

MML



High Pressure Centrifugal Pump

I. Introduction

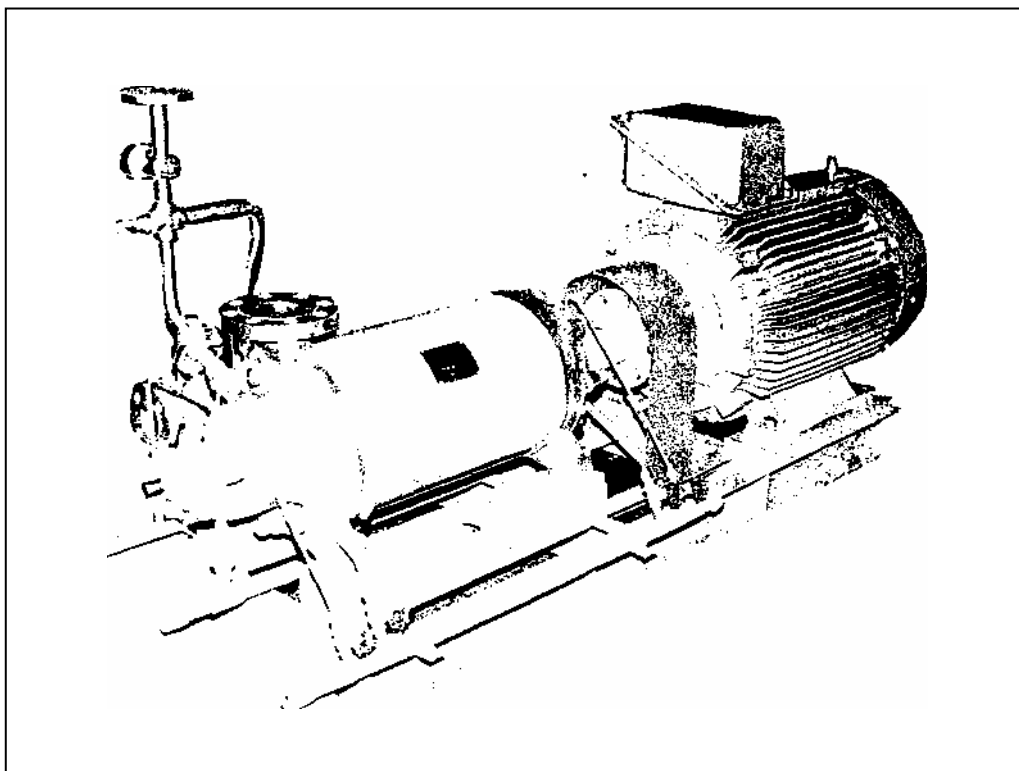
Our machines are very high quality products, which will always give you completely satisfactory and trouble free service, if they are erected, serviced and operated properly by skilled personnel. The instructions and recommendations contained in this booklet should be carefully followed to obtain trouble-free operation, and it should be accessible to everyone in charge of the erection, operation and maintenance of the machines. We shall gladly supply further copies on request.

Please get in touch with us if you require any expert advice. We shall be glad to oblige, and this also applies to any repair work which may be required, and which you may prefer to entrust to us. We can provide the services of a skilled fitter on request, or you may prefer to send the machine back to our works for repair.

If the instructions contained in this booklet are followed, you will be covered by the guarantee contained in our conditions of supply.

Our guarantee will however become void, if the machine is used to pump liquids or media other than those specified in the confirmation of order, and at higher operating temperatures; if damage is caused to the machine as a result of improper manipulation, operation outside the operating range specified, the use of unsuitable operating materials, faulty erection, wrong or unskilled laying of the pipelines, etc.

During the validity period of the guarantee, any dismantling of the machine or its components may only be carried out after receiving our previous consent in writing.



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2. General construction of pump

2.1. Description of pump

MML pumps are normally employed where the total head ranges from 215 to 710 lb/in² = 15 to 50 kg/cm². The size designation is in accordance with the bore of the discharge flange, e.g. MML 40 has a discharge bore of 40 mm = 1.5 in, etc. Constructional details are shown in the sectional drawings at the end of this booklet.

2.1.1. Casing

MML high pressure pumps are multistage centrifugal pumps, with a radially split casing. The casing consists of the suction and discharge casings (see sectional drawing, page 28, part Nos. 1060 and 1070) and of a number of intermediate, or stage casings (IOSO). The individual casing components are clamped together by tie bolts (9050). The intermediate casings and tie bolts are encased in a sheet steel cladding, and pumps which are intended for very hot liquids have a layer of insulating material underneath the cladding. The diffusers (1710) are inserted between each successive pair of intermediate casings. The stuffing box housings (4510), and bearing brackets (3500) are flanged onto the suction and discharge casings by studs. If the nature of the fluid pumped and the operating conditions permit it, the casing components are made of high grade cast iron. Where necessary, bronze, cast steel or chrome steel are used for these components. The diffuser are made of cast iron, bronze or chrome steel, as required.

A leak-proof joint between the individual casing components is ensured by inserting rings (4120.5) profile seals, gaskets, or by providing ground metal-to-metal joints, according to the operating temperature, and the material of the casings. In the latter case, the pressure necessary to seal the metal-to-metal faces is provided by correct tensioning of the tie bolts.

The suction and discharge casings include integrally cast feet, the position of which varies according to the execution and application of the pump and the temperature of the liquid; usually the feet are at the bottom of the casings, but for elevated operating temperatures they may be at shaft centerline level in order to obviate any damage due to uneven expansion in the pump. Renewable case wear rings (5020) are fitted to the suction casing and intermediate stage casings, which can be renewed when the wear has become excessive.

2.1.2. Rotating assembly

The shaft (2100) transmits the torque generated by the driver, in equal proportions to all the impellers, via the impeller keys. The spacer sleeves (5251, and 521 or also 5252 on pump sizes 150 and above), ensure the correct axial location of the impellers and also act as shaft protecting sleeves. The correct axial position of the whole rotor assembly is maintained by the balance disc (6010), which also absorbs the axial thrust. The shaft protecting sleeves (5240.1, 5240.2) provided to protect the shaft where it passes through the stuffing box packing are screwed on to the shaft, one having a left-hand and the other a right-hand thread.

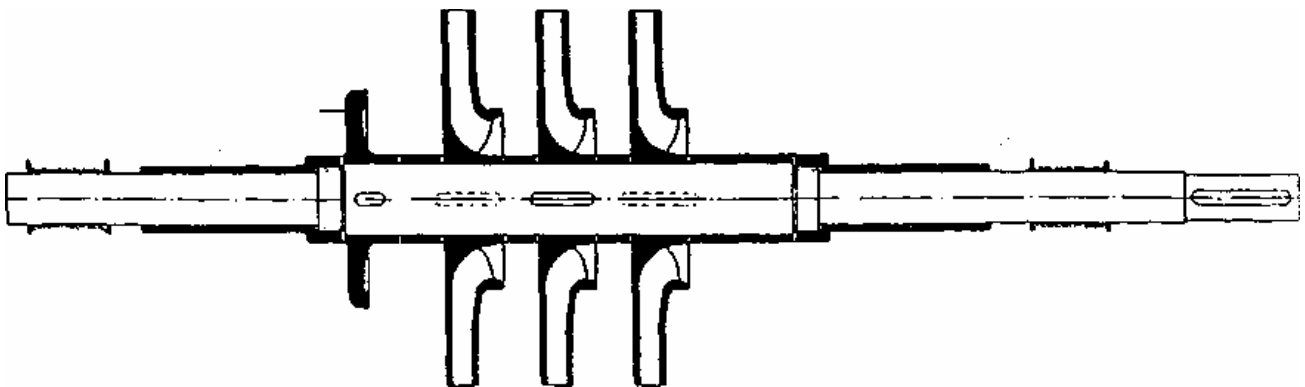


Fig. 2

The shaft (2100) is made of Siemens-Martin steel, or in certain cases, of special quality steel. The impellers (2300), shaft protecting sleeves (5240.1, 5240.2), spacer sleeves (5251, 5210) and the balance device can be supplied in cast iron, bronze, carbon steel or chrome steel according to the nature of the fluid pumped and operating conditions.

2.1.3. Bearings

The rotor assembly in MML pumps sizes 40 to 150 inclusive runs in two anti-friction bearings; from MML 200 and upwards two plain bearings are used. The bearing brackets (3500) flanged to the suction and discharge casings are identical in dimensions. The rotor assembly is afforded a small amount of axial float by the plain bearings and also by the anti-friction bearings, which are NU series taper lock sleeve cylindrical roller bearings (3220).

All bearings are lubricated with oil, the plain bearings having oil rings. The over-flow hole drilled in the bearing end covers (3600,3610) provides a means of checking the oil level (see section 4.4.4.) .

The table in section 7, (page 29) gives a summary of the various types of anti-friction bearings fitted in these pumps.

2.1.4. Stuffing boxes

The purpose of stuffing boxes is to prevent high-pressure liquid from escaping through the gap between shaft and casing, or the entry of air into the pump, if the pump suction is at less than atmospheric pressure.

Whether conventional soft-packed stuffing boxes or mechanical seals in one of the many types available are used, will depend on the pressure, temperature and nature of the liquid pumped.

2.1.4.1. Soft-packed stuffing-boxes

Soft-packed stuffing boxes rely on rings of soft-packing as the sealing element; successive packing rings are inserted in the annular space between the stuffing box housing (4510) and the shaft protecting sleeve (5240.1 or 5240.2), and are lightly pressed in position by the stuffing box gland (4520). The standard stuffing box in fig.3 top left, is quite adequate for sealing clean water under pressure at temperatures not exceeding 220°F (105 °C). When the temperature exceeds 220 °F, the so-called hot water execution HW, with hot water stuffing boxes is used (fig. 3). With this type, an end cover (304) is mounted between the bearing bracket (3500) and the stuffing box housing (4510).

The stuffing box housing (4510) surrounds the shaft protecting sleeve (5240.1 or 5240.2) and can be flushed with cooling water, thus ensuring that the hot water from the pump is effectively cooled in the narrow annulus up-stream of the packing rings, and its temperature considerably reduced before it reaches the packing rings. A prerequisite for effective cooling of the water which reaches the stuffing box is that the packing rings themselves are in good condition and provide an effective seal. The pressure at the stuffing box is not affected by this gap or annulus.

A part from these standard stuffing boxes, there are SPECIAL TYPES recognizable from the fact that the space for the packing is extra long, to provide room for an increased number of packing rings, and usually also a lantern ring, which may be located at the bottom of the box, or amid the packing rings, according to requirements. This lantern ring forms a means of preventing the ingress of liquid from the interior of the pump; this is effected by drilling a passage in the housing (4510) in register with the ring, and passing through it a sealing liquid (e. g. water from the discharge side of the pump) ; in certain cases, leakage fluid may be led off by means of this lantern ring.

If the temperature of the liquid handled by pumps with special stuffing boxes exceeds 220 °F, a cooling chamber 301 (fig. 3) is fitted up stream of the stuffing box to cool the liquid flowing from pump to stuffing box, the action being similar to that of the HW execution described above.

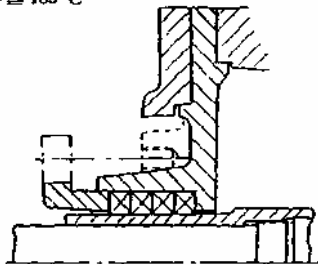
Fig.3 illustrates the various special stuffing boxes V, VSH and VSM with or without cooling chamber (301) for a variety of liquids pumped.

The maintenance of soft-packed stuffing boxes is described in section 4. 4. 2.

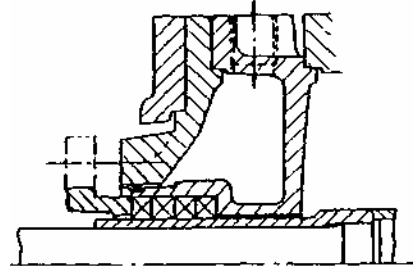
Stuffing Box Conventional Types

Cooling Liquid

Standard
 $t \leq 105^\circ\text{C}$

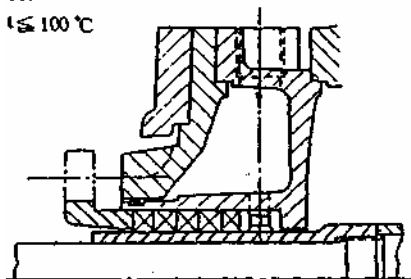


HW $105^\circ\text{C} < t < 220^\circ\text{C}$

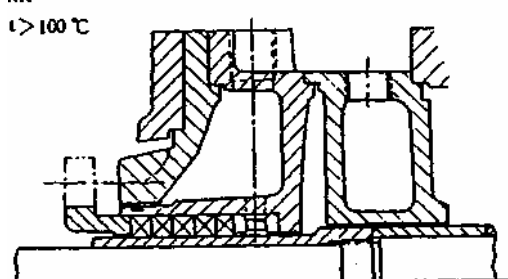


Stuffing Boxes Special Types

VH
 $t \leq 100^\circ\text{C}$



HK
 $t > 100^\circ\text{C}$

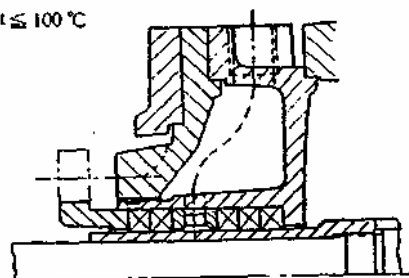


Medium Compressed :

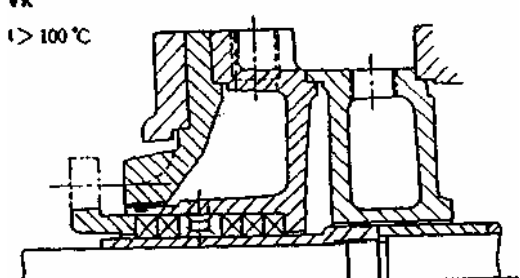
For liquids with entrained abrasive particles, when the packing must be protected against the penetration of any abrasive materials (e. g. oil with Kieselgur, fractions from the catalytic cracking plant with entrained abrasive particles).

Sealing, resp, leakage liquid

VM
 $t \leq 100^\circ\text{C}$

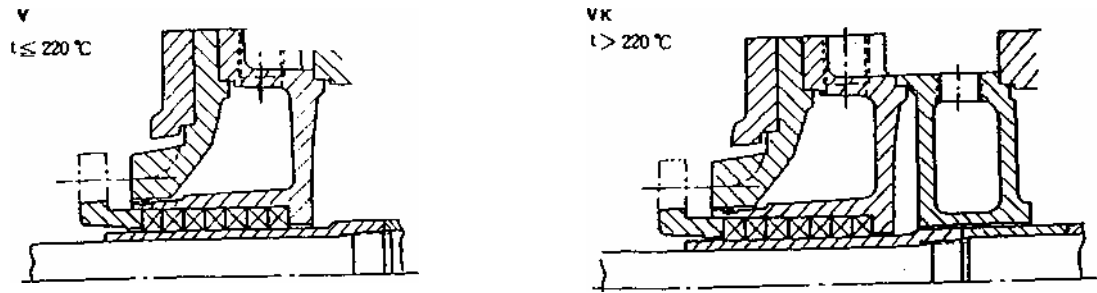


VK
 $t > 100^\circ\text{C}$



Medium Compressed :

For liquid that have to be drawn off under vacuum, (e. g. hydrocarbons and oils that are vaporized in vacuum, residues in vacuum columns, condensate). When stuffing box losses must be trapped before they reach the open, the liquid (e. g. all kinds of solvents, ammonia) are led off through the lantern ring into closed vessels.



Cooling or heating liquid

Medium Compressed :

For LPG, expect liquefied propane below 130 °F (55 °C) above lubricant and heat transfer media (e. g. Down them) below 360 °F (180 °C) above.

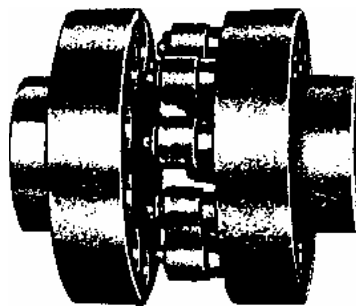


Fig. 6. Flexible Coupling

2.1.5. Coupling

The pump and driver are connected to each other by a flexible coupling. Fig. 6 illustrates the type of flexible coupling most frequently used. All couplings demand very careful alignment of the pump and driver shafts, because any misalignment (whether radial or angular) can only be absorbed to a very limited extent by the rubber or elastic members of the coupling at the prevailing operating speeds see section 3.2).

2.1.6. Foundation

When we supply a complete pumping set, including motor and combined base plate, we only bolt and dowel the pump on to the base plate at our works, after having aligned it with the motor. We do not dowel the driver, because the combined base plate cannot, for economic reasons, be constructed so rigidly that it will not distort to a certain extent during transport, or it is set on an uneven foundation. It only attains its ultimate stability after having been placed on the foundation and grouted in with a cement mixture. Therefore, the pumping set must be levelled up with the aid of shims and carefully aligned afresh after erection at side (see section 3.2.1) and, only after this has been done, should the driver be dowelled in place.

2.2. Driver

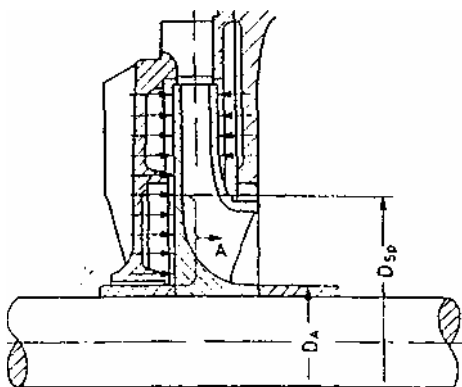
The driver is usually coupled to the suction end of the pump. Pump rotation is clock-wise viewed from driver. On special request, the pump can be supplied with the stub shaft at the discharge end (in this case, rotation is anti-clockwise viewed from driver) or with stub shafts at both ends. The variety of drivers which can be used is so great that it would be impossible to describe them all in the context of this booklet; therefore we refer you to the operating instruction manual supplied by the manufacturer of the driver.

2.3. Mode of operation of pump

The fluid flows through the suction casing (1060) at a given pressure, onto the first stage impeller (2300). A certain amount of energy is imparted to the fluid in the impeller, which is provided with a number of vanes. The fluid then flows out of the impeller into the diffuser (1710), where a partial conversion from kinetic energy into potential energy takes place, resulting in a further increase in pressure. The return guides in the diffuser then lead the fluid onto the eye of the following impeller. This process is repeated from stage to stage, and at each stage the pressure increases by the same amount, i. e. the stage head. After leaving the final diffuser, the fluid penetrates into the discharge casing (1070) and thence into the discharge piping.

An axial thrust A (see fig. 7) acts on every impeller; it is caused by the hydraulic pressure which acts on one side only of the annulus with outside diameter D_{cp} (= sealing clearance gap diameter) and inside diameter D_A (= o.d. of spacer sleeve). This axial thrust A is transmitted to the rotor and is absorbed by a special hydraulic balancing device on MML series pumps. This balancing device consists of a balance disc (6010) and a balance disc seat (6020), and it operates through the action of a fixed area, or constant clearance gap (between the pump rotor and discharge casing) in series with a variable clearance gap (between balance disc and balance disc seat). If, for instance, the variable clearance gap between balance disc and balance disc seat is very narrow, this will result in a high pressure, equal almost to the full pump discharge pressure, acting on the balance disc, and pushing the rotor axially towards the discharge end of the pump; the gap will consequently widen. If, on the other hand, this gap is too wide, the increased flow of balance water which now flows through the balancing device will be subjected to a greater pressure drop through the fixed area clearance gap, and consequently the thrust on the balance disc will decrease, causing the rotor to slide back towards the suction end of the pump. In operation, the rotor will therefore settle down at a median position, corresponding to a median clearance gap between balance disc and seat.

Fig. 7



The balance water is either discharged to atmosphere, or (e. g. when the pump suction pressure is above atmospheric pressure) returned to the suction casing of the pump or to the suction vessel through a separate line. The balancing device will not give trouble – free operation if the balance water is allowed to flow away without hydrant. Any isolating valves in the balance water return line must be kept locked in the open position. The axial position of the rotor assembly can be checked on the axial position indicator at the discharge end of the pump shaft (see section 4. 4. 5) .

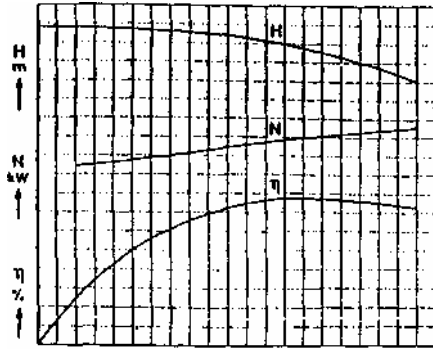


Fig. 8 Characteristic curves at constant pump speed

Fig. 8 illustrates the fact that the power absorbed by the pump does not decrease proportionately with the reduction in pump capacity; on the contrary, the power absorbed at shut-off head (capacity $Q = 0$) is quite considerable. This absorbed power is transformed almost wholly into heat within the pump, and this will rapidly lead to over heating and vapor formation in the pump, when it is operated for any length of time against a closed discharge valve, or at very low through puts; this is particularly true in the case of powerful drivers and hot fluids (high pumping temperatures). In order to prevent vapor formation which could endanger the pump, it is essential to ensure that a certain minimum flow always passes through the pump and carries off the internally generated heat. For this purpose, we recommend the provision of a BY-PASS NON-RETURN VALVE, or automatic leak-off valve (see fig. 14 and 14 a), which automatically opens a by-pass line when the pump capacity drops below a certain figure.

If no such valve is incorporated in the installation, it is important to remember that the pump should never be operated below a certain minimum flow, nor against a closed discharge valve. After running the pump up to operating speed against a closed discharge valve, on start-up, the discharge valve should immediately be opened.

When pumping hot or highly volatile liquids, and when operating the pump under suction lift conditions, care should be taken to ensure that the pressure at pump suction nozzle is adequate, i. e. at least as high as stated in the confirmation of order; otherwise vapor formation and cavitation will occur, which may damage the pump, particularly the first stage impeller and the balancing device. If the discharge pressure is lower than that for which the pump was designed, the capacity will increase correspondingly and this may result in over loading the balancing device or the motor, which will run excessively hot.

3. Erection

1.1. Erection the pump

Correct and skilled erection on an adequate foundation is an essential pre-requisite for trouble-free operation of the pumping set.

The following points should be scrupulously observed in order to avoid operating troubles and damage to the pump :

1. Make sure that the foundation has set properly before placing the pump on it.
2. Level up the base plate by means of packing or shims, with the aid of a spirit level.
3. Check coupling alignment for parallelism and concentricity, and re-align same if necessary, (see section 3.2.1.).
4. Grout in the base plate and the foundation bolt pockets with a quick setting cement mixture in 1 : 2 ratio.

Make sure that no empty spaces or cavities are left beneath the base plate.

5. When the cement has set completely, tighten the nuts on the foundation bolts evenly and firmly.
6. Connect the piping to the pump nozzles without imposing any stress or strain on the pump. Remember that pumps should not be used as anchorage points for the piping.

7. After the piping is connected, the alignment at the coupling should be checked once again. It should be possible to rotate the rotating assembly easily by hand on the coupling, if the stuffing boxes are not packed (see section 3.2.1).
8. Dowel the driver (see section 2.1.6.).
9. Before the pump is started up for the first time, it is essential to check the direction of rotation of the driver, with the pump uncoupled. Remember that even a short run in reverse rotation or a short period of dry running can result in serious damage to the pump.

The correct direction of rotation of the pump is indicated by an arrow on the drive end bearing housing.

Turbine driven pumps should have their turbine over speed trip tested with the pump uncoupled.

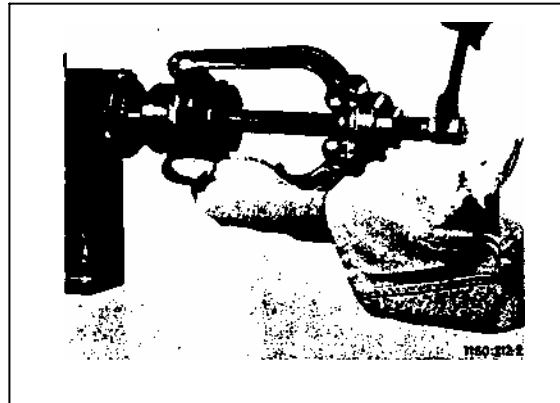


Fig.9 Coupling Extractor

3.2. Fitting and dismantling the coupling

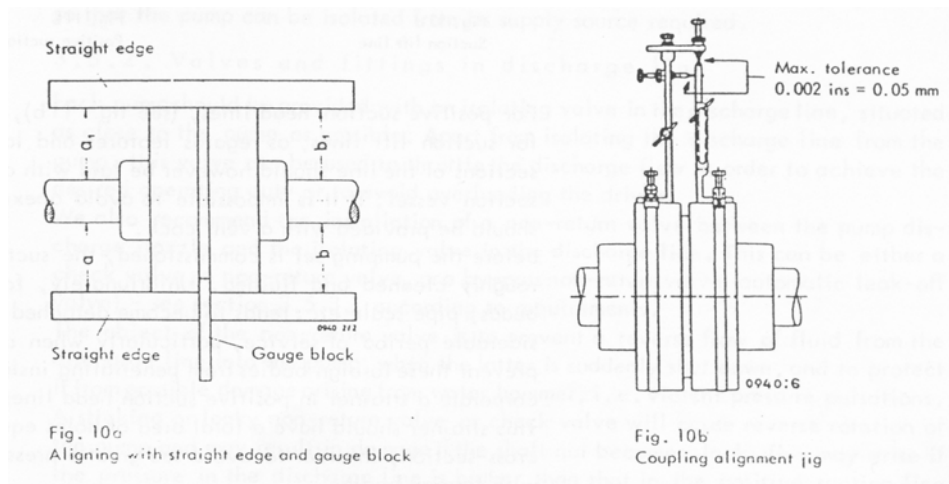
Flexible couplings should either be heated to 180 °C (350 °F) approx, before fitting or removing, or this work should be done with the aid of a suitable coupling extractor (see fig. 9). Never drive the coupling onto the shaft with a hammer.

3.2.1. Aligning the coupling

Faulty alignment will result in damage to the flexible components of the coupling, and will also damage the pump and motor bearings.

In order to align the shafts, the pump and driver are set on the grouted-in bed plate as shown on the General Arrangement Drawing, and pushed towards one another until the pre-scribed gap between the two coupling halves has been attained. Then the coupling can be aligned by means of a straight edge and gauge block (fig. 10a) ; the coupling is correctly aligned if $a=a_1$ and $b=b_1$; furthermore the axial gap between the faces of the coupling halves should remain the same right around the periphery of the coupling.

We can supply a special alignment jig on request (see fig. 10b) which greatly facilitates coupling alignment. When this jig is used, the coupling can be considered correctly aligned if the tolerance, both in the axial and radial planes measured at the tips at four points around the periphery, at 90° intervals, does not exceed 0.05 mm in any case. This control should be repeated after connection of the pipelines.



3.3. Instrumentation

In order to facilitate operating supervision, we recommend that each pump be provided with pressure gauges (with large dials) at the suction and discharge nozzle and on the balance water line. These gauges should incorporate a gauge cock or valve. They should be mounted in such a way that they are exposed to the least possible amount of vibration.

3.4. Piping

It should be possible to connect the piping to the pump easily and without undue strain. Remember that any appreciable forces transmitted from the piping to the pump and base plate will tend to upset the alignment of the set, and cause it to run rough. To avoid any possible damage from this cause, hot water pipelines should be provided with adequate expansion loops. Sharp bends and abrupt changes in cross-section should be avoided. If an increase in pipe cross-section is required, the total angle of the taper piece (twice the angle between centre-line and wall of taper piece) should not exceed 12° . Make sure that the gaskets of flanged connections do not protrude inside the pipe.

341. Suction piping (suction lift piping or positive suction head piping).

The suction piping connected to the suction casing is designated either as suction lift piping or as positive suction head piping (flooded suction), depending on whether the suction pressure upstream of the pump is below or above atmospheric pressure. In either case, the suction piping should be kept as short as possible. Suction lift piping (see fig. 11 a) should be laid with a rising incline towards the pump, should be absolutely leak tight, and not present any features tending to promote the formation of air pockets.

The nominal size of the pump suction flange is no indication of the correct size of suction piping required for any given installation. As a first approximation, the suction line should be sized to give a flow velocity not exceeding 2 m/sec, (6 ft/sec). It is desirable to provide a separate suction line for each pump (in a pumping station comprising several pumps). If this is not possible for practical reasons, the common suction line should be sized for as low a flow velocity as practicable, and this velocity should preferably remain constant right up to the last pump on the line. If the suction pipe is to be laid in an underground trench, it should be hydrostatically tested at 3-4 Kp/cm² (40 to 60 PSIG) before being buried.

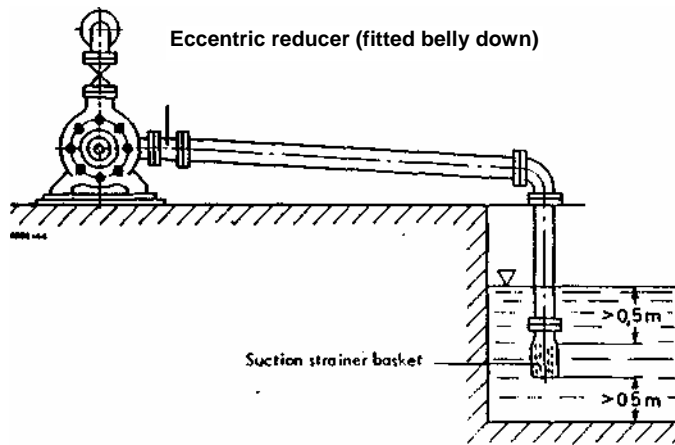


Fig.11a Suction lift line

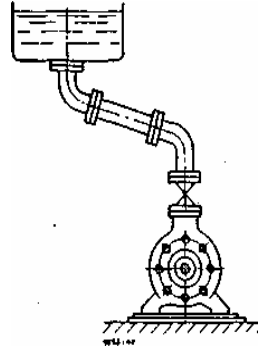


Fig. 11b

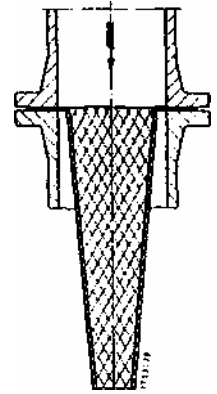


Fig. 12

For positive suction head lines, (see fig. 11b), the same considerations apply as for suction lift lines, as regards features and laying of the line. The horizontal sections of the line should however be laid with a gently rising incline towards the suction vessel. If it is impossible to avoid apexes in the suction line, each apex should be provided with a vent cock.

Before the pumping set is commissioned, the suction lines and vessels must be thoroughly cleaned and flushed. Unfortunately, foreign matter, including welding beads, pipe scale etc. tends to become detached from the piping only after a considerable period of service, particularly when a hot fluid is pumped. In order to prevent these foreign bodies from penetrating inside the pump, it is necessary to incorporate a strainer in positive suction head lines.

This strainer should have a total area of holes equal to three to four times the pipe cross-section, in order to avoid too great a pressure drop when it becomes choked with foreign bodies.

Conical strainers of the type illustrated in Fig. 12 have proved very satisfactory for this purpose, and are recommended; they should be made of corrosion-resistant material.

The pressure at the pump suction nozzle should be checked at regular intervals. If it drops, this indicates that the suction strainer should be removed and cleaned. After severer weeks of operation, when no more foreign bodies are anticipated, the strainer can be permanently removed.

3. 4. 2. Discharge Piping

The hydrostatic test pressure prescribed in DIN 2401 specification only applies to individual lengths of pipe and not to the complete, finally assembled discharge line.

The latter is usually tested at a pressure equal to the maximum operating pressure anticipated.

Discharge lines are usually sized for flow velocities of 3 m/sec. (10 ft/sec).

3. 5. Valves and fittings

Only those valves and fittings (i.e. isolating or control valves, non - return valves and check valves) are described here after, which are incorporated in the suction line, or close to the pump itself in the discharge line.

3.5.1. Valves and fitting in suction line (suction lift line or positive suction head line).

Isolating valves in the suction lift line or the positive suction head line are solely intended to isolated the line. They must always be kept fully open while the pump is running.

An isolating valve should only be incorporated in a suction lift line, if more than one pump is connected to common suction line. In such cases, the valve should be installed with its stem horizontal, or pointing vertically downwards, to prevent the formation of air pockets.

If this proves inconvenient, and the valve has to be installed with its stem vertically upwards, it should be provided with a sealing water connection, or a so called water cup, to prevent the ingress of air through the gland on the valve stem.

Pumps lifting from a suction tank or suction pit should have a strainer basket fitted to the mouth of the suction line, in order to keep coarse impurities away from the pump.

The strainer basket is usually combined with a foot valve, which enables the suction lift line to be primed with fluid before starting the pump (see fig. 13). The strainer basket should be installed at least 0.5 meters (18 ins.) below the minimum water level in the pit, and at least 0.5 meters (18 ins.) above the pit floor, to prevent either air or sand or sludge being entrained into the pump (see fig. 11 a) .

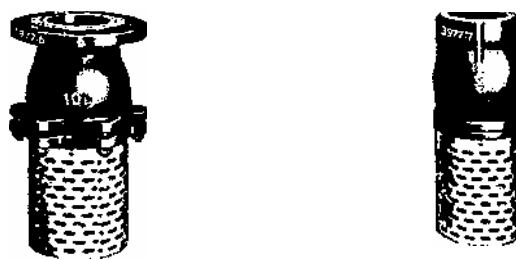


Fig. 13 Suction strainer basket with foot valve

Positive suction head lines should preferably be provided with an isolating valve, so that the pump can be isolated from its supply source required.

3. 5. 2. Valves and fittings in discharge line

Each pump should be provided with an isolating valve in the discharge line, situated as close to the pump as possible. Apart from isolating the discharge line from the pump, this valve can be used to throttle the discharge flow in order to achieve the desired operating duty or to avoid over loading the driver.

We also recommend the installation of a non-return valve between the pump discharge nozzle and the isolating valve in the discharge line. This can be either a check valve, a non-return valve, or by-pass non-return valve (automatic leak-off valve) - see section 3.5.3., according to requirements.

The object of the non-return valve is to prevent a reverse flow of fluid from the discharge line into the pump, when the latter is suddenly shut down, and to protect it from possible damage arising from water hammer, i.e. violent pressure pulsations.

A sticking or leaky non-return valve or check valve will cause reverse rotation of the pump and may result in damage if the shaft nut becomes slack. This may arise if the pressure in the discharge line is higher than that in the positive suction line when the pump is stopped, causing reverse flow of the fluid.

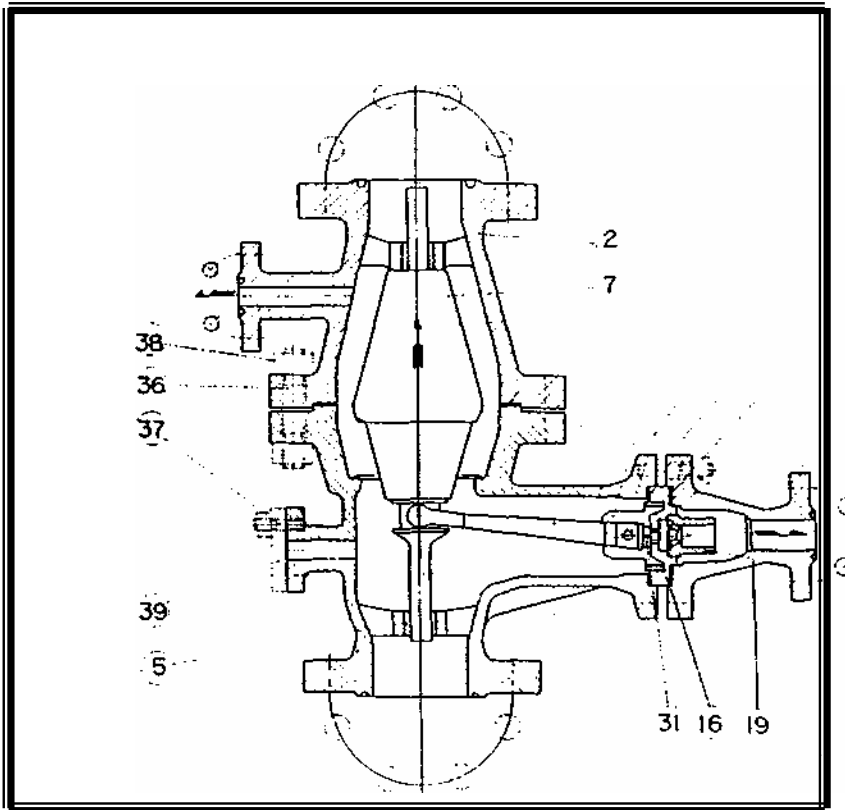
Please note that these reverse rotation speeds can attain very high values, especially when the pump is pumping against an air or gas cushion. In this event, gas will penetrate inside the pump and expand there.

It is recommended to provide two non - return valves in series in such cases.

3.5.3. By-pass non-return valve

The by-pass non-return valve, or automatic leak-off valve is a safety device, the purpose of which has already been described in section 2.3. It is fitted in close proximity to the pump, always between the pump and the isolating valve in the discharge line (never down-stream of the isolating valve).

It must always be installed vertically, with the direction of flow from bottom to top. Its construction and mode of operation is illustrated in fig. 14 and 14a,



No.	Name of Part
1	Body
2	Cover
3	By-Pass Outlet
5	Bearing
7	Cover
16	Seal
19	Venturi
23	Rocker Guide
24	Rocker
29	Arbor
30	Washer
31	Slide
36	Bolt
37	Stud Bolt
38	Nut
39	Blind Flange
40	Seat packing
41	Sest Packing

Each by-pass non-return valve is selected and supplied for the particular operating conditions pertaining to a given pump.

The lift of the by-pass non-return valve cone increases as the rate of flow approaches its maximum. The slide valve rod connects the valve cone with the slide valve of the by - pass outlet. When the valve cone lifts, the slide valve slides, closing the by - pass when a given minimum flow is exceeded, resp. opening it when the flow drops below the minimum.

The minimum rate of flow, at which the valve opens, is selected large enough to obviate undue overheating within the pump (section 2.3.).

4. Operating instructions

4. 1. Commissioning and starting up the pump

A. Points to be checked prior to commissioning or start-up:

1. Check the oil level in the bearings of the pump, and if necessary replenish until the oil runs out of the over flow.
2. Check the condition of stuffing boxes. Follow the instructions for correct packing of the stuffing boxes.
3. If cooling water is provided, turn it on and check that it flows away freely.
4. Close discharge valve; check that isolating valve in the balance water line is wide open.
5. Open valve in suction line to its full extent.
6. Make sure that the pump is completely primed with liquid. Priming is effected through the priming tundish (with valve) or by opening the by-pass on the non return valve. Watch the pressure gauge on the suction casing - the pressure in the suction line should not be allowed to rise excessively during priming. While priming takes place, the shaft should be rotated repeatedly by hand and the vent cock on the suction casing should be opened.
7. When operating with positive suction head, check pressure and temperature in the suction line.
8. If a non-return valve is fitted, and the pump has to be started with the discharge valve open, check that the non-return valve is closed by the pressure in the discharge line (e. g. boiler pressure) on start-up. If the full discharge pressure does not reign in the discharge line before start up, the pump should only be started against a closed discharge valve.

B. Start Up

1. Switch on driver for a short instant, then switch it off again immediately. Observe the rotor, which should run down to a standstill evenly and smoothly. Check that the bearings are being properly lubricated.
2. Run the pump rapidly up to full speed.
3. Check that the pump attains the prescribed discharge pressure.
4. After the pump has attained full operating speed, open discharge valve and adjust it to the operating conditions required.

4.2. Supervision during running

1. The pump should run quietly and without vibration at all times.
2. Check the bearing temperature at regular intervals (it should remain steady). If it rises unduly, check condition of bearings.
3. Watch the stuffing boxes; the glands should drip slightly during running.
4. If water cooling is provided, check the cooling water outlet temperature at regular intervals; a 10 °C (50 °F) temperature difference between cooling water inlet and outlet is acceptable.
5. Avoid over loading pump and driver (this happens when the discharge pressure drops below the design figure).
6. Check the correct functioning of the by-pass non-return valve; the by-pass should open at low through puts. This can be observed by touching the by-pass return line, which should become warm.
7. If the pump operates on suction lift, always ensure that the suction head is adequate, and that no air is entrained into the pump, by checking the water level in the suction pit or vessel.
8. If the pump operates with positive suction head, always ensure that this head does not drop below the figure specified in the confirmation of order, as serious damage to the pump internals might otherwise result, due to cavitation. For the same reason, the suction temperature should never be allowed to exceed the maximum value specified. This point should be watch particularly carefully if the pump is used for hot water duty.
9. Check the pressure in the balance water line and the shaft position the position indicator at the stub end, at the regular intervals.
10. If standby pumping sets are installed, it is advisable to operate all the pumps on a rotation system thus giving each pump in turn a certain amount of operational duty; this ensures that the standby pump will always be in good condition for instant start-up if required.

4. 3. Shutting down the pump

1. Close discharge valve.
2. Switch off driver, and observe pump rotor running down to a stand still.
3. Turn off cooling water, when the pump has cooled down below 105 °C (220 °F).

This only applies to pumps with cooled stuffing boxes or bearings.

4.4. Maintenance

The pump and driver must be kept under careful observation the whole time the set is running.

4.4.1. Maintenance of pump

We recommend keeping a log book in which the operation of the pump should be regularly recorded. The data recorded should include pump capacity, suction and discharge pressures, balance water pressure, water temperature, bearing temperature, and pump speed, as well as the operating data of the driver (output and speed of electric motor, diesel engine or turbine). The switching on and switching off times should also be recorded to enable the total number of operating hours of the pump to be ascertained at any time.

A further column for "remarks" should be provided, in which details of maintenance and repair work can be entered. This log book will thus enable a clear picture of the condition of the pump to be kept at all times.

Pumps erected on new foundations should be subjected to an alignment check at the coupling from time to time, to ascertain whether any settlement in the foundations may have resulted in misalignment of the pumping set. This check should also be recorded in the log book.

Actual maintenance of the coupling is restricted to periodical inspection of the rubber components or flexible members and their renewal when necessary. Rubber parts should be kept well clear of contact with oil or grease.

4.4.2. Maintenance of soft-packed stuffing boxes.

The stuffing boxes will give trouble - free and satisfactory service providing they are carefully and correctly packed and maintained. The pumps are delivered with their stuffing boxes unpacked, and one set of packing for each box is included in the consignment. Before packing the box, the packing compartment and shaft sleeve should be thoroughly cleaned. The individual rings should be cut from the packing coil with a clean scarf joint, stretching the coil flat in a wooden jig, as shown in Fig. 15. The rings must be cut to the correct length, so that the ring butts are in light contact with each other at the scarf joint, when the ring is wrapped around the shaft protecting sleeve.

If the rings are cut too long, they will bulge out at the joint; if they are too short, there will be a gap at the joint. In either case, the stuffing box will leak as a result.

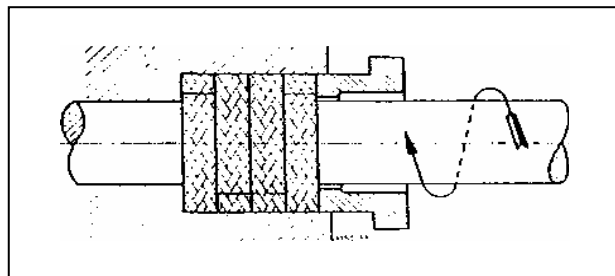
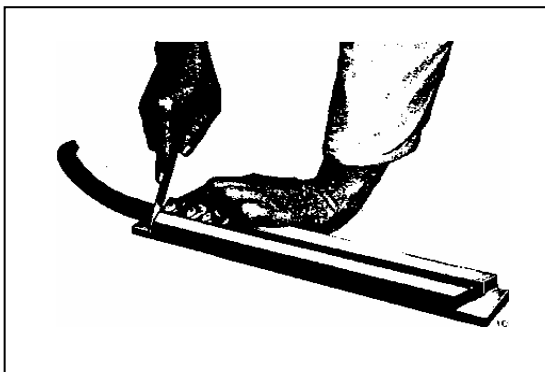


Fig.16 Stuffing Box and Packing Rings

Before insertion in the stuffing box, cotton vibration packing rings must be thoroughly soaked in oil, but asbestos vibration packing rings should only be coated with oil on the inside. The first ring is wrapped around the sleeve and carefully pushed to the bottom of the packing compartment by means of the stuffing box gland. The following rings are then inserted one by one, and the butt joint of each ring should be offset approximately 90 ° from the preceding one; the gland is used to push each ring in position (see fig. 16). The rings should only be pressed lightly against each other by the gland. Only insert as many rings in the compartment as will leave a clear gap at the end, of at least 5 mm (1/4"), for the positive guidance of the gland, to prevent it being tightened askew. This would result in scoring and damage to the shaft protecting sleeve by the gland.

In some pumps, there is a lantern ring in the stuffing box, which latter then bears a plate indicating the position of this lantern ring. It must be located opposite the hole drilled in the stuffing box housing, through which sealing liquid may enter, or leakage fluid may flow out. The pressure of the sealing liquid must be a little higher than the pressure in the stuffing box; this is arranged by tapping the liquid from the appropriate stage in the pump.

When all the packing rings have been inserted, the gland is fitted, and the gland nuts tightened lightly by hand. A newly packed stuffing box will leak appreciably at first. If this leakage does not cease of its own accord after the pump has been running a few hours, the gland nuts should be tightened slowly and evenly on either side, while the pump is running, until the gland only drips slightly; this indicates that the packing is functioning correctly. If the stuffing box does not leak at all, or if it starts to smoke, loosen the gland nuts slightly.

Every newly packed stuffing box needs a certain running-in period before it settles down, and it should be kept under constant observation during this period. After settling down, it need only be checked occasionally.

After a prolonged period of service, when the existing packing has been compressed by approximately the width of one packing ring (by repeated tightening of the gland nuts), it is time to renew the packing and to check the condition of the shaft protecting sleeves on this occasion. If the latter show signs of grooving, scoring or surface roughness, they should be replaced by new ones.

Packing obtained fresh from the manufacturer should preferably not be used; packing which has been kept in store for a period has a longer life. We therefore recommend keeping an adequate supply of spare packing in stock at all times. Only use absolutely clean water for cooling the stuffing box housings (on cooled stuffing boxes). Sludge and lime deposits will seriously hinder heat transfer and render the cooling almost inoperative. We recommend thoroughly cleaning out the cooling chambers from time to time.

The cooling water should be allowed to flow away freely and visibly, so that its temperature and flow rate can be checked at any time. The temperature difference between cooling water inlet and outlet should not exceed 10 °C (50°F). The cooling water supply lines should be provided with isolating valves, to enable the cooling water flow to be adjusted as required, and to be turned off when the cooling chambers and covers are cleaned.

Always turn on the cooling water before starting up the pump, and only turn it off again after the pump has stopped, (see 4.3., effect of temperature).

4.4.3. Maintenance of mechanical seals

Before starting the pump for the first time, check that the flow controllers (see section 2.1 .4.2.) or the needle valves in the circulation line are fully open. The pressure in this line should be 30-55 PSI above the positive suction head pressure; the appropriate tapping from the pump is already provided. After a running-in period of several hours, the coolant flow through the controllers can be gradually reduced by means of the adjusting screw.

The flow is adequate when the temperature of the seal housing is not appreciably higher than that of the other parts of the pump, in cases where the circulation fluid is tapped from the stream of liquid pumped, without any inter cooling. This temperature should be checked by feel from time to time, and if the housing becomes unduly hot, the flow controller should be opened fully. If this does not bring about a fall in temperature, the circulation line must be dismantled and cleaned out. In normal operation, the gland of the auxiliary stuffing box, if one is provided, must not be pulled up tight. It is retained in a partially tight condition by a special device (Fig. 17), and only when a leakage (due too defect in the mechanical seal) is observed, should the pin be depressed and the gland tightened up by clock-wise rotation, or by tightening the stud nuts. The pump must then be stopped, so that the defective mechanical seal can receive attention.

If the carbon rings and rotary rings have to be renewed, they should never be placed anywhere with their working faces down, since even the slightest scoring of the highly finished surfaces may result in leakage.

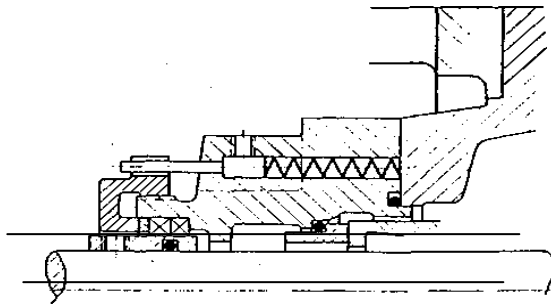


Fig. 17 Auxiliary Stuffing Box

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4.4.4. Maintenance of bearings

Before the pump is first commissioned, or after it has been idle for a prolonged period, the oil level in the bearings must be checked by dipstick or overflow, and its appearance should also be checked. It must not be cloudy (condensation!). Any topping up of oil must be carried out with scrupulous cleanliness, filling being done through the oil cap on the bearing. If necessary, all remains of the old oil can be completely drained off by unscrewing the drain plug, and cleaned out by taking off the bearing covers (3600, 3610). Any flushing must be done with petrol, benzolle or wash oil.

The first oil change in a new bearing should be made after 200 hours of operation; subsequent changes after every 1,000 further hours of operation. Only use well known brands of lubricants for antifriction or plain bearings, to the following specification:

Viscosity at 120 °F = 50 °C : 20 to 45 cSt (Approx, SAE 10 W).

Flash Point : 380 to 450 °F (195 to 230 °C)

Pour point, below : 15 ° F (-10 °C)

Ash content, below : 0.05 %

The temperature of the bearings, the oil levels, and the quiet running of the pump must be kept under careful observation the whole time it is running. The temperature of the bearings must never exceed 175 °F (80 °C) and, with this as a maximum, it must never be more than 120 °F (50 °C) above ambient temperature. If the oil should become contaminated with water or any other foreign matter, the pump must be stopped at once, and the bearings thoroughly cleaned and refilled with oil.

Any cooling of the bearings must be done with pure, cold water, and the remarks on cooling of stuffing boxes (section 4.4.2.) apply equally to the bearings.

4.4.5. Maintenance of the thrust balancing device

Trouble free operation of the pump is dependent on the correct functioning and good condition of the balancing device.

If an isolating valve is incorporated in the balance water line, it should always remain open while the pump is running, irrespective of whether the balance water is discharged into the open, into a vessel, or returned to pump suction.

The working life of the balance disc (6010) and balance disc seat (6020) will depend, amongst other factors, on the number of stops and starts of the pump during normal operation.

The wear on these components will cause the pump rotor to move gradually towards the suction end of the pump. After the wear has attained a certain limit, the danger will arise of the pump rotor fouling the casing, particularly the wear rings (5020).

Therefore the position of the rotor shaft should be checked at regular intervals during running.

The shaft position indicator is situated on the bearing bracket at the discharge end of the pump (see fig. 18). When the pump leaves our works, the measuring edge or marking A on the shaft stub is adjusted to the median position on the wear indicator. The distance between adjacent markings is 1.5 mm. When the measuring edge has moved axially towards the suction end by an amount of 1.5 mm approx., this indicates that wear is so severe that the balancing device must be inspected and over-hauled. The worn components (6020, 6010) must be touched up or replaced by new ones. If necessary, and the measuring edge A must be reset.

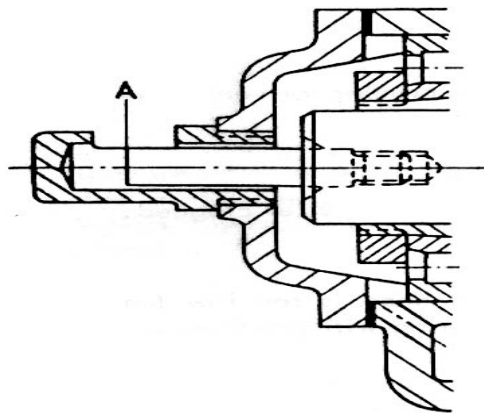
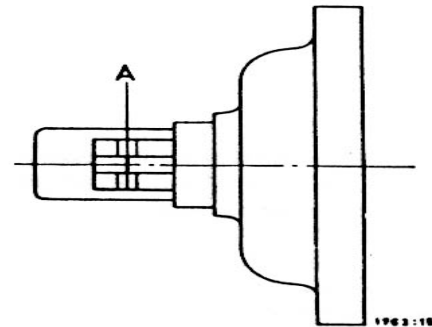


Fig. 18
Shaft position indicator



A = datum position of the balance disc

On the occasion when the balancing device components are touched up or renewed, the radial clearances at the sealing gaps between rotating and stationary parts should be checked. A rough and ready method of doing this consists in raising the rotor and measuring the resulting clearance, preferably close to the final stage impeller. Too great a clearance will upset the axial thrust balance, and give rise to rapid wear of the balancing device. If necessary, the worn components should be replaced by new ones.

The table below lists the clearances which should not be exceeded :

Clearance in millimeters (on diameter)	In new Condition ÷)	Permissible wear	Max. permissible clearance
Between impeller (2300) and wear ring (5020)	0.3 mm	1.2 mm	1.5 mm
Between spacer sleeve (5210) and diffuser (1710)	0.3 mm	0.7 mm	1,0 mm
Between spacer sleeve at suction end (5251) and suction casing (1060) For suction lift operation 01 atmospheric suction pressure For positive suction head operation	0,3 mm	1,7 mm	2.0 mm
	1,0 mm	1,7 mm	2.7 mm
Between the hub of the balance disc (6010) or the spacer sleeve (5252) in the discharge casing, ; and the discharge casing (1070), or in MML sizes 200-350, between the 'pacer sleeve in the discharge-casing (5252) and the bush M 18) in the discharge casing (1070)	0.3 mm	0.2 mm	0.5 mm

*) If the wear rings and spacer sleeves are of chrome steel, the above listed clearances should be slightly increased . This is also true where the materials of construction used have different heat elongation coefficients and, as a result, excessive closing-in of the clearances could take place when fluids are pumped at high temperatures.

4. 5. Operating troubles causes and remedies

Before attempting to cure any operating troubles, the instruments on the pump should be checked in respect of their reliability and accuracy.

4. 5. 1. Pump does not deliver rated capacity

Possible cause	Remedy
1. Excessive pressure in discharge line.	Increase pump speed. If this impossible on an electrically driven pump, it may be necessary to fit oversize impellers or extra stages to the pump. Please consult us first.
2. Incomplete priming or venting of pump or piping.	Prime the pump and piping again and carefully vent them, if necessary change the layout of the piping and fit vent cocks or vent lines.
3. Suction line or impeller clogged.	Clean out the suction line and if necessary dismantle and clean the impeller.
4. The suction head is too low (on pumps operating with positive suction head).	Check the liquid level in the suction vessel. Check that the isolating valves in the suction line are fully open, and if necessary lock them open to prevent accidental closure. Examine piping for faulty runs and high resistance lengths. Clean any strainers incorporate in the line. Before restarting the pump, check that the rotor can be turned easily by hand.
5. Excessive suction lift (on pumps operating with suction lift).	Check liquid level in pit, and make sure that the foot valve is fully open. Clean out the strainer basket and the suction piping, and if necessary fit larger bore suction piping.
6. Entrainment of air through the stuffing box.	Increase sealing fluid pressure; check sealing fluid line in case it is clogged, and clean it if necessary.
7. Reverse rotation.	Restore correct rotation by changing pole connections of the motor. If the pump has run for any length of time in reverse rotation, the condition of balancing device and of the shaft protecting sleeves should be checked; The shaft sleeves must seat properly and should be screwed up if necessary.
8. Pump speed is too low.	On electrically driven pumps, this fault cannot be easily remedied. Please consult our works, indicating the actual speed of the motor. On pumps driven by an internal combustion engine, the speed can be adjusted within certain limits by adjusting the fuel governor. On pumps driven by a steam turbine, the speed can usually be adjusted by suitably adjusting the turbine governor. On belt driven pumps, belt slippage may cause the speed to drop; the belt should be tightened, or if necessary a pulley of different diameter should be used.
9. Excessive wear of the pump internals.	Open up the pump, and check the clearances between part subjected to wear, e.g. 5020/2300, or 1060/5251, or 1070/6010 (on sizes MML 40-125), or 1070/5252 (on sizes MML 150-350), or 6010 or 5252 and 5210 (on sizes MML 200-350), as the case may be. Adjust as necessary, or replace worn components by new ones.

4. 5. 2. Overloading of driver

Possible cause	Remedy
1. Pump discharge pressure is lower than specified at the design stage, and in the confirmation of order (check figures on the pump rating plate).	Partially close the isolating valve in the discharge line until the pump discharge pressure corresponds with the figure on the rating plate. If the driver is permanently overloaded, decrease the driver speed if possible, or trim the impellers after having previously consulted us.
2. The pump is pumping a fluid of higher S. G than specified in confirmation of order. (If the temperature of a fluid pumped, is lower than specified, this will result in a higher S.G.).	If the specified S.G. and temperature cannot be attained, but operating condition permit, the discharge valve can be throttled to the point where the driver is no longer overloaded; or one or more impellers and diffusers can be removed, or the impellers can be trimmed. If none of the above measures are practicable, a more powerful driver should be installed. Please consult us first, stating exact operating conditions.
3. The by-pass non-return valve does not close when pump is operating at full capacity.	Renew worn components. If this does not cure the trouble, please consult us.

4. 5. 3. Excessive discharge pressure

Possible cause	Remedy
1. Excessive speed.	Check speed precisely. If it is not possible to decrease the speed, one or more impellers and their diffusers should be removed, or the outlet tips of the impeller vanes should be cut back. Please consult us first.
2. The S.G. of the fluid pumped is too high (e.g. the temperature of the fluid is lower than specified).	If the pump must operate for prolonged periods under these conditions, the measures outlined in 1. above should be taken.
3. The suction pressure is too high (on pumps operating with positive suction head).	Check suction pressure. If no corrective steps can be taken on the installation, the measures outline in 1. above should be considered.

4. 5. 4. Pump leaks (other than at stuffing boxes)

Possible cause	Remedy
1. The tiebolts are not tightened sufficiently.	Shut down the pump, release the internal pressure, and tighten the nuts on the tiebolts evenly after the pump has cooled down completely.
2. Gasket or metal-to-metal sealing faces damaged.	If the leakage cannot be cured by tightening the tiebolts, new gaskets should be inserted or the metal mating faces should be touched up (fig.22).
3. The fluid pumped is subject to sudden and violent temperature fluctuation.	<p>The pump may leak if the temperature of the fluid drops suddenly. Wait until the normal operating temperature is restored. If the leakage does not cease of its own accord, this may mean that the gaskets or sealing faces are damaged.</p> <p>If the leakage cannot be cured by tightening the tiebolts, proceed as described under 2. above.</p>

4. 5. 5. Stuffing box leak

Possible cause	Remedy
1. Worn, unsuitable or badly fitted packing.	Repack the stuffing box, carefully observing instruction on page 16.
2. Scoring or grooving of the shaft protecting sleeve, due to excessive tightening askew of the stuffing box gland.	The shaft protecting sleeve should be repolished or renewed. When the stuffing box has been repacked, tighten the gland carefully and evenly.
3. Insufficient cooling water, or fouling of cooling water chambers.	Remove cooling water covers, and thoroughly clean out the cooling surfaces in the stuffing box. Make sure that an adequate supply of clean cooling water is available.
4. The pumps runs rough, i.e. the shaft chatters.	No stuffing box can remain tight forever if the shaft chatters. First of all; the coupling alignment and bearing clearance should be checked, and new bearings fitted if necessary. If this does not cure the trouble, open up the pump, and check the shaft for true running. Also rebalance the rotating assembly and check all running clearances. When reassembling the pump, carefully follow the instruction in this manual.

4. 5. 6. Excessive bearing temperature

Possible cause	Remedy
1. The set is misaligned.	Check alignment at the coupling as described in Section 3.2.1.
2. The piping causes the pump to warp.	Ensure that the piping transmits no stress or strain onto the pump by altering the piping layout if necessary. Realign the pumping set.
3. The prescribed clearance between coupling halves has not been observed during erection.	Correct the coupling clearance. See foundation drawing for measurements.
4. Oil level inadequate, or inferior oil quality.	Top up, or change if necessary (see 4.4.4).

4.5.7. Excessive wear of balancing device

Possible cause	Remedy
1. The fixed clearance gap between the rotor and the discharge casing (1070), or on pump sizes MML 200-350 the bush (118) is too wide; this may be caused by corrosion or mechanical wear.	Re-establish the correct radial clearance between the parts concerned, and renew bush (118) if required. Check that the bearings have correct clearance and seat properly. Check the shaft for true running, and if necessary fit a new shaft.
2. Thrust balancing is impaired by reason of an excessive clearance between the impeller neck (2300) and the wear ring (5020) or the diffuser (1710) ; on pump sizes MML 200-350, between diffuser bush (119) and spacer sleeve (5210).	True up impeller neck or bore of the diffuser and renew wear ring (5020) or spacer sleeve (5210).
3. Thrust balancing impaired by reason of axial displacement of the impellers in relation to the diffusers.	Re-establish the correct axial location of the rotating assembly by either lengthening or shortening the spacer sleeve (5252) in the discharge casing, or in the case of pump sizes MML 40-125, adjust the hub of the balance disc (fig. 21).

4. Escape of water between the balance disc (6010) and the shaft (2100).	Replace the parts damaged by water erosion, and carefully grind all end faces absolutely flat; tighten the shaft protecting sleeve very tightly.
5. Vapour formation inside the pump.	Check the suction head. Vapour formation can arise if the pump is overloaded or if the by-pass non-return valve fails, i.e. if the by-pass orifice does not open promptly when the pump capacity drops (the valve cone may stick in the top position). Vapour formation can also arise as a result of sudden temperature or pressure fluctuations in the suction vessel. Check that the operating conditions as specified.
6. Escape of water between balance disc seat (6020) and discharge casing (1070).	Renew the gasket and touch up the components damaged by erosion, or renew them if necessary.

5. Dismantling and reassembling the pump

5. 1. Dismantling

Dismantling to check the pump internals and fit replacements parts should only be carried out by skilled personal or by one of our own expert fitters.

The instruction in para 5.1 and 5.2.1 apply to pump with conventional stuffing boxes and anti-friction bearings as illustrated in fig.24; if the pump has special the seals of plain bearings, the procedure should be modified to accord with the relevant sectional drawing. Dismantling is begun from the discharge end, after disconnection all piping and uncoupling the driver. Proceed as follow :

1. Remove bearing cover plate (3610) and roller bearing (3220).
2. Remove discharge end bearing bracket (3500) and stuffing box housing (4510) with gland (4520).
3. Unscrew shaft protecting sleeve (5240.2).
4. Withdraw balance disc (6010) by means of the extractor illustrated in fig. 19.

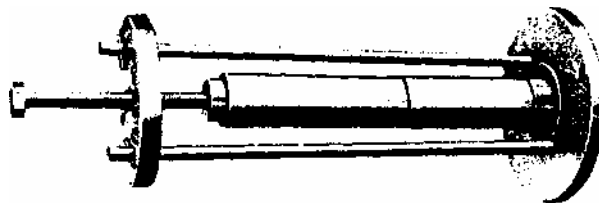


Fig. 19 Withdrawing the balance disc.

In MML pump sizes 150-350, the balance disc (6010) and the spacer sleeve (5252) in the discharge casing are separate components, but share the same key on the shaft. This key must always be removed before the sleeve (5252) is withdrawn.

5. Dismantle the sheet steel cladding of the pump, remove the lagging and take off nuts (9201.1) of tie bolts (9050).

The stage casings (1080) should be underpinned before dismantling proceeds any further, to prevent them collapsing when the discharge casing (1070) is removed.

6. Withdraw discharge casing (1070) and diffuser (1711).
7. Pull of the impellers (2300), stage casings (1080) with their diffusers (1710) and spacer sleeves (5210) for each stage, from the shaft.
8. Finally dismantle the bearing bracket (3500) and the stuffing box housing (4510)

To facilitate removal of components mounted on the shaft of a pump that has been in service for a prolonged period, the use of one of the better-known rust solvents is recommended. If this proves ineffective, the parts in question (not the shaft) may be expanded by gradually heating up with a blow lamp.

This must be done evenly and very carefully, so that the shaft is kept as cool as possible, since heat deformation of a shaft can never be fully remedied. This heating of the parts may be repeated as required, and force should never be used to remove these parts, since this will lead to bending or scoring of the shaft.

Never use a hammer to drive off couplings, balance discs, stage casings, impellers, diffusers or spacer sleeves, as this might damage these components. After completion of dismantling, the shaft should be checked for true running, particularly if it was heated up during dismantling. Shafts used in pumps handling hot liquids can never be permanently straightened by bending after they have been subjected to thermal stresses; they will deform again immediately they are exposed to heat. The sealing faces require special care when dismantling the pump. They must be protected from damage, and ground faces should be placed individually, seal face down, on clean wood or cardboard surfaces.

If dismantling reveals that the pump must be sent away for a major overhaul, it must be reassembled and properly mounted on the bedplate before being despatched to our works.

5. 2. Reassembly

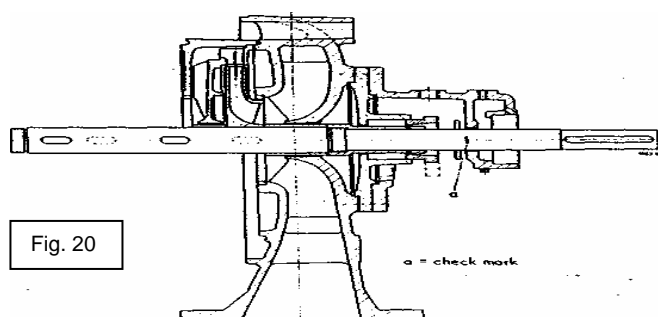
The individual components on the rotating assembly are numbered in sequence, starting at the suction end. Components which belong together should always be reassembled together.

First of all, the rotating assembly, with new parts where required, is reassembled, or a complete replacement rotor is assembled, if the old one is no longer serviceable, and is checked for true running. The shaft should be coated with a suitable lubricant (molybdenum disulphide or similar product), before slipping on the components, to prevent sticking and facilitate subsequent dismantling. After the true running check, the rotor should be dynamically balanced, then dismantled again.

5.2.1. Reassembly of pump with O-ring seals

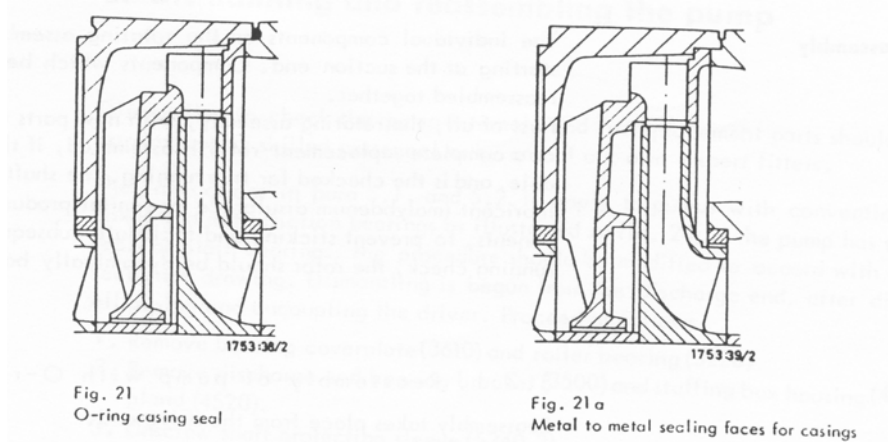
Reassembly takes place from the drive end.

1. The empty stuffing box housing (4510) with gland (4520), the bearing bracket (3500) and the suction casing (1060) are bolted together, and for convenience this partial assembly is best stood on the flange of the suction casing (fig. 20).
2. After the shaft protecting sleeve (5240.1) has been screwed on to the shaft, and the spacer sleeve (5251) slipped into position, the shaft is inserted into the assembly, the flinger ring (5070) being positioned correctly between (4510) and (3500) .
3. The first impeller (2300) and diffuser (1710) are placed on the shaft, making sure that the centre line of the impeller outlet comes into register with the centre line of the diffuser inlet see (fig. 21).



4. A check mark must now be scribed on the shaft at its exit from the bearing housing (fig. 20), so that the axial position of the rotor assembly can later be checked (fig. 21) after all the components have been mounted, and adjusted if necessary by machining the hub of the balance disc (6020), or the spacer sleeve (5252) in the discharge casing (if provided) .

5. The first stage casing (1080) with inserted diffuser (1710) and O-ring (4120.5) are then scaled in the casing (1060). They are to be well tapped in with a wooden or rubber mallet (not a metal hammer), and the stage casing must be suitably underpinned.
6. After the next impeller and spacer sleeve (5210) have been placed on the shaft, the second stage casing with its diffuser and O-ring are tapped into position, as was done with the previous stage.



7. After mounting the last impeller, and, in the case of pump sizes MML 150-350, the spacer sleeve on the discharge side, the discharge cover (1070) with diffuser (1711) of final stage and the last O-rings (4120.5, 4120.6) are fitted.
8. The tiebolts (9050) are then inserted, and the nuts (9201.1) lightly tightened on the cross.
9. The balance disc seat (6020) is carefully placed in position (do not forget gasket) and the balance disc (6010) is then slid onto the shaft (2100). True running of the balancing device can be ensured by making a "blue" test with marking fluid, and touching up the running faces if necessary.
10. The discharge end shaft protecting sleeve (5240.2) is then screwed firmly onto the shaft. At this stage of assembly, the rotor must be able to slide easily in the axial direction.
11. The discharge end bearing bracket and the empty stuffing box housing with its gland are now bolted in position, the nuts being tightened evenly on the cross. The flinger ring (5070) must not be overlooked.
12. The bearings (3220) and the bearing end covers (3600, 3610) are then mounted. Verify that the rotor can be turned easily by hand.
13. Finally check that the shaft is correctly positioned. This is the case when the balance disc (6010) is in contact with the balance disc seat (6020) and at the same time the control mark scribed on the shaft is in its original position in relation to the bearing housing.
14. If this is so, the stuffing box can now be packed as described in section 4. 4. 2.
15. Finally, connect the suction and discharge piping, and also the balance water line.
Before the pump is put into service, check the smooth rotation of the shaft, to make sure that the casing has not been distorted by the piping. See also section 4. 4. for bearing lubrication.

5.2.2. Reassembly of pumps with metal to metal sealing faces (Fig. 21a) .

Proceed as described in section 5.2.1. with the necessary modifications. The highest degree of cleanliness should be observed during assembly of the mating parts. Before assembly is commenced, all the mating faces must be carefully examined. Should they not be perfectly smooth and true, they must be ground manually by means of special cast iron grinding blocks (Figs. 22 and 23).

It is advisable to order these blocks when laying in a stock of spare parts.

Regrinding a sealing face by using the corresponding mating face as a grinding block, e. g. grinding two pump stage casings against one another, must be avoided at all costs, since the spigot and recess (centering) would be opened out there by.

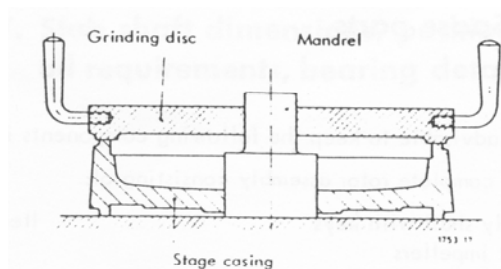


Fig. 22
Grinding block for stage casing

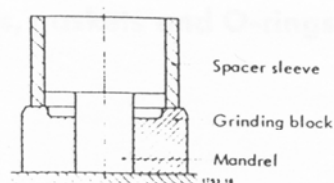


Fig. 23
Grinding block for rotating parts

Fig. 22 illustrates a grinding disc for stage casing, and fig. 23 the grinding tool used for regrounding the rotating parts; the latter is designed as a bushing (socket), since only thus can it be ensured that the ground surfaces are fully perpendicular to the axis of the shaft. The abrasive material (grinding paste) used must be of a high grade fine grained quality.

5. 2. 3. Assembling the bearings.

The most scrupulous cleanliness should be observed the fitting the bearings. Dirt, dust and moisture will damage anti-friction bearings. Petrol or benzol may be used for cleaning bearings, and these should be well oiled immediately after cleaning, and rotated repeatedly, to allow all the tracks and balls and rollers to be completely cated with oil.

A part from special types, MML pump sizes 40-125 are fitted with taper lock sleeve roller bearings these combine the two features of a tight fit on the shaft required by the design, and an assembly which can be readily dismantled, so that there practically no risk of the bearing being damaged by having to use force to remove it from the shaft.

When mounting the bearing, make sure that the inner and outer races are in line, i. e. not off set to each other, before tightening the taperlock sleeve should only be tightened sufficiently far to allow the outer race to rotate freely, without any perceptible resistance. This requires a certain amount of care and attention. The nut on the sleeve is secured by a locking plate which must no be overlooked during erection.

If a trial run produces a squealing noise from the bearing, this usually indicated inadequate lubrication. A louder and intermittent noise may be caused by dirt in the bearing.

When dismantling the bearing, the nut on the taperlock sleeve should first be removed. Then the inner race of the bearing is freed from the taper sleeve by light hammer blows on one end of a suitable length of mild steel or brass piping, the other end of which is applied against the thin end of the taper sleeve.

5. 3. Protection of pump during prolonged shut downs and transport.

If a pump is shut down for a prolonged period, it must be carefully protected. It should be completely dismantled and all components thoroughly cleaned and dried. Then it is reassembled (see page 24), and the suction and discharge nozzles should be blanked off by wooden covers, to prevent foreign bodies entering the pump. All open connection for cooling water and oil should like wise be carefully plugged.

Any machined parts on the assembled pump which are exposed to atmosphere should be coated with a rust preventive varnish, or throughly oiled or greased.

If the pump is sent back to or Works for repairs, it should be drained first, and all the pipe connections and flanges carefully plugged or blanked off, as mentioned above. The pump should always be despatched in the fully assembled state, as the sealing faces of the individual components might otherwise be damaged in transit.

6. Spare parts

It is advisable to keep the following components in stock at all times :

One complete rotor assembly consisting of :

1 only shaft with keys	Item No.	2100
1 set impellers		2300
1 only spacer sleeve for suction casing		5251
1 only spacer sleeve for discharge casing		5252 (on pump sizes MML 150-350)
1 set spacer sleeves for diffusers		5210
1 each shaft protecting sleeve		5240.1, 5240.2
1 set gaskets		6010
Also ;		
1 set diffusers		1710, 1711
1 set bearings		3220, 3700
1 set case wear rings		5020
2 sets O-rings		4120.5, 4120.6
2 sets stuffing box packing		4610
1 only balance disc seat		6020
1 only bush in discharge casing		118 (only on pump sizes MML 200-350)
1 set flat gaskets		4000.1 4000.3, 4000.4

When ordering spare parts, always state the Works serial no. of the pump, stamped of the pump rating plate and on the suction flange, as well as the item no. and designation of each item required as specified in the lists of components on the following pages.

- 1). When plain bearing are fitted (MML 200 – 350) according to fig. 26
- 2). For pumps fitted with mechanical seals, see section 2. 1. 4. 2.

7. Stub shaft dimensions, packing details, cooling water and oil requirements, bearing details, seals gaskets and O-rings.

Size of pump MML	40	50	65	80	100	125
Stub shaft dimensions mm	240 x 60	280x60	280x60	340x80 45/650	340x10	420 x 120
Dimensions of stuffing box compartment mm A	34/500x35	39/550x35	39/550x35	x 45	45/650x45	56/800 x 50
Standard execution						
Packing required for above (with/without lantern ring) mm	8 x 8 x 700/1000	8 x 8 x 750/1050	8 x 8 x 750/1050	10 x 10 x 950/1300	10 x 10 x 950/1300	12 x 12 x 1150/1600
Coolant connection Inches						
Coolant required (max.) Imp. g. h. p. litres/hr	R3/8	R3/8	R3/8	R1/2	R1/2	R1/2
Initial fill, Imp. Pints Kilos	200	250	250	300	300	400
Lubricating oil Per annum (aprox)	0.1	0.15	0.15	0.2	0.2	0.25
Bearings, both end	NU 206K/C3	NU 207K/C3	NU 207K/C3	NU 208K/C3	NU 208K/C3	NU 210 / C3
Taperlock sleeve for above	H 206	H 207	H 207	H208	H208	H 210
Mechanical seals, Flexibox Size No.	25	32	32	36	36	45
O-rings for stage casings (4120. 5) mm	40 x 1900	40 x 2100	40 x 2400	40 x 2750	40 x 3100	40 x 3550
O-rings for last stage diffuser (4120. 6) mm	40 x 1200	40 x 1450	40 x 1500	40 x 2100	40 x 2400	40 x 2800
O-rings for stuffing box housing (4000. 3) mm	30 x 600	30 x 650	30 x 650	30 x 700	30 x 700	30 x 900
Gasket s for cover plate (4000. 4) mm	170/125,50 x 0,5	190/145,50 x 0,5	190/145,50 x 0,5	235/185,50 x 0,5	235/185,50 x 0,5	260/210,50 x 0,5
Gaskets for stuffing box housing (4000. 3) mm	170/125,50 x 0,5	190/145,50 x 0,5	190/145,50 x 0,5	235/185,50 x 0,5	235/185,50 x 0,5	260/210,50 x 0,5
Gaskets for bearing cover plate (4000. 1) mm	75/62.50 x 0,3	84/72.50 x 0,3	84/72.50 x 0,3	90/80.50 x 0,3	90/80.50 x 0,3	100/90.50 x 0,3

Size of pump MML	150	200	250	300	350
Stub shaft dimensions mm	460 x 140	780 x 180	840 x 180	980 x 180	980 x 180
Dimensions of stuffing box compartment mm	66/900 x 55	98/1300 x 70	105/1370 x 85	125/1570 x 85	125/1570 x 85
A standard execution					
Packing required for above mm	12 x 12 x 1000	16 x 16 x 1450	16 x 16 x 1900	16 x 16 x 2220	16 x 16 x 2220
B Special execution mm	66/900 x 91	98/1300 x 117	105/1370 x 135	125/1570 x 135	125/1570 x 135
Packing required for above (with/without lantern ring) mm	12 x 12 x 1250/1750	16 x 16 x 1800/2550	16 x 16 x 2280/3050	16 x 16 x 2660/3550	16 x 16 x 2660/3550
Coolant connection Inches	R1	R1	R1	R1	R1
Coolant required (max.) Imp. G. p. h. Litters/hr.	500	1300	1900	2200	2200
Initial fill, Imp. Pints Kilos	0.3	4	7	8	8
Lubricating oil Per annum (approx.)	3	40	55	80	80
Bearings, both ends	NU 410/C3	Plain bearings	Plain bearings	Plain bearings	Plain bearings
Taperlock sleeve for about	-	-	-	-	-
Mechanical seals, Flexibox Sizes No.	56	80	85	100	100
O-rings for stage casings (4120. 5) mm	40 x 4200	60 x 6000	60 x 6900	60 x 7800	60 x 7800
O-rings for last stage diffuser (4120.6) mm	40 x 2600	40 x 3650	40 x 4220	40 x 4700	40 x 4700
O-rings for stuffing box housing (4000. 3) mm	30 x 1050	30 x 1450	30 x 1600	30 x 1800	30 x 1800
Gasket for cover plate (4000. 4) mm	330/260.50 x 0.5	460/370.50 x 0.5	525/430.50 x 0.5	580/470.50 x 0.5	580/470.50 x 0.5
Gasket for stuffing box housing (4000. 3) mm	330/260.50 x 0.5	460/370.50 x 0.5	525/430.50 x 0.5	580/470.50 x 0.5	580/470.50 x 0.5
Gasket for bearing cover plate (4000. 1) mm	190 x 190 x 0.3	251 x 210 x 0.3	251 x 210 x 0.3	251 x 210 x 0.3	251 x 210 x 0.3

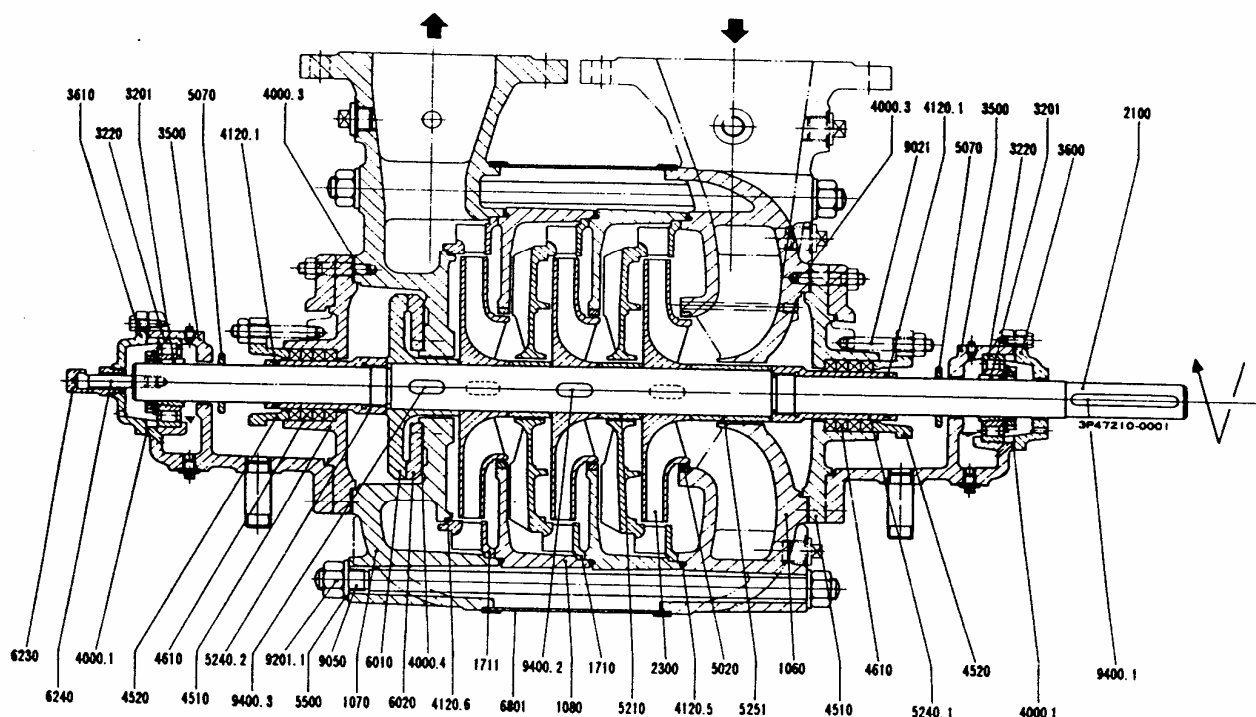
+ 0.3 m thick in HW and V stuffing boxes

++ Overall dimensions

9. Sectional drawings and list of components

Size MML 40, 50, 65

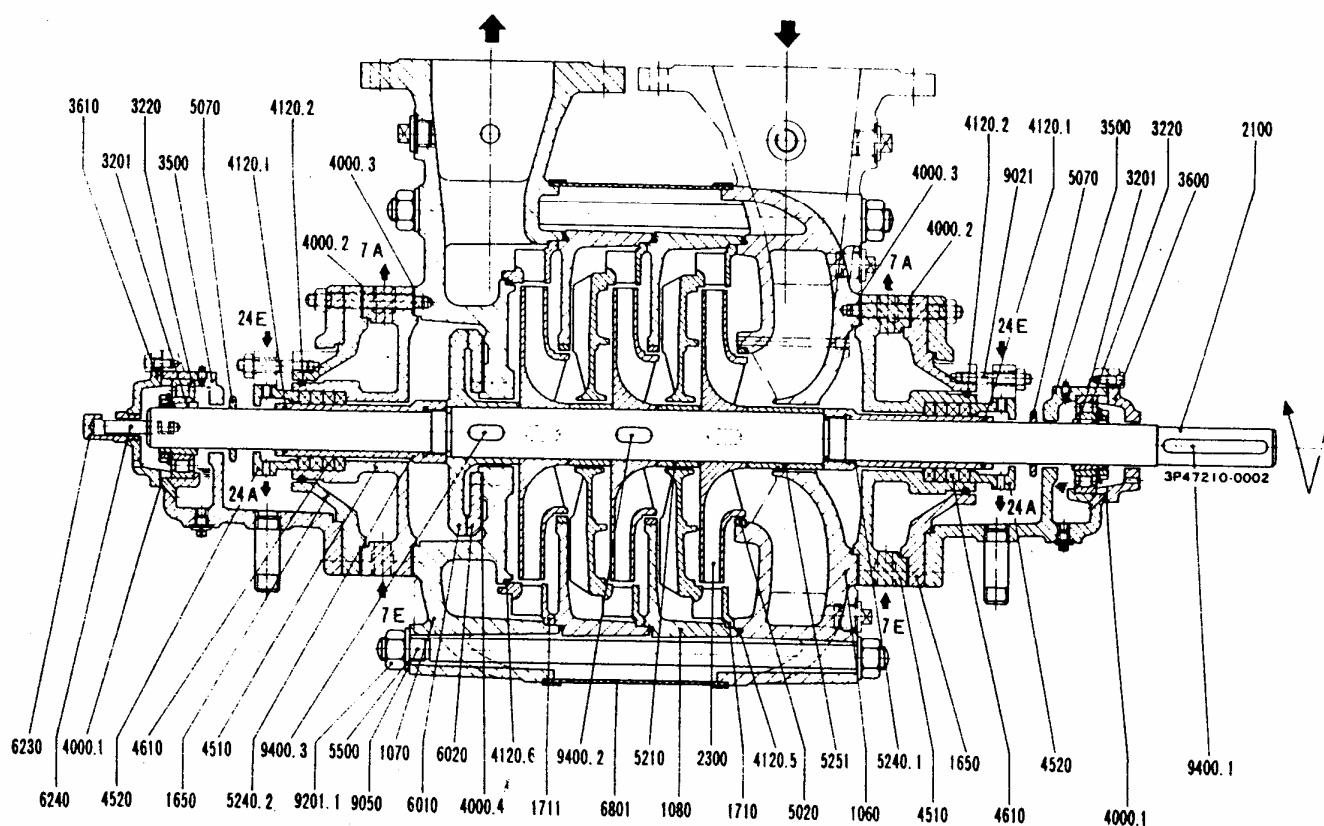
Stuffing box housing : Type N



No	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing		1	4120.5	O-ring	NBR		9021	Stud	SUS420J	4
1070	Discharge casing		1	4120.6	O-ring	ASBESTOS	1	9050	Tie bolt	SCM 3	8
1080	Stage casing			4510	Stuffing box housing		2	9201.1	Hexagonal nut	S45C	16
1710	Diffuser			4520	Stuffing box gland		2	9400.1	Key	S 45C	1
1711	Diffuser Last Stage		1	4610	Stuffing box packing	TOMBO	8	9400.2	Key	S45C	
2100	Shaft		1	5020	Casing wear ring			9400.3	Key	S45C	1
2300	Impeller			5070	Deflector	S35C	2				
3201	Clamping sleeve	SS400	2	5210	Stage sleeve						
3220	Cylindrical roller bearing	NU KC3 + H	2	5240.1	Shaft protecting sleeve		1				
3500	Bearing housing	FC200	2	5240.2	Shaft protecting sleeve		1				
3600	Bearing cover	FC200	1	5250.1	Spacer sleeve		1				
3610	Bearing end cover	FC200	1	5500	Washer	SS400	16				
4000.1	Flat gasket	TOMBO 1630	2	6010	Balance disc		1				
4000.3	Flat gasket	TOMBO 1301	2	6020	Balance disc seat		1				
4000.4	Flat gasket	TOMBO 1900	1	6230	Rotor position indicator	BSBME 1	1				
4000.1	O-ring	NBR	2	6240	Pivot for indicator	S30C	1				
				6801	Gladding	SPCC	1				

Size MML 40, 50, 65

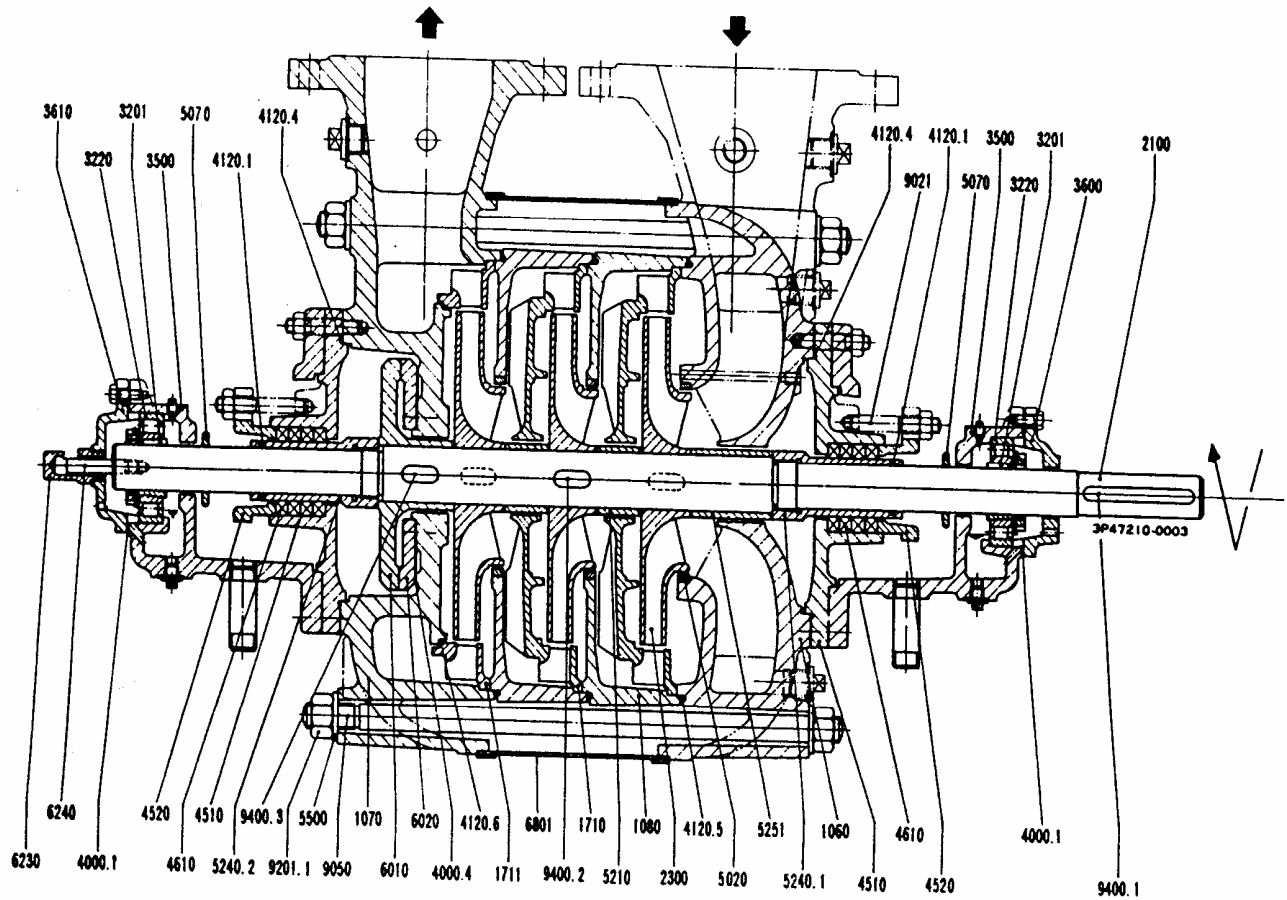
Stuffing box housing : Type HW



No.	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing	FC 250	1	4120.1	O-ring	VITON	2	6020	Balance disc seat	FC 200	1
1070	Discharge casing	FC 250	1	4120.2	O-ring	N B R	2	6230	Rotor position indicator	BSBME 1	1
1080	Stage casing	FC 250		4120.5	O-ring	VITON		6240	Pivot for indicator	SS 400	1
1650	Cooling cover	FC 200	2	4120.6	O-ring	ASBESTOS	1	6801	Gladding	S P C C	1
1710	Diffuser	FC 200		4510	Stuffing box housing	FC 250	2	9021	Stud	SUS 420 J2	4
1711	Diffuser last stage	FC 200	1	4520	Stuffing box gland	FC 200	2	9050	Tie bolt	S C M 3	8
2100	Shaft	S 45 C	1	4610	Stuffing box packing	TOMBO 3300	8	9201.1	Hexagonal Nut	S 45 C	16
2300	Impeller	FC 200		5020	Casing wear ring	FC 200		9400.1	Key	S 45 C	1
3201	Clamping sleeve	SS 400	2	5070	Deflector	S 35 C	2	9400.2	Key	S 45 C	
3220	Cylindrical roller bearing	NU KC3 +H	2	5210	Stage sleeve	FC 200		9400.3	Key	S 45 C	1
3500	Bearing housing	FC 200	2	5240.1	Shaft protecting sleeve	FC 200	1				
3600	Bearing cover	FC 200	1	5240.2	Shaft protecting sleeve	FC 200	1				
3610	Bearing end cover	FC 200	1	5251	Spacer sleeve	FC 200	1				
4000.1	Flat gasket	TOMBO 1630	2	5500	Washer	SS 400	16				
4000.2	Flat gasket	TOMBO 1900	2	6010	Balance disc	FC 200	1				
4000.3	Flat gasket	TOMBO 11900	2								
4000.4	Flat gasket	TOMBO 1900	1								

Size MML 80, 100, 125

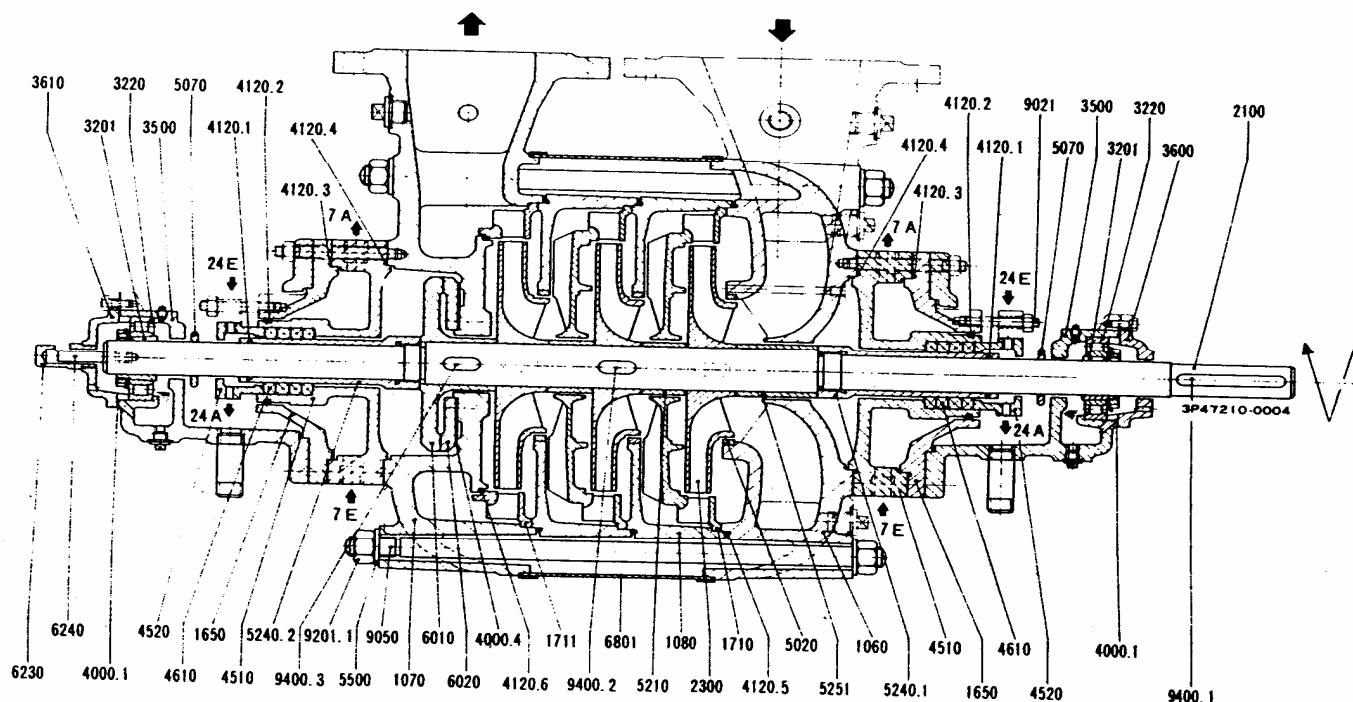
Stuffing box housing : Type N



No.	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing		1	4120.6	O-ring	ASBESTOS	1	9050	Tie bolt	S C M 3	8
1070	Discharge casing		1	4510	Stuffing box housing		2	9201.1	Hexagonal nut	S 45 C	16
1080	Stage casing			4520	Stuffing box gland		2	9400.1	Key	S 45 C	1
1710	Diffuser			4610	Stuffing box packing	TOMBO 3300	8	9400.2	Key	S 45 C	
1711	Diffuser last stage		1	5020	Casing wear ring			9400.3	Key	S 45 C	1
2100	Shaft		1	5070	Deflector	S 35 C	2				
2300	Impeller			5210	Stage sleeve						
3201	Clamping sleeve	SS 400	2	5240.1	Shaft protecting sleeve		1				
3220	Cylindrical roller bearing	NU KC3 +H	2	5240.2	Shaft protecting sleeve		1				
3500	Bearing housing	FC 200	2	5251	Spacer sleeve		1				
3600	Bearing cover	FC 200	1	5500	Washer	SS 400	16				
3610	Bearing end cover	FC 200	1	6010	Balance disc		1				
4000.1	Flat gasket	TOMBO 1630	2	6020	Balance disc. Seat		1				
4000.4	Flat gasket	TOMBO 1900	1	6230	Rotor position indicator	BSBME 1	1				
4120.1	O-ring	N B R	2	6240	Pivot for indicator	S 30 C	1				
4120.4	O-ring	N B R	2	6801	Cladding	S P C C	1				
4120.5	O-ring	N B R		9021	Stud	SUS 420J2	4				

Size MML 80, 100, 125

Stuffing box housing : Type HW



No.	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing	FC 250	1	4120.3	O-ring	N B R	2	6240	Pivot for indicator	SS 40	1
1070	Discharge casing	FC 250	1	4120.4	O-ring	VITON	2	6801	Cladding	S P C C	1
1080	Stage casing	FC 250		4120.5	O-ring	VITON		9021	Stud	SUS 420 J2	4
1650	Cooling cover	FC 200	2	4120.6	O-ring	ASBESTOS	1	9050	Tie bolt	S C M 3	8
1710	Diffuser	FC 200		4510	Stuffing box housing	FC 250	2	9201.1	Hexagonal nut	S 45 C	16
1711	Diffuser last stage	FC 200	1	4520	Stuffing box gland	FC 200	2	9050.1	Key	S 45 C	1
2100	Shaft	S 45 C	1	4610	Stuffing box packing	TOMBO 3300	8	9400.2	Key	S 45 C	
2300	Impeller	FC 200		5020	Casing wear ring	FC 200		9400.3	Key	S 45 C	1
3201	Clamping sleeve	SS 400	2	5070	Deflector	S 35 C	2				
3220	Cylindrical roller bearing	NU KC3 +H	2	5210	Stage sleeve	FC 200					
3500	Bearing housing	FC 200	2	5240.1	Shaft protecting sleeve	FC 200	1				
3600	Bearing cover	FC 200	1	5240.2	Shaft protecting sleeve	FC 200	1				
3610	Bearing end cover	FC 200	1	5251	Spacer sleeve	FC 200	1				
4000.1	Flat gasket	TOMBO 1630	2	5500	Washer	SS 400	16				
4000.4	Flat gasket	TOMBO 1900	1	6010	Balance disc	FC 200	1				
4120.1	O-ring	VITON	2	6020	Balance disc. Seat	FC 200	1				
4120.2	O-ring	N B R	2	6230	Rotor position indicator	BSBME 1	1				

7E : Cooling water inlet

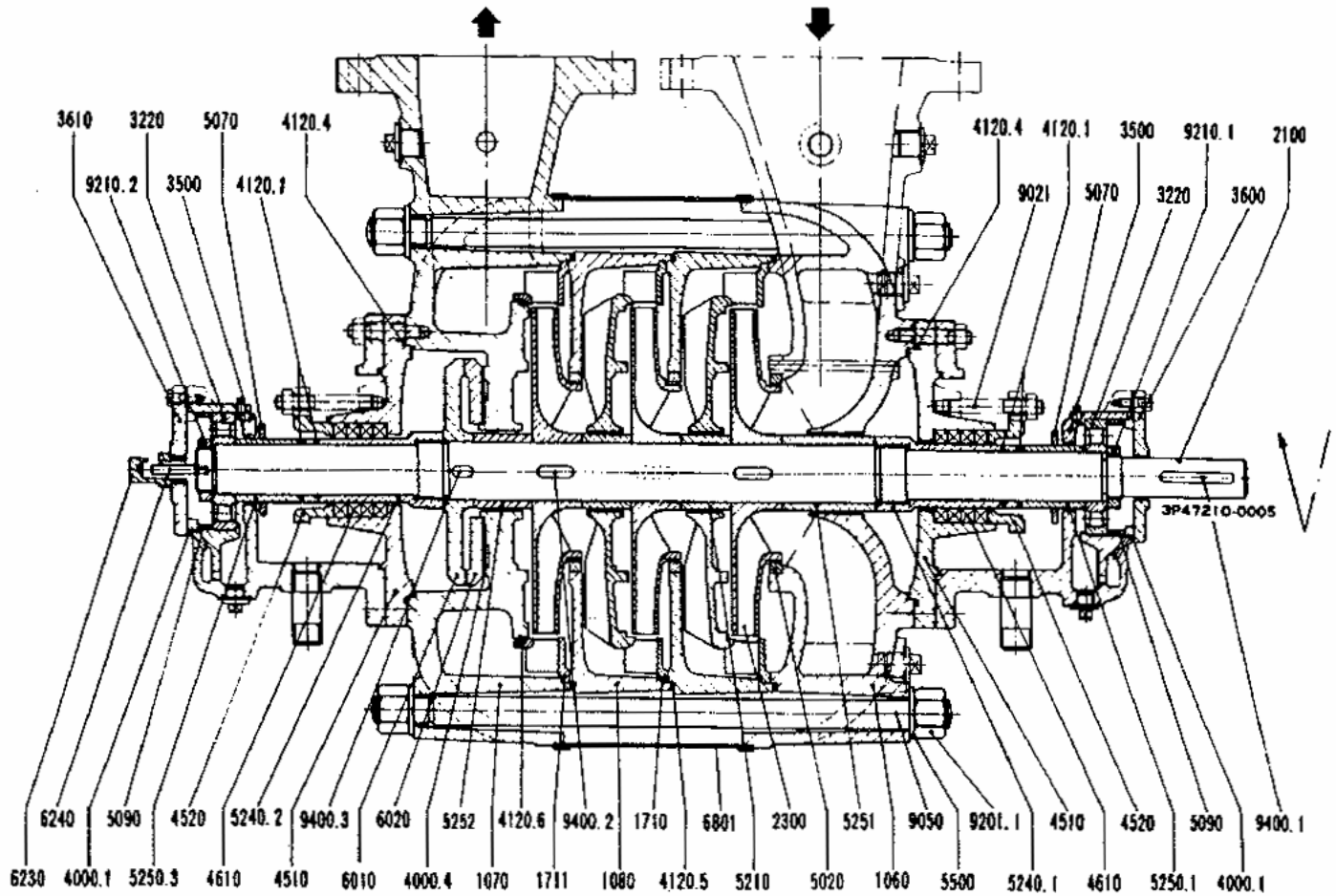
24E : Quenching inlet

7A : Cooling water outlet

24A : Quenching outlet

Size MML 150

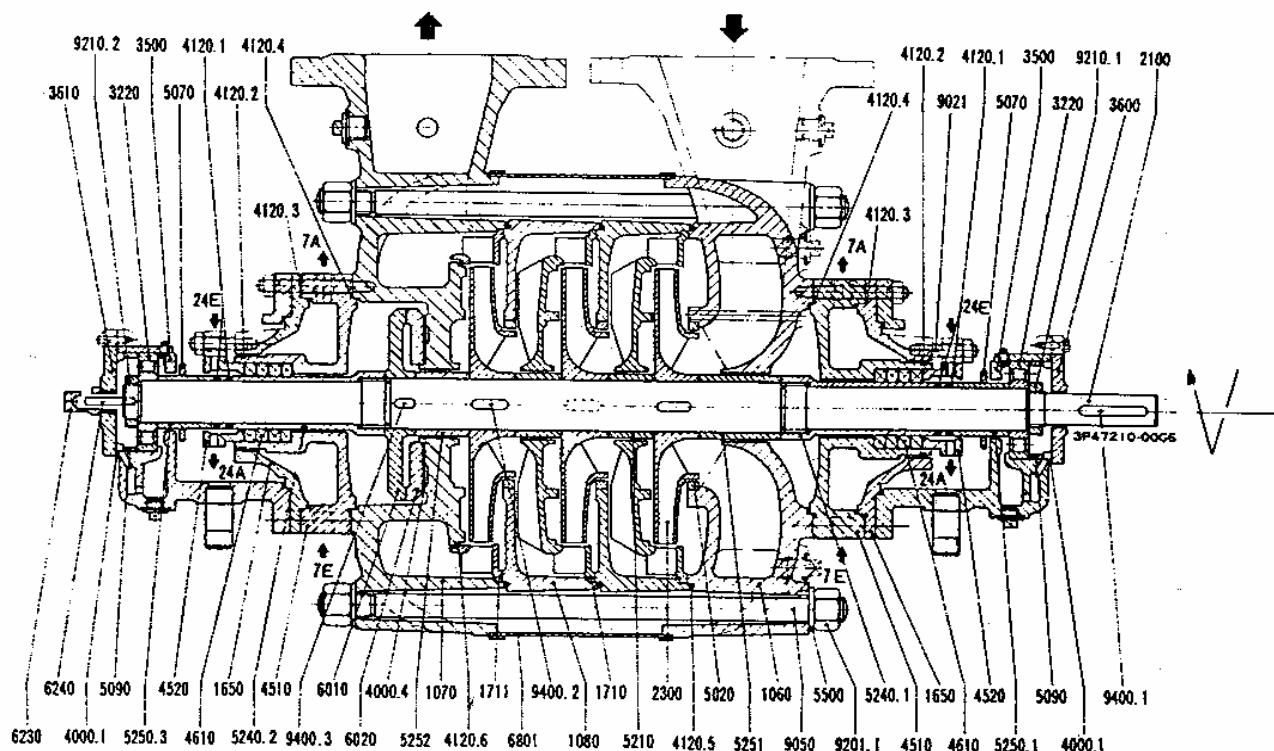
Stuffing box housing : Type N



No.	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing		1	4510	Stuffing box housing		2	6240	Pivot for indicator	S 30 C	1
1070	Discharge casing		1	4520	Stuffing box gland		2	6801	Cladding	S P C C	1
1080	Stage casing			4610	Stuffing box packing	TOMBO 3300	8	9021	Stud	SUS 420 J2	4
1710	Diffuser			5020	Casing wear ring			9050	Tie bolt	S C M 3	8
1711	Diffuser last stage		1	5070	Deflector	S 35 C	2	9201.1	Hexagonal nut	SUS 420 J2	16
2100	Shaft		1	5090	Spacer ring	FC 200	2	9210.1	Nut	SUS 420 J2	1
2300	Impeller			5210	Stage sleeve			9400.1	Nut	S 45 C	1
3220	Cylindrical roller bearing	NU 410 C3	2	5240.1	Shaft protecting sleeve		1	9400.2	Key	S 45 C	
3500	Bearing housing	FC 200	2	5240.2	Shaft protecting sleeve		1	9400.3	Key	S 45 C	1
3600	Bearing cover	FC 200	1	5250.1	Spacer sleeve		1				
3610	Bearing end cover	FC 200	1	5250.3	Spacer sleeve		1				
4000.1	Flat gasket	TOMBO 1630	2	5251	Spacer sleeve		1				
4000.4	Flat gasket	TOMBO 1900	1	5252	Spacer sleeve		1				
4120.1	O-ring	N B R	4	5500	Washer	SS 400	16				
4120.4	O-ring	N B R	2	6010	Balance disc		1				
4120.5	O-ring	N B R		6020	Balance disc. Seat		1				
4120.6	O-ring	ASBESTOS	1	6230	Rotor position indicator	BSBME 1	1				

Size MML 150

Stuffing box housing : Type HW



No.	Name	Material	Pcs	No.	Name	Material	Pcs	No.	Name	Material	Pcs
1060	Suction casing	FC 250	1	420.4	O-ring	VITON	2	6010	Balance disc		1
1070	Discharge casing	FC 250	1	4120.5	O-ring	VITON	2	6020	Balance disc seat		1
1080	Stage casing	FC 250		4120.6	O-ring	ASBESTOS	1	6230	Rotor position indicator		1
1650	Cooling cover	FC 200	2	4510	Stuffing box housing	FC 250	2	6240	Pivot for indicator		1
1710	Diffuser	FC 200		4520	Stuffing box gland	FC 200	2	6801	Cladding		1
1711	Diffuser last stage	FC 200	1	4610	Stuffing box packing	TOMBO 3300	8	9021	Stud		4
2100	Shaft	S 45 C	1	5020	Casing wear ring	FC 200		9050	Tie bolt		8
2300	Impeller	FC 200		5070	Deflector	S 35 C	2	9201.1	Hexagonal nut		16
3220	Cylindrical roller bearing	XU 410 C3	2	5090	Spacer ring	FC 200	2	9210.1	Nut		1
3500	Bearing housing	FC 200	2	5210	Stage sleeve	FC 200		9210.2	Nut		1
3600	Bearing cover	FC 200	1	5240.1	Shaft protecting sleeve	FC 200	1	9400.1	Key		1
3610	Bearing end cover	FC 200	1	5240.2	Shaft protecting sleeve	FC 200	1	9400.2	Key		
4000.1	Flat gasket	TOMBO 1630	2	5250.1	Spacer sleeve	FC 200	1	9400.3	Key		1
4000.4	Flat gasket	TOMBO 1900	1	5250.3	Spacer sleeve	FC 200	1				
4120.1	O-ring	VITON	4	5251	Spacer sleeve	FC 200	1				
4120.2	O-ring	N B R	2	5252	Spacer sleeve	FC 200	1				
4120.3	O-ring	N B R	2	5500	Washer	SS 400	16				

7E : Cooling water inlet

24E : Quenching inlet

7A : Cooling water outlet

24A : Quenching outlet



TORISHIMA PUMP MFG.CO.,LTD.

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