SICMEMOTORI
WIND OF INNOVATION

INSTALLATION, USE AND MAINTENANCE INSTRUCTIONS

FOR

DIRECT CURRENT MACHINES

"MILL" MOTORS

SERIES "SM" - "ML"

FRAMES SM 802 - 804
FRAMES ML 806 - 818

ATTENTION!

SICMEMOTORI electrical machines are used in industrial environments. During functioning they can be a source of danger, both for persons and objects. Correct installation, commissioning and maintenance are therefore indispensable. Do not remove or modify protections.
These instructions do not claim to cover all possible problems and cases that may occur during use of the electric motors. SICMEMOTORI must be informed immediately about any problem not considered by these instructions.

Cod. M-CC-MILL-E-10

INDEX

IMPORTANT NOTES

To highlight the dangers that the operator using the rotating electrical machines may face, the various operations or situations will be indicated in bold writing and/or with the following warnings, depending on the degree of hazard:

DANGER!
Operations and/or situations that can lead to serious physical injury even death, if the instructions are not followed scrupulously.

ALARM!
Operations and/or situations that must be followed scrupulously to prevent serious injury to persons and/or damage to the surrounding environment.

Caution!
Operations and/or situations that must be followed scrupulously to prevent serious injury to persons, contamination of the surrounding environment and material damage.

Attention!
Operations and/or situations that require particular attention.

SAFETY PROVISIONS

High voltage and rotating parts can cause serious injury and/or fatal wounds. The use of electric machines therefore can be very dangerous. Installation, functioning and maintenance of electric machines must be carried out by qualified staff, in compliance with applicable standards and regulations in force in the various countries.

For the electric machines, subject of this manual, it is important to comply with safety provisions to protect staff from possible injury. In particular, staff must be informed about:

- **Avoiding contact with live circuits or rotating parts;**
- **Not by-passing or making safety circuits and barriers inoperative;**
- **Avoiding long periods of time near to very noisy machines;**
- **Moving the electric machine using the relevant lifting eye-bolts**
- **Using all precautions and procedures during movement, lifting, functioning and maintenance of the plant.**

The electric machines must be transported, commissioned, maintained and repaired exclusively by qualified staff, with the supervision of an expert who verifies that these operations are carried out correctly. The qualified staff must be must be authorised by the Security Manager of the Company where the machine is to be installed. Regarding this, the IEC364 International Standards prohibits the use of unqualified staff for jobs where electric power is present. Before starting any maintenance procedure, ensure that:

- **The machinery connected to the machine shaft does not cause mechanical rotations;**
- **The machine windings have been disconnected from the electric power supply and there is no possibility of the power supply being applied accidentally;**
- **All accessories associated with machine functioning in the work area have been disconnected from their power supply.**

If the machine is not earthed it may cause fatal injury. The machine and plant must be earthed in compliance with the regulations in force in the various countries.

Any modification of the machine must be authorised in writing by SICMEMOTORI.

Only use the indicated materials (sealers, oils, greases, solvents, etc.).

1. GENERALITIES

1.1 Applicability and Reference Regulations

These instructions can be applied to direct current motors/generators manufactured by SICMEMOTORI, when installed in industrial environments.

This manual is not valid for asynchronous motors/generators installed in environments with explosion risks.

This manual has been drawn up in compliance with 2006/42/EC Machine Directive and UNI EN292-1 and 292-2 Standards.

1.2 Identification of the Manufacturer and the machine

Every direct current machine produced by SICMEMOTORI has an identification plate realised in conformity with IEC 60034-8 Standards. The name plate is shown in Fig. 1.

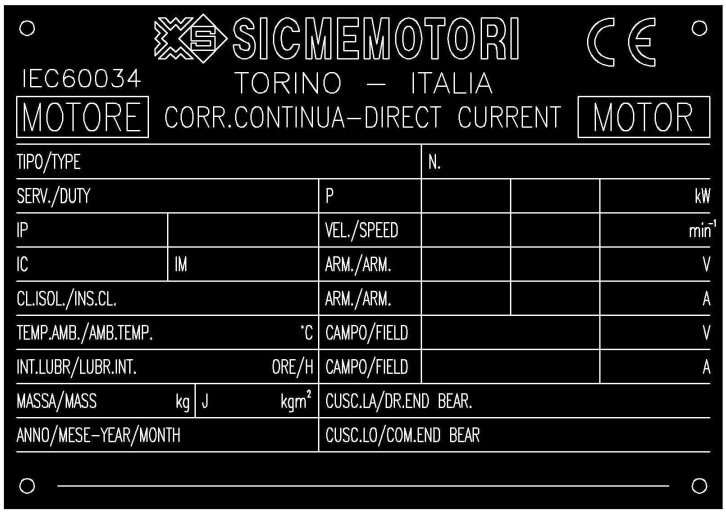


Fig.1

Meaning of the symbols:

TIPO/TYPE	type of motor (according to SICMEMOTORI codes)
N	serial number
P	nominal power
VEL/SPEED	speed
ARM/ARM(V)	armature voltage
ARM/ARM (A)	armature current
CAMPO/FIELD (V)	excitement voltage
CAMPO/FIELD (A)	excitement current
MASSA/MASS	weight of the motor complete with ventilation system
J(kgm^2)	moment of inertia of the rotor
ANNO/MESE-YEAR/MONTH	year/month of manufacture
SERV/DUTY	service
IP	protection level
IC	cooling method
IM	mounting and positions
CL.ISOL/INS.CL	isolation class (the temperature rise is also given if different to class H)
TEMP.AMB/AMB.TEMP.	environmental temperature
CUSC.LA/DR.END BEAR.	drive end bearing
CUSC.LO/COMM.END BEAR.	commutator end bearing
INT.LUBR/LUBR.INT.	bearing lubrication interval

All machines have EC marking.

1.3 Declaration of conformity

The motors described in this catalogue satisfy the essential requisites of the following Directives:
- 93/68/CEE Low Voltage Directive

Reference has also been made to the following directives, specifically for the reasons listed as follows:
- EMC 89/336/EEC (Electromagnetic Compatibility) Directive
- Machine Directive2006/42/CE

The electric motors/generators are components that are incorporated into other machines, systems and plants and therefore the resulting EMC behaviour is under the responsibility of the Manufacturer of the machine or plant incorporating the motor/generator.

With reference to the 2006/42/EC Directive, it must be specified that the motors/generators must be installed in compliance with the installation instructions and cannot be put into service until the machine in which they are incorporated has been declared in compliance with the 2006/42/EC Machinery Directive.

1.4 Use and preservation of this manual. Limitations of use.

This manual has been realised to make the use of this product simple and safe for the staff in charge. The staff must be:

- expert in the use of products destined exclusively to industrial and professional use;
- informed about dangers that can occur from the use of rotating electric machines for power supply voltages up to 1000 V.

On written request SICMEMOTORI will train the client's staff (or final user's) on the correct use and maintenance of the products, both at the installation site and at SICMEMOTORI's establishment. For further information call SICMESERVICE services.

This manual must always be available to the staff in charge of using the motors/generators, and a copy must be preserved (by the user) for future reference.

Other copies and updates can be requested directly from:
SICME MOTORI srl
Strada del Francese 130
10156 Turin – Italy
tel. 011-4076311
fax 011-4500047
e-mail: sicmeservice@sicmemotori.com
can be downloaded from the SICMEMOTORI web site www.sicmemotori.com.

SICMEMOTORI reserves the right to carry out any variation to this manual, which it retains necessary, without the obligation to update previous manuals.

1.5 Assistance networks

SICMEMOTORI has created a network of authorised assistance and repair workshops worldwide. If necessary the user can refer to them directly.
The list of these workshops, which is constantly updated, is published on the SICMEMOTORI web site www.sicmemotori.com, and may be easily downloaded.

1.6 Sicmeservice

SICMESERVICE offers itself for maintenance services for the optimisation of production processes, which cover all electric motors.

The services offered are:

Predictive maintenance
Allows to evaluate the state of the motors in advance and plan any precautionary maintenance when programmed plant standstill takes place.

Precautionary maintenance
Precautionary services are carried out in our workshops, and consist of a series of operations to restore the original state of the motors.

Corrective maintenance
Allows to highlight the necessity for more crucial interventions. Our technical office is able to evaluate the interventions necessary to restore complete functionality.
In the case of uneconomic repair, the technical offices are able to carry out the correct dimensioning for the replacement of **any type of motor of any mark** with one that is technologically more updated.

For information about this service contact:

Sig. A Dolfi
Tel. 0039-011-4076464
Fax 0039-011-4500047
Cell. 0039-348-2716623
e-mail: service@sicmemotori.com

1.7 Liability of the Manufacturer

SICMEMOTORI assumes responsibility for damage to persons or objects attributed by Italian Law Presidential Decree 224 dated 24-05-1988 (which has adopted EEC Directive 85/374) and successive amendments, as long as known and in force at the time of the order. Responsibility will be forfeited if the provisions of these instructions have not been respected, or if the products have been tampered with, for repair or any other cause, by third parties that have not been authorised in writing by SICMEMOTORI.

1.8 Warranty Conditions

SICMEMOTORI guarantees its products for 12 months from the date of delivery. The warranty exclusively concerns manufacturing faults that can be blamed on SICMEMOTORI, which, in the eventuality, has the faculty to choose whether to repair or replace the product or the faulty part. The cost and risk of transport of the faulty part from the Client to SICMEMOTORI is the responsibility of the Client. The warranty is void in the cases of tampering or interventions that have not been authorised by SICMEMOTORI and does not cover product parts that are subject to wear (e.g.: bearings, brushes, filters…). The warranty is also void in the case of failure to comply with the provisions indicated in the INSTALLATION, USE AND MAINTENANCE INSTRUCTIONS, available on request of the Client. The extraction is contained inside the terminal box of all machines supplied by SICMEMOTORI. If a piece must be replaced or repaired, the warranty is renewed only for this piece. The Client cannot object to pay SICMEMOTORI missing payments for the supply depending on the effectiveness of the warranty.
The Client will forfeit the warranty whenever he has omitted the relative declaration for the purpose and effect of art. 1495 1st paragraph of the Civil Code.

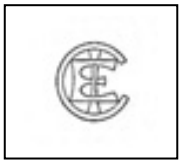
1.9 Important information

For correct use of our machine always take the following information into consideration:

Design and manufacture. In compliance with IEC 60034 Standards, according to table a) indicated below:

IEC	CEI	Title
60034-1	**EN 60034-1**	Rating and performance
60034-2	**EN 60034-2**	Methods for determining losses and efficiency
60034-5	**EN 60034-5**	Classification of protection levels (IP code)
60034-6	**EN 60034-6**	Methods of cooling (IC code)
60034-7	**EN 60034-7**	Types of construction, mounting arrangements and terminal box position (IM code)
60034-8	**EN 60034-8**	Terminal markings and direction of rotation
34-9	**EN 60034-9**	Noise limits
60034-14	**EN 60034-14**	Mechanical vibrations of rotating parts
72-1	**72-1**	Size and power of the rotating machines
1293	**16-8**	Marking of the electrical appliances
UNI ISO 2768/1-2		General tolerance
UNI 9321		Shaft end
73/23/EEC		Low Voltage Directive
89/336/EEC (EMC)		Electromagnetic Compatibility Directive
2006/42/EC		Machine Directive

Table a)



Ratings, operating features and outline dimensions according to A.I.S.E. technical report No. 1 – 1991 / IPSS 1-03-002-94

Tests. All direct current machines produced by SICMEMOTORI undergo complete testing in our Test Room, where their compliance with contractual requirements are verified.

Quality Assurance. All of the production process is managed by the internal Quality Assurance System, which is responsible for compliance to the procedures and manufacture instructions, controls, tests and inspections issued by the internal quality system.
The internal Quality System is controlled by the CSQ (*) in compliance with ISO 9001-2000 European Standards.
(*) The Quality Certification System CSQ is managed by IMQ in collaboration with the CESI, and is part of the CISQ convention (Italian Certification of Quality Systems) and adheres to the EQNET international agreement.

1.10 Limitations of Use

The direct current machines series SM-ML manufactured by SICMEMOTORI are designed for heavy duty in harsh environmental conditions. **Therefore these products are reserved exclusively for professional use.**

Installation environment. It is advisable that the environment is as much clean, dry and cooled as possible. The machine is designed, except when different agreements have been made with the client:

- according to AISE Standards
- for environmental temperatures of –30 +40℃
- for max. height above sea-level of 1000 mt.

Different installation height or temperature conditions, generally lead to variations of the nominal values of performance (consult SICMEMOTORI). See point 1.12 for the lifting problem when the environmental temperature is very low.

Power supply. The machine is envisioned to supply contract performance (power – torque - speed) if powered (armature and field circuits) in nominal conditions, as stated on the plate. Incorrect power supplies can lead to the impossibility to supply contract performance or inefficiency for faults or intervention of the protections

Protections. The machine must be permanently protected against unacceptable power supply or load situations and against the development of faults SICMEMOTORI is always available for collaboration in identifying the most adapt protections for every particular case. Lack of/incorrect calibration or inefficiency of the necessary protections leads to the exclusion of responsibility of SICMEMOTORI in the case of faults or inefficiency.
A Electric protections
The machines are normally supplied with some electrical protections that must be connected and whose functioning must be verified **before machine commissioning**.
The machines must also be **earthed** before commissioning (see par. 4.2).
B Mechanical protections
Before commissioning the machines, the user must check that all mechanical protections on the machines are operational. In particular, **the machines must not be commissioned** if:

- the machine has not been adequately fixed to its base (see par.2.2);
- the machine hatches have not been closed correctly;
- the lid of the main terminal box (and auxiliary if existing) has not been closed adequately with its screws, to prevent accidental contact with live parts;
- the fan, if present, does not have the filter mounted or, if missing, a protection network to prevent accidental contact with the electric fan rotor.

As well as the mechanical protections inherent to the machines, the user must also check that all parts coupled to the machines and moving parts (joints, pulleys, transmission belts, etc.) are adequately protected from accidental contact.

C Protection from heat hazard

The external surfaces of direct current machines may reach very high temperatures during functioning (thermal risk). For this reason this thermal risk is indicated on plates affixed to the surfaces of the machine itself. The user must prepare protective barriers whenever the machines are installed in areas where the risk of accidental contact with the operators is present.

D Protections against sound level

Before using the machine, the user must ensure that all protections against noise emitted by the machine are functioning. SICMEMOTORI is available with its experience in this subject.

1.11 Machine noise level

The noise of the machine expressed in “sound pressure” is detected using a sound level metre functioning in an open-circuit operation, with nominal power supply and ventilation system functioning (IEC 34-9 Standard). The sound level metre is positioned at the centre of the 4 sides of the direct current machine being tested and parallel to the fan air inlet (or of the fan asynchronous motors if the machine has been cooled by the heat exchanger) at a distance of about 1 mt. The average value among the values obtained is the noise level adopted by SICMEMOTORI.

The noise values of SICMEMOTORI machines are given upon request.

The user must decide if the given values lead to the necessity to install noise protection barriers.S

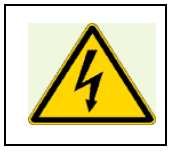
1.12 Transport, receipt and movement of the machine

The machines leave the factory ready for installation, unless agreed differently. The machines are not packaged unless specifically requested on ordering.

Attention:

At destination it is advised to examine the state of the machines to check that they have not been damaged during transport; in this case inform the carrier immediately so as not to loose the warranty. The claim must arrive at SICMEMOTORI within 8 days of receiving the goods!

When moving the machines, they must be lifted by attaching them to the relevant eye-bolts on the machine’s surface. **Never use the eye-bolts positioned on the cooling devices (electric fans, heat exchangers, etc.) to move the machine itself.** If the load is unbalanced because of joints or particular executions, balance using additional ropes.

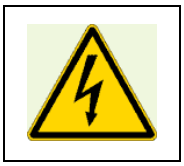


Lifting using eye-bolts must be avoided if the environmental temperature is lower than –15°C .

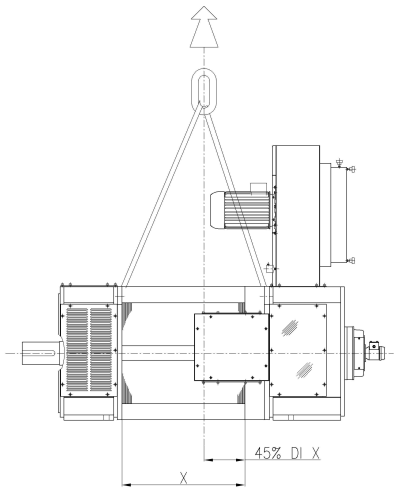
The following table supplies machine weights, complete with cooling systems. Remember that the weights are also stated on the main plates on the machines themselves.

Grandezza motore	PVA-BPVA BPVAB kg	CBA-BCA CNV-CNVC kg	CBARH kg
SM 802 A		240	
SM 802 B		240	
SM 802 C		260	
SM 803		335	
SM 804		440	
ML 806		650	800
ML 808		950	1150
ML 810		1270	1495
ML 812		1600	1890
ML 814		2100	2480
ML 816		2600	3010
ML 818		3500	3920

To lift the motor, check the weight on the plate and use lifting devices with a greater capacity.



Attention: machine unloading and movement operations must be carried out by expert staff (slingers, crane drivers, fork lift drivers, etc.); it is recommended that these operations are assisted by a person on the ground who gives signals.



Posizione del baricentro – la quota "X" è la lunghezza del pacco magnetico statorico

1.13 Immagazzinamento delle macchine

Se le macchine non vengono subito messe in servizio, occorre sistemarle in un ambiente coperto, pulito ed asciutto. **La temperatura minima di immagazzinamento non deve essere inferiore a –30°C**. Se è previsto l'immagazzinamento delle macchine a temperature inferiori a –30°C, occorre prendere accordi con la SICMEMOTORI in sede d'ordine. Se la giacenza fosse prolungata (alcuni mesi) o se siano previsti prolungati periodi di inattività occorre prendere le seguenti ulteriori precauzioni:

- sollevare le spazzole dal collettore per evitare sullo stesso la formazione di impronte dannose;
- controllare periodicamente la resistenza d'isolamento (vedi par. 4.3). Gli isolamenti devono essere protetti dall'umidità;
- ruotare l'albero di alcuni giri almeno ogni due mesi per evitare danni sulle piste dei cuscinetti;
- è consigliabile, per l'estremità albero, verificare lo stato della vernice protettiva per evitare corrosioni ed ossidazioni. Eventualmente, ritrattare con vernice o grassi anticorrosivi.

I cuscinetti a rotolamento in questo periodo non richiedono alcuna manutenzione perché il grasso è già immesso in quantità sufficiente per mantenerli lubrificati.

1.14 Motors SM series

SM series machines have a steel fabricated, split frame

1.15 Motors ML series

ML series machines have a fully laminated stator core, no split frame

2 INSTALLATION

2.1 Installation of the machines

The machine must be positioned so that access to the commutator end brushes and the drive end lateral hatches is always easy. Install the machine in compliance with the mountings and positions IM, the type of cooling IC and the level of protection IP defined in the establishment and specified on the plate.
If the operator does not have the machine's dimension diagram, he can request it, by communicating the serial number printed on the main plate, from the SICMEMOTORI technical office.

2.2 Positioning

Machines with IM 1001 positioning (B3, with horizontal axis with feet), must be fixed using 4 screws with a diameter adequate to the holes in the feet. In the case of double or triple motors, consult SICMEMOTORI.
The resting surface must be uniform, with tolerance so that the maximum difference between the feet is not greater than 0.1 mm (if necessary, use alignment thicknesses) and it must be able to support the torques generated by the electric machines . If necessary, please contact SICMEMOTORI Technical Office

Caution!
The machine base, whether it is in iron or cement grout, must be carried out by staff expert in this type of work.

3. COUPLING TO THE OPERATIVE MACHINE

Coupling device and type of transmission must be selected and designed according to the particular conditions of use. Customer is responsible for correct selection and design: SICMEMOTORI is responsible for accuracy of the technical data which are provided to the Customer on request. Before mounting the coupling device, the protective paint on the shaft end must be removed with appropriate solvent. Do not use emery paper. The machining tolerance of the coupling bore must correspond to the rated diameter of the shaft as specified in the overall drawing with tolerance H7 ISO System. The pulley or half-coupling should preferably be shrunk on at a temperature of 80-90 °C. If this is not possible, fit the transmission device using the threaded nut at the end of the shaft 1.5 (see fig. 1A and 1C). After tightening, turn an edge of the lockwasher 1.4 one a side of the nut to prevent it from slackening (see fig. 2).

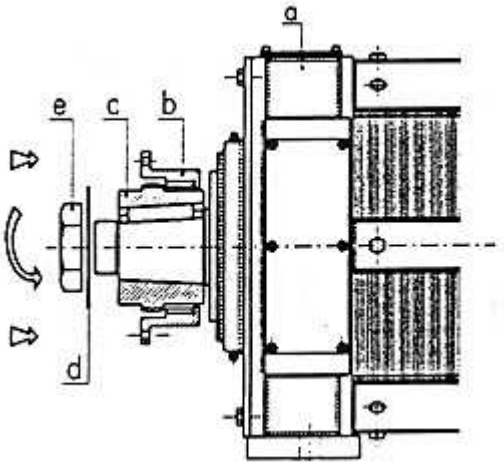


Fig. 2 – Keying the half-coupling (or pulley) on the shaft end

a – Motor
b –c – Half coupling or pulley
d - Lockwasher
e – Shaft nut

3.1 Direct coupling

It is advisable to use flexible couplings that avoid transmission of any thrusts to the bearings. Correct alignment requires use of a comparator and thickness gauge for the following operations:

- Assemble the two half-couplings on the motor and on the driven machine; position the two machines making a first rough alignment. Tighten the locking screws of the feet.
- Apply the comparator on the two half-joints and measure radial alignment. Repeat the measurement after rotating the two shafts together by 45°, 90° and 180°.
- Insert the thickness gauge between the faces of the half-couplings and measure the distance between them. Repeat the measurements at 90°, 180° and 270°. Difference betw een measurements must be lower than 0,1 mm.
- Correct any misalignments found in the operations described, inserting shims between the base and the mounting feet.
- Draw up the locking screws completely, repeat the measurements and if the alignment is accurate, insert the dowel pins between the motor and the base. For approximate radial and axial tolerance values, refer to fig. 3.

Remember that there must be sufficient play between the transmission devices to offset any axial expansion due to heat (< 5 mm according to AISE St. ; effective value for SM Series is < 3,5 mm, for ML Series is < 4,5 mm).

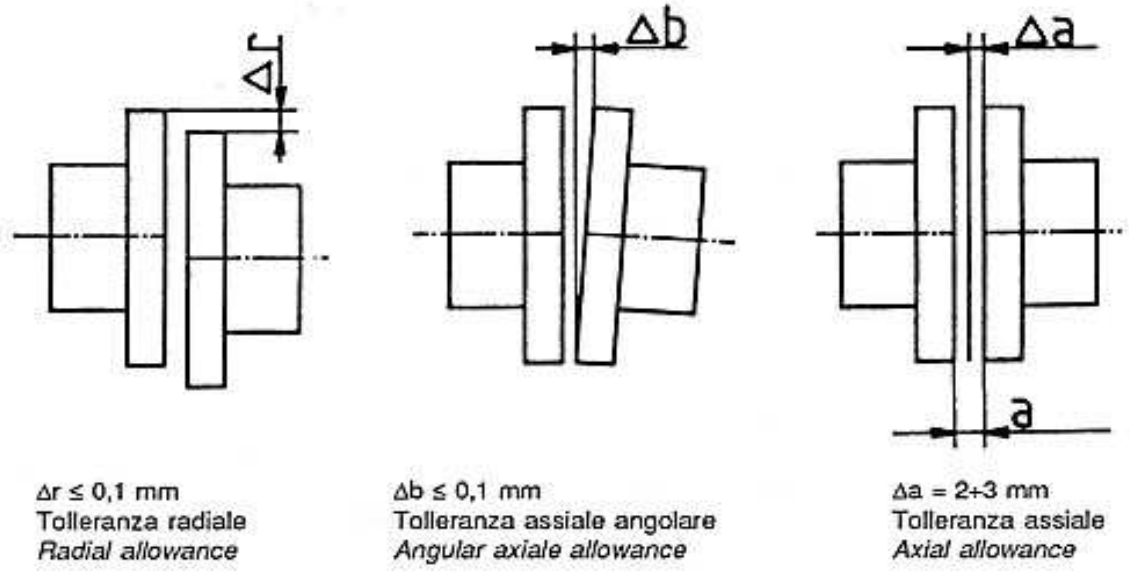


Fig. 3 – Indicative tolerance values for coupling

3.2 Coupling with belts and pulley

To contain radial stress on the motor bearing, choose the max. Compatible diameter for the driving pulley, which is compatible with the requested reduction ratio and with the max. accepted diameter for the shifted pulley. In a first approximation the chosen diameter must be verified by calculating the pull that derives from it and comparing it with the accepted pull (please ask SICMEMOTORI).

To contain the pull on the shaft with equal torque, the angle of the driving pulley embracing the belts must be increased (increase the interaxis between the two pulleys – contain the reduction ratio).
For good belt alignment, there must also be good parallelism between the shafts and a safe and easy system for tensioning the belts must also be present.

4. COMMISSIONING

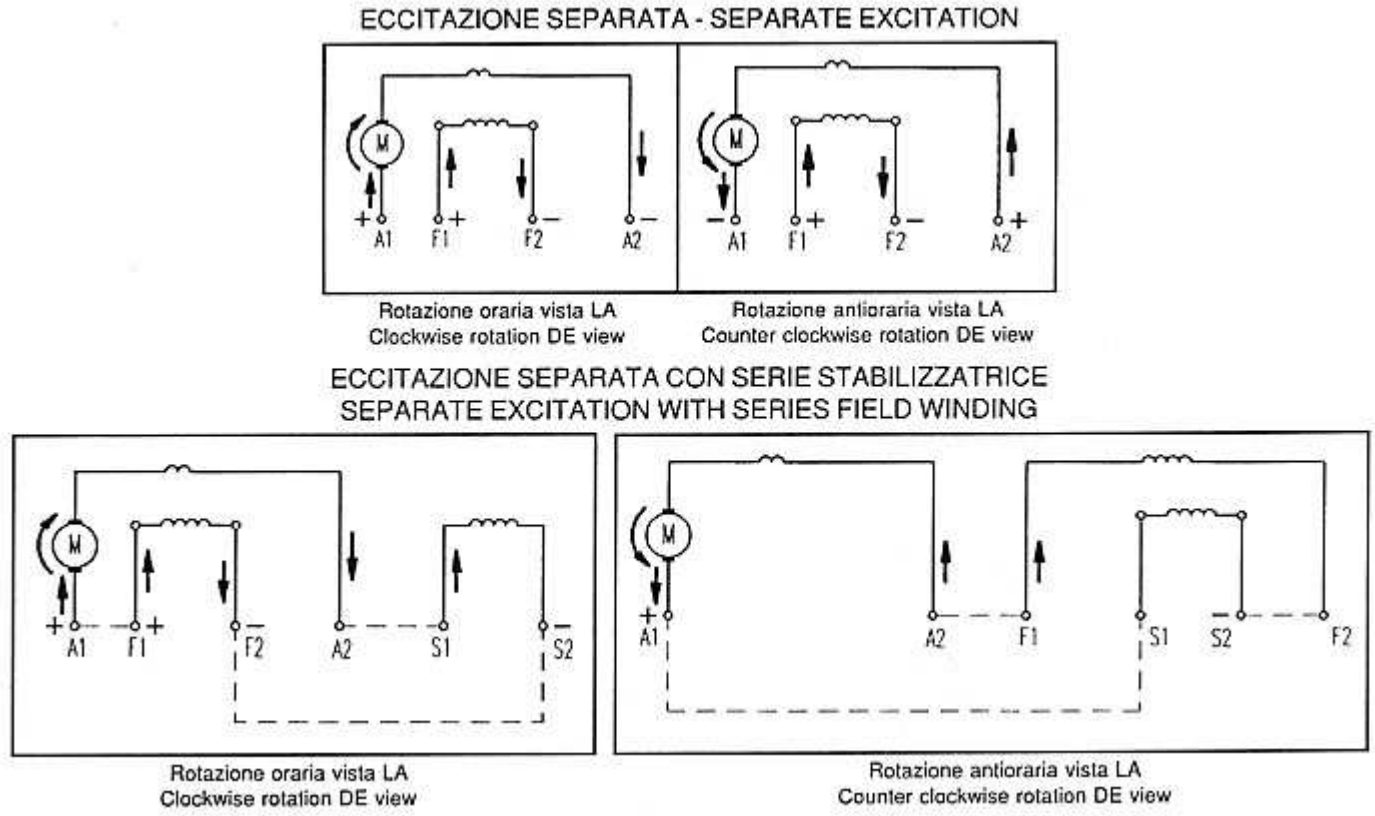
4.1 Electrical connections

The standard machines are supplied with free leads at the right viewed from the coupling side. The cables are marked with the letter given in the diagram attached to the machine. Terminals are marked in conformity with NEMA St. (see table 1) (or according to IEC Standards 34.8, on request). For the connections refer to the diagrams given in fig. 4, connecting the machine for the required direction of rotation. The direction of rotation may be either clockwise or counter-clockwise indifferently.

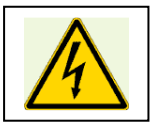
TABLE 1 Terminal markings in accordance with NEMA Standards

A1 – A2: armature winding
F1 – F2: separate or derivate field winding
S1 – S2: series field winding

FIG 4 Wiring diagram - Terminals marking in accordance with NEMA Standards



The compensating winding, when existing, is series connected to aux. poles



Attention: **before starting-up a motor ensure that the separated field is powered at full voltage, and, for motors with series excitation, that the load is coupled.**

4.2 Earth Connection

DANGER!

The machine must always be connected to the earth plant of the establishment where it is installed.

For earthing a screw with respective anti-flattening washer are prepared on the stator play in a visible position along with a screw in the terminal box, both with plate and marking. Both screws must be connected to the earth plant.

Ensure that there is no paint between the screws and the machine's surface. If necessary, remove the paint before carrying out the connection.

4.3 Inspections before start-up

Before commissioning the machine or after a long period of inactivity it is a good idea to carry out the following verifications:

- Use a 500 V Megger to check isolation towards the rotor mass and stator windings. The value revealed must not be less than 3 MΩ. **The operation must be carried out with the power supply cables disconnected.**

ALARM!

During and immediately after measurement of the insulation resistance, the machine's terminals are potentially dangerous and must not be touched. It is necessary to ensure that there is no voltage residue.

If this condition is not found, the causes and remedies could be as follows:
a1) Presence of dust. Non-greasy dust can be removed with a clean, dry cloth or even better with a vacuum cleaner. Dust on inaccessible parts can be removed by blowing the inside of the machine with a jet of clean dry air at a pressure between 2-3,5 bar. Before this operation, remove the machine inspection covers. Repeat the insulation test with the Megger.
a2) Presence of grease or oil. Clean with a cloth moistened (not soaked) in a harmless type petroleum derived solvent. Disassemble the machine and dry the parts concerned in an oven for 3 or 4 hours at a temperature of 100-120 °C. Re peat the insulation test with the Megger before restarting the machine.
b) Check that the connection of the fan motor4.1 for PVA or BPVAB machines or the fan motor of heat exchangers 4.13 for CBARH or CBARO machines (see fig. 1A and 1 C) is made with the right voltage and frequency, and that the direction of rotation is correct. If the fan is fitted with a ventilation failure checking device (pressure switch) make sure that the contacts switch with the fan working. In the case of ventilation by ducts for cooling CBA (TEFV) or BCA, make sure that delivery and pressure data correspond to the figures given in table 2.
c) Check that armature and excitation voltage values match those of the dataplate.
d) Check that the stranded wires of the brushes are all correctly attached and do not interfere with the springs.

Motor type	Cooling data		
	Delivery (m^3/min)	Static pressure at inlet (Pa)	
		DE	NDE
802	4.6	250	130
803	5.7	320	130
804	7.2	320	130
806	9.6	400	200
808	12	400	200
810	15	500	300
812	21	600	450
814	25	600	350
816	34	650	400
818	45	750	450

TABLE 2 Cooling data

DANGER!

Work on the electric machine may only be carried out if it is absolutely sure that the machine is not connected to the electric network.

4.4 Recommended protection devices

All transmission gears must be adequately protected with sumps to prevent contact with moving parts.

4.5 Start-up

DANGER!

The armature voltage may be given to the machine only if excitement is inserted! If the armature voltage is applied without excitement being inserted or with the excitement circuit open or interrupted, the direct current machine may destroy itself (in fact, in these conditions machine speed increases until the bearing bench collapses or the rotor explodes!).

Before starting the machine, as well as the operations in the previous paragraph, ensure that:

- **It turns freely;**
- **The excitement circuit has not been interrupted;**
- **Transport safety devices (if existing) have been removed.**

ALARM!

The direct current machine must not function without ventilation, as it would heat up excessively and burn. Pay attention therefore that the fans function correctly and the cooling water in the heat exchangers (where envisioned) circulates in the quantity and pressure indicated on the heat exchanger plates.

When the machine is commissioned for the first time, it is a good idea to ensure that there are no visible signs of malfunctioning, such as strange noises, vibrations, etc. It is a good idea to allow the machine to function without a load for a period of time before applying a load. If there are problems, consult par. 7 and, eventually SICME SERVICE.

4.6 Inspections after start-up

After machine start-up, it is advisable to make the following inspections:
a) Check that the steady state temperature of bearings does not exceed 90 °C (approximately). Overheat ing of bearings is usually to be ascribed to one of the following causes:

- bad alignment with consequent vibrations and tendency to grip;
- excessive radial or axial thrust;
- excessive amount of grease; in this case, remove the grease drainage tap 4.12, leaving the machine to run, to allow discharge of the excess grease.

b) Check that the excitation current is that indicated on the data plate, remembering that the resistance of the field winding increases from cold to rated temperature. The dataplate values refer to steady state functioning.
c) Check that the armature current is lower or equal to that on the dataplate.

Attention: an excessively low current value causes excessive wear of the brushes with consequent scratching of the commutator (see par. 7.3). Contact SICME SERVICE immediately.

d) Check that the brushes form an even patina on the commutator: this is a sign of good commutation. If local overheating occur after the checks described, the cause needs to be located. The experience says that these are normally due to:
- excessive overload (for either a short or a long lime);
- reduced voltage (operation at excessive low speed) for self ventilated machines (PV type);
- ambient temperature too high;
- air delivery failure (low pressure or flow rate) for CBA (TEFV) or BCA machines with ventilation from an outside system (see table 2), or insufficient water flow rate for motors with air-water heat exchangers (CBARH type);
- wrong direction of rotation of the fan motor for PVA, BPVAB, CBARO, CBARH machines;
- lack of ventilation caused by clogged filler or obstruction of the ducts;
- ventilation circuit not properly working because the connections are not perfectly closed, or an inspection door is open.

ALARM!

Working temperature

The maximum temperature rise accepted by IEC Standards for stator yoke is 125℃ if the machine is in class H (105℃ if in class F, 80℃ if in class B).

Even if it normally has a much lower temperature rise value, our machines do however require *adequate precautions to prevent contact, even accidental*. Moreover, highly inflammable materials must not be left in contact with the functioning machine.

A temperature outside of the stator that is too low must be attributed to a low work load, with possible problems tied to functioning with low load (see par. 7.3) If necessary, contact SICME SERVICE.

5. DISASSEMBLING AND RE-ASSEMBLING - SM SERIES MOTORS

Disassembling and re-assembling operations for a SM motor are described. When necessary, chapter 7 related to the maintenance will refer to these paragraphs. For details, refer to fig. 1A and 1 B.

5.1 Preliminary operations before disassembling

After mechanical decoupling (opening of the joint or equivalent operation, see fig. 12) remove the screws holding feet and remove dowel pins. Besides, disconnect the cooling system and/or the air ducts. In particular, for the various executions:
- CNV (TENV) - nothing;
- CBA (TEFV) - remove screws 4.6 from the upper openings of the drive end and non drive end and disconnect the air ducts;
- PVA - remove screws 4.6 from the upper non drive end opening and remove the electric fan 4.1 ;
- BPVAB - remove screws 4.6 from the upper non drive end opening and remove the electric fan 4.1; remove screws 4.6 from the upper drive end opening and disconnect the air duct;
- BCA - remove screws 4.6 from the upper non drive end opening and disconnect the air duct;
- PV - nothing;
- CBARH-CBARO - proceed as for CBA machines and remove the cooling system 4.13.

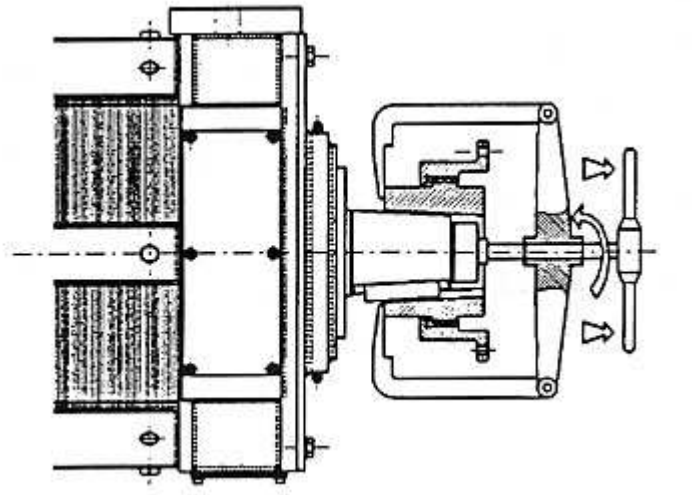


Fig. 12 – How to remove a half-coupling without heating

5.2 Similar operations for all machines

Remove tachogenerator and/or other accessories (as described at 6.2). Remove drive end (4.5) and non drive end (4.4) lateral inspection doors, by removing the tightening screws. Remove the half-coupling (see fig. 12). Disassemble the brushes, as described in 7.7.

5.3 Opening of the stator

Stator is divided in two halves (half-yokes). Remove half-yokes screws 4.10 and tightening screws of bearing bushes 3.12 and 3.13. Now, the top half-yoke can be lifted using its lugs.

5.4 Removing of the rotor

When stator has been opened, rotor can be removed by lifting it vertically with suitable ropes, and it must be layed down on wooden saddle, to avoid any danger of damaging. During this operation the bearing bushes 3.25 must be removed from the self-centering pins 4.9 (fig.5).

5.5 Replacement of the bearings

Great care should always be taken during bearings assembly/disassembly to avoid any damage to the bearings seating on the shaft and on the bearing bush. Bearing used must be removed with a purpose-designed extractor (see fig. 6). New bearings must be of the same type as those used: particular attention must be paid to the play which is usually C3 (upgraded), unless otherwise indicated on the machine dataplate.

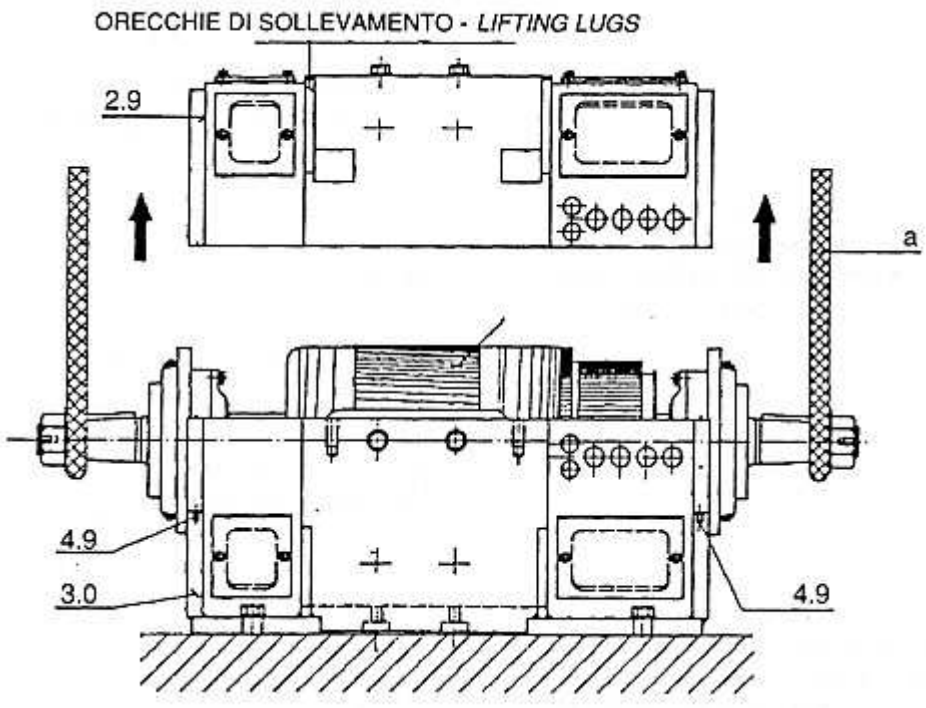


Fig. 5 – Disassembling of the rotor – SM Series

A – Lifting ropes
2.9 – Top half-yoke
3.0 – Bottom half yoke
1 – Rotor
4.9 – Bearing bush location pins

5.6 Disassembling of the bearings

Bearings must be removed cold with a purpose designed extractor, manual or hydraulic. The fitted bearings are of the roller NJ type, comprising an inner ring with edge shrunk onto the shaft, and an outer ring with edge and cage shrunk into the bush (see table 4). At first take the complete bearing bushes off the shaft (bush 3.25 plus inner grease seal 4.7): use a manual or hydraulic extractor positioned to the rear of the extraction ring 3.24. Than remove the outer ring of the bearing 3.23 from the bush 3.25: disassemble the inner grease seal 4.7 by removing the screws 4.18, and use an extractor positioned between bearing outer ring 3.23 and bush 3.25.

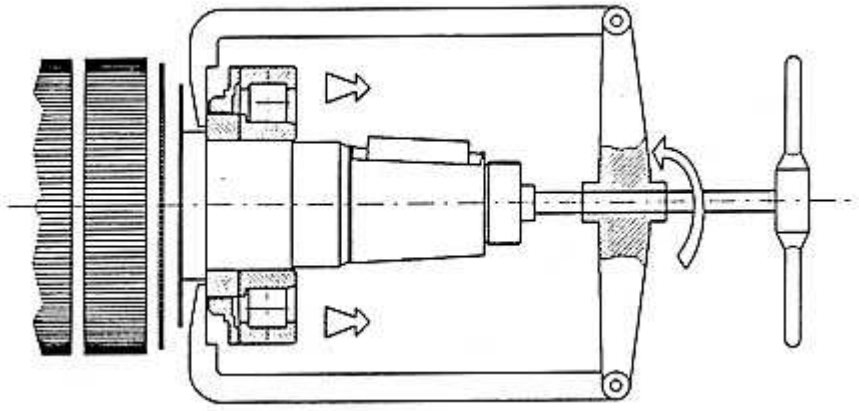


FIG.6 How to withdraw a bearing

5.7 Re-assembling of the new bearings

Before assembling, carefully clean bearings and their housings on the shaft and on the bushes 3.25, using a suitable solvent (petroleum or other); do not use abrasive tools.

5.7.1 Pitting the inner ring on the shaft(flg.1A).

Key the extraction ring 3.24 by hand on the shaft. Heat the bearing inner ring 3.22 to 80-100 "C (by induction, by placing it in an oven or dipping it in an oil bath). Fit it on the shaft and hold it against the shoulder for 60-90 seconds. Remove the pressure applied and check that the inner ring does not rotate on the shaft. If shrinking on is not possible, the operation should be carried out cold. This can be done in two ways:

a) using a lead or iron mallet and hammering on a soft pipe (copper, aluminium or soft iron) to distribute the effort around the whole circumference of the ring;

b) using a steel pipe of adequate diameter and length and the threaded nut 1.5 as a tool (preferable system).

5.7.2 Pitting of the outer ring in the bush (fig. 1A)

Heat the bush 3.25 to 50-60 ℃ and insert the beari ng outer ring 3.22, complete of rollers and cages, with a slight pressure. If the bush can not be heat, place the outer ring in the bush and shrink it with slight and distribute blows using a resin or wooden mallet. Lubricate with the chosen grease (see table 6 and, alternatively, 6a) following the instructions of point 7.17. After fitting, assemble the inner grease seal 4.7 tightening the screws 4.18. Now complete bearing bushes can be fitted on the shaft. First lubrication must be done according to point 7.15.

5.8 Disassembling of stator poles

As the poles are removed completed with the windings, it is necessary at first to disconnect the inner connections. Then remove screws 2.6 for disassembling the complete main poles and screws 2.7 for disassembling of the complete auxiliary poles together with

the airgap correction shims. The coils are encapsulated on the pole core, and none of their parts (main and auxiliary coils) can be individually replaced.

5.9 Re-assembling of the motor

Reverse the sequence of the operations brushes 3.25, paying attention to the self-centering pins 4.9 on the bottom half-yoke 3.0;
- put the top half-yoke 2.9 in its position, by using the screws 4.10; lock the bearing bushes 3.25 by screws 3.12 and 3.13;
- re-assemble eventual external accessories (tachogenerator or other).

5.9.1 Cautions for reassembling of the poles

Make sure to replace insulation and correction shims in their original position.

5.9.2 Cautions for brush-holders dials

After testing in the Testing Room, all machines have the position of the brush-holders dials marked with a proper line. Before disassembling brush-holders dials, be sure that this line is clear without any doubt: otherwise, re-assembling of brush-holders dials must be exclusively done at SICMEMOTORI workshop.

5.9.3 Cautions for brush-holders

When changing or re-assembling brush-holders, be sure that brush-holders:
- have the long side of the box parallel to the commutator segments
- have the lower edge of the box distant max. 2.5 mm from the commutator surface.

5.10 Changing the terminals position

SM motors are symmetrical, as regards to shaft ends, position of fixing holes and opening of ventilation. Besides, the two shaft ends nave same dimensions and can transmit the same torque and the same overloads. If installation requirements make it necessary to position the terminals at the left viewed from coupling side, turn the motor 180° using the commutator side shaft for coupling.

6. DISASSEMBLING AND RE-ASSEMBLING ML SERIES MOTORS

Disassembling and re-assembling operations for a ML motor are described. When necessary, chapter 7 related to the maintenance will refer to these paragraphs. For details, refer to fig. 1C and 1D.

6.1 Preliminary operations before disassembling

After mechanical decoupling (opening of the joint or equivalent operation, see fig.12) remove the screws holding feet and remove reference pins. Besides, disconnect the cooling system and/or the air ducts. In particular, for the various executions:
- CNV (TENV) - nothing;
- CBA (TEFV) - remove screws 4.6 from the upper openings of the drive end and non drive end and disconnect the air ducts;
- PVA - remove screws 4.6 from the upper non drive end opening and remove the electric fan 4.1 ;
- BPVAB - remove screws 4.6 from the upper non drive end opening and remove the electric fan 4.1; remove screws 4.6 from the upper drive end opening and disconnect the air duct;
- BCA - remove screws 4.6 from the upper non drive end opening and disconnect the air duct;
- PV- nothing;
- CBARH-CBARO - proceed as for CBA machines and remove the cooling system 4.13.

6.2 Similar operations for all machines

Remove tachogenerator and/or other accessories, proceeding as follows (see fig. 11):
- unscrew tightening screws 5.12 and remove cover 5.11 to uncover the coupling 5.2;
- unscrew dowel 5.20 from half-coupling keyed on the tachogenerator shaft end; unscrew the tightening screws 5.30, and remove tachogenerator 5.3. If commutator end of main shaft must be free, operations must proceed as follows:
- remove support 5.1 by unscrewing the 3 tightening screws 5.10;
- unscrew the 3 screws 3.40 and remove the reduced shaft 5.4 together with coupling 5.2. The commutator side main shaft end is now accessible.

Remove drive end 4.5 and non drive end 4.4 inspection doors. Withdraw half-coupling (see fig.12). Remove screws 3.17 to disconnect the brush-holders dial from stator windings. Withdraw brushes 3.9 from brush-holders boxes 3.8. Remove key 1.3 of shaft end and screws 3.12 which secure drive end and non drive end shields to the yoke.

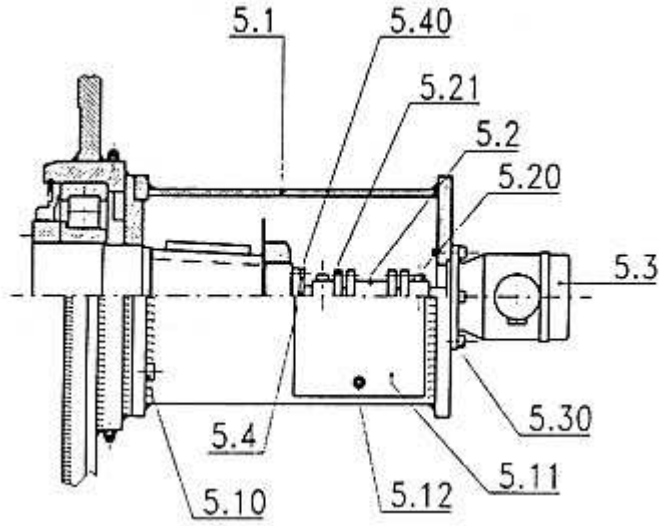


Fig. 11 – Disassembling of tachogenerator

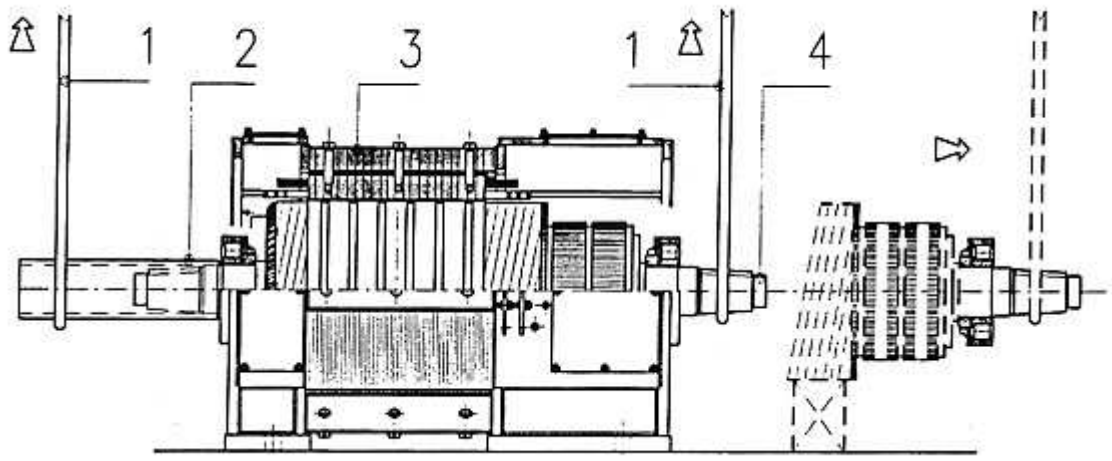
Unscrew tightening screws 5.12, to disassemble the cover 5.11 from support 5.1, and to uncover the coupling 5.2.
Unscrew dowel 5.20 from half-coupling keyed on the tachogenerator shaft end; unscrew the tightening screws 5.30, and disassemble tachogenerator 5.3.
If commutator end of main shaft must be free, operations must proceed as follows:
- remove support 5.1 by unscrewing the 3 tightening screws 5.10;
- unscrew the 3 screws 3.40 and remove the reduced shaft 5.4 together with coupling 5.2.

6.3 Disassembling of the end shields

Shields (3.1 drive end and 3.4 non drive end) are removed using two of the screws 3.12 or 3.13, applied in the threaded holes provided for this purpose: draw up these screws until the guards are released, then unscrew them. During this operation keep the rotor raised by applying an appropriate tension to the shaft: when the shields have been removed, insert strips of 0,5-1 mm thick cardboard in the gap between the armature 1 and the main poles 2.2, to prevent them from contacting and possible damage.
Unscrew tightening screws (5.12), to disassemble the cover (5.11) from support (5.1), and to uncover the coupling (5.12). Unscrew dowel (5.20) from the half-coupling keyed on the tachogenerator shaft-end: unscrew the tightening screws (5.30) and disassemble tachogenerator (5.3). If necessary, the commutator end of the main shaft can be exposed, as follows: Disassemble support (5.1), screwing out the 3 tightening screws (5.10). Screw out the 3 screws (5.40) and disassemble the reduced shaft end (5.4) together with the coupling (5.2). The commutator side main shaft end is now accessible.

6.4 Disassembling of the rotor

After removing the end shields, remove the rotor (armature) and proceed to clean and where necessary repair. Follow the disassembly instructions of fig. 5A.



1 – Hoisting rope
2 – Shaft extension
3 – Whole stator frame
4 - Armature

FIG. 5A Disassembling of the rotor - ML Series

6.5 Replacement of the bearings

Great care should always be taken during bearings assembly/disassembly to avoid any damage to the bearings seating on the shaft. Bearing used must be removed with a purpose-designed extractor (see fig. 6). New bearings must be of the same type as those used: particular attention must be paid to the play which is usually C3 (upgraded), unless otherwise indicated on the machine dataplate.

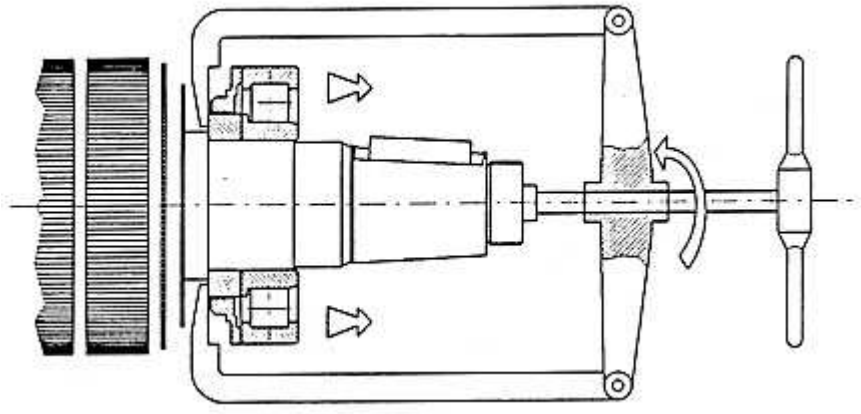


Fig. 6 – How to withdraw a bearing

6.6 Disassembling of the bearings

Bearings must be removed cold with a purpose-designed extractor, manual or hydraulic. The fitted bearings are of the roller NJ type, comprising an inner ring with edge shrunk on to the shaft, and an outer ring with edge and cage shrunk into the bush (see table 4). At first take the bearing holder shield complete with ring 3.23 and inner grease seal 4.7 off the shaft: use a manual or hydraulic extractor positioned to the rear of the extraction ring 3.24. Then remove the outer ring of the bearing 3.23 from the bush 3.1 or 3.4, disassemble the inner grease seal 4.7 by removing the seeger 3.19, and use an extractor positioned between bearing outer ring 3.23 and bush of shield 3.1 or 3.4.

6.7 Re-assembling of the new bearings

Before assembly, carefully clean bearings and their housings on the shaft and on the shield 3.1 or 3.4, using a suitable solvent (petroleum or other); do not use abrasive tools.

6.7.1 Pitting the Inner ring on the shaft (flg.1C).

Key the extraction ring 3.24 by hand on the shaft. Heat the bearing inner ring 3.22 to 80-100 ℃ (by in duction, by placing it in an oven or dipping it in an oil bath). Fit it on the shaft and hold it against the shoulder for 60-90 seconds. Remove the pressure applied and check that the inner ring does not rotate on the shaft. If shrinking on is not possible, the operation should be carried out cold. This can be done in two ways:

a) using a lead or iron mallet and hammering on a soft pipe (copper, aluminium or soft iron) to distribute the effort around the whole circumference of the ring;

b) using a steel pipe of adequate diameter and length and the threaded nut 1.5 as a tool, (preferable system).

6.7.2 Pitting the outer ring In the shield (fig. 1C).

Position the outer ring 3.23 in the shield 3.1 or 3.4, then with a help of a wooden or resin mallet fit it distributing the shocks on the circumference of the outer ring. Avoid knocking the cage which would damage the rollers. For this operation it is advisable to heat shield 3.1 or 3.4 to 50-60 ℃ and insert bearing ri ng 3.23 tapping lightly. Lubricate with the type of grease chosen (see table 6 and, alternatively, 6a), following instructions of point 7.18. When assembly has been completed, fit the inner grease seal 4.7. Now the complete bearing holder shield can be fitted on the shaft. First lubrication must be done according to point 7.15.

6.8 Disassembling of the stator poles

If the poles complete with windings are to be removed, first of all disconnect the terminals of the inside connections and terminal boards. Then remove screws 2.6 to disassemble the complete main poles or screws 2.7 to disassemble the complete auxiliary poles and corrective shims.

6.9 Re-assembling of the motor

Proceed in the opposite order to disassembly, taking care, if poles have been removed, to replace the insulation and correction shims in their original positions. If the brush rocker 3.7 has been moved during disassembly and neutral! zone had not been marked, to restore the correct position proceed as follows:
- feed the independent field from a.c. main network (the RMS voltage value should approximately be similar to the d.c. nominal voltage, but different values may be envisaged, without danger);
- measure the voltage between two ranges of brushes of opposite polarity, using a ± 1,5 V (indicative) central zero-point Voltmeter, while brush rocker is slowly turned;
- connect and disconnect quickly the main field (terminals F1-F2) using a switch, feeding it at about half nominal voltage;
- neutral zone is achieved when the instrument index lies near the zero-point Voltmeter (coarser control);
- repeat the same operation using a ± 60 mV (indicative) central zero-point voltmeter (fine setting).

It should be noted that when a spare armature is placed in a machine, the brush position must always be checked. Brushes must be well bedded in, when this method is used (see point 7.7). If new brushes have been put in, use the wider scale Voltmeter to do the first coarser control, the bed in brushes and finally use the lower scale Voltmeter to do the fine setting. Complete this operation by tightening the screws that fasten the rocker. Finally, follow cautions 5.9.3.

6.10 Changing the terminals position

ML motors are symmetrical, as regards to shaft ends, position of fixing holes and opening of ventilation. Besides, the two shaft ends have same dimensions and can transmit the same torque and the same overloads. If installation requirements make it necessary to position the terminals at the left viewed from coupling side, turn the motor 180° using the commutator side shaft for coupling.

7 MAINTENANCE

An accurately prepared precautionary maintenance programme may reduce faults to a minimum, reducing the running cost at the same time.
The maintenance programme must be studied by competent technicians, which take the features of the electric machine used into consideration along with the particular use to which it is destined and the environment in which it must function.
Use of the machine means: the more or less strategic role that it is assigned within the plant, on which the accuracy and frequency of the controls and precautionary maintenance to be programmed, will depend.
Environment means: the group of temperature, humidity, vibrations, exceptional mechanical stress features, along with the presence of aggressive chemical agents, to which the machine may be exposed in its place of installation. The type and frequency of precautionary maintenance interventions will also depend on the environment.
All maintenance operations must be carried out by qualified staff, which are informed about the content of these instructions, which must always be at their disposal.
SICMEMOTORI advises the user to prepare a specific maintenance file for every direct current machine installed, and its constant update by expert staff.

After any interruption of functioning caused by protection equipment or for any other reason, an in-depth inspection of the machine is necessary and, if necessary, also of plant components. The causes of the interruption must be clarified BEFORE putting the machine back into service.

DANGER!
Before carrying out any work on the electric machine disconnect it from the network!

7.0 Programmed maintenance

Though the motors of the SM and ML Series require very little maintenance, it is advisable to check the main components at regular intervals. Table 7.a indicates a type of programmed maintenance; it must be understood that this programme must be adapted to the client's requirements, and that SICMEMOTORI is available, on request, to collaborate and study the most opportune adaptations for commissioning and the first working period.

7.1 Commutator

The commutator is the key component of the machine and it is therefore highly sensitive to any improper use. Under normal conditions, the commutator requires little maintenance except for periodic inspections. The even patina that forms on the commutator during operation is a sign of good functioning. The colour of the patina may vary according to substances present in the environment. In this case, the commutator does not require any type of attention except for periodic cleaning. If there are irregularities or areas of roughness or slight scratches on the surface of the commutator, it is good practice to dress it with a carborundum or pummy stone. Check commutator eccentricity making sure it does not exceed the value of 0.05 mm. If the values are exceeded or the surface is very rough with the presence of grooves or tracks, the commutator must be turned on a lathe (see 7.2).

Table 7.a – Programmed maintenance – program type

Component	Operations	Interval (H)	See Point
Complete machine	Check vibrations and noise in the bearing seats. ISO 3945 Standard reference values **(a)**	yearly	
	Detection of strange noises (blows, scraping, etc.) **(a)**	weekly	
	Eye-check internal cleanliness of the machine	monthly	
Commutator	Eye-check the surface of the commutator	weekly	7.1
	Check eccentricity **(a)**	1200	
	Clean the commutator well with the relevant rubber sticks and pumice stone	3500-4000	
Brushes	Check wear and play between brush and brush-holder box **(a) (b)**	400-500	7.4 7.5 7.6
Brush-holder	Check efficiency of the brush-press springs	400-500	
Stator and rotor windings	Measure insulation resistance (with temperature of the shell at about 25℃) **(a)**	900-1200 (300-600)*	4.3
	General cleaning of the windings	3500-4000	4.3
Power supply cables	Check tightening of the cables to the machine clamps. Tighten if necessary	yearly	
Bearings	Measure the temperature **(h) (i)**	1200	7.9
	Re-lubricate and apply grease (excluding self-lubricating bearings) **(h) (j) (k)**	See plate on motor	7.12 7.13 7.14 7.15
	Complete replacement of bearing grease	3 years	
	Check for rust on the bearings **(g)**	3 years	
Insulation	Check insulation resistance using a Megger	900-1200 (300-600)*	4.3
Filters	Check if filters are blocked	weekly	7.20
Air-water and air-air heat exchangers	See appendix		
Fixing nuts and bolts	Check that nothing has loosened (this must be carried out mostly for terminal box electric connections as insufficient contacts may cause localised overheating)	1800-2200	
Coupling	Check machine-load alignment and register the measurements **(f)**	Every two years and at every disassembly	
	Maintain the coupling according to the Manufacturers instructions	-	
Electric fan	Check for the presence of rust or dirt. If envisioned, grease the asynchronous motor bearings **(g)**	Every 6-months	
Various accessories	Check their correct functionality	yearly	
Earthing brush (if existing)	Check that it runs freely in its brush-holder. Clean the contact surface between the brush and shaft using very fine sand paper. **(a) (b)**	yearly	

* Humid environments

(a) Compare with previous measurements and observations
(b) Calculate consumption in mm per 1000 working hours and compare with previous measurements; with this measurement you will obtain a good indication about commutator and commutation behaviour.
(c) Remove any rust using a stone and oil and then cover the surface with an anti-corrosive layer
(d) Depends on environmental air contamination
(e) Depends on contamination of the water
(f) If the vibrations increase, inspect immediately or shorten the intervals between inspections
(g) Remove rust
(h) For the bearings lubricated with grease
(i) Compare previous measurements
(j) Observe the lubrication intervals indicated on the direct current machine plate. Machines with long standstill periods must be re-lubricated every year (as the grease may become old or condensation may form inside the bearing)
(k) As soon as phenomenon such as vibrations, temperature rise or noise occur, or when the machine must be disassembled. Experience tells us that bearing problems are mainly caused by their wear, rather than fatigue of the material. However, consumption also depends on functioning conditions.

The particular instructions for maintenance relative to the commutator, brushes, bearings and air filters are stated below.

7.2 Commutator turning, mica undercutting and polishing

The commutator must be turned only by an expert. The centering must be positioned on the seat of the bearings to guarantee perfect concentricity with the surface of the commutator. The minimum machining diameters are shown in fig. 7B and 7C. Machining under these diameters is forbidden.

After turning, an appropriate cutter must be used for mica undercutting. With care, this can be performed by hand with a saw of appropriate thickness. Mica undercutting must be performed following the indications given in table 7 and figures 8 and 9. After mica undercutting, burrs and sharps edges on the surface of the bars must be removed with an appropriate scraper.

The last operation is polishing of the commutator using a pummy stone of extra fine N. 3/0 emery paper. Before returning the machine to normal service, carefully remove all traces of metal dust.

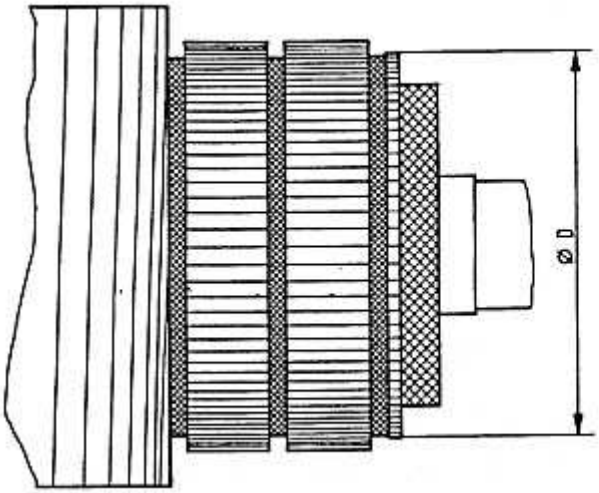


Fig. 7B Minimum machining diameter for banded commutators

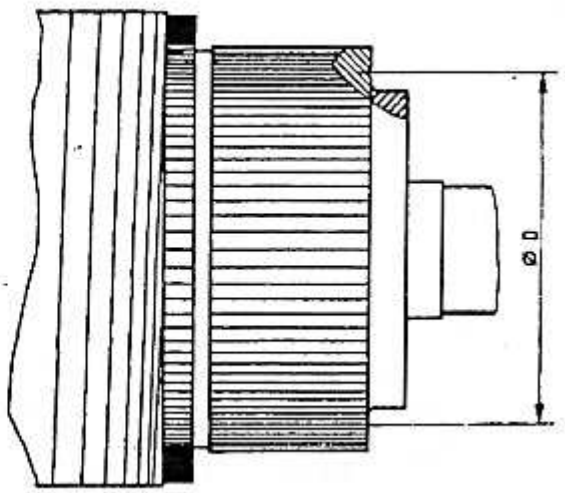


Fig. 7C Minimum machining diameter for moulded and "V" ring commutators

Table 7 – Milling depth and width for mica

Mica thickness A (mm)	Milling depth B (mm)	Milling width C (mm)
0.60	1.2	1.0
0.80	1.2	1.2
1.00	1.5	1.4

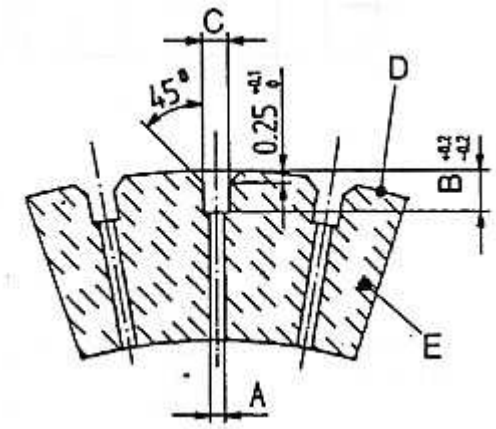


Fig. 8 – Commutator mica removing

A – Micanite nominal thickness
B – Milling depth
C – Milling width
D – Commutator surface
E – Copper segment

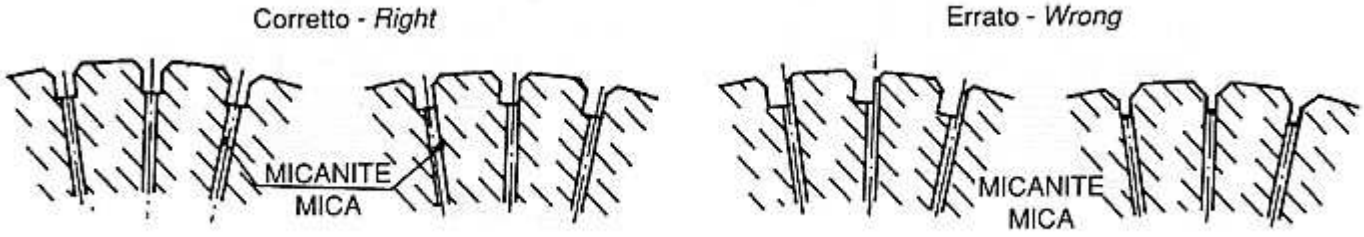


Fig. 9 Right or wrong mica removing operations

7.3 Commutation

The regular operation of the machine or the presence of faults can be checked through a visual inspection of commutation, while machine is turning. Certain malfunctioning of the commutation may be avoided carefully checking brushes, as said in following items.

7.4 Brushes

Heavy brush wear may be caused by insufficient spring pressure. Conversely, excessive brush pressure may cause frictional overheating of the commutator. The normal wear rate of brushes for a machine operating at nominal current and in a normal environment is approx. 2500 - 3000 hours of operation, but it can vary in relation to many factors, as air temperature and humidity and current density on brushes. If wear is higher it is advisable to check the quality of the brushes and of the environment.

7.5 Brushes maintenance

The brush-holders must always be in the right position (see 5.9.3), and brushes must be frequently checked to assure that:
- brushes are free to run in brush holder box (clearance between 0,1 and 0,3 mm);
- wires are well fixed to the brushes and to the brush- holders dials;
- pressure exerted by the spring is between 100 and 250 cN/cm2.

7.6 Brushes wear

In order that the brush wear is regular it is important that the absorbed current is near to the nominal one. If machine works for long lime at reduced load, the patina does not form, and the high friction between brush and commutator produce an excessive brushes wear. For long duty with low current, it is advisable to lift one or more brushes per polarity, to maintain the value of the current density close to the original value (ask always SICMEMOTORI).

7.7 Replacement of the brushes

Worn brushes (which may cause contact between the commutator and the stranded wires of the cable) must be immediately replaced. All brushes must preferably be replaced at the same time. Needed operations are illustrated in fig. 10 and 10A. Always use, when possible, brushes of the same quality as the original ones; in case, quality must be varied only under SICMEMOTORI Service DTP's approval. New brushes should be bedded-in following the prevalent direction of rotation of the machine (if any) by a fine grained emery cloth, paying attention not to break or round off their sharp edges. For this purpose it is advisable to slip a band of emery cloth as large as the commutator under brushes. Carbon dust should be carefully sucked away.

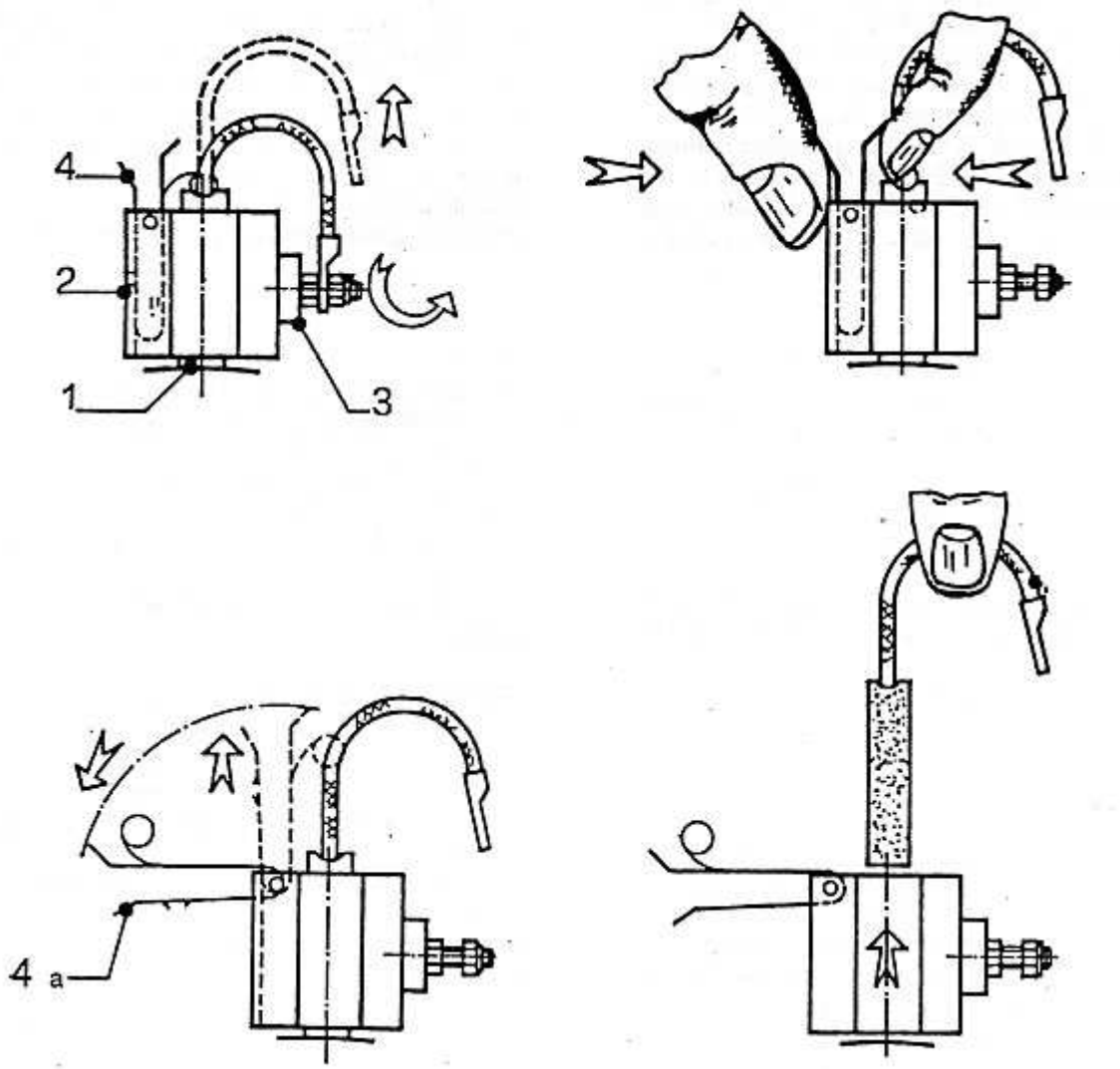
7.8 Bearings

Machines of SM and ML Series are normally fitted with roller bearings. All the bearings used by SICMEMOTORI feature overscaled play C3 and spare bearings must absolutely be of this type. Types of bearings and lubrication intervals are indicated on the dataplate.

7.9 Usefull life of bearings

SICMEMOTORI selects the bearings according to AISE Standards. The normal bearings specified by Standards for this Series are roller bearings on both the coupling and commutator sides. The expected theoretical life is as follows:
- direct coupling: 80.000 hours;
- indirect coupling : ask SICMEMOTORI.

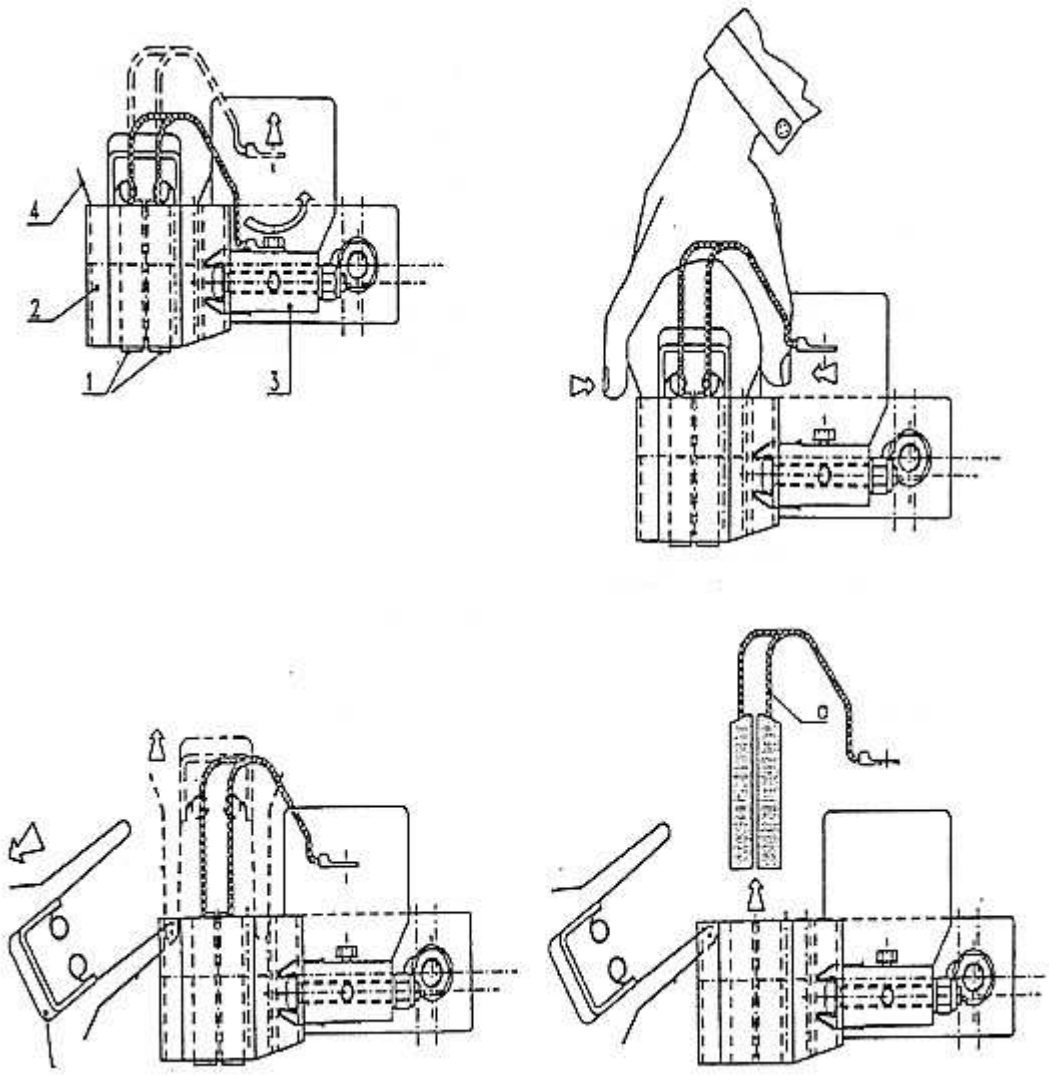
The theoretical life cannot be guaranteed (as this is a statistical value that cannot be used without caution in any individual case), and is communicated to Customer by SICMEMOTORI according to information received from its suppliers. The effective useful life of a bearing mainly depends on the particular use and on the more or less efficient maintenance. The local Maintenance Service must be charged of the definition of a reasonable value for effective useful life, to be taken into account when drawing up a scheduled maintenance program. This estimate must be supported by regular and systematic checking of the machine during functioning.



a – unscrew the nut a securing the spade-terminal, and withdraw the spade-terminal b
b – grip with your thumb and forefinger against the edges of the spring-holder, to release it
c – lift the spring-holder up to the stop pin, then rotate it to rest position, in accord to arrow A
d – withdraw the brush

1 – brush
2 – brush-holder box
3 – brush-holder dial
4 – spring-holder

Fig. 10 – Replacement of brushes



a – unscrew the nut a securing the spade-terminal, and withdraw the spade-terminal b
b – grip with your thumb and forefinger against the edges of the spring-holder, to release it
c – lift the spring-holder up to the stop pin, then rotate it to rest position, in accord to arrow A
d – withdraw the brush

1 – brush
2 – brush-holder box
3 – brush-holder dial
4 – spring-holder

Fig. 10A – Replacement of brushes – twin brushes

7.10 Bearings inspections

Inspections must be carried out according to a well-defined scheduled maintenance program in order to monitor:
- overheating. The steady state overtemperature must never exceed 60 ℃. Greater overheating generally indicates downgrading of coupling conditions with unacceptable radial or axial stresses;
- noise, more or less regular knocks should never be heard. Any knocks are the sign of downgrading of one or more revolving elements. As soon as any abnormal noise is heard or any overheating is detected, a thorough check must be made on bearing condition (wear on tracks, wear of the cage, slack between the external ring and housing, external thrust etc.) stopping the machine and disassembling it as required. If above phenomena persist or worsen, or at the first sign of a faulty bearing, this must be replaced to avoid serious damage to the machine (see point 5.5 for SM Series and 6.5 for ML Series).

7.11 Bearing general data

The following information (from 7.12 to 7.19) are given to assist preparation of the full maintenance programme for bearings, by the Users.

7.12 Types of bearings

Types of bearings normally used are given in table 4. Always consult SICMEMOTORI in the case of different bearings or if you have any doubts.

Motor type	DE and NDE bearing
SM 802	NJ 310-C3
SM 803	NJ 311-C3
SM 804	NJ 313-C3
ML 806	NJ 315-C3
ML 808	NJ 317-C3
ML 810	NJ 319-C3
ML 812	NJ 321-C3
ML 814	NJ 322-C3
ML 816	NJ 326-C3
ML 818	NJ 328-C3

TAB.4 Normal types of bearings

WARNING : Always check the type of bearing on the motor dataplate!

7.13 Lubrication programs

The Customer's Maintenance Service must draw up a bearings periodic lubrication program for each machine. For standard machines under normal conditions of operation, an initial outline program can be drawn up on the basis of tables 5A and 5B. Any deviation from these conditions may lead to downgrading and therefore to a shortening of the interval between lubrications, that can be detected only through practical experience after an initial period of use. If motors operate in damp, very hot or dusty environments, relubrication program should be shorter. No special rules exist on the subject. Only experience will suggest you the most appropriate intervals. The grease must be completely replaced every 4-5 relubrications (see point 7.17 for SM Series and 7.18 for ML Series).

7.14 Relubrication - Specific instructions - SM Series Motors (fig 1A)

This operation should be carried out with the machine running. Apply the pump to the grease nipple 4.11, remove the grease drainage plug 4.12, to drain any downgrade grease. Inject grease in the quantity as specified on motor label. Remove the pump and replace the plug. Relubrication intervals and grease quantity are shown in table 5A.
WARNING: do not apply too much grease. Excess grease leads to overheating of bearings and may damage them. Excess grease also tends to escape along the shaft. Never mix different types of grease as may be incompatible.

Motor type	Speed (rpm')					Grease
	1000	1500	2000	3000	3600	(gr.)
SM 802	8500	6000	4250	2250	1800	15
SM 803	8000	5500	3750	2000	1600	20
SM 804	7000	4500	3000	1500	1300	25

TABLE 5 A Relubrication intervals and grease quantity for SM Series

Warning: Always check the quantity of grease indicated on the motor name plate!

7.15 Relubrication - Specific instructions - ML Series Motors (fig. 1C)

This operation should be carried out with the machine running.
Apply the pump to the grease nipple 4.11, remove the grease drainage plug 4.12 to drain any downgraded grease. Inject grease in the quantity as specified on motor label. Remove the pump and replace the plug. Relubrication intervals and grease quantity are shown in table 5B.
WARNING: do not apply too much grease. Excess grease leads to overheating of bearings and may damage them. Excess grease also tends to escape along the shaft. Never mix different types of grease as may be incompatible.

Motor type	Speed (rpm)					Grease
	500	800	1250	1600	2000	(gr.)
ML 806	15000	9000	6000	4000	3000	30
ML 808	14000	7800	4000	3000	2000	37
ML 810	13000	7400	3600	2500	1600	45
ML 812	12000	6500	3400	2100	1300	55
ML 814	11000	6200	3000	1900	1100	60
ML 816	9500	5000	2300	1300	500	81
ML 818	8500	4500	1900	850	300	93

TABLE 5 B Relubrication intervals and grease quantity for ML Series

Warning: Always check the quantity of grease indicated on the motor name plate

7.16.1 Types of grease for normal conditions

Greases normally used (for ambient temperature < 50 ℃, etc), must have the following characteristics :
- soap base : lithium
- dropping point : 180-190 ℃
- consistency : n. 3 NLGI with penetration values between 220 and 250 tenths of mm.

- working temperature : -25 to +120 ℃
Table 6 indicates some types of grease for normal conditions.

Commercial name of the product	Supplier
Athesia GR3	IP
Mobilux 3	MOBIL
Esso Beacon	ESSO
Alvania 3	SHELL

TABLE 6 Types of grease for normal conditions

7.16.2 Types of grease for difficult conditions
Greases to use as an alternative to above for particular and heavy duties (ambient temperature > 50 °C, high humidity etc), must have the following characteristics:
- organic base : urea or complex calcium salts
- dropping point : 220-250 ℃
- consistency : with penetration values between 240 and 270 tenths of mm.
- working temperature : -30 ℃ to +150 ℃
Table 6A gives some types of grease for particular conditions.

Commercial name of the product	Supplier
SRI 2	CHEVRON
Mobilplex 48	MOBIL
Aeroshell 12	SHELL

Table 6A Types of grease for difficult conditions

7.17 Complete replacement of grease - SM Series Motors (fig. 1A)
Every 4-5 relubrications (point 7.14), if the time to replace the bearings has not yet arrived, the complete replacement of grease must be performed, by partially disassembling the machine (following instructions of points 5.1, 5.2, 5.3 and 5.4), until the extraction of the complete rotor, which must be placed on wooden saddles. Now bearing bush 3.25 must be withdrawn (bearing inner ring remains on the shaft) and inner grease seals 4.7 must be dismounted, removing screws 4.18. Remove the old grease with petroleum and then with hot oil. Dry with clean dry air. Fill the chamber of the bush 3.25 1/3rd full and the chamber of the inside grease seal 4.7 2/3rd full with suitable grease. Fill the rollers housing using the quantity of grease indicated in table 8. Then re-assemble the inner grease seal 4.7, using screws 4.18. For the re-assembling of the machine, see point 5.9.

7.18 Complete replacement of grease - ML Series Motors (fig. 1C)
Every 4-5 relubrications (point 7.14), if the lime to replace the bearings has not yet arrived, the complete replacement of grease must be performed. Machine must be partially disassembled, following the instructions from point 6.1 to 6.5. Then remove the old grease from the external ring 3.23 of roller bearing, from rollers and cage, as well as from the inner grease seal 4.7.

Motor type	Grease quantity (gr.)
SM 802	40
SM 803	50
SM 804	70
ML 806	75
ML 808	85
ML 810	100
ML 812	110
ML 814	120
ML 816	165
ML 818	195

Table 8 Grease quantity for roller housings

The operation must be carried out for both DE and NDE bearings. Grease must be removed firstly with petroleum and then with hot oil. Dry with clean dry air and remount the grease seals and bearings following the instructions of point 6.5 for new bearings. Fill the chamber of the inside grease seal 2/3rd full and the bearings housings one half to 2/3rd full with suitable grease, both DE and NDE. Reassemble the machine according point 6.9 (see table 8 for grease quantity).

7.19 Replacement of the bearings
At the end of the forecast useful life of bearings approaches (see point 7.9), replacement should be planned when carrying out scheduled machine general maintenance. See point 5.5 (SM Series) and 6.5 (ML Series) for the operations to be performed.

7.20 Replacement or cleaning of the filtering panel
The cleaning of the filtering panel must be periodically checked, to avoid clogging and dangerous overheating of the machine. The panel can be cleaned by beating and/or vacuuming, or by washing in water. After 3-4 washings, the panel must be changed.

7.21 Ventilation failure detector
Normally the ventilation failure detector device is positioned in the upper part of the heat exchangers or fitted onto the scroll of the electric fans.

The ventilation failure detector device must never be tampered with; calibration must always be carried out by qualified staff, otherwise it will not function correctly. This manifests in:

- Too frequent interventions, with continual interruption of service; in this case, it is prohibited to short-circuit the device to allow the machine to work;
- Delayed interventions, with lack of intervention even when the dirtiness of the filter requires intervention. In this case, there is great risk of putting the protected machine out of order.

Whenever in exceptional cases, for example during maintenance, or for replacement, it must be calibrated, follow the instructions below.

Attention!
If in doubt always consult the SICMEMOTORI Client Assistance Service.

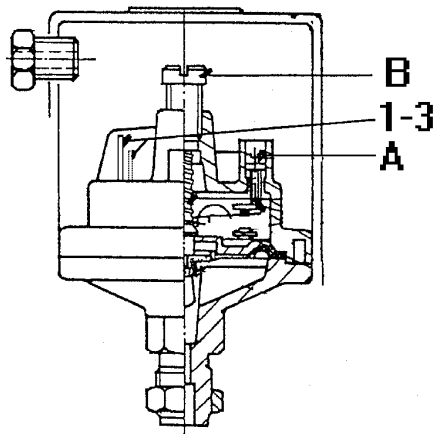
Instruments : Analogue Tester or Digital Tester

Modality :

- Place the tester on the ohmic capacity
- Position the push rods on the ends of the pressure switch contacts identified with numbers 1 and 3 (fig 5.p).
- Tighten differential adjustment screw “A” completely (screws not sealed).
- Check movement of the tester indicator (contact closed).
- Slowly loosen screw “A” until the ’tester indicator returns to the rest position (contacts open).
- Loosen screw “A” further by 1/4 of a turn.
- Loosen adjustment screw “B” until the tester indicator moves (contacts closed).
- Tighten screw “B” slowly until the tester indicator returns to the rest position (contacts open).
- Tighten screw “B” by another 1/2 turn.
- Activate ventilation and check that the tester indicator moves (contacts closed).
- Disconnect ventilation and check that the tester indicator returns to the rest position (contacts open).

By deactivating and activating ventilation the two commutations must occur.

FIG. 5.p



7.22 Tachogenerator

Refer to the Manufacturer's Maintenance Standards
Attention: before mounting and/or connecting the tachogenerator carefully read the instructions. The warranty is jeopardised immediately if these instructions are not respected or if the dynamo is tampered with and/or repaired by unauthorised staff.
Mounting and/or connection of the tachogenerator must be carried out by qualified staff If in doubt always consult the SICMEMOTORI Client Assistance Service.

7.23 Impulse generator (encoder)

Refer to the Manufacturer's Maintenance Standards
Before mounting and/or connecting the encoder carefully read the instructions. The warranty is jeopardised immediately if these instructions are not respected or if the encoder is tampered with and/or repaired by unauthorised staff
Mounting and/or connection of the encoder must be carried out by qualified staff. If in doubt always consult the SICMEMOTORI Client Assistance Service.

Operations that must NOT be carried out using the tachogenerator (dynamo and/or encoder)

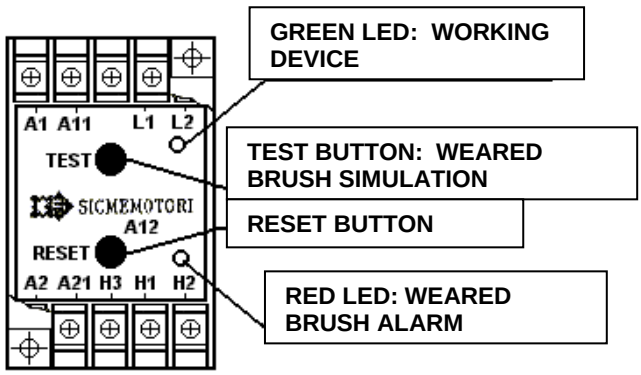
MECHANICAL
Do not disassemble the machine otherwise the warranty will be jeopardised; repairs are accepted under guarantee only for equipment sent free of carriage to Sicme Motori
DO NOT connect the small shaft to moving parts with rigid joints, but exclusively those with flexible joints. Incorrect mounting drastically reduces bearing life and excludes any form of warranty.
DO NOT strike the instrument: it is possible to break internal parts, excluding any form of warranty**. In particular, pay attention when mounting coupling parts to the motor shaft to which the tachogenerator is coupled: NEVER use mallets or other means to fit transmission gears!**
DO NOT carry out any interventions on the shaft; this may cause the disk to break, deterioration of the bearings and loss of the warranty.

DO NOT apply abnormal pressure, bend or twist the instrument's shaft.
NON not mount differently from that envisioned.
During re-mounting of the flexible joint pay attention not to close the dowels with the joint itself compressed or extended, as it would obstruct its extension adjustment function owing to heating of the motor shaft.

ELECTRICAL
DO NOT use power sources with an autotransformer that does not assure galvanic insulation from the network power supply.
DO NOT run the cable near to/parallel to the high voltage lines or to the power supply line, nor join cables in the same track. This precaution must be observed scrupulously, to prevent malfunctioning due to inductive interference.
DO NOT use cables that are longer than necessary. Try to maintain the length of the cable as short as possible, so as to prevent the influx of electrical disturbance.
DO NOT carry out connections if you have any doubts (see the connection diagram n the instruments label). Incorrect connections may cause the instrument's internal circuits to break.
DO NOT connect the instrument's cable shield to a 0 Volt circuit
The cable shield MUST BE connected to earth (GND). DO NOT leave it disconnected! The shield must be connected to earth only from the motor power supply side. In some cases, depending on the type of plant, it may happen that the shield must be connected both from the power supply side and from the instrument side female connector.
DO NOT opt for NPN or PNP electronics with connections greater than 6 m. In this case the use of the line-driver output is recommended, or subsidiary. To extend cables, use twisted shield cabling and a line-receiver compatible with RS422A in the receiving circuit.
DO NOT opt for a power supply voltage of 24 Vdc if a high frequency reply is received. Orientate onto a voltage of about 5 Vdc and an electronic line-driver.

7.24 Centrifugal relay
Refer to the Manufacturer's Maintenance Standards

7.25 Brush wear control device
Refer to the instructions below.



1) Apply network voltage (indicated on the wiring diagram) to the ends of **L1** and **L2** and check that the green LED switches on.
2) Press the **TEST** button and check that the red LED switches on.
3) Press the **RESET** button and check return to the initial position (green LED switched on).
4) Bridge **A1** with **A11** and check the RED led switches on.
5) Reset and try a few more times.
6) Repeat the same test by bridging ends **A2** and **A21.**
7) Connect the tester push rods (in continuity) to ends **H1 - H3** checking that the contact is normally closed and successively connect it onto H1 **- H2** checking that the contact is open.
8) Press the **TEST** button and check inversion of the contacts, i.e. **H1 - H3** from closed it must become open and **H1 - H2** from open it must become closed.

7.26 Air-air and air-water heat exchangers
See appendix.

8 TROUBLESHOOTING

If during movement or machine start-up abnormal phenomenon occur, the causes must be searched for immediately and eliminated.
The table below considers probable faults, their causes and solutions (tab. 7.1 – 7.2 – 7.3.1 – 7.3.2).
For phenomenon not envisioned in the tables contact SICMEMOTORI.

DANGER!
Before carrying out any work on the electric machine, disconnect it from the network!

8.1 Mechanical anomalies

Anomaly	Possible cause	Solution	See point
Vibrations with machine not coupled	Faulty bearings	Replace the bearings	7.19
	Half-coupling not balanced	Balance the machine with half-coupling	
	Foundation bolts have loosened	Tighten and block the bolts	
Vibrations with machine coupled	Machine coupled or joint not balanced	Check balancing	
	Alignment defect	Check coupling	3.3-3.4
	Faulty bearings	Check the bearings	7.19
	Defect in the power supply or coupled machine	Check activation, control, the controlled machine and alignment	
Anomalous overheating of the bearings immediately after start-up or greasing	Too much grease	Remove excess grease	7.14 7.15
	Excessive axial load	Check axial load	
Anomalous overheating of the bearing after a long functioning period	Rubbing of the bearing grease-guard on the shaft	The bearing seal and re-work the grease-guard	
Whistling bearings	Not enough grease	Grease	7.14 7.15
	Faulty bearing	Replace the bearing	7.19
	Noisy cage	Leave the machine to function under tight control	*
Excessive wear of the bearings	Excessive load on the bearing	Reduce radial load, eliminate axial load	
Bearing tracks marked, with machine in service (burns)	Bearing passed through by parasitic current	Stop the machine and contact SICMEMOTORI	

* The cages tend to adapt with time **Table 8.1 – Mechanical anomalies**

8.2 Electrical anomalies

Anomaly	Possible cause	Solution	See point
Motor does not start-up when unloaded	No power supply voltage	Check the power supply	
	No excitement voltage	Check the power supply	
	Main field interrupted	Re-make the main field	9
	Rotor coils in short circuit	Repair or rewind the motor	9
	Short circuit in the connections	Repair the connections	
	Bad contact of the brush with the commutator	Check the brushes and replace the most worn	7.5 7.6
Motor that turns jerkily (not wanted)	Rotor coils in short circuit	Repair or rewind the motor	9
	Commutator thin blades in short circuit	Repair the short circuit, by restoring isolation between the commutator thin blades	7.2
Motor that doesn't start coupled	Excessive load	Check the absorbed current and eliminate the overload	
	Machine with brushes out of neutral area	Put the brushes back in the neutral area	5.9 6.9
	Main field interrupted	Re-make the main field, control internal connections	9
	Low power supply voltage	Control the power supply	
Motor that speeds up or swings when loaded	Machine with brushes out of neutral area in the opposite direction	Put the brushes back in the neutral area	5.9 6.9
	Main field interrupted	Re-make the main field, control internal connections	9
	Rotor coils in short circuit	Repair or rewind the motor	9
Excessive heating	Excessive load	Check voltage, armature current and excitement current	
	Speed too slow	Adjust activation (minimum speed)	
	Insufficient ventilation	Control filter blocking, remove any obstacles to the air passage, clean the air adduction pipe, check the direction of rotation of the electric fans	7.20
	Temperature of the cooling air or water of the heat exchanger is too high	Check the ventilation circuit and clean if necessary. Use cooling air or water at the temperature indicated by SICMEMOTORI	
	Environmental temperature too high	Suspend the service. Contact SICMEMOTORI	
	Brush inspection hatch open or closed incorrectly	Tighten the hatch	
	Shape factors of the armature current to high	Check and eventually replace the armature power supply. Insert a levelling impedance (contact SICMEMOTORI)	

Table 8.2 – Electrical anomalies

8.3 Commutation and brush anomalies

Good commutation depends on many factors, such as the humidity in the air, the presence of gas or dust in the air, temperature of the cooling air too low, vibrations and low loads for a long period of time.
The choice of the direct type of brush for every type of service is indispensable to obtain good commutation and reduced consumption of the brushes themselves. In spite the fact that SICMEMOTORI has great experience in this sense, unexpected factors may intervene and worsen brush performance. In this case please contact SICMEMOTORI.
When commutation problems are detected and the SICMEMOTORI After-sales Service is contacted, the following information must be supplied:
- Type of motor and serial number (to be found on the motor's plate);
- Type and quantity of the brushes mounted, their aspect (rounded corners, surface with the commutator grooved, etc..)
- Description of the eye-check of the commutator surface (colour, if a film exists, presence of grooves, etc.)
- Armature current: average value absorbed by the motor and, if possible, an oscillogramme of armature current
- Type of environment (humidity, etc.)

8.3.1 Sparks

Light sparks are acceptable and in certain cases normal, until they reach the intensity such to leave traces of burning on the commutator and the corners of the brushes.
It may also happen that some blades (generally at regular intervals) show a different colour, or that the film is not distributed evenly on the blade. Normally this is not dangerous, but sometimes the situation can degenerate quickly and lead to serious problems with the commutator.

Sparks caused by quick variations of current and speed are not generally dangerous.

In each case, even sparkling that at the start does not appear to be dangerous may, with the passing of time, and very quickly, become extremely dangerous for the motor; therefore, it is recommended to inspect the surface of the commutator regularly, so that an increase of sparks is detected immediately.

Main causes of sparks or commutation anomalies

1 Sparks may be caused by an increase in friction between the brushes and brush-holders, caused for example by dirt. In this case, the pressure of the spring is no longer sufficient to ensure good contact between the brush and the commutator. The solution lies in cleaning the brush-holder**. The power supply must be interrupted before carrying out this cleaning operation.**

2 When the motor starts to spark without apparent reason, it is very probable that there is a fault in the power supply (e.g. a burned thyristor or control defect).

3 Another cause of sparks with production of burns on the contact surface of the commutator is incorrect contact between brush and commutator. This could be due to:

- One or more blocked brushes or ruined spring. If this happens on just one brush, the problem may not be very important, but if it happens on a lot of brushes, the other brushes are overloaded and the sparks become dangerous.
- Worn brushes. If one or more consumed brushes are not replaced immediately, the commutator contact surface may be damaged by the brush unsheathed cables, with consequent motor sparks.
- Presence of oil on the commutator. In this case, the oil forms an isolating film on the surface of the commutator, preventing good contact between commutator and brush. Small arches are formed that cause burning on the commutator (burned oil)
- Presence of dust. Dust is deposited on the commutator and the rubbing of the brushes causes grooves in the commutator, and therefore sparks.

4 Vibrations. The vibrations, caused, for example, by an unbalanced joint, by incorrect alignment or induced by the operative machine, may cause an increase in sparks. Generally these types of sparks are present with problems on brush corners.

5 Humidity. If the air is too dry (below 6g/m3) the film does not form on the commutator. If the air is too humid (above 15g/m3) the film becomes too thick. In both cases sparks are created.

6 Under loading. If a direct current machine functions for long periods of time with low current, it is recommended to decrease the number of brushes, to obtain a current density in the brushes that guarantees good heating of the brush itself and, therefore, the creation of the film on the commutator.

A commutator with homogenous film, with a colour that is not too intense, will guarantee optimum commutation and therefore long life of the commutator itself and as a consequence also of the motor. Therefore a commutator with a good film must never be lathed or cleaned with pumice stone.

DANGER!

The operations described below must only be carried out by trained and expert staff. Necessary protective measures must be taken and the motor must be disconnected from the network.

Some minor problems may be resolved with the use of a pumice stone, which, even if removing the film does not alter the profile of the commutator.

If damage to the commutator is deep, the commutator must be rectified. This is an operation that requires highly qualified staff.

In extreme cases it may be necessary to disassemble and lathe the commutator.

Anomaly	Possible cause and solutions *
Sparks on entry of the brushes	1 4 8 9 10 33
Sparks on exit of the brushes	1 3 19 21 32 33
Slight sparks	1 3 4 6 8 9 12
Strong sparks with sprays	6 8 9 10 13 26 27 29 30 31 32 33
Flash at the commutator	1 8 10 22 30
Sparks on some brushes or groups of brushes	2 6 7 9 14 16 17 21 23 24 26 27 28 31 32
Burning of the rear brush corner	1 4 8 12 16 23 24 25 27 32
Vibration and breakage of brush corners	5 9 20 21 25 27 28 31 32
Excessive brush consumption	6 7 8 9 11 12 19 20 23 25 26 27 28 32 33
Non-uniform consumption of the brushes	2 6 7 11 13 17 21 23 24 25 26 27 29 32
Interruption and burning of the unsheathed cables	2 6 8 9 10 13 14 15 17 20 26 30
Grooves on the brush contact surfaces	6 8 14
Irregular consumption of the commutator	6 11 14 15 17 20 33
Grooves on the surface of the commutator	6 11 12 13 14 15 17 21 23 25 28
Symmetric stains on the commutator	1 10 18 30
Asymmetric stains on the commutator	17 29 31 32
Grooves on the commutator	6 7 11 12 13 14 16 21 23 25 33

* See Tab. 8.3.2

Table 8.3.1 - Commutation anomalies

	Possible cause	Solutions	See point
1	Brush-holder out of neutral area	Bring the brushes back into the neutral area	6.9
2	Dissymmetry between the brush-holder supports	Correct the distance between the supports	
3	Flow of the auxiliary poles strong	Increase the auxiliary pole air gap	
4	Flow of the auxiliary poles weak	Decrease the auxiliary pole air gap	
5	Excessive functioning without load	Use adapt brushes, reduce the brushes	
6	Dirt and oil on the commutator	Clean the commutator and check the cause	4.3
7	Abrasive dust on the brush surface	Remove the brushes and clean them	
8	Excessive overloads	Reduce the load	
9	Vibrations	Check alignment and balance if necessary	3.1
10	Fault of rotor winding	Repair and rewind if necessary	9
11	Current density at the brushes too low	Decrease the number of brushes	
12	Humidity too high	Introduce fresh air, choose suitable brushes	
13	Dust or sand suspended in the air	Mount filters and eliminate the cause	
14	Gas or acids in the air	Introduce fresh air, choose suitable brushes	
15	Brush friction too high	Reduce brush pressure, use non-abrasive brushes	
16	Brushes not adapted to the commutator	Adapt the brushes perfectly	7.7
17	Different quality of brushes	Use brushes of the same quality	
18	Stains on the commutator with the machine at a standstill	Raise the brushes	
19	Pressure at the brushes too low	Replace the supports complete with spring	
20	Pressure at the brushes too high	Replace the supports complete with spring	
21	Pressure at the brushes different among themselves	Replace inefficient springs	
22	Brushes blocked in the brush-holders	Clean the brush-holders, control play	
23	Brush-holders with excessive play	Replace the brush-holders	
24	Brush-holders not parallel to the thin blades	Adjust the brush-holders	5.9.3
25	Distance from the brush-holder box to the commutator too far	Adjust the distance to 2-2.5 mm	5.9.3
26	Non-uniform distribution of the current in the brushes	Increase current density, by reducing the quantity of the brushes; use more abrasive brushes	
27	Mica projecting from the commutator	Mica undercut and round-off corners	7.2
28	Burrs at the blades	Eliminate burrs, round-off corners, replace the brushes with others that are more adapt	
29	Ovalised commutator	Lathe the commutator	7.2
30	Interrupted welding	Weld the forks to the commutator	
31	Grooves on the commutator	Lathe the commutator	7.2
32	Projecting commutator blades	Pass over the commutator with stone; lathe the commutator if necessary	7.2
33	Lack of levelling reactance where envisioned	Place the levelling reactance	

Table 8.3.2 – Commutation anomalies – troubleshooting

9. INSTRUCTIONS FOR ELECTRICAL REPAIRS

When repair consists in rewinding main field bobbins, auxiliary field bobbins or rotors, consult an expert and adequately equipped workshop for repairs.
On request SICMEMOTORI will send an updated list of workshops that they consider suitable.
Particular attention must be given to the materials to be used regarding this. Specific indications for each machine, as well as diagrams and instructions for rewinding, will be put at disposal by SICMEMOTORI on request, with the fastest means.
Some general indications, which must always be taken into consideration, are shown below:

Component	Recommended material	Class
Wires	Enamelled copper, double enamel	H; H+
Ground strap	Enamelled copper, quadruple enamel	H; H+
Insulation towards earth	Nomex	H
Isolating flange	Polyester	H
Rotor head shields	Polyglass band	H
Windings impregnation	0ven-dry paint	H
Windings surface protections	Non-tarnishing epoxy enamel (can be dried in the open air or in oven)	-

Table 10 – Materials recommended for electrical repairs

10. RECOMMENDED SPARE PARTS

An appropriate stock of spare parts ensures plant continuity and allows to resolve standstill due to faults in a brief period of time. To order spare parts it is always necessary to indicate the type of machine, the serial number and plate information.
The amount of spare parts to have at disposal depends on the amount of the same types of machine used and the importance attributed to standstill time. Table 9 indicates the recommended minimum quantities of spare parts to stock:

Spare parts	Identical machines into operation				
	1	2-4	5-9	10-19	=>20
Set of brushes	2	4	8	12	20
Set of brush-holders	-	1	1	2	2
Set of bearings	1	1	1	2	3
Main pole (wound)	-	1	2	2	4
Auxiliary pole (wound)	-	1	2	2	4
Compensating coil	-	1	2	2	4
Complete armature	-	1	1	2	2
Complete machine	-	-	1	1	1
Commutator	-	-	1	1	1

11. DEMONSTRATION GENERAL DRAWINGS AND NOMENCLATURE

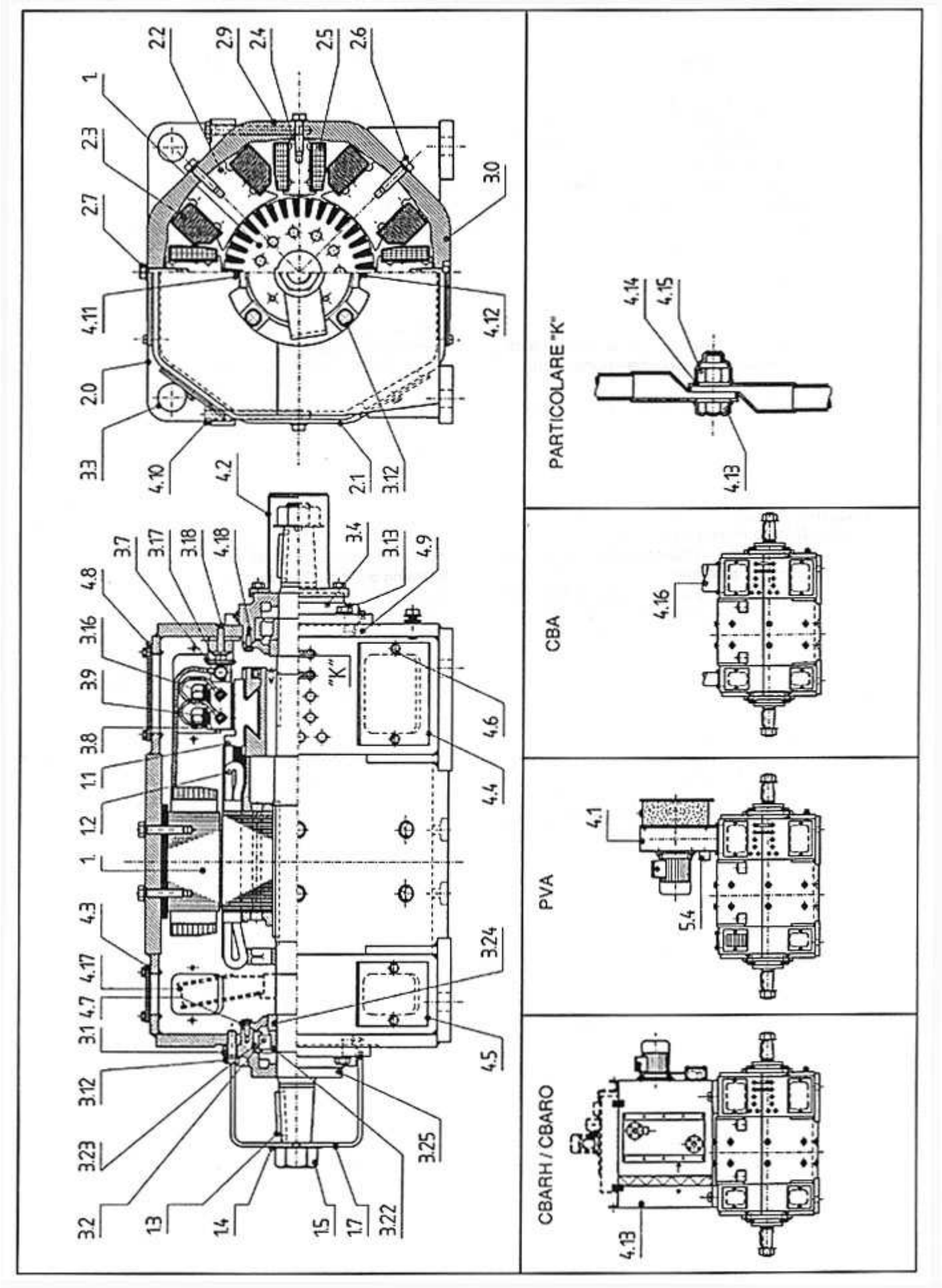


FIG. 1A – Demonstration general drawing for motors SM802-804

FIG.1B Nomenclature for Fig. 1A

1. Rotor
1.1 Commutator
1.2 Rotor coil
1.3 Shaft key
1.4 Lockwasher
1.5 Shaft nut
1.7 Rotor locking device

2. Stator with poles
2.1 Stator core
2.2 Main pole with coil
2.3 Main pole coil
2.4 Commutating pole with coil
2.5 Commutating pole coil
2.9 Top half-yoke

3.0 Bottom half-yoke
3.1 Drive end shield
3.2 Drive end and non drive end bearings
3.3 Lifting lug
3.4 Non drive end shield
3.7 Brush-holder rocker
3.8 Brush-holder
3.9 Brush
3.22 Bearing inner ring
3.23 Bearing outer ring
3.24 Extraction ring
3.25 Complete bearing bush

4.1 Electric fan
4.2 Shaft end protection
4.3 Drive end top door
4.4 Non drive end side door
4.5 Drive end side door
4.7 Inner grease seal
4.8 Non drive end top door
4.11 Grease nipple
4.12 Grease drain plug
4.13 Cooling system
4.16 Cooling ducts
4.17 Fan (for PV execution only)

5. Accessories (on request only)
5.1 Tachoprovision
5.2 Tachocoupling
5.3 Tachogenerator
5.4 Pressure switch

TIGHTENING MEMBERS LIST (FOR DISASSEMBLING AND RE-ASSEMBLING ONLY)
2.6 Main poles securing screws
2.7 Commutating poles securing screws
3.12 Drive end bearing bush securing screws
3.13 Non drive end bearing bush securing screws
3.16 Brushes leads securing screws
3.17 Brush-holders leads securing screws
3.18 Brush-holders securing screws
4.6 Doors securing screws
4.9 Self-centering pins for bearing bushes
4.10 Screws joining the half-yokes
4.13 Feeding leads tightening screws
4.14 Feeding leads washers
4.15 Feeding leads tightening nuts
4.18 Drive end and non drive end inner grease seal securing screws

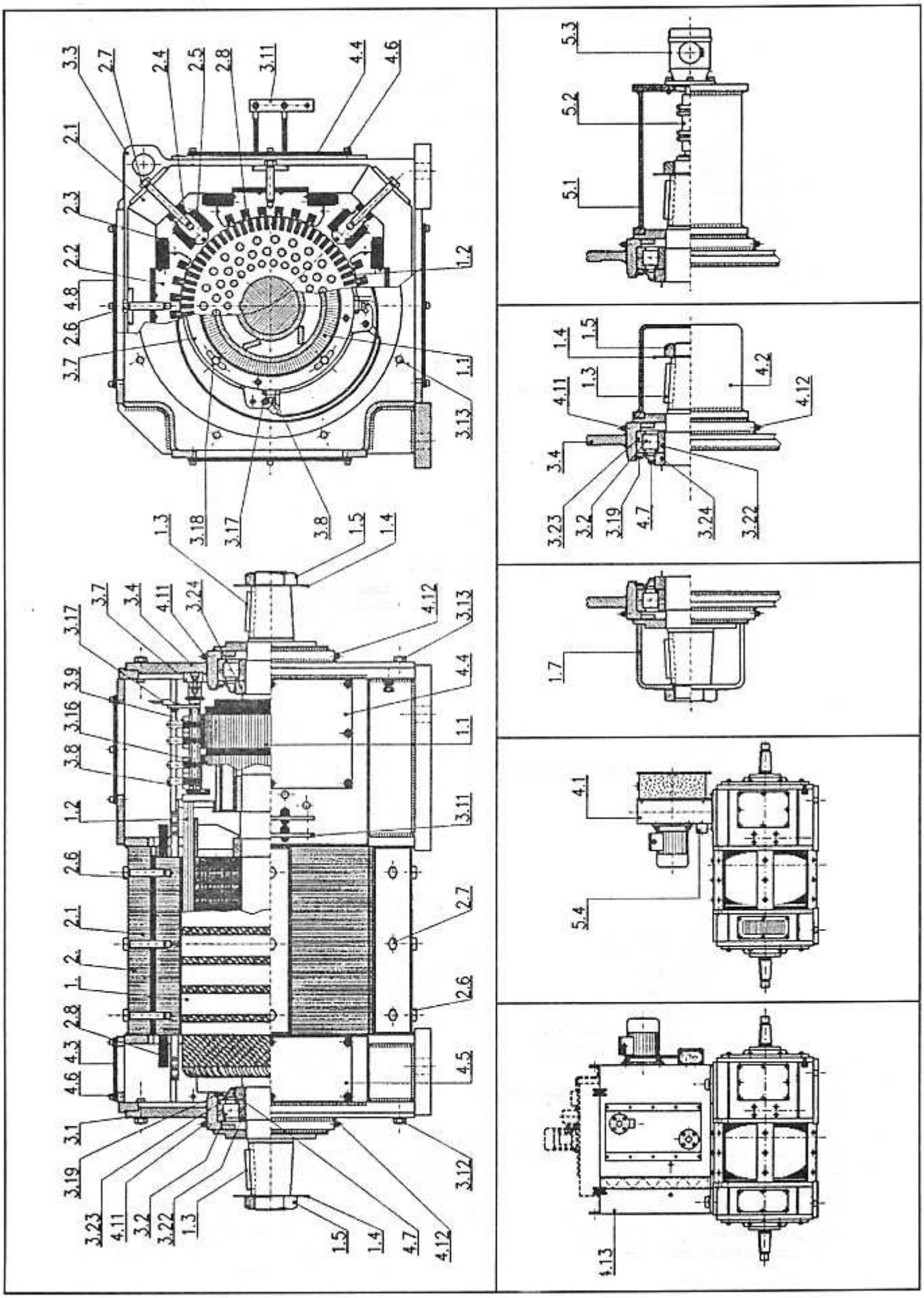


Fig. 1C – Demonstration general drawing for motors ML806-818

FIG.1D Nomenclature for Fig. 1C

1. Rotor
1.1 Commutator
1.2 Rotor coil
1.3 Shaft key
1.4 Lockwasher
1.5 Shaft nut
1.7 Rotor locking device

2. Stator with poles
2.1 Stator core
2.2 Main pole with coil
2.3 Main pole coil
2.4 Commutating pole with coil
2.5 Commutating pole coil
2.6 Compensating coil

3.1 Drive end shield
3.2 Drive end and non drive end bearings
3.3 Lifting lug
3.4 Non drive end shield
3.7 Brush-holder rocker
3.8 Brush-holder
3.9 Brush
3.11 Metallic bar
3.19 Seeger ring
3.22 Bearing inner ring
3.23 Bearing outer ring
3.24 Extraction ring

4.1 Electric fan
4.2 Shaft end protection
4.3 Drive end top door
4.4 Non drive end side door
4.5 Drive end side door
4.6 Doors securing screws
4.7 Inner grease seal
4.8 Non drive end top door
4.11 Grease nipple
4.12 Grease drain plug
4.13 Cooling system (CBARH/CBARO)

5. Accessories (on request only)
5.1 Tachoprovision
5.2 Tachocoupling
5.3 Tachogenerator
5.4 Pressure switch

TIGHTENING MEMBERS LIST (FOR DISASSEMBLING AND RE-ASSEMBLING ONLY)
2.6 Main poles securing screws
2.7 Commutating poles securing screws
3.12 Drive end bearing bush securing screws
3.13 Non drive end shield securing screws
3.16 Brushes leads securing screws
3.17 Brush-holders leads securing screws
3.18 Brush-holders securing screws

APPENDIX

B AIR-AIR HEAT EXCHANGER

b.1 Description of the exchanger
b.2 Casing
b.3 Air filter
b.3.1 Filter extraction
b.3.2 Regeneration of the filter cloth
b.4 Cooling battery
b.4.1 Cleaning the pipe bundle
b.5 Internal circuit electric fan
b.5.1 Cleaning internal air circuit rotor
b.6 External circuit electric fan
b.6.1 Cleaning external air circuit rotor
b.7 Exchanger terminal box
b.8 Control equipment
b.9 Recommended maintenance cycle
b.10 Control equipment calibration

C AIR-WATER HEAT EXCHANGER

c.1 Description of the exchanger
c.2 Casing
c.3 Air filter
c.3.1 Filter extraction
c.3.2 Regeneration of the filter cloth
c.4 Cooling battery
c.4.1 Cleaning inside pipes
c.4.2 External cleaning of the pipe bundle
c.5 Electric fan
c.5.1 Cleaning fan rotor
c.6 Exchanger terminal box
c.7 Control equipment
c.8 Recommended maintenance cycle
c.9 Control equipment calibration

B AIR-AIR HEAT EXCHANGER

Normally the air-air heat exchanger is mounted on the upper side of the motor, which is in closed execution.

b.1 Description of the air-air heat exchanger

The exchanger is made up of the following main components (see figs. 1 and 2).

Casing (2.0)
Air filter (3.0)
Battery with pipe bundle (4.0)
Internal circuit Electric fan (5.0)
External circuit electric fan (6.0)
Terminal box (7.0)
Control equipment

Figures 1 and 2 highlight internal and external air flow

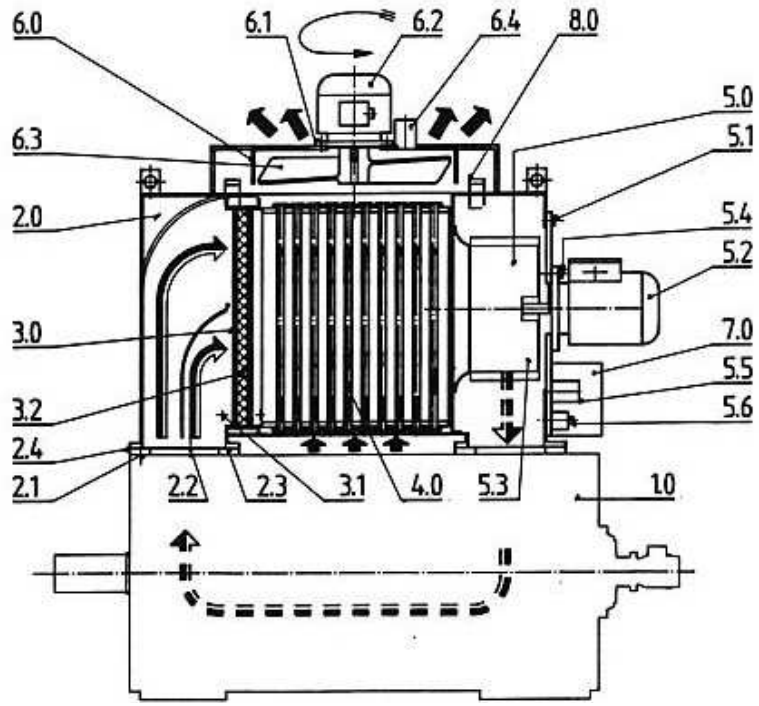


Fig. 1 – Air-air heat exchanger for 132-315 machines

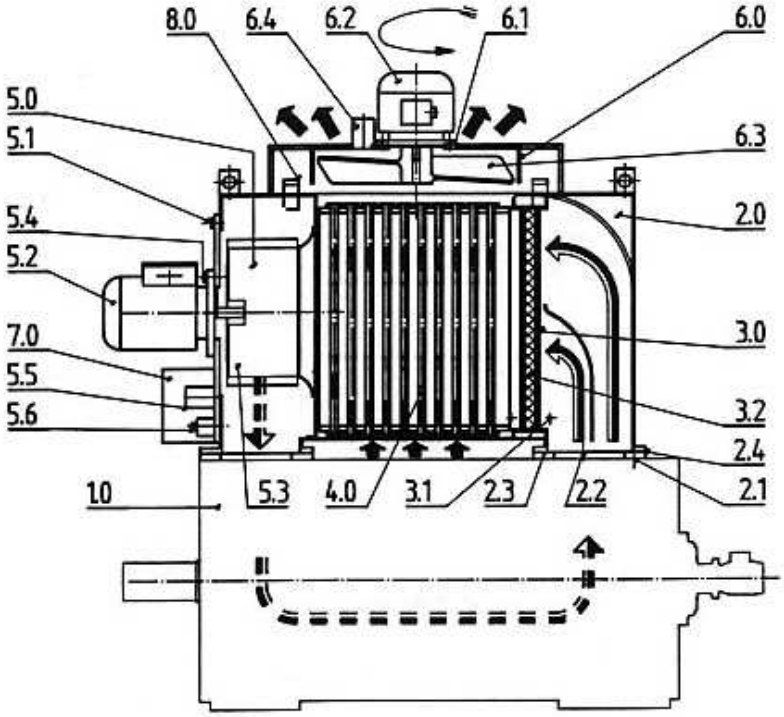


Fig. 2 – Air-air heat exchanger for 355-800 machines

Externat circuit – environmental air

Internal circuit – hot air coming from the machine

Internal circuit – cold air coming from the exchanger

Direct current machine
2.0 Casing
2.1 Screw fasteners for fixing the plate to the machine
2.2 Screw fasteners for fixing the exchanger to the plate
2.3 Plate
2.4 Seal
3.0 Filtering unit
3.1 Filter lid nut fasteners
3.2 Filtering panel
4.0 Pipe bundle
5.0 Internal circuit electric fan unit
5.1 Electric fan unit nut fasteners
5.2 Internal circuit asynchronous motor
5.3 High-pressure rotors
5.4 Asynchronous motor nut fasteners
5.5 Internal circuit pressure switch
5.6 Internal circuit air thermostat
6.0 External circuit electric fan unit
6.1 Asynchronous motor nut fasteners
6.2 External circuit asynchronous motor
6.3 Axial fan
6.4 External circuit pressure switch
7.0 Heat exchanger terminal box
8.0 Adjustable hook closure

Fig. 3 – Nomenclature relative to figures 1 and 2

b.2 Casing
The casing 2.0 guards and encloses filter 3.0, the cooling battery with pipe bundle 4.0 and the electric fan 5.0 for the circulation of cooling air inside the machine 1.0. It is mounted onto the machine using attachment flanges with two air inlet and outlet openings (mouths), for circulation in a closed circuit. It is connected to the motor using screws 2.1 with the interposition of a frame 2.3 for quick removal, connected to the exchanger with screws 2.2. The chloroprene rubber seals 2.4 supply a sufficient hold.

b.3 Air Filter
The internal air filter 3.0 is mounted on the entry of the pipe bundle in the internal ventilation circuit. It can be extracted, regenerated and is self-extinguishing.

b.3.1 Filter extraction
Loosen nuts 3.1 and remove the cover of the filtering unit; extract the filter using the relevant extraction holes.

b.3.2 Regeneration of the filter cloth
The filter cloth 3.2 can be regenerated and does not require replacement if not only after a certain number of washes. The filter is cleaned by using compressed air, beating or suction devices, or by rinsing in warm water up to 40°C with soap if required. In extreme cases petrol can be used. Do not wring after washing. If the filter is washed it must be allowed to dry before re-mounting. When the operation has been carried out re-introduce the filter into the casing and tighten the nuts 3.1 on the cover. The filter must be controlled periodically, to prevent excessive load losses in the ventilation circuit if the pressure switch 5.5 (see point b.8) is calibrated incorrectly or broken.

b.4 Cooling battery
The battery 4.0 is made up of a bundle realised with expanding aluminium pipes on longitudinal perforated plates. It is treated with resins to ensure hold.

b.4.1 Cleaning the pipe bundle
Release the hook closure levers 8.0 that block the cooling circuit unit outside casing 2.0 and raise this unit to expose the pipe entry. Clean the pipe bundle by blowing clean, dry compressed air (2-3 bar).

b.5 Internal circuit electric fan
The internal circulation of air in a closed circuit for cooling the direct current machine takes place using an electric fan, made up of a three-phase asynchronous motor 5.2 and high-pressure rotor 5.3. After filtering the hot air returns into the cycle, cooling down during

passage through the pipe bundle. The correct direction of rotation of the fan is indicated by an arrow. It is important that the rotor is kept clean, because the presence of dirt or deposits may cause unbalance, with consequent vibrations.

b.5.1 Cleaning of internal air circuit rotor

Loosen nuts 5.1 that block the electric fan unit to the casing 2.0 and slide the motor-rotor unit out of the casing. Clean the blades with a jet of compressed air and if necessary, by brushing or washing. Re-mount the electric fan and tighten nuts 5.1.

b.6. External circuit electric fan

Environmental air is made to circulate inside the cooling battery pipes. Circulation of the air takes place by means of the electric fan 6.0 that sucks air from below upwards using the axial fan 6.3 activated by the three-phase asynchronous motor 6.2. The correct direction of rotation of the fan is indicated by an arrow.

b.6.1 Cleaning of external air circuit rotor

To check the cleanliness of the rotor release the hook closure levers 8.0 that block the unit 2.0 to the casing, and lift it for access to the fan. Clean with a jet of compressed air and if necessary, by brushing or washing. Re-mount by re-attaching the hook closure levers 8.0.

b.7 Air-air heat exchanger terminal box

The exchanger has a terminal box 7.0 for connection of all control devices and to power asynchronous motors.

b.8 Control equipment (see diagram in fig. 5)

The heat exchanger has two pressure switches 5.5 and 6.4 to signal the development of any faults (excessive drop in pressure) in the internal or external air circuits. A thermostat 5.6 is also envisioned in the internal circuit, to signal any excessive temperature of the air entering the machine. The pressure switch 5.5 and thermostat 5.6 are mounted inside the terminal box 7.0.

DANGER!

Before carrying out any maintenance operations, ensure that the electric machine and the heat exchanger fans have been disconnected from the network.

b. 9 Recommended maintenance cycle

Component	Operation	Frequency (hours)
Filter	Check if blocked and clean if necessary	750
Cooling battery	Cleaning of pipe bundle	4000
Internal and external circuit electric fans	Cleaning of rotor	8000
Control equipment	Check equipment efficiency and tightness of electric connections	2500
Seals	Replace all seals	15000
Screws	Check for any loosening	2500

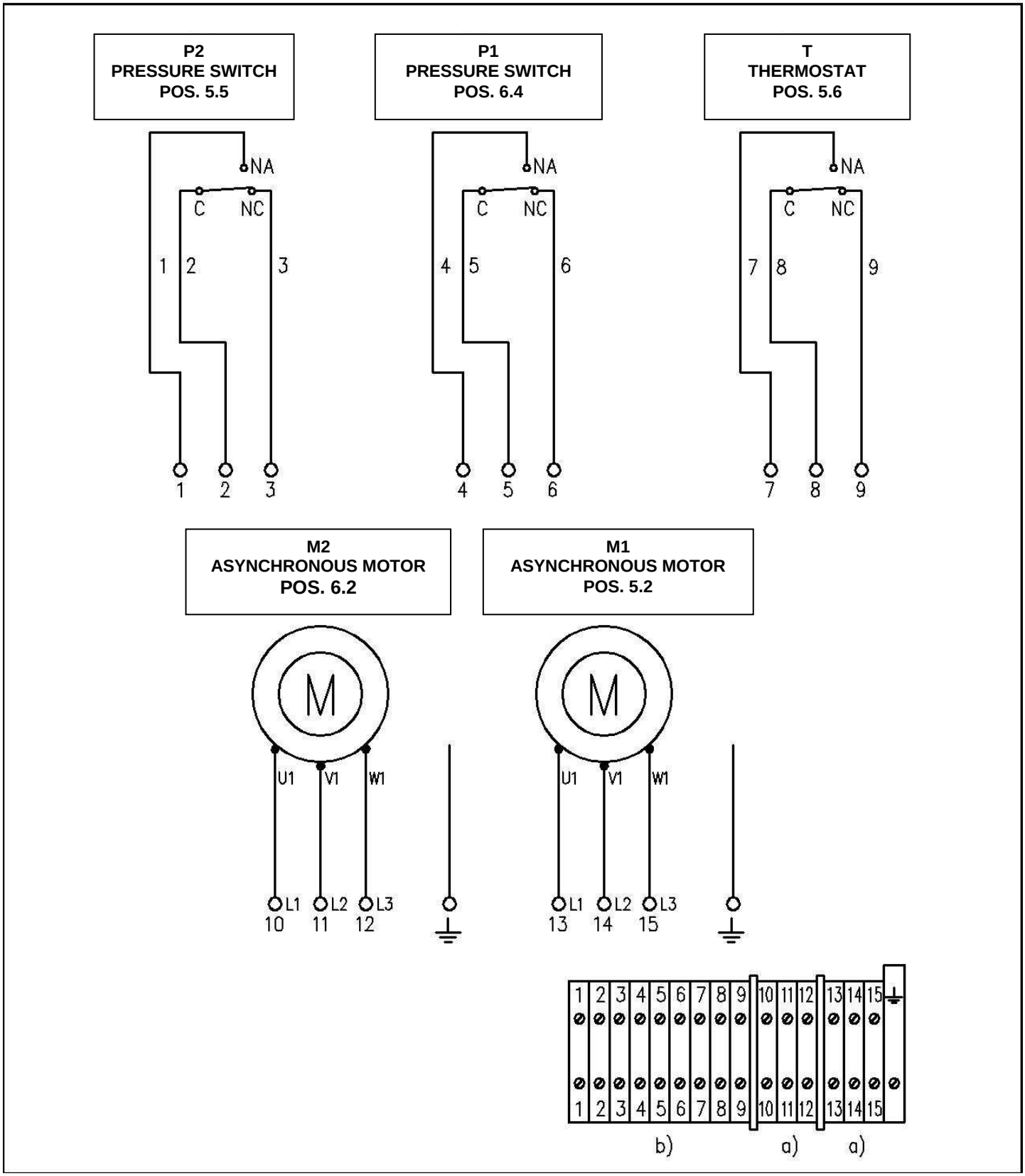


Fig. 5 – Air-air heat exchanger wiring diagram

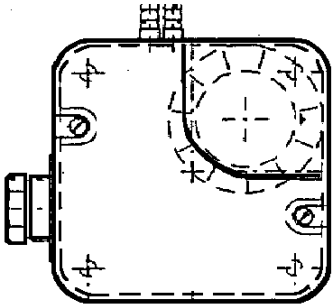
Power supply from three-phase line (400 V – 50 Hz if not indicated differently)
Power supply from single-phase line (230 V - 50 Hz if not indicated differently)

b.10 Calibration of control equipment

-Internal air pressure switch:

The pressure switch is calibrated in our test room. In case of replacement or anomalous functioning of the pressure switch, refer to the following instructions for calibration.

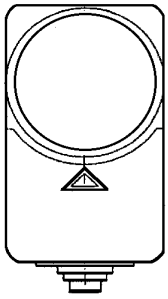
1) Position the control knob in proximity of the minimum calibration value.
2) Activate ventilation.
3) Turn the control knob slowly in a clockwise direction until commutation of the contact.
4) Turn the control knob again in **an anti-clockwise direction** by a few millimetres (≅ 0.2 - 0.3 mbar).
5) Disconnect ventilation and check, much earlier that the fan is at a complete standstill, and the contact returns to the rest position.



-Internal air thermostat:

The internal air thermostat is calibrated in our test rooms. In case of replacement or anomalous functioning of the thermostat, follow the instructions below for new calibration

1) Turn the relevant control knob in proximity of the environmental temperature.
2) Check commutation of the contact.
3) Turn the control knob again, setting it in proximity of the temperature of 45/55℃. If the machine is installed in a place with different environmental temperature from –20℃ ÷ +4 0℃ consult SICMEMOTORI.
4) Check return of the contact to the rest position.



C AIR-WATER HEAT EXCHANGER

Normally the air-water heat exchanger on the upper side of the motor, which is in closed execution.

c. 1 Description of the exchanger

The air-water heat exchanger is made up of (see figs. 6 and 7):

Casing (2.0)
Air filter (3.0)
Air-water cooling battery (4.0)
Electric fan (5.0)
Exchanger terminal box (6.0)
Control equipment.

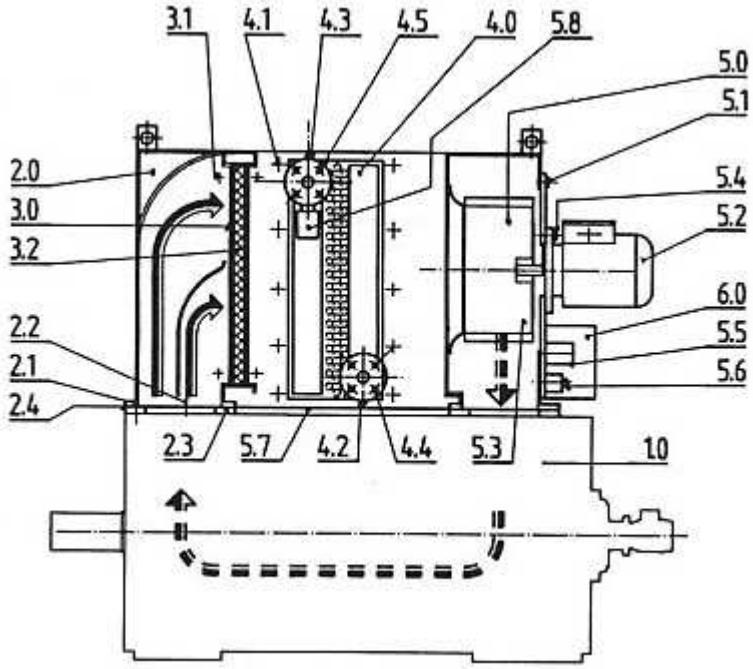


Fig. 6 – Air-water heat exchanger for machines 132-315

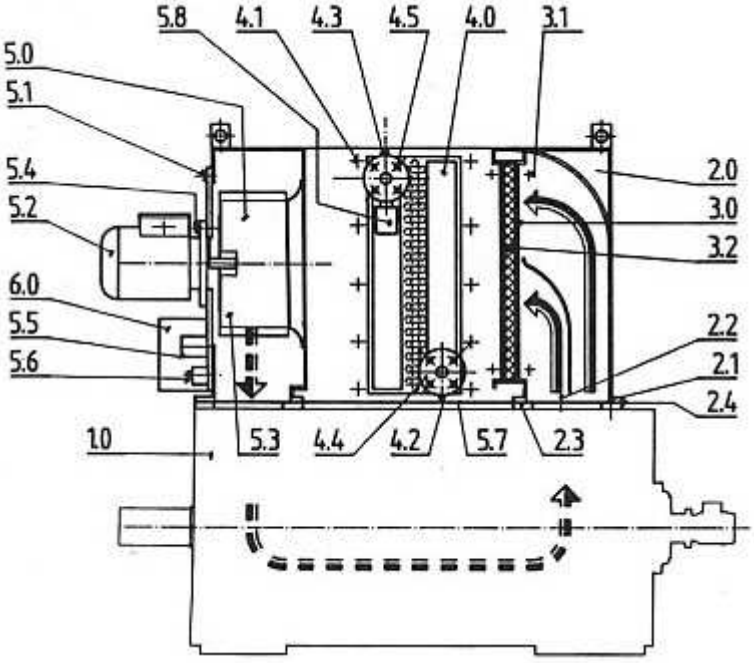


Fig. 7 – Air-water heat exchanger for machines 355-800

Hot air coming from the machine

Cold air coming from the exchanger

1.0 Direct current machine
2.0 Casing
2.1 Screw fasteners for fixing the plate to the machine
2.2 Screw fasteners for fixing the heat exchanger to the plate
2.3 Plate
2.4 Seal
3.0 Filtering unit
3.1 Filtering unit lid nuts
3.2 Filter cloth
4.0 Air-water cooling battery
4.1 Cooling battery screw fasteners.
4.2 Tap on delivery pipe
4.3 Tap on discharge pipe
4.4 Flange on delivery pipe
4.5 Flange on discharge pipe
5.0 Electric fan
5.1 Electric fan screw fasteners
5.2 Asynchronous motor
5.3 Rotor
5.4 Asynchronous motor screw fasteners
5.5 Pressure switch
5.6 Thermostat
5.7 Water leakage indicator
5.8 Flow metre
6.0 Heat exchanger terminal box

Fig. 8 - Nomenclature relative to figures 6 and 7

c.2 Casing

The casing 2.0 guards and encloses filter 3.0, the cooling battery 4.0 and the electric fan 5.0 It is mounted onto the machine using attachment flanges with two air inlet and outlet openings (mouths), for circulation in a closed circuit. It is connected to the motor using screws 2.1 with the interposition of a frame 2.3 for quick removal, connected to the exchanger with screws 2.2. The chloroprene rubber seals 2.4 keep a sufficient hold.

c.3 Air Filter

Filter 3.0 is mounted at the entry of the cooling battery. It can be extracted, regenerated and is self-extinguishing.

c.3.1 Removal of the filter

Loosen nuts 3.1 and remove the cover of the filtering unit; extract the filter using the relevant extraction holes.

c.3.2 Regeneration of the filter cloth

The filter cloth 3.2 can be regenerated and does not require replacement if not only after a certain number of washes. The filter is cleaned by using compressed air, beating or suction devices, or by rinsing in warm water up to 40°C wi th soap if required. In extreme cases petrol can be used. Do not wring after washing. If the filter is washed it must be allowed to dry before re-mounting. Re-mount and tighten the nuts 3.1. The filter must be controlled periodically, to prevent excessive load losses in the ventilation circuit

c.4 Cooling battery

The 4.0 battery is made up of a copper pipe bundle within a pack of thin aluminium sheet. Water passes through these pipes. The air brushes against the thin aluminium sheet, which subtract heat and transmit it for conduction to the pipes. Attention to water features: except for different agreements, the heat exchangers are envisioned for industrial or rural water, without suspended substances and dimensioned for water entering at a maximum temperature of 26°C, with max. pressure of 7 bar. The pipe bundle ends with a normalised flange 4.4 and 4.5 for attachment to the delivery pipes and discharge of water. Drainage tap 4.2 is mounted on the delivery pipes. Tap 4.3 is mounted on the water return for relief.

c.4.1 Cleaning inside pipes

Close the slide valve (not supplied), positioned upstream from the delivery flange to interrupt the supply of water. Remove lid 4.2 on the delivery pipe to remove all water completely from the battery. Remove lid 4.3 and then introduce a jet of compressed air into the copper pipes to eliminate dirt and deposits. If necessary wash with de-scaling agents. Use suitable detergents periodically to reduce the formation of deposits inside the pipes.

c.4.2 Cleaning the outside of the pipe bundle

Loosen screws 4.1 that block the battery to the casing. Slide the battery out of the casing and clean the pipe bundle with a jet of pressurised air or by washing to eliminate and dust deposits. Re-mount the battery and tighten screws 4.1.

c.5 Electric fan

The electric fan 5.0 makes air circulate in the closed machine-exchanger circuit; it is made up of a three-phase asynchronous motor 5.2 and rotor 5.3. The correct direction of rotation is indicated by an arrow.

c. 5.1 Cleaning of the fan rotor

To check if the rotor is clean loosen screws 5.1 that block the electric fan unit to the casing and slide the motor/rotor unit out of the casing. Deposits on the rotor may cause unbalancing, with consequent vibrations. Clean with a jet of pressurised air, by brushing or washing. Re-mount the electric fan and tighten screws 5.1.

c.6 Air-water heat exchanger terminal box

The exchanger is supplied with a terminal box 6.0 for connection of all control equipment e and for the power supply of the asynchronous motor.

DANGER!

Before carrying out any maintenance operation, ensure that any electric machine and its fan are disconnected from the network.
Also ensure that the cooling water slide valves are closed.

c. 8 Recommended maintenance cycle

Component	Operation	Frequency (hours)
Filter	Check if blocked and clean if necessary	750
Cooling battery	External cleaning of the pipe bundle	4000
	Total cleaning	8000
Electric fan	Clean rotor	8000
Control equipment	Check equipment efficiency and check tightening of the electric connections	2500
Seals	Replacement of all seals	15000
Screws	Check for any loosening	2500

c.7 Control equipment (see diagram in fig. 9)

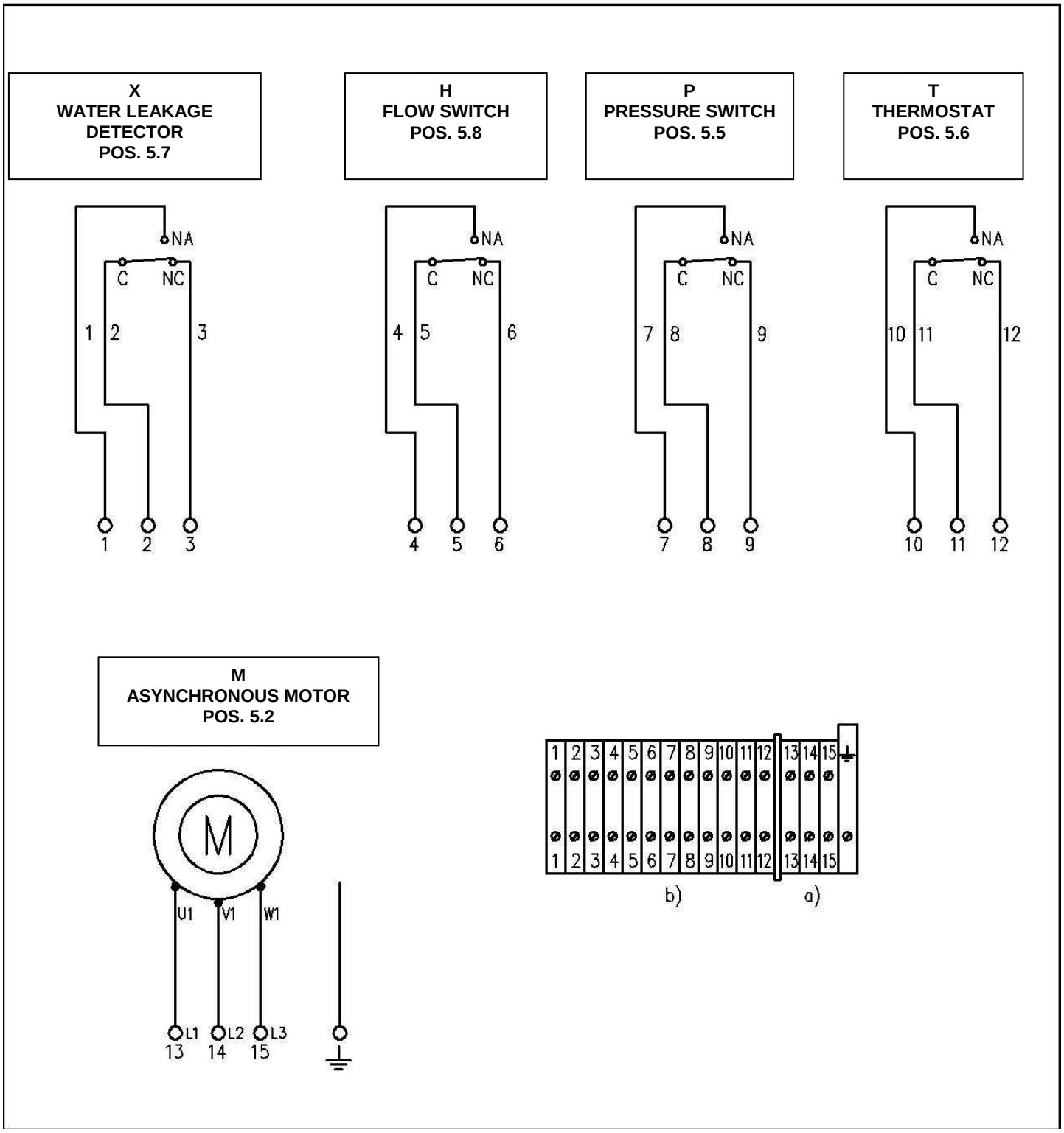


Fig. 9 – Air-water heat exchanger wiring diagram

a) Power supply from three-phase line (400 V – 50 Hz if not indicated differently)
b) Power supply from single-phase line (230 V – 50 Hz if not indicated differently)

In the standard version the indicator is complete with:

- a pressure switch 5.5 on the air circuit to signal any abnormal drops in pressure.
- a thermostat 5.6 to signal any excessive temperature of the air entering the machine.
- A flow metre 5.8 to signal an excessive reduction of water flow.
- A water loss indicator5.7 (only for heat exchangers on 225 and upper range machines).

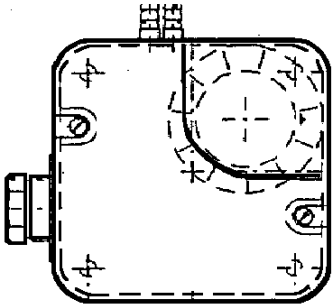
The pressure switch 5.5 and thermostat 5.6 are mounted inside the terminal box 6.0.

c.9 Calibration of control equipment

-Pressure switch:

The pressure switch is calibrated in our test room. In case of replacement of anomalous functioning of the pressure switch, refer to the following instructions for calibration.

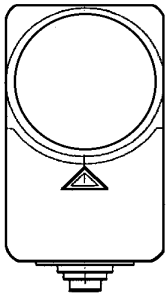
6) Position the control knob in proximity of the minimum calibration value.
7) Activate ventilation.
8) Turn the control knob slowly in a clockwise direction until commutation of the contact.
9) Turn the control knob again in **an anti-clockwise direction** by a few millimetres (≅ 0.2 - 0.3 mbar).
10) Disconnect ventilation and check, much earlier that the fan is at a complete standstill, and the contact returns to the rest position.



-Thermostat:

The thermostat is calibrated in our test rooms. In case of replacement of anomalous functioning of the thermostat, refer to the following instructions for calibration.

5) Turn the relevant control knob in proximity of the environmental temperature.
6) Check commutation of the contact.
7) Turn the control knob again, setting it in proximity of the temperature of 45/55°C. If the machine is installed in a place with different environmental temperature from –20°C ÷ +4 0°C consult SICMEMOTORI.
8) Check return of the contact to the rest position.



USER COMMENTS ABOUT THIS MANUAL

To make this manual as complete as possible with all information necessary to ease the work of the maintenance engineers of our products, any suggestions, observations or criticism, will be a source of continuous improvement for SICMEMOTORI.

Name of the user	Date	If necessary, how can we contact you?
Name and address of the Company	Manual code	Fax
		Tel
Type of company/Reason for using this manual		E-mail

General opinion

	Excellent	Good	Discrete	Very bad	Comments
Content	O	O	O	O	
Organisation	O	O	O	O	
Technical accuracy	O	O	O	O	
Clarity of the text	O	O	O	O	
Completeness	O	O	O	O	
Diagrams/Figures	O	O	O	O	
Tables	O	O	O	O	
References	O	O	O	O	
Legibility	O	O	O	O	

Specific suggestions (corrections, information that requires more space, etc.)

Page N°. Comments

Other comments (what would you like, what could be added, how could the manual be improved, etc.)

In comparison of similar manuals of Manufacturer's of similar products, how do you judge this publication?

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