid, filling up to the mark [10.2] and reinstall the plunger [10.1].
4. Press the syringe plunger in order to inject the fluid into all the internal cavities of the dual diaphragm body, then release this pressure after one minute to allow the gas contained in the dual diaphragm body to rise into the syringe.
5. Repeat this degassing operation four or five times and, then, unscrew the syringe [10].
6. Fit the valve set (taking care to comply with the direction of fitting) in its housing and screw the valve assembly body [045] into place (applying a torque of 1 m.daN).

See Figure 1.5a.

C5

7. Fit the detection assembly on the dual diaphragm body and secure the support [004A] (screw [W]). Connect the detection assembly to the valve assembly body (union [432]).

See Figure 1.5a.

C6

7. Connect the detection assembly to the valve assembly body (union [432]).

1

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a valve assembly (comprising a seat [024], a ball [407] and a retaining ring [092] either in the liquid end body [3] (discharge circuit) or in the valve body [021] (suction circuit).
2. Fit a second valve assembly.
3. Centre the valve assembly body on the liquid end and screw it into place. Lock by tightening to a torque of 4 m.daN.

6

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a valve assembly either in the liquid end body [3] (discharge circuit) or in the connection [045] (suction circuit). Take care to comply with the direction of fitting.
2. Apply tallow on the threads of the connections and screw them on the liquid end body. Tighten to a torque of 8 m.daN.

C5

**A2. Restarting**

2. Connect up the pipe (relief valve/spacer).
3. Fill the spacer and reinstall the cover on the spacer (replacing the cover seal, if necessary).
4. Connect up the pump hydraulically.
5. Connect up the pump electrically.
6. Check that the capacity is set to « 0% ».
7. Check that there are no suspicious noises when starting up.
8. Proceed with degassing of the dual diaphragm (see hereinafter).
9. Proceed with degassing of the displacement chamber (see hereinafter).
10. Adjust the pump capacity to 100% to obtain quicker priming.

D

11. After priming, adjust the pump to the desired capacity and lock the hand-knob.

DA

11. After priming, adjust the pump to the desired capacity.

C6

**A2. Restarting**

2. Connect up the pipe (relief valve/spacer).
3. Fill the spacer and reinstall the cover on the spacer (replacing the cover seal, if necessary).
4. Connect up the pump [584] (Fig. 1.5a) on the union [432A].
5. Connect up the pump hydraulically.
6. Connect up the pump electrically.
7. Check that the capacity is set to « 0% ».
8. Check that there are no suspicious noises when starting up.
9. Proceed with degassing of the dual diaphragm (see hereinafter).
10. Proceed with degassing of the displacement chamber (see hereinafter).
11. Adjust the pump capacity to 100% to obtain quicker priming.

D | 12. After priming, adjust the pump to the desired capacity and lock the hand-knob.

DA | 12. After priming, adjust the pump to the desired capacity.

### *DEGASSING THE DOUBLE DIAPHRAGM*

See Figure 1.5a.

1. Stop the pump (if it is running).
2. Adjust the pump capacity to 10 or 20 %.
3. Open the bleed [022].
4. Start the pump.
5. Wait about 15 minutes and adjust the pump to the desired capacity.
6. Close the bleed [022] when the required flow rate has been reached (after about 1 hour in operation).

Note : During the degassing procedure, it is normal for the injected liquid to appear at the bleed point [022].

### *DEGASSING THE DISPLACEMENT CHAMBER*

See Figure 7.2c.

1. Adjust the pump capacity to 100 %.
2. Unscrew the cap nut [9.1] from the safety valve.
3. Tighten the screw [9.2], noting the number of turns made (so that you can return to the initial position), until it bears on the calibrating screw [9.3]. Tighten by a further 3/4 turn. This forces hydraulic fluid towards the spacer so that the displacement chamber can be degassed.
4. Leave to run for five or six minutes and adjust the pump to the desired capacity.
5. Loosen the screw [9.2] to return to its initial position.
6. Retighten the cap nut [9.1].

### *CLEANING THE AIR BLEED BUILT INTO THE SAFETY VALVE*

**CAUTION** : Do not carry out this operation unless particles have blocked the air bleed so hampering its operation (see Chapter IV - 3).

See Figure 7.2c.

1. Proceed with removal of the safety valve (see section E1). The ball stop [092] and ball [437A] should only be removed if they have to be replaced.
2. Soak the valve in a cleansing solution and press on the nut of the calibrating valve [9.6] by hand to check that the valve stem [9.7] operates correctly.
3. Clean the valve with compressed air.
4. Proceed with reinstallation of the safety valve (see section E.2).

# VII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

## I1. Removing the cylinder

See Figure 7.2c.

1. Separate the plunger [012] from the displacement chamber [072].
2. Remove and clean the magnet [406].
3. Unscrew the cylinder nut [008A].
4. Remove the plunger cylinder [037] (marking the direction of fitting) and clean the displacement chamber.

d3

## K1. Removing the plunger mounting assembly

See Figure 7.2c.

1. Unscrew the screw [B]
2. Remove the plunger assembly [012], the screw [B], the plunger support [012A] and the washer [019]
   (do not unscrew the screw [435A])
3. Remove the washer [019A]
4. Check the wear between the washer [019A] and the contact sphere of the support [012A]

d1

## K2. Reinstalling the plunger mounting assembly

See Figure 7.2c.

1. Grease the plunger support [012A] and the washer [019A]
2. Fit the washer [019A] at the bottm of the crossead [A]
3. Fit the plunger assembly [012], the washer [019], the plunger support [112A]. Screw the screw [B] (torque 8 daN.m)

## I2. Reinstalling the cylinder

See Figure 7.2c.

1. Fit the following components in the displacement chamber [072]: the cylinder [037] (taking care to comply with the direction of fitting, the cylinder nut [008A] (tightening to a torque of 2 m.daN) and the magnet [406].
2. Fit the plunger [012] in the displacement chamber.

# PART VIII - SERVICING THE MECHANICAL ASSEMBLY

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x), in the case of partial servicing operation.

## VIII - 1. GENERAL

A view of the mechanical assembly is shown in Figure 8.1a.

MX

**Note concerning multiplexed pumps**

When carrying out servicing on all the pumps, start with the last pump, then move on to the one adjacent to it, and so on until reaching the driving pump.

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.
- Clean the recess for O-rings when they are removed. Apply tallow in the recess before reinstalling the new O-ring.

# VIII - 2. DISMANTLING THE MECHANICAL ASSEMBLY

### A1. Preliminary operations

The relevant recommendations and procedures are described in section A1, Chapter VII - 2. REINSTALLING THE LIQUID END.

MX

If necessary, prepare lifting equipment compatible with the weight of the mechanical assembly (see TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

5. Drain the oil from the housing and remove the cover from the housing.

### F1. Removing the liquid end

The relevant procedures are described in section F1 of Chapter VII - 2. REMOVING THE LIQUID END.

### M1. Removing the motor

SX

See Figure 8.2a.

1. Shim the mechanical assembly, if necessary, as the motor mount [072] which supports the pump will have to be dismantled.

M1

2. Remove the screws attaching the motor mount [072] onto the housing and take out the motor, the motor mount and the half-coupling [052A].
3. If the shock absorber [440] must be replaced, remove it and remove dust from the two half-couplings.

### N1. Removing the half-coupling

SX

See Figure 8.2a.

1. Measure dimension [D].

M1

2. Remove the screw [435A] through the hole [E] in the housing in order to remove the half-coupling [052].

### AN1. Removing the half-coupling

Mi

See Figure 8.2a.

1. Measure dimension [D2].

Mn

2. Remove screw [R1] through the hole [E] in the housing to remove the half-coupling [052].

### O1 - 1. Removing the connecting rod

See Figure 8.2b.

1. Remove the connecting rod [014] from the crank [216]: unscrew the nut [435J] and withdraw the pin axis [068].

### P1. Removing the crosshead

See Figure 8.2c.

1. Remove the packing cover [005A], connection [005], seal [432D] and packing [436]. Remove the tubing [432E] (by pushing on the bushing of connection [432F] to disengage the tubing).
2. Remove the plug [432A] and screw [435A].
3. Remove the bleed [022] (part bonded with Loctite 221). Rotate the liner [072] to unscrew the connection [432F] (part bonded with Loctite 221).
4. Extract the liner [072], crosshead [010] and connecting rod [014] through the bore in the spacer.
5. Withdraw the crosshead [010] from the liner [072], mark the direction of fitting of the seals, remove the lip seals [408], O-ring [438] and retaining rings [434C].

SX

### V1. Removing the attaching lug

See Figure 8.2b.

Mn

1. Remove the four screws securing the attaching lug [N] to the housing, after shimming the mechanical assembly, if necessary.

### AV1. Uncoupling the pumps

M1

See Figure 8.2e.

Start by working on the “last” MD pump.

Mi

1. Unscrew the screws linking the two pumps as well as the attaching screws (pump - frame). Remove the pump. Remove the spacer [019], if one is fitted.
2. Measure dimension [D1].
3. Remove screw [R1] to remove the half-coupling [052A].

### Q1. Removing the worm

See Figure 8.2b.

1. Unscrew the bearing screw [237]. If any difficulty is encountered, heat the housing with a blowtorch to soften the adhesive applied in the thread tapped in the housing and on the threads of the bearing screw. Remove the bearing screw, the lip seal [408A] and bearing [409]. If a blowtorch is used, the bearing [409] must be replaced.
2. Remove the worm.

### R1. Removing the crank support

See Figure 8.2b.

1. Remove the two locking rings [404A]. Push on the adjusting dies [211] to free the micrometer screw [256].
2. Remove the two screws [435B]. Unscrew the micrometer screw [256] using the hand-knob [255] in order to free the crank support [281A].
3. Remove the crank support [281A] with the bearing [409].
4. Remove the lip seal [408A] from the housing, if it has to be replaced.

D

See Figure 8.2d.

VF

5. If the lock insert [043] has to be replaced, completely unscrew the micrometer screw. Remove screw [008A] and extract the lock insert by making it fall out.

# VIII - 3. REINSTALLING THE MECHANICAL ASSEMBLY

### R2. Reinstalling the crank support

See Figure 8.2b.

1. If necessary, proceed with the replacement of the bearing [409]: apply Loctite 221 adhesive on the outside of the bearing and install it in its recess in the housing.
2. Position the crank support [281A] in the housing.

### Q2. Reinstall the worm

See Figure 8.2b.

1. Fit the worm into the housing. (There is no specific direction of fitting).
2. Apply tallow on the seal [408A] and fit the seal into the housing.
3. Apply tallow on the seal [408A] and fit it into the bearing screw [237], (taking care to comply with the direction of fitting).
4. If necessary, replace the bearing [409]: apply a little Loctite 221 on the bearing screw [237] and fit the bearing on the bearing screw.
5. Apply Loctite 566 on the tapping in the housing and on the threads on the bearing screw. Screw in the bearing screw. Wait for the adhesive to dry (about 3 hours at 18°C) before continuing with the fitting procedure.

### S2. Reinstalling the micrometer screw

See Figures 8.2d and 8.2b.

D

1. If the lock insert [043] was removed, screw the micrometer screw [256], fit the insert in the bore and install the screw [008A] without torquing it. Reinstalling the stop collar [018].
2. Screw the micrometer screw [256] in order to engage the adjusting dies [211] in the groove in the micrometer screw.

VF

3. Position the adjusting dies using the two stop rings [404A].
4. Unscrew the micrometer screw until reaching the "98%" graduation.
5. Place the stop collar [018] fully home against the housing and moderately tighten the two screws [435B].
6. Adjust the micrometer screw to the "100%" graduation and lock the two screws [435B].

### P2. Reinstalling the crosshead

See Figure 8.2c.

1. Proceed with the replacement of the lip seal [408] and O-ring [438], if necessary: apply a little tallow in the liner, fit a seal in the liner. Take care to avoid damaging the lip on the seal during reinstallation. Fit the retaining ring [434C]. Fit the second seal (in the opposite direction to the previous one).
2. Fit the crosshead [010] in the liner [072]. Replace the O-ring [438].
3. Fit the assembly comprising the liner [072] and crosshead [010] in its recess through the bore in the spacer.
4. Apply a little Loctite 221 adhesive on the thread of the tap [432F] and screw the tap into the liner. Apply a little Loctite 221 adhesive on the thread of the bleed [022] and screw the bleed into the liner.
5. Position the liner using the screw [435A] and make sure that the bleed is correctly vertical before locking the screw [435A] (tightening to a torque of 0.5 m.daN). Reinstall the plug [432A].
6. Snap the tubing [432E] into place in the tap [432F]. Fit the seal [432D] and connection [005] in the housing. Fit the packing [436] and packing cover [005A].

### O2 - 1. Reinstalling the connecting rod

See Figure 8.2b.

1.Reinstall the connecting rod [014] on the crank [216]. Fit the pin axis [068] and screw on the nut [435J].

### Z. Servicing the strainer

See Figure 7.2c.

1. Disconnect the tube [047].

H

2. Remove the strainer by unscrewing the nut [435E]. Remove the seal [I] in order to replace it.
3. Unscrew the strainer body [K] from the strainer connection [045]. Remove the filter cloth [047A] (and mark the direction of fitting), the clamping bush [025] and seal [438F], in order to replace them. Clean the strainer body and the strainer connection.

P

4. Fit the strainer connection, the filter cloth (taking care with the direction of fitting), the clamping bush and the seal. Apply tallow on the thread of the strainer connection [045] and screw the strainer body [021] into place.
5. Fit a seal [I] on the strainer body, and fit the strainer on the housing by means of a nut [435E].
6. Connect the tube [047].

### Z. Servicing the strainer

See Figure 7.2c.

M

1. Remove the strainer by unscrewing the nut [435E]. Remove the seal [I] in order to replace it.

X

2. Unscrew the strainer plug [045] from the strainer body [K]. Remove the seal [438C] in order to replace it.

V

3. Reinstall a seal [438C] on the strainer plug. Fit the strainer plug on the strainer body.
4. Fit a seal [I] on the strainer body, and fit the strainer on the housing with a by means of a nut [435E].

### N2. Reinstalling the half-coupling

SX

See Figure 8.2a.

M1

1. Reinstall the half-coupling [052] on the worm shaft, allowing for the measurement conducted during dismantling (dimension [D]).
2. Screw in the screw [435A] via the hole [E] in the housing.

### AN2. Reinstalling the half-coupling

Mi

See Figure 8.2a.

Mn

1. Reinstall the half-coupling [052] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D2]).
2. Install the screw [R1] through the hole [E] in the housing.

### M2. Reinstalling the motor

SX

See Figure 8.2a.

1. Proceed with the replacement of the shock absorber [440], if necessary.
2. Fit the two half-couplings and, at the same time, engage the motor mount [072] in the centring fitting in the housing. The mount must be fully home on the housing and the shock absorber [440] must be fitted without forcing between the two half-couplings.

M1

3. Secure the mount [072] with screws.

### AW2. Positioning the pump

M1

See Figure 8.2e.

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D1]). Install the screw [R1].
2. Position the crank in the high position.

Mi

### AW2. Coupling the pumps

See Figure 8.2e

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (code [D1]). Install the screw [R1].
2. Position the crank in the high position.
3. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
4. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted between the two half-couplings without being placed under stress.
5. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

Mn

### AW2. Coupling the pumps

See Figure 8.2a.

1. Position the crank in the high position.
2. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
3. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted without being placed under stress between the two half-couplings .
4. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

SX

Mn

### V2. Reinstalling the attaching lug

See Figure 8.2b.

1. Secure the attaching lug [N] with four screws.

### F2. Reinstalling the liquid end

The relevant procedures are described in section F2 of Chapter VII - 3. REINSTALLING THE LIQUID END.

### A2. Restarting

1. Fill the housing with oil and reinstall the housing cover (replacing the cover seal, if necessary).

The other relevant procedures are described in section A2, Chapter VII - 3.REINSTALLING THE LIQUID END.

# VIII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

### O1 - 2. Removing the connecting rod

See Figure 8.2c.

1. Remove the connecting rod [014] from the crosshead [010]: unscrew the screw [435E] and withdraw the pin [011] (parts bonded with Loctite 221 adhesive).

### T1. Removing the tangential gear

See Figure 8.2b.

1. Unscrew the nut [405] while holding the crank [216] (parts bonded with Loctite 221.
2. Drive out the crank.

### T2. Reinstalling the tangential gear

See Figure 8.2b.

1. If necessary, adjust the groove in the tangential gear to fit with the key on the crank [216] (in the event of replacement of the worm / tangential gear pair or replacement of the crank).
2. Apply a little adhesive on the thread on the crank. Engage the crank in the crank support [281A], fit the tangential gear (taking care with the direction of fitting) and screw on the nut [405].

### O2 - 2. Reinstalling the connecting rod

See Figure 8.2c.

1. Reinstall the connecting rod [014] on the crosshead [010]: fit the connecting rod on the pin [011] by means of screw [435E] (part bonded with Loctite 221).

# GUARANTEE

The vendor guarantees his products according to the D.M.R. general conditions of sale.

The guarantee for components and sub-assemblies not fabricated by the vendor is limited tothat given by the supplier.

The vendor's guarantee only covers the replacement or the repair, at his cost and in his factory, of all parts acknowledged by his technical services as being defective due to an error in conception, of material or of execution.

It is the purchasers responsability to prove the said defects. The guarantee does not cover the replacement of wear parts mentioned in part V - Preventive Maintenance.

The vendor reserves the right to modify all or part of his products in order to satisfy the guarantee. The guarantee does not cover charges arising from dismantling, assembly, transport and movements.

The replacement of one or several parts, for whatever reason, does not prolong the period of guarantee.

The guarantee is not applicable notably in the following cases :

- installation not in accordance with standard current practice.
- deterioration or accident resulting from negligence.
- lack of surveillance or maintenance.
- modifications to conditions of use.
- chemical corrosive or erosive attack. The proposed materials of construction are recommendations subject in all cases to verification and acceptance by the client. The recommendations, based on the experience of the vendor and the best available information, do not guarantee against wear or chemical action.

The guarantee ceases :

- if the storage of the material, outwith the vendors factory, does not conform to his recommendations or to current standard practices.
- in case of work or dismantling of the material by someone who does not respect written recommendations of the instruction manual (when replacing wear parts).
- if parts from another origin are substituted for the original parts supplied by the manufacturer.

The purchaser cannot call on guarantee claims to justify differing payments.

## INDUSTRIAL OWNERSHIP

DOSAPRO MILTON ROY

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ACCUEIL : Tél. 33.(0)2.32.68.30.00 Fax . 33.(0)2.32.68.30.93
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Tel. 39.039 60.56.891 - Fax. 39.039 60.56.906
Centro Direzionale Colleoni - Via Paracelso 16
Palazzo Andromeda - Ingresso 1
20041 AGRATE BRIANZA (MI)
www.miltonroy.it

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TECHNICAL ASSISTANCE AND SPARE PARTS :
Tel. 44.11.89.77 10 66 - Fax. 44.11.89 77 11 98 -
Oaklands Park, fishponds Road, WOKINGHAM - Berkshire RG 11 2FD
www.miltonroypumps.co.uk

## USA UNITED STATES

L.M.I. (LIQUID METRONICS, INC.)
Tel : 978 263-9800 - Fax : 978 264-9172
8 Post Office Square Acton, MA 01720
www.lmipumps.com

FLOW CONTROL DIVISION
TECHNICAL ASSISTANCE AND SPARE PARTS :
Tel. 215.441.0800 - Fax.215.293.0468
201 Ivyland Road, IVYLAND, PA, 18974
www.miltonroy.com email: customercervice@miltonroy.com

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DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

M/X/V DIAPHRAGM-TYPE LIQUID END

This manual should be made available to the person responsible for installation, operating and maintenance.

**ILLUSTRATIONS VOLUME**

**Date : 12/99** **O / Ref : I.160.0813.001.Rev. B**

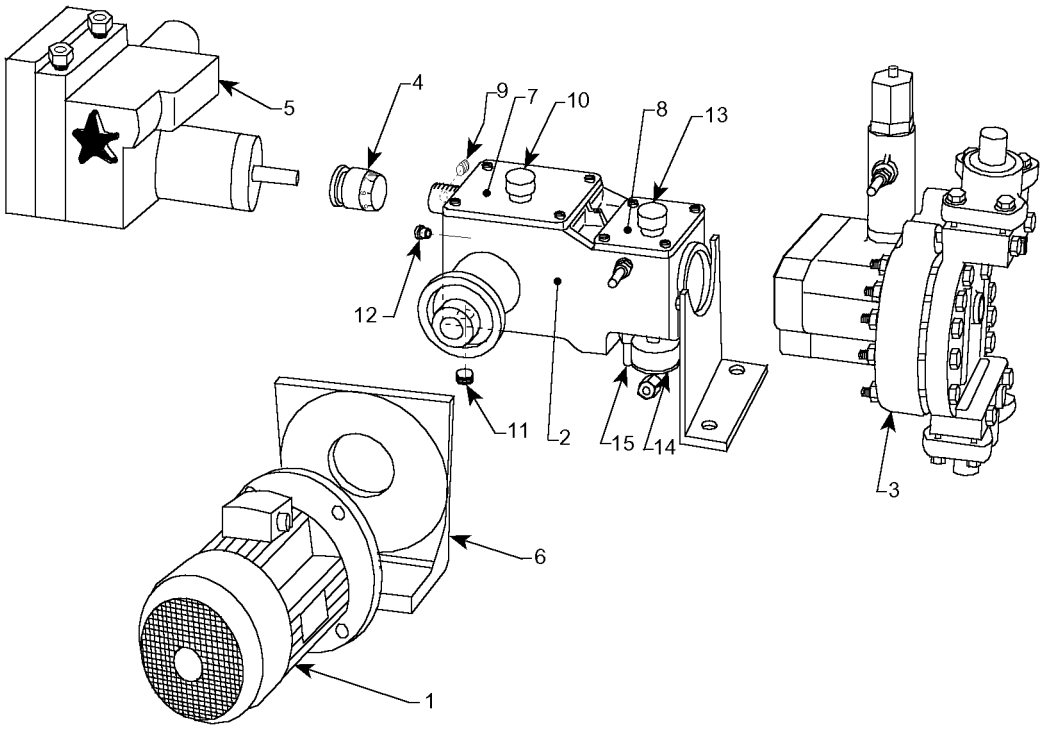
For better understanding, use this volume together with the TEXT VOLUME.

# LIST OF ILLUSTRATIONS

## VIII - SERVICING THE MECHANICAL ASSEMBLY



## TECHNICAL CHARACTERISTICS




| | | | |
|---|---|---|---|
| 1 | Motor | 9 | Stroke adjustment knob locking screw |
| 2 | Mechanical assembly | 10 | Housing filler plug |
| 3 | Liquid end | 11 | Housing drain plug |
| 4 | Stroke adjustment knob | 12 | Oil gauge (housing) |
| 5 | Servo-motor | 13 | Spacer filler plug |
| 6 | Motor support | 14 | Strainer |
| 7 | Housing | 15 | Leak detector |
| 8 | Mechanical assembly spacer | | |

**Fig. 1.2a: Milroyal D pump fitted with diaphragm-type liquid end**

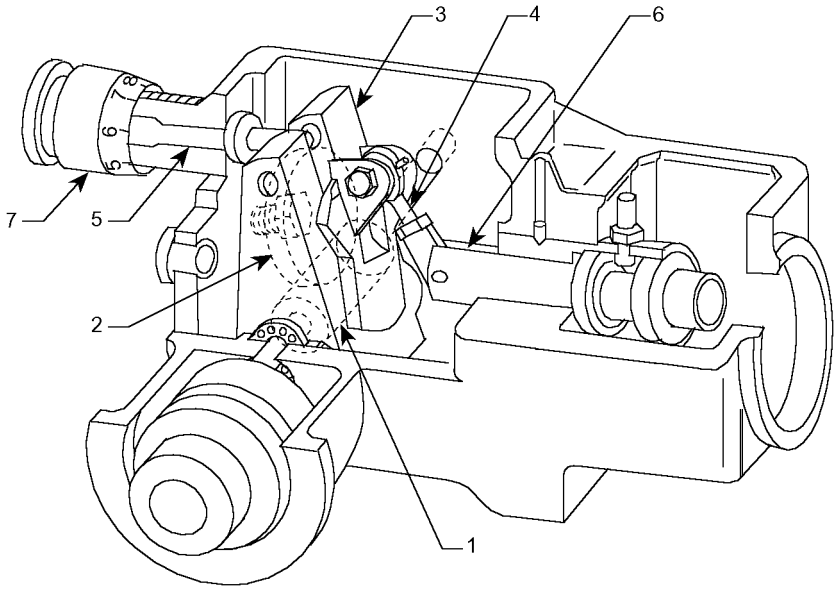



**Fig. 1.3a : Mechanical assembly**

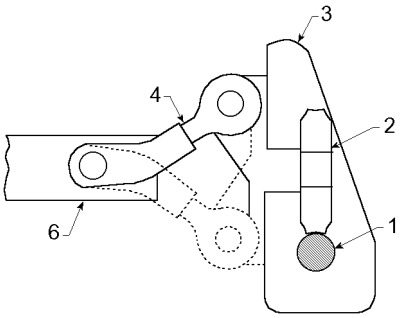



**Fig. 1.3b : Setting to zero stroke**

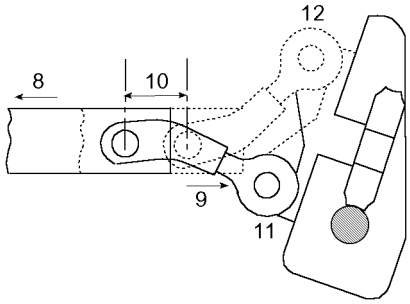
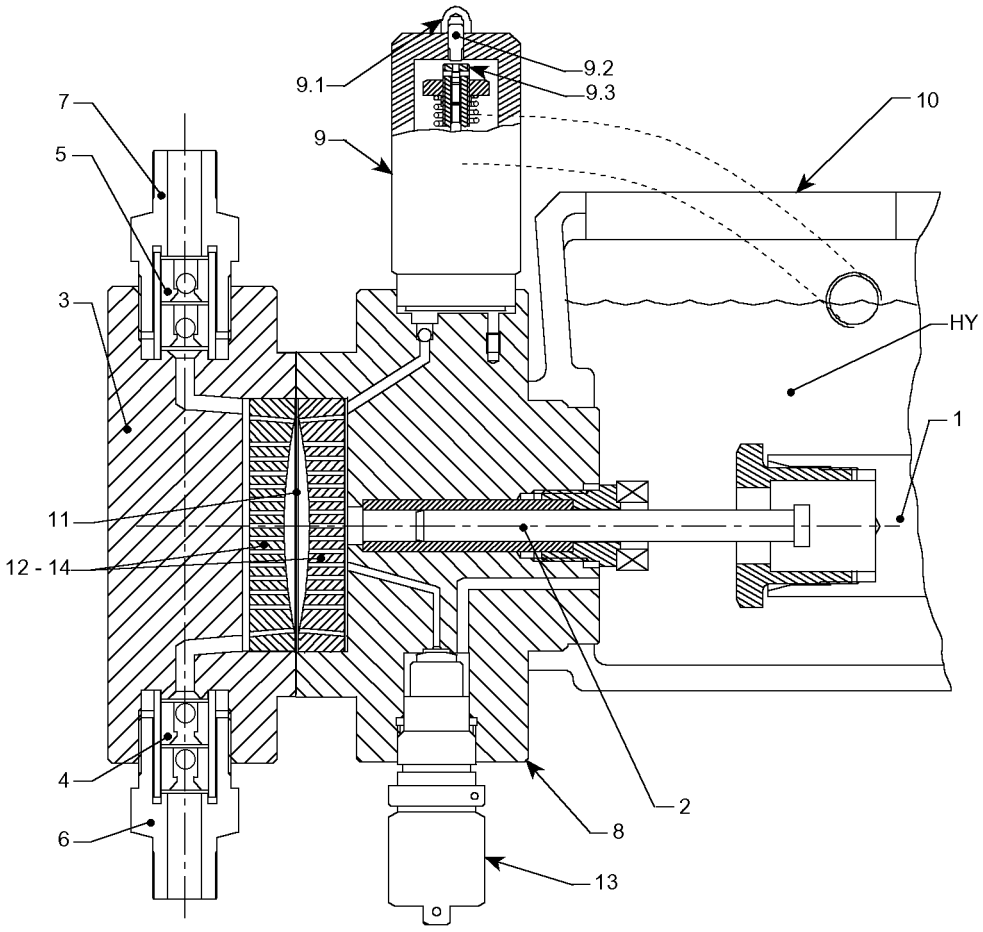



**Fig. 1.3c : Setting to maximum stroke**

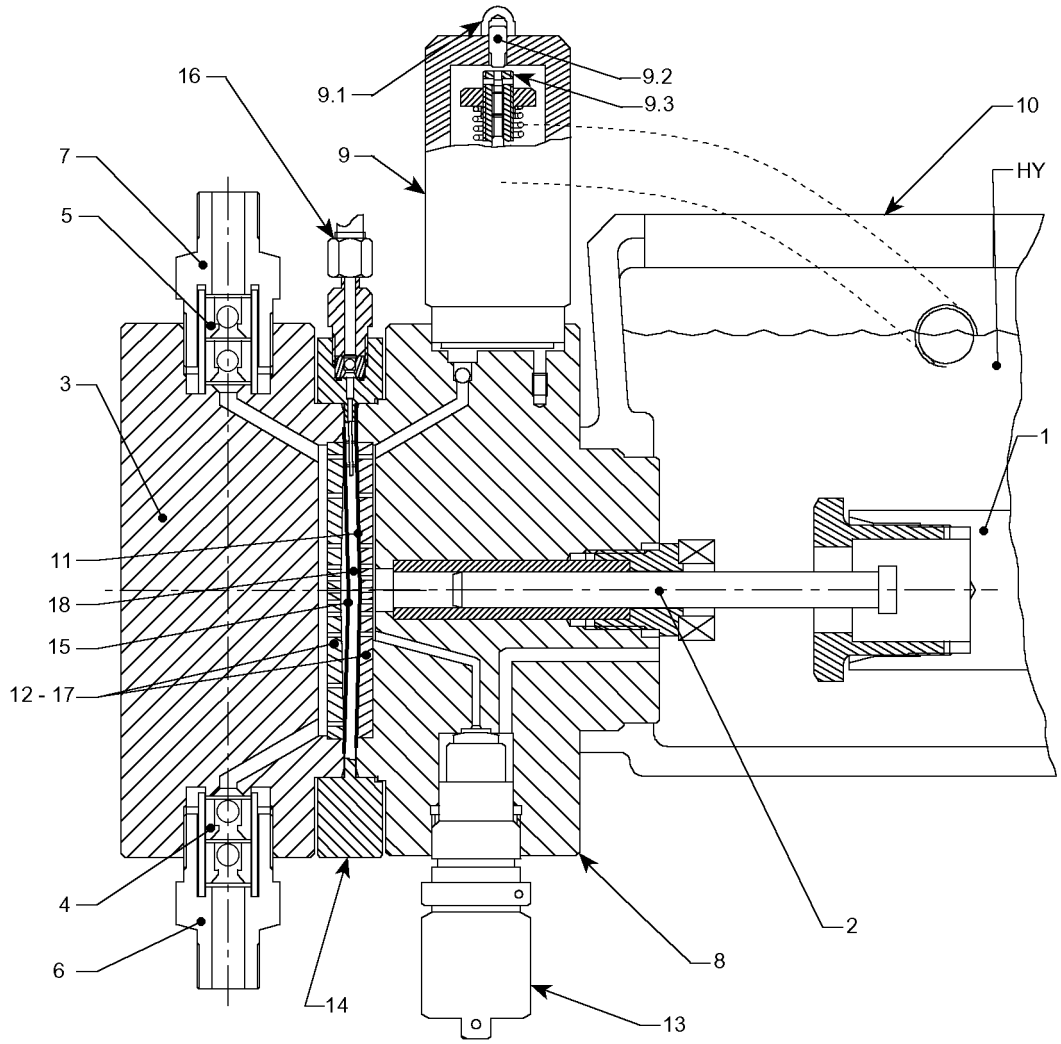
| | | | |
|---|---|---|---|
| 1 | Worm | 7 | Stroke adjustment knob |
| 2 | Tangential gear | 8 | Discharge |
| 3 | Inclinable crank | 9 | Suction |
| 4 | Connecting rod | 10 | Stroke |
| 5 | Micrometer screw | 11 | Position discharge |
| 6 | Crosshead | 12 | Position suction |




0

| HY | Hydraulic oil | 9 | Safety valve |
|---|---|---|---|
| 1 | Crosshead | 9.1 | Cap nut |
| 2 | Plunger | 9.2 | Screw |
| 3 | Liquid end body | 9.3 | Calibrating screw |
| 4 | Valve assembly (suction) | 10 | Spacer |
| 5 | Valve assembly (discharge) | 11 | Diaphragm |
| 6 | Connection assembly (suction) | 12-14 | Contour plates |
| 7 | Connection assembly (discharge) | 13 | Relief valve |
| 8 | Displacement chamber | | |

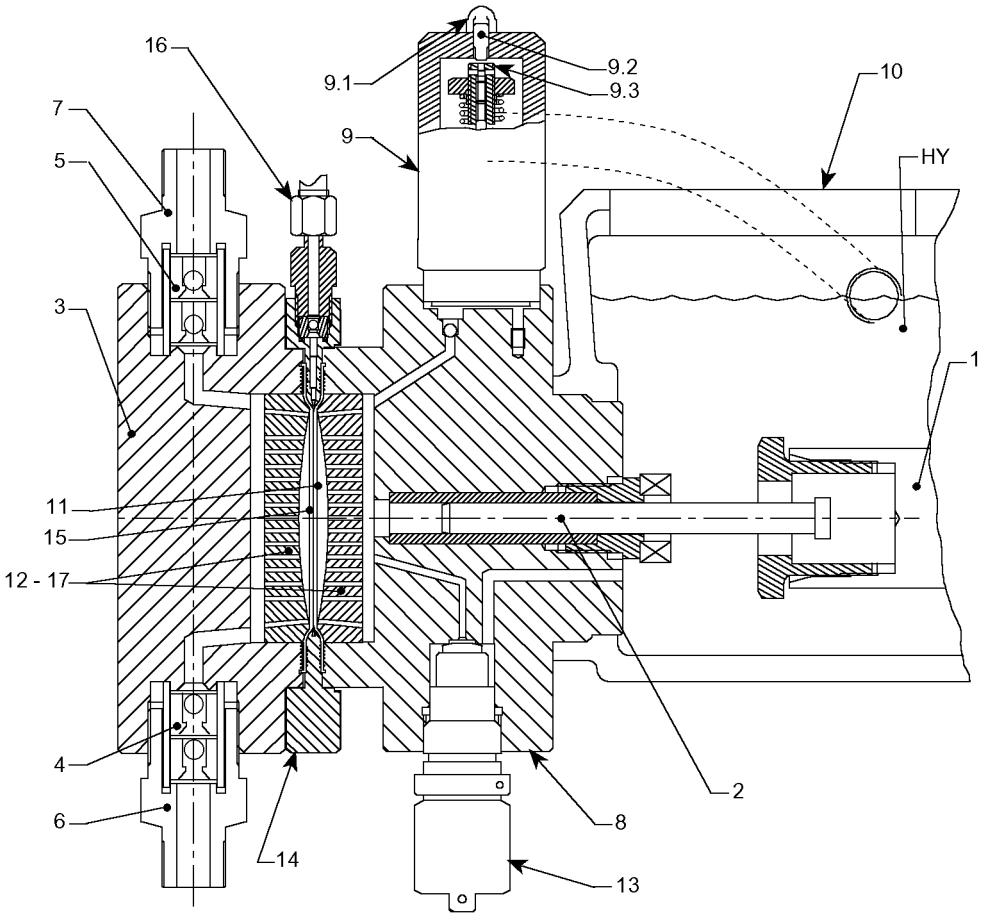
**Fig. 1.4a : Operating principle of the liquid end**




| | | | |
|---|---|---|---|
| HY | Hydraulic oil | 9.2 | Screw |
| 1 | Crosshead | 9.3 | Calibrating screw |
| 2 | Plunger | 10 | Spacer |
| 3 | Liquid end body | 11 | First diaphragm |
| 4 | Valve assembly (suction) | 12-17 | Contour plates |
| 5 | Valve assembly (discharge) | 13 | Relief valve |
| 6 | Connection assembly (suction) | 14 | Double diaphragm body |
| 7 | Connection assembly (discharge) | 15 | Second diaphragm |
| 8 | Displacement chamber | 16 | Detection system |
| 9 | Safety valve | 18 | Intermediate diaphragm |
| 9.1 | Cap nut | | |

M
C

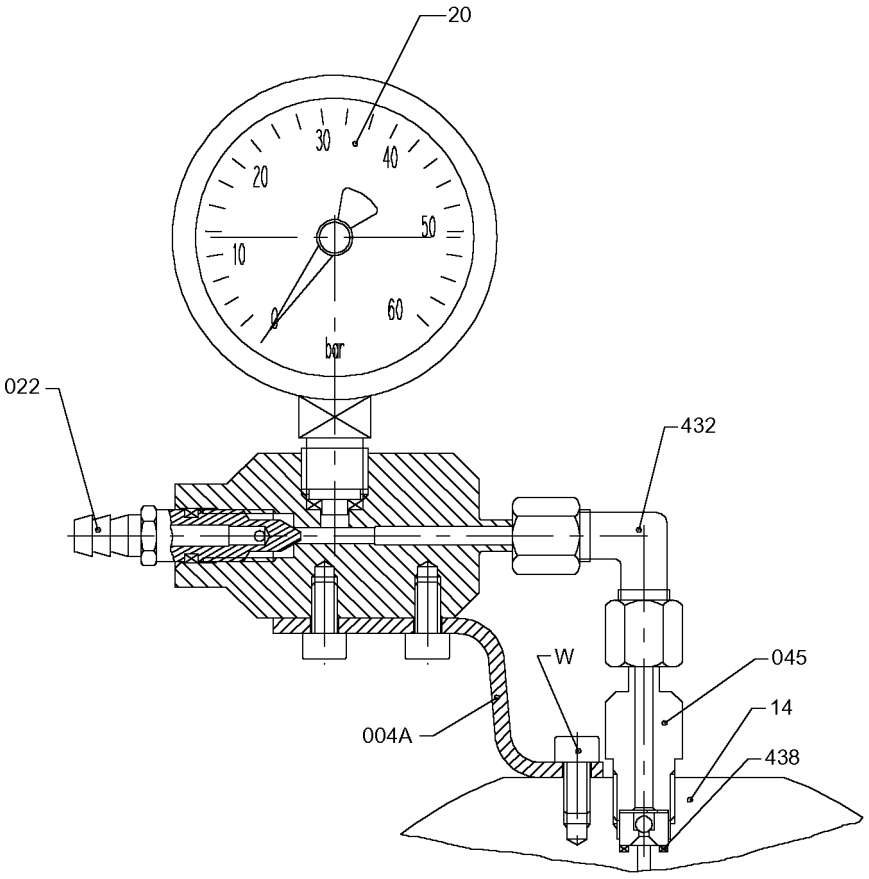
**Fig. 1.4a : Operating principle of the metal disc diaphragm-type liquid end option with double diaphragm**




X
C

| | | | |
|---|---|---|---|
| HY | Hydraulic oil | 9.1 | Cap nut |
| 1 | Crosshead | 9.2 | Screw |
| 2 | Plunger | 9.3 | Calibrating screw |
| 3 | Liquid end body | 10 | Spacer |
| 4 | Valve assembly (suction) | 11 | First diaphragm |
| 5 | Valve assembly (discharge) | 12-17 | Contour plates |
| 6 | Connection assembly (suction) | 13 | Relief valve |
| 7 | Connection assembly (discharge) | 14 | Double diaphragm body |
| 8 | Displacement chamber | 15 | Second diaphragm |
| 9 | Safety valve | 16 | Detection system |

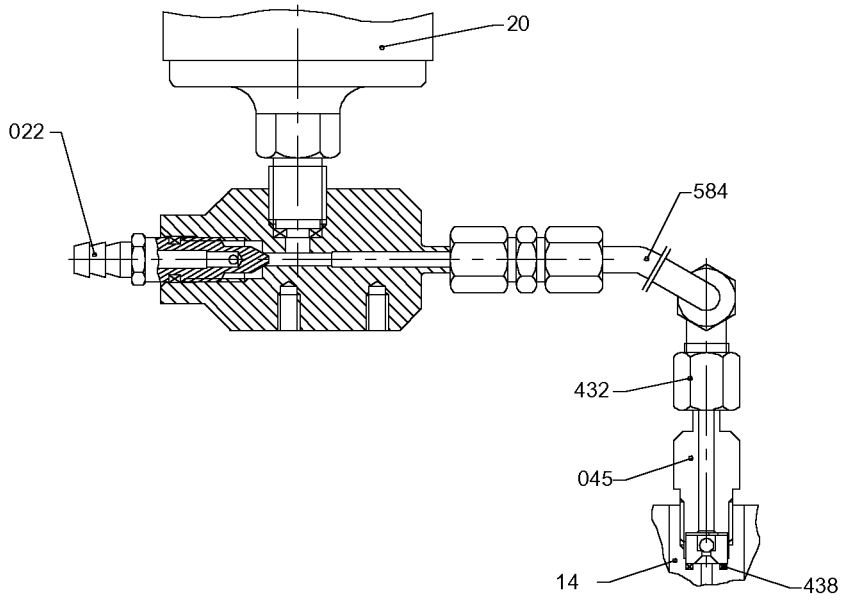
**Fig. 1.4 a: operating principle of the PTFE diaphragm-type liquid end option with double diaphragm**




C5

| | | | |
|---|---|---|---|
| 14 | Double diaphragm body | 045 | Valve body |
| 20 | Manometer | 432 | Connection |
| 004A | Support (mount) | 438 | Seal |
| 022 | Bleed | 584 | Tube |

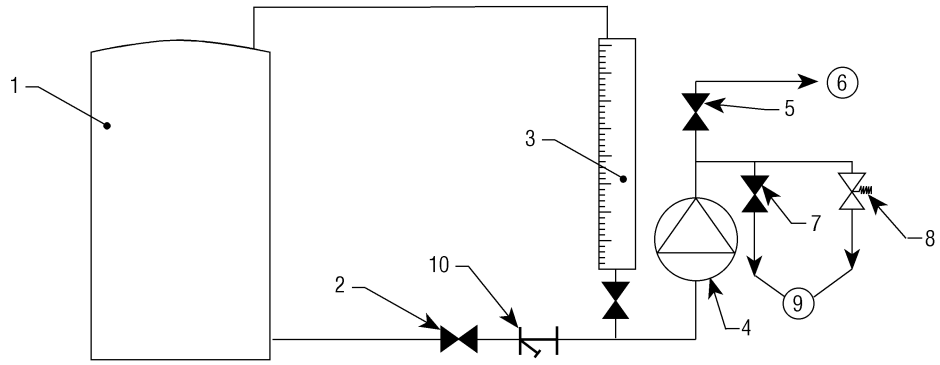
**Fig. 1.5a : Manometer detector assembly**




C6

| | | | |
|---|---|---|---|
| 14 | Double diaphragm body | 432 | Connection |
| 20 | Pressostat | 438 | Seal |
| 022 | Bleed | 584 | Tube |
| 045 | Valve body | | |

**Fig. 1.5a : Pressure switch detector assembly**




| | | | |
|---|---|---|---|
| 1 | Tank | 6 | Utilization |
| 2 | Suction circuit isolating valve | 7 | Priming valve |
| 3 | Calibrating chamber | 8 | Safety valve |
| 4 | Pump | 9 | Return |
| 5 | Discharge circuit isolating valve | 10 | Filter |

**Fig. 2.1a : Diagram of an installation**

SX

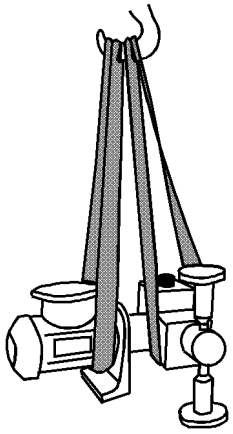


**Fig. 2.3a : Handling**

MX

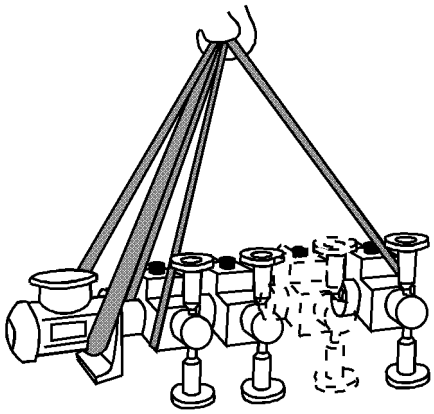
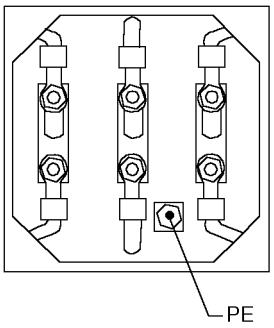


**Fig. 2.3a : Handling**

SX



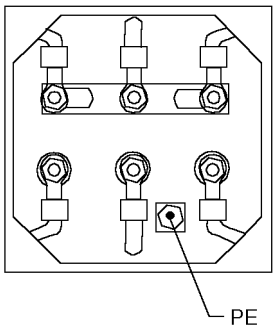




**Fig. 2.5a : Motor terminal box**

M1

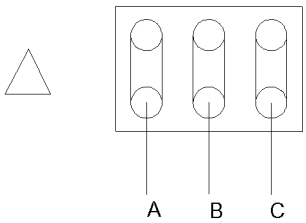



**Fig. 2.5b :**
**230 V delta connection**

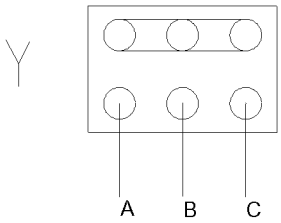



**Fig. 2.5c :**
**400 V star connection**

## MAINTENANCE SHEET

Pump code : Contract No :
Liquid pumped :

| Service Operation | Date | Hours | Remarks |
|---|---|---|---|
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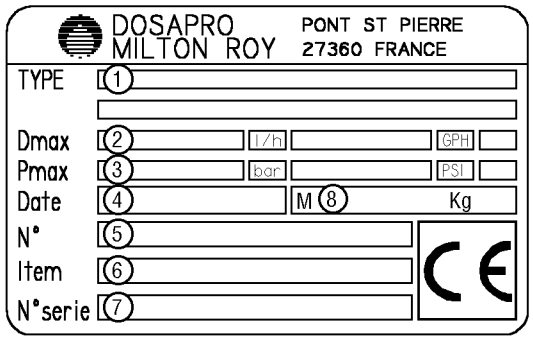
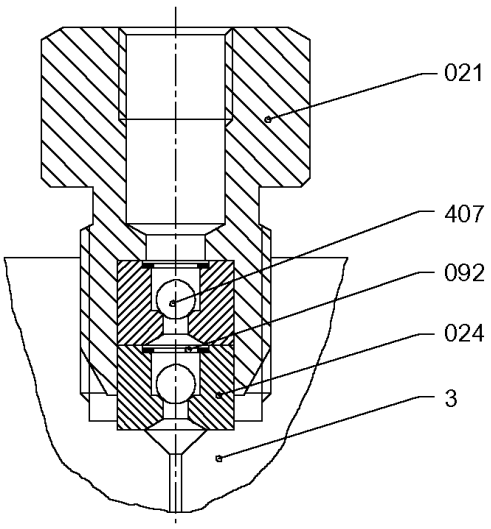
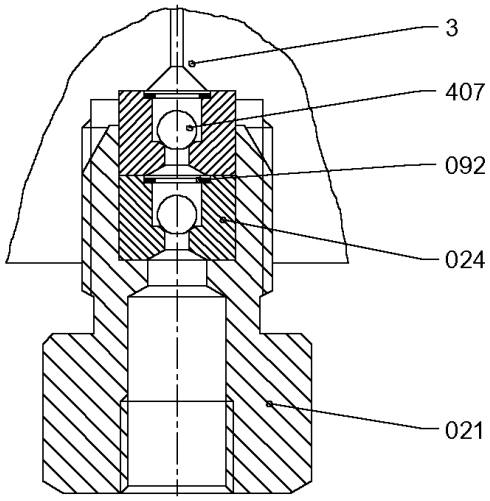
**Fig. 3.4a : Model Maintenance Sheet**




| | |
|---|---|
| **1** | **Type : Pump code** |
| 2 | Dmax : maximum capacity |
| 3 | Pmax : maximun pressure |
| 4 | Date: date of manufacture |
| **5** | **N° : Contract No** |
| 6 | Item : your reference |
| 7 | N° série.: Dmr internal no |

**Fig. 4.4a : Identification plate**



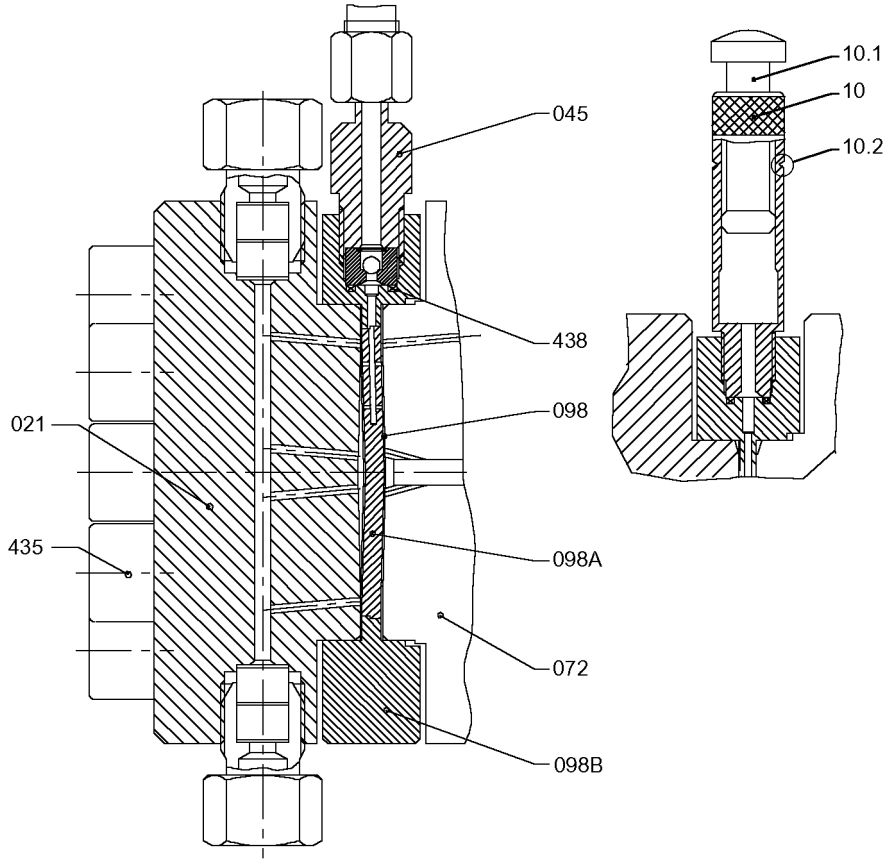




**Discharge** **Suction**

1

| | |
|---|---|
| 021 | Valve assembly body |
| 024 | Seat |
| 092 | Retaining ring |
| 407 | Ball |
| 3 | Liquid end body |

**Fig. 7.2a : Sectional drawing of valve assemblies.**

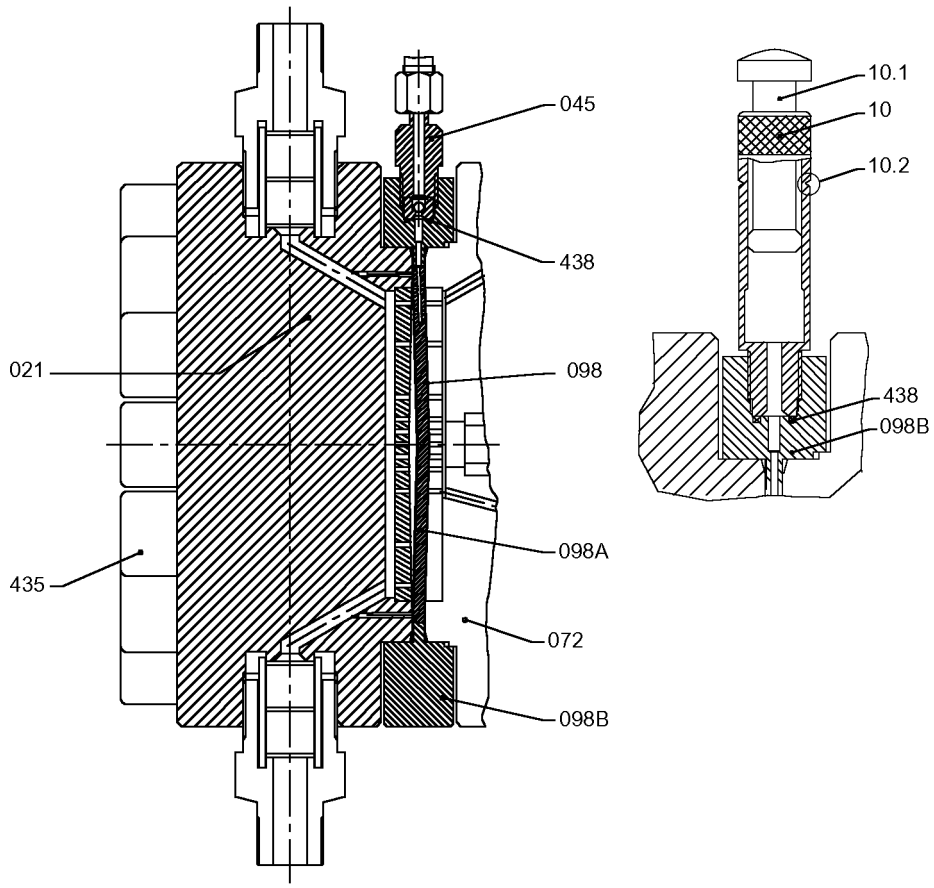



d1

d2

| | | | |
|---|---|---|---|
| 10 | Syringue | 098 | Contour plate |
| 10.1 | Plunger | 098A | Diaphragm |
| 10.2 | Mark | 098B | Double diaphragm body |
| 021 | Liquid end body | 435 | Screw |
| 045 | Valve assembly body | 438 | Seal |
| 072 | Displacement chamber | | |

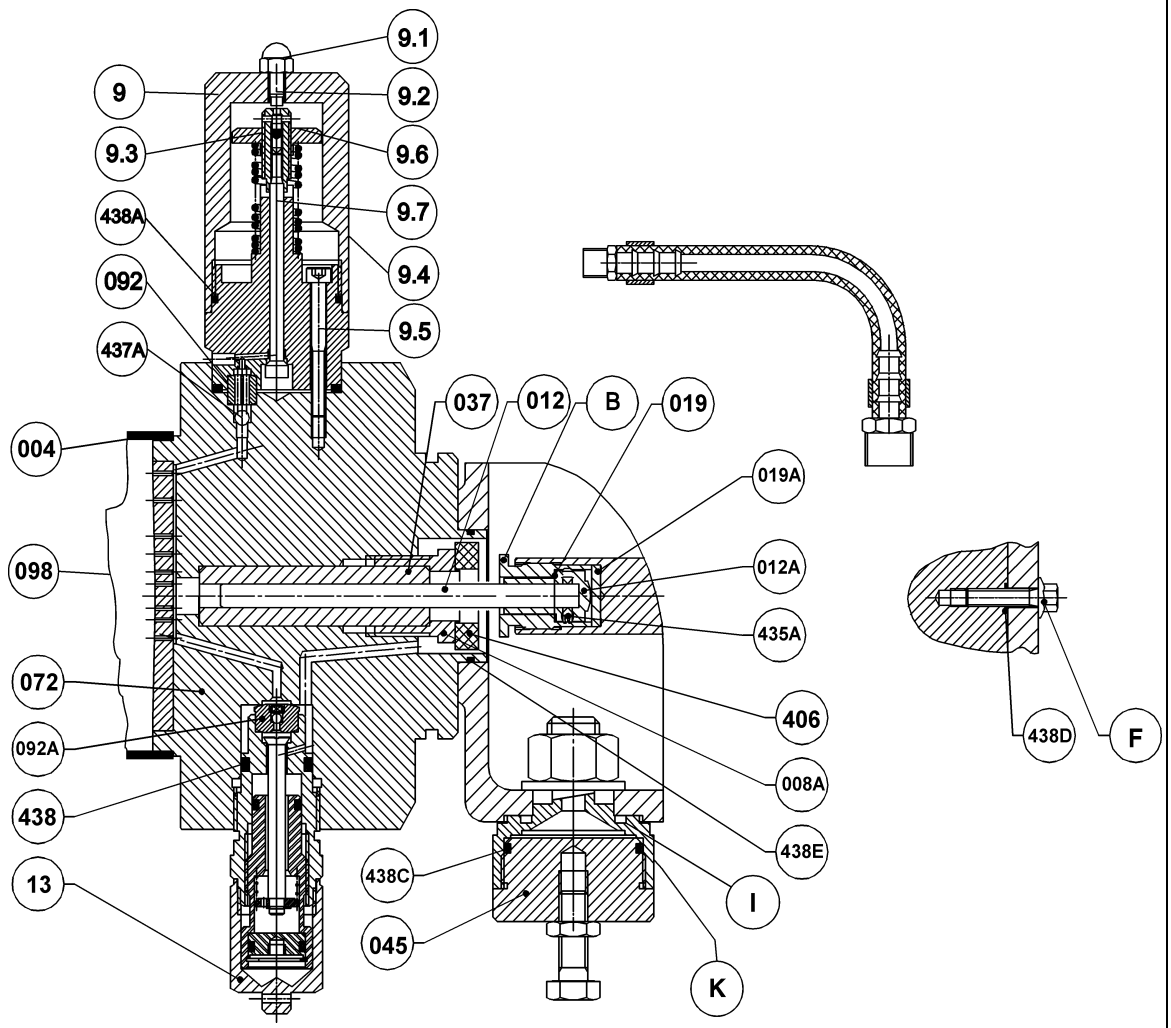
**Fig. 7.2b : Sectional drawing of liquid end assembly**




d3

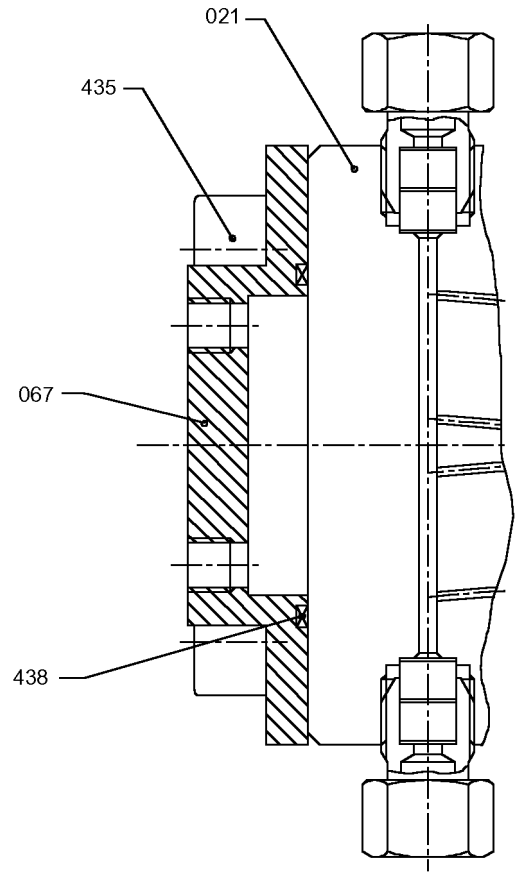
| | | | |
|---|---|---|---|
| 10 | Syringue | 098 | Contour plate |
| 10.1 | Plunger | 098A | Diaphragm |
| 10.2 | Mark | 098B | Double diaphragm body |
| 021 | Liquid end body | 435 | Screw |
| 045 | Valve assembly body | 438 | Seal |
| 072 | Displacement chamber | | |

**Fig. 7.2b : Sectional drawing of liquid end assembly**




| | | | | |
|---|---|---|---|---|
| | 004 | Centring bush | 092 | Ball stop |
| d1 | 008A | Cylinder nut | 092A | Lenticular piece/ball stop assy |
| | 9 | Safety valve | 098 | Diaphragm |
| d2 | 9.1 | Cap nut | 406 | Magnet |
| | 9.2 | Screw | 434B | Washer |
| d3 | 9.3 | Calibrating screw | 435E | Nut |
| | 9.4 | Cover | 437A | Ball |
| | 9.5 | Attaching screw | 438 | O-ring |
| | 9.6 | Nut for calibrating screw | 438A | O-ring |
| | 9.7 | Valve stem | 438B | O-ring |
| | 012 | Plunger | 438C | O-ring |
| | 012A | Support | | |
| | 13 | Relief valve | 438D | O-ring |
| | 019 | Bushing | 438E | O-ring |
| | 019A | Thrust washer | B | Plunger mounting screw |
| | 037 | Plunger cylinder | F | Screw |
| | 045 | Strainer plug | I | Seal |
| | 072 | Displacement chamber | K | Strainer body |

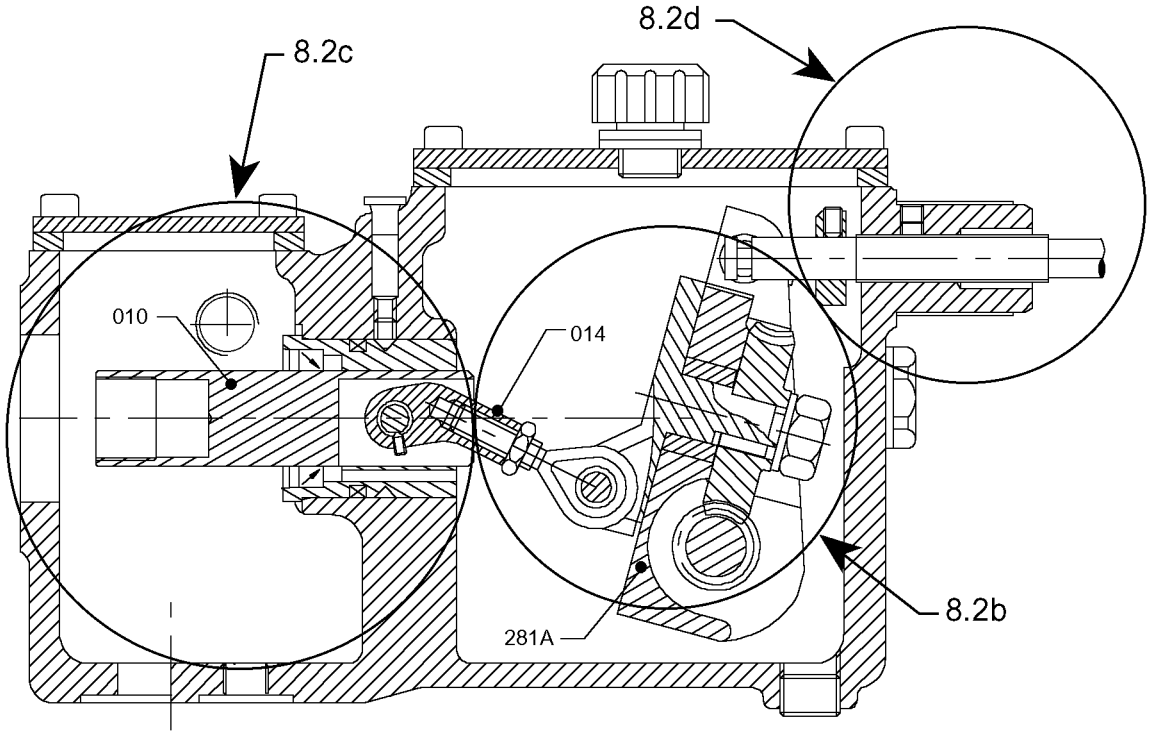
**Fig. 7.2c : Sectional drawing of displacement chamber**




J

| | | | |
|---|---|---|---|
| 021 | Liquid end body | 435B | Screw |
| 067 | Heating shell | 438D | O-ring |
| 435 | Screw (liquid end body attaching) | | |

**Fig. 7.2d : Fitting the heating shell**

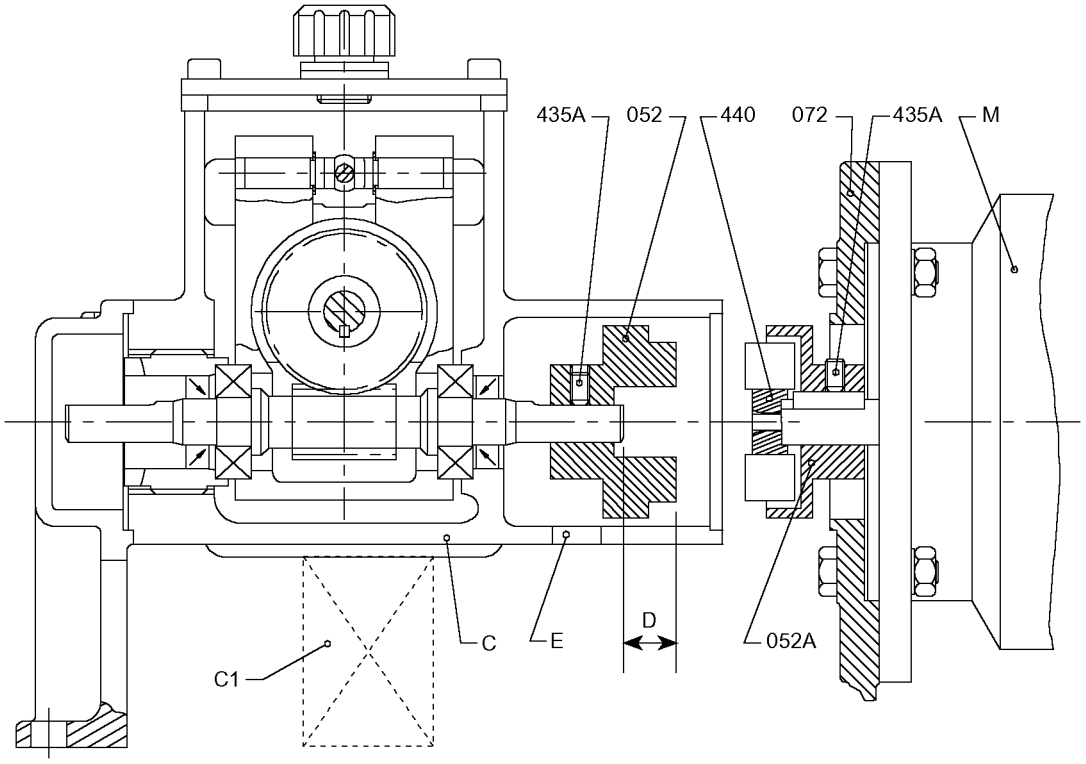



| | | | |
|---|---|---|---|
| 010 | Crosshead | 281A | Crank support |
| 014 | Connecting rod | | |

**Fig. 8.1a : Diagram of mechanical assembly (Milroyal D)**

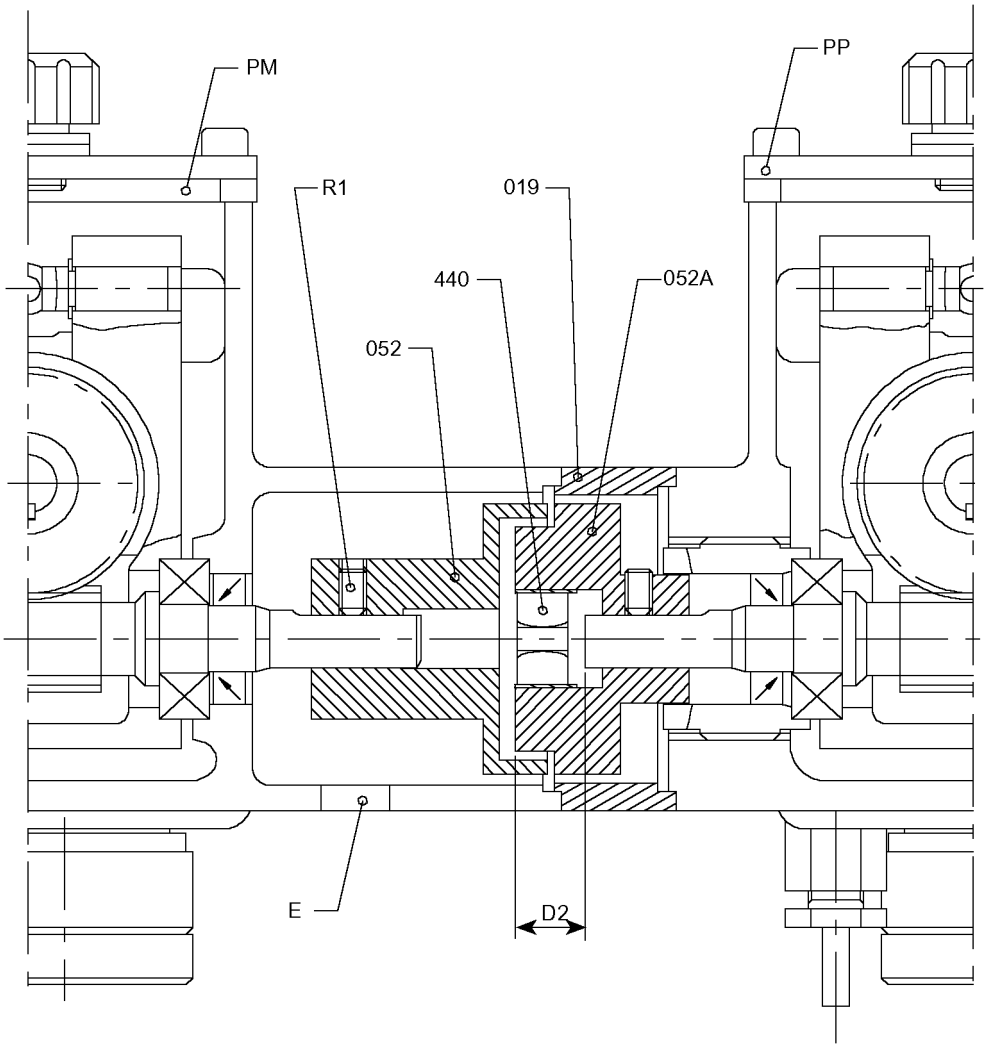
SX

M1




| | | | |
|---|---|---|---|
| C | Housing | 052A | Half coupling on housing side |
| C1 | Wedges | 072 | Motor support |
| M | Motor | 435A | Screw |
| 052 | Half coupling on motor side | 440 | Shock absorber |

**Fig. 8.2a : Fitting the motor**

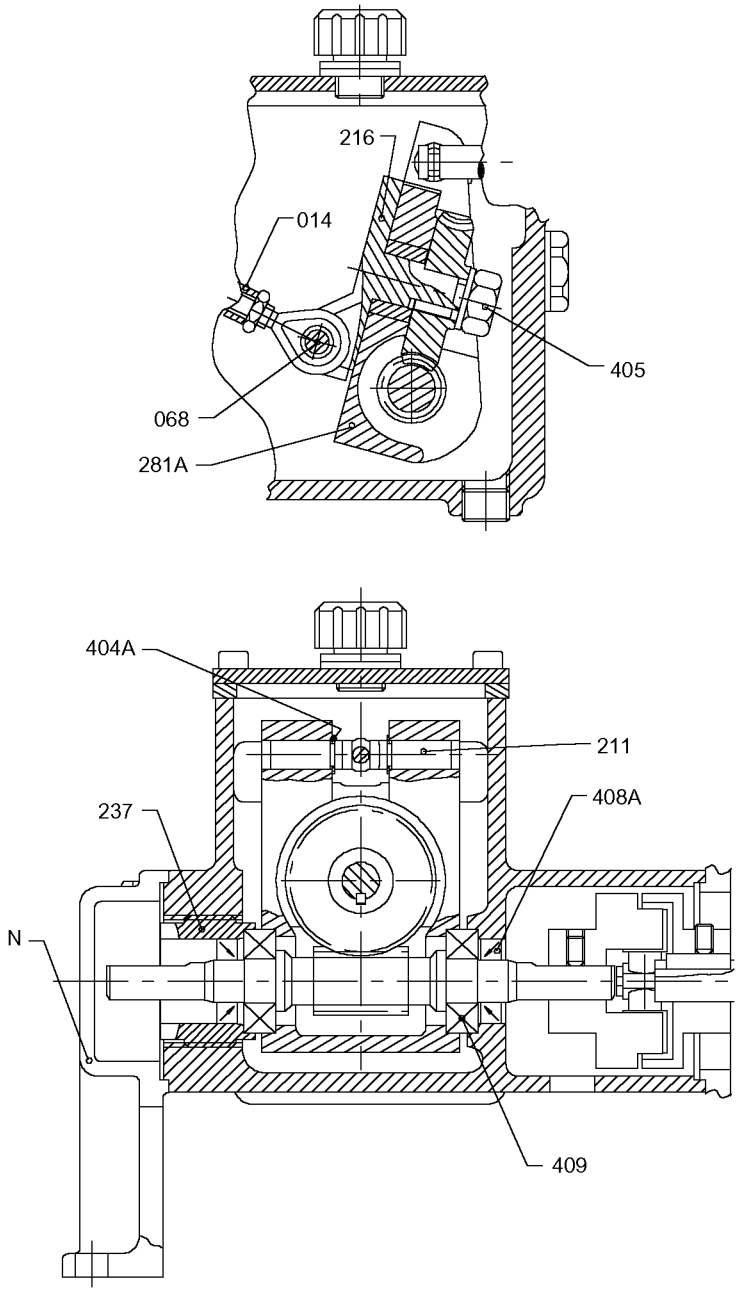



| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.P. | previous pump |
| 052A | Half coupling | R1 | Screw |
| 440 | Shock absorber | | |

Mi

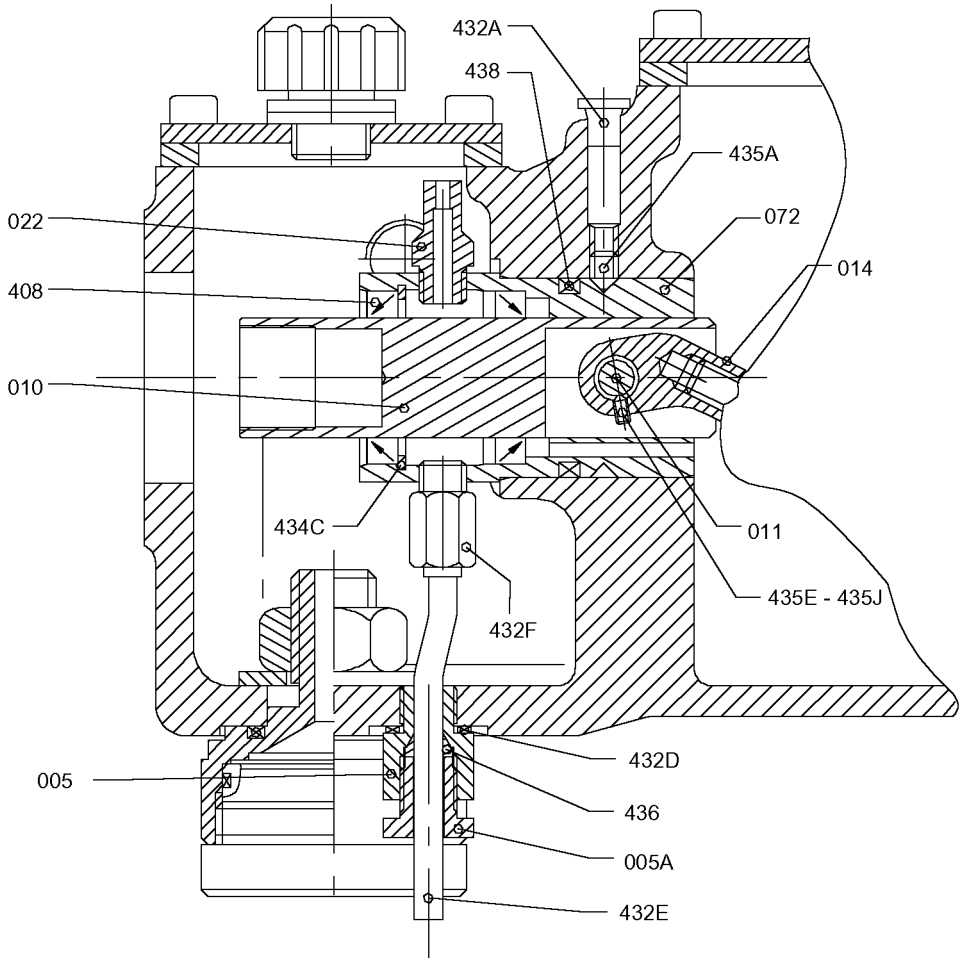
Mn

**Fig. 8.2 a : Multiplexing coupling (previous pump)**



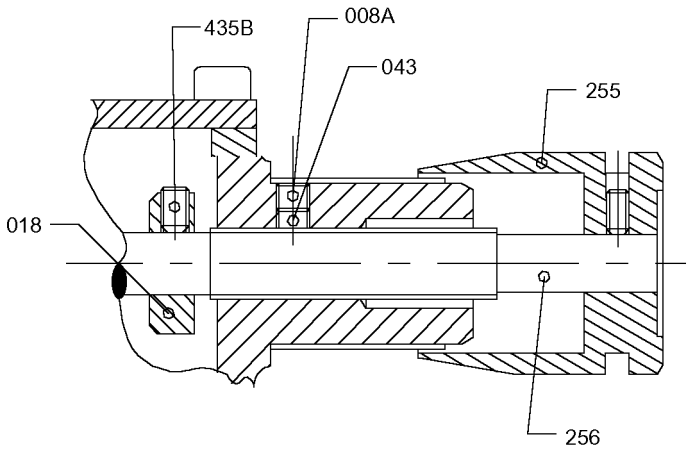

| | | | |
|---|---|---|---|
| 014 | Connecting rod | 405 | Nut |
| 068 | Pin axis | 408A | Worm shaft seal |
| 211 | Adjusting die | 409 | Ball bearing |
| 237 | Bearing screw | 435J | Nut |
| 281A | Crank support | N | Attaching lug |
| 404A | Stop ring | | |

**Fig. 8.2b : Sectional drawing of housing (Milroyal D)**




| | | | |
|---|---|---|---|
| 005 | Connection | 432D | Seal |
| 005A | Packing cover | 432E | Tubing |
| 010 | Crosshead | 432F | Tapping |
| 011 | Axis | 434C | Retaining ring |
| 014 | Connecting rod | 435A | Screw |
| 022 | Bleed | 435E | Screw |
| 072 | Liner | 435J | Nut |
| 408 | Crosshead oil seal | 436 | Packing |
| 432A | Plug | 438 | O-ring |

**Fig. 8.2c : Sectional drawing of spacer (Milroyal D)**

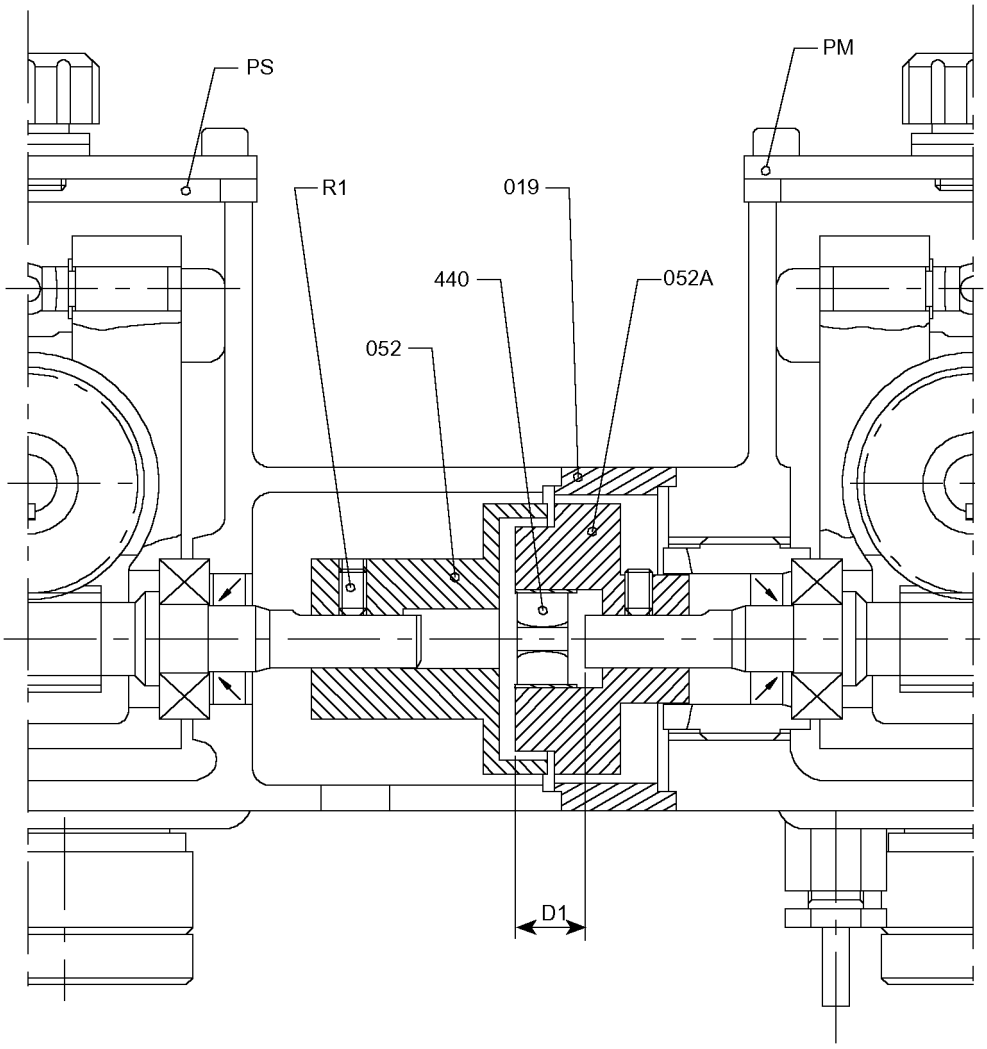



D

VF

| | | | |
|---|---|---|---|
| 018 | Stop collar | 256 | Micrometer screw |
| 043 | Lock insert | 435B | Screw |
| 255 | Stroke adjustment knob | 008A | Screw |

**Fig. 8.2d : Sectional drawing of the flow adjustment (Milroyal D)**




M1

Mi

| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.S. | Next pump |
| 052A | Half coupling | R1 | Vis |
| 440 | Shock absorber | | |

**Fig. 8.2e : Multiplexing coupling (Next pump)**

DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

H.P.D. DIAPHRAGM-TYPE LIQUID END

This manual should be made available to the person responsible for installation, operating and maintenance.

**TEXT VOLUME**

**Date : 10/99** **O / Ref : T.160.0822.001.Rev. A**

For better understanding, use this volume together with the ILLUSTRATIONS VOLUME.

# CONTENTS

**VI - CORRECTIVE MAINTENANCE**



**VII - SERVICING THE LIQUID END**



**VIII - SERVICING THE MECHANICAL ASSEMBLY**



**GUARANTEE**

**TECHNICAL CHARACTERISTICS**

(see last page of illustrations fascicle)

**LIST OF « TECHNICAL ASSISTANCE » AND « SPARE PARTS » DEPARTMENTS**

# HOW TO USE THIS MANUAL ?

**IMPORTANT**: You should read the following paragraphs carefully in order to understand how to use this manual efficiently.

This manual corresponds to the type of pumps mentioned on the cover page.

There may be several different construction versions for each type of pump, however, and this manual takes those differences into account.

## TEXT FASCICLE

The paragraphs or lines specific to a given construction are:

- indented compared to the main text body,
- marked by a vertical line indicating the specific text,
- marked by a rectangle specifying the corresponding code.

If a paragraph is identified by means of two adjoining « boxes » , this means that both codes are required at the same time (« and » relation). If, however, the « boxes » are separated, this means that only one of the codes is required (« or » relation).

## ILLUSTRATIONS FASCICLE

The figures specific to a given construction version are marked by means of a box specifying the corresponding code.

**Note**: When first reading this document, you are advised to highlight the « boxes » corresponding to the construction of your equipment so the manual will be easier to read in future.

## MARKING USED IN THE MANUAL

You will find the list of the various possibilities and the corresponding markings, at the end of the illustrations manual.

The « cross » in the « Done » column in the table indicates the specific construction of your pump.

# PART I - DESCRIPTION

## I - 1. UNPACKING AND STORAGE

### *UNPACKING*

The packaging must be carefully examined on receipt in order to ensure that the contents have not sustained any obvious damage. Precautions must be taken when opening the packaging in order to avoid damaging accessories which may be secured inside the packaging. Examine the contents and check them off against the delivery note.

### *STORAGE PRECAUTIONS*

**Storage for less than six months**

Equipment shall preferably be stored in its original packaging and protected from adverse weather conditions.

**Storage for more than six months**

- Grease all visible unpainted sections. Rubber parts (such as semi-flexible couplings) must be protected from sunlight and sudden temperature changes.
- Store the pump in its original packaging. In addition, packaging in heat-sealing plastic cover and dessicant bags must be provided for. The quantity of dessicant bags should be adapted to the storage period and to the packaging volume.
- Store protected from adverse weather conditions.

## I - 2. DESCRIPTION

The MILROYAL Pump is a compact electro-mechanical metering pump, oil-lubricated with a sealed housing, allowing adjustment of its capacity when stopped or in operation.

It is designed for industrial operation in continuous mode.

It is made up of the following items (Fig. 1.2a):

- a driving device consisting of a motor [1],
- a mechanical assembly [2],
- a liquid end [3].

Capacity adjustment is controlled either manually (by a graduated hand-knob [4] or automatically (such as by a servomotor [5]).

Various components of the mechanical assembly are shown in Figure 1.2a.

## I - 3. OPERATING PRINCIPLE OF THE MECHANICAL ASSEMBLY

See Figure 1.3a.

The mechanical assembly works on the principle of the inclinable crank.

The rotational motion of the motor is transmitted by the worm [1] to the tangential gear [2] which is linked to the inclinable crank [3]. A connecting rod and crank system [4] converts the rotary driving motion into a reciprocating linear motion with adjustable stroke. The stroke depends upon the angle of inclination of the crank, which is determined by the position of a micrometer screw [5]. Figure 1.3a illustrates manual adjustment of the position of the micrometer screw [5] using the hand-knob [7].

When the angle is zero, the connecting rod describes a cone of revolution. The mechanical system turns but there is no longitudinal movement of the crosshead [6] (zero stroke).

Figure 1.3b shows the functional diagram at zero stroke.

Figure 1.3c shows the functional diagram at maximum stroke.

## I - 4. OPERATING PRINCIPLE OF THE H.P.D. LIQUID END

(High Performance Diaphragm)

### *SINGLE DIAPHRAGM*

See Figure 1.4a.

The plunger [2] is connected to the crosshead [1] of the mechanical assembly.

0

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The diaphragm [11] which is hydraulically coupled with the plunger [2], sucks in a given volume (swept volume) of fluid in the liquid end body [3], through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the diaphragm [11], which has the effect of discharging the liquid through the valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

### *DOUBLE DIAPHRAGM WITHOUT SEPARATION FLUID*

The double diaphragm consists of a composite diaphragm (in contact with the hydraulic fluid) and a PTFE diaphragm (in contact with the process fluid).

There is a vacuum between the two diaphragms.

See Figure 1.4a.

C

The plunger [2] is connected to the crosshead [1] of the mechanical assembly.

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The first diaphragm [11] is hydraulically coupled with the plunger [2], the second diaphragm [15] which "bonded" to the first diaphragm [11] sucks in a given volume (swept volume) of fluid in the liquid end body [3], through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the two "bonded" diaphragms, which has the effect of discharging the fluid through valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

### *DOUBLE DIAPHRAGM WITH SEPARATION FLUID*

See Figure 1.4a.

The plunger [2] is linked to the crosshead [1] of the mechanical assembly.

L

During the suction phase, the displacement of the plunger [2] creates a negative pressure in the displacement chamber [8]. The first diaphragm [11] is hydraulically coupled with the plunger [2]. The second diaphragm [15], which is hydraulically coupled to the first diaphragm [11], sucks a given volume (swept volume) of fluid into the liquid end body [3] through valve assembly [4], while valve assembly [5] closes the discharge circuit.

At the end of the suction phase, the process is reversed and the discharge phase begins. The plunger [2] compresses the hydraulic fluid in the displacement chamber [8]. The hydraulic fluid exerts pressure on the diaphragm [11] which displaces the separation fluid which, in turn, exerts pressure on the diaphragm [15]. The effect of this is to discharge the fluid through valve assembly [5] into the discharge circuit. Valve assembly [4] closes the suction circuit.

If the pressure exerted by the hydraulic fluid on the diaphragm becomes greater than normal operating pressure during the discharge phase, the safety valve [9] evacuates the hydraulic fluid to the spacer [10] in order to protect the pump. This safety valve also includes an air bleed acting continuously on the hydraulic circuit.

At each discharge phase, a small quantity of air and hydraulic fluid is expelled through the air bleed built into the safety valve [9]. After a given time, there is no longer enough hydraulic fluid between the plunger [2] and the diaphragm [11]. When this happens, the diaphragm [11] exerts a load on the plate of the MARS hydraulic control pilot [12] (Mechanically Actuated Refill System) at the end of the suction phase. The pilot plate then opens the hydraulic fluid inlet circuit. The purpose of this system is to maintain a constant volume of hydraulic fluid between the plunger and the diaphragm.

## 1 - 5. OPTIONS FOR DIAPHRAGM-TYPE LIQUID END

### *HEATING OR COOLING SHELL OPTION*

The heating or cooling product flows from the upper section of the liquid end to its lower section.

J

**Safety note for users**

The technician has to take in account all usual precautions regarding heat echangint fluids (boiling or freezing).

### *OPTION RUPTURE DETECTION BY PRESSURE GAUGE*

A detection system [16] (Fig. 1.4a) is fitted on the double diaphragm body [14] (Fig. 1.4a).

C5

See Figure 1.4b.

When the two diaphragms are in perfect condition, the vacuum that exists between them is indicated by the indication "0" on the pressure gauge.

When one of the two diaphragms ruptures, pressure is exerted between the two diaphragms and is indicated on the pressure gauge.

### *OPTION RUPTURE DETECTION BY PRESSURE SWITCH*

A detection system [16] (Fig. 1.4a) is fitted on the double diaphragm body [14] (Fig. 1.4a).

C6

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When the two diaphragms are in perfect condition, there is a vacuum between the two diaphragms. The given indication is equal to zero.

When one of the two diaphragms ruptures, the pressure increases and exceeds the pressure switch detection threshold which causes a change in state of the output contact on the pressure switch.

You then use this electrical signal as you wish (audio alarm, indicator light, shutdown of the pump, etc.).

### *OPTION RUPTURE DETECTION BY RESISTIVITY CELL*

See Figure 1.4a.

A resistivity cell is fitted on the double diaphragm body [14] in place of the plug [17].

L2

When the two diaphragms are in perfect condition, the cell sends a signal constituting an electrical "zero" and which corresponds to the resistivity of the separation fluid.

When one of the two diaphragms ruptures, the separation fluid is mixed either with the process fluid or with the hydraulic fluid. The resistivity of the product present in the double diaphragm body is modified and generates a different signal on the cell. This modification causes a change in state of the output of the resistivity relay.

You then use this electrical signal as you wish (audio alarm, indicator light, shutdown of the pump, etc.).

### *OPTION RUPTURE DETECTION BY VISUAL SYSTEM*

A detection system is fitted on the double diaphragm body [14] (Fig. 1.4a) in place of the two plugs [16] and [17] (Fig. 1.4a).

See Figure 1.4b.

L3

This mainly consists of a detector body [1], a magnetic float [2] and an assembly of white/red bicoloured magnetic flaps [3].

When the two diaphragms are in perfect condition, the density of the fluid present in the double diaphragm body (and the detector body) corresponds to that of the separation fluid. There is a corresponding balance position on the magnetic float at this density. The white face of the magnetic flaps is visible.

When one the two diaphragms ruptures, the separation fluid is mixed either with the process fluid or with the hydraulic fluid. The density of the fluid present in the double diaphragm body (and the detector body) is then different and the previous state of balance is upset. The magnetic float causes the flaps to rotate as it moves to its new balance position. The red face is then visible.

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You then use this electrical signal as you wish (audio alarm, indicator light, shutdown of the pump, etc.).

## 1 - 6. SAFETY AND HEALTH INSTRUCTIONS

The personnel responsible for installing, operating and maintaining this equipment must become acquainted with, assimilate and comply with the contents of this manual in order to:

- avoid any possible risk to themselves or to third parties,
- ensure the reliability of the equipment,
- avoid any error or pollution due to incorrect operation.

Any servicing on this equipment must be carried out when it is stopped. Any accidental start-up must be prevented (either by locking the switch or removing the fuse on the power supply line).

A notice must be attached to the location of the switch to warn that servicing is being carried out on the equipment.

During oil changing operations, the waste oil must be collected in a suitable receptacle. Any overflow of oil which may result must be removed using a degreasing agent suitable for the operating conditions.

Soiled cleaning cloths must be stored in suitable receptacles. The oil, degreasing agent and cleaning cloths must be stored in accordance with the rules on pollution.

Switch off the power supply as soon as any fault is detected during operation: abnormal heating or unusual noise.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

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When one the two diaphragms ruptures, the separation fluid is mixed either with the process fluid or with the hydraulic fluid. The density of the fluid present in the double diaphragm body (and the detector body) is then different and the previous state of balance is upset. The magnetic float causes the flaps to rotate as it moves to its new balance position. The red face is then visible.

***OPTION RUPTURE DETECTION BY ELECTRICAL SYSTEM***

A detection system is fitted on the double diaphragm body [14] (Fig. 1.4a) in place of two plugs [16] and [17] (Fig. 1.4a).

See Figure 1.4b.

This mainly consists of a detector body [1], a magnetic float [2] and a magnetic contact [3].

L4

When the two diaphragms are in perfect condition, the density of the fluid present in the double diaphragm body (and the detector body) corresponds to that of the separation fluid. There is a corresponding balance position on the magnetic float at this density.

When one the two diaphragms ruptures, the separation fluid is mixed either with the process fluid or with the hydraulic fluid. The density of the fluid present in the double diaphragm body (and the detector body) is then different and the previous state of balance is upset. As it moves to its new balanced position, the magnetic float triggers a magnetic contact which generates an electrical signal.

You then use this electrical signal as you wish (audio alarm, indicator light, shutdown of the pump, etc.).

## 1 - 6. SAFETY AND HEALTH INSTRUCTIONS

The personnel responsible for installing, operating and maintaining this equipment must become acquainted with, assimilate and comply with the contents of this manual in order to:

- avoid any possible risk to themselves or to third parties,
- ensure the reliability of the equipment,
- avoid any error or pollution due to incorrect operation.

Any servicing on this equipment must be carried out when it is stopped. Any accidental start-up must be prevented (either by locking the switch or removing the fuse on the power supply line).

A notice must be attached to the location of the switch to warn that servicing is being carried out on the equipment.

During oil changing operations, the waste oil must be collected in a suitable receptacle. Any overflow of oil which may result must be removed using a degreasing agent suitable for the operating conditions.

Soiled cleaning cloths must be stored in suitable receptacles. The oil, degreasing agent and cleaning cloths must be stored in accordance with the rules on pollution.

Switch off the power supply as soon as any fault is detected during operation: abnormal heating or unusual noise.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

# PART II - INSTALLATION

## II - 1. HYDRAULIC INSTALLATION

All the information concerning the hydraulic installation of a metering pump is detailed in a volume, « Generalities about metering pumps installation ». You should consult that manual to determine the installation required for your application.

Certain essential points are, however, also briefly covered in this document.

### *GENERAL*

- Piping layout

There must be no swan-necks or stagnant volumes which are liable to trap air or gas.

Stresses due to incorrect alignment of piping with respect to the centreline of valves must be avoided as far as possible.

- Remove burrs and clean the piping before fitting.
- It is advisable to provide for a calibrating chamber in order to calibrate the pump in service conditions.

### *PIPING ON THE SUCTION CIRCUIT*

- Provide for a filter with suitable mesh size upstream of the pump.
- Check whether the diameter and length of pipe are compatible with the pump's maximum capacity.

### *PIPING ON THE DISCHARGE CIRCUIT*

- Provide for a safety valve on the discharge pipe, designed to protect the installation. (The pump is protected by its own internal safety system).
- Check whether it is necessary to install a pulsation dampener, according to the width and diameter of the tubing.
- It is advisable to install a priming valve on the discharge circuit in order to make starting and maintenance of the pump easier.

Figure 2.1a is a schematic representation of a calibrating chamber, a priming valve and a safety valve in ideal conditions.

## II - 2. DRIP COLLECTION

Provide for outlets so that any leak or drips can be easily drained off without any danger. This is especially important in the case of harmful liquids.

See Figure 1.2a.

Leak detector [15] allows leaks of hydraulic fluid or lubricating oil to be checked and drained off.

## II - 3. HANDLING

Choose lifting equipment that is compatible with the weight of the pump. (See TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

See Figure 2.3a.

Handling requires the following precautions :

Fit one sling under the motor and install the other under the pump mechanical assembly or assemblies.

Check that the assembly is correctly balanced before starting to move it.

Secure the pump as soon as it is positioned in its required location (see Chapter II - 4. Setting up).

## II - 4. SETTING UP

Secure the pump to a correctly dimensioned, horizontal support by its attaching holes. Leave enough clear space around the pump to be able to carry out servicing operations and adjustments.

Pumps installed outdoors must be protected by a shelter (according to the climatic conditions).

MX

Note: the pumps are « aligned » in the factory on their frames. Before securing the frame, check that the supporting surface is flat (and use shims, for example, to ensure that it is horizontal).

## II - 5. ELECTRICAL INSTALLATION

### *CONNECTING THE MOTOR*

Check the specifications of the motor and compare them with the voltage available on your installation before making connections. Connect up the motor in accordance with the instructions in the terminal box (Fig. 2.5a).

SX

A delta connection is required to connect up to a 230 V 3-phase power supply (Fig. 2.5b).

M1

A star connection is required to connect up to a 400 V 3-phase power supply (Fig. 2.5c).

**CAUTION** : Do not forget to connect the earth terminal on the motor [PE] (Fig. 2.5a) to the equipment earth conductor.

The electrical protection installed for the motor (fuse or thermal protection) must be suitable for the motor's rated current.

### *CONNECTING THE RESISTIVITY CELL DETECTION SYSTEM*

L2

See Figure 1.5a.

Connect the coaxial cable to the input on the resistivity relay.

Energize the relay. (See the information on the relay box).

Connect a cable onto the box output relay.

### *CONNECTING THE ELECTRIC DETECTION SYSTEM*

L4

See Figure 1.5a.

Connect a two-conductor cable to the « normally closed » contact of the magnetic contact (230 V maxi, 10 A maxi).

Tighten the stuffing box and check that it is leaktight.

### *CONNECTING THE PRESSURE SWITCH DETECTION SYSTEM*

C6

See Figure 1.5a.

Connect a two-conductor cable to the « normally closed » contact of the pressure switch (230 V maxi, 10 A maxi).

Tighten the stuffing box and check that it is leaktight.

# PART III - START UP

## III - 1. PROCEDURES BEFORE START UP

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

- Remove the cover from the housing [7] and fill the housing with the lubricating oil supplied up to the middle of the level indicator [12]. Reinstall the cover on the housing.
- Remove the cover from the spacer [8] and fill the spacer with the hydraulic fluid supplied up to the middle of the valve reject connection. Reinstall the cover on the spacer.
- Check the opening of all the isolating valves installed on the suction and discharge circuits. If the discharge circuit is equipped with an injection nozzle or a back-pressure valve, open the priming valve for discharge (if there is no priming valve, disconnect the discharge pipe). This makes it possible to verify that there is liquid present if the pump is installed in flooded suction, or to prime the pump if it is installed in suction lift.

D

- Check that the pump capacity is set to "0%" (hand-knob [4]).

SX

**Checking the electrical connection of the motor**

M1

Start up the pump to check the motor's direction of rotation. It must comply with that indicated by the arrow marked on the pump housing. To reverse the motor's direction of rotation, invert A and B or A and C (See Figure 2.5b or 2.5c). Stop the pump.

## III - 2. START UP

- Once all the checks and procedures described in the previous section have been carried out, start up the pump.
- Check visually and by listening. (In particular, check that there are no suspicious noises).

D

- Make sure that the hand-knob is unlocked.

- Adjust the pump capacity gradually from 0 % to 100% and control the liquid output at priming valve or discharge check valve.
- As soon as the liquid to be pumped flows out of the priming valve or the discharge valve, priming on the process side has been achieved. Close the priming valve or reconnect the discharge pipe, as applicable.
- Then check the level of hydraulic fluid in the spacer and top it up, if necessary.

- Once the priming is obtained, adjust the pump to the desired capacity.

D

- Lock the hand-knob with the locking screw [9] (Fig. 1.2a).

## III - 3. FAILURES ON START UP

### *PROBLEMS WITH MOTOR*

**The motor runs with difficulty and heats up**

SX

- One phase is incorrectly connected.
- The characteristics of the electrical power supply do not match the specifications of the motor.

M1

- The electrical connection used is not suitable.

**The motor overheats**

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

### *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The housing does not contain any oil. Fill up with oil (See Chapter III - 1. Procedures before start up).

SX

M1

- The direction of rotation of the motor is incorrect. (Check using the arrow marked on the housing). Reverse the direction of rotation (see Chapter III - 1. Procedures before start up, Checking the electrical connection of motor).

### *PROBLEMS WITH FLOW RATE*

**The flow rate is lower than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The suction power is insufficient (pipe cross-section too small or pipe too long): replace the pipe with ones that have a larger cross-section or install the pump in flooded suction.
- The leak-tightness of suction pipe is unsatisfactory.
- The viscosity of the liquid is incompatible with the pump's capabilities.
- Degassing of the displacement chamber is incorrect: proceed with degassing of the displacement chamber (See Chapter IV - 2.).

**The capacity is greater than desired**

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- A syphoning phenomenon is observed: check that the suction pressure is not greater than the discharge pressure. Install a back-pressure valve on the discharge side.
- Too many flow pulsations : a pulsation dampener is required, or the pulsation dampener installed is of the wrong size, or the pressurization of the pulsation dampener is incorrect.

**The capacity is variable**

- This problem may be due to particles from the piping which interfere with the operation of the valve assemblies: clean the piping (if there is an abnormal presence of particles) and the valve assemblies (by checking the assembly sequence of different components, or by referring to table 5.2c, chapter V - 2.).

## III - 4. OPERATION - SCHEDULE FOR CHECKS AND MAINTENANCE OPERATIONS

The programme of checks and maintenance operations depends on the conditions in which the equipment is used. For this reason, the following frequencies are given as an example only. Individual users should adapt these frequencies to their own specific operating conditions.

| When | Check | Maintenance | See |
|---|---|---|---|
| After 250 hours | | Change lubricating oil | Chapter IV-1 |
| Every month | Check oil level in the housing<br>- if incorrect -> | Trace lubricating oil leak | Chapter IV-2 |
| | Check hydraulic fluid level in spacer<br>- if incorrect -> | Trace hydraulic fluid leak | Chapter IV-2 |
| | Check for the appearance of any leak on the leak detector<br>- if a leak appears -> | Trace leak | Chapitre IV-2 |
| Every 3 months | Check the oil temperature (max : Chapter IV-1)<br>if incorrect -> | Verify<br>- the date of the last oil change<br>- the extent of contamination of the oil<br>- the equipment operating conditions | |
| Every 6 months or 2,500 hours | | Change lubricating oil | Chapter IV-1 |
| | | Change hydraulic fluid | Chapter IV-1 |
| Frequency to be defined according to process (2,500 hours approx.) | Check conformity of capacity | Check capacity | Chapter IV-2 |
| Every year | | ** Annual overhaul | Part V |

** Our Technical Assistance Department staff is available for any maintenance matters on site (see DOSAPRO adress at the end of this manual).

A model maintenance sheet is shown in Figure 3.4a to help you ensure follow-up of your servicing actions (checking or maintenance).

# PART IV - ROUTINE MAINTENANCE

## IV - 1. OIL CHANGE

### *LUBRICATING OIL*

- Perform the first housing oil change after 250 hours' operation. Subsequent oil changes will be carried out every 2,500 hours' operation or every six months.
- Disconnect the pump electrically, check that the equipment cannot be switched on accidentally. Position a notice at the location of the switch.

**Note**

To avoid any risk of burning by the hot oil, protective gloves should be worn.

See Figure 1.2a.

- Unscrew the plug [11] and drain the oil into a tray. Degrease the plug, apply a little Loctite 221 adhesive on the threads and screw the plug into place.
- Remove the cover from the housing [7] and fill the housing up to the middle of the level indicator [12] with an oil suitable for service conditions.
- Quantity: see TECHNICAL CHARACTERISTICS at the end of the illustrations manual.
- Remove any overflow of oil immediately with a suitable degreasing agent for the operating conditions.

**Recommendations**

- Standard conditions: standard oil

Ref.: 437 0013 021N, Ref.: 437 0013 024N (COFRAN Mecanep 220) or equivalent (see below).

- Ambient temperature: > - 5°
- Max. oil temperature: + 90°

Table of equivalencies:

| | |
|---|---|
| FUCHS | RENEP 220 |
| B.P. | GR XP 220 |
| CASTROL | ALPHA SP 220 |
| ELF | REDUCTELF SP 220 |
| FINA | GIRAN 220 |
| IGOL | DYNAM SP 220 |
| MOBIL OIL | MOBILGEAR 630 |
| SHELL | OMALA 220 |
| TOTAL | CARTER EP 220 |
| ESSO | SPARTAN EP 220 |

- Special conditions: for example, low-temperature oil: temperature range: -35°C to +46°C. Ref: Sintofluid (FUCHS)

## *HYDRAULIC FLUID*

- Change the hydraulic fluid in the spacer every 2,500 hours' operation or every six months.
- Disconnect the pump electrically, check that the equipment cannot be switched on accidentally. Position a notice at the location of the switch.

**Note**

To avoid any risk of burning by the hot oil, protective gloves should be worn.

See Figure 1.2a.

- As the spacer is of a small volume, draw out the hydraulic fluid through the plug [13] with a syringe.
- Fill the spacer up to the middle of the valve reject connection with a hydraulic fluid suitable for service conditions.
- Quantity: see TECHNICAL CHARACTERISTICS at the end of the illustrations manual.
- Remove any overflow of oil immediately with a suitable degreasing agent for the operating conditions.

**Recommendations**

- Standard conditions: standard oil

Ref.: 437 0013 031N, Ref.: 437 0013 033N (COFRAN Cofraline Extra 32S) or equivalent (see below).

- Ambient temperature: > - 12°
- Max. oil temperature: + 80°

Table of equivalencies:

| | |
|---|---|
| FUCHS | RENOLIN EXTRA 32S |
| BP | HLPD 32 |
| CASTROL | HYSPIN VG 32 |
| ELF | OLNA 32 |
| FINA | CIRKAN 32 |
| IGOL | SONHYDRO 32 |
| MOBIL | DTE 24 |
| SHELL | TELLUS 32 |
| TOTAL | AZOLLAS ZS 32 |
| ESSO | NUTO H 32 |

- Special conditions: for example, low-temperature oil: temperature range: -40°C to +60°C.

Ref: Hydrofrima 15 (FUCHS)

# IV - 2. OTHER MAINTENANCE OPERATIONS

## *TRACING A LUBRICATING OIL LEAK*

See Figure 1.2a.

- Check that the drain plug [11] is correctly tightened.
- Check for leakage on the shaft on the motor side or on the protective cap side. If a leak is found, change the seals on the worm shaft (see Table 5.2f).
- Check for the appearance of an oil leak on the leak detector [15]. If there is leakage, change the crosshead oil seals (see Table 5.2e).

## *TRACING A HYDRAULIC FLUID LEAK*

- Check the leak-tightness of the strainer [14] (Fig. 1.2a) and of the oil resupply connection [13] (Fig. 1.4a). If there is a leak, change the relevant seals.
- Check the leak-tightness on the diaphragm clamping. If there is a leak, it may come from the contour plate or from the diaphragm if it is damaged.
- Check the leak-tightness of the connection and the base of the safety valve [9] (Fig. 1.4a). Check the leak-tightness of the spacer connection. If there is a leak, change the relevant seals.

## *TRACING A LEAK ON THE LEAK DETECTOR*

Check whether the leak appears on the inside of the tubing or outside.

- If the leak appears outside the piping, check the leak-tightness of the connection and the stuffing box of the leak detector [15]( Fig. 1.2a). If there is a leak, replace the relevant seals.
- If the leak appears inside the piping, check the level of hydraulic fluid. If it is higher than it should be, adjust the hydraulic fluid level to the middle of the valve reject connection. Also check if the piping is correctly snapped into place in its connection. If these two checks prove satisfactory, replace the crosshead points (see Table 5.2e).

## *CHECKING THE PUMP CAPACITY*

This is a question of determining the straight line representing the pump's capacity according to its adjustment.

Four measurements are sufficient (adjustment at 100%, 75%, 50% and 25%).

There are two possible methods:

- If the pump is installed in pressurizing mode (Fig. 2.1a), measure the volume of pumped liquid in a calibrating chamber for a given period of time. It may be necessary to reproduce actual operating conditions (suction pressure).
- If the pump is installed in suction mode, measure the volume of discharged liquid. It may be necessary to reduce actual operating conditions (discharge pressure).

The first method is recommended. In addition, this method avoids placing the operator in contact with the liquid, which is important if the pumped liquid is hazardous.

For a precise check, which cannot be performed using the two methods described above, it may be necessary to use an electromagnetic flowmeter.

### *DEGASSING THE DISPLACEMENT CHAMBER*

Generate pressure on the discharge side (closing the discharge circuit valve, if necessary, to force the safety valve to release the air contained in the displacement chamber).

Gradually increase the flow rate from the pump until the safety valve releases the fluid into the spacer.

## IV - 3. TRACING CAUSES OF FAILURE

### *PROBLEMS WITH MOTOR*

**The motor does not run**

SX

The thermal relay has been tripped.

- The motor is defective.
- Wiring is defective.

M1

- Check the parts of the mechanical assembly.

**The motor heats up abnormally**

- The quantity of lubricating oil is incorrect: trace the leak (see Chapter IV - 2.)
- The quality of the lubricating oil is incorrect. Check the date of the last oil change and the specifications of the oil used.
- The pump is used in conditions it was not designed for.

### *PROBLEMS WITH NOISY MECHANICAL PARTS*

- The tangential gear is worn. Replace it.
- The " bearings " are worn. Replace them.
- The half-coupling attaching screws are loose or the shock absorber is worn.

## *PROBLEMS WITH FLOW RATE*

### The pump produces no flow

The crosshead and the plunger do not move :

D

- The pump capacity is adjusted to « 0 % » : Adjust the capacity to the desired value and lock the hand-knob.

- The connecting rod is broken,
- The tangential gear is worn.

The crosshead and plunger move :

- The liquid end is unprimed: release the pressure on the discharge pipe and prime the liquid end, or check the leak-tightness of the suction circuit.
- The balls of the valve assemblies are blocked by particles: clean or replace the valve assemblies. First, check whether the presence of these particles is normal and take corrective action if necessary.

### The pump does not provide the required flow rate

D

- The pump capacity is incorrectly adjusted: adjust the capacity to the desired value and lock the hand-knob.

- The level of hydraulic fluid in the spacer is incorrect: trace the leak (see Chapter IV - 2. : Others maintenance operations).
- The safety valve (for the installation) releases pressure: the discharge pipe is partially or completely obstructed.
- The safety valve (internal to the pump) continuously releases pressure: the discharge pipe is partially or completely obstructed.
- The air bleed built into the safety valve is blocked by particles: clean the bleed element (see Part VII - Servicing the liquid end, on Cleaning the air purge built into the safety valve).
- The MARS valve is defective : replace the pilot (see Table 6.2c).
- The oil inlet filter is clogged: replace the filter cloth in the strainer (see Part VII - Servicing the liquid end, Section Z - Servicing the strainer).
- The plunger seals are worn: replace the plunger head or the plunger (see Table 5.2d).

L

- The volume of intermediate fluid contained in the dual diaphragm body is incorrect. Trace the leak, if any, and take remedial action. Drain the dual diaphragm body (see Chapter VII - Servicing on liquid end, section on Draining the dual diaphragm body) and carry out the filling procedure (see Chapter VII - Servicing on the liquid end, section on Filling the dual diaphragm body).

C

- Check the leaktightness of the unions on the detection assembly and the dual diaphragm body. If necessary, carry out the degassing procedure on the dual diaphragm (see Chapter VII - Servicing on the liquid end, sections on Reinstalling the detection system and Degassing the dual diaphragm).

- The ball seats and/or the balls are dirty or worn: clean or replace the ball seats and the balls or the valve assemblies.
- The leak-tightness of the suction circuit is unsatisfactory: repair or replace the piping.

## IV - 4. ORDERING SPARE PARTS

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).

- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

# PART V - PREVENTIVE MAINTENANCE

*ANNUAL OVERHAUL*

This consists in replacing the wear parts included in a "spare parts kit" (see below). The corresponding action is detailed in Part VII : Servicing of the liquid end, and in Part VIII : Servicing of the mechanical assembly.

This servicing is conducted by carrying out the following procedures :

- removing the liquid end,
- removing the mechanical assembly,
- reinstalling the mechanical assembly,
- reinstalling the liquid end.

The tables (Chapter V - 2.) show the sequential action into individual servicing actions.

## V - 1. SPARE PARTS CONSTITUTING THE "SPARE PARTS KIT"

**For H.P.D. diaphragm liquid end**

- diaphragm(s) (Table 5.2a)
- seat and ball assemblies (with seals) or valve assemblies (Table 5.2c)
- plunger head or plunger (Table 5.2d)
- valve and pilot seals
- set of chamber seals

**For mechanical assembly**

- crosshead oil seals (Table 5.2e)
- worm shaft seals (Table 5.2f)
- cover seals (for housing and spacer)
- tubing, washer, packing for leak detector
- O-ring for strainer

SX
M1

- shock absorbers for motor coupling (Table 5.2g)

Mi
Mn

- shock absorbers for pump coupling (Table 5.2g)

Certain products will be necessary to carry out these servicing actions, such as the following:

- a degreasing agent (e.g. Loctite super clean 7063),
- a lockwire adhesive (e.g. Loctite self-locking compound 221),
- a tight sealing adhesive (e.g. Loctite 566).

It is advisable to conduct the annual overhaul at the same time as changing the oil in the housing and the hydraulic fluid in the spacer (see Chapter IV - 1. Oil change).

### *OTHER SPARE PARTS*

Other spare parts are available. You will find the list in Chapter VI - 1. List of other spare parts.

### *ORDERING SPARE PARTS*

To make it easier to register your order for spare parts and ensure quicker delivery, please provide us with the following details:

- information on the pump: type [1] and contract number [5]. These two items of information are shown on the identification plate mounted on the pump (see Fig. 4.4a).

- Information on the spare part: reference, description and quantity. These items of information are specified in the parts lists supplied with the pump.

You will find the phone and fax number of the Spare Parts Department at the end of this documentation.

## V - 2. SEQUENTIAL ACTIONS

**REPLACING THE DIAPHRAGM(S)**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| | Operation | Chapter | Section |
|---|---|---|---|
| | • Preliminary operations | VII - 2 | A1(1-3) |
| C | • Removing the detection assembly | VII - 2 | L1 |
| | • Removing the diaphragm(s) | VII - 2 | C1 |
| | • Reinstalling the diaphragm(s) | VII - 3 | C2 |
| C | • Reinstalling the detection assembly | VII - 3 | L2 |
| | • Restarting | VII - 3 | A2(as per A1) |

**Table 5. 2a : Sequential action.**

**REPLACING THE VALVE ASSEMBLIES**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1-3) |
| • Removing the valve assembly | VII - 2 | B1 |
| • Reinstalling the valve assembly | VII - 3 | B2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2c : Sequential action.**

**REPLACING THE PLUNGER**
**REPLACING THE PLUNGER MOUNTING ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the plunger | VII - 2 | G1 |
| • Removing the plunger mounting assembly | VII - 2 | K1 |
| • Reinstalling the plunger mounting assembly | VII - 3 | K2 |
| • Reinstalling the plunger | VII - 3 | G2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2d : Sequential action.**

**REPLACING THE CROSSHEAD SEALS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2e : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the motor | VIII - 2 | M1 |
| SX • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 5.2f : Sequential action.**

**REPLACING THE WORM SHAFT SEALS**
**REPLACING THE BEARINGS**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| MX • Removing the half-coupling | VIII - 2 | AN1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 5.2f : Sequential action.**

SX

M1

**REPLACING THE SHOCK ABSORBER FOR MOTOR COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Removing the motor | VIII - 2 | M1 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

Mi

Mn

**REPLACING THE SHOCK ABSORBER FOR PUMP COUPLING**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapters VII - 1. and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 | A1(1;2) |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Restarting | VII - 3 | A2(as per A1) |

**Table 5.2g : Sequential action.**

# PART VI - CORRECTIVE MAINTENANCE

## VI - 1. LIST OF OTHER SPARE PARTS

This list completes the list given in Chapter V - 1. which covers the set of replacement parts required for annual overhaul of the pump.

**For H.P.D. diaphragm liquid end**

- pilot (see Table 6.2c)
- safety valve
- plunger mounting assembly (see Table 5.2d)

**For mechanical assembly**

- crosshead + pin axis assembly (see Table 6.2d)
- connecting rod + crank (see Table 6.2e)
- bearing screw (see Table 6.2f)
- bearings (see Table 5.2f)
- « gear + worm » assembly (see Table 6.2i)

## VI - 2. SEQUENTIAL ACTIONS

**REPLACING THE PILOT**

The references given identify the relevant sections in Part VII : Servicing the liquid end.
First read the general information, Chapter VII - 1.

| | Operation | Chapter | Section |
|---|---|---|---|
| | • Preliminary operations | VII - 2 | A1 (1-4) |
| C | • Removing the detection assembly | VII - 2 | L1 |
| | • Removing the diaphragm(s) | VII - 2 | C1 |
| | • Removing the pilot | VII - 2 | D1 |
| | • Reinstalling the pilot | VII - 3 | D2 |
| | • Reinstalling the diaphragm(s) | VII - 3 | C2 |
| C | • Reinstalling the detection assembly | VII - 3 | L2 |
| | • Restarting | VII - 3 | A2(as per A1) |

**Table 6.2c : Sequential action.**

**REPLACING THE « CROSSHEAD + PIN AXIS » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Replacing the liquid end | VII - 2 | F1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the crosshead | VIII - 2 | P1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the crosshead | VIII - 3 | P2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2 |

**Table 6.2d : Sequential action.**

**REPLACING THE CONNECTING ROD/CRANK ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 (1;2:5) |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the connection rod (rod/crosshead junction) | VIII - 4 | O1 - 2 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the crank | VIII - 4 | T1 |
| • Reinstalling the crank | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 3 | R2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connection rod (rod/crosshead junction) | VIII - 4 | O2 - 2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Restarting | VII - 3 & VIII - 3 | A2 (as per A1) |

**Table 6.2e : Sequential action.**

**REPLACING THE BEARING SCREW**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1(1;2;5) |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the bearing screw | VIII - 2 | Q1 (1) |
| • Reinstalling the bearing screw | VIII - 3 | Q2 (2 - 5) |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2h : Sequential action.**

**REPLACING THE « GEAR + WORM » ASSEMBLY**

The references given identify the relevant sections in Part VII : Servicing the liquid end and Part VIII : Servicing the mechanical assembly.
First read the general information, Chapter VII - 1 and VIII - 1.

| Operation | Chapter | Section |
|---|---|---|
| • Preliminary operations | VII - 2 & VIII - 2 | A1 |
| • Removing the liquid end | VII - 2 | F1 |
| • Removing the motor | VIII - 2 | M1 |
| • Removing the half-coupling | VIII - 2 | N1 |
| • Removing the half-coupling | VIII - 2 | AN1 |
| • Removing the connecting rod (rod/crank junction) | VIII - 2 | O1 - 1 |
| • Removing the attaching lug | VIII - 2 | V1 |
| • Uncoupling the pumps | VIII - 2 | AV1 |
| • Removing the worm | VIII - 2 | Q1 |
| • Removing the crank support | VIII - 2 | R1 |
| • Removing the tangential gear | VIII - 4 | T1 |
| • Reinstalling the tangential gear | VIII - 4 | T2 |
| • Reinstalling the crank support | VIII - 4 | R2 |
| • Reinstalling the worm | VIII - 3 | Q2 |
| • Reinstalling the micrometer screw | VIII - 3 | S2 |
| • Reinstalling the connecting rod (rod/crank junction) | VIII - 3 | O2 - 1 |
| • Reinstalling the half-coupling | VIII - 3 | N2 |
| • Reinstalling the half-coupling | VIII - 3 | AN2 |
| • Reinstalling the motor | VIII - 3 | M2 |
| • Positioning the pump | VIII - 3 | AW2 |
| • Coupling the pumps | VIII - 3 | AW2 |
| • Reinstalling the attaching lug | VIII - 3 | V2 |
| • Reinstalling the liquid end | VII - 3 | F2 |
| • Restarting | VII - 3 & VIII - 3 | A2(as per A1) |

**Table 6.2i : Sequential action.**

# PART VII - SERVICING THE LIQUID END

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x) in the case of partial servicing operation.

## VII - 1. GENERAL

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.
- Clean the recess for O-rings when they are removed. Apply tallow in the recess before reinstalling the new O-ring.

Special care has to be taken for chemicals used in the process (acids, bases, oxiding/reducing solutions, ...).

## VII - 2. REMOVING THE LIQUID END

### A1. Preliminary operations

Before carrying out any servicing action on the liquid end or tubes, take the necessary steps to ensure that any harmful liquid they may contain is not spilt and does not touch personnel. Provide for the rinsing of the liquid end, if necessary, and provide for appropriate protective equipment. Check that there is no pressure and the temperature of components before starting to dismantle.

1. Position the pump capacity adjustment on "0%".
2. Disconnect the pump electrically. Check that the equipment cannot be started up accidentally. Place a notice at the location of the switch.
3. Disconnect the pump hydraulically.
4. Drain the spacer and remove its cover. Disconnect the tube connected to the safety valve and the tube connected to the strainer.
   Disconnect the pipe [584] (Fig. 1.5a) from the union [432].
   Disconnect the liquid end from the cooling or heating circuit. Remove the fiiting [R2] (fig7.2b)

7

**B1. Removing the valve assemblies**

See Figure 7.2a.

1. Loosen the four nuts securing the flanges and remove the connecting assemblies [6] and [7].
2. Remove the first valve assembly: remove the seal [025], ball guide [003], ball [437] and seat [024] equipped with two seals [025].
3. Remove the second valve assembly: remove the ball guide [003], ball [437] and seat [024] equipped with two seals [025].
4. Clean the ball guides [003] if they are not to be replaced.

8

**B1. Removing the valve assemblies**

See Figure 7.2a.

1. Unscrew the three flange clamping screws and remove the connecting assemblies [6] and [7].
2. Remove the seal [025], ball guide [003], ball [437] and seat [024] equipped with two seals [025].
3. Clean the ball guide [003] if it is not to be replaced.

9

**B1. Removing the valve assemblies**

See Figure 7.2a.

1. Loosen the four nuts securing the flange and remove the connecting assembly [7] (discharge circuit).
2. Remove the spring [080] and the seal [025] from the connecting assembly [7].
3. Remove the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025].
4. Loosen the four nuts securing the flange and remove the connecting assembly [6] (suction circuit).
5. Remove the spacer [019] (fitted with two seals [025]), the spring [080A], the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025].
6. Clean the ball guides [003] if they are not to be replaced.

10

**B1. Removing the valve assemblies**

See Figure 7.2a.

1. Loosen the four nuts securing the flange and remove the connecting assembly [7] (discharge circuit).
2. Remove the spring [080] and the seal [025] from the connecting assembly [7].
3. Remove the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025].
4. Loosen the four nuts securing the flange and remove the connecting assembly [6] (suction circuit).
5. Remove the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025].
6. Clean the ball guides [003] if they are not to be replaced.

### B1. Removing the valve assemblies

See Figure 7.2a.

11

1. Loosen the four nuts securing the flange and remove the connecting assembly [7] (discharge circuit).
2. Remove the spring [080] and the seal [025] from the connecting assembly [7].
3. Remove the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025]. Remove the second valve set (ball guide, ball, seat).
4. Untighten the four nuts securing the flange and remove the connecting assembly [6] (suction circuit).
5. Remove the ball guide [003], the ball [437] and the seat [024] fitted with two seals [025].
6. Clean the ball guides [003] if they are not to be replaced.

### L1. Removing the detection assembly

See Figure 1.5a.

1. Unscrew the two screws [435] and remove the flange [004] with the detection assembly.
2. Remove the union [432] (part bonded with Loctite 566) to free the flange [004].
3. Unscrew the detector body [021A] and remove the valve assemblies. Clean the valves before reinstalling. Remove the valve body [021] and the seal [438].

### C1. Removing the diaphragms

See Figure 7.2b.

1. Remove the screws [435] and [435B] to remove the liquid end body [021], the seal [025], the adaptor part [021A], the PTFE diaphragm [L2], the double diaphragm body [098C] and the composite diaphragm [L]. (Provide for a receptacle to collect drips).

### D1. Removing the pilot

See Figure 7.2c.

1. Remove the contour plate [098]. It is advisable to use a hook between the upper section of the pilot and the contour plate.
2. Remove the O-ring [438D] in order to replace it.
3. Remove the pilot [12] using the extractor.
4. Remove the seals [438] if they have to be replaced.

### E1. Removing the safety valve

See Figure 7.2c.

1. Unscrew the two screws [435C] to remove the safety valve [9].
2. Remove the seal [438A] in order to replace it in the context of annual overhaul.

### F1. Removing the displacement chamber assembly

If necessary, the whole liquid end can be removed when carrying out this procedure.

See Figure 7.2c.

1. Remove the mounting screw [B] (liquid end/crosshead junction).
2. From inside the spacer, unscrew the two screws [F] (liquid end/spacer junction), and extract the displacement chamber with the plunger.
3. Remove the O-ring [S] and seals [438K] in order to replace them.

### G1. Removing the plunger

See Figure 7.2c.

1. Separate the adaptor piece [072A] (and the clamping lug [072B]) from the displacement chamber [072] (two attaching screws). If necessary, remove the seal [438E] in order to replace it.
2. Separate the plunger [012] from the cylinder [037].

## VII - 3. REINSTALLING THE LIQUID END

### G2. Reinstalling the plunger

See figure 7.2c.

1. Engage the plunger [012] in the cylinder [037].
2. Where applicable, fit the clamping lug [072B] and adaptor piece [072A] on the displacement chamber (two attaching screws), after replacing the seal [438E].

### F2. Reinstalling the displacement chamber assembly

See Figure 7.2c.

1. Fit seal [S] and two seals [438K] on the adaptor piece [072A].
2. Position the crosshead at the rear neutral point (hand-knob [055] (Fig. 4.4a) set to the "100%" position and the crank upwards).
3. Position the displacement chamber assembly in the spacer.
4. Screw the plunger mounting screw [B] in the crosshead without torquing.
5. Attach the displacement chamber assembly on the spacer with two screws [F], and tighten to a torque of 0.5 m.daN.
6. Lock the mounting screw [B], (torque of 1 m.daN).

### D2. Reinstalling the pilot

See Figure 7.2c.

1. Where applicable, fit the seals [438] on the pilot [12].
2. Apply hydraulic fluid on the seals and in the pilot recess.
3. Place the pilot in the extractor. Centre the pilot in the displacement chamber [072]. It must, mandatorily, be correctly positioned (see Figure 7.2d).
4. Fit the pilot in the displacement chamber by gently striking it with the counterweight of the tool.

### C2. Reinstalling the diaphragms

See Figure 7.2b.

1. Apply tallow on the groove in the contour plate [098] and position the O-ring [438D] in it.
2. Fit the contour plate on the displacement chamber and check that the split pin [431] is positioned in its recess.
3. Fit the diaphragm [L] on the contour plate with the blue side visible (position with care).
4. Install the seal [025], the adaptor piece [021A], the PTFE diaphragm [L2] and the double diaphragm body [098C] on the liquid end body [021]. Check that the split pin [431] is fitted in its recess. Fit the seal [025A].
5. Fit this assembly on the displacement chamber and install the four screws without torquing [435B]. Check the positioning of the double diaphragm body and correct if necessary. (The detection system must be in line with the valve assembly).
6. Tighten screws [435] and [435B] in opposite pairs (to a torque of 0.2 m.daN).
7. Lock the screws (applying a torque of 12 m.daN).

### L2. Reinstalling the detection assembly

See Figure 1.5a.

1. Reinstall the detection assembly: fit the two valve sets on the valve body [021] (taking care to comply with the direction of fitting). Screw the detector body [021A] in place (applying a torque of 2 m.daN). Fit the flange [004] on the above-mentioned assembly.
2. Apply a few drops of Loctite 566 adhesive on the threads of the union [432] and screw it into the detector body [021A]. Caution: The adhesive must not reach the valve assemblies).

See Figure 7.2b.

3. Fit the seal [438] (Fig. 1.5a) on the adaptor piece [021A].
4. Pour in 1 or 2 cl of fluid (compatible with the pump fluid) via this location to allow the degassing of the double diaphragm).
5. Fit the detection assembly on the adaptor piece [021A] with two screws [435] (Fig. 1.5a). Tighten to a torque of 0,5 m.daN.

7

### B2. Reinstalling the valve assemblies

See Figure 7.2a.

1. Fit a seal on each face of the seats [024].
2. Position a seat [024] either on the liquid end body [3] or on the connecting assembly [6], taking care to comply with the direction of fitting.
3. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide).
4. Fit a second valve assembly.
5 Install the heating cylinder [J1]
6. On the liquid end, assemble the valve assemblies with the connecting assembly by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
7 Screw the fitting nut [R2] (fig 7.2b)

8

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a seal on each face of the seats [024].
2. Position a seat [024] either on the liquid end body [3] or on the connecting assembly [6], taking care to comply with the direction of fitting.
3. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide).
4 Install the heating cylinder [J1]
5. On the liquid end, assemble the valve assemblies with the connecting assembly by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 3 m.daN.
6 Screw the fitting nut [R2] (fig 7.2b)

9

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a seal [025] on each face of the seats [024].
2. Position a seat [024] on the liquid end body [3] (discharge circuit) taking care to comply with the direction of fitting.
3. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide). Fit the spring [080].
4 Install the heating cylinder [J1]
5. Position the connecting assembly [7] and assemble by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
6. Position a seat [024] on the connecting assembly [6] (suction circuit) taking care to comply with the direction of fitting.
7. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide). Fit the spring [080A] and the spacer [019] (fitted with two seals [025]).
8 Install the heating cylinder [J1]
9. Assemble the connecting assembly [6], fitted with the valve assembly, on the liquid end by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
10 Screw the fitting nut [R2] (fig 7.2b)

10

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a seal on each face of the seats [024].
2. Position a seat [024] on the liquid end body [3] taking care to comply with the direction of fitting.
3. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide). Fit the spring [080].
4 Install the heating cylinder [J1]
5. Position the connecting assembly [7] and assemble by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
6. Position a seat [024] on the connecting assembly [6] taking care to comply with the direction of fitting.
7. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide).
8 Install the heating cylinder [J1]
9. Assemble the connecting assembly [6], fitted with the valve assembly, on the liquid end by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
10 Screw the fitting nut [R2] (fig 7.2b)

11

**B2. Reinstalling the valve assemblies**

See Figure 7.2a.

1. Fit a seal on each face of the seats [024].
2. Position a seat [024] on the liquid end body [3] taking care to comply with the direction of fitting.
3. Position a ball [437], a ball guide [003]. Fit a second valve set (seat, ball, ball guide and a seal [025] (on the ball guide)). Fit the spring [080].
4 Install the heating cylinder [J1]
5. Position the connecting assembly [7] and assemble by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
6. Position a seat [024] on the connecting assembly [6] taking care to comply with the direction of fitting.
7. Position a ball [437], a ball guide [003] and a seal [025] (on the ball guide).
8 Install the heating cylinder [J1]
9. Assemble the connecting assembly [7], fitted with the valve assembly, on the liquid end by means of nuts. (Caution: the flange must be perpendicular to the centreline of the valves). Tighten to a torque of 6 m.daN.
10 Screw the fitting nut [R2] (fig 7.2b)

## A2. Restarting

2. Connect the displacement chamber to the spacer.
3 Fill the spacer and fit its cover (replacing the cover seal, if necessary).
4 Fill the displacement chamber very slowly to the brim through the port for the safety valve.
5 Reinstall the safety valve (see section E2 hereinafter).
6 Connect the safety valve to the spacer
7. Connect the pipe [584] (Fig. 1.5a) to part [021A].
8. Connect up the pump hydraulically.
9. Connect up the pump electrically.
10. Check that the capacity is set to 0%.
11. Check that there are no suspicious noises when starting up.
12. Proceed with degassing of the double diaphragm (see hereinafter).
13. Proceed with degassing of the displacement chamber (see hereinafter).
14 Adjust the pump capacity to 100% to obtain quicker priming.

D | 15. After priming, Adjust the pump to the desired capacity and lock the hand-knob.

DA | 15. After priming, Adjust the pump to the desired capacity.

## E2. Reinstalling the safety valve

See Figure 7.2c.

1. Place the seal [438A] in the recess on the displacement chamber [072].
2. Fit the safety valve [9] with two screws [435C].

## *DEGASSING THE DOUBLE DIAPHRAGM*

See Figure 1.5a.

1. Stop the pump (if it is running).
2. Adjust the pump capacity to 10 or 20 %.
3. Open the bleed [022].
4. Start the pump.
5. Wait about 15 minutes and adjust the pump to the desired capacity.
6. Close the bleed [022] when the required flow rate has been reached (after about 1 hour in operation).

## *DEGASSING THE DISPLACEMENT CHAMBER*

Generate pressure on the discharge side (closing the discharge circuit valve, if necessary, to force the safety valve to release the air contained in the displacement chamber).

Gradually increase the flow rate from the pump until the safety valve releases the fluid into the spacer.

## *CLEANING THE AIR BLEED INTEGRATED IN THE SAFETY VALVE*

**CAUTION** : Do not carry out this operation unless particles have blocked the air bleed, hampering its operation (see Chapter IV - 3. Tracing causes of failure). In addition, your equipment must no longer be under guarantee.

See Figure 7.2c.

1. Unscrew the screws [435C] to remove the safety valve [9].
2. Remove the lead seal on the safety valve.
3. Unscrew the cap [9.4].
4. Mark the position of the screw [9.3] with respect to the valve plug [9.2].
5. Unscrew the nut [9.6] and remove the screws [9.3].
6. Remove the valve plug [9.2] (equipped with O-rings [438C]).
7. Remove the spring seat [9.1], spring [9.5] and the components of the bleed (bleed body [021B], needles [439B], ball [437], guide bushing [439A] and valve closure element [012B]).
8. Proceed with the cleaning of the component parts of the bleed (using a cleansing solution).
9. Reinstall the component parts of the bleed in the valve body [021A].
10. Reinstall the spring [9.5], spring seat [9.1] and valve plug [9.2].
11. Install the screw [9.3] in accordance with the measurement taken during dismantling.
12. Screw on the nut [9.6], fixing the screw [9.3] (apply a torque of 2 m.daN). Screw on the cap [9.4].
13. If necessary, replace the seal [438A] and fit the safety valve with screws [435C].

# VII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

### I1. Removing the cylinder

See Figure 7.2c.

1. Unscrew the screw [435G].
2. Remove the cylinder [037] and O-ring [438G].

### K1. Removing the plunger mounting assembly

See Figure 7.2c.

1. Push on the mounting screw [B] to gain access to screws [435F]. Unscrew the two screws [435F].
2. Remove the plunger support [012A], washer [019A] and mounting screw [B]. If necessary, remove the thrust washer [019] from the bore in the crosshead (if the plunger mounting assembly has to be replaced).
3. Clean parts [012A] and [B] with degreasing agent and compressed air if the plunger mounting assembly is not to be replaced.

### I2. Reinstalling the cylinder

See Figure 7.2c.

1. Fit the O-ring [438G] on the cylinder [037].
2. Engage the cylinder in its recess and position it fully home in the displacement chamber [072].
3. Tighten the screw [435G].

### K2 Reinstalling the plunger mounting assembly

See figure 7.2c.

1. Engage the attaching screw [B] on the plunger [012].
2. Grease the washer [019A] and fit it on the plunger support [012A].
3. Fit the plunger support [012A] on the plunger and tighten the two screws [435F].
4. Where applicable, place the thrust washer [019] at the bottom of the bore in the crosshead.

# PART VIII - SERVICING THE MECHANICAL ASSEMBLY

***Carry out the procedures described below***

- in the order mentioned in the text for annual overhaul,
- in the order specified in the sequential breakdown table (Part V : Table 5.2x, Part VI : Table 6.2x), in the case of partial servicing operation.

## VIII - 1. GENERAL

A view of the mechanical assembly is shown in Figure 8.1a.

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**Note concerning multiplexed pumps**

When carrying out servicing on all the pumps, start with the last pump, then move on to the one adjacent to it, and so on until reaching the driving pump.

**Note**

- For the sake of simplicity, the procedures described do not mention the washers fitted with fasteners (such as screws and nuts). Do not forget to reinstall washers after removing them.
- Some parts are bonded when fitted. Before reinstalling them, all traces of adhesive must be removed and the parts must be degreased. Wipe away the excess adhesive after reinstalling.
- Verify that parts are undamaged before reinstalling.
- Clean the recess for O-rings when they are removed. Apply tallow in the recess before reinstalling the new O-ring.

# VIII - 2. DISMANTLING THE MECHANICAL ASSEMBLY

### A1. Preliminary operations

The relevant recommendations and procedures are described in section A1, Chapter VII - 2. REINSTALLING THE LIQUID END.

MX

If necessary, prepare lifting equipment compatible with the weight of the mechanical assembly (see TECHNICAL CHARACTERISTICS at the end of the illustrations manual).

5. Drain the oil from the housing and remove the cover from the housing.

### F1. Removing the liquid end

The relevant procedures are described in section F1 of Chapter VII - 2. REMOVING THE LIQUID END.

### M1. Removing the motor

SX

See Figure 8.2a.

1. Shim the mechanical assembly, if necessary, as the motor mount [072] which supports the pump will have to be dismantled.

M1

2. Remove the screws attaching the motor mount [072] onto the housing and take out the motor, the motor mount and the half-coupling [052A].
3. If the shock absorber [440] must be replaced, remove it and remove dust from the two half-couplings.

### N1. Removing the half-coupling

SX

See Figure 8.2a.

1. Measure dimension [D].

M1

2. Remove the screw [435A] through the hole [E] in the housing in order to remove the half-coupling [052].

### AN1. Removing the half-coupling

Mi

See Figure 8.2a.

1. Measure dimension [D2].

Mn

2. Remove screw [R1] through the hole [E] in the housing to remove the half-coupling [052].

### O1 - 1. Removing the connecting rod

See Figure 8.2b.

1. Remove the connecting rod [014] from the crank [216]: unscrew the nut [435J] and withdraw the pin axis [068].

### P1. Removing the crosshead

See Figure 8.2c.

1. Remove the packing cover [005A], connection [005], seal [432D] and packing [436]. Remove the tubing [432E] (by pushing on the bushing of connection [432F] to disengage the tubing).
2. Remove the plug [432A] and screw [435A].
3. Remove the bleed [022] (part bonded with Loctite 221). Rotate the liner [072] to unscrew the connection [432F] (part bonded with Loctite 221).
4. Extract the liner [072], crosshead [010] and connecting rod [014] through the bore in the spacer.
5. Withdraw the crosshead [010] from the liner [072], mark the direction of fitting of the seals, remove the lip seals [408], O-ring [438] and retaining rings [434C].

SX

### V1. Removing the attaching lug

See Figure 8.2b.

Mn

1. Remove the four screws securing the attaching lug [N] to the housing, after shimming the mechanical assembly, if necessary.

### AV1. Uncoupling the pumps

M1

See Figure 8.2e.

Start by working on the “last” MD pump.

Mi

1. Unscrew the screws linking the two pumps as well as the attaching screws (pump - frame). Remove the pump. Remove the spacer [019], if one is fitted.
2. Measure dimension [D1].
3. Remove screw [R1] to remove the half-coupling [052A].

### Q1. Removing the worm

See Figure 8.2b.

1. Unscrew the bearing screw [237]. If any difficulty is encountered, heat the housing with a blowtorch to soften the adhesive applied in the thread tapped in the housing and on the threads of the bearing screw. Remove the bearing screw, the lip seal [408A] and bearing [409]. If a blowtorch is used, the bearing [409] must be replaced.
2. Remove the worm.

### R1. Removing the crank support

See Figure 8.2b.

1. Remove the two locking rings [404A]. Push on the adjusting dies [211] to free the micrometer screw [256].
2. Remove the two screws [435B]. Unscrew the micrometer screw [256] using the hand-knob [255] in order to free the crank support [281A].
3. Remove the crank support [281A] with the bearing [409].
4. Remove the lip seal [408A] from the housing, if it has to be replaced.

D

See Figure 8.2d.

VF

5. If the lock insert [043] has to be replaced, completely unscrew the micrometer screw. Remove screw [008A] and extract the lock insert by making it fall out.

# VIII - 3. REINSTALLING THE MECHANICAL ASSEMBLY

### R2. Reinstalling the crank support

See Figure 8.2b.

1. If necessary, proceed with the replacement of the bearing [409]: apply Loctite 221 adhesive on the outside of the bearing and install it in its recess in the housing.
2. Position the crank support [281A] in the housing.

### Q2. Reinstall the worm

See Figure 8.2b.

1. Fit the worm into the housing. (There is no specific direction of fitting).
2. Apply tallow on the seal [408A] and fit the seal into the housing.
3. Apply tallow on the seal [408A] and fit it into the bearing screw [237], (taking care to comply with the direction of fitting).
4. If necessary, replace the bearing [409]: apply a little Loctite 221 on the bearing screw [237] and fit the bearing on the bearing screw.
5. Apply Loctite 566 on the tapping in the housing and on the threads on the bearing screw. Screw in the bearing screw. Wait for the adhesive to dry (about 3 hours at 18°C) before continuing with the fitting procedure.

### S2. Reinstalling the micrometer screw

See Figures 8.2d and 8.2b.

D

1. If the lock insert [043] was removed, screw the micrometer screw [256], fit the insert in the bore and install the screw [008A] without torquing it. Reinstalling the stop collar [018].
2. Screw the micrometer screw [256] in order to engage the adjusting dies [211] in the groove in the micrometer screw.

VF

3. Position the adjusting dies using the two stop rings [404A].
4. Unscrew the micrometer screw until reaching the "98%" graduation.
5. Place the stop collar [018] fully home against the housing and moderately tighten the two screws [435B].
6. Adjust the micrometer screw to the "100%" graduation and lock the two screws [435B].

### P2. Reinstalling the crosshead

See Figure 8.2c.

1. Proceed with the replacement of the lip seal [408] and O-ring [438], if necessary: apply a little tallow in the liner, fit a seal in the liner. Take care to avoid damaging the lip on the seal during reinstallation. Fit the retaining ring [434C]. Fit the second seal (in the opposite direction to the previous one).
2. Fit the crosshead [010] in the liner [072]. Replace the O-ring [438].
3. Fit the assembly comprising the liner [072] and crosshead [010] in its recess through the bore in the spacer.
4. Apply a little Loctite 221 adhesive on the thread of the tap [432F] and screw the tap into the liner. Apply a little Loctite 221 adhesive on the thread of the bleed [022] and screw the bleed into the liner.
5. Position the liner using the screw [435A] and make sure that the bleed is correctly vertical before locking the screw [435A] (tightening to a torque of 0.5 m.daN). Reinstall the plug [432A].
6. Snap the tubing [432E] into place in the tap [432F]. Fit the seal [432D] and connection [005] in the housing. Fit the packing [436] and packing cover [005A].

### O2 - 1. Reinstalling the connecting rod

See Figure 8.2b.

1.Reinstall the connecting rod [014] on the crank [216]. Fit the pin axis [068] and screw on the nut [435J].

### Z. Servicing the strainer

See Figure 7.2c.

1. Disconnect the tube [047].

H

2. Remove the strainer by unscrewing the nut [435E]. Remove the seal [I] in order to replace it.
3. Unscrew the strainer body [K] from the strainer connection [045]. Remove the filter cloth [047A] (and mark the direction of fitting), the clamping bush [025] and seal [438F], in order to replace them. Clean the strainer body and the strainer connection.

P

4. Fit the strainer connection, the filter cloth (taking care with the direction of fitting), the clamping bush and the seal. Apply tallow on the thread of the strainer connection [045] and screw the strainer body [021] into place.
5. Fit a seal [I] on the strainer body, and fit the strainer on the housing by means of a nut [435E].
6. Connect the tube [047].

### Z. Servicing the strainer

See Figure 7.2c.

M

1. Remove the strainer by unscrewing the nut [435E]. Remove the seal [I] in order to replace it.

X

2. Unscrew the strainer plug [045] from the strainer body [K]. Remove the seal [438C] in order to replace it.

V

3. Reinstall a seal [438C] on the strainer plug. Fit the strainer plug on the strainer body.
4. Fit a seal [I] on the strainer body, and fit the strainer on the housing with a by means of a nut [435E].

### N2. Reinstalling the half-coupling

SX

See Figure 8.2a.

M1

1. Reinstall the half-coupling [052] on the worm shaft, allowing for the measurement conducted during dismantling (dimension [D]).
2. Screw in the screw [435A] via the hole [E] in the housing.

### AN2. Reinstalling the half-coupling

Mi

See Figure 8.2a.

Mn

1. Reinstall the half-coupling [052] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D2]).
2. Install the screw [R1] through the hole [E] in the housing.

### M2. Reinstalling the motor

SX

See Figure 8.2a.

1. Proceed with the replacement of the shock absorber [440], if necessary.
2. Fit the two half-couplings and, at the same time, engage the motor mount [072] in the centring fitting in the housing. The mount must be fully home on the housing and the shock absorber [440] must be fitted without forcing between the two half-couplings.

M1

3. Secure the mount [072] with screws.

### AW2. Positioning the pump

M1

See Figure 8.2e.

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (dimension [D1]). Install the screw [R1].
2. Position the crank in the high position.

Mi

### AW2. Coupling the pumps

See Figure 8.2e

1. Fit the half-coupling [052A] on the worm shaft, taking into account the measurement taken during dismantling (code [D1]). Install the screw [R1].
2. Position the crank in the high position.
3. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
4. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted between the two half-couplings without being placed under stress.
5. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

Mn

### AW2. Coupling the pumps

See Figure 8.2a.

1. Position the crank in the high position.
2. Set the pump out of phase: rotate the worm through the number of turns (nb) specified in the table, multiplexing option, Technical Characteristics (at the end of the illustrations manual).
3. Fit the spacer [019], if there is one. Fit the two half-couplings with the shock absorber [440]. The shock absorber [440] must be fitted without being placed under stress between the two half-couplings .
4. Install the screws linking the two pumps, as well as the screws attaching the pump onto the frame.

SX

Mn

### V2. Reinstalling the attaching lug

See Figure 8.2b.

1. Secure the attaching lug [N] with four screws.

### F2. Reinstalling the liquid end

The relevant procedures are described in section F2 of Chapter VII - 3. REINSTALLING THE LIQUID END.

### A2. Restarting

1. Fill the housing with oil and reinstall the housing cover (replacing the cover seal, if necessary).

The other relevant procedures are described in section A2, Chapter VII - 3.REINSTALLING THE LIQUID END.

# VIII - 4. OTHER PROCEDURES FOR FURTHER SERVICING

### O1 - 2. Removing the connecting rod

See Figure 8.2c.

1. Remove the connecting rod [014] from the crosshead [010]: unscrew the screw [435E] and withdraw the pin [011] (parts bonded with Loctite 221 adhesive).

### T1. Removing the tangential gear

See Figure 8.2b.

1. Unscrew the nut [405] while holding the crank [216] (parts bonded with Loctite 221.
2. Drive out the crank.

### T2. Reinstalling the tangential gear

See Figure 8.2b.

1. If necessary, adjust the groove in the tangential gear to fit with the key on the crank [216] (in the event of replacement of the worm / tangential gear pair or replacement of the crank).
2. Apply a little adhesive on the thread on the crank. Engage the crank in the crank support [281A], fit the tangential gear (taking care with the direction of fitting) and screw on the nut [405].

### O2 - 2. Reinstalling the connecting rod

See Figure 8.2c.

1. Reinstall the connecting rod [014] on the crosshead [010]: fit the connecting rod on the pin [011] by means of screw [435E] (part bonded with Loctite 221).

# GUARANTEE

The vendor guarantees his products according to the D.M.R. general conditions of sale.

The guarantee for components and sub-assemblies not fabricated by the vendor is limited tothat given by the supplier.

The vendor's guarantee only covers the replacement or the repair, at his cost and in his factory, of all parts acknowledged by his technical services as being defective due to an error in conception, of material or of execution.

It is the purchasers responsability to prove the said defects. The guarantee does not cover the replacement of wear parts mentioned in part V - Preventive Maintenance.

The vendor reserves the right to modify all or part of his products in order to satisfy the guarantee. The guarantee does not cover charges arising from dismantling, assembly, transport and movements.

The replacement of one or several parts, for whatever reason, does not prolong the period of guarantee.

The guarantee is not applicable notably in the following cases :

- installation not in accordance with standard current practice.
- deterioration or accident resulting from negligence.
- lack of surveillance or maintenance.
- modifications to conditions of use.
- chemical corrosive or erosive attack. The proposed materials of construction are recommendations subject in all cases to verification and acceptance by the client. The recommendations, based on the experience of the vendor and the best available information, do not guarantee against wear or chemical action.

The guarantee ceases :

- if the storage of the material, outwith the vendors factory, does not conform to his recommendations or to current standard practices.
- in case of work or dismantling of the material by someone who does not respect written recommendations of the instruction manual (when replacing wear parts).
- if parts from another origin are substituted for the original parts supplied by the manufacturer.

The purchaser cannot call on guarantee claims to justify differing payments.

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DOSAPRO MILTON ROY
Groupe Sundstrand

# INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

CE

## Dosing pump

## MILROYAL D

H.P.D. DIAPHRAGM-TYPE LIQUID END

This manual should be made available to the person responsible for installation, operating and maintenance.

**ILLUSTRATIONS VOLUME**

**Date : 10/99** **O / Ref : I.160.0822.001.Rev. A**

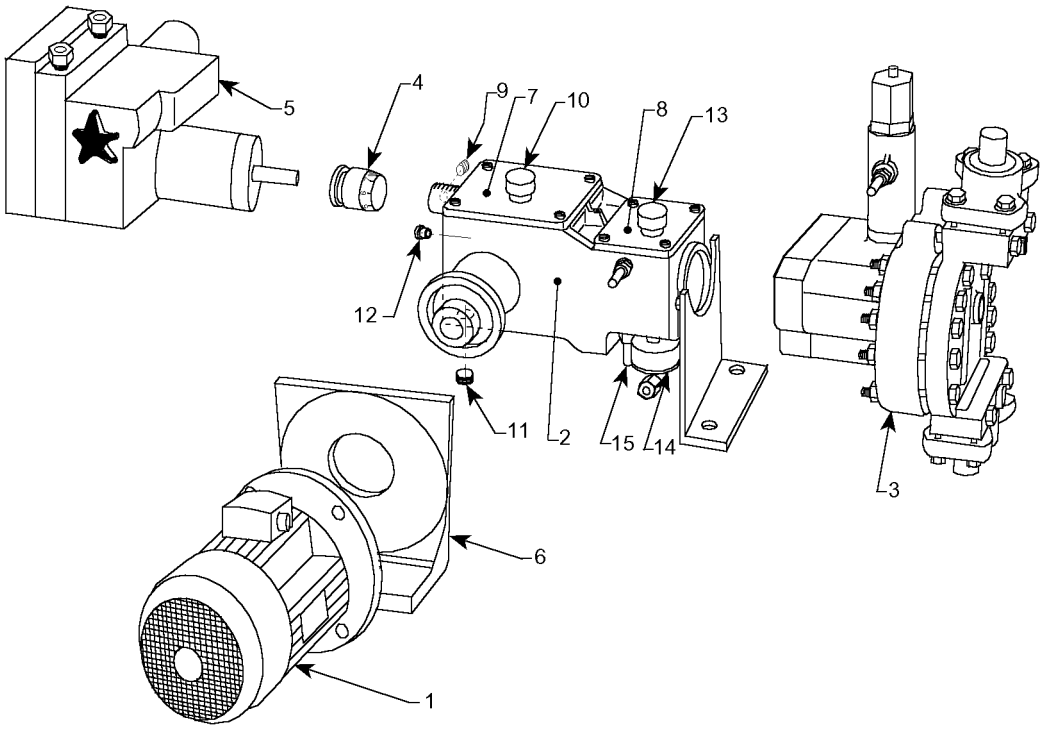
For better understanding, use this volume together with the TEXT VOLUME.

# LIST OF ILLUSTRATIONS

## VIII - SERVICING THE MECHANICAL ASSEMBLY



## TECHNICAL CHARACTERISTICS




| | | | |
|---|---|---|---|
| 1 | Motor | 9 | Stroke adjustment knob locking screw |
| 2 | Mechanical assembly | 10 | Housing filler plug |
| 3 | Liquid end | 11 | Housing drain plug |
| 4 | Stroke adjustment knob | 12 | Oil gauge (housing) |
| 5 | Servo-motor | 13 | Spacer filler plug |
| 6 | Motor support | 14 | Strainer |
| 7 | Housing | 15 | Leak detector |
| 8 | Mechanical assembly spacer | | |

**Fig. 1.2a: Milroyal D pump fitted with diaphragm-type liquid end**

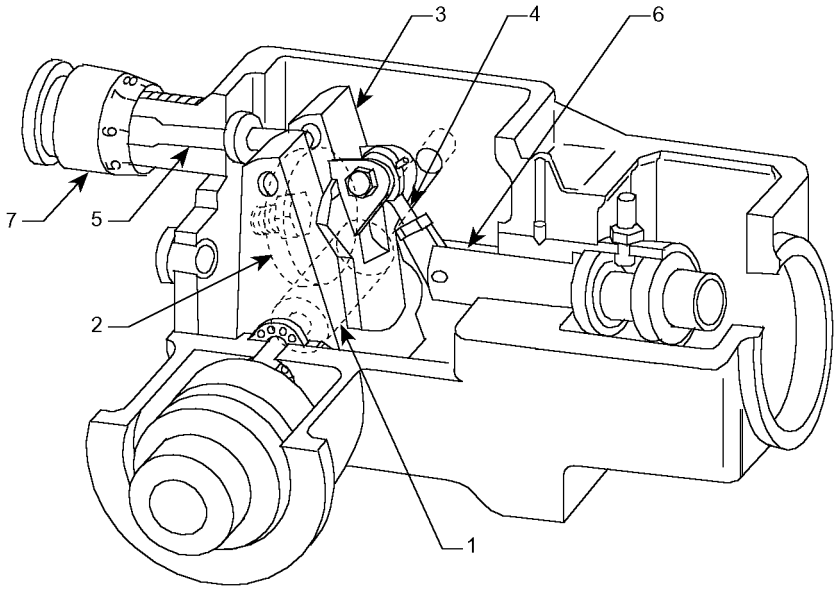



**Fig. 1.3a : Mechanical assembly**

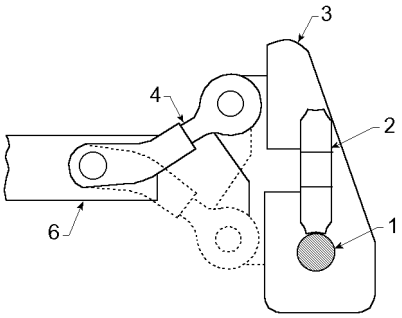



**Fig. 1.3b : Setting to zero stroke**

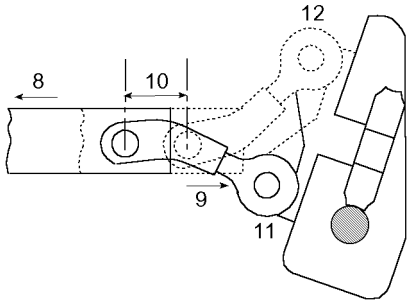
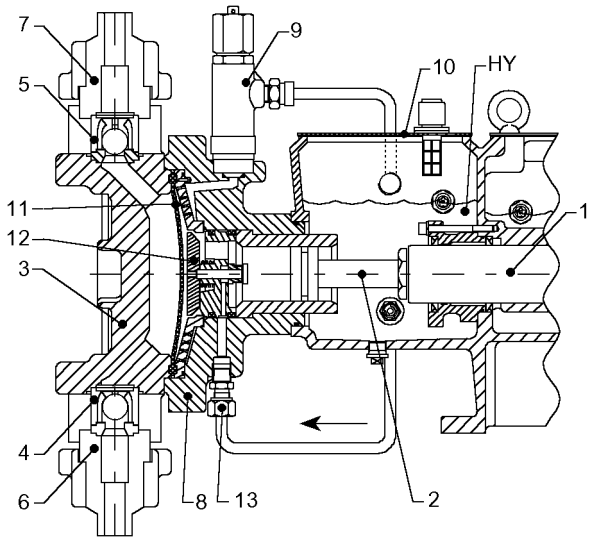
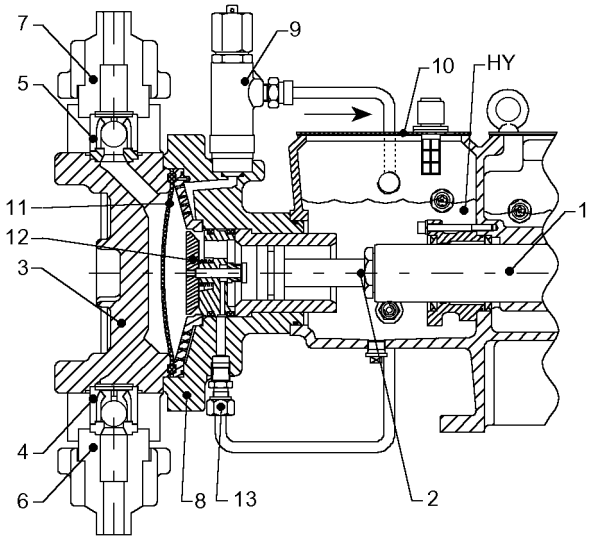



**Fig. 1.3c : Setting to maximum stroke**

| | | | |
|---|---|---|---|
| 1 | Worm | 7 | Stroke adjustment knob |
| 2 | Tangential gear | 8 | Discharge |
| 3 | Inclinable crank | 9 | Suction |
| 4 | Connecting rod | 10 | Stroke |
| 5 | Micrometer screw | 11 | Position discharge |
| 6 | Crosshead | 12 | Position suction |




**Suction phase**

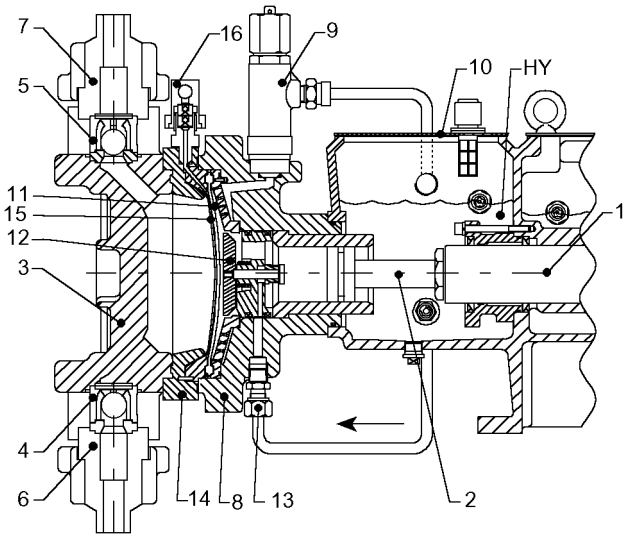



**Discharge phase**

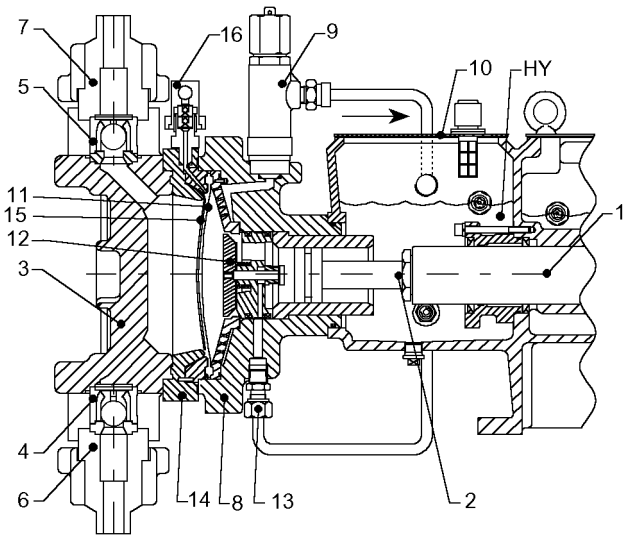
0

| | | | |
|---|---|---|---|
| HY | Hydraulic oil | 7 | Connection assembly (discharge) |
| 1 | Crosshead | 8 | Displacement chamber |
| 2 | Plunger | 9 | Safety valve |
| 3 | Liquid end body | 10 | Spacer |
| 4 | Valve assembly (suction) | 11 | Diaphragm |
| 5 | Valve assembly (discharge) | 12 | Mars valve |
| 6 | Connection assembly (suction) | 13 | Oil resupply connection |

**Fig. 1.4a: operating principle of the h.p.d. Diaphragm-type liquid end**




**Suction phase**

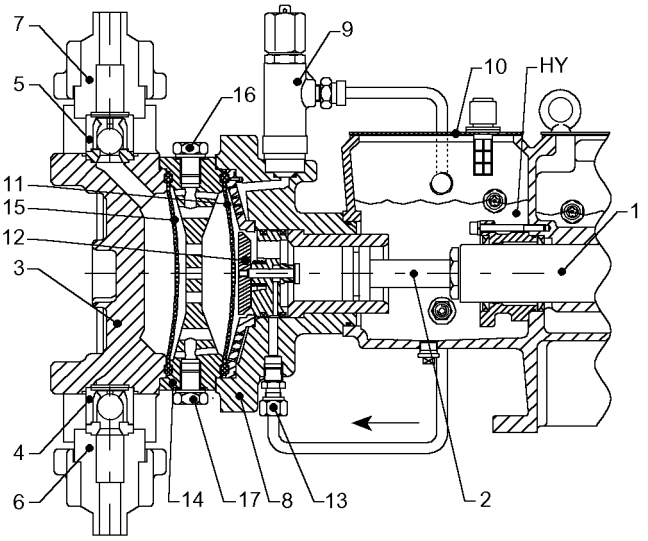



**Discharge phase**

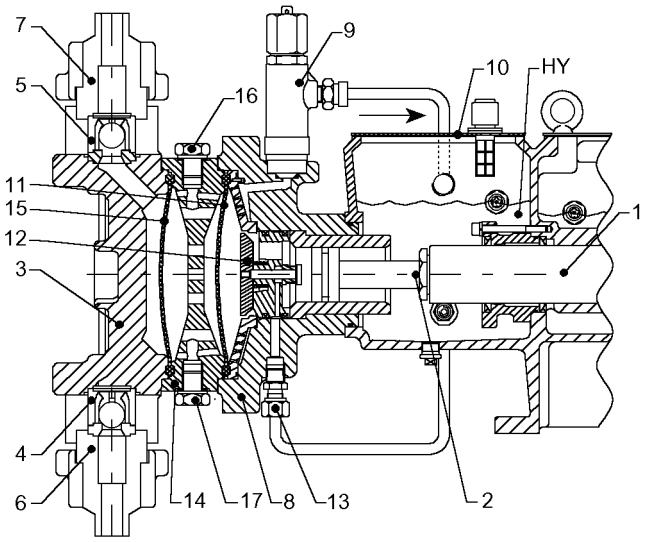
C

| Hy | Hydraulic oil | 9 | Safety valve |
|---|---|---|---|
| 1 | Crosshead | 10 | Spacer |
| 2 | Plunger | 11 | First diaphragm |
| 3 | Liquid end body | 12 | Mars valve |
| 4 | Valve assembly (suction) | 13 | Oil resupply connection |
| 5 | Valve assembly (discharge) | 14 | Double diaphragm body |
| 6 | Connection assembly (suction) | 15 | Second diaphragm |
| 7 | Connection assembly (discharge) | 16 | Detection system |
| 8 | Displacement chamber | | |

**Fig. 1.4a: operating principle of the h.p.d. Diaphragm-type liquid end option with double diaphragm without intermediate fluid**




**Suction phase**

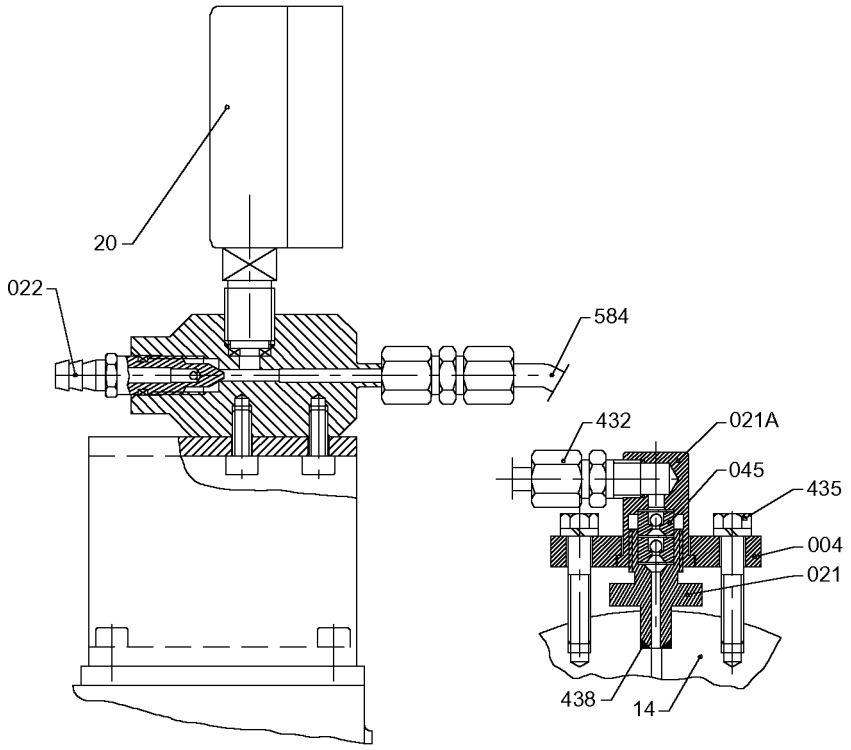



**Discharge phase**

L

| HY | Hydraulic oil | 9 | Safety valve |
|---|---|---|---|
| 1 | Crosshead | 10 | Spacer |
| 2 | Plunger | 11 | First diaphragm |
| 3 | Liquid end body | 12 | Mars valve |
| 4 | Valve assembly (suction) | 13 | Oil resupply connection |
| 5 | Valve assembly (discharge) | 14 | Double diaphragm body |
| 6 | Connection assembly (suction) | 15 | Second diaphragm |
| 7 | Connection assy (discharge) | 16-17 | Double diaphragm body plugs |
| 8 | Displacement chamber | | |

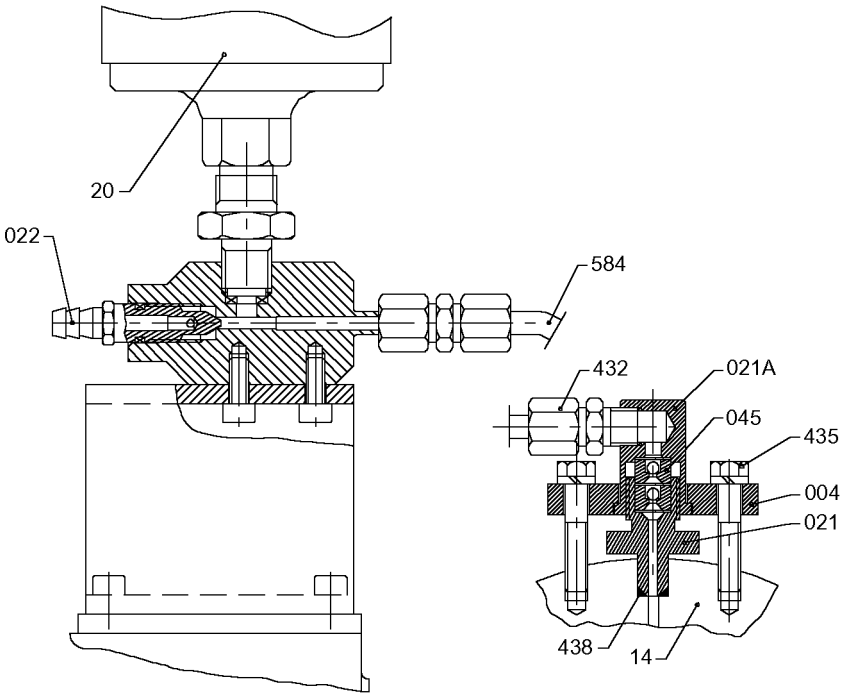
**Fig. 1.4a: operating principle of the h.p.d. Diaphragm-type liquid end option with double diaphragm with intermediate fluid**




C5

| | | | |
|---|---|---|---|
| 14 | Double diaphragm body | 045 | Valve assembly |
| 20 | Manometer | 432 | Connection |
| 004 | Flange | 435 | Screw |
| 021 | Valve body | 438 | Seal |
| 021A | Detector body | 584 | Tubing |
| 022 | Bleed | | |

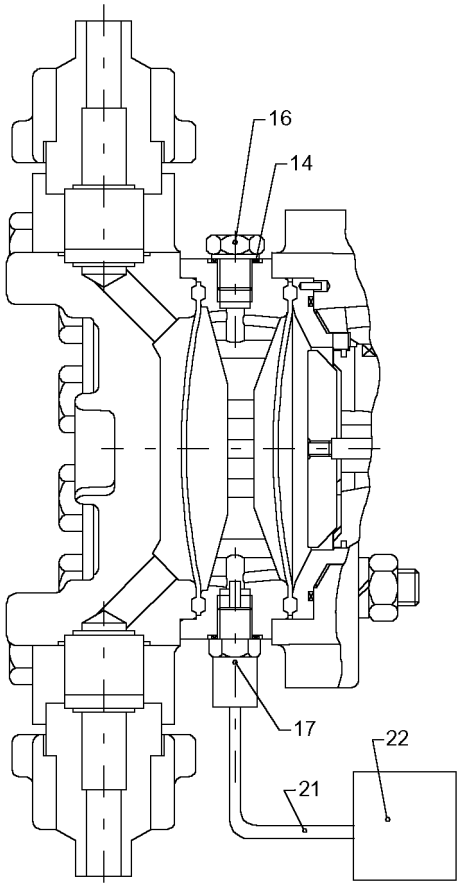
**Fig. 1.5a Manometer detector assembly**




C6

| | | | |
|---|---|---|---|
| 14 | Double diaphragm body | 045 | Valve assembly |
| 20 | Pressure switch | 432 | Connection |
| 004 | Flange | 435 | Screw |
| 021 | Valve body | 438 | Seal |
| 021A | Detector body | 584 | Tubing |
| 022 | Bleed | | |

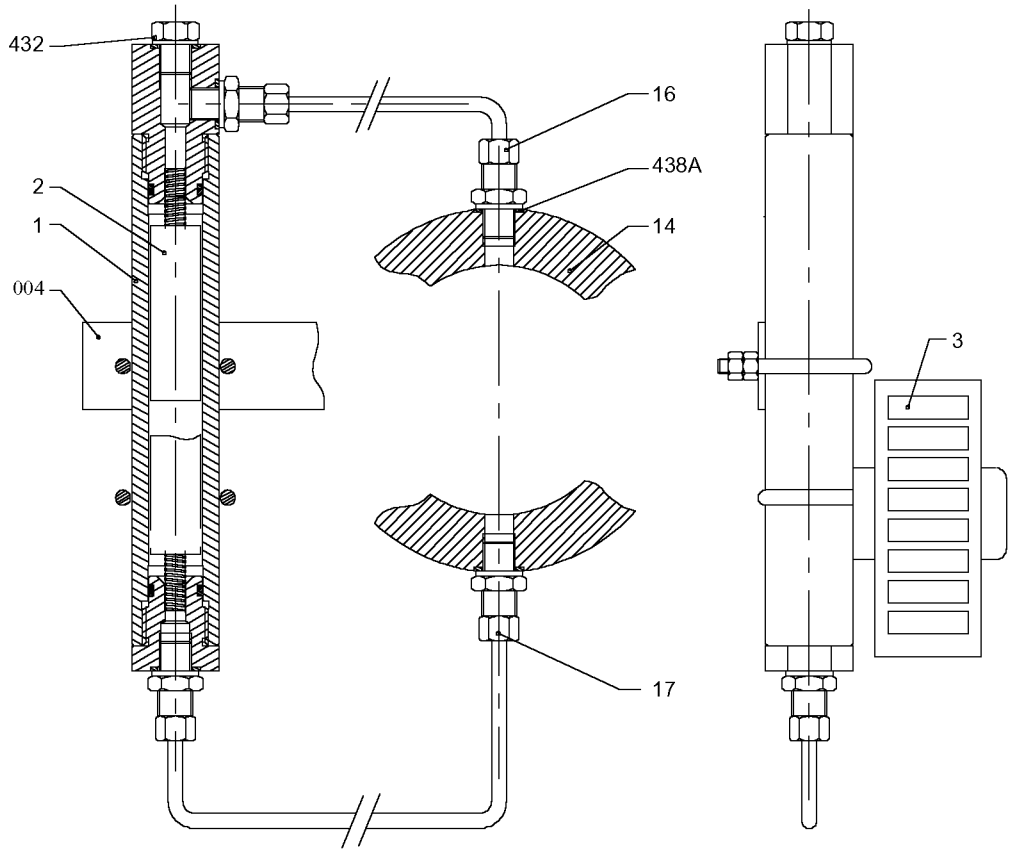
**Fig. 1.5a Pressure switch detector assembly.**




L2

| | | | |
|---|---|---|---|
| 14 | Double diaphragm body | 21 | Coaxial cable |
| 16 | Plug | 22 | Resistivity relay box |
| 17 | Resistivity cell | | |

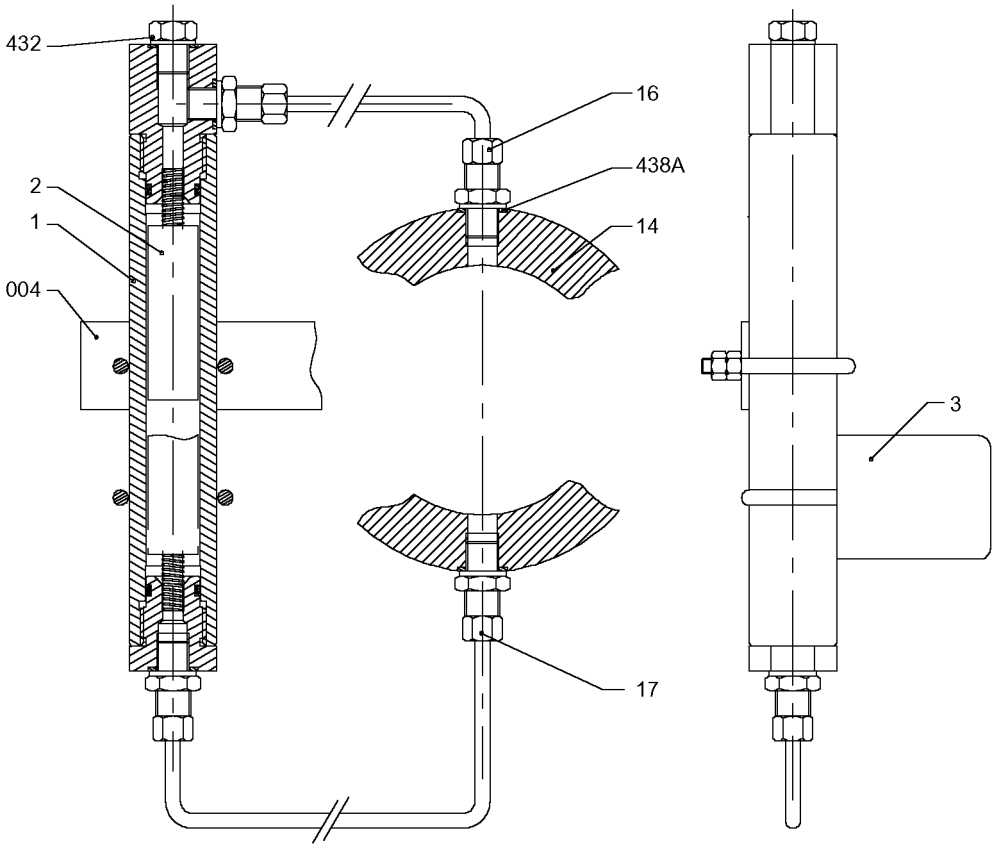
**Fig. 1.5a : Resistivity cell detector assembly**




L3

| | | | |
|---|---|---|---|
| 1 | Detector body | 17 | Connection |
| 2 | Magnetic float | 004 | Attaching lug |
| 3 | Bicoloured magnetic flats | 432 | Plug |
| 14 | Double diaphragm body | 438A | Seal |
| 16 | Connection | | |

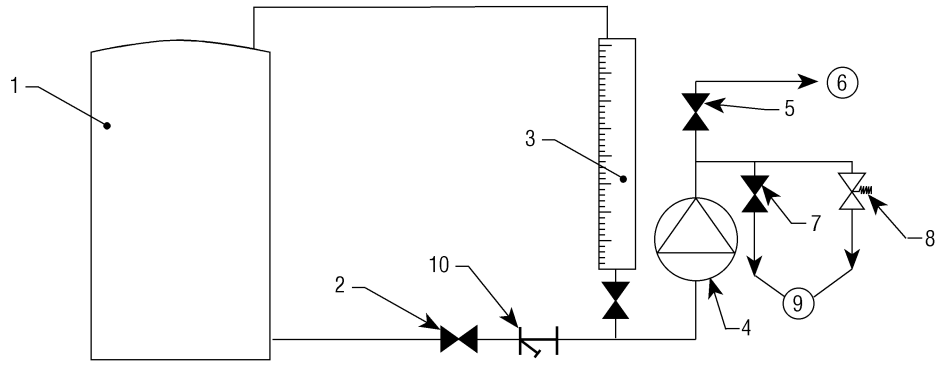
**Fig. 1.5a : Visual detector assembly.**




L4

| | | | |
|---|---|---|---|
| 1 | Detector body | 17 | Connection |
| 2 | Magnetic float | 004 | Attaching lug |
| 3 | Magnetic contact | 432 | Plug |
| 14 | Double diaphragm body | 438A | Seal |
| 16 | Connection | | |

**Fig. 1.5a : Electric detector assembly.**




| | | | |
|---|---|---|---|
| 1 | Tank | 6 | Utilization |
| 2 | Suction circuit isolating valve | 7 | Priming valve |
| 3 | Calibrating chamber | 8 | Safety valve |
| 4 | Pump | 9 | Return |
| 5 | Discharge circuit isolating valve | 10 | Filter |

**Fig. 2.1a : Diagram of an installation**

SX

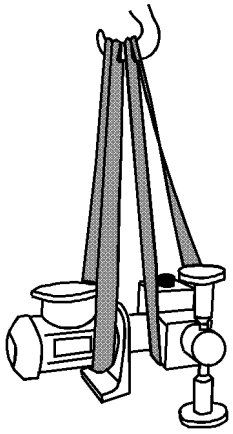


**Fig. 2.3a : Handling**

MX

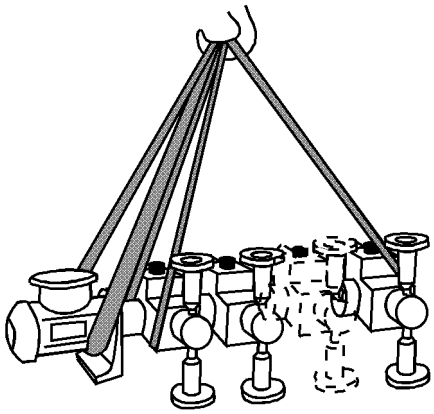
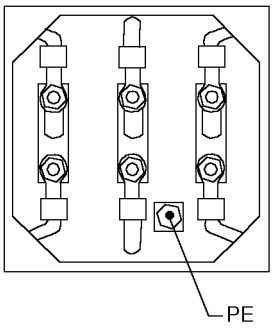


**Fig. 2.3a : Handling**

SX



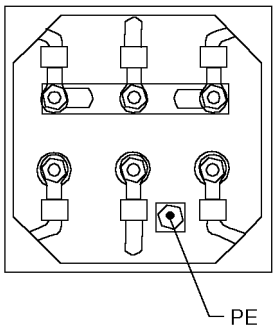




**Fig. 2.5a : Motor terminal box**

M1

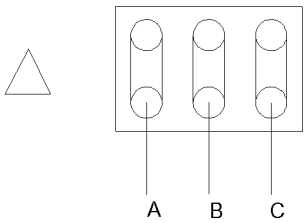



**Fig. 2.5b :**
**230 V delta connection**

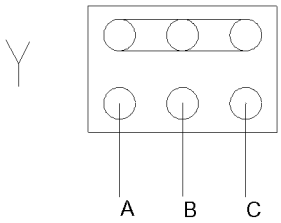



**Fig. 2.5c :**
**400 V star connection**

## MAINTENANCE SHEET

Pump code : Contract No :
Liquid pumped :

| Service Operation | Date | Hours | Remarks |
|---|---|---|---|
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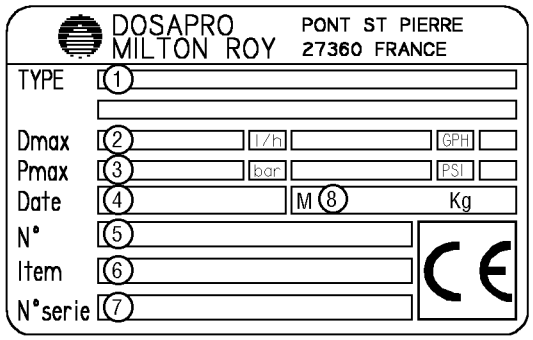
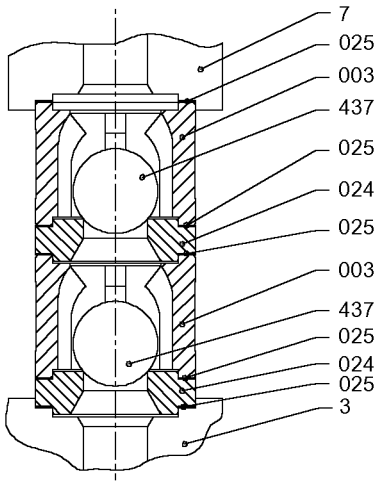
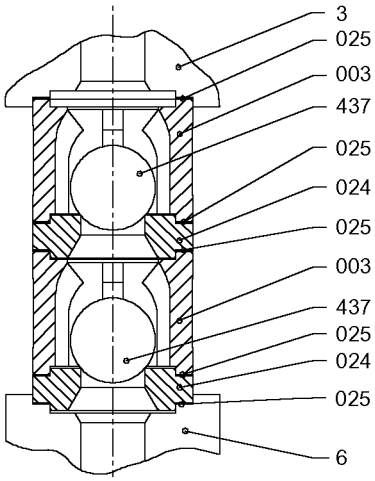
**Fig. 3.4a : Model Maintenance Sheet**




| | |
|---|---|
| **1** | **Type : Pump code** |
| 2 | Dmax : maximum capacity |
| 3 | Pmax : maximun pressure |
| 4 | Date: date of manufacture |
| **5** | **N° : Contract No** |
| 6 | Item : your reference |
| 7 | N° série.: Dmr internal no |

**Fig. 4.4a : Identification plate**



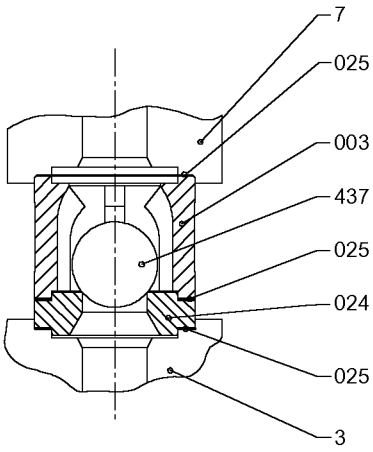



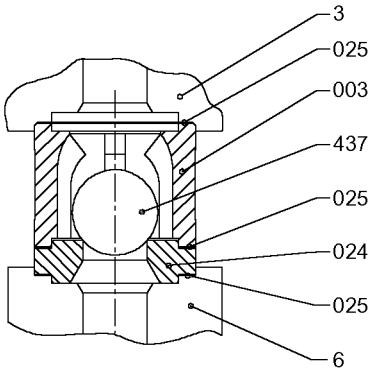

Discharge Suction

7

| | | | |
|---|---|---|---|
| 003 | Ball guide | 3 | Liquid end body |
| 024 | Seat | 6 | Connection assembly (suction) |
| 025 | Seal | 7 | Connection assembly (discharge) |
| 437 | Ball | | |

**Fig. 7.2a: Sectional drawing of valve assemblies.**



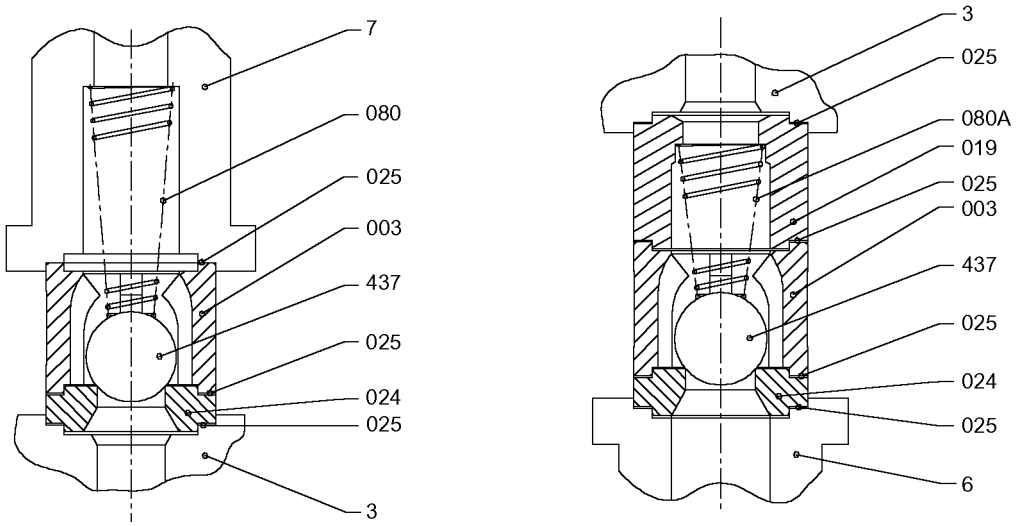




Discharge Suction

8

| | | | |
|---|---|---|---|
| 003 | Ball guide | 3 | Liquid end body |
| 024 | Seat | 6 | Connection assembly (suction) |
| 025 | Seal | 7 | Connection assembly (discharge) |
| 437 | Ball | | |

**Fig. 7.2a: Sectional drawing of valve assemblies.**

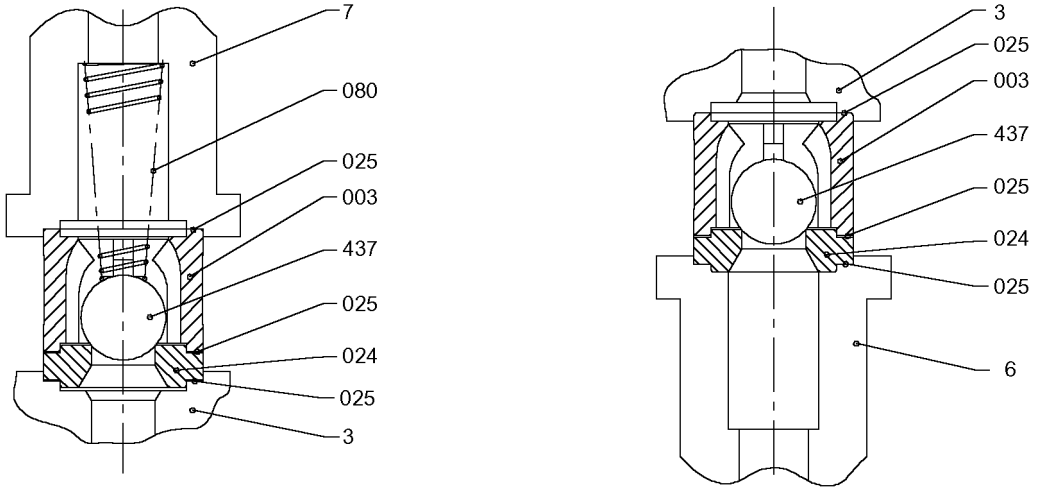



Discharge Suction

9

| | | | |
|---|---|---|---|
| 003 | Ball guide | 080A | Spring (Suction circuit) |
| 019 | Spacer | 437 | Ball |
| 024 | Seat | 3 | Liquid end body |
| 025 | Seal | 6 | Connection assembly (suction) |
| 080 | Spring (Discharge circuit) | 7 | Connection assembly (discharge) |

**Fig. 7.2a: Sectional drawing of valve assemblies.**

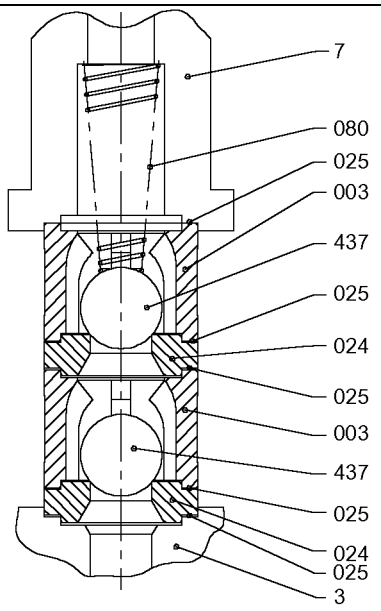


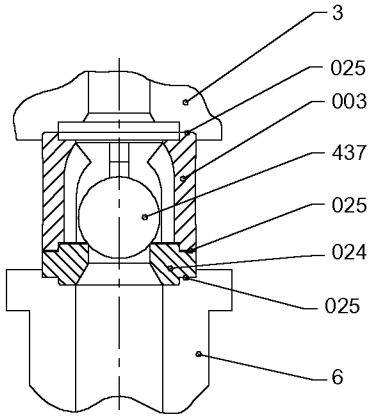

Discharge Suction

10

| | | | |
|---|---|---|---|
| 003 | Ball guide | 437 | Ball |
| 024 | Seat | 3 | Liquid end body |
| 025 | Seal | 6 | Connection assembly (suction) |
| 026 | Spring (Discharge circuit) | 7 | Connection assembly (discharge) |

**Fig. 7.2a: Sectional drawing of valve assemblies.**



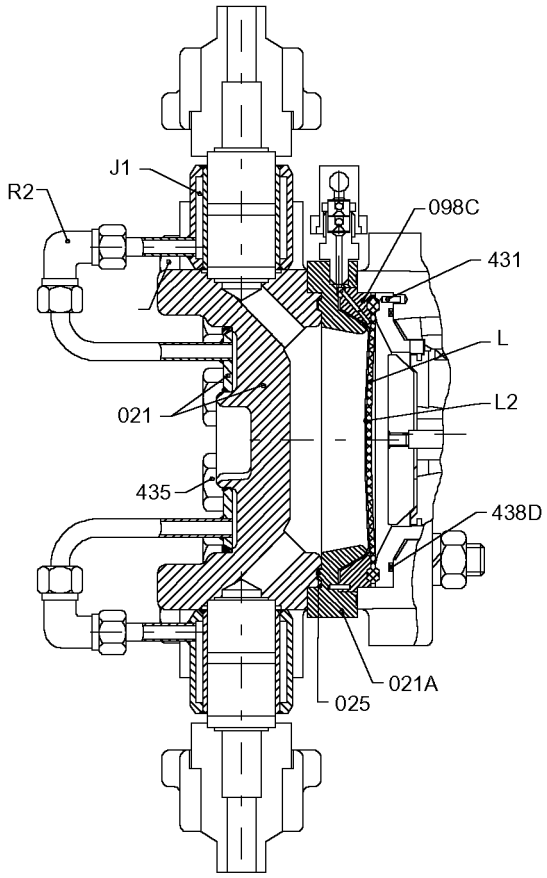




Discharge Suction

11

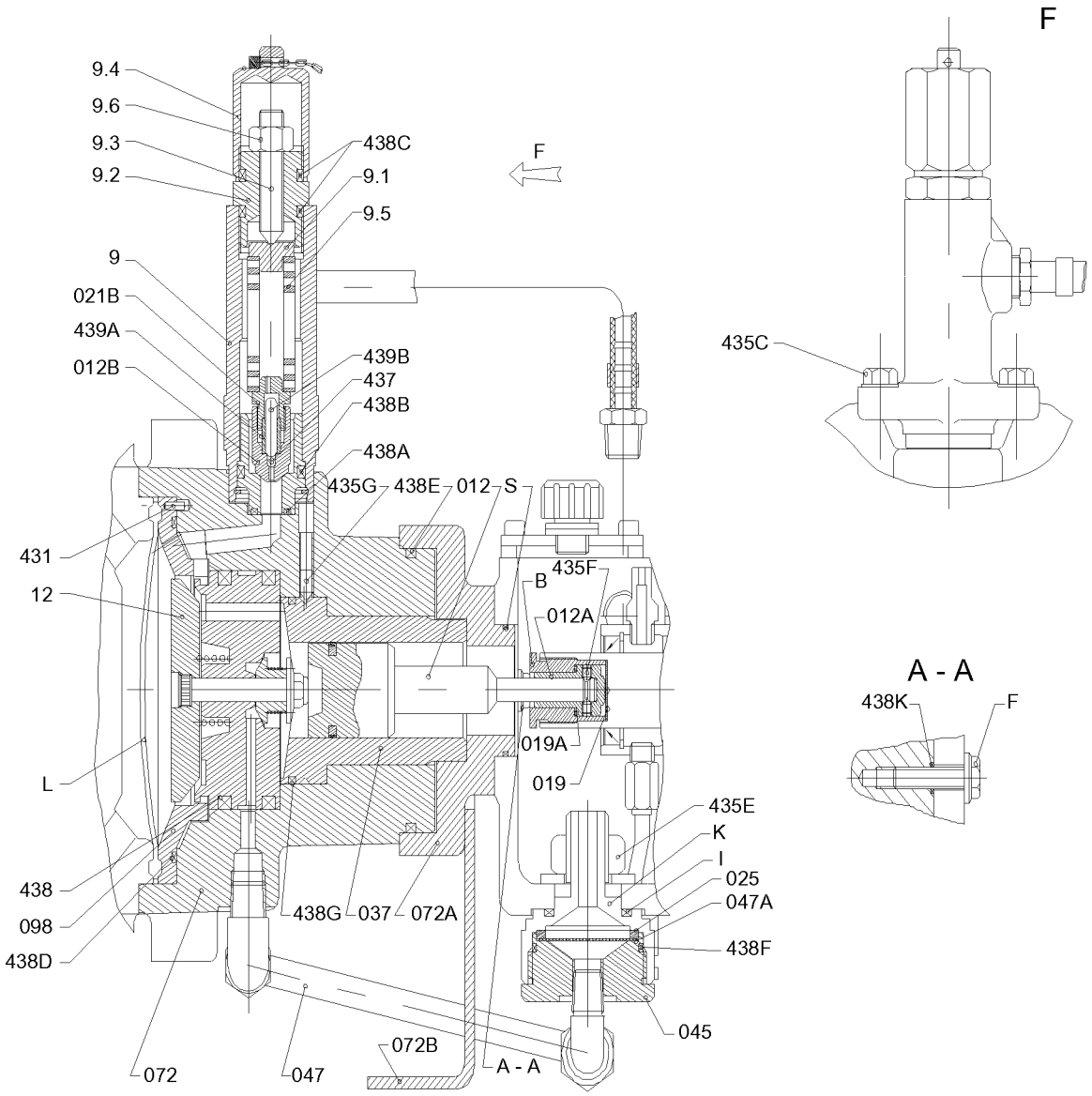
| | | | |
|---|---|---|---|
| 003 | Ball guide | 437 | Ball |
| 024 | Seat | 3 | Liquid end body |
| 025 | Seal | 6 | Connection assembly (suction) |
| 080 | Spring (Discharge circuit) | 7 | Connection assembly (discharge) |

**Fig. 7.2a: Sectional drawing of valve assemblies.**



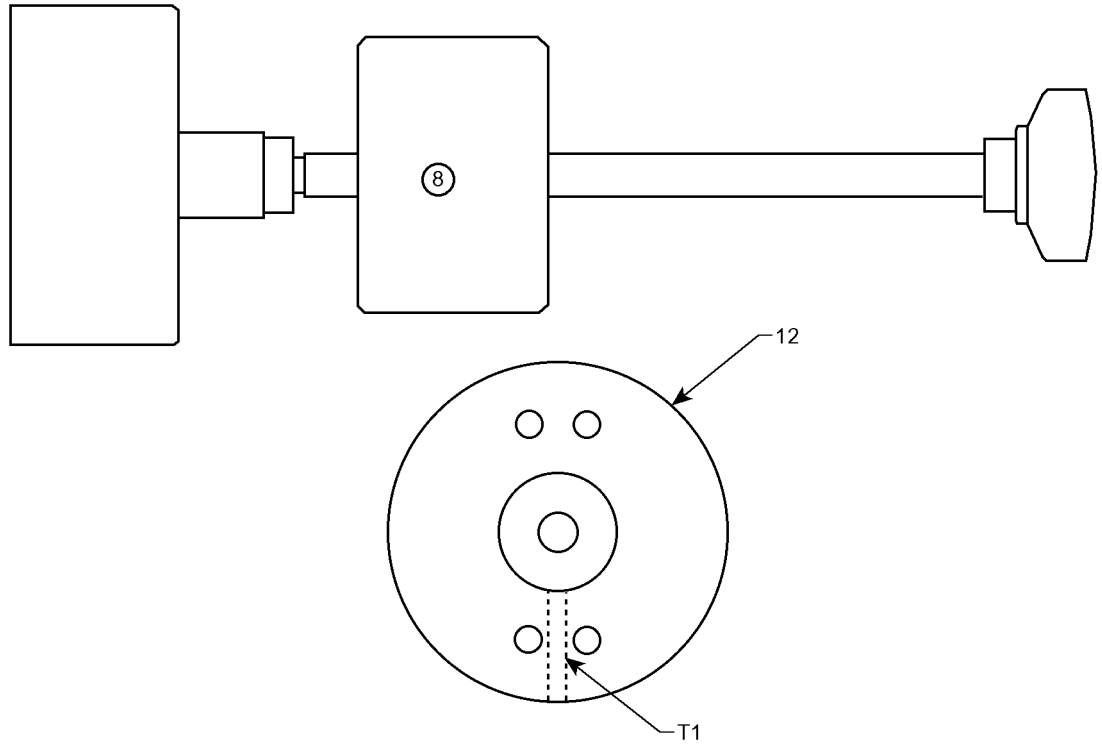

| | | | |
|---|---|---|---|
| 021 | Liquid end body | 435 | Screw (liquid end body attaching) |
| 021A | Adaptator | 435B | Screw (liquid end body attaching) |
| 025 | Seal | 438D | O-ring |
| 098 | Contour plate | L | Diaphragm |
| 098C | Double diaphragm body | L2 | PTFE Diaphragm |
| 431 | Pin | R2 | Fitting |

**Fig. 7.2b : Sectional drawing of liquid end assembly**



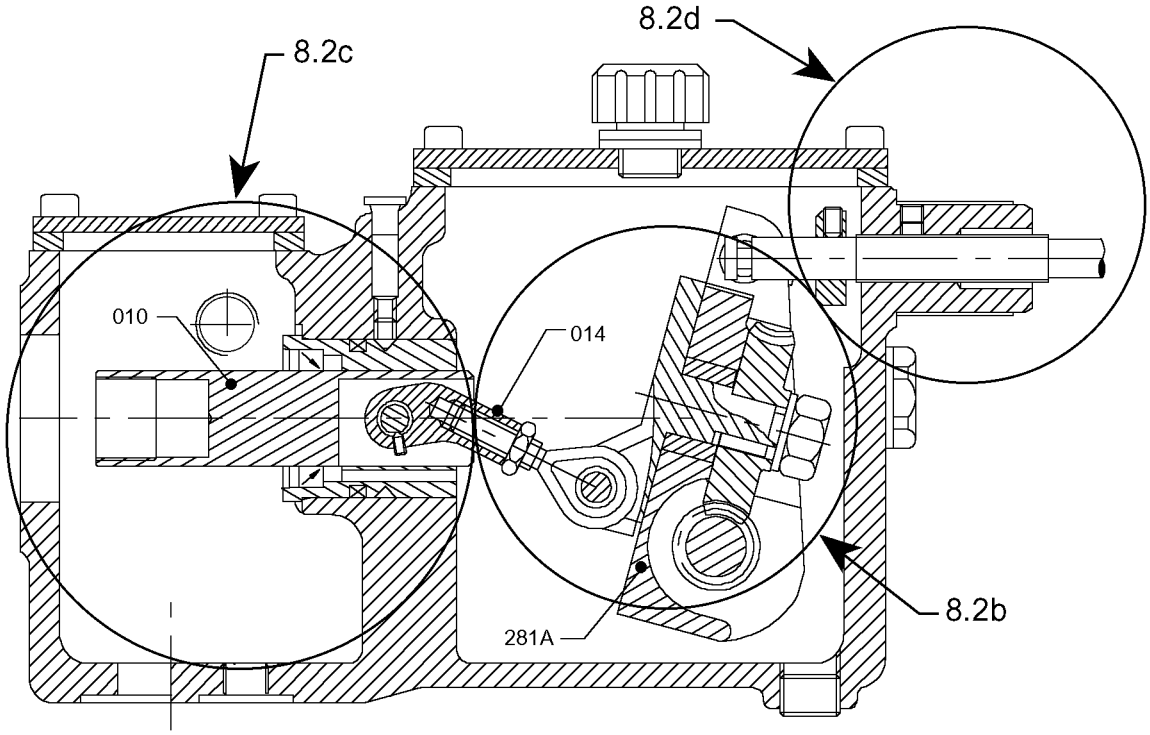

| | | | |
|---|---|---|---|
| 9 | Safety valve | 431 | Pin |
| 9.1 | Spring seat | 435C | Screw |
| 9.2 | Valve plug | 435E | Nut |
| 9.3 | Screw | 435F | Screw |
| 9.4 | Cover | 435G | Screw |
| 9.5 | Spring | 437 | Ball |
| 9.6 | Nut | 438 | O'ring |
| 12 | Pillot | 438A | O'ring |
| 012 | Plunger | 438C | O'ring |
| 012A | Plunger support | 438D | O'ring |
| 012B | Valve closure element | 438E | O'ring |
| 019 | Thrust washer | 438F | Seal |
| 019A | Washer | 438G | Seal |
| 021B | Bleed body | 438K | Seal |
| 025 | Clamping bushing | 439A | Guide bush |
| 037 | Plunger cylinder | 439B | Needle |
| 045 | Strainer connection | B | Plunger mounting screw |
| 047 | Tube | F | Screw (liquid end spacer attaching) |
| 047A | Filter cloth | I | Seal |
| 072 | Displacement chamber | K | Strainer body |
| 072A | Adaptator | L | Diaphragm |
| 072B | Clamping lug | S | O'ring |
| 098 | Contour plates | | |

**Fig. 7.2c: Sectional drawing of displacement chamber**




| | |
|---|---|
| T1 | Degassing hole, (mandatorily downwards) |
| 8 | Extractor |
| 12 | Pilot |

**Fig. 7.2d : Fitting the pilot**

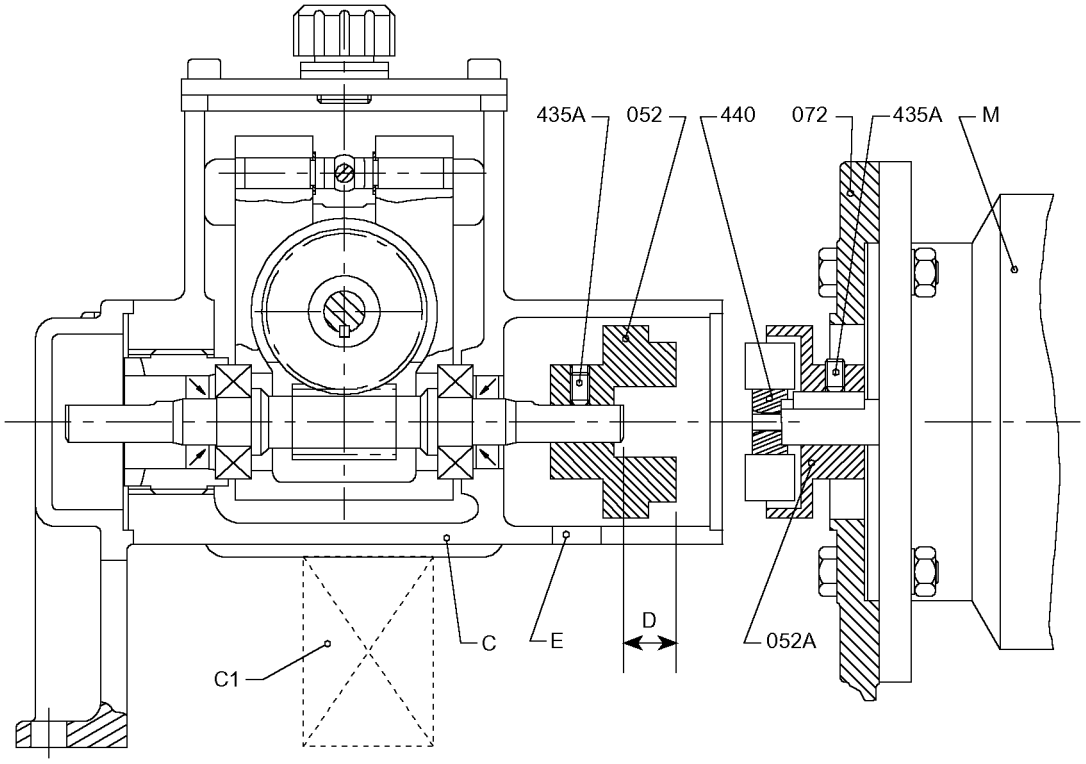



| | | | |
|---|---|---|---|
| 010 | Crosshead | 281A | Crank support |
| 014 | Connecting rod | | |

**Fig. 8.1a : Diagram of mechanical assembly (Milroyal D)**

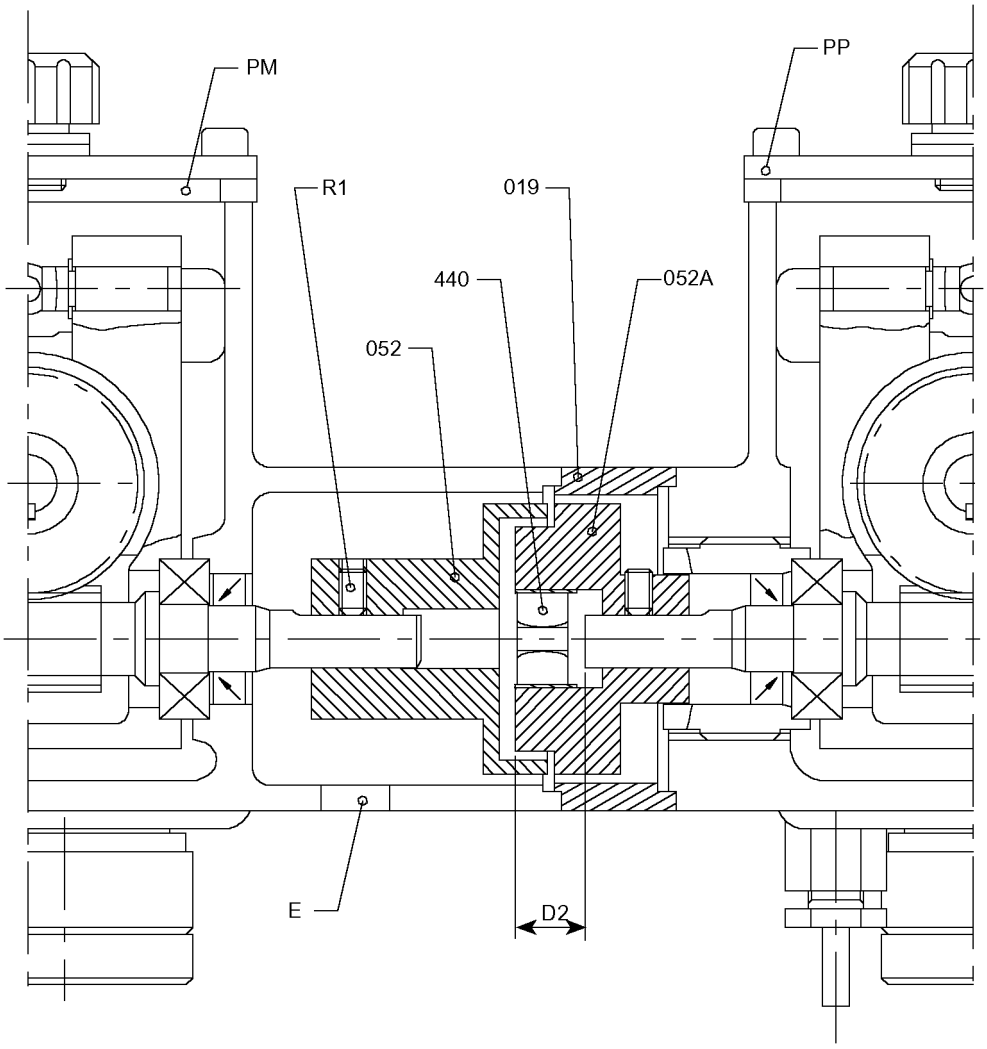
SX

M1




| | | | |
|---|---|---|---|
| C | Housing | 052A | Half coupling on housing side |
| C1 | Wedges | 072 | Motor support |
| M | Motor | 435A | Screw |
| 052 | Half coupling on motor side | 440 | Shock absorber |

**Fig. 8.2a : Fitting the motor**

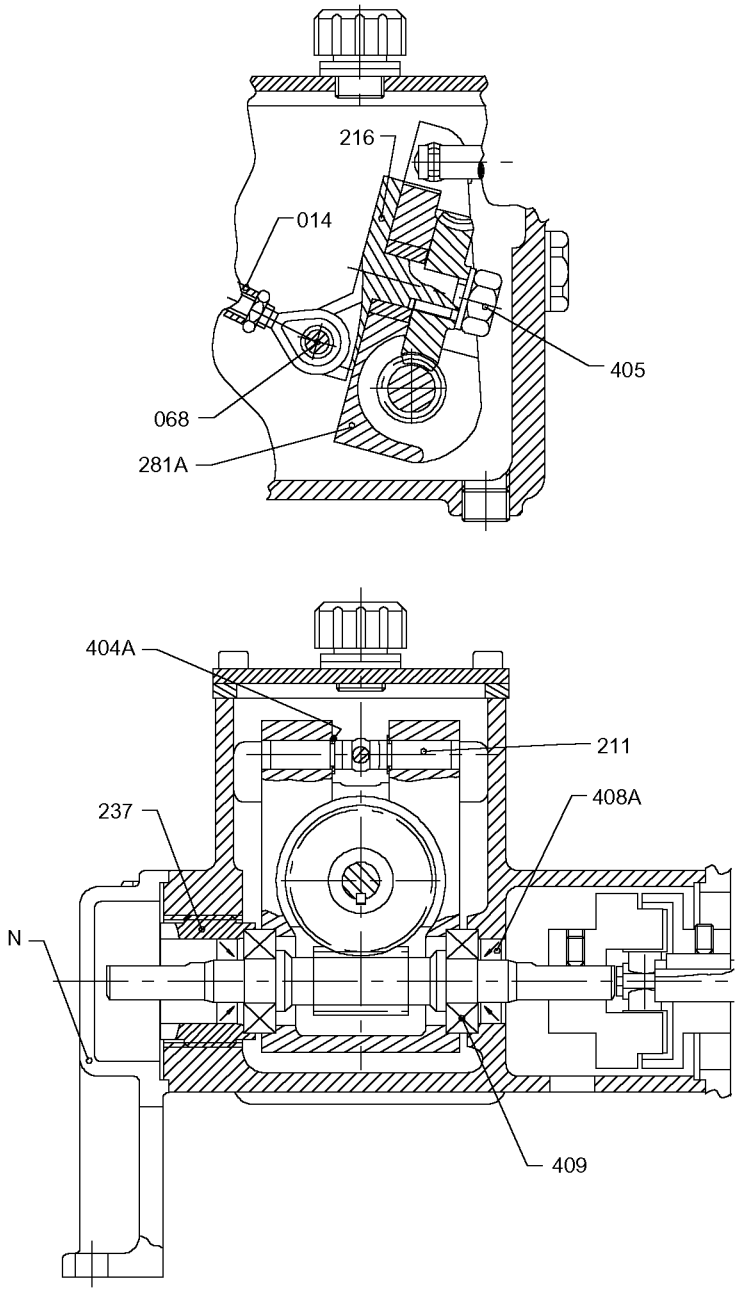



| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.P. | previous pump |
| 052A | Half coupling | R1 | Screw |
| 440 | Shock absorber | | |

Mi

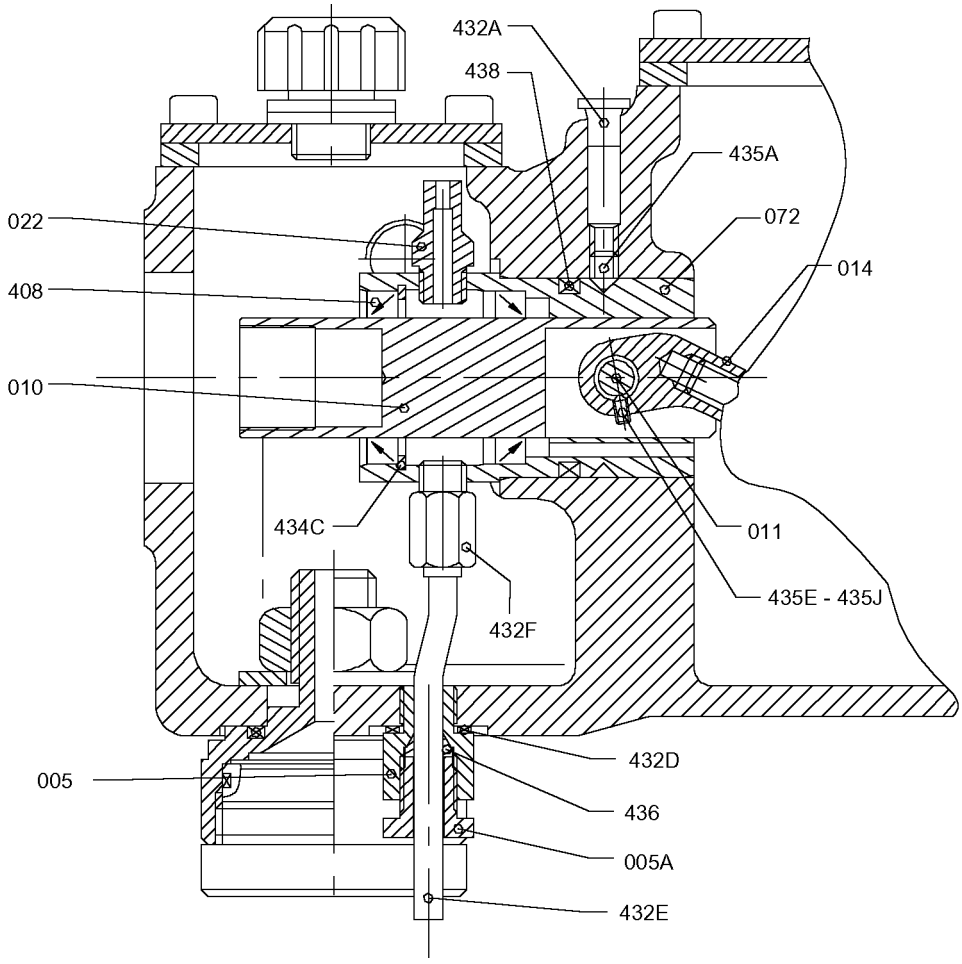
Mn

**Fig. 8.2 a : Multiplexing coupling (previous pump)**



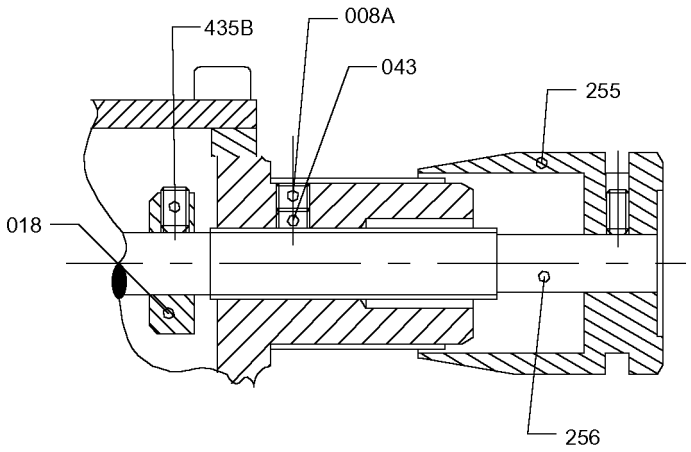

| | | | |
|---|---|---|---|
| 014 | Connecting rod | 405 | Nut |
| 068 | Pin axis | 408A | Worm shaft seal |
| 211 | Adjusting die | 409 | Ball bearing |
| 237 | Bearing screw | 435J | Nut |
| 281A | Crank support | N | Attaching lug |
| 404A | Stop ring | | |

**Fig. 8.2b : Sectional drawing of housing (Milroyal D)**




| | | | |
|---|---|---|---|
| 005 | Connection | 432D | Seal |
| 005A | Packing cover | 432E | Tubing |
| 010 | Crosshead | 432F | Tapping |
| 011 | Axis | 434C | Retaining ring |
| 014 | Connecting rod | 435A | Screw |
| 022 | Bleed | 435E | Screw |
| 072 | Liner | 435J | Nut |
| 408 | Crosshead oil seal | 436 | Packing |
| 432A | Plug | 438 | O-ring |

**Fig. 8.2c : Sectional drawing of spacer (Milroyal D)**

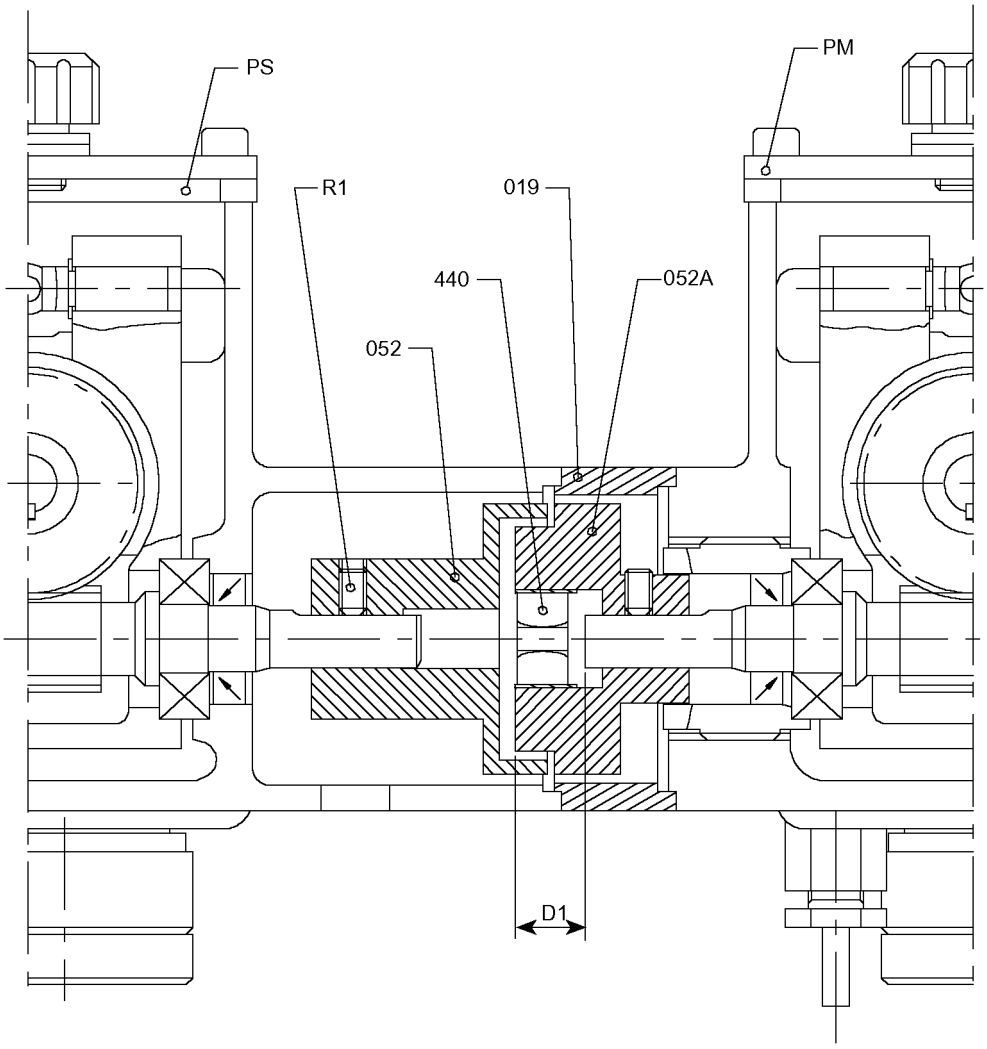



D

VF

| | | | |
|---|---|---|---|
| 018 | Stop collar | 256 | Micrometer screw |
| 043 | Lock insert | 435B | Screw |
| 255 | Stroke adjustment knob | 008A | Screw |

**Fig. 8.2d : Sectional drawing of the flow adjustment (Milroyal D)**




M1

Mi

| | | | |
|---|---|---|---|
| 019 | spacer | P.M. | instruction manual pump |
| 052 | Half coupling | P.S. | Next pump |
| 052A | Half coupling | R1 | Vis |
| 440 | Shock absorber | | |

**Fig. 8.2e : Multiplexing coupling (Next pump)**