Indar
Una Marca Ingeteam

THREEPHASE SYNCHRONOUS MACHINES

START-UP & MAINTENANCE

INSTRUCTIONS HANDBOOK

JANUARY 2006

CONTENTS

1. INTRODUCTION

The scope of this manual is to provide the necessary information for the correct installation, starting up, maintenance and repair of the threephase synchronous machines, make INDAR.

All the procedures and standards included in this manual must be followed in order to guarantee a good operation and to prevent personal injuries that may be caused by unforeseen situations.

Therefore, this manual should be read carefully, before the installation of the machine, and in case of doubt, please contact:

INDAR Máquinas Eléctricas, S.L.
Bº Altamira, Polígono Industrial Txara
20200 –BEASAIN
Guipúzcoa (España)
Telef. 34 943 02 82 00
Fax. 34 943 02 82 04
E-Mail: indar@indar.net
Web site: www.indar.es

1.1. SAFETY RECOMENDATIONS

IMPORTANT:

The machine has to be installed and handled by skilled personnel who must know and has to apply the necessary safety precautions to avoid any accident when commissioning and maintenance of the machine, by complying with the pertinent rules of safety of the country where the installation is carried out.

All the personnel working in electric installations, i.e. operation, mounting, handling, maintenance and repair, have to be informed carefully about updated standards and safety instructions about work and must be advised to observe them. The person in charge must have the confirmation that everything has been duly observed and must warn the personnel about possible danger or problems and let them know of the care they must take when carrying out their job.

This type of machines, if inadequately used or incorrectly maintained or handled by unqualified personnel, can cause serious accidents or damage to materials and personnel.

Therefore, it is highly recommended that the work should be carried out by duly qualified personnel. Qualified personnel are those who (due to their studies, experience, instruction level, knowledge of relevant standards, specifications, safety recommendations and prevention of accidents and knowledge of operating conditions), have been authorised by the person in charge to carry out the job and are able to avoid any possible risk of accident.

Equipments to combat a fire and first aid warnings must be installed on the site and have to be visible and accessible.

1.2. STANDARDS AND PRESCRIPTIONS

The machines comply with the recommendations of the Standard **VDE 0530 "Standards for Electric Machines"**, as well as with the Recommendations **of the International Electrotechnical Commission IEC-34 "Rotative Electric Machines"**. Should the machine were to be installed in Spain, they additionally would comply with the paragraph 2 of the instructions **MIE BT 034**.

Along with the final documentation a **Declaration of conformity is issued,** according to the **Recommendations of the Board D-98/37/CE, D-89/336/CEE and D-93/68/CEE.**

In general, and excepting some slight differences, the machines comply with the following standards:

UNE	Spain
AFNOR	France
VDE	Germany
DIN	
BS	UK
NEMA	U.S.A.
IEC	Europe

2. DESCRIPTION

2.1. GENERAL

The machines included in this catalogue, correspond to those of our catalogue "Three-phase Synchronous Machines, up to 10 kV".

Protection IP23. Cooling IC 01 / IC11 / IC 21 / IC 31

Protection IP54. Cooling IC 410 / IC 411 / IC 416

Protection IP54. Cooling IC 01 611 / IC 616 / IC 666

Protection IP54. Cooling IC 81 W / IC 86 W.

2.2. CONSTRUCTIVE DESIGN

These machines are normally built according to design IM B3 or IM V1, with ball or roller bearings which denomination corresponds to IEC 34-7. In special cases, slide bearings will be used. Any other constructive design will refer also to said Recommendation

2.3. TYPE OF PROTECTION

The type of protection refers to the Recommendation IEC-34-5.

The main protections correspond to:

- **IP-23:** Machine protected against penetration of foreign bodies grater than 12 mm. and against spraying water.
- **IP-54:** Machine protected against dust deposits and against splashing water.
- **IP-55:** Machine protected against dust deposits and protected against water jets.

2.4. TYPE OF COOLING

The denomination corresponds to the IEC-34-6 Recommendation.

The main cooling types correspond to:

- **IC 01:** The cooling air circulates freely through the inside of the machine moved by a fan driven by the proper shaft.
- **IC 81 W:** Totally enclosed machine. Air-water exchanger mounted on top of the machine; self-ventilated.
- **IC 611:** Totally enclosed machine; air-air exchanger; self-ventilated. Inner and outer circuit.
- **IC 411:** Totally enclosed machine; nerved frame; self-ventilated. Inner and outer circuit.

2.5. STATOR WINDING

2.5.1. Stator winding with flat bar

The stator winding is made by means of complete winding, double layer and fractional pass, previously manufactured to the mounting by means of electrolytic copper rectangular flat conductors.

The insulation of the coils, at its straight part is carried out by the "MICAPRESTERM" system, which consists on a unit pressed of impregnated mica with epoxy resin on glass cloth support.

On overhangs, over the mica, epoxy and glass taping, a finishing taping with termocompressible material is carried out.

The coils are fastened in the stator slots by means of magnetic edges or glass wedges.

The overhangs are bound with strings in the form of a vault and on a glass fiber support, where distant blocks between the coils have been introduced, in such a way that the windings are strong enough to resist the worst case incident.

Vacuum pressure impregnation (VPI) is always used. The insulation system has shown to be very reliable even in extreme operating conditions.

The insulation is always class F or H.

2.5.2. Stator winding with wire

The stator winding is made by means of concentrical windings, of stepped pass, previously manufactured to the mounting by means of insulated conductors with thermal class H polyestyrimide varnish.

The coils are fastened in the stator slots previously insulated with a polyester laminating of mechanical protection, overlapped to which there is a thermal class F flexible laminating. The fastening is carried out by means of fiberglass edges.

The overhangs are bound with strings in the form of a vault and on a glass fiber support, where distant blocks between the coils have been introduced, in such a way that the windings are strong enough to resist the worst case incident.

The statoric unit is impregnated in type polyester-polyurethane thermal class F resin, with a later drying in stove.

2.6. ROTOR CONSTRUCTION

The polar wheel is manufactured with slotted steel sheet. A compact pressed core is formed after a keying process.

All rotors are provided with a damping cage.

The coils are conformed in machines, in moulds. They are introduced in the cylindrical peripherical slots, previously insulated by means of flexible laminatings.

The fastening of the winding in the rotor slots is performed by means of fiber glass wedges, and the overhangs by means of the banding by using fiber glass taping, which has been polymerized in hot.

After a previous drying, a vacuum pressure impregnation (VPI) is carried out, with resin of the thermal class F.

The balancing of the rotor is effected on dynamic machine, until a quality grade of G = 2.5 is achieved, according to ISO 1940 Standard. Said balancing is carried out with entire key.

2.7. BEARINGS

2.7.1. Ball or roller bearings

All the machines of our catalogue are usually delivered with bearings, provided with a greasing device.

Up to type 450, the old grease should be extracted into a grease trap, which can be emptied merely by dismounting the outside bearing cover. For higher types, the grease can be removed from the trap by means of an emptying device, even during operation.

The commutator end bearing is mounted as a fixed bearing. The driving end bearing is free.

2.7.2. Slide bearings

For special service conditions, the machines are provided with slide bearings. Friction bearings of spherical body can be used, which are mounted with different alternatives depending on:

- **Fixing support:** flange or feet.
- **Heat dissipation:** natural or water cooling.
- **Type of lubrication:** greasing ring and/or oil circulation.
- **Thrust surface:**

Usually, the driving end bearing is fixed bearing and the non driving end bearing is removable, in such a way that the length differences because of thermal expansion are absorbed.

2.8. TERMINAL BOX

The outgoing cables for connection of the winding of the machine are welded to the three connection bolts housed in ceramic material electrical connectors.

The electrical connectors are bolted on an insulating material plate, which at the same time is bolted to the machine terminal box.

The terminal box is normally placed on the right side of the frame, seen from driving end and corresponds at least to the IP44 protection. The cable entrance is usually from the bottom.

The marking of the terminals is arranged in such a way that a clockwise direction of rotation is obtained, seeing the machine from driving end, when the alphabetical sequence of the markings of the terminals (U1, V1, W1) corresponds to the sequence of the phase voltage of the system or net (L1, L2, L3) according to the EN 60034-8 Standard.

If a machine is required to run counter-clockwise, the sequence of the phase voltages of the system or net should be inverted by changing the supply cable arrangement (L2 and L3 in case of 3 phases).

2.9. PROTECTING DEVICES

2.9.1. Earthing terminal

All the machines will be at least provided with the prescribed earthing terminal with the mark

Besides, another earthing terminal for connection of the feeding cable metallic sheathing has been foreseen in the terminal box.

2.9.2. Heating elements

When the machine has to operate under environmental unfavourable conditions, some heating elements should be provided by means of a heating system, which keeps the inside machine air above the ambient temperature.

For that purpose, single-phase resistances will be placed in the lower part of the inner side of the machine in one or both sides, ready to be connected to the low voltage auxiliary mains.

2.9.3. Temperature control

Overload can originate not allowed temperatures on the winding and on the bearings. The monitoring of the temperature allows a disconnection or reduction of the load, which prevents from the breakdown.

2.9.3.1. Platinum thermo-resistors Pt100

The embedded temperature detectors (E.T.D.) are Pt 100 platinum thermo-resistors, consisting of a platinum filament wrapped in ceramic material cylindrical in shape and placed within a metallic protection sheath, when the measurement of bearing temperature is intended, or flat-shaped, for insertion in the winding.

The outgoing pins are connected with the measuring wires, allowing a continuous temperature reading in the measuring instrument.

2.9.3.2. Thermistors

They are highly sensitive semiconductor material elements that change with the temperature. A very sudden change in ohmic resistance at a given temperature will trigger a starting device, giving an alarm or disconnection signal.

These temperature detectors are commercial elements graduated every 10°C, ranging from 90°C to 170°C, and they are embedded into the stator windings, one in each phase. Duplicating the number of detectors, one for alarm and the other for switching off, requires installing an additional tripping element.

2.9.3.3. Bimetallic detectors

The thermocontacts or bimetallic detectors can be placed in the stator winding in order to "open" a contact or to "close" it. They can be used to act on windings of contactors, or on signalling devices.

2.9.3.4. Thermocouples

The thermoelectrical torques, thermo-couplings or thermocouples are formed by two different metals welded between them in two points. At the ends of the conductors, an electromotive force is retaken. Said electromotive force is proportional to the existing temperature difference between the two welding points and which further depend on the nature of the metals used.

The electromotive force can be measured with the aid of a millivoltmeter which, for calibrated metals, will be converted into °C.

3. INSTALLATION

3.1. MAINTENANCE AND UNPACKING

3.1.1. Delivery

The machine is delivered fully mounted and for operating conditions. The adjusting surfaces and those of sliding, shaftend, etc. have been protected against oxidation by means of an anticorrosive film.

Within the shipping unit, the machine is protected by a plastic wrapping. Immediately after the reception, the wrapping will be checked. Any anomaly in the wrapping will be informed to the transport agency or to INDAR.

When handling, the hoisting signals and the given weights will be noted. Handle with care in order to avoid any damage in slide and roller or ball bearings.

3.1.2. Unpacking

Should the shipping unit have a temperature lower than the ambient air where the unpacking is carried out, wait until the shipping unit has taken the room temperature.

When unpacking, do not remove the protective lining from the shaft end and the cover of the terminal box openings, water connections, etc., to keep the protection until the moment of the mounting.

Machines with roller bearings on driving end will be delivered with a rotor-blocking device in order to prevent damage when transporting. Said device that consists in three screws at 120° (painted in red) should be removed before the starting up of the machine. This will be checked by rotating the rotor freely. The rotor should be blocked again for a later transport even in the case that the machine has been coupled.

3.1.3. Storage

Machines which must be stored for a long time before putting into service must be kept in a suitable place, offering the following conditions:

a. Cleanliness, so that deposited dust amounts to a minimum, and machines may be kept in acceptable cleanliness conditions.

b. A steady temperature with an ambient as dry as possible, limitations in this regard being the specified operating conditions. Important changes in temperature may originate condensations, liable to damage the insulation.

c. The ambient will never be corrosive. The most corrosive ambients are the sulphuric, chlorine and ammonic ambients.

d. The location will be vibration-free, and as far as possible away from other running machines, liable to originate mechanical actions on stored machines.

Even if important, the choice of a good storing site does not free from maintenance care, which is essential during protracted periods.

To this end, the following must be taken into considerations:

a. The machine must be kept with all its cooling vents and manhole covers shut.

b. Machines must be covered, in order to protect them against dust and water, leakage, etc.

c. Whenever great changes in temperature are foreseen, heaters should be connected, if available. If not, use outer heaters, in order to avoid condensation of ambient moisture.

d. The corrosion-resisting film at the end or ends of the shaft must never be removed.

e. The condition of machine paint should be periodically checked during protracted storing periods in hard environment.

f. The rotors should be periodically rotated by hand, in order to avoid corrosion risks in bearings, and lessen damage due to vibrations coming from outside.

3.1.4. Handling

For handling the machine, use the hoisting eyes provided on the frame. Be aware of the weight given on the nameplate.

The supporting rings covers and bearings exclusively serve to handle these pieces.

The shaft should never be used to hoist the total weight of the machine.

The cables will be applied to the crane hook, ensuring them against sliding. Check the capacity of cable buoyancy.

3.2. INSTALLATION SITE

The agreed environmental conditions should be respected.

The installation site must be such that an adequate vibration level is obtained.

In the case of machines of forced ventilation, make sure that inlet and outlet cooling air vents are located in such manner that the air may freely circulate. The location must have as well enough aeration volume, so that the air entering the motor will not effectively exceed the specified temperature conditions.

Bear in mind the machine protection when choosing the installation site.

The possibility of access to lubricators must be checked, and room enough for the other maintenance operations should be available.

Foresee the use of sufficient power elevation devices when mounting and dismounting the machines.

3.3. FIXING OF THE MACHINE

3.3.1. General advices

Install the machine on solid seating, assuring that the flatness of the four supports is under 0.1 mm.

The machine should be seated on a cement or steel foundation. Check that it concords with the mounting dimension drawings. In any case, it will be sufficient to support the forces and load torques and overload as well as to guarantee an adequate alignment between the machine and the driven machine.

Besides, the foundation must be sufficiently dampening to support the vibrations.

3.3.2. Installation on baseplate (fig. 1)

To install the machine on the baseplate, proceed as follows:

1. Inspect the foundation (1) by checking that anchoring openings have been carried out according to the relevant dimension drawing.

2. Level the baseplate (2) by means of supplementary metallic fine sheets (3). Finally, support the unit and fasten the bolts (4) partially.

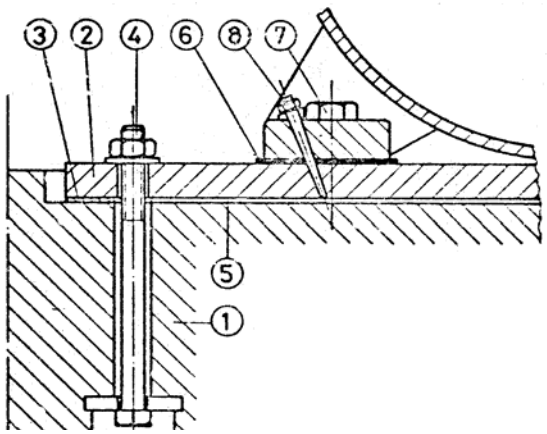
3. Pour the fluid cement (5) between the baseplate and the cementing mass and let it to forge during at least 48 hours.

4. Fasten definitively the anchor bolts.

5. Align the machine, by fitting fine supplementary metallic sheets (6), in such a way that they allow the adjusting of the machine shaft height. For that purpose, follow the instructions of the coupling supplier and in any case, be sure that the radial and axial misalignments are within the given tolerances.

6. Fasten the fixing screws (7) of the baseplate machine.

7. Put the machine in operation and when everything is according the normal values, fit fixing conical pins (8) in the opposite feet in order to definitively fix the machine alignment.



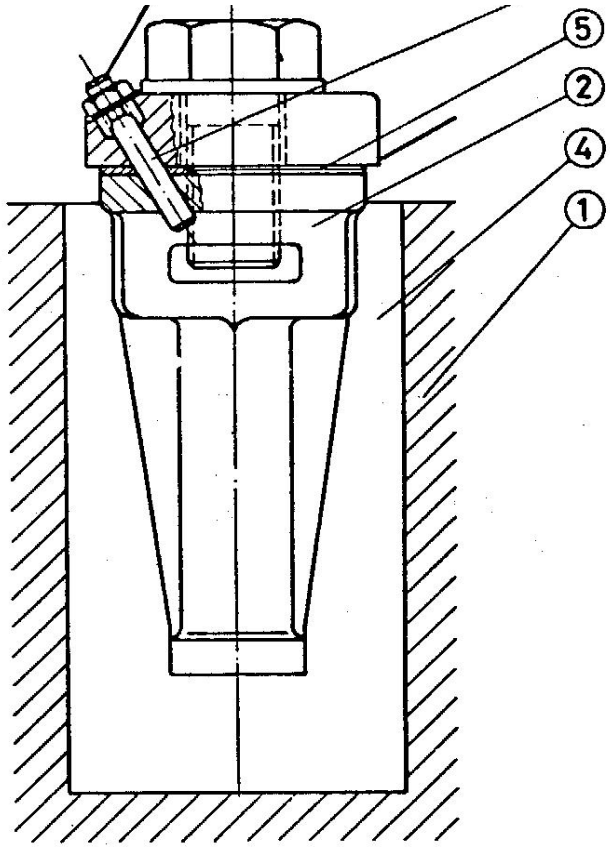
0. Cementing mass
1. Base plate
2. Metallic sheets.
3. Anchor bolt.
4. Fluid cement.
5. Metallic sheets.
6. Feet fixing screw.
7. Conical pin.

Fig.1 Installation of a machine on a baseplate

3.3.3. Installation on supporting plates (fig.2)

Check the dimensions of the cement mass (1).

1. Fix the machine on the plates (2) by means of the fixing screws (6)
2. Align the machine in relation to the coupling of the driven machine, bearing in mind the supplier coupling instructions.
3. Pour the fluid concrete (4) on the cement mass and let it to settle during 48 hours.
4. Check the alignment and correct it, if necessary, by means of supplementary metallic fine sheets (5).
5. In some cases, the machine will be provided with holes for the leveling screws in order to make that job easier.
6. Put the machine into operation and if everything is correct, fit fixing conical pins (3) on the opposite feet in order to definitively fix the machine.



1. Cement mass
2. Support seatings
3. Conical pins.
4. Fluid cement.
5. Fixing screw of support plate.

Fig. 2. Detail of the installation on support plates.

3.4. MOUNTING AND ALIGNMENT

3.4.1. General

All the machines are delivered dynamically balanced, with the shaft end key incorporate. Therefore, pulleys, coupling systems, gears, etc., should be balanced without the key.

Previous to the mounting of the transmission elements, remove the anticorrosive painting from the shaft end by means of a solvent. After that, and previous to drying, impregnate the shaft end with grease or oil. Do not use products containing molybdenum disulfide that reduces the coefficient of friction that is quite important in those pieces that are mounted by contraction.

Before mounting of the half coupling, check the sense of rotation of the machine, by means of a provisional connection. The machines designed for only one direction because of curve blades fans will be marked with an indicating arrow. Should they are not marked, machines should be understood are designed to operate in both sense of rotation. Should the change of sense of rotation be required, interchange two of the feeding cables.

3.4.2. Mounting of the semi-coupling

In general, the machine should be coupled by means of a flexible coupling, which absorbs the radial misalignments, angular displacements, longitudinal movements and torsional deformations.

The rigid coupling systems, in general, are not admissible. They can only be used in exceptional circumstances.

Should the machine is to be used with transmission elements that cause radial or axial loads on the shaft (pulleys, gears, etc.) consult the admissible load diagram on the machine.

3.4.3. Driving by belts

In case of driving by belts, the installation is carried out on tension supports. The machine feet are screwed on guide rails. The tensioning of the belts is carried out by tension screws fitted one at each side of the machine, making to coincide the nearest to the pulley between the latter and the driven machine.

The driving pulley should be aligned with the driven one in such a way that the belt works in the very same plane, which will be that of the driven pulley. See fig. 3.

In any case, the application point of the resulting force should be situated within the free shaftend length.

The tensioning of the belts should be carried out according to the instructions of the supplier. As a reference, a progressive tensioning can be applied until an elongation of 0.4 ÷ 0.6% is achieved. That is, should the initial length between two points of the belt is 500 mm: 500 x 1.006 = 503 mm. final length.

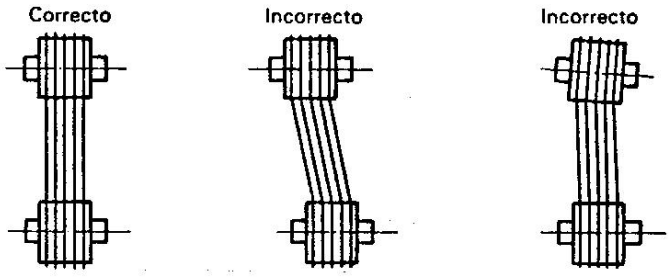


Fig. 3. Alignment by pulleys

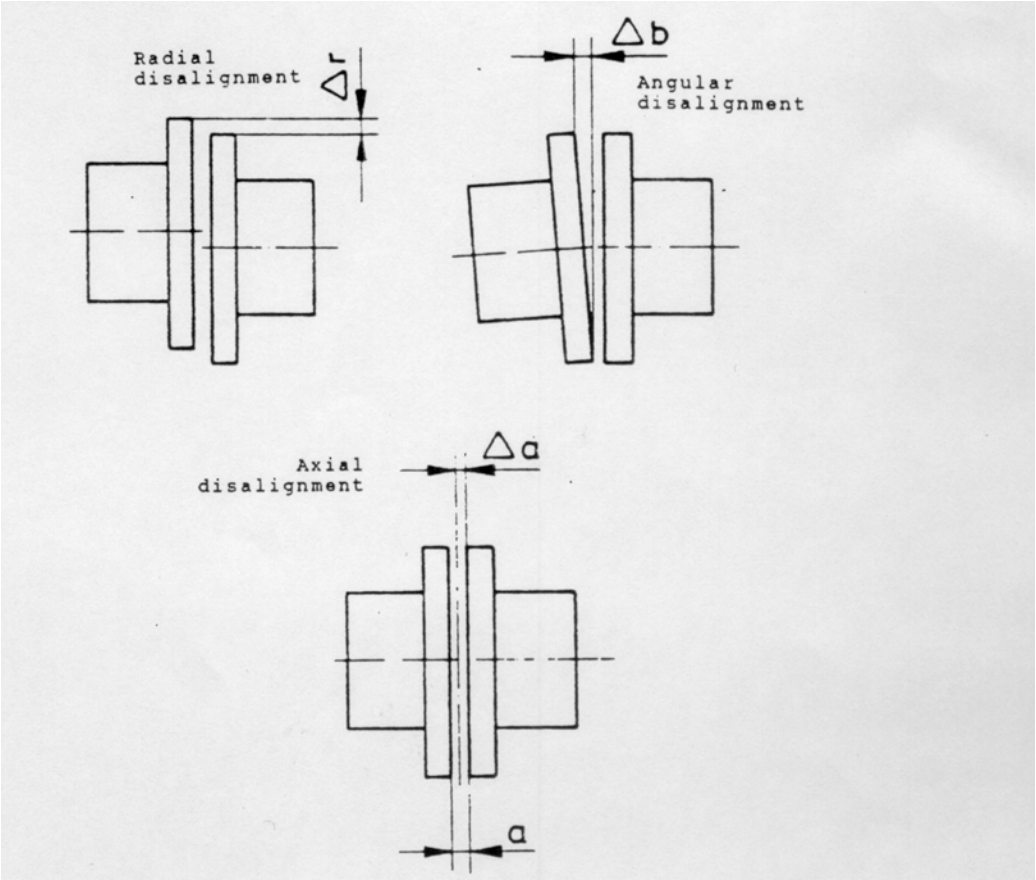


Fig. 4. Alignment of a flexible coupling.

3.4.4. Alignment

In general, the alignment will be carried out bearing in mind the instructions given for the coupling.

By fitting the sheets under the frame bottom, arrange the shafts at the same height. The exact alignment of the two shafts will be carried out by means of two comparator watches in the axial sense and in the radial sense in such a way that the differences in a complete rotation can be checked. (fig. 4)

The misalignment of the shaft centers (radial misalignment Δ r) should not exceed 0.03 mm. Neither the distance between the semi-couplings, measured 4 times in the periphery should present higher differences than 0.03 mm.

The space between the two semi-couplings should be 3 to 4 mm.

Alignment should be checked at normal working temperature.

3.5. CONNECTIONING

3.5.1. Cable connection

For connection of the feeding line, unscrew the terminal box cover, and adapt the separable rubber catches of the cable by sliding over it. Feeding conductors will be adapted by applying adequate terminals to the ends. All feeding contacts will be greased with protective contact grease. Feeding lines L_1, L_2 and L_3 will be coupled to the U_1, V_1 and W_1 motor terminals for clockwise sense of rotation; and for anticlockwise rotation exchange two phases between them.

Couple the protection conductor of the earthing rule and secure it carefully.

3.5.2. Cooling system

In the case of machines with air-water heat interchanger IC 86 W, sufficient cooling water flow should be provided for a pressure drop in the interchanger given for an adequate temperature. Data are stated on the interchanger nameplate.

Make sure that all tightening joints are fitted.

3.5.3. Lubricating oil

In the antifriction bearings for high speed machines and, in general, when lubrication and heat dissipation are required to be through external circulation oil, an oil circulation system will be provided, by means of tubes or hoses electrically insulated besides of backward motion valves and throttle valves and governing valves which prevent the bearing from emptying of the bearing in case of failure of the oil feeding.

The oil overpressure before the bearings should be adjusted approx. at 0.3 -0.5 bar at the oil rated temperature.

Check that the return way has an adequate section (max. flow speed 0.15 m/sec) and a drop of at least 2° to the oil tank in such a way that the circulation oil be sufficiently cooled and that the filters can work perfectly.

The oil volume in the circulation system must be at least six times the oil quantity required per minute, for all the bearings supplied by the system. In no case should the oil tank be under pressure, since this could originate leakage in bearings.

Before starting the machine, check that the oil circulation system operates perfectly well. For that purpose, check that through the plastic small opening on the bearing frame or by means of adequate flowmeters.

A typical example is shown in fig. 5.

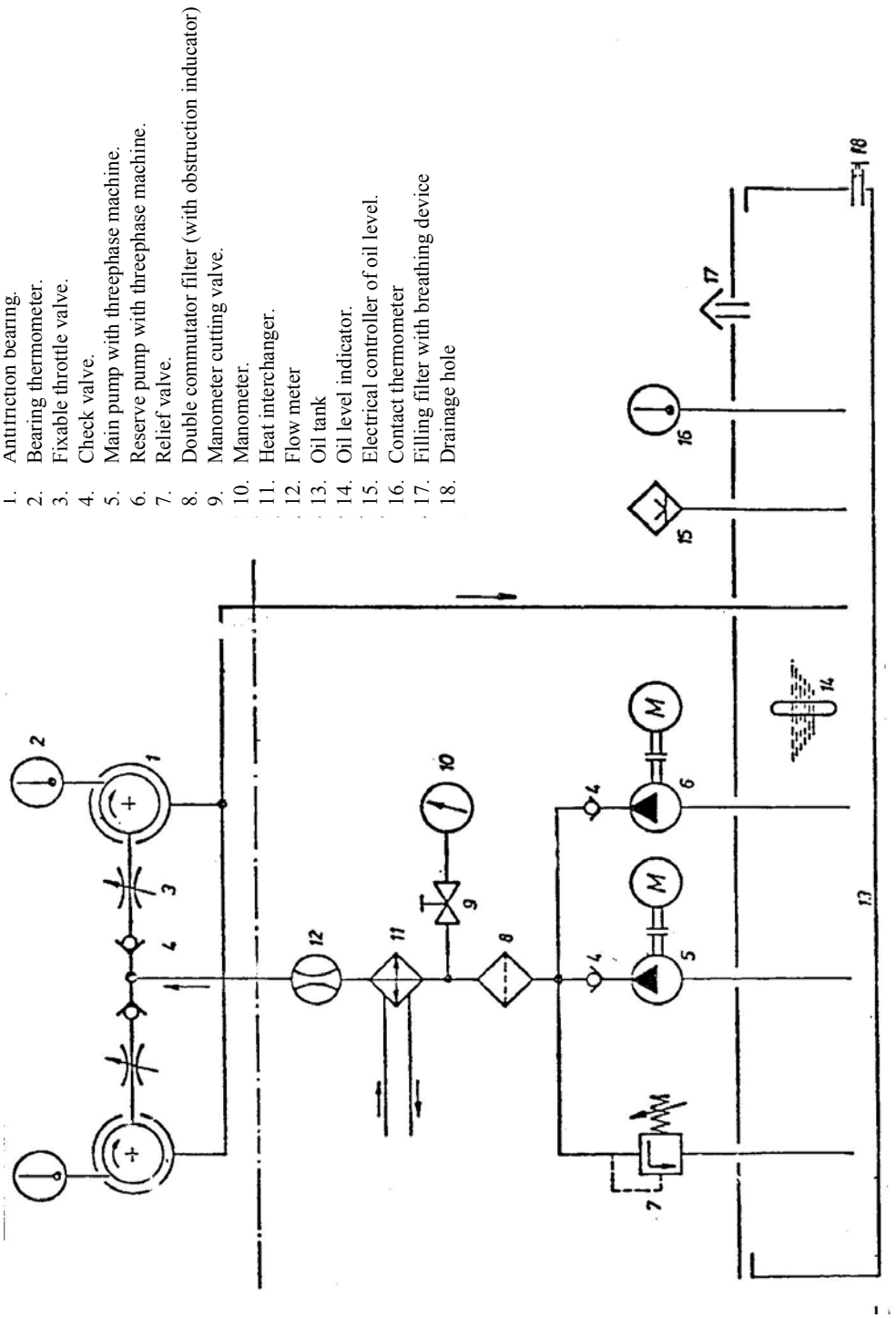


Fig. 5. Example of oil circulation system for 2 antifriction bearings.

4. PUTTING INTO SERVICE

4.1. BEFORE THE FIRST START-UP

Before the first start-up or after a prolonged standstill, the following aspects should be especially examined and checked:

1. Remove the dust, the antioxidant and the packing parts that could have remained adhered.

   All tools and objects used for the installation of the machine should be removed from site.

   Check cooling air in and outlets are free from any obstruction. (Should be the case, check that the cooling water circuit or the lubrication oil circulation are operating correctly).

2. Check that:

   Machine is duly anchored, and that couplings have been filled up with the prescribed oil.

3. Check that ball or roller bearings are filled with grease.

   Check also that the slide bearings are full of oil up to the adequate level.

   Verify in any case that the oil circulation system operates correctly.

4. Check that the operational rated values given on the nameplate are the ones requested for the installation.

   In the case of motors with only one sense of rotation, it is important to be sure that the motor runs in the sense shown by the arrow fitted for that purpose.

5. Check that insulation resistance is enough, according to the point 4.5.

6. Check that machine is duly connected, as regards to the main feeding terminals and to the auxiliary ones.

7. Check that the rotor rotates freely before the starting up.

4.2. START-UP

Let the machine run in no load condition, during several hours before applying load. Verify that everything operates correctly. Running without vibrations, consumption, etc.

All values of the measurements that can be effected will be registered, and the good functioning of the measuring apparatus installed will be checked.

Load will be applied slowly, letting the machine to run for a certain time so measurements at different stabilized temperatures can be obtained at each load point. Those will serve to control the machine behaviour all along its life.

Check that the maximum load point does not exceed the rated consumption, as well as that the admissible vibration limits are not exceeded according to the ISO 10816-3 Standard and the stabilized ball or roller bearings temperature and bearings do not exceed 90°C.

If the bearing temperature is usually low, investigate the causes, because there is the possibility that the thermometers are damaged.

4.3. DEFINITIVE FIXING

Once it is checked that everything operates correctly, fixing conical pins will be fitted at the two opposite feet of the machine, in order to fix the machine definitively. For that purpose, the previously bored holes at the feet of the machine will be used.

5. MAINTENANCE

5.1. MAINTENANCE SCHEDULE

The accurate maintenance of the machine constitutes the best guarantee against incidents and damages, which necessarily originate an interruption of the service.

The maintenance model schedule presented below, as a recommendation guide, is the result of a very long practical experience. The periodicity given corresponds to a working of 8 hours/day.

It is considered very interesting the elaboration of a maintenance diary where all the incidents in service will be registered.

MAINTENANCE SCHEDULE

OBJECT OF OBSERVATION	PERIODICITY					
	1 Day	1 Week	1 Month	3 Months	1 Year	5 Years
Ball and roller bearings and sleeve bearings	Oil		Control of vibrations and temperature		Checking of grease interval, Inspection of oil in antifriction bearing.	Dismount and check completely. Replace if necessary.
Cooling			Cleaning of filters.		Thorough cleaning.	
Coupling		Check alignment 1 week after each new mounting.			Check alignment..	
Terminal box				Tighten screws.	Inside cleaning. Grease contacts points.	
Measuring apparatus	Registration of data.					
Winding				Visual inspection.	Measure insulation resistance.	Thorough cleaning.
COMPLETE MACHINE	Visual inspection.				Tighten screws.	Dismount rotor. Thorough cleaning.

5.2. ROLLER OR BALL BEARINGS

As a general rule, the machines included in these instructions are provided with greasers mounted on the outside ends of the covers. A thorough cleaning is recommended before applying the greasing pump.

The grease is pressed towards the inside of the greaser until clean grease appears in the evacuation bucket that communicates with the bearing box. The incorporated grease regulator makes the old grease and the excess of grease be ejected so as to avoid an overheating of bearings precisely due to an excess of grease quantity.

The greasing periodicity is indicated on the edge of the end shield of the respective bearing, along with the serial number.

The grease the machines are originally fitted with, for ordinary operation conditions, is of lithium base and quality tested, that is, VERKOL ASTURUS 3. In general, lubrication should always be carried out using high quality bearing grease. In general, it can be substituted by greases of the following characteristics:

a. Soup metal: Lithium

b. Grease should not contain any abrasive material capable of scratching the bearings.

c. Penetration index (mm/10 220 - 295)

d. Consistency 2-3 NLGI

e. Dropping point 190°C.

f. Utilization field: from -20 to +130ºC.

g. Further characteristics: allowance of a small quantity of condensed water, and be mechanical stable for moderately vibratory mountings, besides of being homogeneous and anti-corrosive.

The following are equivalent to the grease used at the factory:

- SHELL-ALVANIA GREASE R-2 or 3.
- ESSO-BEACON 2 or 3.
- MOBILUX GREASE 2 or 3.

5.3. BEARINGS

5.3.1. Check-ups

The following points should be checked in each case:

a. Oil level or should it be the case the amount and pressure of oil (1.2 - 1.4 bar).

b. Bearing temperature should not exceed 90ºC. In exceptional cases, consult with the factory.

c. Good functioning of the oil ring should be checked. To this end, check that the oil level keeps constant, by filling up to 50% the sight gage provided to this effect.

d. Besides, and if necessary, the following should be checked:

e. A good recirculation of the necessary oil flow.

f. Inlet temperature and cooling water flow.

g. Oil pressure of the oil load relief device.

5.3.2. Oil changing

Under normal operation conditions, the bearing oil should be replaced every 8,000 hours of operation in the case of self-oiled bearings, and every 20,000 hours in the case of forced lubrication. Such an interval must be reduced in case of frequent start-ups and stops, when oil temperatures are high or pollution is excessive, due to external influence, for instance.

Oil replacements should be performed when the machine is stopped, and with the oil corresponding to the viscosity degree indicated on the machine. Normally, it is ISO VG 32 or ISO VG 40.

As a rule, any mineral oil of a reliable brand offering the following characteristics can be used:

a. Additives creating a good resistance to foaming, and ensuring a quick removal of air trapped as small bubble embedded in the oil, and interfering in the good operation of the circulation system.

b. Good aging resistance.

c. Emulsibility.

d. Anticorrosion and antirust protection, so as to achieve a good resistance to oxidation and rusting.

A bearing with accumulated dirt should be cleaned up before refilling with clean oil, which must be poured through a filter funnel into the hole placed in the upper part of the bearing.

In order to clean the bearing, it should be flooded with light oil (do not use petroleum), until outflowing oil is clean. The last flooding must be carried out with the prescribed oil to be used.

5.4. INSULATING RESISTANCE MEASURING

The insulation resistance of a winding depends on the temperature, the humidity and the amount of dirtiness. Besides, it depends on the voltage value and the measuring time.

The measuring voltage will be 1000 V for machines at $U_N \leq$ 6000 V and 5000 V for machines at Un > 6000 V.

At a temperature of 40°C and for the checking time of 1 minute, the minimum value of insulation resistance will be:

$$R_m = kV + 1$$

where R_m = insulation resistance at 40°C in MΩ, and

kV = rated voltage of the machine, U_N, in Kilovolts.

Should it be impossible to measure the insulation resistance at 40°C, the obtained value R_L will be multiplied by a **factor K**, which will depend on the temperature according to the following law:

Winding Temperature	K
20	0,27
30	0,5
40	1
50	2
60	4
70	8
80	16
90	32

The comparison of K x RT with Rm, will indicate whether it is within an acceptable value.

As a precaution, the static loads will be discharged before and after measuring.

The recording of the insulation resistance values of a given machine, carried out under uniform working conditions, will be a good exponent of the ageing of the insulation along the time.

If a machine, after a thorough drying and cleaning, does not easily pass the minimum insulation given value, it means that the insulation conditions are not optimum and therefore an improving of the working conditions will be needed, and above all what is referred to cleaning, temperature and environmental humidity.

5.5. CLEANING AND DRYING

Cleaning of the machine is essential, and now and again, the machine should be cleaned from dust, oil and other residues.

This operation should be done when the machine is shutdown and, depending on the periodicity, it will be complete.

If it is not possible to clean the machine with dry compressed air, without oil, care should be taken not to use cleaning techniques that can damage the insulation. For example, trichloroethylene will not be employed.

A good cleaning system is the use of a steam blower with adequate additives. After the cleaning, machine should be dried with hot air, approx. at 100°C.

If a steam blower or adequate drying installation is not available, the machine can be cleaned with benzene or perchloroethylene.

To clean the cooling channels in the stator and rotor core, preferably compressed dry air will be used.

Special importance is given to the cleaning of the cooling air filters of the machine. When metallic filters are fitted, a mere washing by means of hot water with detergent or by means of steam will be sufficient.

6. DISMOUNTING AND MOUNTING OF SPARE PARTS

6.1. DISMOUNTING AND MOUNTING OF THE COUPLING

6.1.1. Coupling with fixing rings (fig. 6)

These fixing sets consist of a split biconical inside ring, a split biconical outside ring and two flanges which are bolted. Conicity has been calculated in order to avoid any unforeseen blocking. The unit is generally unblocked after the last bolt is loosened.

Dismounting sequence:

1. Loosen the nuts uniformly and crosswise, in several stages.

2. Fixing can be adjusted again or dismounted. If necessary, proceed to the distension of the anterior and posterior pressure rings, as shown in figures 7 and 8.

Because of having 3 to 5 wires of active threads, the dismounting auxiliary threads do not resist big traction stresses but enable the extraction of the fixing set by means of threaded bolts. These threads are placed in the housings where the cadmium-plated nuts are located.

The cadmium-plated nuts are provided with flat protection washers of the dismounting threads; the replacement of these washers is necessary in case of several successive dismounting.

As regards to the mounting, special attention should be given to the good condition of the contact surfaces and to the good tightening of the tension nuts. Besides, proceed with the following points:

1. All the contact surfaces, included threads and supports of the bolt heads, should be cleaned and covered with an oil film. Do not use oils containing molybdenum disulphide.

2. Screw up slightly the tension nuts and centre the cube. Due to the fact that the fixing rings are not self-centring, the eccentricity of the unit will depend on the care that has been spent in the completion of this stage. Proceed to check the alignment.

3. Tighten the nuts uniformly and crosswise, in two or three stages, until the tightening torque of the fixing set is achieved.

4. Control the tightening torque of the nuts according to its arrangement. Mounting is considered finished when all the tension nuts are butt tightened.

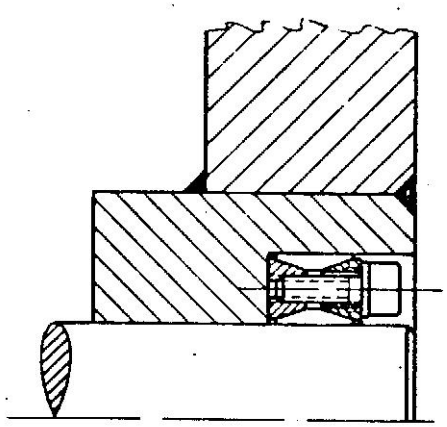


Fig. 6. Mounting of the coupling shank with a fixing set.

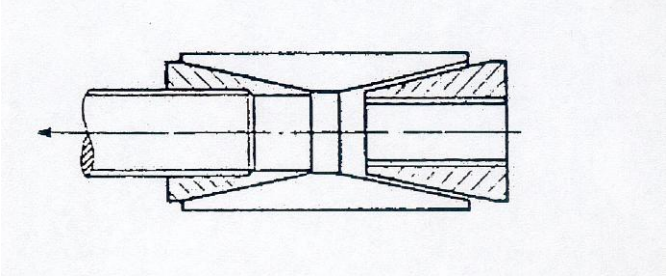


Fig. 7

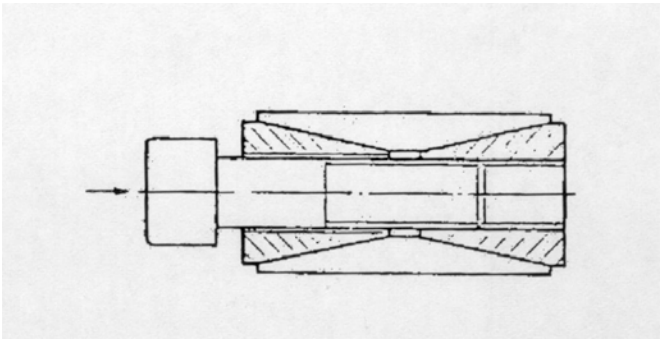


Fig. 8

6.1.2. Coupling shank with key mounted on cylindrical shaft end

The couplings which are mounted in that way are taken out by means of an extractor, interposing a supporting piece "A" to protect the shaft end. Fig. 9.

6.1.3. Coupling shank mounted on conical shaft end

To dismount such a shank, proceed as follows:

1. First remove the safety nut.
2. Place the extractor and tighten moderately.
3. Beat once or several times on the extractor screw, which will unblock the shaftend shank. Then, remove the coupling.

For the mounting, heat the hub until temperatures from 220 to 350°C are reached.

6.2. REPLACEMENT OF A BEARING

6.2.1. Extraction

1. Loose the fixing screws of the bearing small plate.
2. In order to scotch the rotor, introduce presphan paper or similar in the airgap.
3. Put a sling around the bearing flange and hook it with a crane. Then, let the sling tight.
4. Loose the fixing screws of the bearing flange.
5. Remove the centring groove shield and slowly lower with the crane in order to deposit the rotor on the stator.
6. Remove the bearing shield.
7. Remove the centrifugal socket from the shaftend. Remove the circlips. Use threaded stud extractor to extract the centrifugal sockets.
8. Extract the bearing.

The ball bearings, as well as the rolling inside ring of the cylindrical roller bearing, should only be extracted with the aid of a well adapted extractor. See figures 9, 10 and 11.

Also in some cases, a press could be used, but care should be taken not to spoil the rolling outside ring. (See fig. 12).

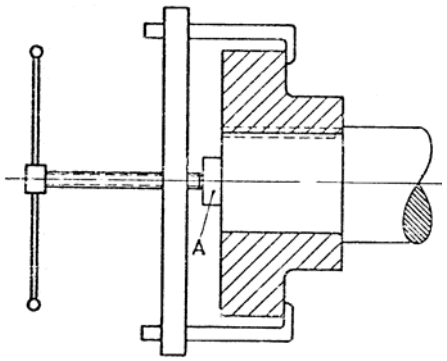


Fig. 9. Dismounting of a coupling shunk by using an extractor.

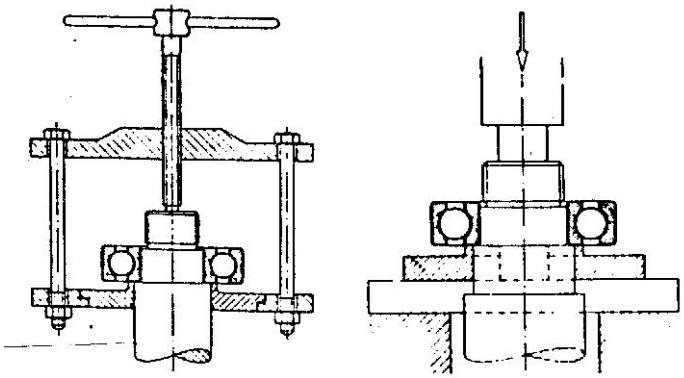


Fig. 10.

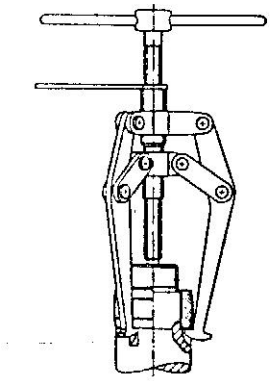


Fig. 11. Tools for extraction of bearings

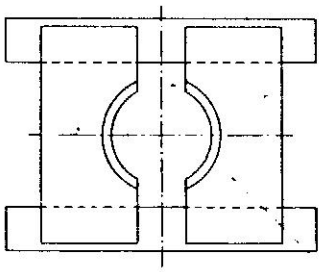


Fig. 12. Dismounting of a bearing by means of a press

6.2.2. Mounting

1. Be sure that the bearing seat is free from burrs, markings of shocks or other imperfections. If necessary, eliminate all defects of this kind.

2. Impregnate the seat with fluid oil before the bearing mounting, in order to avoid damage on the shaft.

3. Heat the bearing at a temperature of 80-90°C above the environmental temperature, without ever exceeding the 120°C. When a heater is not available, a good procedure is the oil bath. Any other procedure should bear that the heating is uniform.

4. Introduce the bearing (or the inner guide-slide-ring) on the shaft end.

5. Press the bearing on the supporting surface until it is cool, so that the inner ring adjusts well to the projection.

6. Verify the position of the bearing. In order to mount the outside ring of a displaceable bearing, use a system similar to the one represented in fig.13.

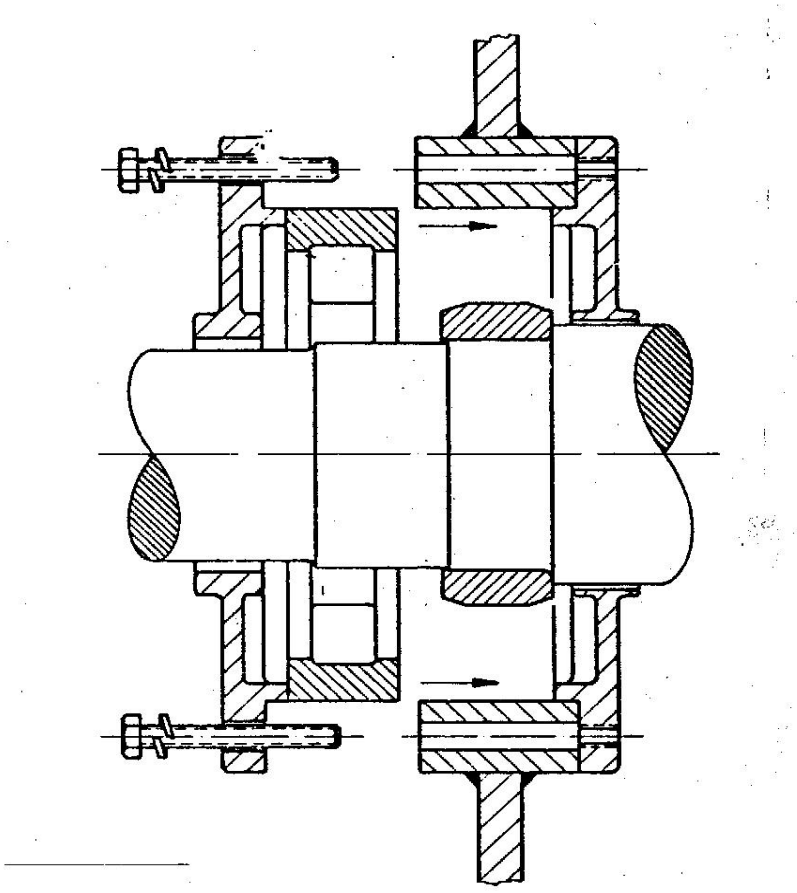


Fig. 13. Mounting of the guide outside ring of a bearing of cylindrical rolls.

It is important to provide the bearing with a grease quantity approximately equivalent to the third of the total space between the side small plates of bearing and the shaft hub. Use grease according to 4.2 bearing in mind that the excess of quantity will cause excessive overheating.

6.3. ROTOR DISMOUNTING

Once the bearing holder shields are dismounted, extract the non driving end bearing as described above. By means of an extension tube, the seating area of the bearing being properly protected, extract the rotor as shown in fig. 14.

In machines with two shaft ends, it will be sufficient to dismount the bearing holder shields.

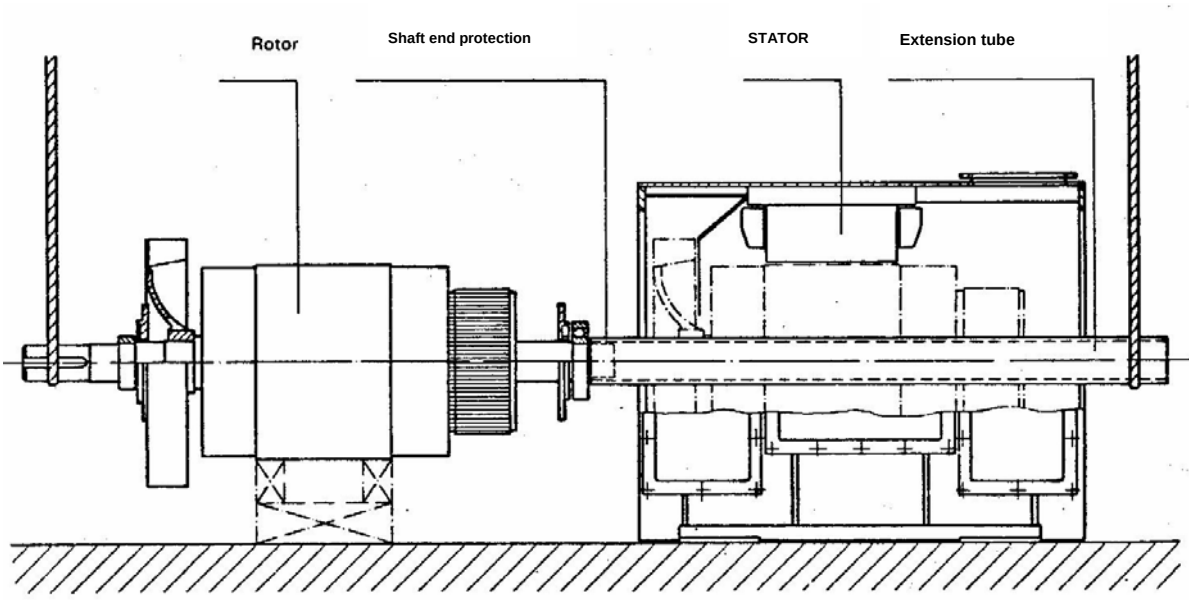


Fig. 14. Scheme for mounting-dismounting the rotor

6.4. INSTRUCTIONS FOR SLIDE BEARINGS

6.4.1. Cleaning

¡¡ Most important principle applicable to any mounting job, as regards to slide bearings, is that of cleaning!!

In spite of the great care that can be taken during the packing of a slide bearing, it is very difficult to avoid that any damaging small particle can enter the bearing. For that reason, it is essential that all slide bearing are perfectly cleaned before the mounting. Do not use cotton or fiber cloth for the cleaning, since any thread that remains in the oil circuit can originate overheating and, in a extreme case, cause the total damage of the bearing.

6.4.2. Changing of bearings

In order to extract a slide bearing, first dismount all thermometers and oil and water pipes. After that, dismount the upper section of the bearing by unscrewing the tapered pins. If necessary, extract the lubricating ring.

Then, lift the shaft by means of adequate slings until the rotor does not rest on the shaft, so that it can be removed from the bearing frame. The screwed labyrinth joints should be previously dismounted at the rotor lifting and mounted after the reassembling of the bearing.

For the mounting of the new bearing proceed in the same way, however in the reverse form. Carefully, align the slide bearing to the shaft; this will be carried out easier if the seating is oiled. When the new or the rearranged bearing is placed, the seating should be adjusted to the latter (max. play 0.02 mm).

Check that the socket moves freely on the seating and that the housing for the embedding element at the half upper socket is exactly fitted below the guide pin.

When a bearing is dismounted, it is advisable to measure the diametrical play, which value can be asked to the Technical Service of INDAR.

After replacement of a new bearing, check the machine alignment.

6.4.3. Fitting of sealings

The labyrinth joints can be adjusted when the sockets are in the proper position; the lower halves should be rotated over its seatings as described above.

The so called floating labyrinthic sealings, should be adjusted by means of laminated springs so as to make a slight pressure on the shaft; then, adjust in a higher section and connect this to the lower section by means of tension springs.

Take the precaution to exactly fit the pin of the upper section in the correspondent sealing key seat, since on the contrary the sealing will get damaged when the bearing upper section is to be replaced.

The cutting sealing which are to be screwed firmly is first screwed in a loose way in front of the bearing; also, the screwed points of these sealing are left loose. The screws of the surface joint are gradually fastened while the sealing are being settled and the sealing itself is not firmly screwed until the previous stage has been completed.

At the time of the delivery, the holes of all the sealing are slightly of a smaller size than the shaft and, for that reason, they should be mouthed; the settling surfaces should be previously oiled. Only the indivisible sealing, called “comb" type can be firmly installed directly and do not require a previous mouthing. All the screwed labyrinthic sealing should be adjusted on a underlying coat of a sealed liquid compound.

6.4.4. First start-up of sealings and bearings

All new bearings and sealings should have a settling running.

They should run approx. during 1 hour at the lower speed that the lubricating rings can run; if there are not lubricating rings, then at approx. 100 r.p.m.

After that, the speed should be increased gradually until the operation speed is reached, in such a way that the latter is achieved after reaching the stabilizing temperatures at different speed, not exceeding the limit temperature under no circumstances.

The first running of the bearings takes approx. from 5 to 6 hours. That of the sealing, approx. 1 hour. For that reason, the speed should be increased very slowly.

6.5. SPARE PARTS

To order any spare parts to the factory, it is indispensable to give the serial number of the machine, which is engraved on the nameplate.

Although in the case of brushes it is quite evident, it is not so clear what other type of replacement should be kept as spare part, since considerations which are far beyond to the purely technical ones would come into play.

A good criterion to be followed is to have a set of coils available for every five identical machines in service and also a set of bearings.

Over 10 identical machines in service, it would be advisable to keep a complete machine as spare.

7. ANOMALIES IN SERVICE

At the following table the main incidents that can arise in the running of synchronous machines are given. This table corresponds to synchronous machines, in general.

It should be used as follows:

Search in the column "DISTURBANCE" the incident that has occurred and in the line "CAUSE", numbered from 1 to 24, the places marked with X which will state the different checking point that will give the "REMEDY" in the incident.

Indar
Una Marca Ingeteam

TABLE OF INCIDENTS

POSSIBLE CAUSE		DISTURBANCE											SCHEKUP AND REMEDY	
		It does not start even without coupling. There is not any noise.	It does not estart even without coupling. Buzzing.	It estarts in no load condition, however on load condition it starts too slowly and does not reach te rated speed.	Variable stator current with double sliding frequency. Buzzing at the startingg	Starting current in no load condition too big.	Quick heating of the staator winding. Buzzing at running condition.	Excessive heating of the stator winding.	Local heatingas in rotor.	Abnormal noise when turning the machine to be driven uncoupled.	Abnormal noise when the machine is loades; when uncoupled there es no abnormal noise.			
There is no feeding voltage /Feeding conductor is cut	1	X	X	X				X				1	Revise switches, fuses, feeding lines, brush seating termin.
Rotor is choked	2		X							X		2	Remove foreign bodies fron the airgap.
Roller or ball bearing is damaged	3		X									3	Replace roller or ball bearing.
Starting torque and/or load too big.	4											4	Start with no load. Test the machine in no load condition
Feeding voltage is too low.	5			X				X				5	Adjust voltahe into the correct value.
Feeding voltage is too high.	6					X	X	X				6	Adjusta voltage into the correct value.
Voltage drop at the feeding line is excessive.	7			X								7	Provide adequate feeding section.
Rotor winding es cut	8			X	X				X			8	Revise and repair otor winding.
Short-circuit between turns at the stator winding..	9						X			X		9	Repair stator winding.
Insufficient cooling because of dirtiness of air passing.	10						X	X				10	Clean the air passingas.
Sens of rotation of the machine is not correct..	11						X	X				11	Change two feeding terminals.
Insufficient cooling-.	12						X	X				12	Correct what is icorrect in the cooling circuit.
Too high load.	13							X				13	Reduce the load or use a bigger machine. Consult factoy
Too frequent startings.	14							X				14	Reduce the number of startings / time.
Friction between stator and rotor.	15							X				15	Compare running connected after disconnection. Dismount.
Application does not concord with nameplate.	16											16	Adeqiate application to the machine charac. And viceversa
Coupling discs produce unbalance..	17									X		17	New balancing, with and without coupling discs.
Machine is not aligned	18									X		18	Check the alignment.
Resonance at the foundation.	19									X		19	Complet foundation.
Fixing screws ar loose..	20									X		20	Fasten and secure fixing screws.
Proper unblancing of the machine.	21									X		21	Irregularity persists in the machine without voltage.
Failure in any transmission element or at driven machine.	22										X	22	Revise transmission, coupling and driven machine.
Sagging of the foundation.	23										X	23	Correct the foundation. Make new alignment.
Dynamic unbalancing of the driven machine.	24										X	24	Correct unbalancing at the driven machine.

8. SAFETY

Although the machine has been designed to comply with the laws, standards, regulations and recommendation established to protect the users, it is never amiss to state some considerations that can be of interest.

8.1. EARTHING

The machine is provided, at least, with two earthing connections: one at the terminal box for connection of the metallic cover of feeding cable and one on the frame.

Both should be used with bare cable, after checking that the earthing picks of the installation comply with the Electrotechnical Rules.

8.2. MECHANICAL SAFETY

All the rotative mechanical parts, as the coupling and second shaft end, etc., should be protected with defences to prevent damages to persons, at unexpected situations.

8.3. MAINTENANCE OF THE PROTECTION DEVICES

It is important to carry out a preventive maintenance of the whole protection system of the machine, so that the risks of firing, electrocution, excessive heating and, in general, all the unforeseen risks can be reduced as much as possible.

8.4. SPECIAL ENVIRONMENTS

It is important to know that there are industries that use or can produce in their manufacturing processes, gas or steams which, mixed with the air in a certain proportion, can form an ignitable mixture. The machines used in said environments could cause an explosion of the mixture, if the necessary corrective actions are not taken in the manufacturing, to avoid sparking or excessive temperature rise.

There are six known forms to obtain the required operation safety:

1. Protection against firedamp and explosion-proof.
2. Dusty insulation.
3. Increased safety.
4. Oil immersion.
5. Intrinsical safety.

It is important to check the control of those special atmospheres or, should it be impossible, machines that comply with the above given requirements should be installed.

9. RECOMMENDATIONS FOR MATERIALS TO BE WASTED OR CONSUMED

9.1. RAW STUFF

The main components of this product are iron and copper. Other raw stuff which is present in less proportion are:

- Bronze
- Plastic or fiber glass insulating material (inert material).
- Varnish layers and dried paint (inert material)
- Oil and grease, and other hazardous residuals than can easily be extracted from the machine.

9.2. USE OF THE PRODUCT

The use of present machine has not any negative effect in the environment.

ATTENTION:The present machine contains oil (or grease). The maintenance of the machine requires periodical changes. The oil that has been used must be dealt according to the law in force.

Great part of the total weight of the machine corresponds to iron or copper, which are inert materials that can be easily reused. The small proportion of the rest of organic components must be dealt according to the law in force.

9.3. CONSIDERATIONS ABOUT RECYCLING

The main instructions for the recycling of the machine are:

- Recycling of the D.E. and N.D.E. bearing, once dismounted.
- Recycling of the grease of the bearings.
- Recycling of the discharge brushes.
- Recycling of the discharge brush-holders.
- Extraction of the rotor.
- Extraction of the stator from the frame, by heating the frame with a torch.
- Enter the rotor and stator in an oven at 180ºC, during 5 or 6 hours, to burn the varnish.
- Extract the windings from rotor and stator.
- Recycling of the winding copper.
- Recycling of the iron from the frame.
- Recycling of the rest of pieces.

INDAR ELECTRIC, S.L.
Barrio Altamira, Pol. Industrial
Txara S/N
✉: +20200 BEASAIN (Gipuzkoa) Spain
☎:+34 943 02 82 00
Fax:+34 943 02 82 04
E-mail : electric@indar.ingeteam.com
Web site: http://www.indar.net