INSTALLATION AND

MAINTENANCE MANUAL FOR

LOW AND HIGH VOLTAGE

THREE PHASE INDUCTION MOTORS

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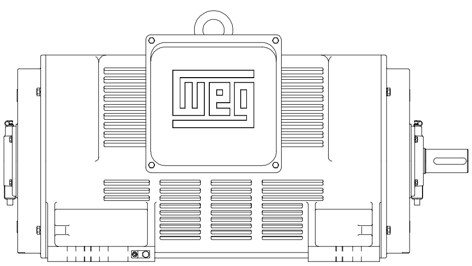

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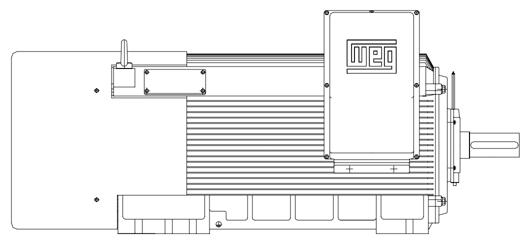

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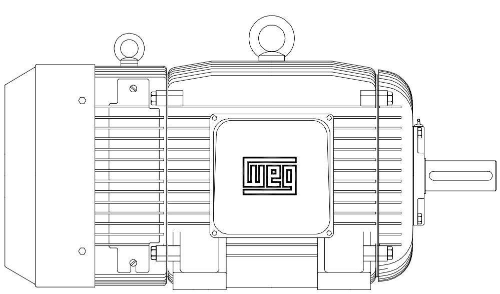

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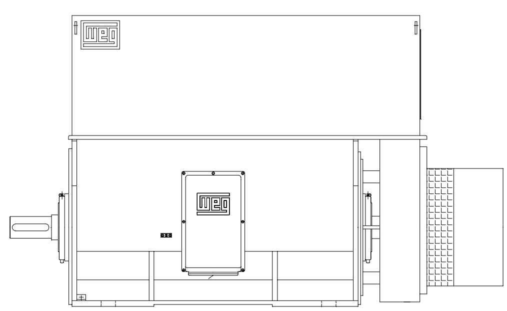

---- IMPORTANT ----

READ CAREFULLY THE INSTRUCTIONS INCLUDED IN THIS MANUAL IN ORDER TO ENSURE A SAFE AND CONTINUOUS OPERATION TO THE EQUIPMENT.

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FOREWORD

The electric motor is an equipment widely used by man
in the industrial development as most of the machines
he has been inventing depend on it.

Taking into consideration the prominent role the electric motor plays on people's life,
it must be regarded as a prime power unit embodying
features that require special care including its installation
and maintenance in order to ensure perfect operation and longer life to the unit.

This means that the electric motor should receive particular attention.

The INSTALLATION AND MAINTENANCE MANUAL
FOR LOW AND HIGH VOLTAGE THREE-PHSE INDUCTION MOTORS
intends to assist those who deal with electric machines facilitating
their task to preserve the most important item of the unit:

The ELECTRIC MOTOR.

WEG INDÚSTRIAS S.A. - MÁQUINAS

ÍNDICE

1. INTRODUCTION

IMPORTANT:

This manual concerns all Weg three phase asynchronous squirrel cage and slip ring motors. For motors built with high number of special features, contact Weg Máquinas whenever an additional support is required.

All standard and procedures included in this manual must be followed accordingly to ensure a proper operation to the equipment as well as to ensure safety conditions to the personnel involved in the motor operation.

Following these procedures is also important for the warranty policy as explained at the end of this manual.

Therefore, we strongly recommend to any user of Weg motors to read carefully this manual before motor installation and operation. In case you still have further doubts, please contact Weg Máquinas.

2. GENERAL INSTRUCTIONS

2.1. SAFETY INSTRUCTIONS

All personnel involved with electrical installations, either handling, lifting, operation and maintenance, should be well-informed and up-to-dated concerning the safety standard and principles that govern the work and furthermore, they should be advised to heed them.

Before work commences, it is the responsibility of the person in charge to ascertain that these have been duly complied with and to alert his personnel of the inherent hazards of the job in hand.

It is recommended that these tasks be undertaken by qualified personnel and they should be instructed to:

- Avoid contact with energized circuits or rotating parts;
- Avoid by-passing or rendering inoperative any safeguards or protective devices;
- Avoid extended exposure in close proximity to machinery with high noise levels;
- Use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment, and
- Follow consistently any instructions and product documentation supplied when they do such work.

Before initiating maintenance procedures, be sure that all power sources are disconnected from the motor and accessories to avoid electric shock.

2.2. UNPACKING

Prior to shipment motors are factory-tested and dynamically balanced.

The adjusting and sliding surfaces are protected with corrosion inhibitors.

Upon receipt, we recommend to check the boxes to see if any damage has occurred during transportation.

The motors are shipped with a shaft locking device to avoid any damage to the bearings. We recommended to keep this device in stock to be used on all further transportation.

If any damage, contact the carrier and Weg Máquinas. The lack of notice will void the warranty.

When lifting the boxes, it is important to observe the locals appropriate for this purpose as well as to check the weight of the box and the hoist capacity.

The motors shipped in wooden boxes must be always lifted by the eyebolts or by forklift machines and never by the shaft. The box never can be turned around. Lifting and lowering of such boxes must be done gently in order to avoid damage to the bearings.

Make a visual inspection after the unpacking has been effected. Do not remove the protecting grease from the shaft end neither the stoppers from the terminal boxes. These protecting devices should remain at their places until the installation is finished. For motors fitted with shaft locking device, this device must be removed. For motors fitted with ball bearings, rotate manually the rotor several times. If damages are noticed, contact the carrier and Weg Máquinas immediately.

2.3. STORAGE

When motors are not immediately unpacked, boxes should be stored in their normal upright position in a dry temperature place, free of dust dirt, gases and corrosive atmosphere. Any other objects should not be stacked over or against the boxes.

Motors must be storaged in places free from vibrations in order to avoid damage to the bearings. For motors fitted with space heaters, these accessories must be kept switched-on. If painting has suffered any damage, this must be repainted to avoid rusting. The same appliers to the machined surfaces when protecting grease has been wasted.

For slip ring motors, brushes must be lifted and removed from their pocket to avoid oxidation between contacts and rings when these motors are storage for more than 2 months.

NOTE: Before operating the motor, brushes must be reset in their pocket and the fitting must be checked.

2.3.1. BEARING

When a motor is kept in stock for a period of six months or less, it is not necessary to effect a full inspection on the bearings before running it. What has to be done is to rotate manually the shaft monthly. However, when motor is kept in stock for more than six months, the bearings must be regreased, before operation, according to item 4.1.2.3 on the other hand, if motor is kept in stock for approximately 2 year or more, bearings must be disassembled, according to item 4.2.1.4 and washed with ether and checked.
All the old grease must be removed. After the reassembly, bearings must be regreased according to item 4.2.1.3 of this manual.

2.3.2. SLEEVE BEARINGS

The performance of sleeve bearings depends on its proper installation, lubrication and maintenance. Before assembling and disassembling it, read carefully the instructions of this manual. The procedure described under item 4.2.2 refers to the assembly and disassembly of bearings in motors with the rotor already mounted.

2.3.3. INSULATION RESISTANCE

When a motor is not immediately put into operation, it should be protected against moisture, high temperatures and impurities in order to avoid damage to the insulation. The winding insulation resistance must be measured before operating the motor.
If the ambient contains high humidity, a periodical inspection is recommended during storage. It is difficult to determine rules for the actual insulation resistance value of a motor as the resistance varies according to type, size, rated voltage, condition of the insulating material used and method of construction of the motor. A lot of experience is required to decide when a motor is ready for operation. Periodical records will help to take such decision.
The following guidelines show the approximate insulation resistance values that can be expected from a clean and dry motor at 40ºC temperature ambient, when test voltage is applied for a period of one minute, supplied by the curve of figure 2.1, as per NBR 5383.
The RM insulation resistance is given by the formula:

$$RM = Un + 1$$

Where:
RM - Minimum insulation resistance recommended in Mega Ohm with the winding at a temperature of 40ºC;
Un - Rated voltage of the motor in kV.

If the test is performed at a different temperature, it is necessary to correct the reading to 40ºC by using an insulation resistance variation curve in relation to temperature, given by the motor it self. If this curve is not available it is possible to use an approximate correction given by the curve of figure 2.1, as per NBR 5383 Standard.
On new motors, lower values are sometimes obtained, as solvents are present in the insulating varnishes which become volatile in a later stage during normal operation. This does not necessarily mean that the motor in not suitable for operation considering that the insulation resistance will increase after a period of operation.

On old motors, still in operation, higher values are normally obtained. The comparison with values obtained from previous tests on the same motor under identical load, temperature and humidity conditions will be a better indication of the insulation conditions in comparison to the value obtained from a single test. Any sudden or high reduction of the value requires careful attention.
The insulation resistance is normally measured with a MEGOMETER.

If the insulation resistance is lower than the values obtained by the above mentioned formula, motors must be submitted to a drying process, as per item 4.8.

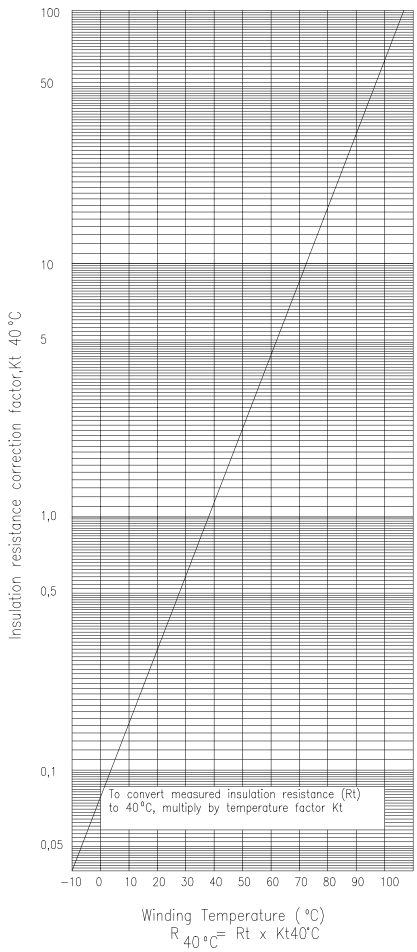


Figure 2.1.

Table 2.1. - Reference limits for insulation resistant of electric motors.

Insulation Resistance Value	Insulation Level
2MΩ or smaller	Bad
< 50MΩ	Dangerous
50...100MΩ	Abnormal
100...500MΩ	Good
500...1000MΩ	Very good
> 1000MΩ	Excellent

Table 2.2. - Polarization index (ratio between 1 and 10 minutes).

Polarization Index	Insulation Level
1 or smaller	Bad
< 1,5	Dangerous
1,5 a 2,0	Abnormal
2,0 a 3,0	Good
3,0 a 4,0	Very Good
> 4,0	Excellent

2.4. HANDLING

Use only the existing eyebolts to lift the motor. Never lift the motor by the shaft. Check the motor weight. Lifting and lowering must be done gently in order to avoid damage to the bearings. The eyebolts attached to bearing housing, heat exchanger, endbells, etc, should be used to handle these components only.

3. INSTALLATION

Electric motors should be installed in locations of easy access for inspection and maintenance. If the surrounding atmosphere contains humid, corrosive or flammable substances or particles, it is essential to ensure an adequate degree of protection. The installation of motors in ambient where there are vapours, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be done in accordance with ABNT NBR, NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) Standard.

Under no circumstances, motors can be enclosed in boxes or covered with materials which may impede or reduce the free circulation of cooling air. Motors fitted with external cooling must be located at least 50mm from the ground to permit free air circulation. The air inlet and outlet should never be obstructed or reduced by conductors, pipes or other objects. The installation site should permit conditions of air renewal at a rate of 30m³ per minute for each 100kW motor output.

3.1. MECHANICAL ASPECTS

3.1.1. FOUNDATIONS

The motor base must be level and free from vibrations. For this reason, concrete foundation is recommended.

The type of base to be built will depend on the nature of the soil at the installation site or on the floor capacity.

When designing the motor foundation, it must be taken into consideration the fact that the motor might, occasionally, be submitted to a torque higher than the rated torque. If such designing is not correctly made, vibration problems can occur to the unit (foundation, motor and driven machine).

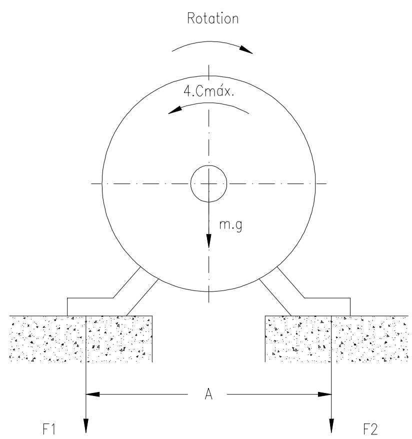
NOTE: On the concrete base, a metallic plate to support the leveling bolt must be provided.

Based on figure 3.1, the forces over the foundation can be calculated by the following formulas:

$$F_1 = +0.5.m.g.+\frac{(4C\max)}{(A)}$$

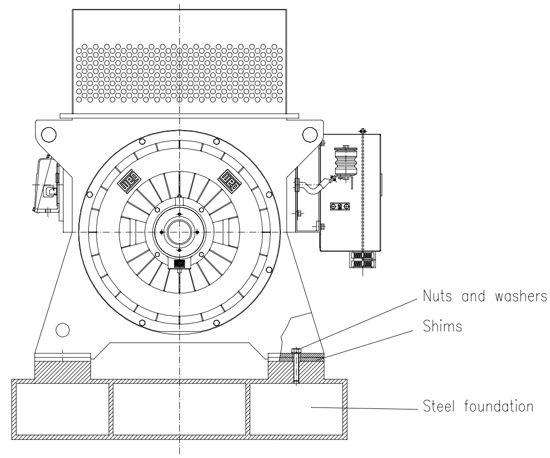
$$F_2 = +0.5.m.g.-\frac{(4C\max)}{(A)}$$

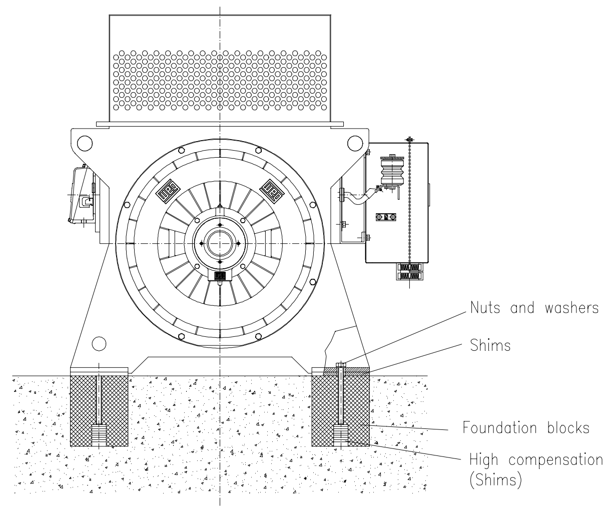
Where:
F1 and F2 - Forces on the base (N).
g - Gravity acceleration (9.81m/s²).
m - Motor weight (N).
Cmax - Breakdown torque (Nm).
A - Taken from motor dimensional drawing (m).

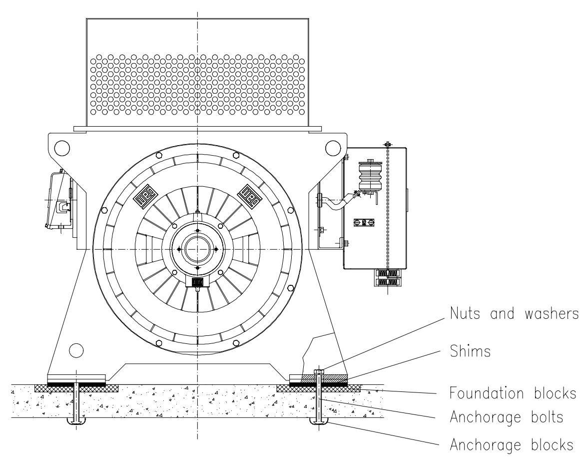


NOTE: The drawing above shows the forces over the motor when running clockwise. For counter clockwise rotation, forces are reversed (F1, F2, 4.Cmax.).

Steel or iron blocks, plane surfaces blocks with anchorage devices can be fitted in the concrete foundation to fix the motor feet as suggested in figure 3.2. It is important that all the structure equipment are made in such a way that they can transmit any force or torque which may occur during the operation.







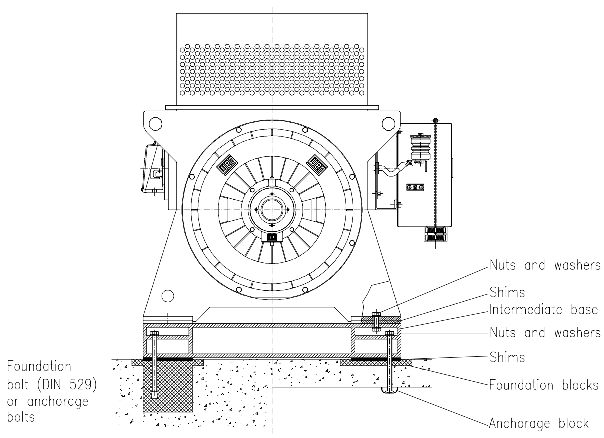


Figure 3.2. Motor Fixation Types.

3.1.1.1. TYPES OF BASES

a) Concrete bases
As mentioned above, the concrete bases are the most commonly used for the fixation of these motors.

The type and size of the foundation - as well as other fixing devices for this purpose will depend on the type and size of the motor.

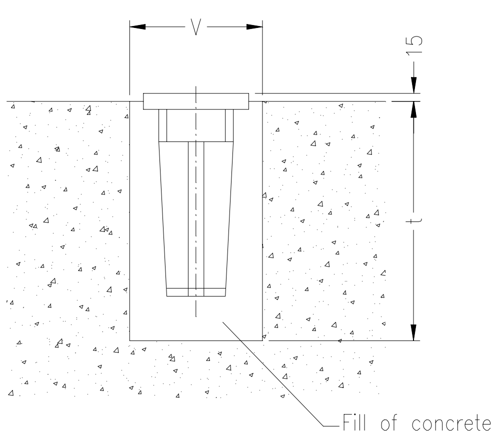
The motors can be mounted on a concrete base with four foundation blocks. See dimensions of the installation components in the table below. Installation and examples:

Hole diameter in the motor feet	Foundation block		Fastening bolts (DIN 933)		Tapered pins (DIN 258)	
	Number	Dimension	Number	Dimension	Number	Dimension
28	4	M24	4	M24 x 60	2	14 x 100
36	4	M30	4	M30 x 70	2	14 x 100
42	4	M36	4	M36 x 80	2	14 x 100
48	4	M42	4	M42 x 90	2	14 x 100

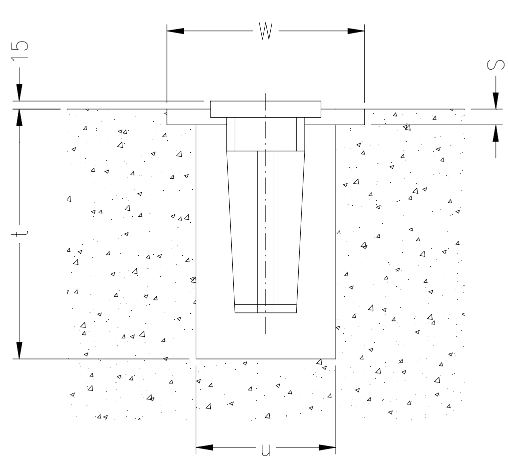
Table 3.1 - Anchorage measurements (example of installation).

Thread	Mounting dimensions				
	s	t	u	v	w
M26 and M30	50	450	220	265	315
M36	70	539	240	300	350
M42	70	600	270	355	400

Example 1



Example 2



Examples of preparation:
Remove all dirt from the foundation blocks in order to ensure a perfect anchorage between the foundation blocks and the motor. Fix the foundation blocks at the motor feet by means of bolts.
Provide shims of different thickness (total trickiness of about 2mm) between the motor feet and the foundation base to ensure a further accurate alignment vertically.
Inside the feet holes, the fastening bolts must be covered with a metal sheet or presspan in order to center the foundation blocks exactly to the feet holes and perform an accurate alignment horizontally.
Place shims or leveling bolts under the foundation blocks in order to obtain a perfect motor leveling and alignment between the motor and the driven machine. After introducing the concrete, make an accurate control of the alignment. Eventual small corrections can be done by washers or metal plates or by means of a new adjustment of the fastening bolt clearences. Tighten now firmly all fastening bolts.
Make sure all motor feet surfaces are supported uniformly without damaging motor frame. After completing the test, introduce two tapered pins for correct fastening. For this purpose, use the pre-drilled holes in the feet.

b) Slide rails
When drive system is done by pulleys, the motor should be mounted on slide rails and the lower part of the belt must be pulling.
The rail that stays near the drive pulley is positioned in such a manner that the adjusting bolt be between the motor and the driven machine. The other rail must be positioned with the bolt in the opposite position, as shown in fig. 3.3. The motor is bolted to the rails and set on the base.
The drive pulley is then aligned in such a way that its center be in the same level of the driven pulley center.
Motor and driven machine shafts must be in a parallel position.
The belt should not be excessively stretched, see fig. 3.9.After the alignment, rails are to be fixed.

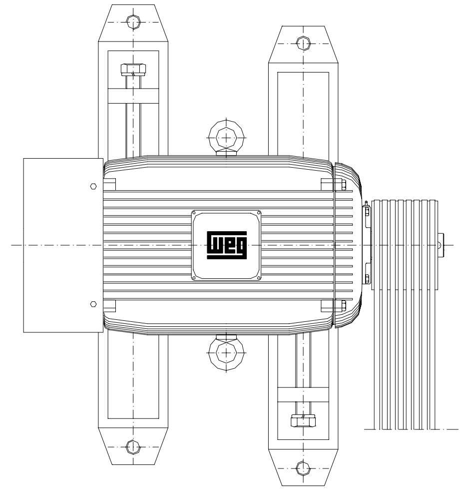


Figure 3.3.

c) Metallic bases
The metallic bases must have a flat surface under motor feet in order to avoid frame deformation. The bearing housing surface should be so determined that under the feet of the motor one can place shim plates of approximately 2mm thickness.
Motor should not be removed from their common metallic bases for alignment, the metallic bases should be leveled on the actual foundation.
When a metallic base is used to adjust the height of the motor shaft end with the machine shaft end, it should be leveled on the concrete base.
After the base has been leveled, foundation studs tightened, and the coupling checked, the metal base and the studs are then cemented.

3.1.2. ALIGNMENT/LEVELING

The electric motor must be accurately aligned with the driven machine, particularly in cases of direct coupling. An incorrect alignment can cause bearing defects, vibrations and even shaft breaking.
The best way to ensure correct alignment is to use dial indicator placed on each coupling half, one reading radially and the other axially.
In this way, simultaneous readings can be informed and one can check any parallel (fig. 3.4a) or concentricity deviations (fig. 3.4b) by rotating the shaft. The dial indicator should not exceed 0.05mm. If the operator is sufficiently skilled, he can obtain alignment with clearance gauge and a steel ruler, providing that the couplings be perfect and centered (fig. 3.4c)

A measurement at 4 different points of the circumference should not give a reading difference larger than 0.03mm.

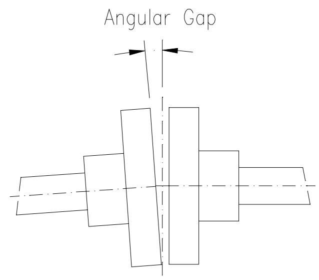


Figure 3.4a- Angular alignment (parallelism).

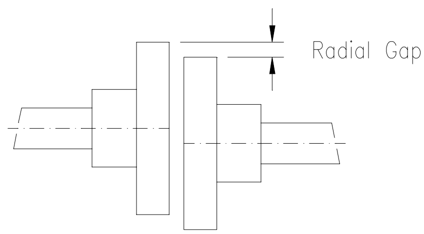


Figure 3.4b - Radial alignment (concentricity).

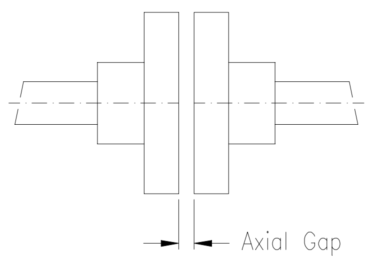


Figure 3.4b - Radial alignment (concentricity).

On the alignment/leveling it is important to take into consideration the effect of the temperature over the motor and driven machine. The different expansion levels of the coupled machines can modify the alignment/leveling during motor operation.
After the set (motor and base) is perfectly aligned either at cold or at hot, motor must be bolted, as shown in fig. 3.5. There are instruments which use visible laser ray added by specific computer programs that can perform and ensure high precision alignment.

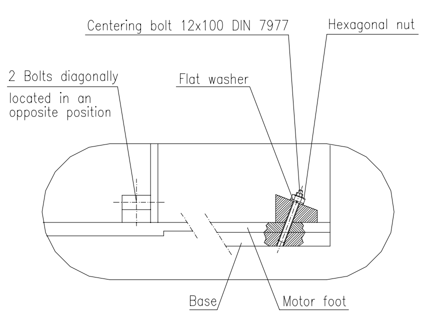


Figure 3.5.

NOTE: Bolts, nuts and washers can be supplied with the motor, if required.

3.1.3. COUPLINGS

a) Direct coupling
Whenever possible, it is recommended to use direct coupling due to lower cost, less space required, no belt slippage and lower accident risk.
In case of speed ratio drives, it is also common to use direct coupling with a gearbox.

IMPORTANT: Align carefully the shaft ends using, whenever possible, flexible coupling.

Clearance values recommended for direct coupling		
Clearance	Poles	
	2	≥ 4
Radial	0,03mm	0,05mm
Axial	3 to 4mm	3 to 4mm
Angular	0,10mm	0,10mm

b) Gearbox coupling
Poorly aligned gearbox couplings normally cause jerking motions which provoke vibration to the coupling and to the motor. Therefore, due care must be given to correct shaft alignment, perfectly parallel in cases of straight gears, and at the correct angle for bevel or helical gears.
Perfect gear arrangements can be checked by inserting a strip of paper on which the teeth marks will be traced after a single rotation.

c) Belt and pulley coupling
Belt transmission is the most commonly used when a speed ratio is required.

ASSEMBLY OF PULLEYS: The assembly of pulleys on shafts featured with keyway and threaded hole must be done by inserting it halfway up to the keyway merely by manual pressure.
On shafts without threaded hole it is recommended to heat up the pulley to about 80ºC (fig. 3.6).

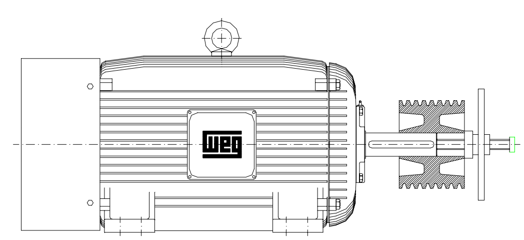


Figure 3.6. - Assembly or pulleys.

DISASSEMBLY OF PULLEYS: for disassembly of pulleys it is recommended to use the devices shown in figure 3.7 in order not to damage the key neither shaft surface.

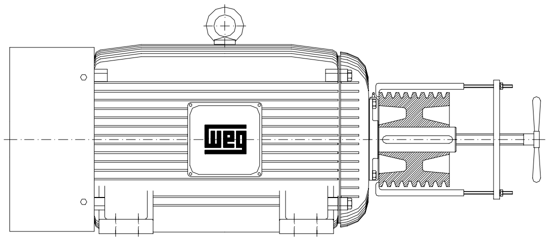
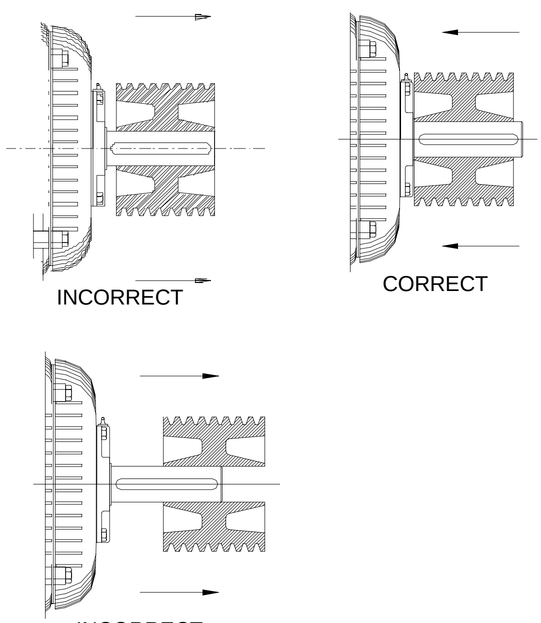


Figure 3.7. - Disassembly of pulleys.

Hammers should be avoided when fitting pulleys and bearings. The fitting of bearings with the aid of hammers causes spots in the bearing races. These initially small spots increase with usage and can develop to a stage that completely damage the bearing. The correct positioning of a pulley is shown in figure 3.8.



RUNNING: Avoid unnecessary thrusts on the bearings by ensuring that the shafts are parallel and the pulleys perfectly aligned (figure 3.9).

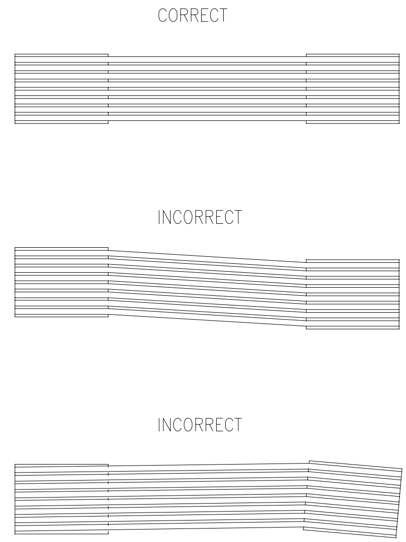


Figure 3.9 - Correct pulley alignment.

Laterally misaligned pulleys, when running, transmit alternating knocks to the rotor and can damage the bearing housing. Belt slippage can be avoided by applying a resin type material such as rosin.
Belt tension is only required to avoid slippage during operation (figure 3.10). Excessively small pulleys should be avoided; these cause shaft flexion as belt traction increases with the decrease of pulley size.

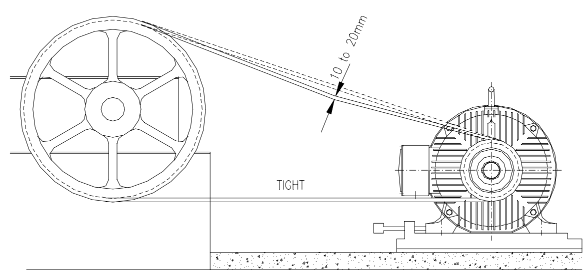


Figure 3.10 - Belt tension

NOTE: A belt with excessive tension increases the force on the shaft end causing vibrations and fatigue leading to a possible shaft rupture.
When specific pulleys are required, contact Weg Máquinas in order to insure a correct designing.

Due to the existing tensions on the belts, there is a reaction acting as radial load over the motor shaft end.
The data to calculate such reaction (radial force) are:
- Output transmitted [kW] (P);
- Motor speed [rpm] (RPM);
- Diameter of driven pulley [mm] (DPMV);
- Diameter of driven pulley [mm] (DPMT);
- Distance between centers [mm] (I);

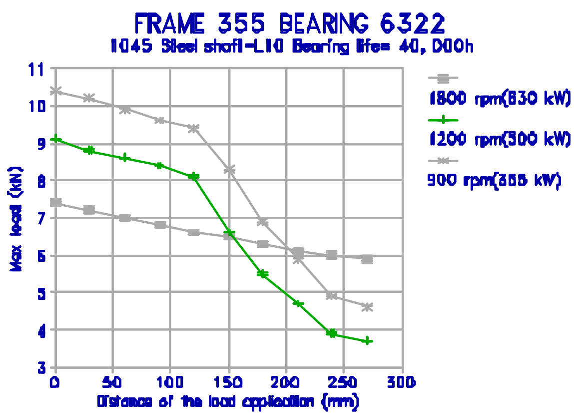
- Friction coefficient [-] (MI) - (normally 0.5);
- Slip coefficient [-] (K);
- Belt contact angle on smaller pulley [RAD] (alfa);
- FR: Radial force acting over the shaft end [N] (FR).

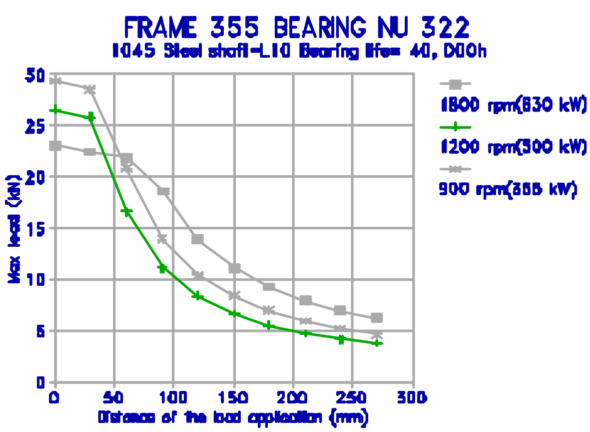
$$ALFA = \pi - \left(\frac{DPMV - DPMT}{1}\right)$$

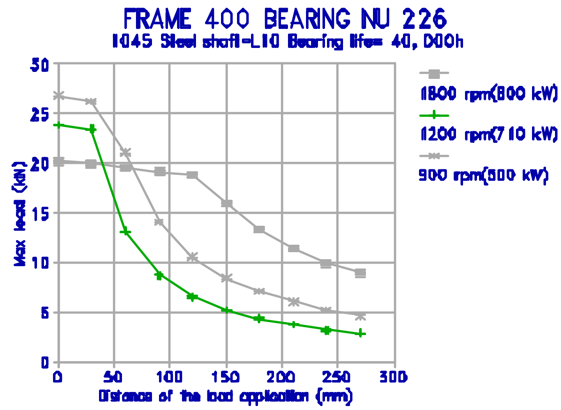
$$K = 1.1x\left[\frac{\varepsilon(MIxALFA)+1}{\varepsilon(MIxALFA)-1}\right]$$

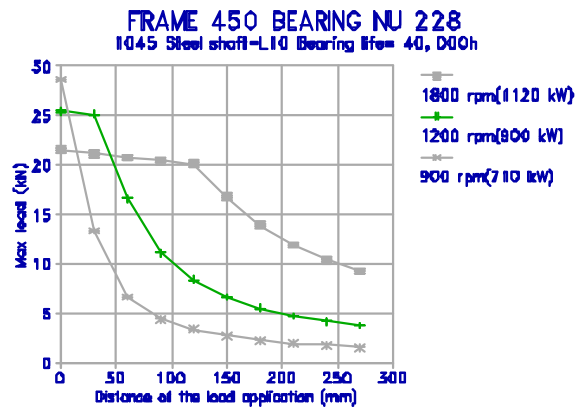
$$FR = \frac{18836{,}25\chi N}{DPMTxRPM}x\frac{\sqrt{K^2x[1-COS(ALFA)]+1.21x[1+COS(ALFA)]}}{2}$$

The following graph indicate the maximum radial thrusts acceptable by motor bearings up to frame 450. Frame 500 and largeh will require an analysis by Weg Máquinas.









NOTE: Always use couplings and pulleys duly machined and balance with concentric and equidistant holes.
Avoid, in all cases, oversized keys as these can cause unbalancing.
In case these instructions are not followed accordingly, vibration levels will occur.

3.1.3.1. COUPLING ARRANGEMENT FOR SLEEVE BEARING MOTORS - AXIAL CLEARANCE

Motors fitted with sleeve bearings should be directly coupled to the driven machine or even using a gearbox. Pulley/belt coupling is not recommended.
These sleeve bearing motors have three identification marks on the shaft end. The central mark (red painted) indicated the magnetic center; the other two indicate the limits for the rotor axial displacement
When coupling the motor, the following aspects must be considered:
- Bearing axial clearance which is shown on the chart below for each bearing size.
- Axial displacement of the driven machine, if any.

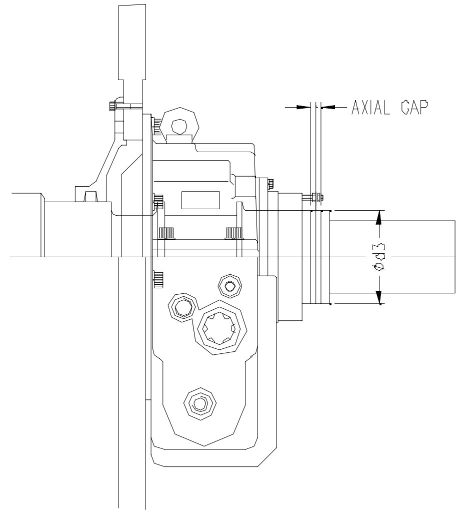
Maximum axial clearance allowed by the coupling.

Clearances applied to sleeve bearings for motor supplied by Weg Máquinas	
Bearing size	Total axial clearance in mm
9	3 + 3 = 6
11	4 + 4 = 8
14	5 + 5 = 10
18	7,5 + 7,5 = 15
22	12 + 12 = 24
28	12 + 12 = 24

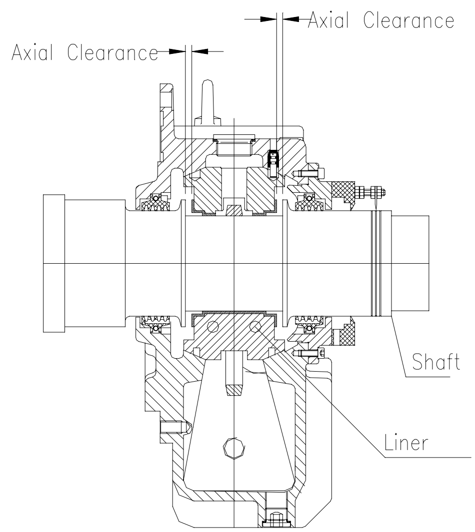
The motor must be coupled in such a way that the arrow attached to the bearing frame be positioned exactly on the central mark (red painted) while motor is in operation.
During motor starting or even under operation, rotor should move freely between the two external lots if the driven machine creates any axial force on the motor shaft. Under no circumstance, motor can operate continuously with axial force on the bearing.

Sleeve bearings normally used by Weg Máquinas are not designed to withstand axial forces continuously.

Figure below shows part of the drive end bearing highlighting a basic configuration of the shaft/bearing set as well as axial clearances.



The figure below shows part of the bearing frame where the arrow indicates the magnetic center and the three marks on the shaft.



3.2. ELECTRICAL ASPECTS

3.2.1. SUPPLY SYSTEM

Proper electric power supply is very important. All the wires and protection system must ensure an excellent quality of electric power supply on the motor terminals within the following parameters:
- Voltage: It can fluctuate within a range of more or less 10% in relation to rated value.
- Frequency: It can fluctuate within a range of more or less 15% in relation to rated value.
- Voltage/frequency: It can occur a combined fluctuation of more or less 10%.

3.2.2. CONNECTION

In order to connect the supply conductors, remove the covers of the rotor and stator terminal boxes (if any).
Cut the sealing rings (standard motors are not supplied with cable glands) according to the diameter to be used.
Insert the conductors into the rings. Cut the supply conductors to desired length, disbarkt the ends and assemble the terminals on them. Connect the metallic covering of the conductors (if any) to the common grounding.
Cut the grounding terminal to size and connect it to the existing connector in the terminal box and/or frame.
Fasten all connections firmly.

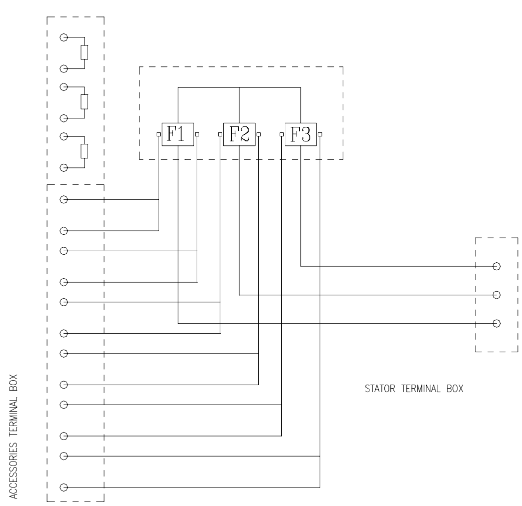
NOTE: Do not use, for terminal fastening, eel washers or other material which do not have excellent electric conductivity characteristics.

It is recommended to apply a grease protection on all connections before performing the connection. Insert all sealing rings into the respective grooves. Screw the terminal box cover carefully, ensuring that the sealing rings are correctly introduced.

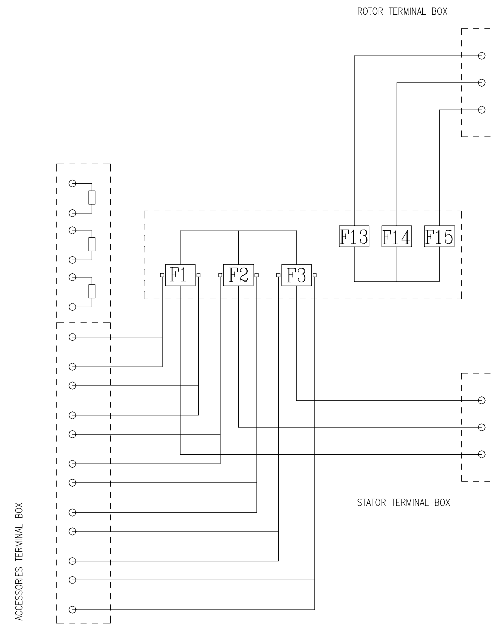
3.2.3. GENERAL CONNECTION DIAGRAMS

We are presenting below orientative connection diagrams for squirrel cage and slip ring induction motors as well as motors supplied with lighting arrestors and surge capacitors:

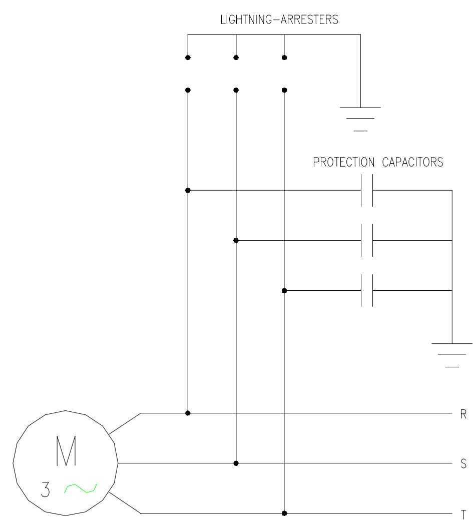
General connection diagram for squirrel cage motors:



General connection diagram for slip ring motors:



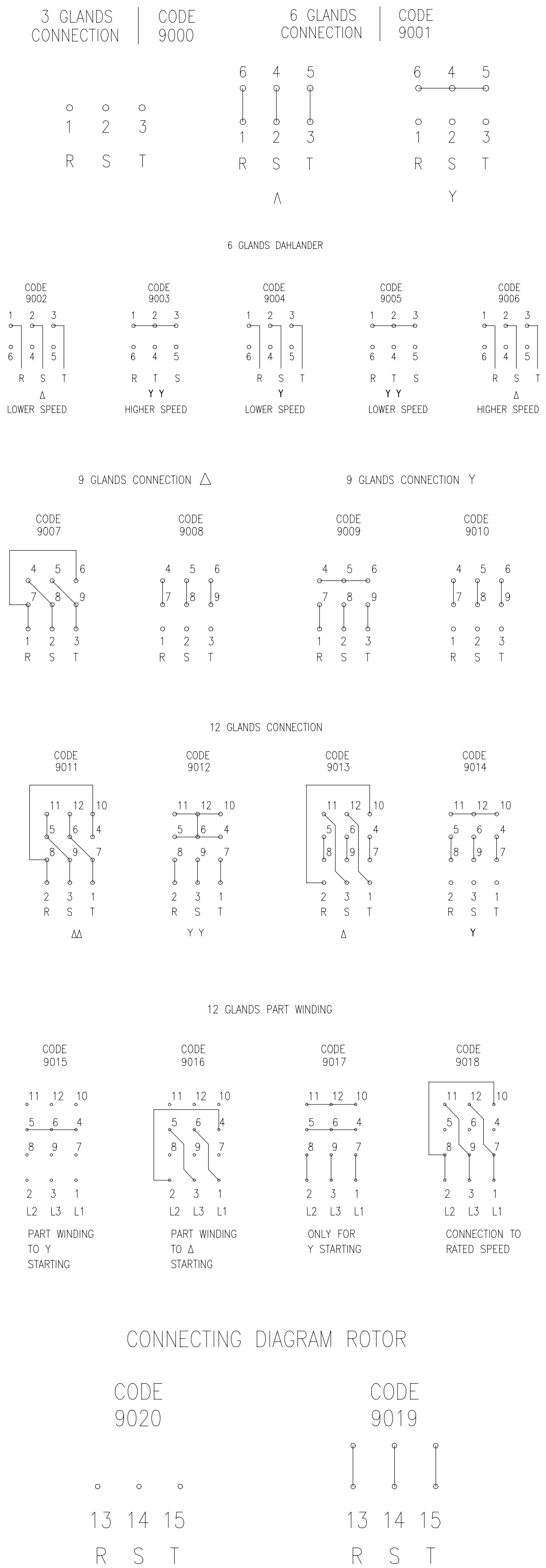
General connection diagram for motors supplied with lightning arrestors and capacitors:



3.2.4. CONNECTION DIAGRAMS FOR STATORS AND ROTORS

The following connection diagrams show the number of terminals and how they have to be connected.
There is a nameplate on the motor indicating the connection diagram code that must be used.

CONNECTION DIAGRAMS FOR STATORS:



3.2.5. STARTING METHODS FOR ELECTRIC MOTORS

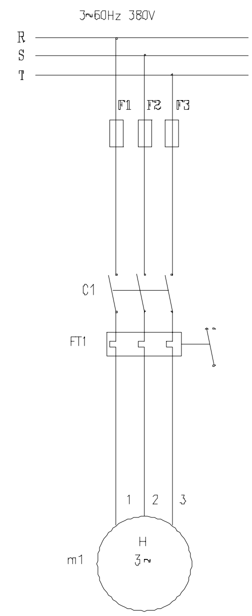
A) DOL STARTING.

Whenever possible, three-phase squirrel cage motors should be started directly at full voltage through a contactor.

DOL is the easiest method of starting; only feasible, however, when the starting current does not affect the power supply.

Normally, the starting current of induction motors is six to seven times the rated current. Note that high starting current can cause supply disturbances to other consumers due to voltage drops in the main power supply.

	Starting	Duty
C1	Close	Close



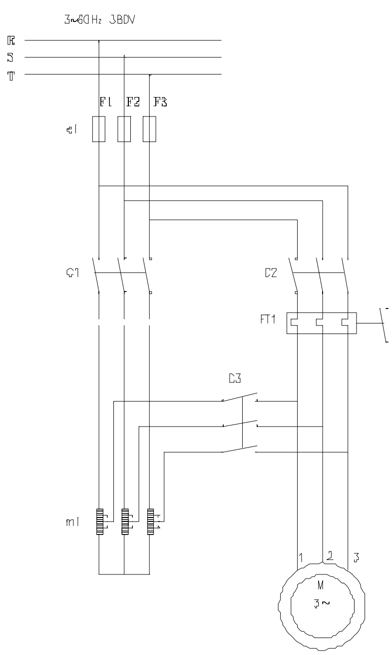
This situation can be corrected with one of the following options:

a) The power supply rated current is so high that the starting current is not proportionally high;
b) Motor is started under no-load conditions with a short starting cycle and, as a consequence, a low starting current with a transient voltage drop tolerable to other consumers;
c) When duly authorized by the regional Hydro Company (utility);

B) STARTING WITH A COMPENSATING SWITCH.

If DOL starting is not feasible, either due to restrictions imposed by the utility or due to the installation itself, reduced voltage indirect starting methods can be used in order to reduce the starting current.
The single line connection diagram (b) shows the basic components of a compensating switch featuring a transformer (usually an auto-transformer) with a series of taps corresponding to the different values of the reduced voltage. Only three motor terminals are connected to the switch, being the others interconnected as per diagram for the indicated voltage.

	Starting	Duty
C1	Close	Open
C2	Open	Close
C3	Close	Open



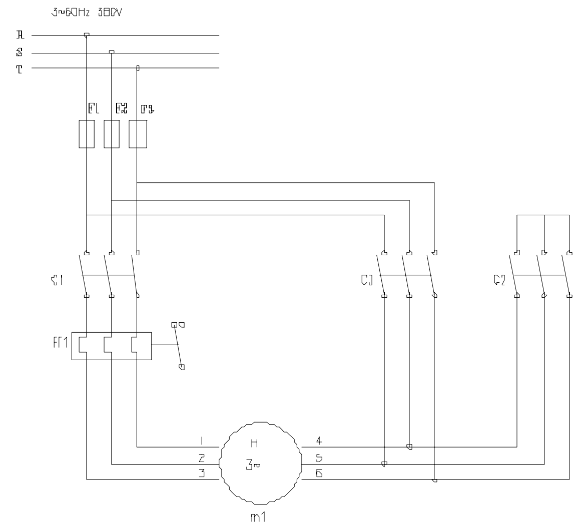
C) WYE-DELTA STARTING.

For wye-delta starting it is important that the motor allows dual-voltage connections, and the higher voltage must be equal to the lower multiplied by 3.

For example:

The wye-delta connection is normally used only for low-voltage motors due to availability of control and protection devices:

	Starting	Duty
C1	Close	Close
C2	Close	Open
C3	Open	Close

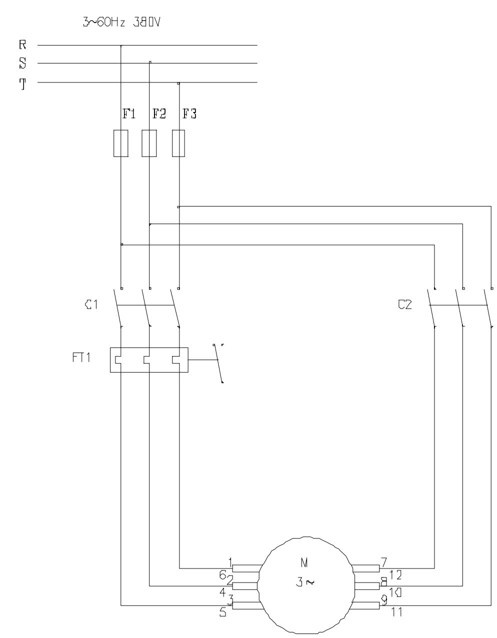


D) PART WINDING START (12 LEADS)

Motor with part winding. The starting is made using only fifty percent of the winding.

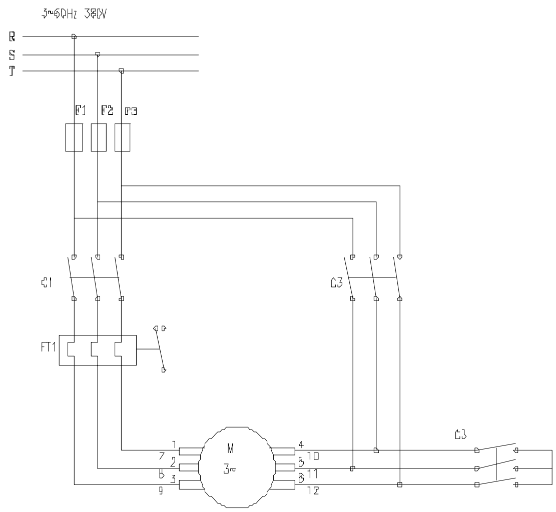
d1) Part-winding start (12 leads).

	Starting	Duty
C1	Close	Close
C2	Open	Close



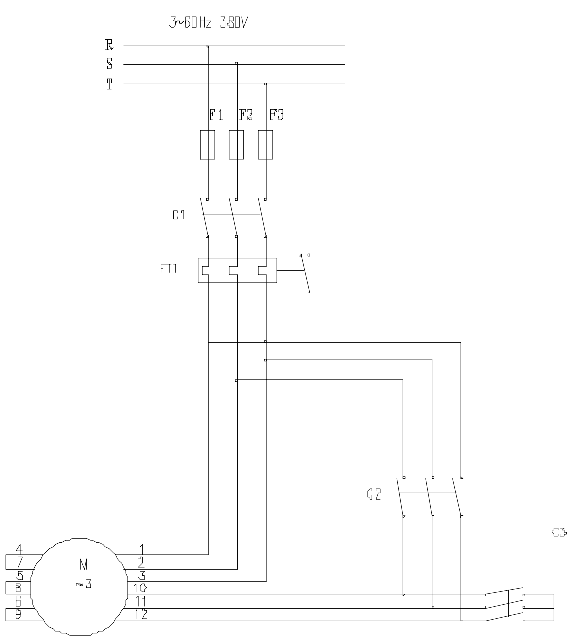
d2) (Y/Δ) Lower voltage.

	Starting	Duty
C1	Close	Close
C2	Open	Close
C3	Close	Open



d3) (Y/Δ) Higher voltage.

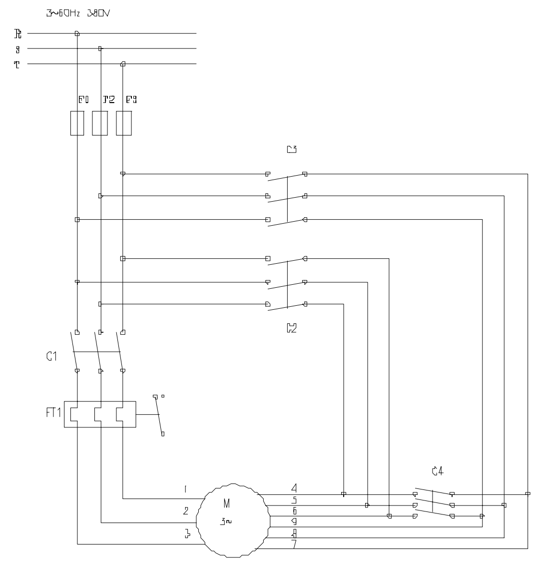
	Starting	Duty
C1	Close	Close
C2	Open	Close
C3	Close	Open



E) SERIES-PARALLEL STARTING.

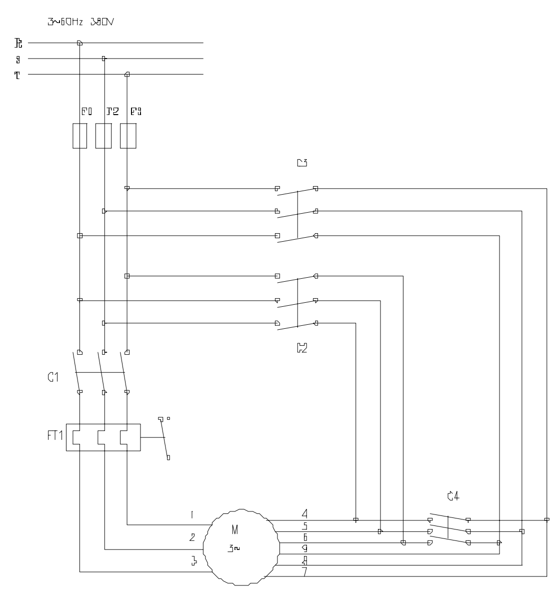
e1) Series-parallel starting Δ/ΔΔ (12 leads).

	Starting	Duty
C1	Close	Close
C2	Open	Close
C3	Open	Close
C4	Close	Open



e2) Series-parallel starting Δ/ΔΔ (9 leads).

	Starting	Duty
C1	Close	Close
C2	Open	Close
C3	Open	Close
C4	Close	Open



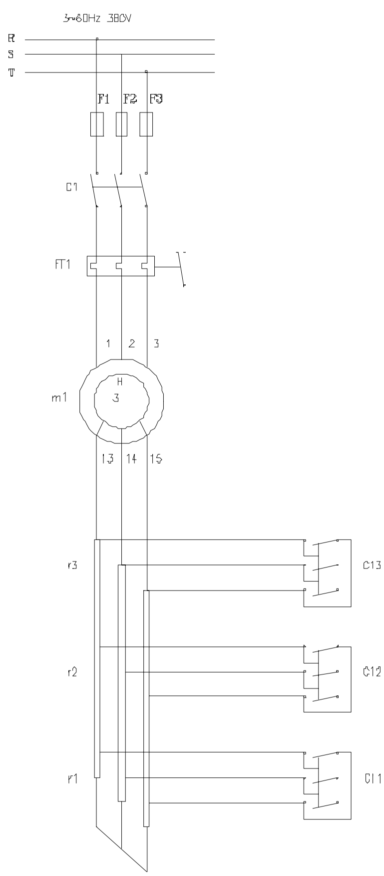
F) STARTING OF SLIP RING MOTORS WITH RHEOSTAT

For starting of slip ring motors an external rheostat is connected to the rotor by means of a set of brushes and slip rings (connection diagram F).

The extra rotor resistance is held in the circuit during the starting to reduce the starting current and increase torque. Furthermore, it is possible to regulate the external resistance so as to have a starting torque equal to, or close to the motor breakdown torque.

NOTE: Every time customers intend to use other than DOL, inform WEG Máquinas in advance so we can analyse the starting torques required by the load .

	Starting	Duty
C1	Close	Close



Symbols:
C1, C2, C3 = contactors
C1, F2, F3 = fuses
FT1 = overload relay

3.2.6. MOTOR PROTECTION

Motors have, in principle, two types of protection: protection against overload/locked rotor, and short circuits.

Motors in continuous use should be protected from overloading by means of a device incorporated into the motor, or by independent device, usually a fixed or adjustable thermal relay equal or inferior to the value derived from multiplying the rated power supply current at full load by:

- 1.25 for motors with a service factor equal or superior to 1.15 or
- 1.15 for motors with service factor equal to 1.0.

Electric motors are fitted, under customers request, with overheating protective devices (in case of overload, locked rotor, voltage drop, inadequate motor ventilation) such as a thermostat (thermal probe), thermistors, RTD s. These overheating protective devices do not require other independent devices.

3.2.6.1. TEMPERATURE LIMITS FOR WINDINGS

The temperature of the winding hottest point must be kept below the thermal class limit.

The total temperature corresponds to the sum of ambient temperature plus temperature rise (T) plus the difference between average temperature of the winding and the hottest point.

By standard, maximum ambient temperature is 40°C. any temperature above this is considered special.

The temperature values and the permissible total temperature at the hottest point are given in the chart below:

Insulation class		**B**	**F**	**H**
Ambient temperature	°C	40	40	40
T = Temperature rise (resistance method)	°C	80	100	125
Difference between hottest point and average temperature	°C	10	15	15
Total: Hottest point temperature	°C	130	155	180

THERMOSTAT (Thermal probe):

These are bimetallic thermal detectors with normally closed silver contacts and they trip at pre-determined temperatures. Thermostats are series-connected or independent according to the connection diagram.

THERMISTORS (PTC or NTC):
They are thermal detectors composed of semi-conductors PTC which sharply change their resistance when reaching a set temperature. They are series-connected or independent according to the connection diagram

NOTE: Thermostats and thermistors are connected to a control unit that cuts off the motor power supply or switches on an alarm system, in response to the thermistors reaction.

RESISTANCE TEMPERATURE DETECTORS (RTD's):
RTD's are resistance thermal detectors usually made of platinum.
Basically, RTD's operate on the principle that the electrical resistance of a metallic conductor varies linearly with the temperature. The detector terminals are connected to a control panel, usually fitted with a temperature gauge.
Normally Weg Motors are supplied with one RTD per phase and one per bearing where these protective devices are regulated for alarm and subsequent switch-off. For extra safety reasons, it is possible to fit two RTD's per phase.
Table 3.2 shows a comparison between the protection systems.

NOTE:

1) If required by the application, other protective devices must be used besides the ones indicated above.
2) Table 3.3 shows the temperature values in relation to the measured Ohmic resistance.
3) It is recommended to adjust the relays according to table 3, that is:

<u>Class F:</u>
Alarm: 140°C.
Tripping: 155°C.
<u>Class H:</u>
Alarm: 155°C.
Tripping: 180°C.
The alarm and tripping values can be defined based on experience. However, they can not exceed the values given previously.

TABLE 3.2 - Comparison between Motor Protection Systems.

Causes of overheating	Current-based protection		Protection with thermal probe in the motor
	Fuse only	Fuse and thermal protector	
1. Overload with 1.2 times the rated current.	unprotected	totally protected	totally protected
2. Duty cycles S1 to S8, EB 120.	unprotected	partially protected	totally protected
3. Brakings, reversion and operation with frequent starts.	unprotected	partially protected	totally protected
4. Operation with more than 15 starts p/hour.	unprotected	partially protected	totally protected
5. Locked rotor.	partially protected	partially protected	totally protected
6. Fault on one phase.	unprotected	partially protected	totally protected
7. Excessive voltage fluctuation.	unprotected	totally protected	totally protected
8. Frequency fluctuation on power supply.	unprotected	totally protected	totally protected
9. Excessive ambient temperature.	unprotected	totally protected	totally protected
10. External heating caused by bearings, belts, pulleys etc.	unprotected	unprotected	totally protected
11. Obstructed ventilation.	unprotected	unprotected	totally protected

Table 3.3 - Variation of Platinum RTD's.

ºC	0	1	2	3	4	5	6	7	8	9
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51
10	103.90	104.29	104.68	105.07	105.46	105.95	106.24	106.63	107.02	107.40
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.28
30	111.67	112.06	112.45	112.83	113.22	113.61	113.99	114.38	114.77	115.15
40	115.54	115.93	116.31	116.70	117.08	117.47	117.85	118.24	118.62	119.01
50	119.40	119.78	120.16	120.55	120.93	121.32	121.70	122.09	122.47	122.86
60	123.24	123.62	124.01	124.39	124.77	125.16	125.54	125.92	126.31	126.69
70	127.07	127.45	127.84	128.22	128.60	128.98	129.37	129.75	130.13	130.51
80	130.89	131.27	131.66	132.04	132.42	132.80	133.18	133.56	133.94	134.32
90	134.70	135.08	135.46	135.84	136.22	136.60	136.98	137.36	137.74	138.12
100	138.50	138.88	139.26	139.64	140.02	140.39	140.77	141.15	141.53	141.91
110	142.29	142.66	143.04	143.42	143.80	144.17	144.55	144.93	145.31	145.68
120	146.06	146.44	146.81	147.19	147.57	147.94	148.32	148.70	149.07	149.45
130	149.82	150.20	150.57	150.95	151.33	151.70	152.08	152.45	152.83	153.20
140	153.58	153.95	154.32	154.70	155.07	155.45	155.82	156.19	156.57	156.94
150	157.31	157.69	158.06	158.43	158.81	159.18	159.55	159.93	160.30	160.67

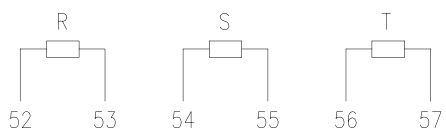
NOTE: When motors are supplied with accessories T-box, the connection terminals for thermal protectors and other accessories are fitted in this T-box.

GENERAL IDENTIFICATION OF TERMINALS, STATOR, ROTOR AND ACCESSORIES

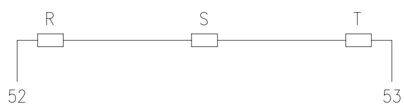
01 to 12 = Stator.
13 to 15 = Rotor.
16 to 19 = Space heater.
20 to 27 = RTD (PT100)in winding.
36 to 43 = Thermistors (PTC) in winding.
52 to 59 = Thermostats in winding (Klixon, Compela).
68 to 71 = RTD's in the bearings.
72 to 75 = Thermistors in the bearings.
76 to 79 = Thermostats.
80 to 82 = Thermometer.
92 to 93 = Brakes.
94 to 99 = Current transformers.

CONNECTION DIAGRAM OF THERMOSTATS (Klixon, Compela)

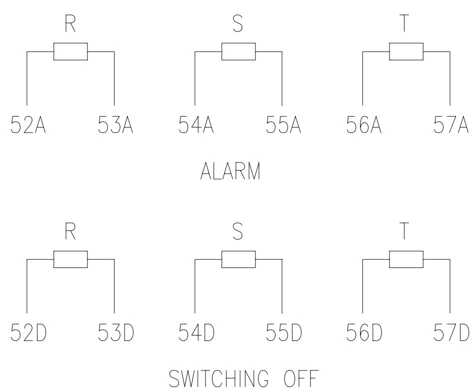
IN WINDING (one per phase) – CODE 9029



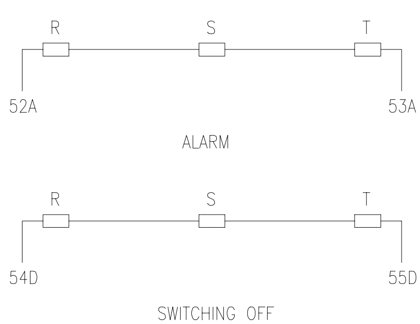
IN WINDING (one per phase series connected) – CODE 9030



IN WINDING (two per phase) – CODE 9031

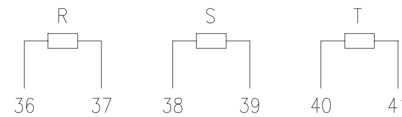


IN WINDING (two per phase series connected) – CODE 9032

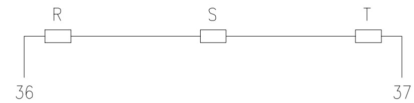


CONNECTION DIAGRAM OF THERMISTORS (PTC)

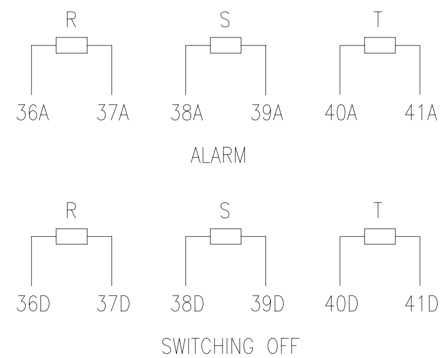
IN WINDING (one per phase) – CODE 9025



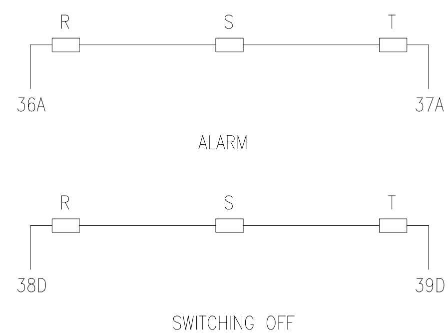
IN WINDING (one per phase series connected) – CODE 9026



IN WINDING (two per phase) – CODE 9027

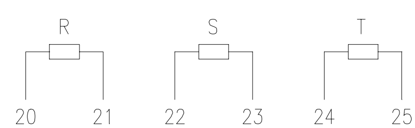


IN WINDING (two per phase series connected) – CODE 9028

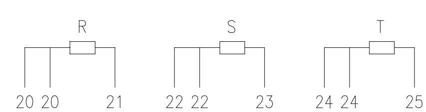


CONNECTION DIAGRAM OF RTD'S (PT100)

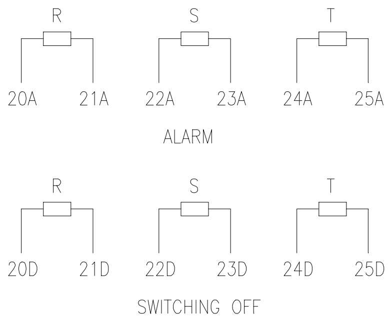
IN WINDING (one per phase) – CODE 9021



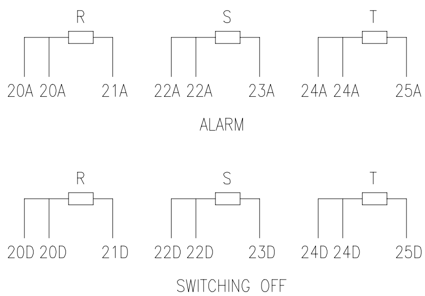
NO ESTATOR (um por fase com tres fios) – CODIGO 9022



IN WINDING (two per phase) – CODE 9023



IN WINDING (two per phase with three wires) – CODE 9024



CONNECTION DIAGRAM IN THE BEARINGS

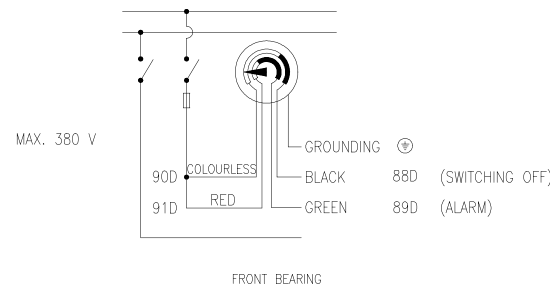
PT100 (one per bearing) – CODE 9033

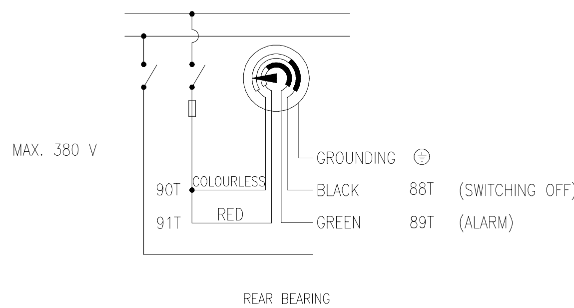
PT100 (one per bearing with three wires) – CODE 9034

PTC (one per bearing) – CODE 9035

KLIXON,COMPELA (one per bearing) – CODE 9036

THERMOMETER (one per bearing) – CODE 9037



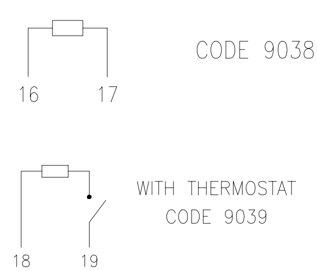


3.2.7. SPACE HEATERS

When motors are fitted with space heaters to avoid water condensation during long periods o standstill,

the space heaters must be connected so that they are energized immediately after the motor is switched-off and are energized immediately after the motor is switched-on. A dimensional drawing and a specific nameplate existing on the motor indicate the supply voltage and the characteristics of the space heaters installed.

CONNECTION DIAGRAM OF SPACE HEATERS



3.3. COMMISSIONING

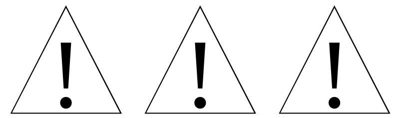
3.3.1. PRELIMINARY INSPECTION

Before starting a motor for the first time, or after long period of standstill, check the following items:

1) Is the motor clean? Were all packing materials and cleaning materials removed?
2) Make sure the supply voltage and frequency correspond to those indicated on the nameplate.
3) Ascertain that the endbell and bearing-housing fastening bolts are firmly tightened.
4) Make sure the motor is correctly aligned (as per item 3.1.2).
5) Are the bearings correctly lubricated (as per item 4.2).
6) Are the rotor terminals connected? (Only for slip ring motors).
7) Are the thermal protector conductors, the rounding terminal and the space heaters connected?
8) Is the insulation resistance of the rotor and stator according to the prescribed value ? (as per item 2.3.3).
9) Were all objects such as tools, measuring instruments and alignment devices removed from the area of the motor?
10) Are the brush-holders in order? Are the brushes making contact? (see item 4.6).
11) Are all motor fixing bolts duly tightened?
12) When the motor is started at no load, does it rotate freely without abnormal noise? Is the direction of rotation correct? (To reverse the rotation, invert any of two terminal leads of the power supply).
13) Is the motor ventilation OK? Note the direction of rotation of unidirectional motors.

NOTES:

1) The gap between brush holder and Slip ring surfaces should be between 2mm to 4mm.
2) Brush pressure on the slip ring should be in accordance with the specified value, and the brush incidence to the contact surface should be perpendicular.
3) If the load (operation rated current) applied to the motor are not in accordance with the rated characteristics of such motor (above or below), the brushes specification must be analyzed in relation to the actual load requirements. Check data given in item 4.6.
4) Before changing rotation direction of two-pole motors, contact Weg Máquinas for analysis.
5) The "H" line motors with special noise level are built with unidirectional fan (all RPM´s). To reverse rotation direction, contact Weg Máquinas in order to analyze the fan.
6) The "Master" line motors are also built with unidirectional fans. So if rotation direction has to be reversed, contact Weg Máquinas in order to analyze the fan.



WARNING:
The non observation of the items described above can lead to serious problems to motor performance, causing excessive wear to brushes and slip rings (for wound rotor motors), overheating and possible damage to motor windings. These problems are not covered under the warranty terms included in this manual.

3.3.2. PARTIDA INICIAL

THREE-PHASE SQUIRREL CAGE ROTOR MOTOR
After careful examination on the motor, follow the normal sequence of starting operation listed above.

THREE-PHASE SLIP RING MOTORS
The starting method must follow the manufacturer instructions for starting methods.
On motors with permanent contact brushes, the starting rheostat remains in the "run" position while the motor is running. Special speed control rheostat designed for permanent connection to resistance contacts within a given range of settings are an exception to the above.

FIX BRUSH-HOLDER SYSTEM
(permanent contact of brush with slip ring)
Brushes must be correctly set against the slip ring.

ADJUSTABLE BRUSH-HOLDER SYSTEM
(manual or automatic)
Brushes must be in contact and correctly set against the slip rings.
After complete motor acceleration, make sure that the brush lifting system has worked.

3.3.3. OPERATION

Run the motor coupled to the load for a period of at least one hour to check if abnormal noises or sign of overheating occur. If there will be excessive vibrations in the unit between the

initial operation condition and the condition after thermal stability, alignment and leveling must be rechecked. Compare the line current drawn with the value shown on the nameplate.
Under continuous duty without load fluctuation, this should not exceed the rated current times the service factor, also shown on the nameplate.
All measuring instruments and devices should be continuously checked in order to correct any abnormal operation, if required.

3.3.4. SHUTDOWN PROCEDURE

Before proceeding any task on the motor, it is extremely important to observe the following: to touch any moving part on a running motor, even switched-off, is a danger to life.

a) Three-phase squirrel cage motors:
It suffices to open stator circuit switch, and with the motor stopped, reset the auto-transformer, if any, to the "start" position;

b) Three-phase slip ring motors:
Open the stator circuit switch. When the motor is stopped, reset the rheostat to the "start" position.

3.4. ACOUSTICAL PROPERTIES

Day by day, electrical motors are increasingly used in offices and homes. Under these circumstances, it is essential that motors operate silently and safe without contributing to ambient discomfort. The solution lies in the ever closer collaboration of the user and the motor manufacturer.
The proper planning of home, office and factory acoustics requires a knowledge of the sources of motor noises and how they affect the ambient noise level wherever motors are located.
The following parts of a motor can generate noise within the audio-frequency range:

1. Cooling system.
2. Brushes.
3. Bearings.
4. Magnetic circuit.

The part of the motor mainly responsible as noise source depends on its size, speed, degree of mechanical protection (casing) and of the driven machine design. Cooling system noise is airborne and usually affects only the noise level in the ambient where motor is installed. How ever, it is a different matter if the noise source is in the bearings or in the magnetic circuit. In this case, the noise is due to mechanical vibration of the part itself, or of the entire motor, and the sound is spreaded through the foundation, walls or ducts. This type of sound propagation, via structural components of an installation, can be reduced by installing the motor on suitable designed vibration dampers. It is important to note that improper dampers can even increase vibration.
The graphs in figures 3.11 to 3.18 show noise reduction attainable with different devices. The illustrations below each graph represent imaginary motors.
The dotted line indicates the noise level without any steps have been taken to reduce noise; the continuous line shows noise level after the suggested measures have been taken

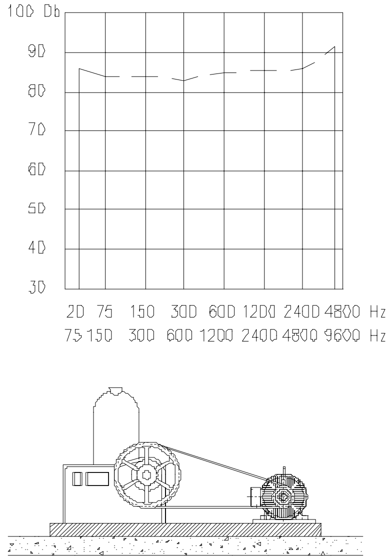


Figure 3.11 - Motor without dampers

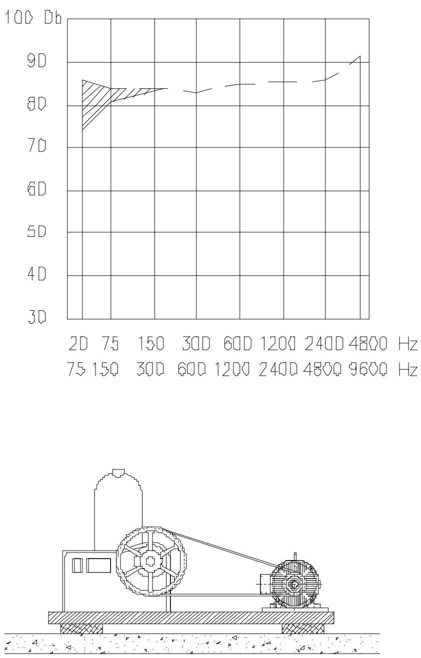


Figure 3.12 - Motor mounted on dampers.

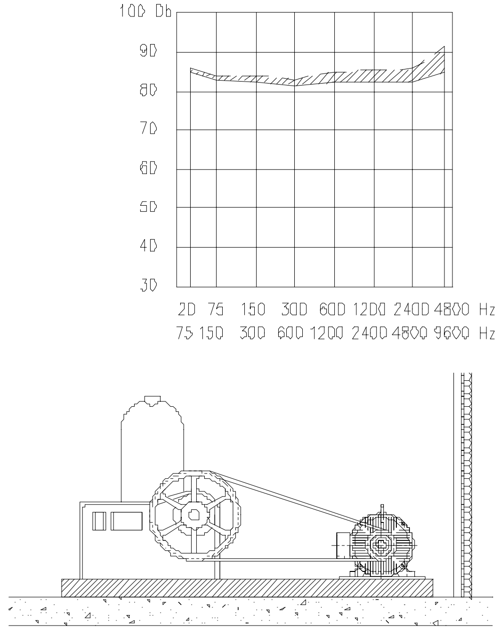


Figure 3.13 - Motor without dampers but with wall covered with sound absorbent material

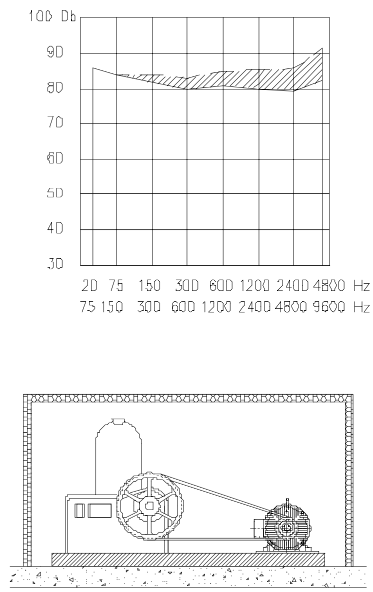


Figure 3.14 - Motor installed in a cubicle covered with absorbent material

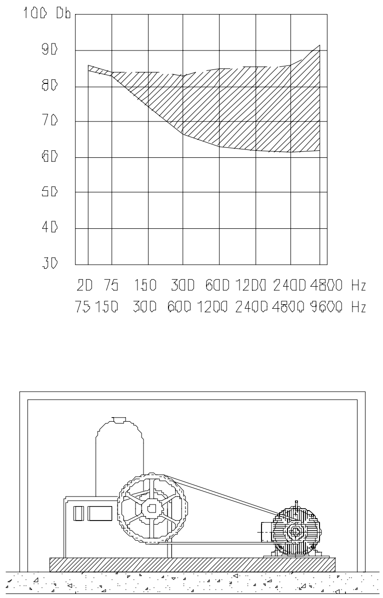


Figure 3.15 - Motor enclosed in solid-walled cubicle. Wall material is of high density

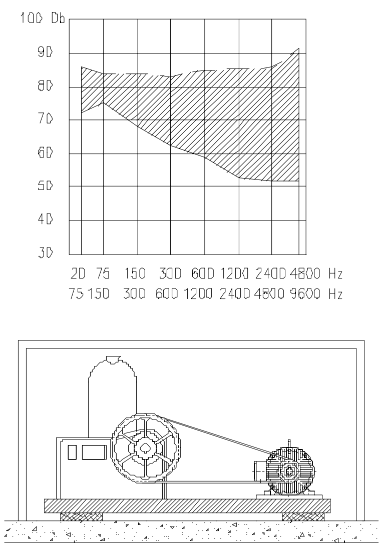


Figure 3.16 - Motor in solid-walled cubicle and additionally mounted on dampers

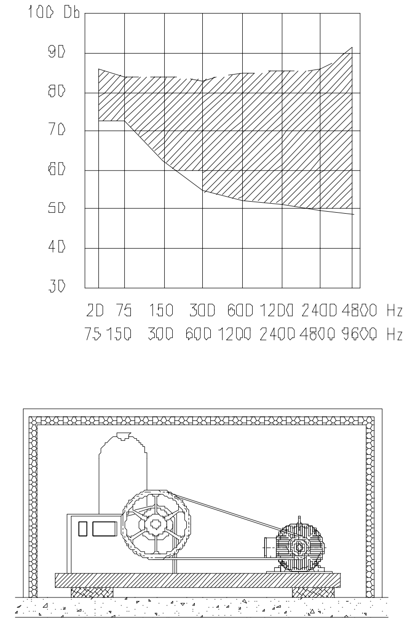


Figure 3.17 - Motor in solid-walled cubicle covered by absorbent material and mounted on dampers

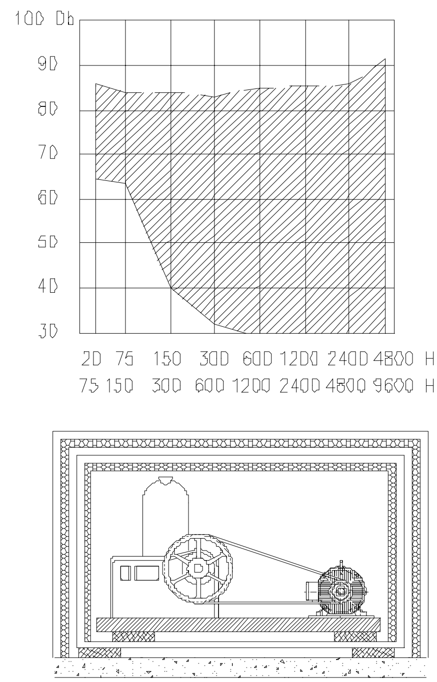


Figure 3.18 - Motor in double solid-walled cubicle with internal surfaces covered with absorbent material and mounted on a double set of dampers.

3.5. MOTOR USED ON HAZARDOUS AREA – EXPLOSIVE GAS ATMOSPHERES

Motors designed for hazardous areas are fitted with additional safety features which are defined in specific standards for each type of hazardous location, based on its classification.
The general requirements for electrical apparatus for hazardous locations are described in the following Brazilian and foreign standards, respectively:
NBR 9815 = Electrical apparatus for explosive gas atmospheres.
General requirements (specifications)
IEC 79-0 = Electrical apparatus for explosive gas atmospheres.
EN 50014 = Electrical apparatus for potentially explosive atmosphere.
General requirements

3.5.1. GENERAL CARE WITH ZHAZARDOUS LOCATION MOTORS

Before installing, operating or carrying out maintenance services on electric motors used on hazardous locations, care must be taken on the following:

- The standards listed below, applied to each case, must be studied and understood;
- All requirements included in the applicable standards must be understood accordingly.

Exe – Increased Safety: IEC 79-7 / NBR 9883 / EN 50019.
Exp. – Pressurized: IEC 79-2 / NBR 5420.
Exn – Non sparking: IEC 7915.

3.5.2. ADDITIONAL CARE RECOMMENDED FOR HAZARDOUS LOCATION MOTORS

- Before carrying out maintenance services, inspections or repairs on the motor, make sure it is de-energized and completely stopped;
- All motor protections must be correctly installed and duly adjusted before starting the operation;
- Make sure motors are properly grounded;
- Connection terminals must be properly connected so as to avoid poor contacts which can result in overheating or sparking.

NOTE: All other recommendations referring to storage, handling, installation and maintenance included in this manual and applied to the motor in question must also be followed accordingly.

4. MAINTENANCE

A well-programmed maintenance of electric motors can be summed up as a periodical inspection of insulation levels, temperature rise (winding and bearings), wears, bearing lubrication and useful life, and occasional checking of fan air flow, vibration levels, brushes and slip rings wears.
In case one of the above items are not followed accordingly, you might have unexpected stops of the equipment. Inspection cycles depend on the type of the motor and conditions under which it operates.
Frame must be kept clean, free of dust, dirt or oil in order to make the cooling process easier.

Transportation care:
On any transportation, motors fitted with roller or ball bearings must have their shaft locked in order to avoid bearing damage.
To lock the shaft use the shaft locking device shipped together with the motor. See item 2.2.

4.1. CLEANLINESS

Motors should be kept clean, free of dust, dirt and oil. Soft brushes or clean cotton rags should be used to clean the motors. A jet of compressed air should be used to remove non-abrasive dust from the fan cover and any accumulated grime from the fan and cooling fins.
The heat exchanger tubes (if any) must be kept clean and free of any obstructing object to facilitate the air circulation. For the cleanliness of the tubes, a stick with a round brush at the ends can be used which, inserted in such tubes, removed all accumulated dirt.

NOTE: To perform such cleanliness, remove the ND endbell of the heat exchanger and insert the brush into the tubes.

In order to effect this cleanliness, a stick can be used which, inserted into the tubes, remove all the accumulated dust. If motor is fitted with air-water heat exchanger, a periodical cleanliness is inside the radiator tube is required to remove any dirt condensation.
On slip ring motors, brushes and brush-holders should never be cleaned with compressed air, but with vacuum cleaner or any cotton rag soaked in a suitable solvent (see item 4.4. and 4.5).
Oil or damp impregnated impurities can be removed with rags soaked in a suitable solvent.
Terminal boxes of IP54 protection motors should also be cleaned; their terminals should be free of oxidation, in perfect mechanical condition, and

all unused space dust-free. For aggressive environment, IP(W)55 protection motors are recommended.

4.1.1. PARTIAL MAINTENANCE

- Drain the condensed water.
- Clean the inside of the terminal boxes.
- Make a visual inspection of the winding insulation.
- Clean the slip rings (see 4.4 and 4.5).
- Check the condition of the brushes.
- Clean the heat exchanger.

4.1.2. COMPLETE MAINTENANCE

- Clean the dirty windings with a soft brush.
- Grease, oil and other impurities which adhered on the winding can be removed with a rag soaked in alcohol. Dry the windings with a jet of compressed air.
- A jet of compressed air should be used to clean the bearings and the air ducts in the stator and rotor cores.
- Drain the condensed water and clean the inside of the terminal boxes as well as the slip rings.
- Measure the insulation resistance (see table 2.1).
- Clean the brushes/brush holders according to items 4.4 and 4.5.
- Clean the heat exchanger accordingly.

NOTE: When motor is fitted with air inlet and/or air outlet filters, these should be cleaned with a jet of compressed air. If the dust is difficult to be removed with a jet of compressed air, then they should be washed in cold water with neutral detergent. After that, dry them in horizontal position.

4.2. LUBRICATION

4.2.1. GREASE LUBRICATED BEARINGS

The purpose of this maintenance is to lengthen bearing life.

MAINTENANCE INCLUDES:

a) Attention to the overall status of the bearings;
b) Cleaning and lubrication;
c) Inspection in details of the bearings.

Motor noise should be measured at regular intervals of one to four months. A well-tuned ear is perfect capable of distinguishing unusual noises, even with rudimentary tools such as a screw driver, etc. For a more reliable analysis of the bearings, sophisticated equipment is required.

Bearing temperature control is also part of routine maintenance. The temperature rise of grease lubricated bearings as recommended under item 4.2.1.2 should not exceed 60ºC (T = 60°C/max. ambient = 40°C, absolute temperature = T + ambient) measured at the external bearing cap.

Constant temperature control can be done by means of external thermometers or by embedded thermal elements.

Alarm and tripping temperatures for ball bearings can be set for 90°C and 100°C respectively.

Weg motors are normally supplied with grease lubricated ball or roller bearings.

Bearings should be lubricated to avoid metallic contact of the moving parts, and also for protection against corrosion and wear. Lubricant properties deteriorate in the course of time and due to mechanical operation and, furthermore, all lubricants are subject to contamination under working conditions. For this reason, lubricants must be renewed or replaced from time to time.

4.2.1.1. LUBRICATION INTERVALS

WEG motors are supplied with Polyurea-based POLIREX EM grease (Supplier: ESSO) enough for the running period given on the data sheet and bearing nameplate..

Lubrication intervals depend on the size of the motor, speed, working conditions, type of grease used and working temperature. The lubrication period and type of bearings are indicated on the motor nameplate.

Motors kept in stock should be relubricated every six months. Once a month, shaft must be in order to have the grease homogenized.

Table 1

MAXIMUM LUBRICATION INTERVAL FOR HORIZONTALLY MOUNTED MOTORS

ROLLER BALL BEARINGS

Bearings	Poles	Lubrication Interval (hours) 60 Hz	Lubrication Interval (hours) 50 Hz	Amount of Grease (grams)	Bearings speed limit (rpm) 100%	Bearings speed limit (rpm) 75%
6204	8 or +	12000	13200	5	15000	11250
	6	10200	11300			
6205	8 or +	11100	12300	5	13000	9750
	6	9500	10500			
6206	8 or +	10500	11600	5	11000	8250
	6	9000	9900			
6306	4	7100	7800	10	9500	7125
	2	4500	5100			
6307	4	6800	7500	10	8500	6375
	2	4100	4800			
6208	8 or +	9600	10700	10	8500	6375
	6	8100	9200			
6308	4	6300	7200	10	7500	5625
	2	3800	4500			
6209	8 or +	9300	10400	10	7500	5625
	6	8000	8900			
6309	4	6200	6900	15	6700	5025
	2	3500	4200			
6210	8 or +	9000	10100	10	7100	5325
	6	7700	8600			
6310	4	5900	6600	15	6000	4500
	2	2900	3900			
6211	8 or +	8900	9800	15	6300	4725
	6	7400	8300			
6311	4	5700	6500	20	5600	4200
	2	2400	3800			
6212	8 or +	8600	9600	15	5600	4200
	6	7200	8100			
6312	4	5400	6200	20	5300	3975
	2	2100	3300			
6214	8 or +	8300	9300	15	5000	3750
	6	6900	7800			
6314	4	5100	5900	30	4500	3375
	2	1400	2600			
6315	2	1050	2100	30	4300	3225

Bearings	Poles	Lubrication Interval (hours) 60 Hz	Lubrication Interval (hours) 50 Hz	Amount of Grease (grams)	Bearings speed limit (rpm) 100%	Bearings speed limit (rpm) 75%
6216	8 or +	8000	9000	20	4500	3375
	6	6600	7500			
6316	4	4800	5600	35	3800	2850
	2	750	1800			
6218	8 or +	7700	8700	25	4000	3000
	6	6300	7200			
6318	4	4500	5300	45	3600	2700
6220	2	-	650	35	3600	2700
6220	8 or +	7500	8400	35	3600	2700
	6	6000	6900			
6320	4	4200	5000	50	2800	2100
6222	8 or +	7200	8300	40	2800	2100
	6	5900	6800			
6322	4	3900	4800	60	2400	1800
6224	8 or +	7100	8000	45	2600	1950
	6	5600	6500			
6324	4	3500	4500	75	2200	1650
6226	8 or +	6600	7700	50	2400	1800
	6	5300	6200			
6326	4	2700	4100	85	2200	1650
6228	8 or +	6200	7100	55	2200	1650
	6	4800	5700			
6328	4	2000	3600	95	2000	1500
6230	8 or +	5700	6800	65	2000	1500
	6	4400	5300			
6230	4	1500	3000	105	1800	1350
6232	8 or +	5400	6300	70	1900	1425
6332	6	4100	5000	120	1700	1275
6234	8 or +	5100	6000	85	1800	1350
6334	6	3800	3800	130	1600	1200
6238	8 or +	4500	5300	95	1600	1200
6338	6	2600	3900	160	1400	1050
6244	8 or +	3600	4500	130	1300	975
6344	6	1400	2700	205	1200	900
6252	8 or +	2000	3300	195	1100	825

NOTE: - Standard lubrication interval applied to 40°C ambient temperature and types of grease according to table 4.1;
- For vertically mounted motors, lubrication interval must be reduced by half;
- Bearing average temperature considered T = 90°C;
- For ambient temperature other than 40°C, use the following corrections:
  - Tamb = 45°C (lubrication interval at 40°C) x 0.6;
  - Tamb = 50°C (lubrication interval at 40°C) x 0.36.

Table 2

MAXIMUM LUBRICATION INTERVAL FOR HORIZONTALLY MOUNTED MOTORS

LOCKED BALL BEARINGS

Bearing	Pole	Lubrication Interval (hours)		Amount of Grease (grams)	Bearing speed Limit (rpm)	
		60 Hz	50 Hz		100%	75%
NU310	4	4700	5300	15	5600	4200
NU212	8 or +	6900	7700	15	5000	3750
	6	5700	6500			
NU312	4	4100	5000	20	4000	3000
NU214	8 or +	6600	7400	15	4500	3375
	6	5400	6200			
NU314	4	3500	4700	30	3600	2700
NU216	8 or +	6300	7200	20	4000	3000
	6	5300	6000			
NU316	4	3000	4200	35	3200	2400
NU218	8 or +	6200	6900	25	3600	2700
	6	5000	5700			
NU318	4	2700	3800	45	2800	2100
NU220	8 or +	6000	6800	35	3200	2400
	6	4800	5600			
NU320	4	2400	3300	50	2400	1800
NU222	8 or +	5700	6600	40	2800	2100
	6	4500	5400			
NU322	4	2000	3000	60	2000	1500

Bearing	Pole	Lubrication Interval (hours)		Amount of Grease (grams)	Bearing speed Limit (rpm)	
		60 Hz	50 Hz		100%	70%
NU224	8 or +	5600	6500	45	2400	1800
	6	4200	5100			
NU324	4	1700	2700	75	1900	1425
NU226	8 or +	5300	6000	50	2200	1650
	6	3600	4800			
NU326	4	1400	2300	85	1800	1350
NU228	8 or +	5000	5700	55	2000	1500
	6	3000	4400			
NU328	4	1050	1800	95	1800	1350
NU230	8 or +	4500	5400	65	1900	1425
NU330	6	2600	3800	105	1700	1275
NU232	8 or +	3900	5000	70	1800	1325
NU332	6	2300	3300	120	1500	1125
NU234	8 or +	3500	4800	85	1800	1325
NU334	6	1800	2900	130	1600	1200

NOTE: - Standard lubrication interval applied to 40°C ambient temperature and types of grease according to table 4.1;
- For vertically mounted motors, lubrication interval must be reduced by half;
- Bearing average temperature considered T = 90°C;
- For ambient temperature other than 40°C, use the following corrections:
  Tamb = 45°C (lubrication interval at 40°C) x 0.6;
  Tamb = 50°C (lubrication interval at 40°C) x 0.36.

MAXIMUM LUBRICATION INTERVAL FOR HORIZONTALLY MOUNTED MOTORS						
SPHERICAL ROLLER BEARINGS						
BEARING	AMOUNT OF GREASE (GRAMS)	BEARING SPEED LIMIT (RPM)		POLE	LUBRICATION INTERVAL (HOURS)	
		100%	75%		60 Hz	50 Hz
23032	75	1700	1275	12 or +	2400	3000
				10	1800	2400
				8	1300	1700
				6	700	1100
23036	105	1400	1050	12 or +	1800	2400
				10	1500	1800
				8	1000	1400
				6	-	800
23040	130	1200	900	12 or +	1500	2000
				10	1200	1500
				8	750	1100

NOTE: - Standard lubrication interval applied to 40°C ambient temperature and types of grease according to table 4.1;
- For vertically mounted motors, lubrication interval must be reduced by half;
- Bearing average temperature considered T = 90°C;
- For ambient temperature other than 40°C, use the following corrections:
  - Tamb = 45°C (lubrication interval at 40°C) x 0.6;
  - Tamb = 50°C (lubrication interval at 40°C) x 0.36.

SOME TYPICAL GREASES FOR CERTAIN APPLICATIONS			
SUPPLIER	APPLICATION	GREASE	TEMPERATURE FOR CONSTANT OPERATION (ºC)
ESSO	NORMAL	POLYREX EM (POLYUREA BASE)	(-30 a +170)
		UNIREX N2 (LITHIUM BASE)	(-30 a +165)
SHELL		(*)ALVÂNIA R3 (LITHIUM BASE)	(-35 a +130)
KLÜBER	LOW TEMPERATURES	ISOFLEX NBU15 (BARIUM COMPLEX)	(-60 a +130)

Table 4.1 shows some types of grease.

NOTE: (*) If use the grease ALVÃNIA R3, do the correction:
LUBRICATION INTERVAL (ALVÂNIA R3) = Normal Lubrication Interval x 0.65

4.2.1.2. QUALITY AND QUANTITY OF GREASE

Correct lubrication is important for proper bearing operation. It means to say the grease must be applied correctly and in sufficient amount. On the other hand, insufficient or excessive greasing are prejudicial.
Excessive greasing causes overheating due to high resistance encountered by the rotating parts and, in particular, by the compacting of the lubricant and its eventual loss of lubricating qualities.
This can cause leakage with the grease penetrating into the motor winding, commutator rings or brushes.
A lithium based grease is commonly used for the lubrication of electric motor bearings as it is of good mechanical stability, insoluble in water and has a melting point of approximately 200ºC.
This grease should never be mixed with sodium or calcium based grease.

> Never mix greases with different base components.
> Example: A calcium based grease must not be mixed with a polyurea based grease.

4.2.1.3. COMPATIBILITY

The compatibility of different types of grease can create occasional problems. When the properties of the mixture remain within the individual property range of the greases, we can say the greases are compatible. To avoid any possible incompatibility grease problem we recommend to perform an appropriate lubrication which can be summarized as follows: after removing the old grease and caring out a complete cleanliness of the grease cavity, new grease must be pumped in. When this procedure is not allowed, pump in new grease by pressure. This must be repeated until a new grease is drained out through the grease relief.
As a general rule, greases with same soponification type are compatible. However depending on the mixture rate, they can then be recommended to mix different types of grease before contacting a service agent and/or WEG.
Same and basic oils can not be mixed as they will not produce a homogeneous mixture. In this case, either a hardening or a softening (or drop of the resulting mixture melting point) can occur.

Standard grease used on WEG motors is Polyurea-based POLIREX EM (Supplier: ESSO). The specification of this grease as well as lubrication intervals are supplied on the bearing nameplate attached to motor frame.

4.2.1.4. LUBRICATING INSTRUCTIONS

All high and low voltage motors are fitted with grease fitting for the bearing lubrication.
The lubrication system was designed to allow, when regreasing, the removal of all grease from the bearings races through a grease relief which at the same time impedes the entry of dust or other contaminants harmful to the bearing.
This grease relief also avoids injury to the bearings from the already known problem of over-greasing. It is advisable to relublicated while the motor is running so as to allow the renewal of grease in the bearings housing.
If this procedure is not possible due to existing parts near the nipple (pulleys, etc), which can be harmful to the operator, the following procedure should be followed:

- Inject about half the estimated amount of grease and run the motor at full speed for approximately one minute;
- Switch off the motor and inject the remaining grease.

The injection of all the grease with the motor stopped can cause penetration of a portion of the lubricant into the motor through the internal seal of the bearing housing.

NOTE: Grease fittings must be clean before greasing the motor in order to avoid entry of any foreign bodies into the bearing. For lubrication, use only a manual grease gun.

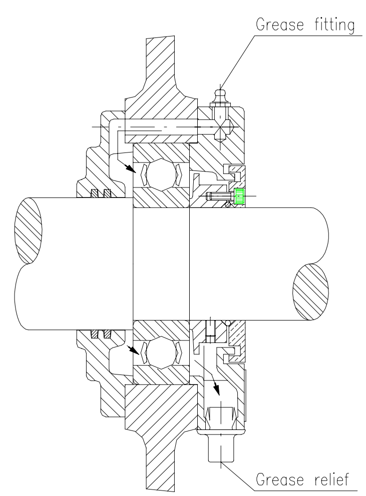


Figure 4.1.
- Bearings and lubrication system.

BEARING LUBRICATION STEPS

1) Remove the grease relief cover.
2) Clean the area around the grease fitting with a clean cotton fabric.
3) With the motor running, add grease with a manual grease gun until the lubricant commences to expelle from the grease relief, or insert the amount of grease recommended in Tables herewith indicated.
4) Leave the motor running enough time to drain all excess of grease.

4.2.1.5. REPLACEMENT OF BEARINGS

After removing the bearing cap, avoid demage to the cores by filling the air gap between the rotor and the stator with stiff paper of a proper thickness. Providing suitable tooling is employed, disassembly of bearings is not difficult. (See bearing extractor with 3 grips in fig. 4.2).

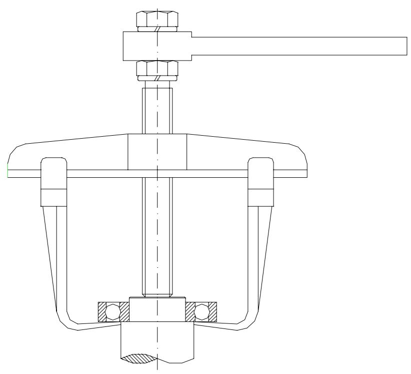


Figure 4.2 - Bearing Extractor.

The extractor grips must be applied to the sidewall of the inner ring to be stripped, or to an adjacent part.
To ensure perfect functioning and no injury to the bearing parts, it is essential that the assembly be done under conditions of complete cleanliness and by skilled personnel. New bearings should not be removed from their packages until they are assembled. Prior to fitting a new bearing, ascertain that the shaft has no rough edges or signs of hammering.
During assembly, bearings cannot be subjected to direct blows. To make the assembly easier, it is recommended to heat up (inductive heater) the bearing. The aid used to press or strike the bearings should be applied to the inner ring.

4.2.2. ASSEMBLY/DISASSEMBLY OF SLEEVE BEARINGS

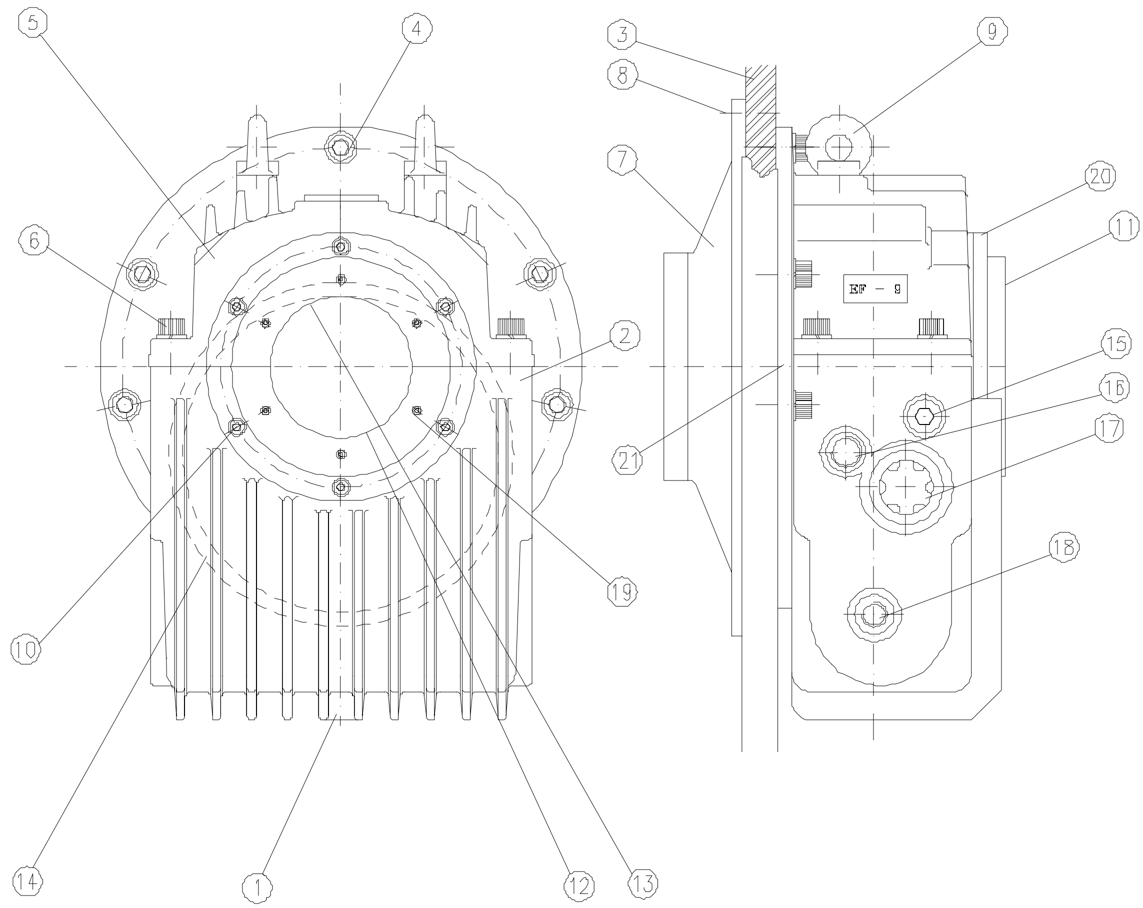
4.2.2.1. GENERAL INSTRUCTIONS

Sleeve bearing performance is dependent on proper installation, lubrication and maintenance. Before assembling the bearing carefully read all instructions contained herein to become familiar with the complete bearing assembly procedure.
A proper maintenance of sleeve bearings include periodical checking of the level and actual condition of the lubricating oil, checking of noise level and vibration of the bearings, follow-up of the operating temperature, and fastening of the fixing and assembly bolts. The frame must be kept clean, free from dust, oil and dirt to facilitate cooling system.
Threaded holes for connecting the thermometer, oil sight glass, oil inlet, and immersion heater, or cooling coil (for oil sump thermometer or circulating pump with adapter) are provided on either side, so that all connections can be made on the right or left side of the bearing housing as required.
The oil drain plug is located centrally on the underside of the bearing housing.
In case of circulating oil lubrication, the outlet connection should be screwed into the threaded hole of an oil sight glass.
If the bearing is electrically insulated, the spherical liner seat surfaces in the housing are lined with a non-conducting material.
Do not remove this lining.
The antirotation pin is also insulated and the shaft seals are manufactured from a special non-conducting material.
Temperature monitoring instruments with contact to the bearing liner should be insulated appropriately (i.e., insulated protection tubes, synthetic fittings, etc.)
Water-cooled bearings are provided with the cooling coil installed. Care must be taken to protect the connections from damage when handling the housing prior to installation.

4.2.2.2. DISASSEMBLY OF THE SLEEVE BEARING SYSTEM (TYPE "EF")

To disassemble the bearing liner and all associated parts from the bearing housing, carry out the following instructions. Carefully store all disassembled parts in a safe location (see fig. 4.3.).

Figure 4.3.



1) Drain plug;
2) Bearing housing;
3) Motor frame;
4) Fixing bolts;
5) Bearing housing cap;
6) Bearing housing cap split line bolt;
7) Machine seal;
8) Machine seal bolt;
9) Lifting eyebolt;
10) External cover bolts;
11) External cover;
12) Bearing liner - bottom half;
13) Bearing liner - top half;
14) Oil ring;
15) Oil inlet;
16) Connection for temperature sensor;
17) Oil sight glass or oil outlet for
18) Lubrication;
19) Drain for pipe;
20) External protection bolts;
21) Labyrinth seal carrier;
22) Labyrinth seal carrier - bottom half.

Drive end side:

- Throughly clean the exterior of the bearing housing. Loosen and remove the oil drain plug (1) at the bottom of the bearing housing. Drain the oil from the bearing housing.
- Loosen and remove the bolts (4) connecting the frame cover (3) to the flange of the bearing housing cap (5). Remove the frame cover.
- Loosen and remove the bolts (6) at the split line of the bearing housing (2) and bearing housing cap (2 and 5).
- Use the lifting eyebolts (9) to lift (by hand or hoist) the bearing housing cap (5) straight up, so that the cap is completely disengaged from the lower halves of the stationary baffle (11) labyrinth seals labyrinth seal carrier (20), machine seal bearing housing and the bearing liner (12).
- Pull the bearing housing cap forward out of and away from the bearing area.
- Loosen and remove the bolts (19) securing the upper half of the stationary baffle. Loosen and remove the bolts (10) securing the upper half of the seal carrier (20) to the bearing housing cap.
- Lift (by hand or hoist) the upper half of the bearing liner (13) and remove it.
- Loosen and remove the bolts at the split line of the oil ring (14). Carefully disengage the dowels holding the oil ring halves together and remove the oil ring.
- Remove the garter springs that encircle the labyrinth seals. Lift off the upper half of each seal, then rotate the lower half of each seal out of the grooves in the seal carrier and bearing housing.
- Disconnect and remove RTD's, thermocouples, or any other temperature detecting instruments that enter the lower half of the bearing liner.
- Using a hoist or jack, raise the shaft slightly so that the lower half of the bearing liner can be rolled out of the bearing housing.

IMPORTANT: To make that feasible it is necessary that bolts 4 and 6 of the other bearing half be loose.

- Roll out (be careful not to use excessive force) the lower half of the bearing liner and remove it.
- Loosen and remove the bolts (19) securing the bottom half of the stationary baffle (11) to the seal carrier. Loosen and remove the bolts (10) securing the bottom half of the seal carrier (21) to the bearing housing. Remove the seal carrier.
- Loosen and remove the bolts (4) securing the bearing housing (2) to the motor frame.
- Loosen and remove the bolts (8) securing the machine seal (7) to the bearing housing. Remove the machine seal.
- Thoroughly clean and inspect all individual parts which have been removed. Clean the interior of the bearing housing.
- To reassemble the bearing system, follow the preceding instructions in the reverse order.

NOTE: Festening torque of the bearing fixing bolts to the motor = 10 Kgfm.

Non drive end side:

- Thoroughly clean the exterior of the bearing housing. Loosen and remove the oil drain plug at the bottom of the bearing housing. Drain the oil from the bearing housing.
- Loosen and remove the bolts (19) connecting the frame cover to the flange of the bearing housing cap (11). Remove the frame cover.
- Loosen and remove the bolts (4) securing the end cover (5) to the bearing housing and to the bearing housing cap. Remove the end cover.
- Loosen and remove the bolts (6) at the splitine of the bearing housing and bearing housing cap (2 and 5).
- Use the lifting eyebolts (9) to lift (by hand or hoist) the bearing housing cap (5) straight up, that the cap is completely disengaged from the lower halves of the labyrinth seal and bearing housing (2) and the bearing liner (12).
- Lift (by hand or hoist) the upper half of the bearing liner (13) and remove it.
- Loosen and remove the bolts at the split line of the oil ring (14). Carefully disengage the dowels holding the oil ring halves together and remove the oil ring.
- Remove the garter spring that encircles the labyrinth seal. Lift of the upper half of the seal, then rotate the lower half of the seal out the groove in the bearing housing.
- Disconnect and remove RTD's, thermocouples, or any other temperature detecting instruments that enter the lower half of the bearing liner.
- Using a hoist or jack, raise the shaft slightly so that the lower half of the bearing liner (12) can be rolled out of the bearing housing.
- Roll out (be careful not to use excessive force) the lower half of the bearing liner (12) and remove it.
- Loosen and remove the bolts (4) securing the bearing housing (2) to the motor frame.
- Remove the bearing housing. Loosen and remove the bolts (8) securing the machine seal (7) to the bearing hosing (2). Remove the machine seal (7).

- Thoroughly clean and inspect all individual parts which have been removed. Clean the interior of the bearing housing.

To reassemble the Bearing System, follow he preceding instructions in the reverse order.

NOTE: Festening torque of the bearing fixing bolts to the motor = 10 Kgfm.

4.2.2.3. SLEEVE BEARING ASSEMBLY

Check contact face and mounting recess of the bracket making sure it is clean and properly machined. Inspect shaft to ensure it is smooth (R_a 0.4, equivalent to 32 micro-inch finish, or better), within the dimensions and tolerances given by RENK and free of burr or any rough spots.

After removing the upper part of the housing (2) and the bearing liner (12 and 13) the interior of the housing and the running surfaces of the liner are to be cleaned thoroughly and checked for any damage caused in transit.

With the shaft slightly, locate the bearing base into the mounting recess of the machine end shield and bolt into position.

Apply oil to spherical seats in the housing base and the shaft and rotate the bottom liner half (12) into position. Special care must be taken so that the axial surfaces of the locating bearing are not damaged.

After the split faces of the bottom liner half and the housing base are aligned, lower the shaft into place. With a slight hammer blow against the housing base settle the liner into its seating so that the liner axis and shaft axis are parallel. The slight hammer blow produces a high frequency vibration which reduces the static friction between the liner and the housing and allows the correct adjustment of the liner. The self-alignment feature of the bearing is to compensate for normal shaft deflection during the assembling procedure only.

The loose oil ring is installed next. The ring must be handled with special care as safe operation of the bearing is also dependent on the effective and safe functioning of the oil ring. The bolts must be tightly fastened. Split misalignment must be avoided and any burrs or edges carefully removed in order to ensure smooth running of the ring. In any maintenance care must be taken that the ring is not distorced and its geometrical shape is maintained.

The outside of the two liner halves is stamped with identification numbers or marks near the split line. Make sure that these marks align and the split faces are clean when placing the top liner half into position. Incorrect fitting may lead to heavy damage to the bearing liners.

Check to ensure that the loose oil ring can still rotate freely on the shaft. With the top liner half in place, install the seal on the flange side (see paragraph "Shaft Seals").

After coating the split faces with a nonhardening sealing compound, place the housing cap into position. Care must be taken that the seal fits properly into the groove. Ensure also that the antirotation pin is seated without any contact with the corresponding hole in the liner.

NOTE: Housing or liner may be interchanged as complete assemblies only. Individual halves are not interchangeable.

4.2.2.4. SETTING OF THERMAL PROTECTIONS (PT100)

Each bearing is fitted with a Pt100 temperature detector installed directly in the bearing liner near the point where the load is applied. This device must be connected to a controlling panel with the purpose of detecting overheating and protect the bearing when operating under high temperature.

IMPORTANT: The following temperature must be set on the bearing protecting system:

ALARM 100ºC.
TRIPPING OFF 120ºC.

4.2.2.5. WATER COOLING SYSTEM

When using water cooling system, the oil reservoir at the bearing is equipped with a cooling coils through which the water circulates. This circulating water must present at the bearing inlet a temperature smaller or equal to the ambient one in order to make the cooling possible.

The water pressure must be 0.1 bar and the water flow must be 0.7 L/s. The pH must be neutral.

NOTE: When connecting the cooling coils, leaks in or on the bearings housing and oil reservoir must be avoided so that lubricating oil is not contaminated.

4.2.2.6. LUBRICATION

The oil change of the bearings must be effected every 8000 operating hours, or every time the oil modifies its characteristics. Viscosity and oil pH must be checked periodically.

Oil level must be checked daily which must be kept approximately at the center of the oil level sight glass.

The bearing must be filled with the prescribed type of oil through the oil port after removing the pipe plug.
All holes and threads not used are to be closed by pipe plugs. Also check all connections for oil leaks.
Filling the bearing with lubricant beyond the middie of the oil sight glass (II) does not impair the function of the bearing, but there is a possibility that excess oil may leak out through the shaft seals.

IMPORTANT:
The cares taken with bearing lubrication will determine the life for such bearings as well as the assurance of motor operation. For this reason, it is essential to follow these recommendations:

- The oil selected must have a viscosity suitable for the bearing operating temperature. This must be checked during eventual oil change or during periodical maintenances.
- If the bearing is filled with oil bellow the required oil level, or if the oil level is not checked periodically, insufficient lubrication may lead to damage to the bearing liner. The minimum oil level is reached when the oil can just be seen in the oil sight glass when the machine is not in operation.

4.2.2.7. SHAFT SEALS

The two halves of the floating labyrinth seal are held together by a garter spring. They must be inserted into the groove of the carrier ring in such a way that the stop pin is always in the corresponding recess in the upper half of the housing or carrier ring. Incorrect installation destroys the seal.

The seal is to be carefully cleaned and coated with a nonhardening seating compound on the faces in contact with the grooves. The drain holes in the lower part of the seal must be clean and disobstructed. When installing the bottom half of the seal, press it lightly against the underside of the shaft.
An additional sealing is installed inside the motor to prevent sugging of oil due to low pressure generated by the motor cooling system.

4.2.2.8. OPERATION

The operation of motors fitted with sleeve bearings is similar to motors fitted with roller bearings.
It is recommended that the oil circulating system be accompanied carefully and also the first hours of operation.
Before the start-up, check the following:

- If the oil used has been prescribed accordingly.
- Characteristics of the lubricating oil.
- Oil level.
- Alarm and tripping off temperatures set for the bearings (100ºC for alarm and 120 C for tripping off).

During the first start-up, check for vibrations or noises. In case bearing operation is not quiet and not uniform, motor is to be stopped at once.
Motor must operate for several hours until the bearing temperature is fixed within the limits previously indicated. If a temperature overheating occurs, motor must be stopped immediately and the temperatures detectors checked.
When bearing operating temperature is reached check for any oil leakage by the plugs joints or by the shaft end.

4.3. AIR GAP CHECKING (Large ODP motors)

After disassembly and assembly of the motor it is necessary to check the air gap measurement between the stator and the rotor by using appropriate gauges. The gap variation at any two vertically opposite points must be less than 10% of the average air gap measurement.

4.4. SLIP RINGS (For slip ring motors)

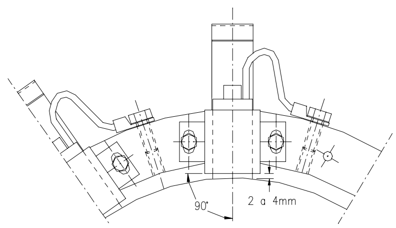
Rings must be accurately centered as at high speed the mechanical vibrations cause contact faults, which in turn cause sparking. Rings must also be kept clean and polished.
As a general rule, cleaning should be done monthly in order to remove the dust accumulated between the rings (see item 4.10). Stained or slightly rough ring surfaces can be polished with fine sandpaper. Oval or rough surfaced rings will require machining and

repolishing to avoid wear problems to brushes and brush-holders.

4.5. BRUSH HOLDERS

Brush holders must be set radially to the slip ring and adjusted approximately 4mm away from the contact surface to avoid brush rupture or injury (Fig. 4.4).

CORRECT



INCORRECT

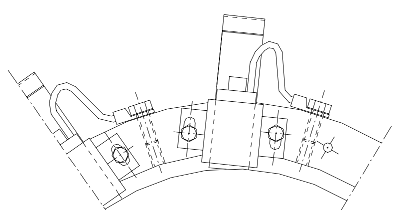


Figure 4.4. - Air gap between brush holder and ring contact surface.

OBS.: Brushes must be checked weekly to ensure free sliding inside the brush-holder.

4.6. BRUSHES (For slip ring motors)

There is a factory-specified brush type for each electric motor fitted with slip rings.

NOTA: *In case motor is operating below its rated output (low load) or intermittent load, the set of brushes (brush type and quantity) must be adjusted to the actual operating conditions, avoiding in this way motor damage. This adjustment must be done with the help of Weg Máquinas.*

Never use assorted brushes of different types on the same rings. Any change of brush type must be authotized by WEG Máquinas, as different brushes cause performance alterations to the machine in operation.

Brushes should be constantly checked during operation. Any brush presenting signs of wear should be exceeding the mark indicated figure 4.5, immediately replaced.
At the time of replacement and whenever feasible, all brushes should be replaced. Having replaced the first one, the second brush should be replaced after a suitable running-in-period.
Replacement brushes should be sanded to set perfectly on the ring surface curvature (min. 75%).

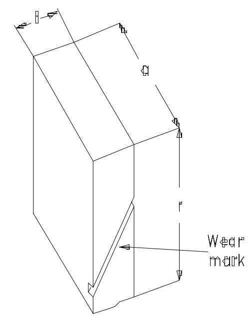


Figure 4.5

On machines that always rotate in the same direction, the brushes should be set in a single direction only. During the backward movement of the shaft the brushes must be lifted (fig.4.6)

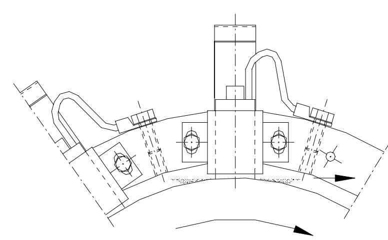


Figure 4.6

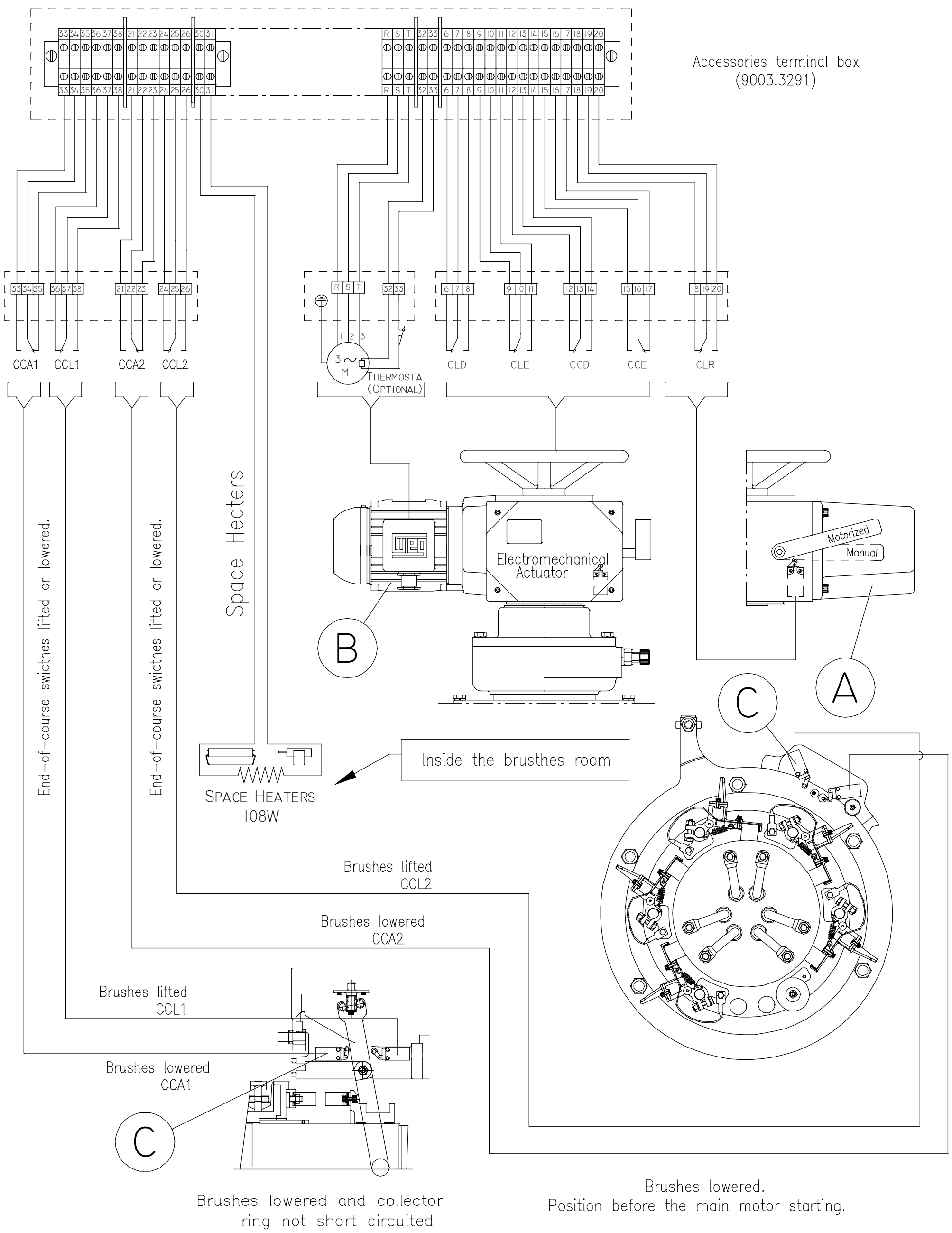
Brush pressure control is done by dynamometer. "Tired" springs should be replaced.

4.7. LIFTABLE BRUSH HOLDERS

4.7.1. CONNECTION DIAGRAM

MOTORIZED OPERATION:
Condition: Lifted brushes and short circuited collector ring.
In order to assure the brushes are lowered, the switches:
CCL1 - contacts 34 and 35,
CCL2 - contacts 22 and 23,
CCE - contacts 13 and 14, must have the contacts simultaneously closed (logic "AND").
At this logic the motor is in ready to run.

Description of components:
A - Electromechanical Actuator ATIS
Type: MAI-25.B3.d9-25.10-F10-2CC-2CT-IP65
B - Three Phase induction motor FS 71
6 pole, 0.25kW, Mounting B3L, IPW55
Flange C105-DIN 42948
Voltage and frequency as per client request.
C - End-of-course
Type XCK-P121 - Telemecanique



Condition: Lifted brushes and short circuited collector ring.

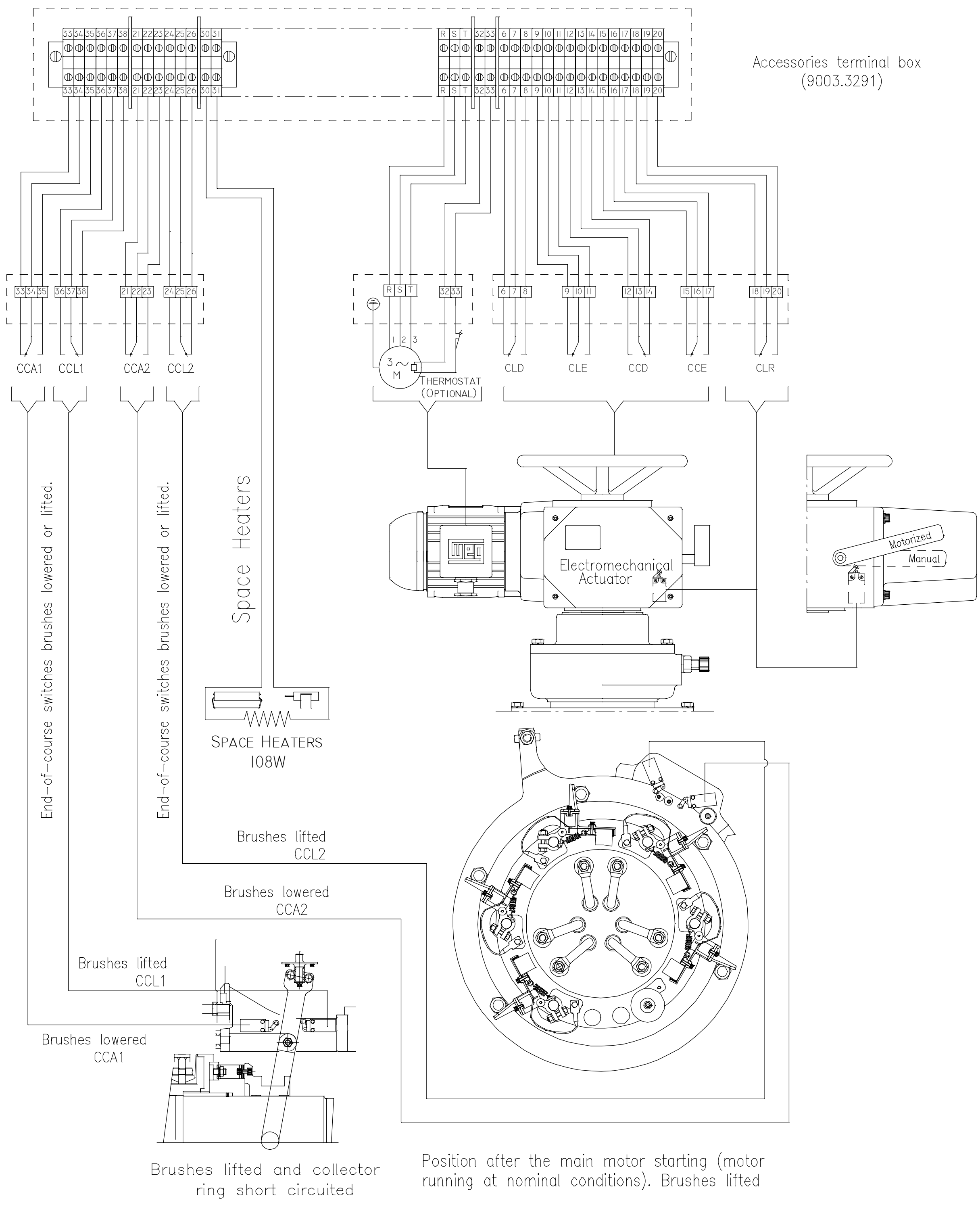
In order to assure the brushes are lifted, the switches:

CCL1 - contacts 37 and 38,

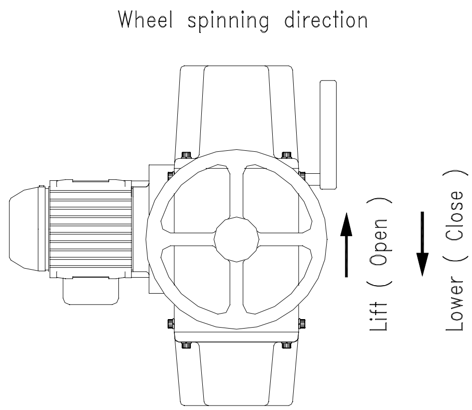
CCL2 - contacts 28 and 29,

CCE - contacts 16 and 17, must have the contacts simultaneously closed (logic "AND").

At this logic the motor is in continuous operation.

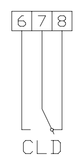


MANUAL OPERATION:



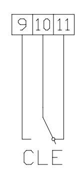
Simbology:
CLD = Torque switch for overload switching off during lowering of the brushes (or phase reversion).

In case of fault on the CCD.



CLE = Torque switch for overload switching off during lifting of the brushes (or phase reversion).

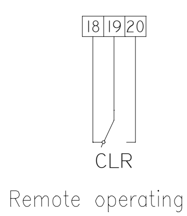
In cause the fault on the CCE.

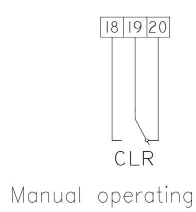


CCD = End-of-course switch for switching off when brushes are totally lowered.

CCE = End-of-course switch for switching off when brushes are totally lifted.

CLR = Selecting switch indicating manual or motorized position.





ADDITIONAL END-OF-COURSE SWITCHES FOR SIGNALIZATION.

CCL1 and CCL2 = End-of-course to indicate when the brushes are totally lifted.

CCA1 and CCA2 = End-of-course to indicate when the brushes are totally lowered.

4.7.2. OPERATION

Brush position or through a signal coming from the CCE switch which indicates the brush position, totally lowered.
In case the signal is not indicating the brush position totally lowered, motor can not be started before adjusting the commanding switch to the position of
brushes totally lowered.
This can be done manually through the flywheel (7), operating the lever (8) or automatically operating the brake motor (9). If the manual system(7) is used, the lever (8) returns automatically to the previous position operating the brake motor (9). Under this condition (brushes totally lowered), the rings (5) are not short-circuited, allowing in this way a series connection of the external resistances (rheostat) with the rotor winding through the brushes (6).

NOTE: Perform the commanding tests with the complete liftable brush holder system before running the motor under load.

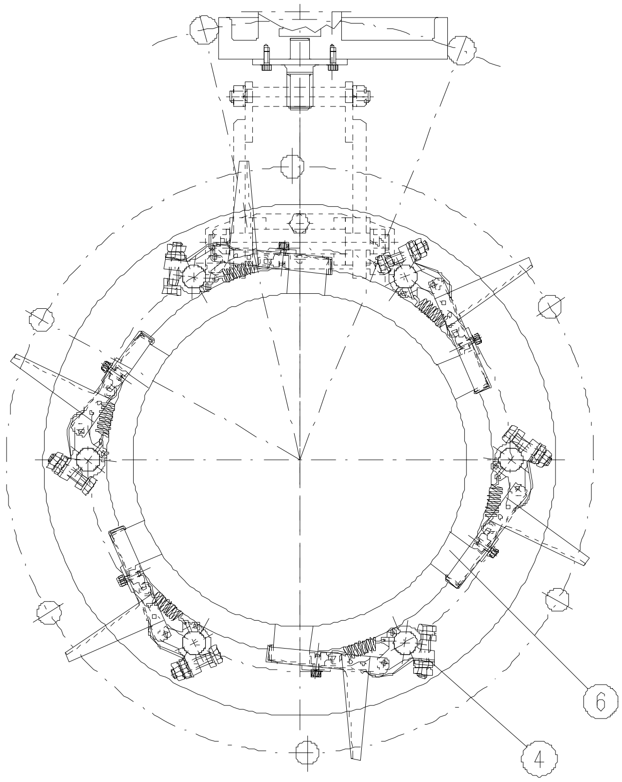
4.7.2.1. PROCEDURE AFTER MOTOR STARTING

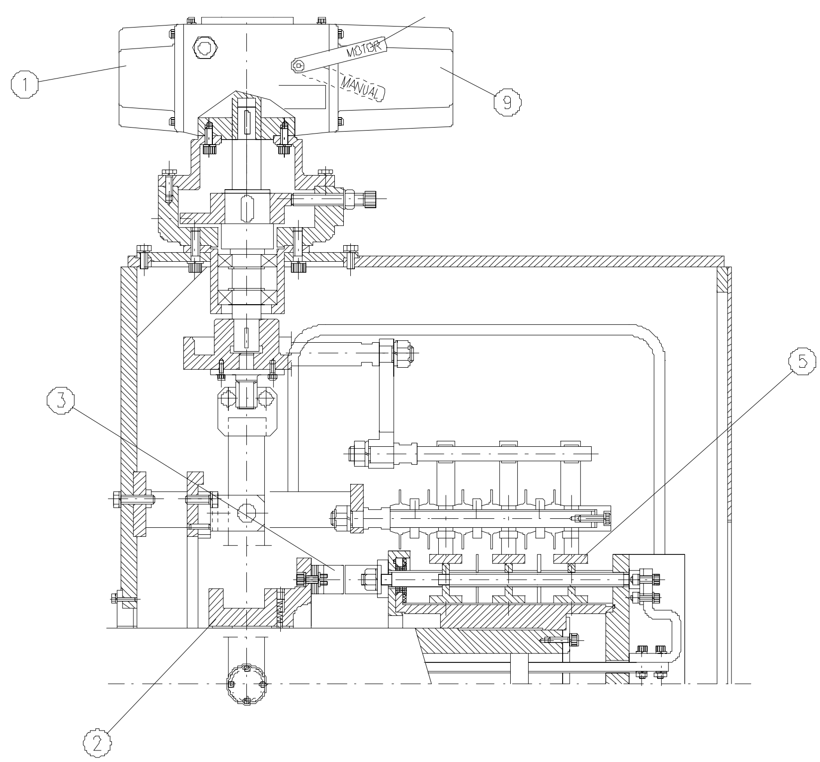
At the moment motor has reached its rated speed, the short-circuit procedure of the collector rings must be started, operating the lifting and short-circuit device (1), on the reserve way, through the brake motor (9), or manually through the flywheel (7).
The short-circuit is done through the slide brushing (2) which holds the silver contacts (3). Furtherly, the brush lifting mechanism (4) is operated.
When brushes are totally lifted, the device is automatically switched-off through the CCE switch.

NOTE 1: The automatic brush lifting system is provided with an overload protection system for the operation brake motor (9), through the torque switches for overload switching off during lowering (CLD) or lifting of brushes (CLE).

NOTE 2: Before motor start up, make sure CLD, LE, CCD and CCE switches are correctly connected to the panel.

NOTE 3: When one of the CLE or CLD switches operate, the rense of the system must be avoided before checking the reason they have operated.





4.7.3. ASSEMBLY

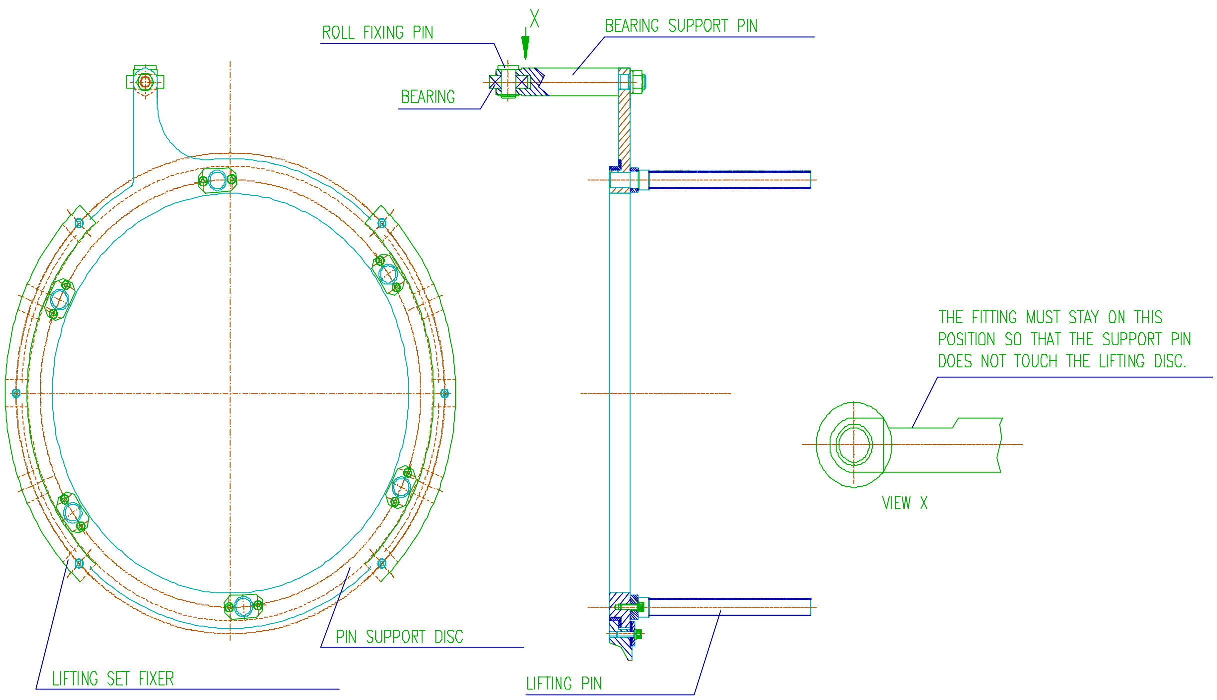
4.7.3.1. BRUSH HOLDER LIFTING DEVICE

1) Fix the pin support disc with the lifting set fixer on the protection box of the brush holder set.

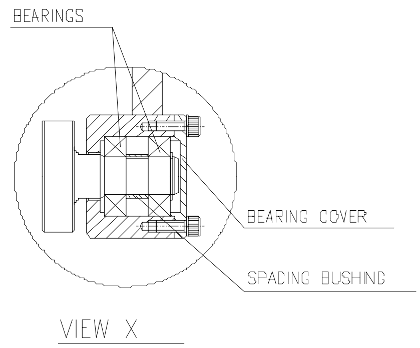
2) Mount the bearing in the support pin and fix with a fixing pin witch must be fixed with a retaining ring.

3) Fix the bearing support pin on the support disc.

NOTE: Bearing support pin: 6305 2ZRS1.



4.7.3.2. SHORT-CIRCUIT BUSHING MOVEMENT SET

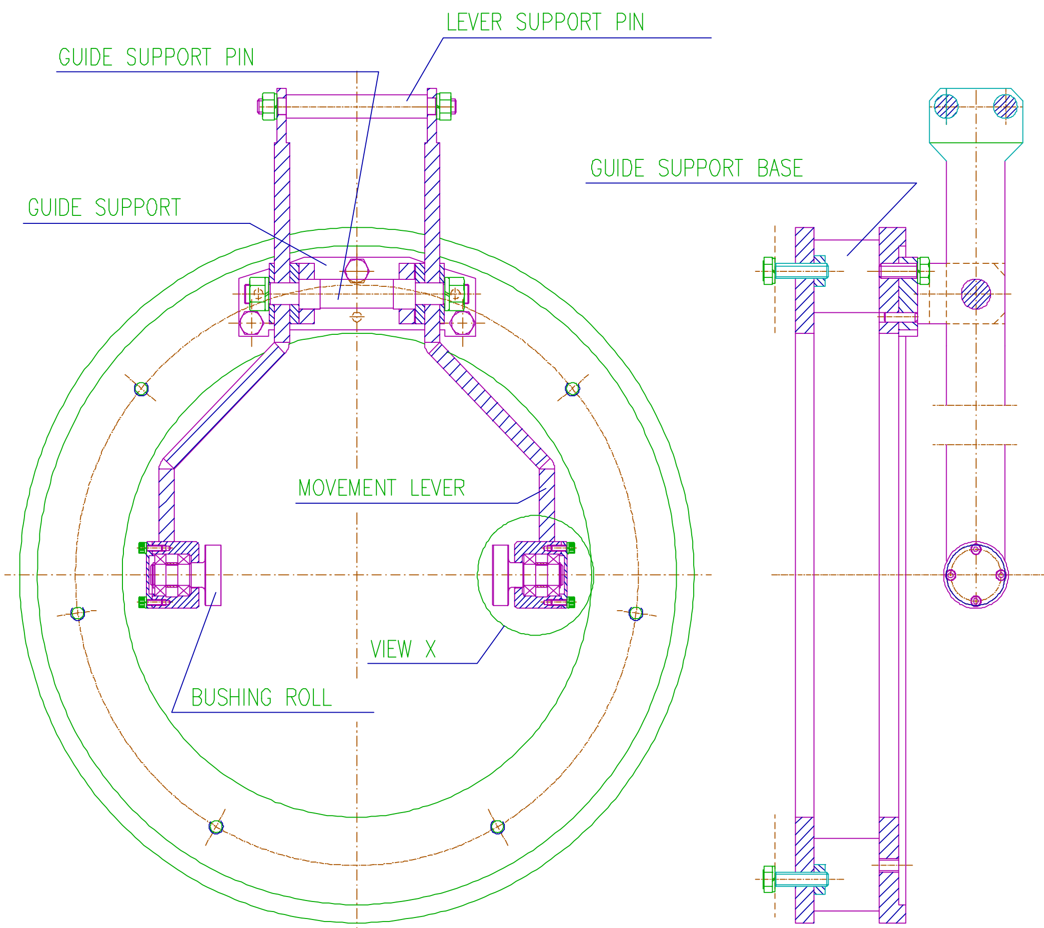


1) Mount the roll on the roll bearing on short bushing movement lever, and then the bearings, the spacing bushing and fix the bearing cover.

2) Fix the upper pins on one of the movement levers.

3) Mount the support pin on the movement lever.

4) Fix the guide support on the support base and the movement lever on the support. The rolls must be aligved with the short circuit bushing in such way that both touch the bushing simultaneously.



4.7.3.3. BRUSH HOLDER OPERATION SET

1) Mount the bearing on the shaft and fix it with retaining rings. Then put a retaining ring to hold the second bearing. After that, mount it with retaining ring.

2) Mount and fix the disc on the operation shaft.

3) Insert the operation shaft in the set flange.

4) Fix the lifting disc on the operation shaft.

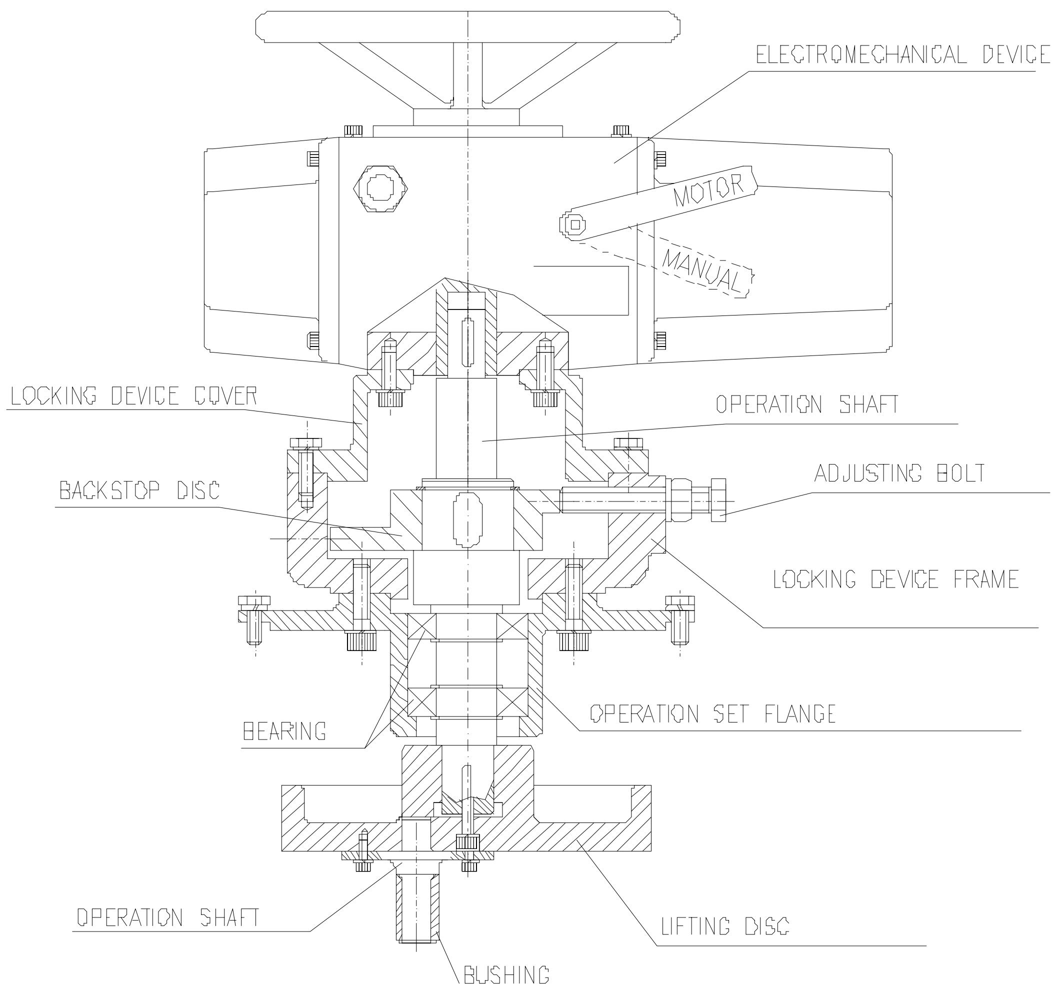
5) Mount the bushing on the lever operation shaft and fix it with a retaining ring. Fix the shaft on the operation disc.

6) Fix the locking device cover on the electromechanical device and then fix it to the device frame.

7) Fix the operation set on the brush holder protection box.

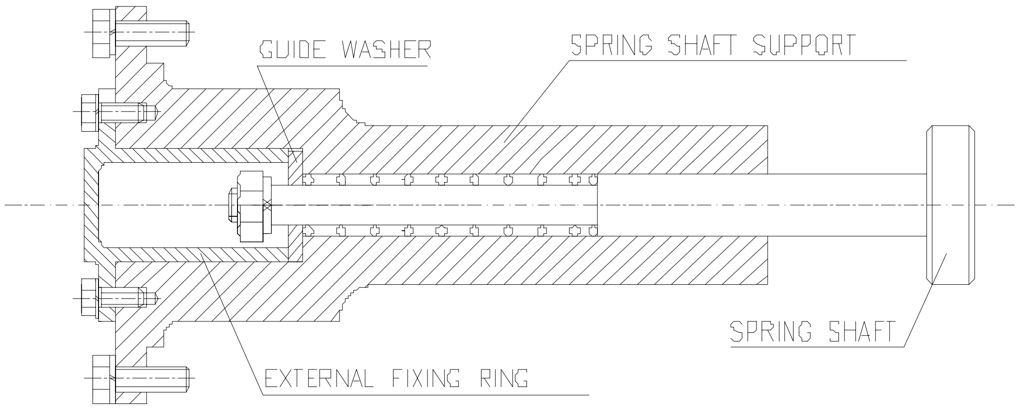
NOTE 1: The operation shaft must be fitted between the upper pins of the lifting lever.

NOTE 2: All the parts touching mechanically must be lubricated. After 6 months of use, check the lubrication of such parts.



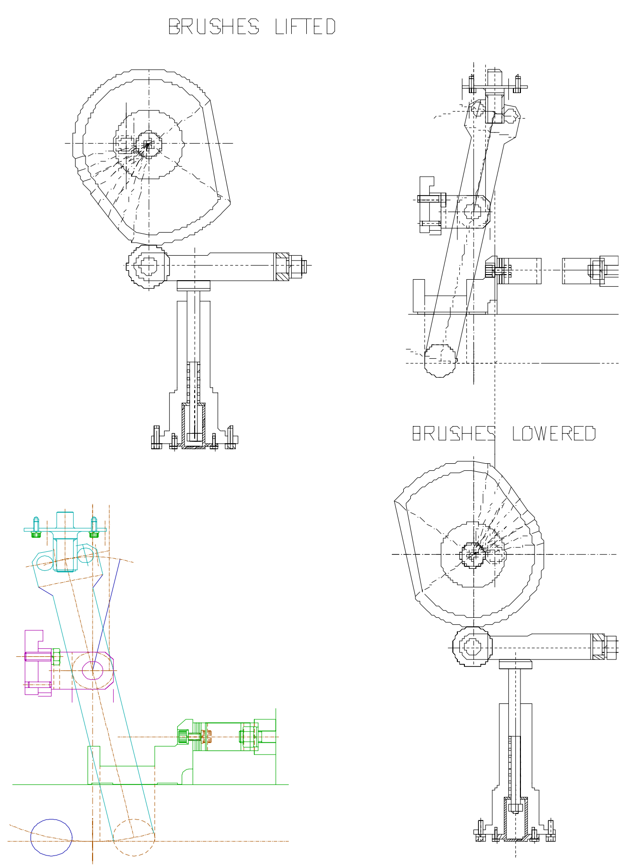
4.7.3.4. RETURN PIN SET

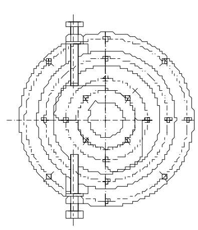
1) Mount the spring shaft on the shaft support. Mount the shaft guide washer; fit it on the shaft and lock it on the shaft and lock it with a nut.
2) Close the set with an external fixing ring and fix on the brush holder protection box.



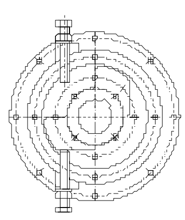
4.7.3.5. BRUSH HOLDER SET

1) Fix the brushes on the brush holder.
2) Fix the isolated pins on the support; mount the isolated discs, brush holders and contact rings on the pins.
3) Adjust the curvature ray existing on the brushes with the collector rings and put a sandpaper between brush and ring. The sandpaper must be moved back and forth in order to make a better fitting of the brush ray with the ring ray. Unfasten the brush holder fixing bolt and turn the brush holder clockwise until the brush ray matches perfectly the ring.





POSITION NON SHORT-CIRCUITED



POSITION SHORT-CIRCUITED

4.7.4. DISASSEMBLY

For the disassembly of the liftable brush holder, proceed in the reserve way in relation to assembly procedures.

4.7.5. ADJUSTMENT OF THE BRUSH LIFTING SYSTEM

1) Turn the lifting disc up to the short-circuit position and then turn it a bit more to release the rolls to avoid unnecessary thrusts on the roller bearings.

2) Fasten the adjusting bolt up to the backstop disc and then lock the adjusting bolt.

3) Turn the lifting disc up to the position of non short-circuit (brushes lowered) and repeat the same procedure carried out for the short circuit position.

4.8. DRYING OF THE WINDINGS

It is recommended that this task be undertaken carefully and by qualified personnel. The rate of temperature rise should not exceed 5ºC per hour and the winding should not be heated up to more than 150ºC.
Excessive temperature as well as too quick temperature rise can generate steams which damage the windings. During the drying process, the temperature should be controlled carefully and the insulation resistance should be measured at regular intervals.
In the beginning, the insulation resistance will decrease due to the temperature increase, but it will increase during the drying process.
The drying process should be continued until successive measurements of the insulation resistance show a constant insulation resistance which should be higher than the minimum value specified, as indicated in item 2.3.3.
It is important to provide a good ventilation inside the motor during the drying process assuring that the moisture is removed effectively.

4.9. DESMANTLING AND REASSEMBLY

4.9.1. " MASTER" LINE

A) Squirrel-cage rotor:

DRIVE-END:

1) Remove the heat exchanger (if any).
2)
3) Remove the temperature detectors from the bearing (if any).
4) Unscrew the bolts which fasten the bearing assembly.
5) Remove the external bearing caps (for roller bearing motors).
   4.1. For ball bearing motors, follow the procedures described in item 4.2.2.2.
6) Unscrew the bolts of the endshield. After being removed, the bolts should be screwed endshields in order to force its removing. To prevent the rotor falling onto the rotor, provide a support for it.
7) Remove the bearing(s) (for roller bearing motors).
8) Remove the internal bearing cap (for roller bearing motors).

NON DRIVE-END

1) Unscrew the protecting screen of the fan (enclosed motors).
2) Remove the fan by unscrewing the bolts which fasten it on the shaft.
3) Loosen the four nuts which fasten the fan cover and remove it.
4) Repeat the procedures 2 to 7 of previous paragraph.

B) Slip Ring Motors:

DRIVE-END:

The procedures are the same as for squirrel cage rotor motors.

NON DRIVE-END:

1) Remove the back protecting cover of the brush holders.
2) Disconnect the cables from the collector ring. Dismantle the brush holders.
3) Unscrew the brush holder protecting box from the cooling box. Remove the collector rings and the ventilating.
4) Repeat the procedures 2 to 4 as mentioned for disc.
5) the dismantling of the "Non drive-end" of squirrel cage rotor motors.

4.9.1.1. ROTOR REMOVING

Remove the rotor from the inside of the stator by means of hoisting ropes or other devices. The device must avoid that the rotor rubs on the stator or on the coil heads.

4.9.2. " A " AND " H " LINES

DRIVE-END:

1) Disconnect the space heater leads from the terminal boxes.
2) Remove the bearing temperature detectors (if any).
3) Unscrew the bolts of the bearing assembly.
4) Remove the external bearing caps (for roller bearing motors). For ball bearing motors, follow the procedures described in item 4.2.2.2.
5) Unscrew the endshield. By using an appropriate tool, force the endshield to release and at the same time turn it to help the removal. Make sure that the shaft is held on a plate and so an eventual fall of the rotor on the stator is avoided.
6) Remove the bearing(s) (for roller bearing motors).
7) Remove the internal bearing cap.

NON DRIVE END:

1) Remove the fan cover.
2) Release the fan retaining ring.
3) Repeat the procedures from 2 to 7 of item 4.8.2. (a).

NOTE:

1) For removing of rotor, observe section 4.8.1.1.
2) It is not necessary to remove the stator from the frame to perform an eventual rewinding.

4.9.3. FAF LINE

A) Drand "H" lines.

B) Non drive end:

1) Repeat the procedures 1 to 3 of item 4.8.2 (b).
2) Remove back protecting cover of the brush holder.
3) Disconnect the cables from the collector ring.
4) Remove the brushes and dismantle the brush-holder.

4.10. GENERAL ADVICES

Any damaged part (cracked, or distorted machined parts, damaged threads) should be replaced and never recovered.
All services herewith described should be undertaken by qualified personnel in order not to damage the equipment. In case of further doubts, contact WEG Máquinas.

4.11. MAINTENANCE SCHEDULE

COMPONENT	DAILY	WEEKLY	EVERY 3 MONTHS	YEARLY (PARTIAL MAINTEN.)	EVERY 3 YEARS (COMPLETE MAINTEN.)
- Complete motor.	- Check the noise and the vibration levels.		- Drain condensed water (it any).	- Retighten the bolts.	- Dismantle the motor. Check spare parts.
- Winding of the stator and rotor.				- Visual inspection. Measure insulation resistance.	- Cleanliness: check the fastenings and the slot wedges; measure the insulation resistance.
- Bearings.	- Check the noise level.	- Regrease; for intervals see the greasing plate.			- Clean the bearings. Replace them, if required, check bearing liner and replace it, if required (sleeve bearing) check sleeve race (shaft) and rebuild, if required.
- Terminal boxes and grounding lugs.				- Clean the inside area retighten the bolts.	- Clean the inside area retighten the bolts.
- Coupling: follow the maintenance instructions contained in the manual of the coupling manufacturer.		- After the first week of operation: check the alignment and fastening.		- Check alignment and fastening.	- Check alignment and fastening.
- Monitoring devices.	- Record the measurement values.				- If possible, disassemble and check its operating condition.
- Filter.			- Clean it, if required.	- Clean it, if required.	- Clean it (see section 4.1.2).
- Slip rings area.		- Inspect the cleanliness and clean it, if required.		- Check the cleanliness and clean it, if required.	
- Slip rings.		- Check surface and contact area.			
- Brushes.		- Check and replace them when 2/3 of their height is worn (check wear mark in fig. 4.5).			
- Air/air heat exchanger.					- Clean the pipes of the heat exchanger.

5. SPARE PARTS

5.1. HOW TO ORDER

When ordering spare parts, motor type and serial number must be always given as indicated on the nameplate or on the frame.

5.2. KEEPING STOCK

It is recommended to keep in stock the spare parts that, under normal use, can have some kind of wear such as:

6. ABNORMAL SITUATIONS DURING OPERATION

The majority of the abnormal situations during operation that affect the running of electric motors can be avoided by a predictive maintenance.
Sufficient ventilation, cleanliness and careful maintenance are the main factors. A further essential factor is the prompt attention to any abnormal situation such as vibrations, shaft knocks, declining insulation resistance, smoke or fire, sparking or unusual slip ring or brush wear, sudden changes of bearing temperature.
When failures of an electric or mechanical nature arise, the first step to be taken is to stop the motor and perform a subsequent examination of all mechanical and electrical parts of the installation.
In the event of having a fire, the motor should be disconnected from the power supply, which is normally done by turning off the respective switches.
In case of starting of fire inside the motor itself, steps should be taken to retrain and suffocate it by covering the ventilation openings. To extinguish a fire, dry chemical or CO² extinguishers should be used. Never use water.

6.1. COMMON FAILURES ON INDUCTION MOTORS

Motors built by WEG Máquinas are normally designed for Class F insulation (155ºC) and for ambient temperatures up to 40ºC(as indicated on the motor nameplate). Most winding failures occur when temperature limits, due to current overload, are surpassed throughout the winding or even in only portions thereof. These failures are identified by the darkening or carbonizing of the wire insulation.

6.1.1. SHORT BETWEEN TURNS

A short circuit between turns can be a consequence of two coincident insulation defects, or the result of defects arising simultaneously on two adjacent wires.
In some cases, the three-phase current imbalance can be so insignificant that the motor protective device fails to react. A short circuit between turns, and phases to ground due to insulation failure is rare, and even so, it normally occurs during the early stages of operation.

6.1.2. WINDING FAILURES

a) One winding phase burnt
This failure occurs when a motor runs wired in delta and current fails in one power supply conductor. Current rises from 2 to 2.5 times in the remaining winding with a simultaneous drop of speed. If the motor stops, the current will increase from 3.5 to 4 times its rated value. In most cases, this defect is due to lack of a protective switch, or because this switch has been set too high.

b) Two winding phases burnt
This failure occurs when current fails in one power supply conductor and the motor winding is star-connected. One of the winding phases remains currentless while the other absorb the voltage and carries an excessive current. The slip almost doubles.

c) Three winding phases burnt.
- **Probable cause 1:**
Motor protected only by fuses. An overload on the motor will be the cause of the trouble. As a consequence, progressive carbonizing of the wires and insulation will generate a short between turns, or a short against the frame. A protective switch placed before the motor would easily solve this problem.

- **Probable cause 2:**
Motor incorrectly connected.
For example: a motor with windings designed for 220/380V is connected through a stat-delta switch of 380V. The drawn current will be so high that the winding will burn out in a few seconds if the fuses or a protective switch incorrectly set fail to react promptly.

- **Probable cause 3:**
The star-delta switch is not commutated and the motor continues to run for a certain time connected to the star under overload conditions. As it only develops 1/3 of its torque, the motor cannot reach rated speed. The increase of slip

results in higher ohmic losses arising from the Joule effect. As the stator current, consistent with the load, may not exceed the rated value for delta connection, the protective switch will not react. Consequent to increased winding and motor losses the motor will overheat and the winding will burn out.

- **Probable cause 4:**
Failures from this cause are caused by thermal overload, due to excessive starts under intermittent operation or to an overly long starting cycle.
The perfect functioning of motors operating under these conditions is only assured when the following values are taken into account.

a) Number of starts per hour;
b) starting with or without load;
c) Mechanical brake or current inversion;
d) Acceleration of load connected to motor shaft;
e) Load torque related to speed during acceleration and braking.

The continuous effort withstood by the higher rotor during intermittent starting brings about losses which provoke overheating. Under certain circumstances, there is a possibility that the stator winding be subject to damage with the motor stopped as a result of the heating on the motor.

6.1.3. ROTOR FAILURES (SQUIRREL CAGE)

If a motor running under load conditions produces a noises of varied intensity and decreasing frequency while the load is increased, the reason, in most cases, will be an unsymmetrical rotor winding.
In squirrel-cage motors the cause will nearly always be a break in one or more of the rotor bars; simultaneously, periodical stator current fluctuations may be recorded. As a rule, this defect appears only in molded or die cast aluminum cages. Failures due to spot heating in one or another of the bars in the rotor care are identified by blue coloration at the affected points.
If there are failures in various contiguous bars, vibrations and shuddering can occur. When the rotor core gets a blue or violet coloration, it is a sign of overloading.
This can be caused by overly high slip, by too many starts or overlong starting cycles. This failure can also come from insufficient power supply voltage.

6.1.4. SLIP RING ROTOR FAILURES

A break in one phase of the rotor winding is noticed by a strong noise that varies according to the slip and, in addition, stronger periodical stator current fluctuations occur.
It is possible, but rarely so, that a rupture could have occurred in the connection between the winding and the slip ring. However, it is advisable to first check if there is a break in the rheostat starter connection, or even in the part itself.

6.1.5. SHORT BETWEEN TURNS ON SLIP RING MOTORS

This abnormal situation occurs only under extremely rare circumstances. Depending on the magnitude of the short circuit, the start can be violent even if the rheostat is at the first tap of its starting position. In this case, heavy starting currents are not carried through the rings and so no burn marks will be noticed on them.

6.1.6. BEARING FAILURES

Bearing failure are the most frequent causes for delayed breakdowns.
The most common reasons for this failure are identified as excessive vibration, incorrect operation, bad alignment, unbalanced couplings, excessive radial and/or axial loads.
Check item 4.2 for bearing maintenance.

6.1.7. SHAFT BREAKING

Although bearings traditionally constitute the weakest. part, and the shafts are designed with wide safety margins, it is possible that a shaft may break by fatigue from bending stress caused by excessive belt tension. In most cases, breaking occur right behind the drive end bearing.
As a consequence of alternating bending stress induced by a rotating shaft, breaking travel inwards from the outside of the shaft until the point of rupture is reached when resistance of the remaining shaft cross-section no longer suffices. At this point, avoid additional drilling on the shaft (fastening screw holes) as such operations tend to cause stress concentration.
The replacement of only one or two belts of a belt drive system is frequently a cause of shaft breaking, besides being an incorrect practice.
Any used and consequently stretched belts on a drive system, specially those closer to the motor, while new and unstretched belts are placed on

the same drive but farther from the bearing, can cause shaft stress.

6.1.8. DAMAGE ARISING FROM POORLY FITTED TRANSMISSION PARTS OR IMPROPER MOTOR ALIGNMENT

Damaged to bearing and breaking of shafts are often resulted from inadequate fitting of pulley, couplings or pinions on the shaft.
These parts "knock" when rotating. The defect can be recognized by the scratches that appear on the shaft or the eventual scalelike flaking of the shaft end. Keyways with edges pitted by loosely fitted keys can also cause shaft failures.
Pooly aligned couplings cause knocks and radial and axial shaking to shaft and bearings. Within a short while, these bad practices cause the deterioration of the bearings and the enlargement of the bearing on the drive end side. In other cases, motor shaft can break.

6.2. ABNORMAL SITUATIONS DURING OPERATION

NOTE: The following chart presents a list of abnormal situations during motor operation, the probable cause for such abnormal situations, and the corrective measures. In case of further doubts, contact Weg Máquinas.

ABNORMAL SITUATION	PROBABLE CAUSE(S)	CORRECTIVE MEASURE(S)
- Motor fails to start, neither coupled, nor uncoupled.	- At least two feeding conductors are broken, no voltage supply. - The rotor is locked. - Brushes problem. - Bearing is damaged.	- Check commanding board, switch, fuses, power supply conductors, terminals and setting of brushes. - The brushes might be worn or set incorrectly. - Replace the bearing.
- Motor starts very slowly with load and does not reach rated speed. - Motor starts under no load, but is fails when the load is applied .	- Too high load during start. - Supply voltage too low. - Too high voltage drop on the feeding conductors. - Rotor bars damaged or interrupted. - One supply conductor remained interrupted after the starting.	- Do not apply load on the machine during start. - Measure supply voltage, set the correct value. - Check the cross section of the feeding conductors. - Check and repair the rotor winding (squirrel cage), test the short circuit device (slip ring). - Check the supply conductors.
- Stator current changes with double frequency of the slip; during start humming can be heard.	- Rotor winding is interrupted. - Brushes problem.	- Check and repair rotor winding and short-circuit device. - Clean, set correctly or replace the brushes.
- No load current too high.	- Supply current too high.	- Measure the supply voltage and set it to the correct value.
- Rapid overheating of the stator, there is a humming during the operation.	- Parallel or in phase connected wires of the stator winding are broken.	- Measure the resistance of all winding phases. Replace the stator core with the winding.
- Areas of heating on the stator winding	- Short between turns. - Interruption of conductors connected in parallel or in phase of the stator winding - Poor connection.	- Rewind the motor. - Remake the connections.
- Areas of heating on the rotor.	- Interruption in the rotor winding.	- Repair the rotor winding, or replace it
- Abnormal noise with motor connected to load.	- Mechanical problems. - Electric problems.	- Noise decreases generally with the speed drop; see also "Noisy operation when uncoupled" - Noise disappears when motor is switched on. Contact the manufacturer
- Noise occurs when coupled and disappears when not coupled.	- Failure in the drive components, or on the driven machine. - Failure on the gearing. - Coupling problem. - Foundation is sunk. - Poor balancing of the parts or of the driven machine. - Supply voltage too high. - Direction of rotation is not correct.	- Check the power transmission, coupling and alignment. - Align the driving, check the position (coupling) of the gearing. - Align the motor and the driven machine. - Repair the foundation. - Test the supply voltage and the noload current. - Reverse the connections of two phases. - Rebalance the unit.

ABNORMAL SITUATION	PROBABLE CAUSE(S)	CORRECTIVE MEASURE(S)
- Overheating of the stator winding with load.	- Poor cooling due to dirty air tubes. - Load too high. - Excessive number of starts, or the inertia is too high. - Voltage too high and consequently also the iron losses are too high. - The voltage is too low and consequently the current is too high. - One feeding conductor is interrupted, or one phase of the winding is interrupted. - Rotor is rubbing on the stator. - The operation mode does not correspond to the data on the nameplate. - Electrical load unbalanced (blown fuse, incorrect control). - Dirty windings. - Obstructed cooling system. - Dirty filter. - Rotation direction not compatible with the fan used.	- Clean the air tubes of the cooling system. - Measure the stator voltage, decrease the load, use a larger motor. - Reduce the number of starts. - Do not exceed more than 110% the rated voltage, unless specifications on the nameplate are different. - Check the voltage supply and the voltage drop. - Check the current in all phases and make correction. - Check air gap, operation conditions, bearings, vibrations. - Maintain the operation mode as specified on the nameplate, or reduce the load. - Verify if there are unbalanced voltages, or if the two phases are operating. - Clean. - Clean the felt of the filter. - Analyze the fan in relation to motor rotation direction.
- Noisy operation when uncoupled.	- Unbalancing. - One phase of the stator winding is interrupted. - Dirt in the air gap. - Fastening bolts are loose. - Unbalancing of the rotor increase after the assembling of the driving components. Unbalanced rotor. - Foundation resonance. - Motor frame is deformed. - Bent shaft. - Uneven air gap.	- Noisy operation continues during rundown time after switching off the voltage; rebalance the motor. - Test current input of all feeding conductors. - Remove the dirt and clean the air gap. - Tighten and block bolts. - Check balancing. - Level the foundation. - Check the alignment. - The shaft can be bent, check the balancing and the eccentricity of the rotor. - Check if the shaft is bent or if the bearings are damaged.
- Slip ring motor operating at low speed with external resistance disconnected.	- Control circuit conductors too light. - Open circuit on rotor circuits. - Dirt between brush and slip ring. - Brushes gripe on brush holders. - Incorrect pressure on brushes. - Rough surfaces on slip rings. - Eccentric rings. - High current density on brushes. - Brushes incorrectly set.	- Install heavier conductors on control circuit. - Bring control closer to motor. - Test circuit with a magneto, or other means, and undertake necessary repairs. - Clean slip rings and insulation assembly. - Select brushes of correct size. - Check pressure on each brush and adjust it accordingly. - Clean, sand and polish. - Machine on lathe or with portable tool without removing from machine. - Reduce load or replace brushes. - Reset brushes correctly.
- Brush sparking.	- Poorly set brushes with insufficient pressure. - Overload. - Slip rings in poor condition. - Oval slip rings. - Excess of vibration. Rough surfaces and scored rings. - Low load causing damage to slip rings.	- Check brush setting, adjust for correct pressure. - Reduce load or install motor with higher capacity. - Clean rings and reset brushes. - Polish the slip rings and machine the same on lathe. - Balance the rotor, check the brushes for free movement within holders. - Check origin of vibration and correct it. - Adjust the brushes to the actual load requirement and machine the slip rings.

6.3. ABNORMAL BEARING SITUATIONS AND FAILURES DURING OPERATION

NOTE: The following chart presents abnormal bearing situations and failures during motor operation, the probable cause for such abnormal situation and the corrective measures. In certain cases, bearing manufacturer must be contacted to find out the cause of the failure.

ABNORMAL SITUATION	POSSIBLE CAUSE(S)	CORRECTIVE MEASURE(S)
- The motor "snores" during operation.	- Damaged bearings.	- Replace the bearing.
- Bearing noisy, dull spots, grooves in the ball races.	- Bearing was slanting mounted.	- Align the bearing and machine the bearing seat.
- High bearing noise and a high overheating of the bearing.	- Cage corrosion, small chips in the grease, race failure due to insufficient grease, or inadequate clearance.	- Clean and replace the grease according to the specifications. Replace the bearing.
- Overheating of bearings.	- Excessive grease. - Excessive axial or radial strain on belt. - Bent shaft. - Lack of grease. - Hardened grease cause locking on balls. - Foreign material in the grease.	- Remove the grease relief and run the motor until excess grease is expelled. - Reduce belt tension. - Have shaft straightened and check rotor balance. - Add grease to bearing. - Replace bearing. - Flush out housing and lubricant; regress.
- Dark spots on one side of the ball races subsequently the formation of grooves.	- Excessive axial strength.	- Check the condition between coupling and driving.
- Dark lines on the ball races or very close transversal grooves.	- Current on the bearings.	- Clean and replace the bearing insulation. Install an insulation if there was not any. - Branch the current avoiding that it circulates through the bearing.
- Grooves in the races and depressions in the division of the cylindrical elements.	- External vibration, mainly when the motor stopped for a long period of time. - Lack of maintenance during storage.	- If the motor is stopped during a long period, turn the shaft to an other position from time to time. This is mainly required for spare motors.

IMPORTANT:
The motors listed in this manual are constantly updated. For this reason, the information here with included may change without prior notice.

WARRANTY TERMS FOR ENGINEERING PRODUCTS

These products, when operated under the conditions stipulated by WEG in the operating manual for such product, are warranted against defects in workmanship and materials for twelve (12) months from startup date or eighteen (18) months from manufacturer shipment date, whichever occurs first.
However, this warranty does not apply to any product which has been subject to misuse, misapplication, neglect (including without limitation, inadequate maintenance, accident, improper installation, modification, adjustment, repair or any other cases originated from inadequate applications).
The company will neither be responsible for any expenses incurred in installation, removal from service, consequential expenses such as financial losses nor transportation costs as well as tickets and accommodation expenses of a technician when this is requested by the customer.
The repair and/or replacement of parts or components, when effected by WEG within the Warranty period do not give Warranty extension, unless otherwise expressed in writing by Weg.
This constitutes WEG's only warranty in connection with this sale and is in lieu of all other warranties, expressed or implied, written or oral.
There are no implied warranties of merchantability or fitness for a particular purpose that apply to this sale.
No employee, agent, dealer, repair shop or other person is authorized to give any warranties on behalf of WEG nor to assume for WEG any other liability in connection with any of its products.
In case this happens without Weg's authorization, Warranty is automatically cancelled.

LIABILITY

Except as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products", the company shall have no obligation or liability whatsoever to the purchaser, including, without limitation, any claims for consequential damages or labor costs, by reason of any breach of the express warranty described therein.
The purchaser further hereby agrees to identify and hold the company harmless from any causes of action (other than cost of replacing or repairing the defective product as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products", arising directly or indirectly from the acts, omissions or negligence of the purchaser in connection with or arising out of the testing, use, operation, replacement or repair of any product described in this quotation and sold or furnished by the company to the purchaser.

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