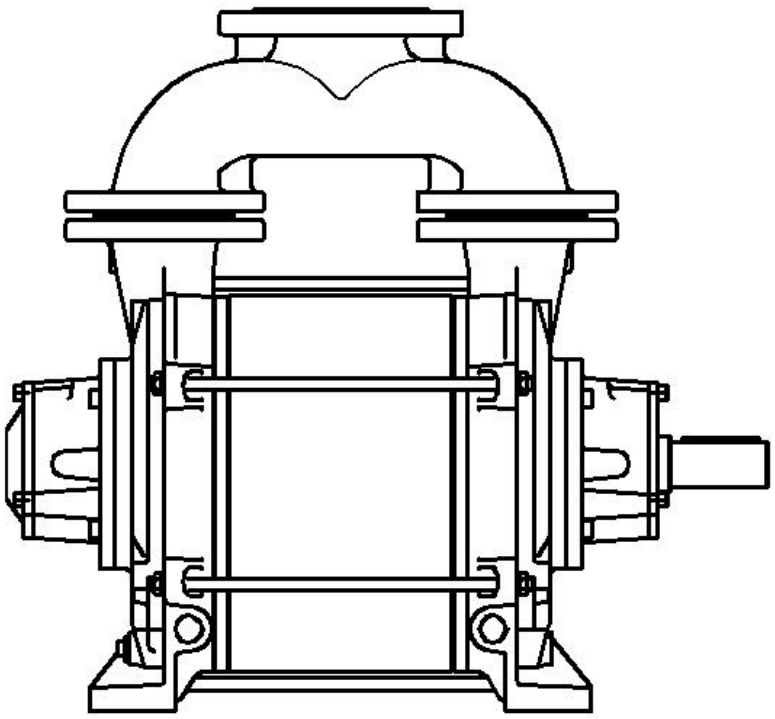
DEX

LIQUID RING VACUUM PUMPS

OPERATION AND MAINTENANCE MANUAL



INDEX

1. *INTRODUCTION* *Page 3*

2. *REVIEW OF THE SHIPPING DOCUMENTS* *,, 3*

3. *WARRANTY* *,, 3*

4. *OPERATING PRINCIPLE* *,, 4*

5. *TECHNICAL DESCRIPTION* *,, 4*

6. *USE* *,, 5*
USE AS A VACUUM PUMP
USE AS A COMPRESSOR

7. OPERATING CONDITIONS *,, 6*
OPERATING DATA
GAS AND VAPOURS
SERVICE LIQUID SUPPLY

8. TRANSPORT *,, 7*

9. STORAGE *,, 8*
SHORT TERM STORAGE
LONG TERM STORAGE

10. STANDARD NORMS FOR SAFETY *,, 8*
GENERAL PRESCRIPTIONS
PRECAUTIONS DURING OPERATION

11. ADDITIONAL RISKS *,, 9*

12. INSTALLATION *,, 9*

13. CONNECTIONS *,, 10*
PIPEWORK
ACCESSORIES
ELECTRICAL WIRING

14. SERVICE LIQUID SUPPLY ARRANGEMENTS *,, 10*

15. START UP *,, 14*
PREPARATION TO START UP
START UP
STOP

16. SHUT DOWN PERIOD *,, 15*

17. MAINTENANCE *,, 15*

18. OPERATING PROBLEMS AND TROUBLE SHOOTING *,, 16*

19. REPAIR *,, 17*
DISASSEMBLY OF THE CASING, PORT PLATE AND IMPELLER
REASSEMBLY OF THE IMPELLER, PORT PLATE AND CASING

20. SPARE PARTS *,, 21*

21. PUMP SCRAP AND DISPOSAL *,, 21*

ATTACHMENTS: SECTION WITH PART

1. INTRODUCTION

The purpose of the present manual is to ease the installation, the operation and the routine maintenance activities of the liquid ring vacuum pumps belonging to the **DEX** range.

Before proceeding with the installation and the start up of the pump, it is very important to undertake the reading of the present manual, inform the operators and the plant personnel about the content of each section in order to grant the correct operation of the equipment as well as the maximum safety of the personnel in charge for installation, start up and maintenance.

Please note that the **DEX** liquid ring vacuum pumps could be potentially harmful to people and things for the following reasons:

- ***Rotating parts at high speed***
- ***Deep vacuum***
- ***Fluids and gas handled by the equipment could be hazardous and toxic***
- ***Presence of electric power***

WARNING !

The non observance of the instructions reported in this manual or the improper use of the pump by unskilled and/or unauthorised personnel may result in severe damage to things or serious injury and even death of people!
The Technical and Service Departments are available for any technical assistance or clarification you may need. In case of doubt, call up.

2. REVIEW OF THE SHIPPING DOCUMENTS

When receiving the goods, it is necessary to inspect and check them against the shipping documents. Make sure that no shipping damages are occurred to the equipment during transportation.

3. WARRANTY

The warranty does not cover for damages or failures caused by mishandling, incorrect installation and wrong electrical wiring of any piece of equipment of the plant.
In any case the warranty excludes the reimbursement for any sort of damages originated by any cause.
Ing. Centra declines any responsibility for what concerns to injuries of people and damages to things due to the improper use of its equipment.
For additional or replacement warranty clauses in respect to the statements of present manual, please refer to the contractual conditions mentioned in the order acknowledgement.

Consumables are not subject to any warranty.

4. OPERATING PRINCIPLE

Pumps belonging to the **DEX** range are designed and operating based on the liquid ring principle.
The pump consists of a cylindrical housing within which an impeller with fixed blades turns off set in respect to the housing itself.
The impeller rotation spins by centrifugal force the service liquid around the housing thus forming a ring of liquid concentrically to the housing. Because of the off set between the housing and the impeller, during the impeller revolution, chambers between the blades are formed with a progressively increasing and decreasing volume resulting in producing respectively vacuum and compression. The presence of vacuum in the inlet port area draws in gas through the pump suction nozzle which is then compressed and discharged through the discharge port up to the dedicated pump nozzle.
During pump operation, it has to be supplied a continuos service liquid flow in order to remove the heat absorbed by the liquid itself due to the isothermal compression.

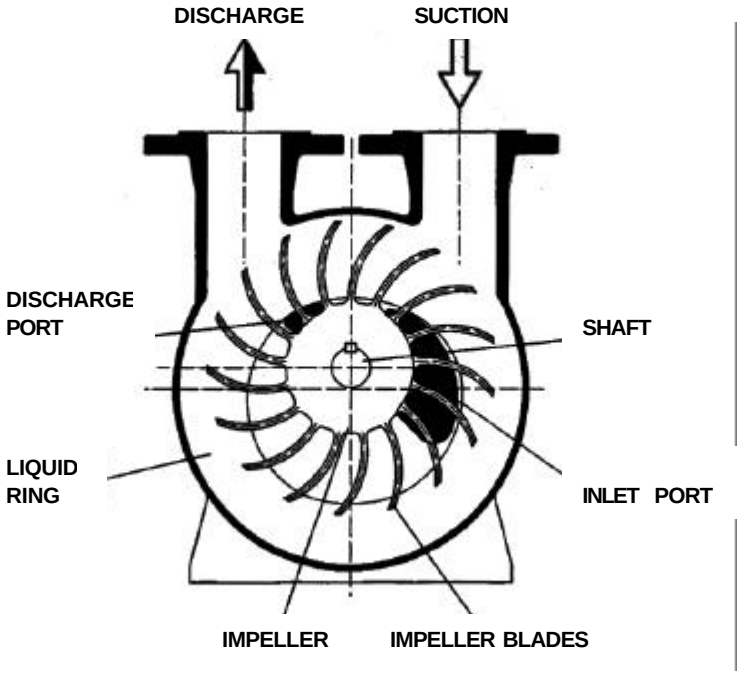


FIG. 1

5. TECHNICAL DESCRIPTION

The **DEX** pump is single stage type, acting in parallel due to the symmetric design, with horizontal axis, provided with vary port valves. The rotating part is supported by two robust life grease lubricated ball bearings located in the casings at shaft ends.
The pump is self standing on feet present under each casing.
The pump shaft driving end has to be connected an electric motor in B3 construction through a flexible coupling.

The shaft sealing is granted by two single mechanical seals, standardized according to DIN 24960, fitted directly on the shaft and located in each casing (shaft ends).

The standardisation of specific items among different pump sizes reflects the modular design in order to rationalise the construction of the whole range and reduce the amount of spare parts to be kept on stock.

6. USE

DEX pumps are mainly used for the following applications:

Suction of gas and vapours from autoclaves and sterilizers
Vacuum packaging, drying and impregnation
Priming
Process under vacuum, suction of gas and vapours in the chemical, food and wine industry
Dryers and evaporators used in the textile, brick and soap industry
Solvent recovery.

• USE AS VACUUM PUMP

The whole range of **DEX** liquid ring vacuum pumps can handle any gas suitable with the material of construction and with the service liquid as well as limited quantity of liquid carry over flowing into the pump together with the process gas.

The deepest suction pressure which can be achieved by the pump is related to the vapour tension of the service liquid; any time the vapour tension comes close to the suction pressure the pump may cavitate therefore it is advisable to keep the service liquid temperature as low as possible.
Process conditions close to cavitation do require the installation of an anticavitation valve or relief valve to protect the pump (see section 13).
In case it is requested a deeper suction pressure compared to what the pump can provide, it is possible to combine the pump with a gas ejector (or other type of equipment) in order to achieve even 10 mbar abs. of vacuum.

The recommended operating limits are reported in TAB.1.

CAUTION !

The extensive use of the pump under cavitation conditions may result in heavy damages to the pump itself.

• USE AS COMPRESSOR

The **DEX** liquid ring pump range can be used also as a compressor.
Normally when the gas suction pressure is atmospheric (1013 mbar abs.), the discharge pressure must not exceed the differential pressure stated in TAB.1 where are indicated the operating limits.

TAB. 1

PUMP MODEL		**DEX 600-800**
Max. pump speed	rpm	1750
Max. inlet gas temperature	° C	100
Max. service liquid temperature	° C	70
Max. discharge pressure (vacuum pump)	mbar	200
Max. differential pressure (compressor)	mbar	1100

7. OPERATING CONDITIONS

- **OPERATING DATA**

The nominal pump capacity and the absorbed power related to the suction pressure or differential pressure can be determined by reading the performance curve attached to the technical-commercial documentation submitted with the offer or with the order acknowledgement; in any case it will be provided copy of upon customer request.

- **GAS AND VAPOURS**

Gases and vapours handled by the pump as well as the service liquid must not contain solid particles which may damage the seal surface of the mechanical seal stationary and rotating ring; minor quantities of fine solids in suspension are admitted.
In case the inlet temperature of the process gas is above 70°C, it may be necessary to increase the service liquid flow rate up to even 50% more compared to the design flow stated in TAB. 3.
If the inlet stream contains a consistent quantity of condensables, it is advisable to install a pre condenser ahead of the pump suction nozzle; the condensate resulting from the cooling can flow into the pump provided that the total amount shall not exceed the allowed max. quantity of liquid carry over stated in TAB 2.

- **SERVICE LIQUID SUPPLY**

As already mentioned above, the service liquid shall not contain any solid particles therefore it is recommendable to install a strainer in the service liquid supply piping.
The flow rates stated in TAB. 3 are mandatory; those values are referred to suction conditions of dry gas only.
The pressure of the service liquid supply shall be adequate to overcome the pressure losses of the liquid through the piping and through the heat exchanger, if any, plus assure a positive pressure of 0,5 bar above the pump discharge pressure at pump service liquid inlet.
The selected service liquid must be compatible with the process gases and vapours, its density shall range from 800 to 1200 Kg/m^3 and its viscosity shall be below 8 cST.

Pump improper use or not in accordance with what specified and recommended in the present manual may result in malfunctioning of the equipment and in serious consequences for people and things.

TAB. 2

PUMP MODEL	Max. quantity of liquid carry over allowed through the suction nozzle (m^3/h)	
	Continuos operation	Discontinuous operation
DEX 600	6,2	6,7
DEX 800	7,8	8,4

TAB. 3

DESIGN SERVICE LIQUID FLOW RATE (m^3/h)							
PUMP MODEL	RPM	VACUUM PUMP			COMPRESSOR		
		Suction pressure (mbar)			Differential pressure (mbar)		
		40	200	600	200	600	1000
DEX 600	1450	2	1,9	1,8	1,8	1,7	1,6
	1750	2,2	2,2	2	2	1,9	1,8
DEX 800	1450	2,5	2,25	2,1	2,2	2,1	2
	1750	2,5	2,25	2,1	2,2	2,1	2

8. TRANSPORT

Before arranging the transport of the pump, the following has to be checked:

- Weight of the pump/equipment
- Overall dimensions of the pump/equipment
- Lifting points

WARNING !

The pump must be transported by selecting adequate means of lifting and transportation suitable to the pump weight and to its packing dimensions nevertheless in compliance with the safety standards on force.
When transporting, installing and performing maintenance, it is important to grant a safe lifting of the equipment; use serviceable lifting slings installed and operated by skilful personnel (see FIG. 2).
Any eye bolt or lifting point present on a single part of the pump shall not be used for any reason to lift the whole pump assembly or the vacuum unit.

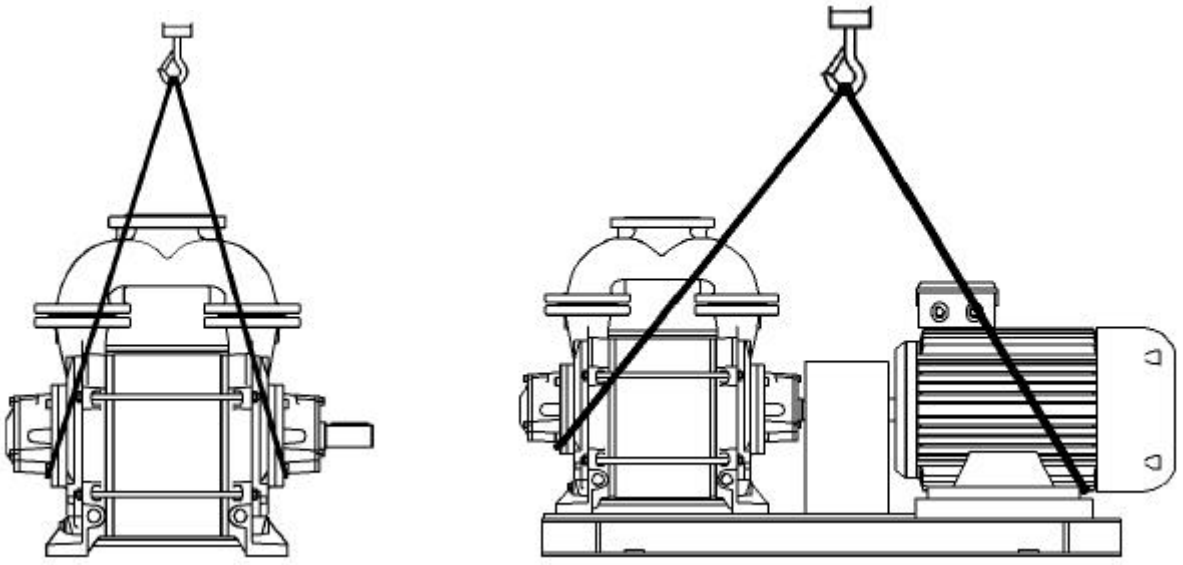


FIG. 2

9. STORAGE

All **DEX** pumps are dispatched with the main connections like suction and discharge nozzles, service liquid connection, etc. closed by plastic plugs or adhesive disks.

- **SHORT TERM STORAGE (UP TO 2 MONTHS) :**

-Store the pump indoor and possibly in a dry and clean environment.
-Make sure that the ambient temperature does not go below 5°C.
-**On a routine basis (every 10 day max.) turn the pump rotating part for some revolutions by acting on the motor cooling fan.**

- **LONG TERM STORAGE (MORE THAN 2÷3 MONTHS) :**

-Lift the pump from the floor by putting wood blocks underneath.
-Periodically replace the inhibitor oil to increase the internal preservation status or pour in additional oil (example Mobil Oil type SINTILO R) through the suction nozzle after having removed the protection plugs. Afterwards it is recommendable to re install the plugs.
-Fully cover the pump with a plastic sheet or PVC film and put inside anticondensation products.
-Check on a regular basis the conditions of the protections.
-**On a routine basis (every 30 day max.) turn the pump rotating part for some revolutions by acting on the shaft drive end or on the coupling if it is already installed on a base and connected to a motor.**

10. GENERAL NORMS FOR SAFETY

Before pump start up it is necessary to activate all protection devices meant for people and things so that any possibility of hazardous risk is avoided during operation but also during routine maintenance of the pump and of its accessories.

- **GENERAL PRECAUTIONS**

DEX pumps shall be used exclusively for the specified duty and within the limitations stated in the technical-commercial documentation submitted at quotation stage or with the order acknowledgement.
For any use not covered by the present manual, it is necessary to contact the Technical Department in order to get confirmation of the suitability to the new operating conditions in terms of performance, safety and duration.

- **PRECAUTIONS TO BE FOLLOWED DURING OPERATION**

-Avoid to get close to pump suction and discharge nozzles.
-In case the pump is running at high temperature due to hot sucked gas or hot service liquid, protections against the accidental contact with external parts have to be foreseen and installed.
-When running, do not disconnect any pump auxiliary piping (service liquid supply line, etc.).
-Avoid to run the pump under cavitation for long time (it makes high and unpleasant noise).
-On routine basis, the efficiency of the monitoring and protecting devices has to be checked.
-Check that all electrical devices with protection duties are installed and activated.

11. RESIDUAL RISKS

Avoid to have the pump suffering from:

-Shocks.
-Mishandling or moving errors of mobile means present around the pump.
-Hitting with sharp and heavy equipment.
-Dry operation or running under cavitation.
-Improper use with dangerous or hazardous liquids and gases, different from those stated in the specifications issued for order.

In case of failure, check that all protection and safety devices are functioning and activated, afterwards disconnect the electric power supply and advise the plant personnel responsible for the operation.

12. INSTALLATION

DEX pumps are normally connected to the electric motor by means of a flexible coupling.
The equipment is accommodated on a base in welded construction.
It is mandatory to fix the pump base on a foundation made in concrete by using anchor bolts or expansion bolts passing through the dedicated base holes.
The base shall be located on a levelled floor; if required, use metal shims of different thickness to put underneath the base in order to get a proper base levelling.
When the pump is supplied together with the motor on a base, the alignment of the assembly is made in the workshop; **in any case it is necessary to re-check the alignment of the assembly after the fixing on the foundation.**
If it is a new installation, before tightening the foundation bolts, check the concrete set and its consistency.

- **PUMP-MOTOR ALIGNMENT**

Before starting up the pump it is mandatory to check the pump-motor alignment.
To check the alignment it is necessary to inspect the concentricity and parallelism of the installed coupling halves by using a ruler, a feeler gauge, a sliding gauge or a dial gauge.
Remove the coupling guard first; put the ruler against the halves in position 1-2-3-4 (see Fig. 3) and check with the feeler gauge or the dial gauge that the radial clearance "**a**" does not exceed 0,1 mm.
Measure with the sliding gauge the distance "**b**" in position 1-2-3-4; the difference among the four measurements shall not exceed 0,1mm.
Additionally, check that the distance between the coupling halves "**b**" is not less than 2 mm.

WHEN THE ALIGNMENT CHECK HAS BEEN COMPLETED, RE-INSTALL THE COUPLING GUARD!

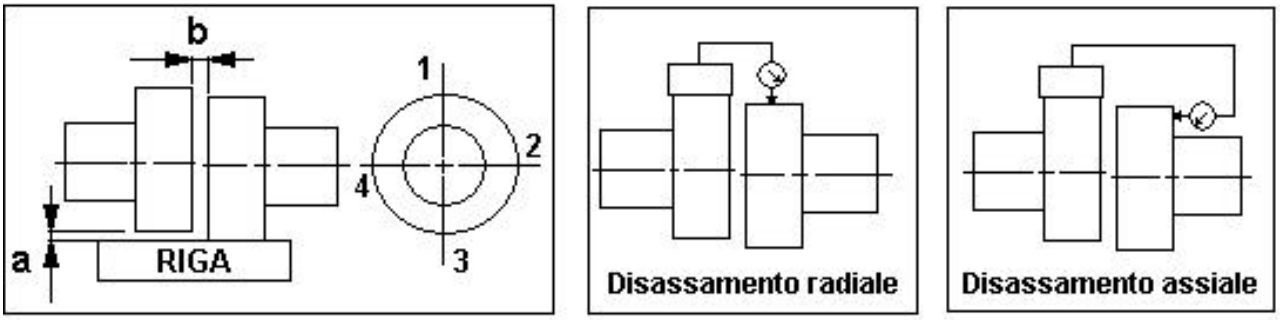


FIG. 3

13. CONNECTIONS

- **PIPEWORK**

As already stated previously, the pumps are dispatched with the main nozzle and the service liquid connection closed with protection plugs.

CAUTION !

Remove the protections only when the pump is ready for being connected to the plant pipework. Before doing it, make sure that all piping has been checked for cleanness.

To increase the protection at start up, during the first operation hours it can be fitted an inlet screen on the pump suction with the aim to avoid that any welding shot or dirt still present in the pipework may enter into the pump.
The suction and discharge nozzles can be easily identified by checking the arrows located closed to each nozzle.
Each pipe connected to the pump must have the same diameter size of the respective pump nozzle and shall be constructed so that it easily connects with the dedicated pump nozzle allowing the tightening of the bolting without any consequence to the pump casing.
The service liquid supply pipe, before branching off to the service liquid connection points located on each pump casing, shall be double in size compared to each pump connection point.
It is extremely important to adequately support the suction and discharge pipework in order to avoid loads on the nozzles which may generate problems to the smooth operation of the pump.
When constructing the pipework, pay attention to the fittings and to the supporting structures in order to take into account allowance for thermal expansion.
The vertical section of the discharge line shall not exceed 1 meter height in order to avoid the forming of backpressure inside the pump with consequent motor overload and pump flooding during pump shut down caused by the return of the discharged liquid back into the housing.

14. SERVICE LIQUID SUPPLY ARRANGEMENTS

- **ONCE THROUGH (FIG. 4)**

Standard arrangement for installation where there is enough fresh service liquid available and there are no handling problems down-stream as both the liquid and the gas are not considered polluted and polluting.
The gas mixed together with the service liquid can be sent directly into the discharge system or, if it is requested a gas-liquid separation, to a separator tank: by gravity, the gas will flow out from the top and the liquid from the bottom.
It is recommended to make sure that the service liquid supply pressure will be 0,5 bar above the pump discharge pressure.

- **PARTIAL RECIRCULATION (FIG. 5)**

This configuration is particularly indicated when the fresh liquid consumption must be low, the pump can take service liquid at a higher temperature compared to the fresh liquid and when there are no handling problems down-stream as both the liquid and the gas are not considered polluted and polluting.
The service liquid flow consists partly of fresh liquid (normally approx. 50%) and the remaining quantity by liquid at higher temperature recovered from the separator tank.
Also in this case it is recommended to make sure that the service liquid supply pressure will be 0,5 bar above the pump discharge pressure.

- **RECIRCULATED SERVICE LIQUID ARRANGEMENT (FIG. 6)**

This arrangement has to be followed any time there is an application which requires to avoid any process gas leakage or when there are involved fluids which for their chemical composition or pollution caused by the process gas can not be leave the plant for environmental or process reasons.
The service liquid flows from the pump into the separator tank, recirculated back through a heat exchanger where it is cooled down at the specified temperature and then back to the pump.
In case the heat exchanger generates a high a pressure drop thus altering the conditions for a good service liquid supply, it is necessary to install a recirculation pump to restore the pressure required in the system.

- **ACCESSORIES (see FIG. 4-5-6-7)**

Particular attention has to be paid when installing the **gaskets** between flanges which shall be placed concentrically in respect to the flange to avoid the restriction of the area dedicated to the passing of fluids.

-A **check valve** is fitted on the pump suction nozzle when it runs as a vacuum pump in order to avoid the loss of vacuum ahead of the pump; the check valve is installed on the gas discharge line when the pump runs as a compressor in order to prevent the loss of the backpressure.

-The separation of the process gases from the service liquid normally takes place in a **separator tank** which has also the duty to recover the service liquid completely or partially.
The separator can be fitted directly on top of the pump discharge nozzle or to the side of the pump with a tangential inlet.
Normally the separator tank is provided with an **overflow connection** (to drain the excess of liquid in case the pump sucks liquid or process vapours which do condense) and a service liquid **make up** connection.

-When the **DEX** pump runs with full recirculated service liquid, it is required to cool down the service liquid at the design inlet temperature; this can be achieved by using a **heat exchanger** located on the recirculated service liquid line back to the pump.

-The service liquid **recirculation pump** is usually installed together with a check valve fitted on its discharge line and followed down stream by a **flow adjusting valve**.

-The monitoring of the service liquid flow can be made either with a **pressure gauge,** located down stream the recirculation pump, in combination with the knowledge of the recirculation pump performance or, more accurately, by a **flow meter** or a **flow indicator** installed on the service liquid recirculation line.

-When the pump runs close to cavitation conditions, or the process stream contains gases with high vapour tension, it is recommend to install an **anticavitation valve** on the service liquid supply line before it branches off to the casing connection points; It shall be fitted in vertical position (!) and normally connected to the separator.

-To avoid the flooding of the liquid ring pump during shut down time, it is required to stop the recirculation pump at the same time when the liquid ring pump is stopped.

-On complex plants or when there are present toxic and hazardous gases and liquids, normally there are installed monitoring, control and self adjusting equipment, safety devices to check levels, flow rates, pressures in all critical points like **low/high level switches, actuated valves**, **control valves, safety valves and any sort of extra safeties/alarms.**

-When installing a **gas ejector** on the pump suction, it can be achieved a deeper vacuum.
The ejector does not have any impact on the absorbed power and usually it is installed in vertical position.
(it can be also installed in horizontal position without affecting the functioning).

CAUTION !

The gas ejector motive fluid must not contain any liquid droplets!

To reduce the hogging time when the pump is combined with a gas ejector, it is recommendable to provide an ejector **by-pass line** including **shut off** valve; as soon as the pump runs close to 50 mbar abs, the ejector can be brought in operation by closing the by pass valve.

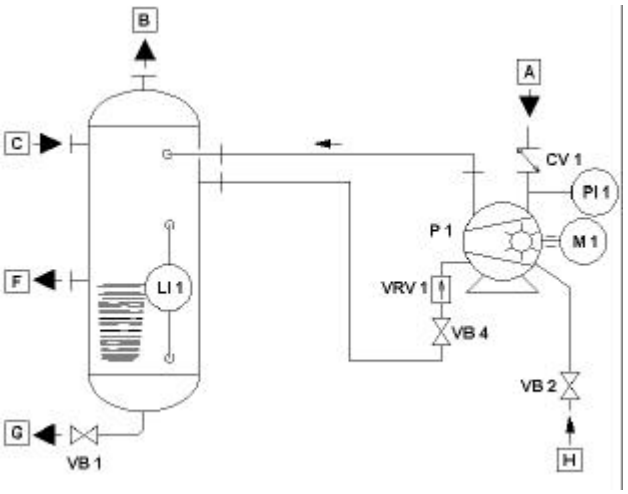


FIG. 4

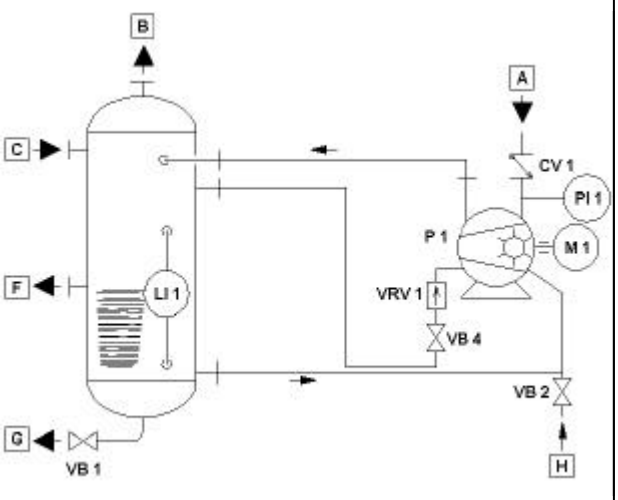


FIG. 5

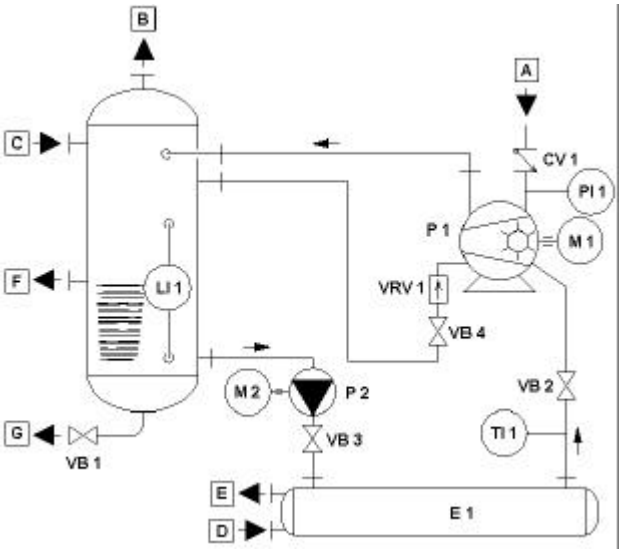
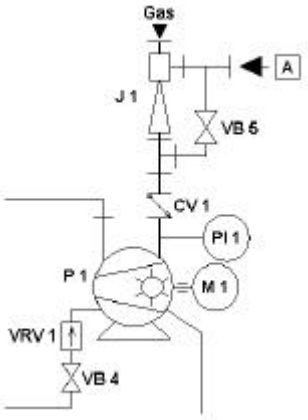


FIG. 6



Ejector with by-pass

FIG. 7

LEGEND

NOZZLE	
A	SUCTION
B	DISCHARGE
C	SERVICE LIQUID MAKE UP
D	COOLING WATER INLET
E	COOLING WATER OUTLET
F	OVERFLOW
G	SEPARATOR DRAIN
H	SERVICE LIQUID INLET

ACCESSORIES	
P 1	Vacuum pump
M 1	Vacuum pump electric motor
V 1	Separator tank
E 1	Heat exchanger
P 2	Recirculation pump
M 2	Recirculation pump electric motor
CV 1	Inlet check valve
PI 1	Vacuum gauge
TI 1	Temperature gauge
VRV 1	Anticavitation valve
J 1	Gas ejector
VB 1	Drain valve
VB 2 – VB 5	Shut off valve
VB 3 – VB 4	Adjusting valve

- **WIRING**

The electrical wiring must be carried out by specialised personnel only; it has to be strictly followed the instructions provided by the electric motor supplier and by the various manufacturers of the electric components involved in.
Check that the motor name plate data matches with the local power supply in terms of voltage, frequency, phase and absorbed current.
In case of three phase power supply, check that the voltage of all phases is identical.
Connect the motor earthing properly.
Remove the terminal box cover by losing the fixing screws; connect the wires as indicated in the instructions or on the inside of the cover and **then reposition the terminal box cover and fix it by tightening the dedicated screws.**
It is recommended to install a thermal circuit breaker in order to protect the motor from excessive low voltage or overload.
For its correct sizing, follow the current values reported on the motor nameplate.

15. START UP

- **PREPARATION TO START UP**

When the pump is started up for the first time, the following checks shall be performed:
-Open the shut off valve located on the pump discharge line, if any.
-Check the tightness of the gaskets installed in the pipework.
-Prime the pump and the service liquid lines up to the pump center-line or up to the highest level allowed by the level control devices.
-Check the sense of rotation of the liquid ring pump and of the recirculation pump, if any, by starting the dedicated motors for a very short time. If the sense of rotation is not correct, assuming the power supply is three phase, disconnect the power supply, open the motor terminal box and exchange the connection of two phases, afterwards close the terminal box by fixing the cover; **when performing this step make sure that the safety device which prevents the accidental supply of power is activated.**

- **START UP**

Start up the pump after having checked that all shut off valves located in the suction and discharge lines are open as well as the service liquid supply shut off valve in case of once through or partial recirculation arrangement. Start up the recirculation pump, if any.
Just after start up, the service liquid flow adjusting valve has to be set according to the amount required by the pump. Block the achieved valve setting; this position shall be kept even during shut down period (for safety, it is advisable to remove the hand wheel to prevent any tampering).
The exact service liquid flow required by each **DEX** model is specified in TAB. 3.
Open the cooling water supply to the heat exchanger, if present, and adjust the flow according to the value stated in the specific documentation.
Check that the current absorbed by the motor and indicated by the Amp meter located in the panel does not exceed the value reported on the motor nameplate.
Check that the pump runs smoothly by turning silent and without vibration.
In case during pump operation there is the impression that there is something wrong with the pump, it is required to stop it immediately and to identify the reason of the malfunctioning.

During the normal operation, check on a routine basis the main parameters like the suction pressure, the discharge pressure by reading the vacuum or pressure gauge, the level in the separator, the service liquid flow and temperature and the motor absorbed current.
If required, add make up liquid inside the separator.

DO NOT RUN THE PUMP WITHOUT SERVICE LIQUID !
BEFORE STARTING UP THE PUMP, IT IS NECESSARY THAT THE PLANT IS COMPLETED FROM BOTH MECHANICAL AND ELECTRICAL POINT OF VIEW, IN ACCORDANCE WITH THE LOCAL SAFETY STANDARDS ON FORCE.

- **STOP**

Switch off the vacuum pump motor and the recirculation pump motor, if any; stop the service liquid supply in case of once through or partial recirculation or stop the cooling water supply to the heat exchanger by closing the dedicated valves in case of recirculated service liquid arrangement.
If the process conditions require the pump stop against the presence of vacuum ahead of the pump below 100 mbar, in order to allow the pump to start again, it is necessary to arrange the equalising of the pressure inside the suction and discharge lines.
This is not required if there is installed the anticavitation valve.

16. SHUT DOWN PERIOD

When it is foreseen a relatively long shut down period (more than 2 months), or when meant required, it is necessary to drain the liquid ring pump but also the recirculation pump and the heat exchanger, if present.
Remove the threaded drain plugs located in the lowest part of the pump casing and wait for the complete discharge of the liquid.
This procedure has to followed also when it is required to preserve the pumps and the heat exchanger from potential damages caused by freezing or when the service liquid may generate deposits.

If the service liquid is classified hazardous then before draining the pump it is mandatory to flush the service liquid circuit by using a suitable liquid; the flushing can be made by keeping the pump in operation.

IT IS END USER DUTY TO MAKE SURE THAT THE DISPOSAL OF THE SERVICE LIQUID MAY CAUSE DANGER TO PEOPLE HEALTH AND TO THINGS AND THAT THE ADOPTED DISPOSAL PROCEDURES SHALL COMPLY TO THE LOCAL LAW AND RELEVANT STANDARDS ON FORCE.

17. MAINTENANCE

If the pump runs within the limits of the operating range specified in the previous sections and, more important, if the service liquid is clean and does not contain solid abrasive particles, the **DEX** pumps will be able to operate for long time without the need of performing any maintenance activity.
The personnel in charge for the plant operation is routinely requested to check the smooth operation of the pump according to the procedures reported in section 15.

Extreme care has to be dedicated any time there is a leak from the mechanical seals or when an unusual noise or vibration arises either from the pump or from the motor particularly if it is associated with an increase in power consumption or irregular fluctuations of the Amp meter.
When water is used as service liquid, especially in case of reciculated service liquid arrangement, it is required to check its hardness as it might form lime deposits on the internals with consequent wear of the inner parts and increase of the absorbed power.

The most important and frequent maintenance activities are normally the following:

- Replacement of the mechanical seals
- Pump internal cleaning
- Replacement of the bearings

For any activity involving the pump disassembly and reassembly in order to replace failed parts, please refer to Section 19 – REPAIR.

18. OPERATING PROBLEMS AND TROUBLE SHOOTING

All actions to be put in place to recover from the malfunctioning problems reported in the next table (TAB. 4) must be performed in full safety conditions and, depending on the type of action required, in accordance with the procedures described in the dedicated section of the present manual.

TAB. 4

MALFUNCTIONING	*POSSIBLE CAUSE*	REMEDY
1. The motor is switched on but does not turn and makes no noise	*1.1 At least two wires are cut off*	Check the rating of the motor protection device and the wiring to the terminals of the motor box
2. The motor is switched on but does not turn and makes some buzzing noise	*2.1 At least one wire is cut off.* *2.2 The pump rotating part is blocked due to dirt or deposits*	Check the wiring to the terminals of the terminal box Drain the pump, clean and remove the lime build up on the internals
3. The motor protection device goes on just after start up	*3.1 Short cut in the motor winding* *3.2 Motor overload* *3.3 Backpressure is to high* *3.4 Too much liquid goes into the pump through the suction stream* *3.5 The motor rotor is blocked*	Check and replace the motor Decrease the service water flow Decrease the backpressure Reduce the liquid carry over See point 2.2 and 2.3
4. Absorbed current above the rated value stated on the motor nameplate	*4.1 Deposits or foreign material inside the pump* *4.2 Backpressure is to high* *4.3 Too much liquid goes into the pump through the suction stream* *4.4 Motor overload*	See point 2.2 See point 3.3 See point 3.4 Reduce the service liquid flow
5. The pump does not make vacuum	*5.1 No supply of service liquid* *5.2 Air leak in the suction line* *5.2 Wrong sense of rotation*	Check the service liquid line Check the tightness of the suction line and gaskets conditions Exchange the connection of two phases
6. The inlet pressure provided by the pump is not deep enough	*6.1 The pump is undersized* *6.2 Low service liquid flow* *6.3 The service liquid temperature is too high* *6.4 Air leak in the suction line* *6.5 Excessive wear of pump internals* *6.6 Failure of the vary port valves*	Replace the pump Increase the service liquid flow Reduce the service liquid temperature or increase the flow See point 5.2 Reconditioning of the pump is required Replace the vary port valve
7. Unusual internal noise	*7.1 Pump runs under cavitation* *7.2 Excessive service liquid flow*	Install the anticavitation valve or arrange for an air bleed valve on the suction line Reduce the service liquid flow
8. Liquid leaks between pump housing and casing	*8.1 Gaskets with defects*	Replace the gaskets
9. Pump vibrates and is noisy	*9.1 The impeller is unbalanced* *9.2 Pump bearings are worn out* *9.3 Motor bearings are worn out*	Pump inspection and repair is required Pump inspection and repair is required Repair the motor

19. REPAIR

Due to the accuracy required in performing the disassembly and assembly activities of the **DEX** pumps, they shall be carried out exclusively by trained and skilled personnel.
If required, the pump can be returned back to the Supplier for repair.

Before crating and dispatching the pump back for repair, make sure that the equipment is completely drained and properly cleaned.
In case of operation with toxic and/or hazardous fluids, it is mandatory to flush the pump internals for removing any process trace.
The disposal of the cleaning liquid shall comply to the local law and relevant standards on force.

- **PUMP DISASSEMBLY (see section dwg)**

Before starting the disassembly activity, make sure that all kind of safety precautions have been applied in order to prevent any accidental power supply to the motor with consequent start of the pump!
All activities shall be carried out in accordance with the safety procedures and standards already described in the present manual.

Before disassembly, it is required to isolate the pump from the plant by closing the dedicated valves and then proceed to disconnect the plant piping connected to the pump.
Drain the pump and the service liquid supply line; in case the pump has operated with toxic and hazardous fluids, follow the warning already highlighted.
Remove the coupling guard, lose the fixing bolts holding the pump on the baseplate, take it off and lay it on a working surface which allows to carry out all maintenance activities in an easy way without impediment.

Replacement of the bearings and of the mechanical seals:

Start the disassembly from the drive end: after having removed the coupling half from the pump shaft and its relevant key (945), lose the screws (807) fixing the drive end bearing cover (603) and take it off.
Lose the screws (804) fixing the bearing housing (357), remove the circlip blocking the bearing (241) on the shaft and then slide out the bearing housing complete with the bearing (321), the bearing abutment (240), the lip seal (405) and the mechanical seal stationary ring (436); for the 316 construction (ss), the stationary ring is located in a holder (364) pressed in the housing.
To ease the disassembly of the housing, it is recommended to use two screws (804) of those just removed, by screwing them into the threaded extraction holes present on the housing flange; make sure not to damage the bearing circlip and the mechanical seal stationary ring.
Slide the mechanical seal rotating ring (436) out from the shaft and check the condition of the ring seal surfaces as well as the shaft surface condition in correspondence with the mechanical seal elastomer and of the lip seal.
Remove the bearing from the housing but also the bearing abutment, the mechanical seal stationary ring and check whether the lip seal needs to be replaced or not.

Lose the screws (807) fixing the idle end bearing housing (604); once all screws are out take the housing off.
Lose the bearing locknut (845), lose the screws (804) fixing the bearing housing (357) and then slide out the bearing housing complete with the bearing (322), the bearing abutment (235), all shims (238), the lip seal (405) ad the mechanical seal stationary ring (437) by acting in the same way as done previously for the drive end.

Before proceeding with the replacement of the worn out parts, it is necessary to clean very carefully all parts especially the contact and sliding surfaces (shaft, centering points, seat areas, etc.); the shaft surface in correspondence with the mechanical seal elastomer and of the lip seal which shall be polished and without any sign of wear.
To ease the fitting of the mechanical seal rotating parts (436/437), lubricate the seal elastomers in contact with the shaft by greasing with neutral grease or with soap; in case of installing mechanical seals with tapered spring, make sure that the spring spinning of the new seal matches with the replaced one.

After having installed the mechanical seal stationary ring and, in case of replacement, the lip seal (405) inside its seat present in the bearing housing (357/357.1), slide the housing on the shaft till it ends against the suction-discharge casing (103/104) and fix it by using the dedicated screws (804). Make sure that between the contact surfaces there is the relevant gasket (404).
When carrying out this step, be extremely careful not to damage the lip seal and the mechanical seal stationary ring.
Before installing the bearings (321/322) it is necessary to grease the lip seal by introducing a small quantity of grease in correspondence to the lip so that a proper lubrication is granted.
Slide the bearing abutments (235/240) on the shaft and, on the idle end side, the spacer rings (238) previously removed, then proceed by fitting on the bearings; as the shaft/bearing is a forced fit, use an adequate pipe sleeve together with a rawhide mallet; do not hammer or hit the bearing directly for any reason.
Install on the idle end side the bearing locknut (845) and tighten it till the bearing (322) is blocked against the shoulder while on the drive end side the bearing can be blocked just by installing the dedicated circlip (241).
Close the housing by installing the relative cover (603/604) and fix it by using the dedicated screws (807).

WARNING !

The tickness of the installed spacer rings (238) shall be identical to the one of the removed rings in order to grant that the internal clearance is restored as specified.

Turn the pump shaft by hand and check that there is no friction point.

Pump complete disassembly:

Before disassembly it is required to mark the casings and the port plates in order to be in the position to rebuild the pump by keeping the parts in the original position.
Remove the suction manifold (147.1) and the discharge manifold (147.2) first by losing the screws (563) and the nuts (563.4) which fix them on to the casing flanges.
Remove the bearing housing and the mechanical seals as previously instructed, lose the rods (906) which connect the two suction/discharge casings (103/104) to the central housing (109) and then, by light hammering with the rawhide mallet, remove the suction/discharge casings complete with port plates (137.1/.2) from the central housing.
Disassembly the port plate from the respective suction/discharge casing in the same way described above; To ease the separation, it is possible to insert a long screw or a rod of proper dimension into the casing hole as shown in FIG. 8.

After taking apart the port plates, dismount the vary port valves (435) by loosing the relevant fixing screws (902) and remove the vary port valve plates (360).
Slide out from the central housing the shaft assembly consisting of the shaft (210) with the impeller (230) fitted on; remove the mechanical seal spacer (623), lose the impeller lock nut screws (844.2) and then lose the impeller lock nut (844). For the 316 construction, the lockwasher (844.1) tabs have to be lifted to free the locknut and then allow to slide out the impeller (230) from the shaft (210).

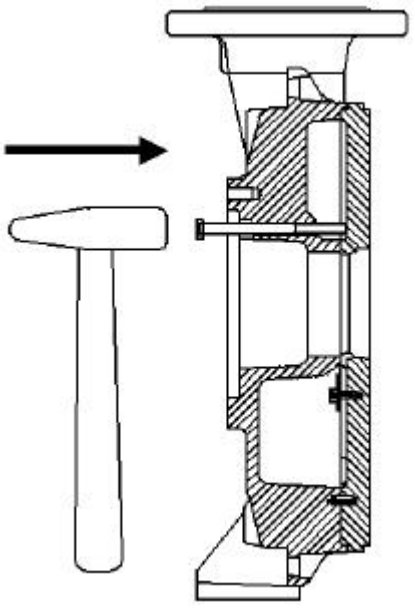


FIG. 8

PUMP REASSEMBLY (see section dwg)

CAUTION !

Before starting the pump reassembly, it is requested to carefully clean all parts by removing any trace of deposits or material build up present on the internals.
During the cleaning make sure not to damage the parts especially when using a scraper on the contact surfaces of the central housing, the port plates and the suction/discharge casings.
To seal the contact surfaces use the relevant liquid gasket (Motorsil D-Arexons / Loctite 518).

Install the impeller keys (946) in the shaft caves (210), slide on the impeller (230) till it ends against its shoulder and fix it by installing the locknut (844) to be blocked by tightening the locknut screws (844.2); for the 316 construction, after having slid the impeller on the shaft, install the lockwasher (844.1) and then the locknut (844); tighten the locknut so that its caves match with the lockwasher tabs; bend the tabs into the corresponding caves.

Install the vary port valves (435) on the port plates (137.1/.2) by using the dedicated valve plates (360) and the fixing screws (902); install the port plates on the suction/discharge casings (103/104) by using the locating pins (562) as reference for the correct positioning but make sure that previously the contact surfaces were coated by a thin layer of liquid gasket.
Install the central housing (109), complete with its port plate, on the drive end suction/discharge casing but make sure that previously the contact surfaces were coated by a thin layer of liquid gasket; slide the shaft assembly complete with the impeller in the housing, fit the idle end suction/discharge casing on the housing but make sure that previously the contact surfaces were coated by a thin layer of liquid gasket. Finally install the rods (906) and the dedicated nuts; tight them in crossed sequence.

CAUTION !

Do not exceed with the quantity of liquid gasket as the excess of coating might enter into the internals and block the rotation of the impeller.

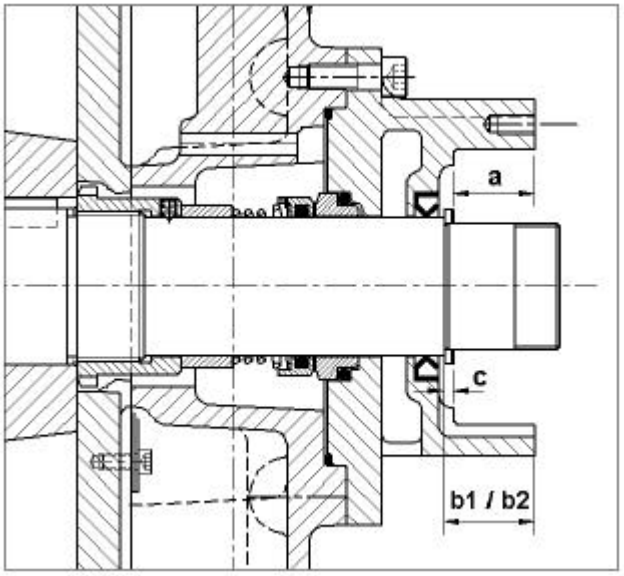
Check the impeller clearance (travel) by determining the distance between the port plate surfaces and the impeller itself by sliding the shaft assembly in both directions to the two extreme positions. Using a depth sliding gauge fixed on one shaft end, by moving the assembly by hand in order to avoid any hitting, check the travel distance. The measured clearance shall be within the range reported in TAB. 5.
In case the measurement is less then specified in the table, it is necessary to remove the idle end suction/discharge casing complete with port plate in order to slide out the shaft assembly. Lathe the side of the impeller in order to reach the indicated clearance.
In case the measured value is bigger than required, it is necessary to machine the central housing contact surface in order to reduce the length and consequently the clearance value within the stated range.
Once the machining of the parts has been completed, rebuild the pump as indicated above.

TAB. 5

PUMP MODEL	**Clearance between impeller and port plate (mm)**	
	Min.	Max.
DEX/GB-GX	0,18	0,22
DEX/XX	0,25	0,30

After having completed the assembly of the drive end side by installing the bearing housing complete with its cover (603), fit the mechanical seal spacer (623) on the opposite end of the shaft, the mechanical seal and the bearing housing complete with lip seal as specified in the previous section “Replacement of the bearings and of the mechanical seals”.
Before installing the bearing (322) and close the relevant housing with the dedicated cover (604), it is required to set the exact position of the rotating assembly between the casings (see FIG. 9).

Slide the shaft assembly towards the drive end till the end travel; do it carefully in order to avoid any hitting.
By using a depth sliding gauge located on the external surface of the bearing housing, measure the distance **“a”** (housing shoulder of bearing outer ring) and the distance **“b1”** (shaft shoulder of bearing inner ring).
Slide the shaft assembly in the opposite direction till the end travel; do it carefully in order to avoid any hitting. Measure the distance **“b2”**. The dimension **“c”,** corresponding to the sum of the bearing abutment tickness (235) plus the tickness of the spacer ring (238), shall be determined by using the following formula:



$$c = \frac{(b1 - a) + (b2 - a)}{2}$$

FIG. 9

Fit on the shaft the bearing abutment, the spacer, the bearing, tight the locknut (845) up to the complete blocking of the bearing and finally install the bearing cover (604) by using the dedicated screws (807) as previously indicated in the “Replacement of the bearings and of the mechanical seals” section.

When tightening the rods and the other bolting, make sure that the torque applied on the wrench meets the values reported in TAB. 6.

TAB. 6

Fixing bolts tightening torque						
Bolt size	M 8		M 10		M 12	M 16
Material class	8.8	12.9	8.8	12.9	8.8	8.8
Tightening torque (Nm)	25	35	50	75	85	205

20. SPARE PARTS

To order spare parts required for the pump repair and reconditioning, it has to be indicated the following:

- Part description
- Item number
- Pump model
- Pump serial number

The first two data can be found on the pump section drawing and the remaining two on the pump identification nameplate.
Some items are standard article from commerce therefore can be purchased directly on the market.

21. PUMP SCRAP AND DISPOSAL

When scrapping and tearing down the pump, it is required to apply the specific disposal procedures depending on the material of each part of the pump.
It is mandatory that pump internals are cleaned and drained from any hazardous and polluting fluid which can be dangerous to people, to things and to the environment.
As already stated in other sections of the present manual, the handling and disposal of fluids as well as parts or any other item shall be performed in compliance with the local law and relevant standards on force.