Operating Instruction

MMK

TORISHIMA PUMP

High Pressure Centrifugal Pump

PT. TORISHIMA GUNA INDONESIA

I. Introduction

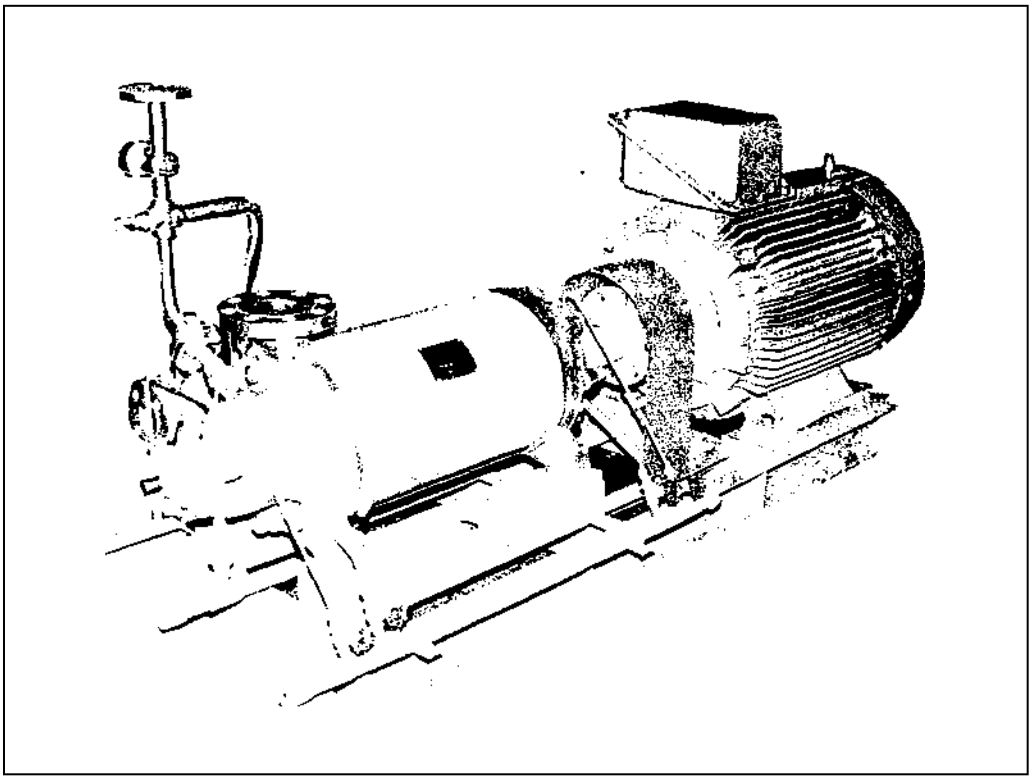
Our machines are very high quality products, which will always give you completely satisfactory and trouble free service, if they are erected, serviced and operated properly by skilled personnel. The instructions and recommendations contained in this booklet should be carefully followed to obtain trouble-free 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 lo 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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1. General construction of pump

1.1. Description of pump

MMK pumps can generally be used for generated heads up to 15kg/cm^2 (2l3 PSl). They are designated in accordance will the bore of the discharge nozzle e. g. MMK 40.50 etc. (MMK 4Q has a discharge nozzle bore of 40 mm) Constructional details are shown in the sectional drawings.

1.1.1. Casing

MMK High pressure pumps are multistage centrifugal pumps, with a radially split The casing consists of the suction and discharge casings (see sectional drawings, part Nos. 1060 and 1070) and of a number of Intermediate, or stage, casing (1080). The individual casing components are clamped together by tie bolts (9050).The intermediate casings and tiebolts 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 clamped in between each successive pair of intermediate casings. The stuffing box housings (4510), and bearing brackets (3500) are flanged onto the suction and discharge casing 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 diffusers are made of cast iron, bronze or chrome steel, as required.

A leak-proof joint between the individual casing components is ensured by inserting O-ring (4120.5), profile seals, gasket or by providing ground metal-to-metal joints, according to the operating temperature, and the material of the casings. The pressure necessary to seal off the internal pressure 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 ring (5020) are fitted to the intermediate stage casings and diffusers, which can be renewed when the wear has become excessive.

1.1.2. Rotating assembly

The shaft (2100) transmit the torque generated by the driver, in equal proportions to all the impellers, via the impeller keys. The spacer sleeves (5251, 5252 and 5210) ensure the correct axial location of the impeller and also act as shaft protecting sleeves. The shaft 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, opposed to the direction of rotation.

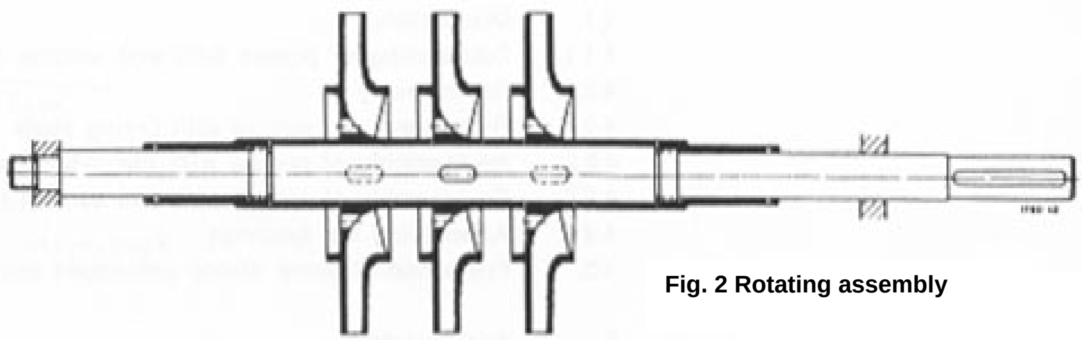


Fig. 2 Rotating assembly

The shaft (2100) is made of Siemens-Martin steel, or, in certain case, of special quality steel. The impellers (2300), shaft sleeves (5240.1, 5240.2) and spacer sleeve (5251, 5252, 5210), can be supplied in cast iron, bronze, carbon steel or chrome steel according to the nature of the fluid pumped and operating conditions.

1.1.3. Bearings

The weight of the rotor is supported on two anti-friction bearings (plain bearings are used on pump sizes MMK 200 and above). The two bearing bracket (3500) are normally identical, and flanged onto the suction casing, respective the discharge casing. The pumps equipped with end suction nozzle (102a), are an exception; on these pumps, the suction end bearing is always a plain bearing lubricated by the fluid pumped. The generated head on multistage centrifugal gives rise to an axial thrust on the pump rotor, which is compensated individually at each impeller by the provision of close clearance wear rings (5020) at either side of the impeller, and also by balance holes drilled through the impeller back plate. Any residual axial thrust is absorbed by the bearings. This bearing is arranged as a located bearing, i.e. it cannot slide axially after having been mounted in the pump. The bearing at the other end of the pump is a loose bearing, either a cylindrical roller bearing of NU series mounted on a taper lock sleeve (3220), or a plain bearing, which affords a limited amount of axial freedom of movement to the rotor. All the bearings are oil-lubricated. Plain bearings are provided with an oil ring. The maintenance of an adequate oil level in the bearing housing can be checked by the overflow hole in the bearing cover plate (see section 3.4.4). The various bearing sizes and types fitted to individual pump sizes shown on the table in sectional drawing.

1.1.4. Shaft seals

The purpose of a shaft seal s 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 are available are used, will depend on the pressure, temperature and nature of the liquid pumped.

1.1.4.1. 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 sleeve (5240.1, 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 105 °C (220 °F). When the temperature exceeds 105 °C, the so-called hot water execution HW, with hot water stuffing boxes is used (Fig. 3). On this type, an end cover (3610) is mounted between the bearing bracket (3500) and the stuffing box housing (4510).

The stuffing box housing (4510) surrounds the shaft 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 narrow annulus upstream of the packing rings, and its temperature considerably reduced before it reaches the packing rings. A pre-requisite 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.

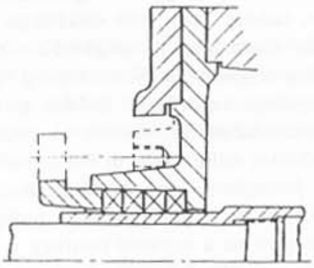
A part from these standard stuffing boxes, there are **special types** recognizable from the fact that the space for the packing is extra long, to provide room from an increased number of packing rings, and usually also a lantern ring, which may be located at the bottom of the box, or amid the packing rings, according to the 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 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 105 °C (220 °F) a cooling chamber 301 (Fig. 3) is fitted upstream 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) fro a variety of liquid pumped. The maintenance of soft-packed stuffing boxes is described in section 3. 4. 2.

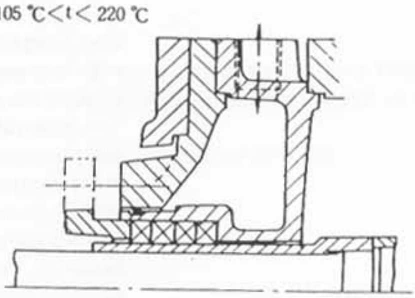
Conventional Stuffing Box

Standard
t ≤ 105 ℃



Cooling liquid

HW
105 ℃ < t < 220 ℃

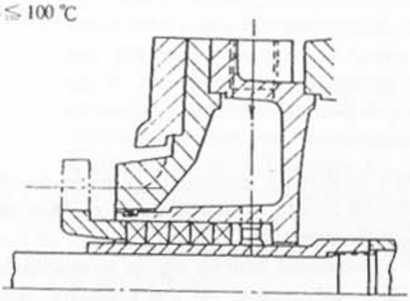


Special Execution Stuffing Box

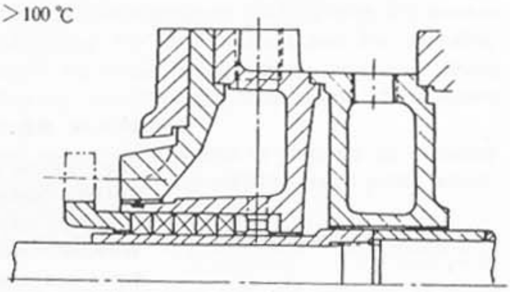
Product pumped:
For liquid with entrained abrasive particles, when the packing must be protected against the penetration of any abrasive materials (e.g. oil with Kieselgur, fractions from the catalytic cracking plant with entrained abrasive particles).

Flushing fluid

VH
t ≤ 100 ℃



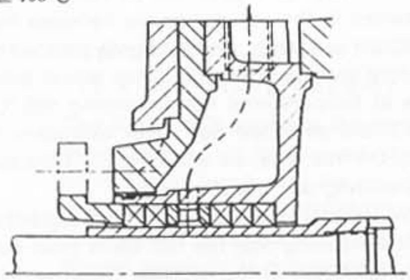
HK
t > 100 ℃



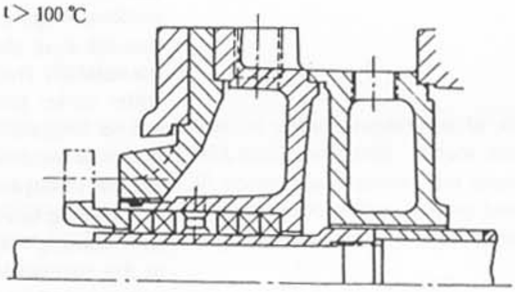
Product pumped:
For liquid that have to be drawn off under vacuum (e.g. hydrocarbons and oil that are vaporized in vacuum residues in vacuum columns, condensate).
When stuffing box losses must be trapped before they reach the open, the liquids (e.g. all kinds of solvents, ammonia) are led off through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

Sealing, resp. leakage fluid

VM
t ≤ 100 ℃



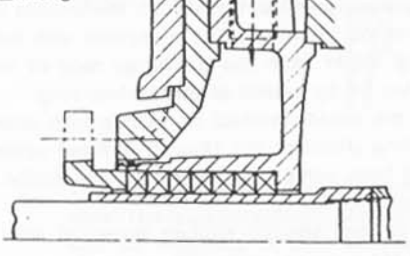
MK
t > 100 ℃



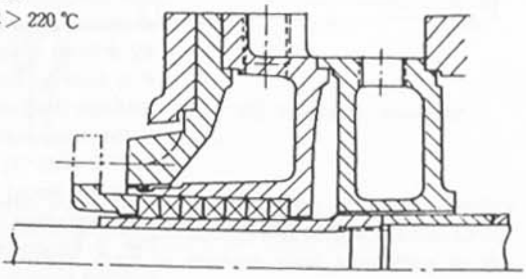
Product pumped:
For LPG, especially liquefied propane
- Below 55 °C (130 °F)
  Above 55 °C (130 °F)
  Lubricant and heat transfer media.
  (e.g. Diphyl etc.)
- Below 180 °C (360 °F)
  Above 180 °C (360 °F)

Cooling or heating liquid

V
t ≤ 220 ℃



VK
t > 220 ℃



1.1.4.2. Mechanical seal

A mechanical shaft seal (Fig. 4a to d) consist essentially of two rings pressed against each other, in close rubbing contact; one ring (5) rotates with the shaft, whilst the other ring (1) is stationary and is resiliently mounted in the seal clamping plate (3A).

There are various types available , viz. :

1. Standard type with O-ring seal (Fig. 4a)
2. Standard type with Teflon profile seal (Fig 4b)
3. Standard type with auxiliary stuffing box and O-ring seal (Fig. 4c)
4. Standard type with auxiliary stuffing box and Teflon profile seal
5. Standard type as No. 3 above, plus cooling jacket (Fig. 4d)
6. Standard type as No. 4 above, plus cooling jacket

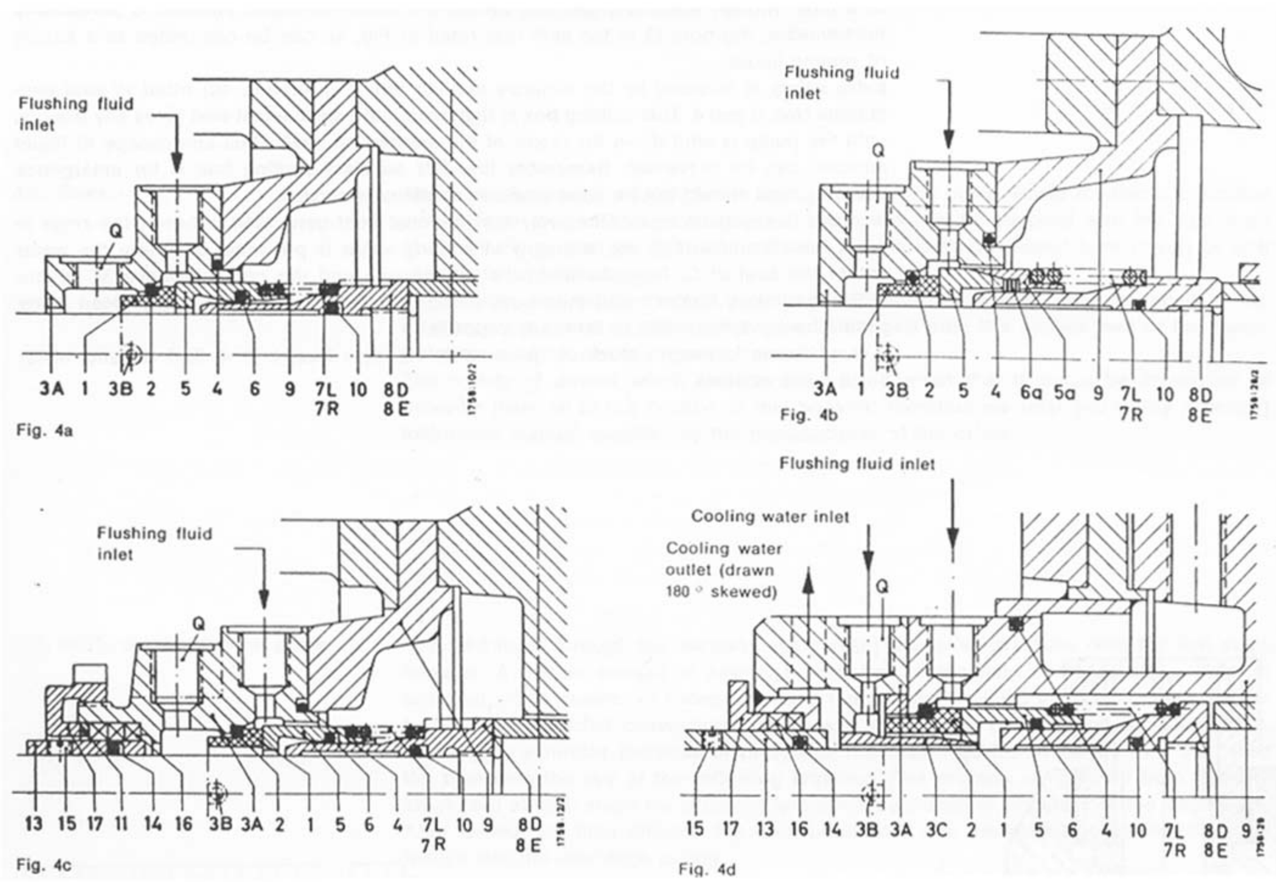


Fig. 4a

Fig. 4b

Fig. 4c

Fig. 4d

List of components

	Item Nr. in Fig. 4a–d	Designation	Sectional drawing Item No.	Quantity required per pump For Fig. 4a and 4b	For Fig. 4c	For Fig. 4d
Stationary parts	1	Stationary seal ring, carbon	338	2	2	2
	2	O-ring	339	2	2	2
	3 A	Seal clamping plate	305 a	2	2	2
	3 B	Locking pin	338 a	2	2	2
	3 C	Coolant sleeve		–	–	2
	4	O-ring	340	2	2	2
	9	Seal housing	304 a	2	2	2
	11	Backing ring	342	–	2	–
	16	Packing for stuffing box	343	–	2	2
	17	Stuffing box gland	341	–	2	2
Rotating parts	5	Rotary seal ring	244	2	2	2
	5 a	Wedge*)	244 a	2	–	–
	6	O-ring	246	2/2	2	2
	6 a	Teflon sealing ring*)			–	–
	7 R	Spring, right-hand coil	245	1	1	1
	7 L	Spring, left-hand coil	245 a	1	1	1
	8 E	Spring sleeve, suction end	212 a	1	1	1
	8 D	Spring sleeve, discharge end	213 a	1	1	1
	10	O-ring	243	2	2	2
	13	Shaft sleeve in auxiliary stuffing box	247	–	2	2
	14	O-ring	248	–	2	2
	15	Grub screw	247 a	–	2	2

*) Wedge and Teflon sealing ring only on Fig. 4b execution

Whether type 1 with an O-ring seal (Fig. 4a) or type 2 with a Teflon seal (Fig. 4b) is used, depends on the temperature and physical properties of the liquid pumped.

The frictional heat generated by the rubbing of the seal rings one upon the other is dissipated by means of cooling liquid led to the seal through a flushing fluid line. This cooling liquid circulates in the seal and is drawn either from the liquid pumped or from a separate flushing system. The flushing fluid enters the seal plate 3A, and then flows into the suction casing through a return line. The rate of flow and pressure of the flushing fluid are regulated by flow controllers (Fig. 5) fitted upstream of the entry to the seal plate; pressure and flow can be adjusted as required. Needle valves can be used in place of the controllers shown here.

When highly **volatile liquids** are being pumped, the bore Q (Fig. 4a - d) is connected to a pipe through which any gas can be led off. When the liquid pumped is **particularly inflammable,** the bore Q in the seal illustrated in Fig. 4c can be connected to a supply of sealing liquid.

Extra safety is afforded by auxiliary stuffing box (Fig. 4c and 4d) fitted to seal executions Nos. 3 and 4. **This stuffing box is tightened if the mechanical seal gives any trouble,** until the pump is shut down for repair of the mechanical seal. Thus any escape of liquid pumped can be prevented. **Remember that this auxiliary stuffing box is for emergency use only, and should not be used alone in continuous service.**

In order to dissipate more effectively the frictional heat generated between the rings in seals Nos. 5 and 6 (Fig. 4d), a supply of cooling water is provided, and here the water enters the seal at Q, flows between the carbon ring and the coolant sleeve 3C to the faces in rubbing contact, and then back along the shaft to the outlet. Only clean water should be used, not liable to form any deposits.

It is advisable to keep a stock of spare part, viz. item Nos. 1, 2, 4, 5, 6, 10 and 14 for these types of seals.

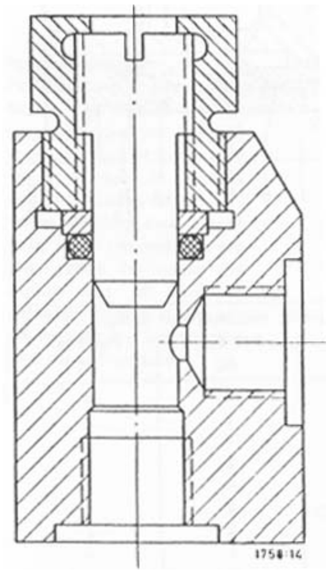


Fig. 5 Flow Controller

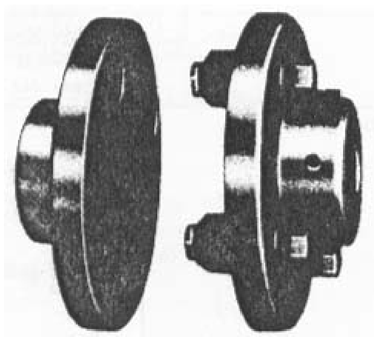


Fig. 6 Pin-and-cushion coupling

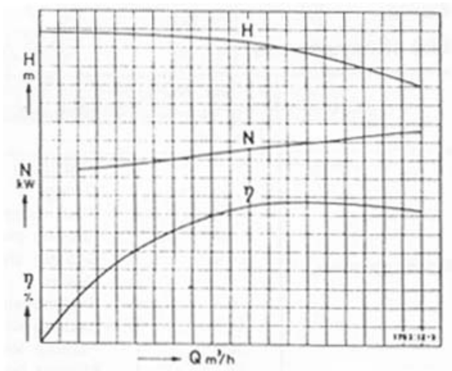


Fig. 7 Characteristic at constant pump RPM

1.1.5. 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 flexible members of the coupling at the prevailing operating speeds (see section 2.2).

1.1.6. Foundations

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 if 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 leveled up with the aid of shims and carefully aligned afresh after erection at site (see Section 2.2.1.), and, only after this has been done, should the driver by dowelled in place.

1.2. Driver

He driver is usually coupled to the suction end of the pump. Pump rotation is clockwise viewed from driver. On special request, the pump can be supplied with the stub shaft at the discharge end (in this case, rotation is anticlockwise viewed from driver) or with stub shafts at both ends.

Pumps with end suction nozzle have their drive arranged at the discharge end, because the suction pipe is flanged onto the suction end of the pump. Rotation is anticlockwise, viewed from driver. 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.

1.3. Mode of operation of pump

The fluid flows through the suction casing (1060) at a given pressure, onto the first stage impeller. 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.

Fig. 7 illustrates the fact that the power absorbed by the pump does not decrease proportionally 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 overheating and vapor formation on the pump, when it is operated for any length of time against a closed discharge valve, or at very low throughputs; 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 no-return valve,** or automatic leak-off valve (see Fig. 13) which automatically opens a by-pass line when the pump capacity drops below a certain figure.

If no such valve or no permanent by-pass 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 pressure at pump suction nozzle is adequate, i.e. at least as high as state in the confirmation and cavitation will occur, which may damage the pump, particularly the first stage impeller.

If the discharge pressure is lower than that for witch the pump was designed, the capacity will increase correspondingly and this may result in overloading the motor, which will run excessively hot.

2. Erection

2.1. Erecting 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 2.2.1).
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 line coupling, if the stuffing boxes are not packed (see Section 2.2.1).
8. Dowel the driver (see Section 1.1.6.).
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 driver pumps should have their turbine over speed trip tested with the pump uncoupled.

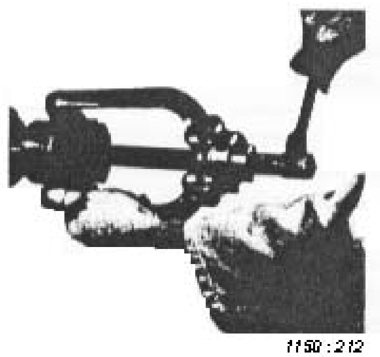


Fig. 8 Coupling extractor

2.2. Fitting and dismantling the coupling

Faulty alignment will soon result in damage to the flexible components of the coupling and will also damage the pump and motor bearings. Flexible couplings should be heated to 180 °C (350°F) approx, before fitting, and removal from the shaft should be effected with the aid of a suitable coupling extractor (see Fig. 8). Never drive the coupling onto or off the shaft with a hammer.

2.2.1. Aligning the coupling

In order to align the shafts, the pump and the driver are pushed towards one another until the prescribed gap between the two coupling halves shown on the “General arrangement drawing” has been attained. Then the coupling ca be aligned by means of a straight edge and gauge block (Fig. 9a); the coupling is correctly aligned if $a = a_1$ and $b = b_1$; furthermore the axial gap between the face 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. 9b), 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 alignment check should be repeated after connection of the piping to the pump.

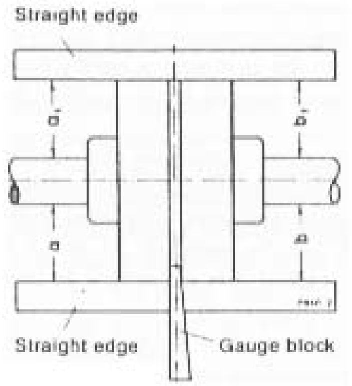


Fig. 9a
Aligning the coupling with straight edge and gauge block

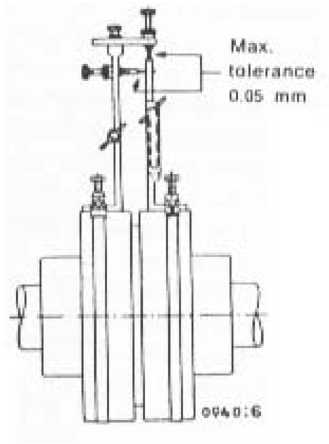


Fig. 9b
Coupling alignment jig

2.3. Instrumentation

In order to facilitate operating supervision, we recommended that each pump be provided with pressure gauges (with larger dials) at the suction and discharge nozzle. These gauges should incorporate a gauge cock or valve. They should be mounted in such away that they are exposed to the least possible amount of vibration. Their working life will be considerably increased if the cock or valve is kept shut all times except when a reading is taken, i.e. if they are not subjected continuously to the full operating pressure.

2.4. 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 is required, the total angle of the taper piece (twice the angle between centerline and wall of taper piece) should not exceed 12°. Make sure that the gaskets of flanged connections do not protrude inside the pipe.

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

The suction piping connected to the suction casing (1060) 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. The suction piping should always be kept as short as possible..

Suction lift piping (see Fig. 10a), 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 2m/sec (6ft/sec). It is desirable to provide a separate suction line for each pump (in a pumping station comprising several pumps).

If this 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 line.

If the suction pipe is to be laid in an underground trench, it should be hydrostatically tested at 3 – 4 kg/cm^{2}g (40 to 60 PSIG) before being buried.

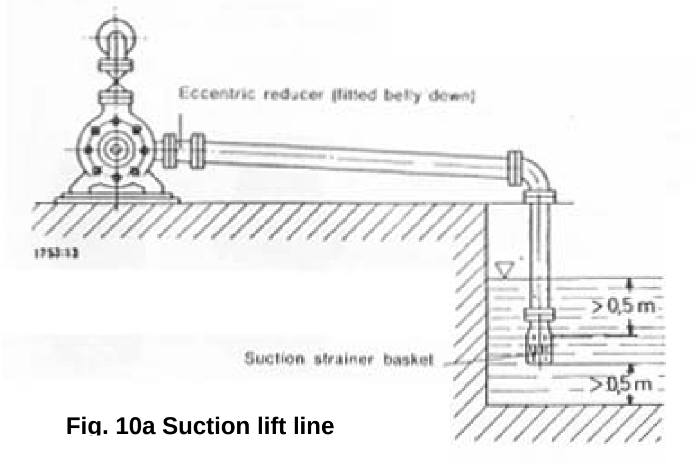


Fig. 10a Suction lift line

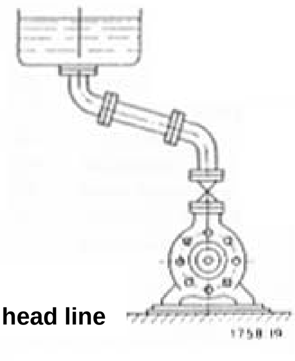


Fig. 10b
Positive suction head line

For positive suction head line, (see Fig. 10b), the same considerations apply as for suction lift lines, as regard 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 line and vessel 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 hot fluid is pumped. In order to prevent this 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 o 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. 11 have proved very satisfactory for this purpose, and are recommended; they should be made of corrosion-resistance 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 several weeks of operation, when no more foreign bodies are anticipated, the strainer can be permanently removed.

2.4.2. Discharge piping

The hydrostatic test pressure prescribed in DIN 2410 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 maximum operating pressure anticipated. Discharge lines are usually sized for flow velocities of 3m/sec (10 ft/sec).

2.5. Valves and fittings

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

2.5.1. Valves and fittings in suction line (suction lift line or positive suction head line)

Isolating valve in the suction lift line or the positive suction head line are solely intended to isolate 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 a 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 horizontal, or pointing vertically upwards, it should be provide 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 fro 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. 12). The strainer basket should be installed at least 0,5 m above the pit floor, to prevent either air or sand or sludge being entrained into the pump (see Fig. 10a).

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

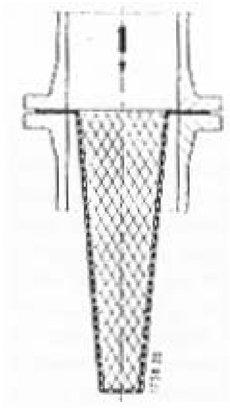


Fig. 11
Conical strainer in positive suction head line

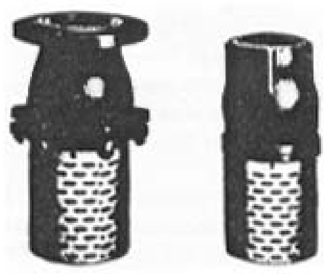


Fig. 12
Suction strainer baskets with foot valve

2.5.2. Valves and fittings in discharge line

Each pump should be provided with an isolating valve in discharge line, situated as close to the pump as possible. A part from isolating the discharge line from the pump this valve can be used to throttle the discharge floe in order to achieve the desired operating duty point or to avoid overloading the driver. We also recommend the installation discharge line. This can be either a check valve, a non-return valve, or a by-pass non-return valve (automatic leak-off valve) – (see Section 2.5.3), 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 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 such cases.

2.5.3. By-pass non-return valve (automatic leak-off 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 1.3. It is fitted in close proximity to the pump, always **between** the pump and the isolating valve in the discharge line (never downstream 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. 13.

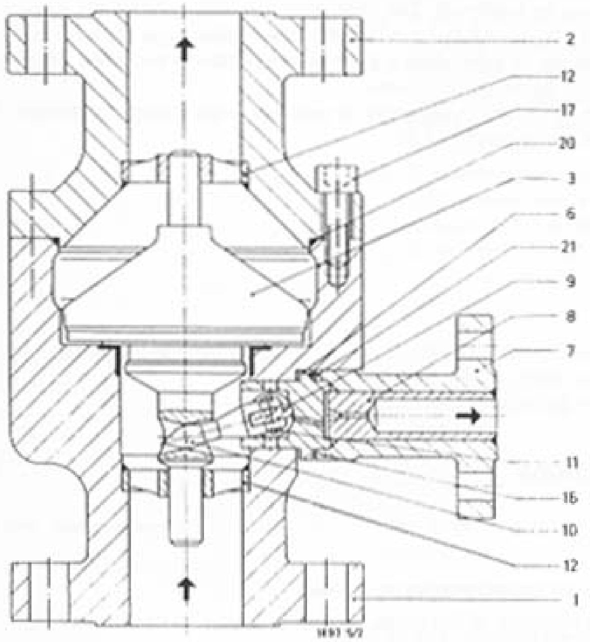


Fig. 13a By-pass non-return valve
Nom. press. 25 and 40, Type SLV

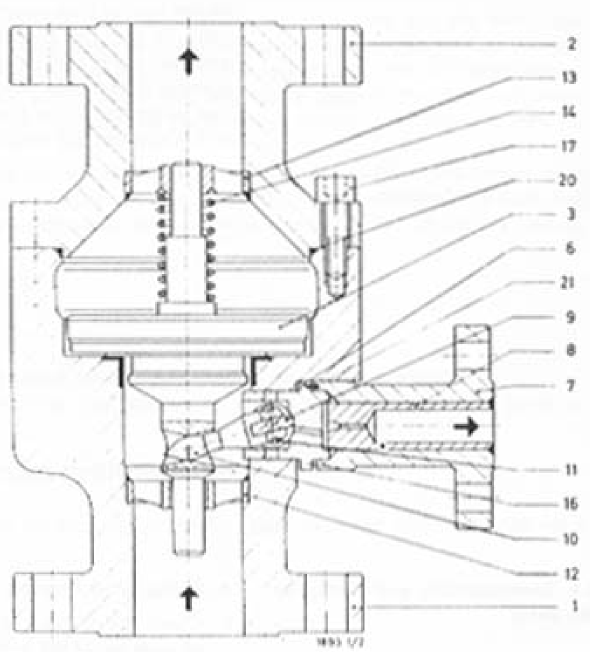
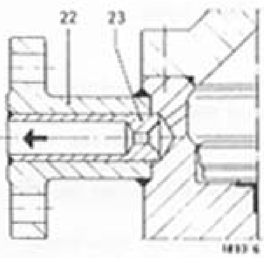


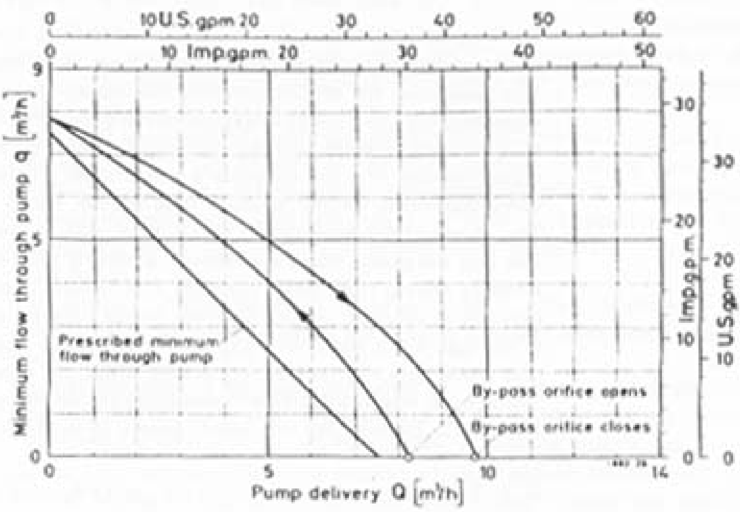
Fig. 13b By-pass non-return valve
Nom. press. 25 to 250, Type SSV



Execution with hand traversing nozzle

Item No.	Designation	Item No.	Designation	Item No.	Designation
1	Lower casing	9	Rotary slide valve	16	Cylindrical screw
2	Upper casing	10	Slide valve rod	17	Cylindrical screw
3	Non-return valve cone	11	Gudgeon pin	20	O-ring seal*)
6	Slide valve head	12	Guide	21	Safety pin
7	By-pass	13	Upper guide	22	Hand traversing nozzle
8	Throttling bush	14	Cylindrical spiral spring	23	Throttling bush/hand traversing nozzle

*) Only applicable up to 130 °C and nominal pressure 64 (metal-to-metal-sealing).
Parts 6 – 11 (complete by-pass nozzle) can be separately replaced.



Pump delivery downstream of by-pass non-return valve, Q m³/h

Example:
Diagram for pump with a design capacity Q = 50 m^3/h; when the isolating valve is closed, the minimum flow through the by-pass nozzle is q = 7,5 m^3/h.

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 (13) connect the valve cone (7) with the slide valve (11) of the by-pass (9). When the valve cone (7) lifts, the slide valve (11) slides, closing the by-pass when a given minimum flow is exceeded, respective 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 1. 3).

3. Operating Instructions

3.1. 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 overflow.
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.
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. Check pressure and temperature in the suction line (on positive suction head line).
8. If a non-return valve is fitted, and the pump has to be started wit 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.

3.2. 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 (18 °F) temperature difference between cooling water inlet and outlet is acceptable.
5. Avoid overloading the 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 throughputs. 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 watched particularly carefully if the pump is used for hot water duty.
9. If standby pumping sets are installed, it is advisable to operate all the pumps on a rotation system, thus giving each pumping turn a certain amount of operational duty; this ensures that the standby pumps will always be in good condition for instant start-up if required.

3.3. Shutting down the pump

1. Close discharge valve.
2. Switch off driver, and observe pump rotor running down to a standstill.
3. Turn off cooling water. This only applies to pumps with cooled stuffing boxes or bearings.

3.4. Maintenance

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

3.4.1. 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, water temperature, bearing temperature, and pump speed, as well as the operating data of the driver.

The switching on and the 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.

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 wit oil or grease.

3.4.2. Maintenance of soft-packed stuffing boxes

The stuffing box 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. 14. 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, whether ring is wrapped around the shaft 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.

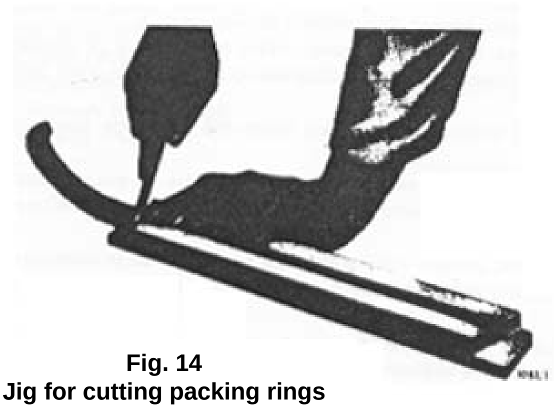


Fig. 14
Jig for cutting packing rings

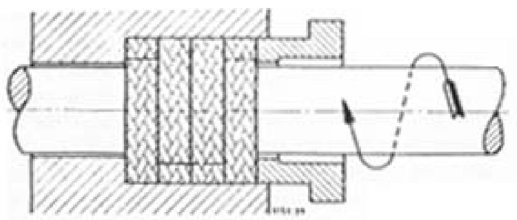


Fig. 15
Stuffing box packing

Before insertion in the stuffing box, the packing rings must be thoroughly soaked in oil. 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 off-set approximately 90° from the preceding one; the gland is used to push each ring in position (see Fig. 15). 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 (¼") for the positive guidance of the gland, to prevent it being tightened askew. This would result in scoring and damage to the shaft 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 register opposite the holes 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 arrange by tapping the liquid from the appropriate stage in the pump.

When all packing rings have been inserted, the gland is fitted, and the gland nut s 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 stars to smoke, loosen the gland nuts slightly.

Every newly packed stuffing box needs a certain running-in period before it settle down, and it should be kept under constant observation during this period. After setting 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 sleeves on this condition of the shaft 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 no 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 (18°F). The cooling water supply line should be provided with 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.

3.4.3. Maintenance of mechanical seal

Before starting the pump for the first time, check that the flow controllers (see Section 1.4.2) or the needle valves in the circulation line are fully open. The pressure in this line should be 2 to 4 kg/cm² (30 to 55 PSI) above the positive suction head pressure; the appropriate tapping from the pump is already provided.

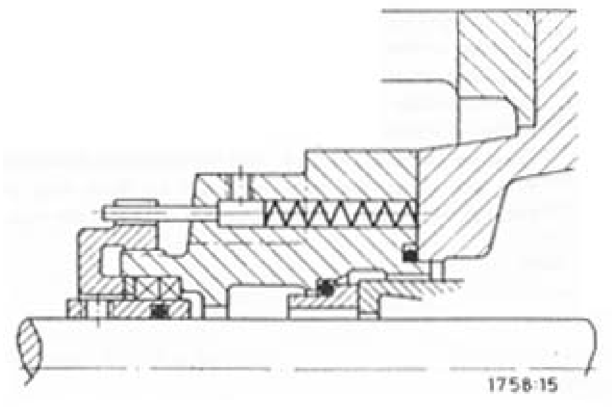


Fig. 16 Auxiliary stuffing box

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 other parts of the pump. 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 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. 16), and only when a leakage (due to a defect in the mechanical seal) is observed, should the pin be depressed and the gland tightened up by clockwise rotation, or by tightening the stud nuts. The pump must then be stopped to that the defective mechanical seal can receive attention.

If the carbon rings and rotary seal 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.

3.4.4. Maintenance of bearings

Before the pump is first commissioned, or after it has been idle for a prolonged period, the level of the oil 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, fitting being done through the oil fitting plug, 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 or benzole, but not heavy fuel oil. The first oil change in a new bearing should be made after 200 hours of operation approx, and subsequent changes after every 1000 further hours of operation.

Only use **well-known brands of lubricants** for antifriction or plain bearings, to the following specification :

Viscosity at 50 °C (122 °F) :	20 to 45 cSt (3 to 6°E)
Flash point :	195 to 230 °C (380 to 450 °F)
Pour point, below :	-10 °C (15 °F)
Ash content, below :	0,05 %

The temperature of the bearings, the oil levels, and the quite running of the pump must be kept under careful observation the whole time it is running. The temperature of the bearings must never exceed 80 °C (175 °F) and, with this as a maximum, it must never be more than 50 °C (90 °F) above ambient temperature.

If the oil should become contaminated with water of 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 3.4.2) apply equally to the bearings.

3.5. Operating troubles: Causes and remedies

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

3.5.1. Pump does not deliver rated capacity

Possible cause	Remedy
1. Excessive pressure in discharge line.	Increase pump speed. If this is impossible on an electrically driven pump. It may be necessary to fit oversize impeller 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, investigate piping layout and execution, to make sure that friction losses are not too high. Clean any strainers incorporated 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 piping fluid pressure; check sealing fluid line in case it is clogged, and clean 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 the shaft 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 pumps internals.	Open up the pump, and check the clearances between parts subjected to wear, e.g. items 5020/2300, or 1060/5251, or 1070/252, or 1710/5210. Adjust clearances as necessary.

3.5.2. Driver is overloaded

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 discharge valve 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 consult ed us.
2. The pump is pumping a fluid of higher S.G. than specified in confirmation of order. (If the temperature of the	If the specified S.G. or operating temperature can not be attained, but operating conditions permit, the

fluid pumped is lower than specified, this will result in a higher S.G).	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.

3.5.3. Pump discharge pressure is excessive

Possible cause	Remedy
1. Excessive speed.	Check speed precisely. If it is not possible to decrease the speed, one or more impeller 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 outlined in 1. above should be considered.

3.5.4. Pump leaks (other than a stuffing boxes)

Possible cause	Remedy
1. The tie bolts are not tightened sufficiently.	Shut down the pump, release the internal pressure, and tighten the nuts on the tie bolts 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 tie bolts, new gaskets should be inserted, or the metal mating faces should be re-ground. (Fig. 19).
3. The fluid pumped is subject to sudden and violent temperature fluctuation.	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 gasket or sealing faces are damaged. If the leakage cannot be cured by tightening the tiebolts, proceed as described under 2. above.

3.5.5. Stuffing boxes leak

Possible cause	Remedy
1. Worn, unsuitable or badly fitted packing.	Repack the stuffing box, carefully observing instructions.
2. Scoring or grooving of the shaft sleeve, due to	The shaft sleeve should be re-polished or renewed.

excessive tightening or tightening askew of the stuffing box gland.	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 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 re-assembling the pump, carefully and follow the instruction.

3.5.6. Excessive bearing temperature

Possible cause	Remedy
1. The set is misaligned.	Check alignment at the coupling as described in Section 2.2.1.
2. The piping causes the pump to warp.	Ensure that the piping transmit 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 oil if necessary. (See Section 3.4.4.).

4. Dismantling and reassembling the pump

4.1. Dismantling

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

The dismantling and reassembly instruction in Section 4.1. to 4.2.1. apply to pumps with conventional stuffing boxes; if your pump has special stuffing boxes or shaft seals the procedure should be modified to accord with the relevant sectional drawings. Dismantling is begun from the discharge end (front end), after disconnecting all piping and uncoupling the driver. Proceed as follows:

- Remove bearing cover plate (3610) and unscrew shaft nut (219).
- Pull off discharge end bearing bracket (3500) with bearing (3220) and stuffing box housing (4510) with gland (4520).
- Unscrew shaft sleeve (5240.2).

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

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

Now the discharge casing (1070) and the stage casing can be pulled off. The spacer sleeves (5210), impellers (2300), and stage casings together with diffuser (1710) are striped off the shaft in succession, and finally the drive end bearing brackets (3500) with the stuffing box housing (4510) can be removed.

To facilitate removal of impellers and spacer sleeves mounted on the shaft of a pump that has been in service for a prolonged period, and which are difficult to pull off, 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 them up with a low lamp or welding torch. This must be done evenly all round and very carefully, so that the shaft is kept as cool as possible. This heating of the parts may be repeated as required, and **force should never be used** to remove them, since this will lead to bending or scoring of the shaft.

Never use a hammer to drive off couplings, stage casings, impellers, diffusers or spacer sleeves, as this might damage these components.

After completion of dismantling, the shaft should be checked for out-of-true, **particularly if it was heated up during dismantling.** Shaft used in pumps handling hot liquids can never be permanently straightened by bending after they have been subjected to thermal stresses; they will in all probability become deformed again immediately they are exposed to the hot liquid. The sealing faces require special care when dismantling the pump. They must be protected fro 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 re-assembled at least partially before being dispatched to our Works.

4.1.1. Dismantling of pumps with end suction nozzle

This starts from the suction end, after having first disconnected the piping, with the removal of the suction nozzle (102a). Then the shaft nut (217, respective 233) is unscrewed, and dismantling proceeds generally as described above.

4.2. Re-assembly

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

First of all, the rotating assembly, with new parts where required, is re-assembled, or a complete replacement rotor is assembled, if the old one is no longer serviceable, and then 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, hen dismantled again.

4.2.1. Re-assembly of pumps with O-ring seals (Fig. 18)

Re-assembly takes place from the drive end. The shaft is slipped into the suction casing (1060), which for convenience is best stood on the suction nozzle (Fig. 17), the stuffing box housing (4510), gland (4520) and bearing bracket (3500) having previously been bolted onto the casing.

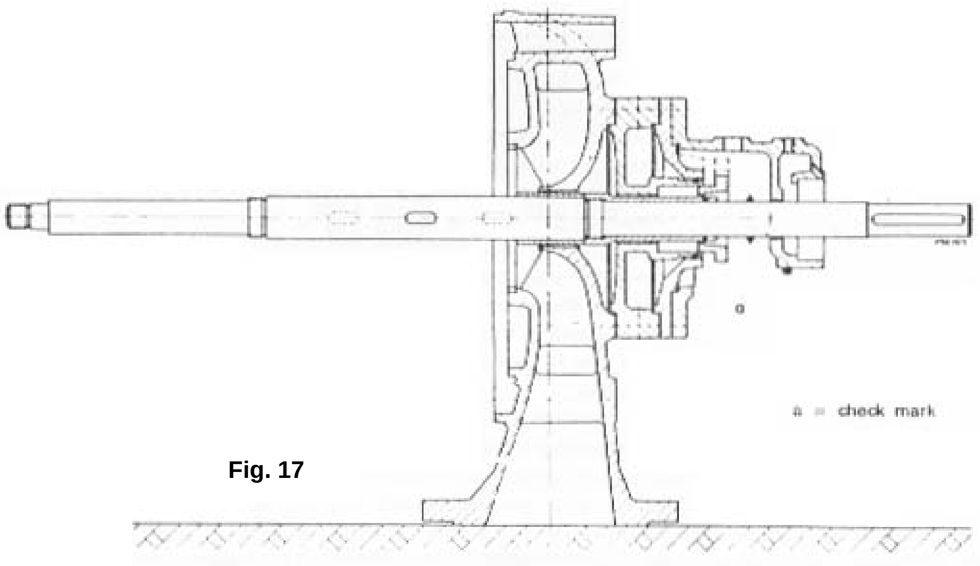


Fig. 17

The shaft sleeve (5240.1) with O-ring (4120.1) has previously been screwed on, and the spacer sleeve (5251) slipped on. Remember to fit the flinger ring (5070). Now the first stage impeller (2300) is placed on the shaft, and then diffuser (17100, making sure that the centerline of the impeller outlet comes in register with the centerline of the diffuser inlet (see Fig. 18). Before proceeding further with re-assembly, a check mark must be scribed on the shaft at its exit fro the bearing housing (see Fig. 17), so that the axial position of the rotor assembly can be checked according to Fig. 18, after completion of assembly, and if necessary adjusted by fitting shim to the bearing (3220). Then the first stage casing (1080) with inserted diffuser (1710) and O-ring (4120.5) is seated in the casing and tapped firmly in position with a wooden or rubber-tipped mallet. The stage casings should be suitably underpinned.

After the next spacer sleeve (5210) and the second impeller have been fitted, the next stage casing together with O-ring and diffuser, is pushed into place. This procedure is repeated stage by stage, and after the last impeller and spacer sleeve have been fitted, the discharge casing (1070) with final stage diffuser (110) and the last O-rings (4120.5 and 4120.6) are mounted, the tie bolts (9050) are inserted and the nuts (9201.1) tightened lightly only.

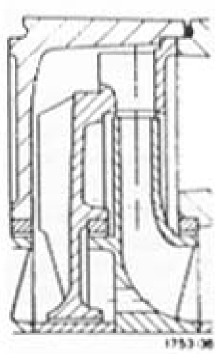


Fig. 18
Sealing of casing by O-ring

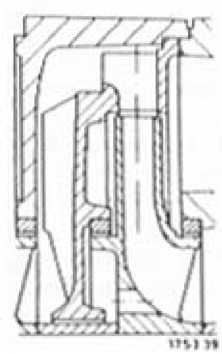


Fig. 18a
Sealing of casing by metal-to-metal sealing faces

Now the shaft sleeve, the front end bearing bracket, the stuffing box housing with gland (do not forget the flinger ring) and all the remaining components are fitted or bolted on. The nuts on the tie bolts and on the studs of the bearing bracket should be tightened slowly and evenly on the cross. It must be possible to rotate the shaft easily by hand. If this is the case, the stuffing box packing can now be inserted. After the piping has been re-connected, the shaft rotation should be checked again, to ascertain in good time whether any distortion has taken place.

4.2.2. Re-assembly of pumps with metal-to-metal sealing faces (Fig. 18a)

The highest degree of cleanliness should be observed during assembly. Before assembly is commenced, the condition of al 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.

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

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

Fig. 19 illustrates a grinding disc for stage casings, and Fig. 20 the grinding tool used for regrinding the rotating parts; the latter is designed as a bushing (socket), since only thus can it be ensured that the ground surfaces are truly perpendicular to the axis of the shaft.

The abrasive material (grinding paste) used must be of a high grade fine-grained quality. Re-assembly is carried out as described in Section 4.2.1.

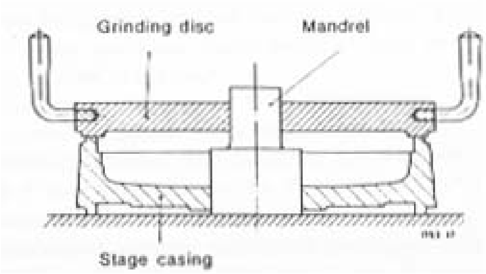


Fig. 19
Grinding block for stage casing

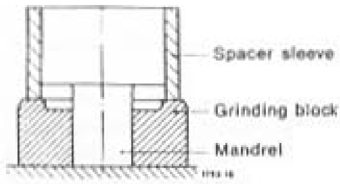


Fig. 20
Grinding block for rotating parts

4.2.3. Re-assembly of pumps with end suction nozzle

Start re-assembly at discharge end. First slip spacer sleeve (5252) onto the discharge end of the shaft, and screw shaft protecting sleeve (5240.2) up against the shaft shoulder on the discharge end. Then proceed as described above for the standard execution, from the discharge end towards the suction end.

4.2.4. Assembling the bearings

The most scrupulous cleanliness should be observed when fitting the bearings. Dirt, dust and moisture will damage antifriction bearings. Petrol or benzole can be used to clean bearings which have been in prolonged service. After washing, they should be well oiled immediately, and repeatedly rotated, to allow the tracks, balls or rollers to be thoroughly coated with oil.

The **located bearing** at the discharge end can be mounted on the shaft (provided it is a small-size bearing) with the aid of a short length of mild steel or brass piping applied evenly against the end face of the inner race, and by means of moderately firm hammer blows on the other end of the pipe. It is however preferable to use a press for this purpose.

Avoid direct hammer blows onto the bearings it self. Larger size antifriction bearings should preferable be preheated in an oil bath before being slipped onto the shaft. Oil bath temperatures of 80°C (175°F), up to 100°C (210°F) max. will usually be adequate. The important thing is to avoid transmitting any axial force required to push the baring onto the shaft through the balls or rollers.

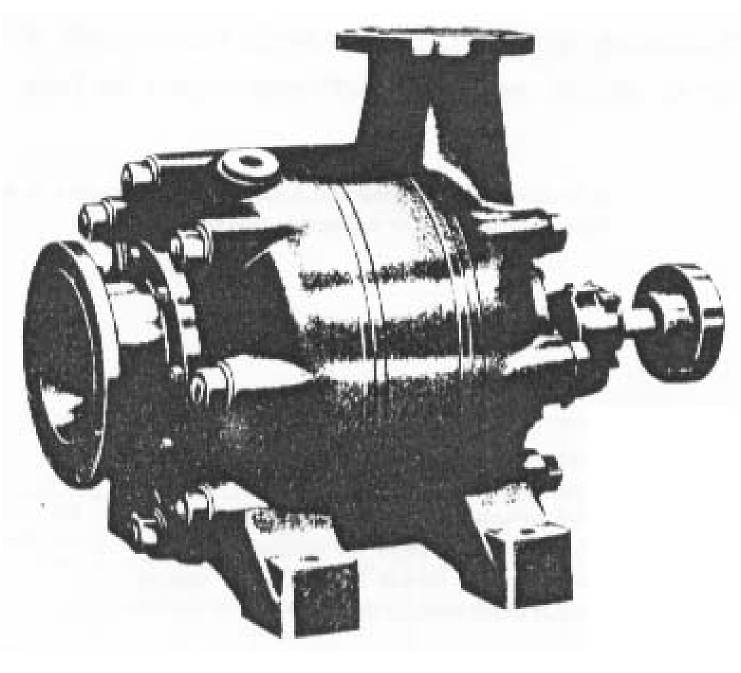


Fig. 21
MMK A pump with end suction nozzle

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

When dismantling the located bearing, it is advisable to use a suitable extractor or a press, because the friction which has to be overcome is usually greater than that arising when mounting the bearing. Here again, the axial force required for dismantling must not be transmitted through the balls or rollers.

The loose bearing at the suction end of pump sizes 40 through 125 is provided in the shape of a taper lock sleeve-mounted bearing (a part from certain special executions). This mounting combines the two features of a tight fit on the shaft (required for operational reasons) and an assembly which can be readily dismantled, thus largely avoiding any risk of damage to the bearing by having to use force to remove it from the shaft.

As no axial thrust can be transmitted through the taper lock sleeve, this type of mounting is restricted to loose bearings, which do not have to absorb any axial thrust.

When mounting the loose bearings, make sure that the inner and outer race are in register, i.e. in one plane, before tightening the taper-lock sleeve nut. The fit of the inner race is determined not by the shaft clearance, but by the bearing pressing against the tapered sleeve. Therefore the nut on the taper-lock sleeve should only be tightened sufficiently firmly to allow the outer race to rotate freely, without any perceptible resistance.

This requires a certain amount of feel and care. The nut on the sleeve is secured by a locking plate which must not be overlooked during erection. When dismantling the loose bearing, the nut on the taper-lock sleeve should first be unscrewed.

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. The same precautions as previously described for the located bearings also apply to the taper-lock sleeve-mounted bearings.

4.3. Protection of pump during prolonged shut down 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 re-assembled and the suction and discharge nozzle should be blanked off by wooden covers, to prevent foreign bodies entering the pump.

All open connections for cooling water and oil should likewise carefully plugged. Any machined parts on the assembled pump which are exposed to atmosphere should be coated with a rust preventive varnish or thoroughly oiled or greased.

If the pump is sent back to our 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 dispatched in the fully assembled state, as the sealing faces of the individual components might otherwise be damaged in transit.

5. Spare parts

It is advisable to keep the following components in stock at all times. One complete rotor assembly consisting of:

	Item No.
1 only shaft with keys	2100
1 set impellers	2300
1 set of spacer sleeves in the diffuser	5210
1 only spacer sleeve for suction casing	5251
1 only spacer sleeve for discharge casing	5252
1 each shaft protecting sleeve	5240.1 and 5240.2

*) only on pumps with end suction nozzle

Furthermore:

	Item No.
1 set of diffusers	1710 and 1711
1 set of bearings	3220 and 3210
1 only bush in discharge casing	
1 set of diffuser bushes	
1 set of case wear rings	5020
2 set O-rings	4120.5 and 4120.6
1 set O-rings	4120.1
2 sets of stuffing box packing	4610
1 set of flat gaskets as listed in Section 6	400.1, 4000.3, 4000.4
1 only bearing sleeve	
1 only bearing bush	5251

When ordering spare parts, always please specify the Works serial number of the pump, stamped on the rating plate and on the suction flange, as well as the item number and exact designation of each item required, as specified in the list of components attached to the sectional drawings on the following pages.

[1] On pumps with end suction nozzle

[2] For pumps fitted with mechanical seal, see Section 1.1.4.2.

[3] On pump sizes MMK 200 through 350

[4] On pumps with end suction nozzle

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

Pump size		40	50	65	80	100	125
Stub shaft dimensions	mm	24Φ x 60	28Φ x 60	28Φ x 60	34Φ x 80	34Φ x 100	42Φ x 120
Dimensions of standard stuffing box compartment	mm	34/50Φ x 35	39/55Φ x 35	39/55Φ x 35	45/65Φ x 45	45/65Φ x 45	56/80Φ x 50
Packing required, per standard stuffing box	mm	8 x 8 x 550	8 x 8 x 600	8 x 8 x 600	10 x 10 x 750	10 x 10 x 750	12 x 12 x 900
Dimensions of special execution stuffing box compartment	mm	34/50Φ x 59	39/55Φ x 61	39/55Φ x 61	45/65Φ x 75	45/65Φ x 75	56/80Φ x 89
Packing required, per special exec. stuffing box, with/without lantern ring		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	12x12x1150/1600
Cooling water connection	inches	R 3/8	R 3/8	R 3/8	R 1/2	R 1/2	R 1/2
Cooling water required (max.)	litres/nour	200	250	250	300	300	400
Lubricating oli required — Initial fill	Kg. approx.	0.2	0.2	0.2	0.25	0.25	0 25
Lubricating oli required — Annual consumption	Kg. approx.	2	2	2	2.5	2.5	2.5
Bearing / drive end		NU 206K/C3	NU 207K/C3	NU 207K/C3	NU 208K/C3	NU 208K/C3	NU 210K/C3
Taperlock sleeve for above		H 206	H 207	H 207	H 208	H 208	H 210
Bearing / front end (for pumps provided with a single driver)		6403/C3	6404/C3	6404/C3	6405/C3	6405/C3	6406/C3
Bearing / front end (for pumps provided with a driver at each end)		6305/C3	6306/C3	6306/C3	6307/C3	6307/C3	6308/C3
Mechanical seal, Flexibox system	Size No.	25	32	32	36	36	45
O-ring for stage casing (4120.5)	mm	4Φ x 190Φ	4Φ x 210Φ	4Φ x 240Φ	4Φ x 275Φ	4Φ x 310Φ	4Φ x 355Φ
O-ring for final stage diffuser (4120.6)	mm	4Φ x 120Φ	4Φ x 145Φ	4Φ x 150Φ	4Φ x 210Φ	4Φ x 240Φ	4Φ x 280Φ
O-ring for stuffing box housing (4000.3)	mm	3Φ x 60Φ	3Φ x 65Φ	3Φ x 65Φ	3Φ x 70Φ	3Φ x 70Φ	3Φ x 90Φ
Flat gasket for end cover (4000.4)	mm	170/125.5Φ x 0.5	190/145.5Φ x 0.5	190/145.5Φ x 0.5	235/185.5Φ x 0.5	235/185.5Φ x 0.5	260/210.5Φ x 0.5
Flat gasket for stuffing box housing (4000.3) *)	mm	170/125.5Φ x 0.5	190/145.5Φ x 0.5	190/145 5Φ x 0.5	235/185.5Φ x 0 5	235/185.5Φ x 0.5	260/210.5Φ x 0 5
Flat gasket for bearing coverplate (4000.1) **)	mm	75/ 62.5Φ x 0.3	84/ 72.5Φ x 0.3	84/ 72.5Φ x 0.3	90/ 80.5Φ x 0.3	90/ 80.5Φ x 0.3	100/ 90.5Φ x 0.3

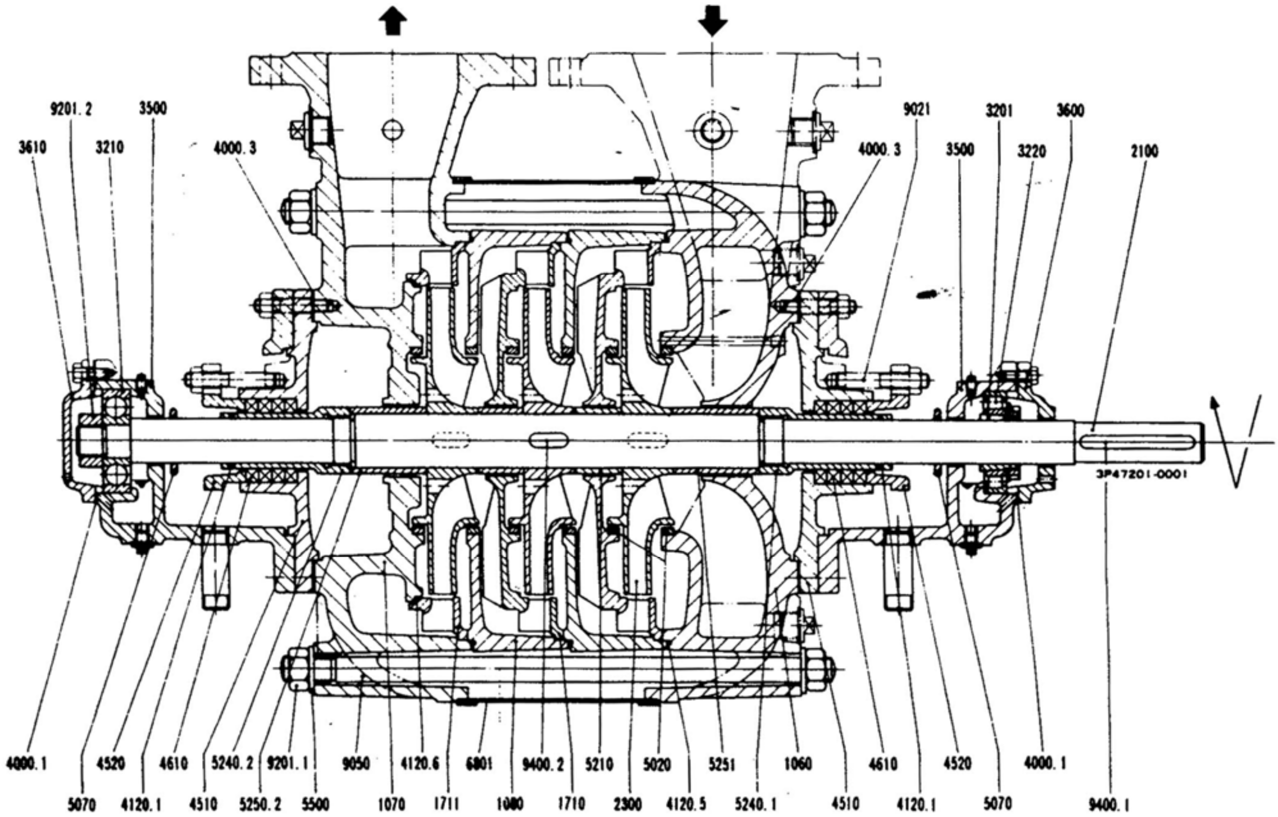
Pump size		150	200	250	300	350
Stub shaft dimensions	mm	46Φ x 140	78Φ x 180	84Φ x 180	98Φ x 180	98Φ x 180
Dimensions of standard stuffing box compartment	mm	66/90Φ x 55	98/130Φ x 70	105/137Φ x 85	125/157Φ x 85	125/157Φ x 85
Packing required, per standard stuffing box	mm	12 x 12 x 1000	16 x 16 x 1450	16 x 16 x 1900	16 x 16 x 2220	16 x 16 x 2220
Dimensions of special execution stuffing box compartment	mm	66/90Φ x 91	98/130Φ x 117	105/137Φ x 135	125/157Φ x 135	125/157Φ x 135
Packing required, per special exec. stuffing box, with/without lantern ring		12x12x1250/1750	16x16x1800/2550	16x16x2280/3050	16x16x2660/3550	16x16x2660/3550
Cooling water connection	inches	R 1	R 1	R 1	R 1	R 1
Cooling water required (max.)	litres/hour	500	1300	1900	2200	2200
Lubricating oil required — Initial fill	Kg. approx.	0.3	4	7	8	8
Lubricating oil required — Annual consumption	Kg. approx.	3	40	70	80	80
Bearing / drive end		NU 410/C3	Journal bearing			
Taperlock sleeve for above		–	–	–	–	–
Bearing / front end (for pumps provided with a single driver)		6410/C3	6314/C3 + Journal bearing	6315/C3 + Journal bearing	6318/C3 + Journal bearing	6318/C3 + Journal bearing
Bearing / front end (for pumps provided with a driver at each end)		6410/C3	6314/C3 + Journal bearing	6314/C3 + Journal bearing	6318/C3 + Journal bearing	6318/C3 + Journal bearing
Mechanical seal, Flexibox system	Size No.	56	80	85	100	100
O-ring for stage casing (4120.5)	mm	4Φ x 420Φ	6Φ x 600Φ	6Φ x 690Φ	6Φ x 780Φ	6Φ x 780Φ
O-ring for final stage diffuser (4120.6)	mm	4Φ x 260Φ	4Φ x 365Φ	4Φ x 422Φ	4Φ x 470Φ	4Φ x 470Φ
O-ring for stuffing box housing (4000.3)	mm	3Φ x 105Φ	3Φ x 145Φ	3Φ x 160Φ	3Φ x 180Φ	3Φ x 180Φ
Flat gasket for end cover (4000.4)	mm	330/260.5Φ x 0.5	460/370.5Φ x 0.5	525/430.5Φ x 0.5	580/470.5Φ x 0.5	580/470.5Φ x 0.5
Flat gasket for stuffing box housing (4000.3) *)	mm	330/260.5Φ x 0.5	460/370.5Φ x 0.5	525/430.5Φ x 0.5	580/470.5Φ x 0.5	580/470.5Φ x 0.5
Flat gasket for bearing coverplate (4000.1) **)	mm	190x190x0.3	251x210x0.3	251x210x0.3	251x210x0.3	251x210x0.3

*) 0.3 mm thick on HW and V execution stuffing boxes
**) Overall dimensions

7. Sectional drawings and lists of components

Size MMK 40, 50, 65

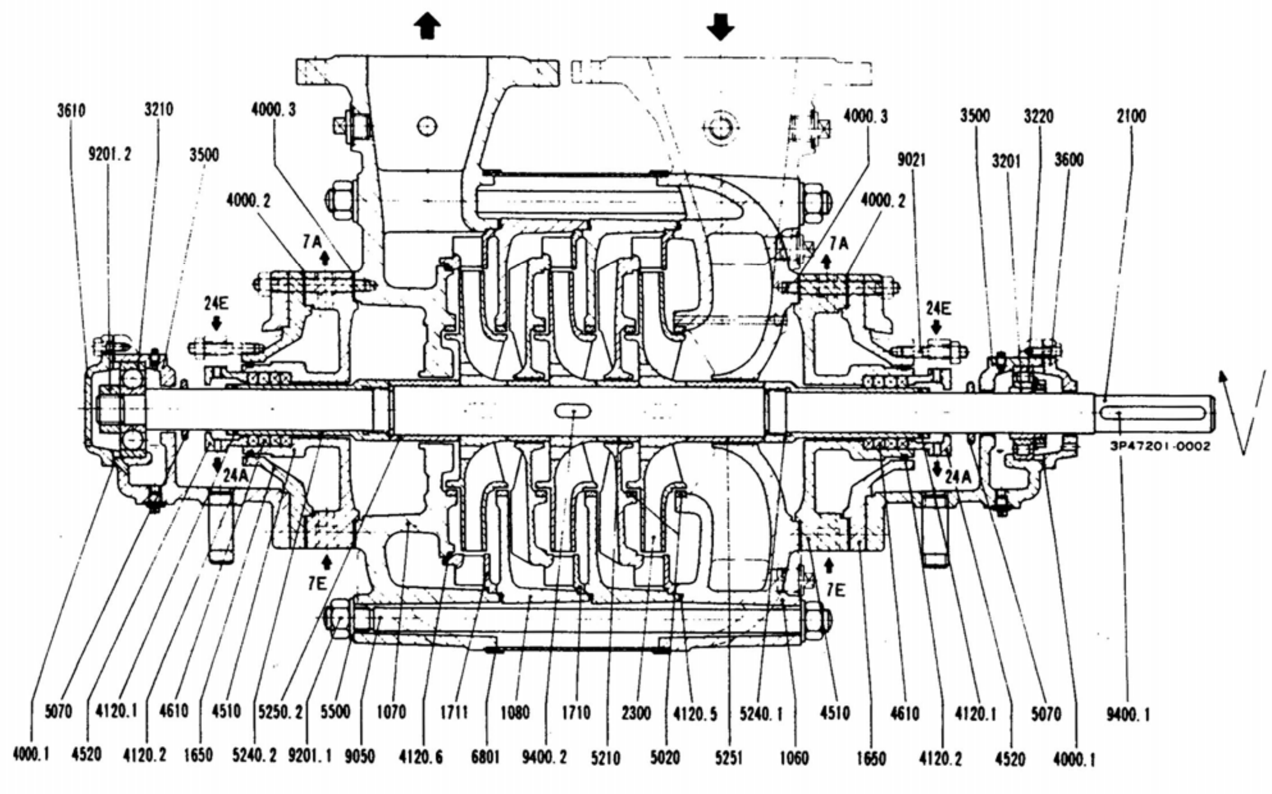
Stuffing box housing : Type N



No.	Name	Material	Pcs.	No.	Name	Material	Pcs	No.	Name	Material	Pcs.
1060	Suction casing		1	4120.6	O-ring	ASBESTOS	1	9400.1	Key	S 45C	1
1070	Discharge casing		1	4510	Stuffing box housing		2	9400.2	Key	S 45C	
1080	Stage casing			4520	Stuffing box gland		2				
1710	Diffuser			4610	Stuffing box packing	TOMBO3300	8				
1711	Diffuser, last stage		1	5020	Casing wear ring						
2100	Shaft		1	5070	Deflector	S 35C	2				
2300	Impeller			5210	Stage sleeve						
3201	Clamping sleeve	SS400	1	5240.1	Shaft protecting sleeve		1				
3210	Deep groove ball bearing	No. 64 C_3	1	5240.2	Shaft protecting sleeve		1				
3220	Cylindrical roller bearing	NU +H KC_3	1	5250.2	Spacer sleeve		1				
3500	Bearing housing	F C 200	2	5251	Spacer sleeve		1				
3600	Bearing cover	F C 200	1	5500	Washer	SS400	16				
3610	Bearing end cover	F C 200	1	6801	Cladding	SPCC	1				
4000.1	Flat gasket	TOMBO1630	2	9021	Stud	$SUS420J_2$	4				
4000.3	Flat gasket	TOMBO1301	2	9050	Tie bolt	S 45C	8				
4120.1	O-ring	NBR	2	9201.1	Hexagonal nut	SS400	16				
4120.5	O-ring	NBR		9201.2	Hexagonal nut	SS400	1				

Size MMK 40, 50, 65

Stuffing box housing : Type HW



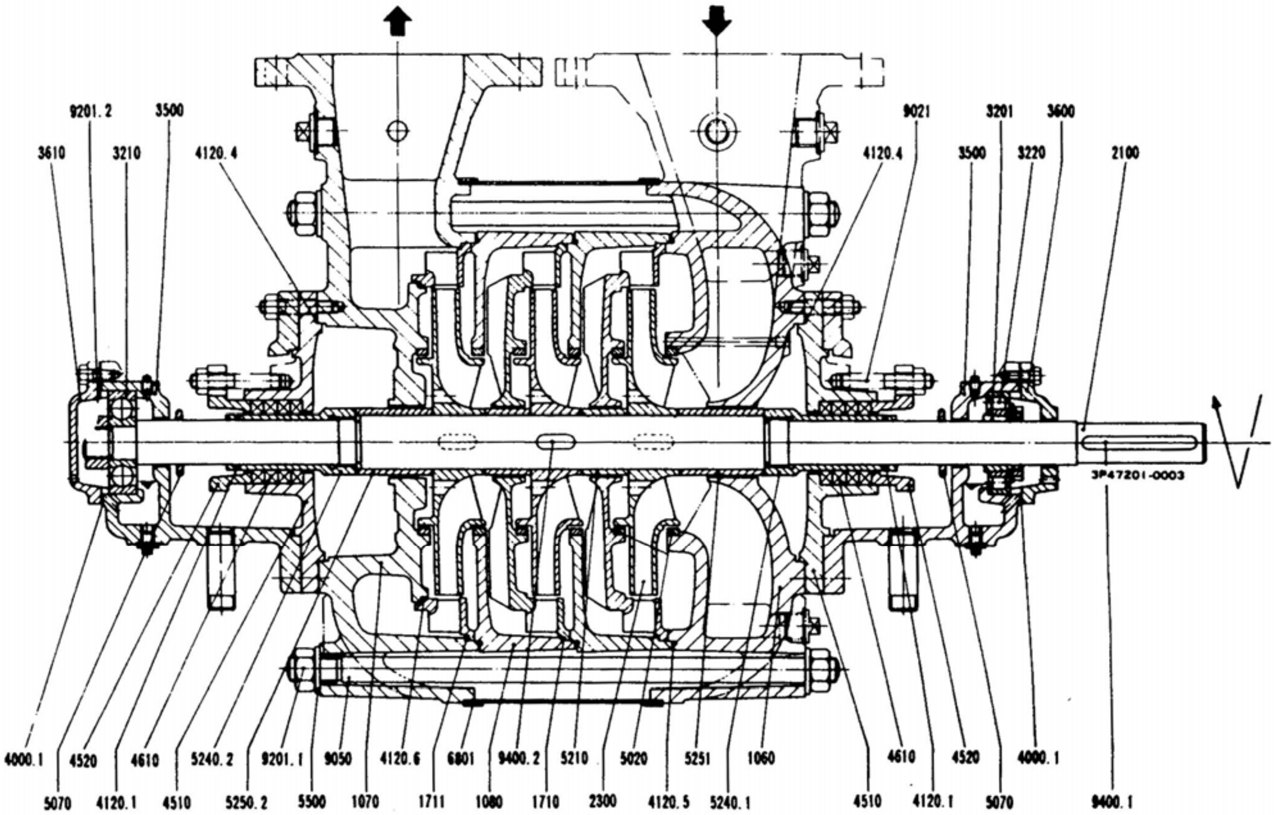
No.	Name	Material	Pcs.	No.	Name	Material	Pcs.	No.	Name	Material	Pcs.
1060	Suction casing		1	4120.1	O-ring	VITON	2	9050	Tie bolt	S 45C	8
1070	Discharge casing		1	4120.2	O-ring	N B R	2	9201.1	Hexagonal nut	SS400	16
1080	Stage casing			4120.5	O-ring	VITON		9201.2	Hexagonal nut	SS400	1
1650	Cooling cover	F C 200	2	4120.6	O-ring	ASBESTOS	1	9400.1	Key	S 45C	1
1710	Diffuser			4510	Stuffing box housing		2	9400.2	Key	S 45C	
1711	Diffuser, last stage		1	4520	Stuffing box gland		2				
2100	Shaft		1	4610	Stuffing box packing	TOMBO3300	8				
2300	Impeller			5020	Casing wear ring						
3201	Clamping sleeve	SS400	1	5070	Deflector	S 35C	2				
3210	Deep groove ball bearing	No.64 C_3	1	5210	Stage sleeve						
3220	Cylindrical roller bearing	NU +H KC3	1	5240.1	Shaft protecting sleeve		1				
3500	Bearing housing	F C 200	2	5240.2	Shaft protecting sleeve		1				
3600	Bearing cover	F C 200	1	5250.2	Spacer sleeve		1				
3610	Bearing end cover	F C 200'	1	5251	Spacer sleeve		1				
4000.1	Flat gasket	TOMBO1630	2	5500	Washer	SS400	16				
4000.2	Flat gasket	TOMBO1900	2	6801	Cladding	SPCC	1				
4000.3	Flat gasket	TOMBO1301	2	9021	Stud	$SUS420J_2$	4				

7E : Cooling water inlet
7A : Cooling water outlet

24E : Quenching inlet
24A : Quenching outlet

Size MMK 80, 100, 125

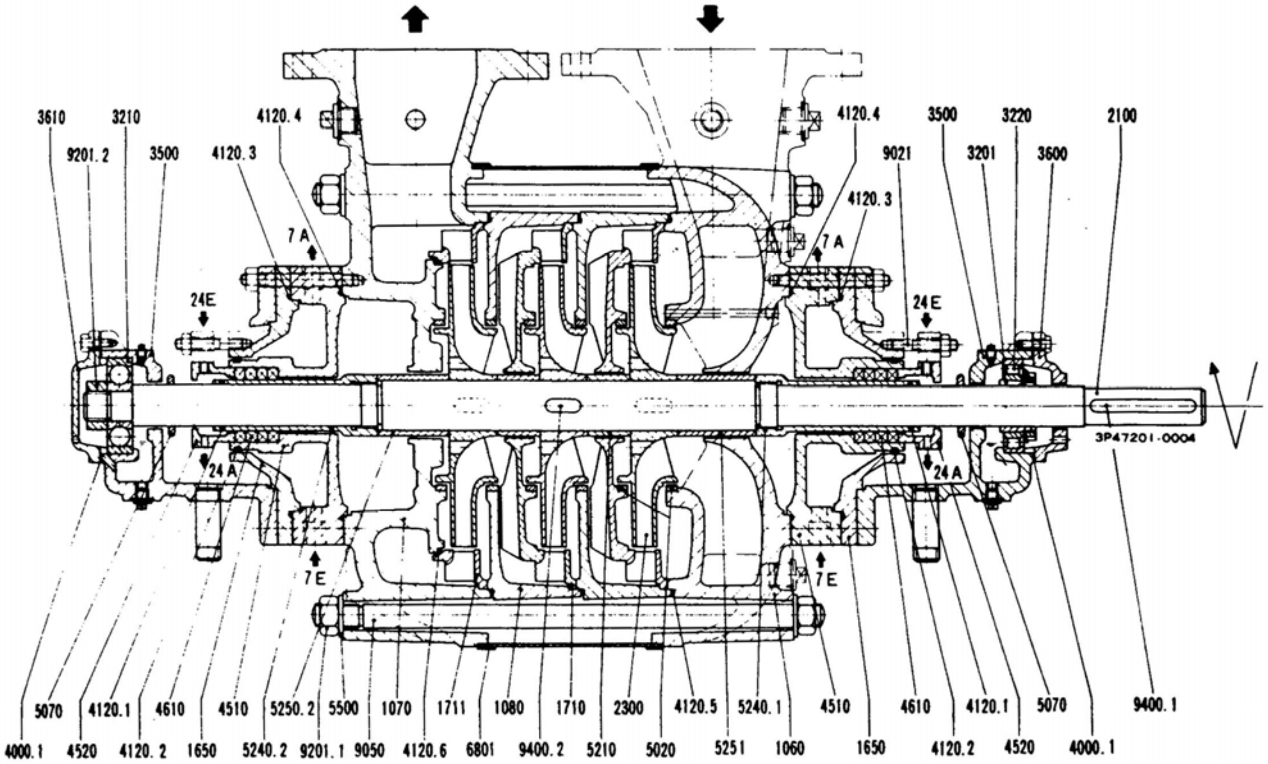
Stuffing box housing : Type N



No.	Name	Material	Pcs.	No.	Name	Material	Pcs.	No.	Name	Material	Pcs.
1060	Suction casing		1	4120.6	O-ring	ASBESTOS	1	9400.1	Key	S 45C	1
1070	Discharge casing		1	4510	Stuffing box housing		2	9400.2	Key	S 45C	
1080	Stage casing			4520	Stuffing box gland		2				
1710	Diffuser			4610	Stuffing box packing	TOMBO3300	8				
1711	Diffuser, last stage		1	5020	Casing wear ring						
2100	Shaft		1	5070	Deflector	S 35C	2				
2300	Impeller			5210	Stage sleeve						
3201	Clamping sleeve	SS400	1	5240.1	Shaft protecting sleeve		1				
3210	Deep groove ball bearing	No.64 C_3	1	5240.2	Shaft protecting sleeve		1				
3220	Cylindrical roller bearing	NU +H KC_3	1	5250.2	Spacer sleeve		1				
3500	Bearing housing	F C 200	2	5251	Spacer sleeve		1				
3600	Bearing cover	F C 200	1	5500	Washer	SS400	16				
3610	Bearing end cover	F C 200	1	6801	Cladding	SPCC	1				
4000.1	Flat gasket	TOMBO1630	2	9021	Stud	SUS420J_2	4				
4120.1	O-ring	NBR	2	9050	Tie bolt	S 45C	8				
4120.4	O-ring	NBR	2	9201.1	Hexagonal nut	SS400	16				
4120.5	O-ring	NBR		9201.2	Hexagonal nut	SS400	1				

Size MMK 80, 100 125

Stuffing box housing : Type HW



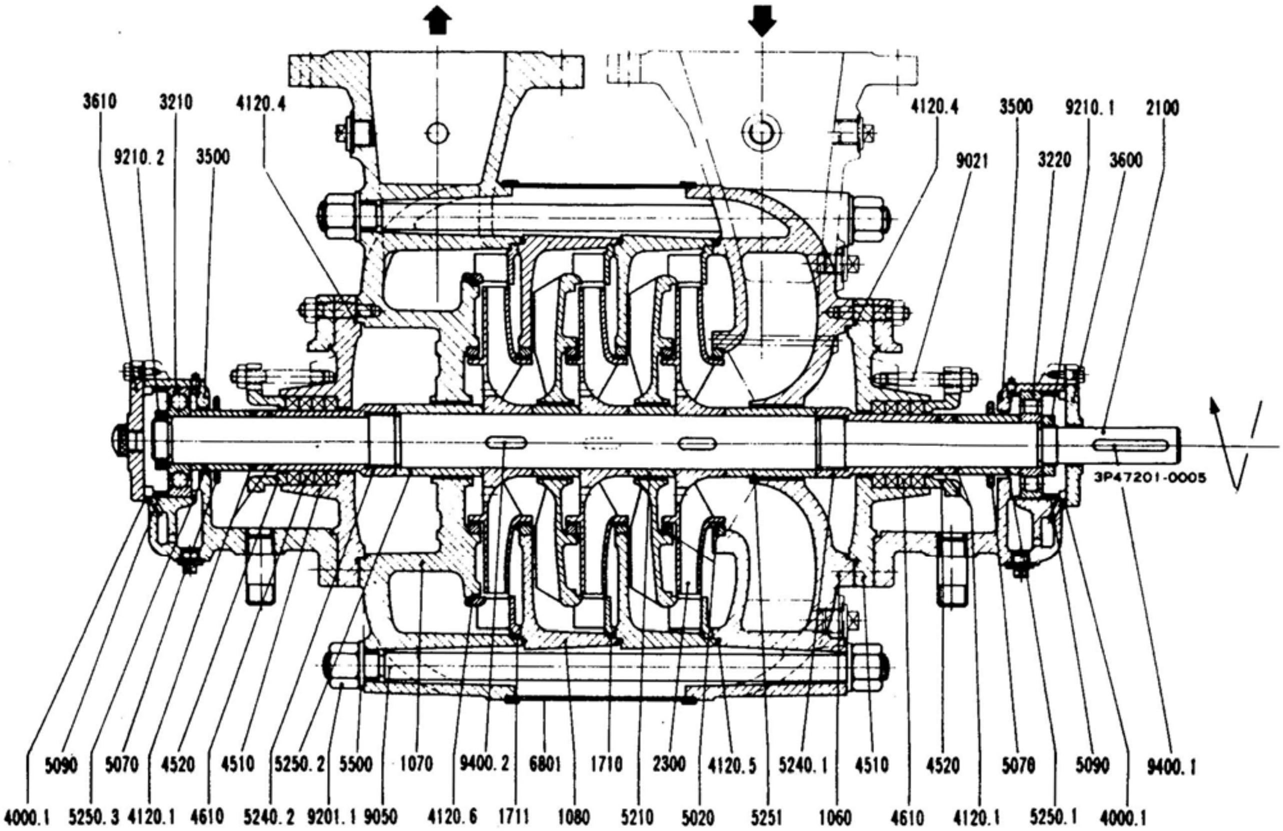
No.	Name	Material	Pcs.	No.	Name	Material	Pcs.	No.	Name	Material	Pcs.
1060	Suction casing		1	4120.3	O-ring	NBR	2	9050	Tie bolt	S 45C	8
1070	Discharge casing		1	4120.4	O-ring	VITON	2	9201.1	Hexagonal nut	SS400	16
1080	Stage casing			4120.5	O-ring	VITON		9201.2	Hexagonal nut	SS400	1
1650	Cooling cover	F C 200	2	4120.6	O-ring	ASBESTOS	1	9400.1	Key	S 45C	1
1710	Diffuser			4510	Stuffing box housing		2	9400.2	Key	S 45C	
1711	Diffuser, last stage		1	4520	Stuffing box gland		2				
2100	Shaft		1	4610	Stuffing box packing	TOMBO3300	8				
2300	Impeller			5020	Casing wear ring						
3201	Clamping sleeve	SS400	1	5070	Deflector	S 35C	2				
3210	Deep groove ball bearing	No.64 [illegible] C[illegible]	1	5210	Stage sleeve						
3220	Cylindrical roller bearing	NU [illegible] +H [illegible] KC[illegible]	1	5240.1	Shaft protecting sleeve		1				
3500	Bearing housing	F C 200	2	5240.2	Shaft protecting sleeve		1				
3600	Bearing cover	F C 200	1	5250.2	Spacer sleeve		1				
3610	Bearing end cover	F C 200	1	5251	Spacer sleeve		1				
4000.1	Flat gasket	TOMBO1630	2	5500	Washer	SS400	16				
4120.1	O-ring	VITON	2	6801	Cladding	SPCC	1				
4120.2	O-ring	NBR	2	9021	Stud	SUS420J2	4				

7E : Cooling water inlet   24E : Quenching inlet

7A : Cooling water outlet   24A : Quenching outlet

Size MMK 150

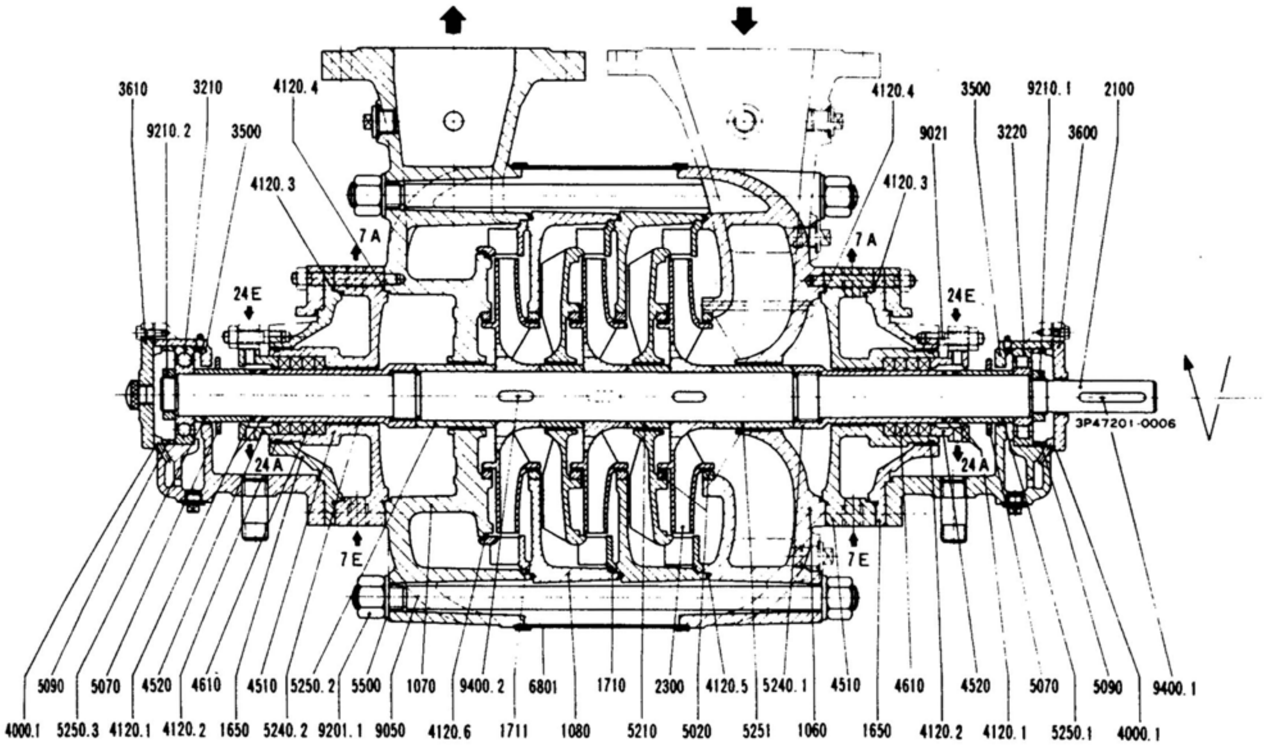
Stuffing box housing : Type N



No.	Name	Material	Pcs.	No.	Name	Material	Pcs.	No.	Name	Material	Pcs.
1060	Suction casing		1	4510	Stuffing box housing		2	9201.1	Hexagonal nut	SS400	16
1070	Discharge casing		1	4520	Stuffing box gland		2	9210.1	Nut	SUS420J$_2$	1
1080	Stage casing			4610	Stuffing box packing	TOMBO3300	8	9210.2	Nut	SUS420J$_2$	1
1710	Diffuser			5020	Casing wear ring			9400.1	Key	S 45C	1
1711	Diffuser, last stage		1	5070	Deflector	S 35C	2	9400.2	Key	S 45C	
2100	Shaft		1	5090	Spacer ring	F C 200	2				
2300	Impeller			5210	Stage sleeve						
3210	Deep groove ball bearing	No.6410C$_3$	1	5240.1	Shaft protecting sleeve		1				
3220	Cylindrical roller bearing	NU410 C$_3$	1	5240.2	Shaft protecting sleeve		1				
3500	Bearing housing	F C 200	2	5250.1	Spacer sleeve		1				
3600	Bearing cover	F C 200	1	5250.2	Spacer sleeve		1				
3610	Bearing end cover	F C 200	1	5250.3	Spacer sleeve		1				
4000.1	Flat gasket	TOMBO1630	2	5251	Spacer sleeve		1				
4120.1	O-ring	N B R	4	5500	Washer	SS400	16				
4120.4	O-ring	N B R	2	6801	Cladding	SPCC	1				
4120.5	O-ring	N B R		9021	Stud	SUS420J$_2$	4				
4120.6	O-ring	ASBESTOS	1	9050	Tie bolt	S 45C	8				

Size MMK 150

Stuffing box housing : Type HW



No.	Name	Material	Pcs.	No.	Name	Material	Pcs.	No.	Name	Material	Pcs.
1060	Suction casing		1	4120.4	O-ring	VITON	2	6801	Cladding	SPCC	1
1070	Discharge casing		1	4120.5	O-ring	VITON		9021	Stud	SUS420J$_2$	4
1080	Stage casing			4120.6	O-ring	ASBESTOS	1	9050	Tie bolt	S 45C	8
1650	Cooling cover	F C 200	2	4510	Stuffing box housing		2	9201.1	Hexagonal nut	SS400	16
1710	Diffuser			4520	Stuffing box gland		2	9210.1	Nut	SUS420J$_2$	1
1711	Diffuser, last stage		1	4610	Stuffing box packing	TOMBO3300	8	9210.2	Nut	SUS420J$_2$	1
2100	Shaft		1	5020	Casing wear ring			9400.1	Key	S 45C	1
2300	Impeller			5070	Deflector	S 35C	2	9400.2	Key	S 45C	
3210	Deep groove ball bearing	No.6410C$_3$	1	5090	Spacer ring	F C 200	2				
3220	Cylindrical roller bearing	NU410 C$_3$	1	5210	Stage sleeve						
3500	Bearing housing	F C 200	2	5240.1	Shaft protecting sleeve		1				
3600	Bearing cover	F C 200	1	5240.2	Shaft protecting sleeve		1				
3610	Bearing end cover	F C 200	1	5250.1	Spacer sleeve		1				
4000.1	Flat gasket	TOMBO1630	2	5250.2	Spacer sleeve		1				
4120.1	O-ring	VITON	4	5250.3	Spacer sleeve		1				
4120.2	O-ring	NBR	2	5251	Spacer sleeve		1				
4120.3	O-ring	NBR	2	5500	Washer	SS400	16				

7E : Cooling water inlet
7A : Cooling water outlet

24E : Quenching inlet
24A : Quenching outlet

MEMO