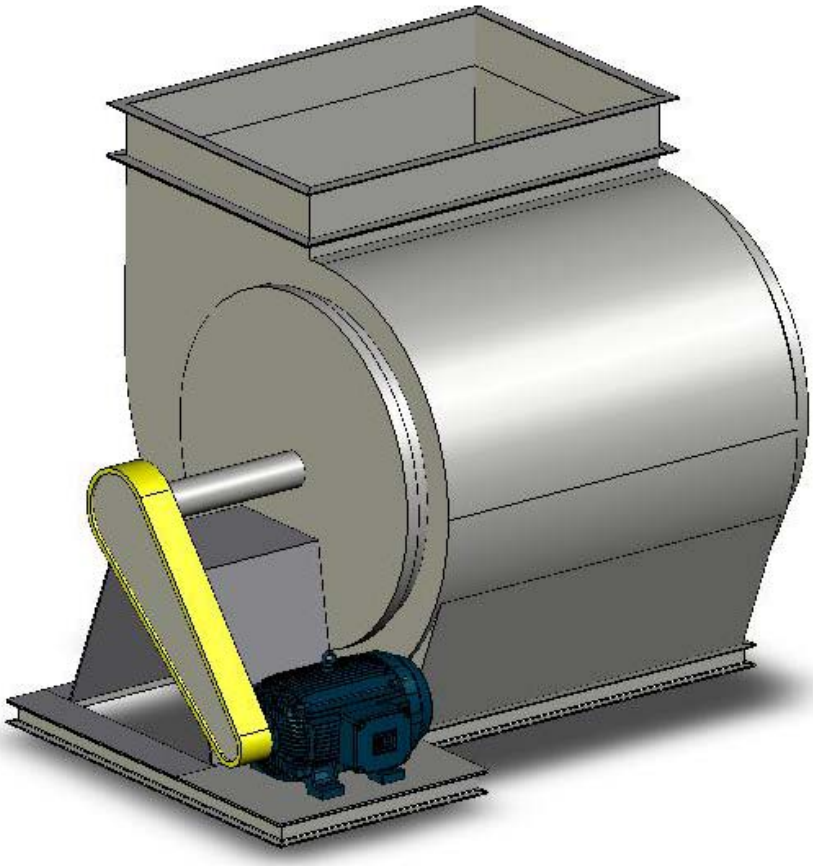
Technical Manual on Installation, Operation, & Maintenance

Centrifugal / Axial Fan



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1 – INTRODUCTION

The recommendations provided in this manual have been prepared based on the data of the project involved and experimental laboratory know-how that made it possible to apply the products supplied.

However, the user has additional information about hands-on operating conditions and about the workplace. Therefore, the user can join this know-how to the hands-on recommendations in this guide; information and more specific details on each component supplied by the manufacturer and prepare a good installation and operation scheme and a safe maintenance program.

Several data sheets specific to the sets and to key accessories are part of this Manual. They indicate the most relevant technical and construction characteristics.

Besides the recommendations in this manual, which must be considered as supplementary, we recommend not leaving aside the usual norms relating to good operation, maintenance and installation techniques.

It must be pointed out that the use of qualified personnel, both in operation and in maintenance of the equipment means eliminating countless problems.

2- GENERAL CONCEPTS

Centrifugal /Axial fans are rotating machines, volumetric displacers of gaseous fluids.

They key characteristics to select the fans are fluid volume and air pressure to be overcome for this displacement. Together with these two characteristics are density (specific weight) and aggressiveness of the displaced fluid.

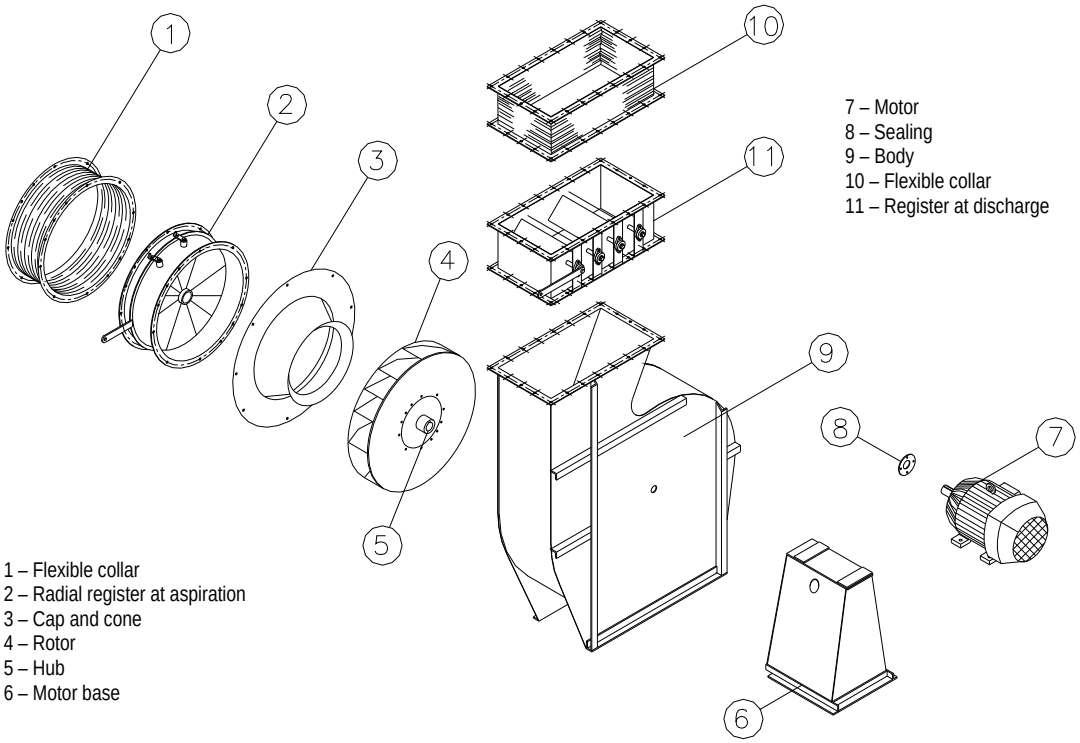
Based on this information from the customer process, the project for the equipment is carried out.

However, it is important to use the equipment as designed. In case of equipment altering the equipment, please inform the manufacturer to optimize your operation.

In sight of the constructive differences between centrifugal and axial fans, the recommendations of these manuals must only be considered where applicable.

3 – EQUIPMENT DRAWING

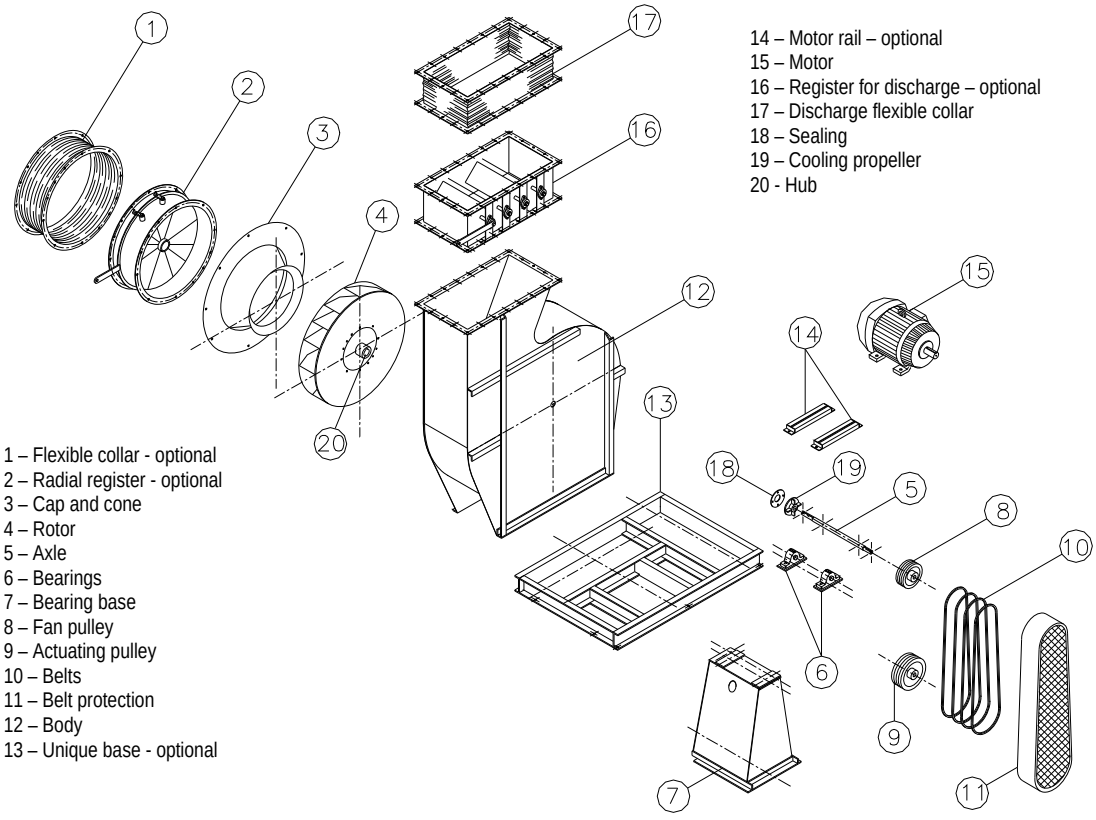
3.1 - Arrangement 4 – Fans with rotor coupled directly to motor axle end



1 – Flexible collar
2 – Radial register at aspiration
3 – Cap and cone
4 – Rotor
5 – Hub
6 – Motor base

7 – Motor
8 – Sealing
9 – Body
10 – Flexible collar
11 – Register at discharge

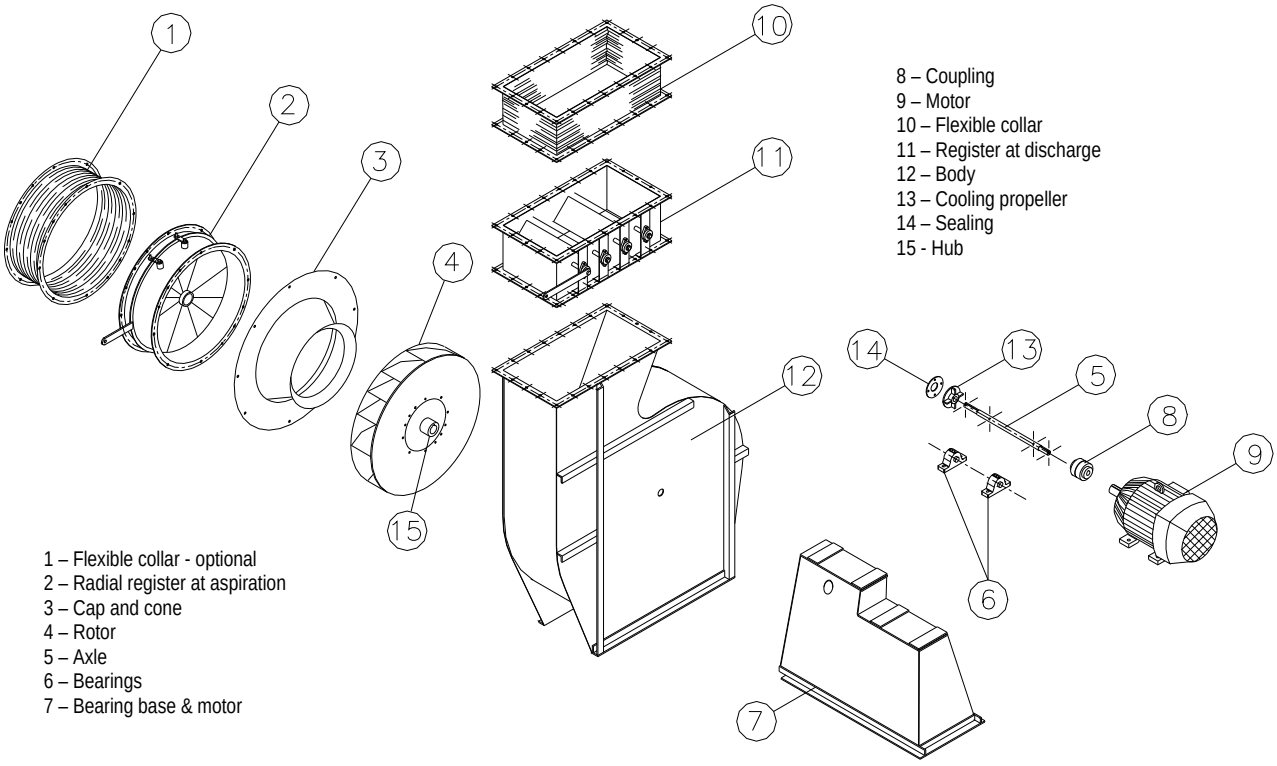
3.2 - Arrangement 3 & 12 Fans actuated by pulleys and belts



1 – Flexible collar - optional
2 – Radial register - optional
3 – Cap and cone
4 – Rotor
5 – Axle
6 – Bearings
7 – Bearing base
8 – Fan pulley
9 – Actuating pulley
10 – Belts
11 – Belt protection
12 – Body
13 – Unique base - optional

14 – Motor rail – optional
15 – Motor
16 – Register for discharge – optional
17 – Discharge flexible collar
18 – Sealing
19 – Cooling propeller
20 - Hub

3.3 - Arrangement 7 & 8 – Fans actuated with elastic coupling (rotor direct rotation)

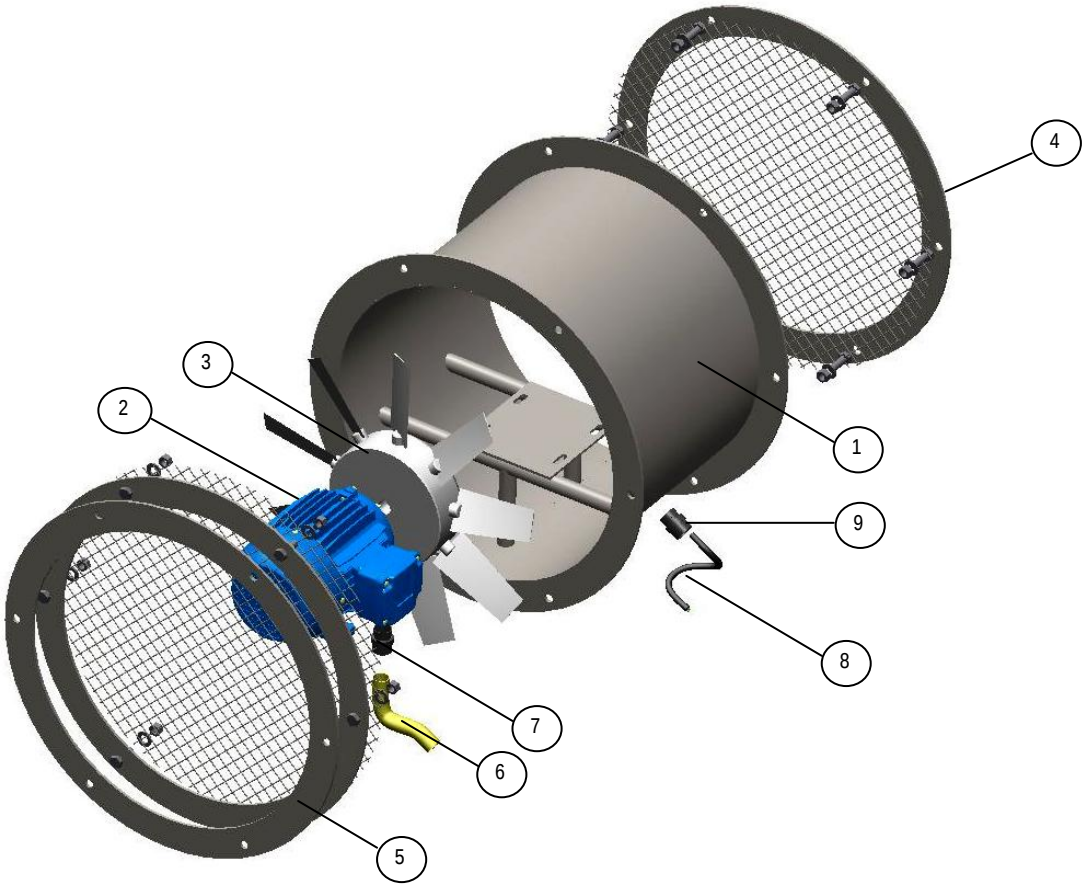


8 – Coupling
9 – Motor
10 – Flexible collar
11 – Register at discharge
12 – Body
13 – Cooling propeller
14 – Sealing
15 - Hub

1 – Flexible collar - optional
2 – Radial register at aspiration
3 – Cap and cone
4 – Rotor
5 – Axle
6 – Bearings
7 – Bearing base & motor

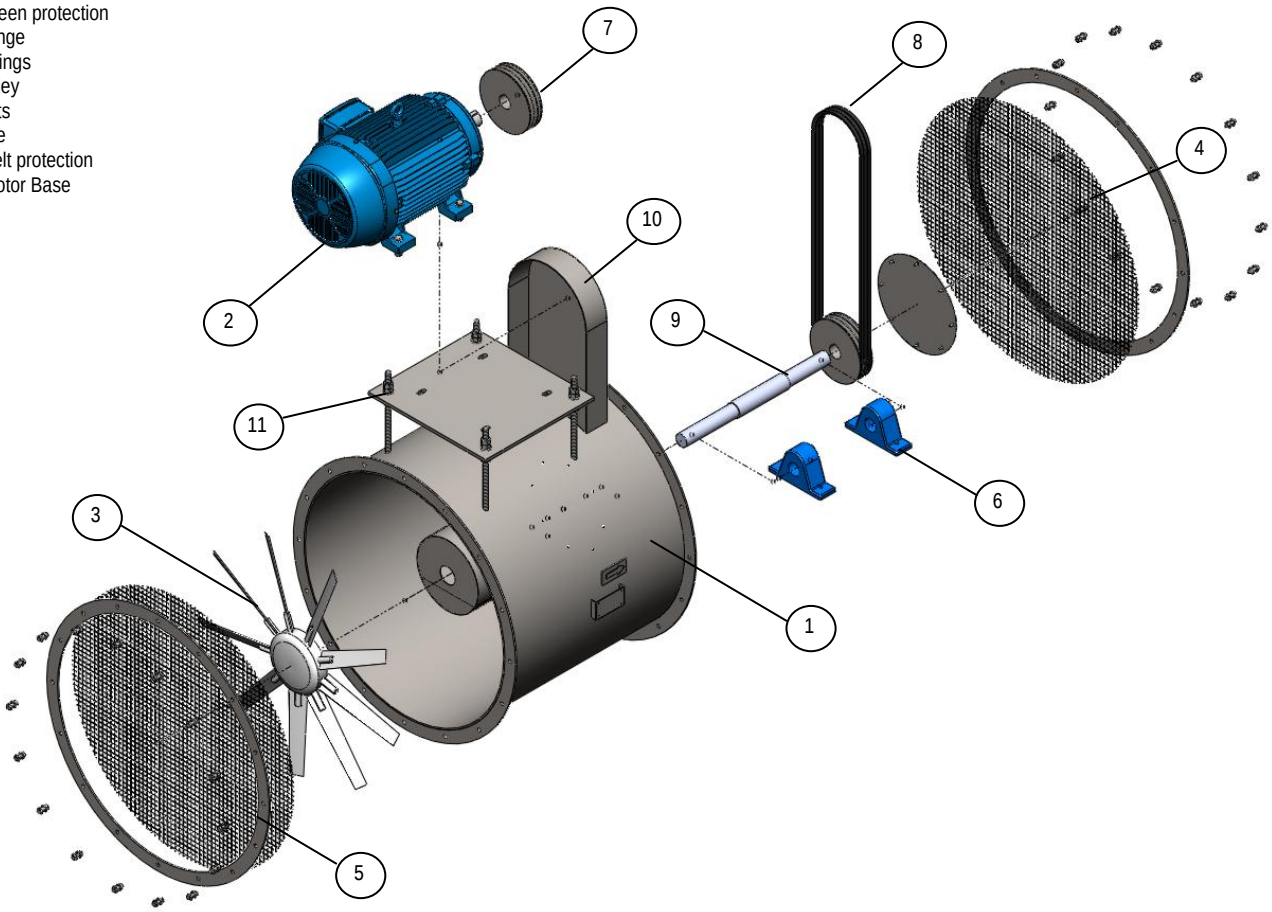
3.4 - Arrangement 4 – Axial Fan

1 – Body
2 – Motor
3 – Helix
4 – Screen protection
5 – Flange
6 – Eletroduto
7 – Rotatable Connection
8 – Electric Cable
9 – Fixed Connection



3.5 - Arrangement 9 – Axial Fan

1 – Body
2 – Motor
3 – Helix
4 – Screen protection
5 – Flange
6 – Berings
7 – Pulley
8 – Belts
9 – Axie
10 – Belt protection
11 – Motor Base



4 – ASSEMBLY

4.1 - Transport

Before shipping, all pieces of equipment are visually controlled as to construction and finishing. They are strictly tested under operation. Operation of all parts and accessories involved in manufacturing and assembly is checked.

However some damage may occur in transport. For this reason the customer should inspect the unit upon delivery and any irregularities should be reported to manufacturer.

When transporting parts and equipment, suspending or sustaining spots should be avoided such as rotors, helixes, motors, valves, bearings, axles etc. Only lifting eyelets should be used. Flange holes should be used as the last resort.

Do not allow any kind of chocks or damage due to poor transport because they might misalign mouthpieces, bearings, and cause consequent assembly problems.

4.2 - Storage

If equipment is not immediately assembled, we recommend storing them in a dry place, free of dust, gases and corrosive smokes. If this is not feasible due to local conditions, do the following at least:
- Cover the equipment and/or accessory with waterproof canvas.
- Block the rotor/helix so as to prevent abrupt movements.
- Do not place any materials on the equipment and/or accessories.

After 15 days of storage, take the following care:
- Fill bearings thoroughly with grease
- Put high-viscosity or anti-corrosive oil on machined parts such as axles, coupling etc.
- Turn the rotor 450º weekly.

4.3 - Foundation

Through the specific drawings supplied, you can obtain the basic dimension required to prepare the foundations, always considering the main characteristics of the implantation place, as well as the load values of the equipment.

The influence of transmission of vibrations and shocks to the floor or structures and vice-versa must be well analyzed to establish the need or not to use Vibration bumpers. Note that rubber cushions and/ or springs have complex application in fans and, for full effect, depend on factors such as symmetrical distribution of loads, degree of rigidity (or freedom) of the metallic base and work frequency, For this reason, we do not recommend the use of these tricks without contacting the manufacturer first.

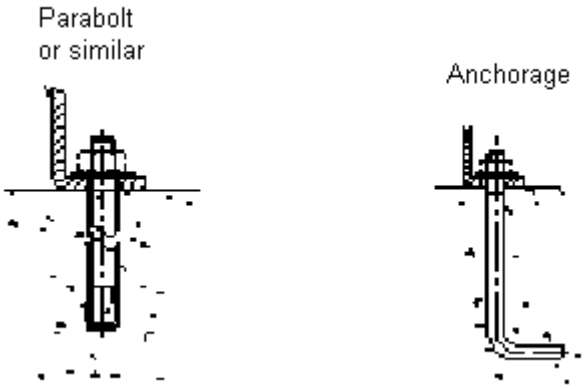
In these cases, we can also observe noise emission through structures firmly connected to the equipment, transforming them into sources of noise. This negative aspect can be prevented by installing flexible collars in fan connections.

Centrifugals Fans supported only on the floor need to stay on a very solid and rigid base at least 100 mm larger all around to prevent cracks when tightening anchor bolts. Metal structures and supports are not recommended; however if they are required, they must be adequately projected to support static and dynamic loads and take machine frequency into consideration.

On base spots where anchor bolts will be set, larger holes should be made, if possible, and leave a circle with a radius of approximately 30 mm for later adjustment of the correct position.

If this is not possible, drilling should be made taking in consideration the dimensional tolerances set by the standards.

Type of fixation used:



4.4 - Seating and connections

The centrifugals fans must be installed in a position that is suitable to the foundations so that they stay in the right position (as in drawing). The equipment must be leveled with the help of shims until it receives the anchorage bolts in the right holes. Only after this procedure, the fixing elements should be tightened.

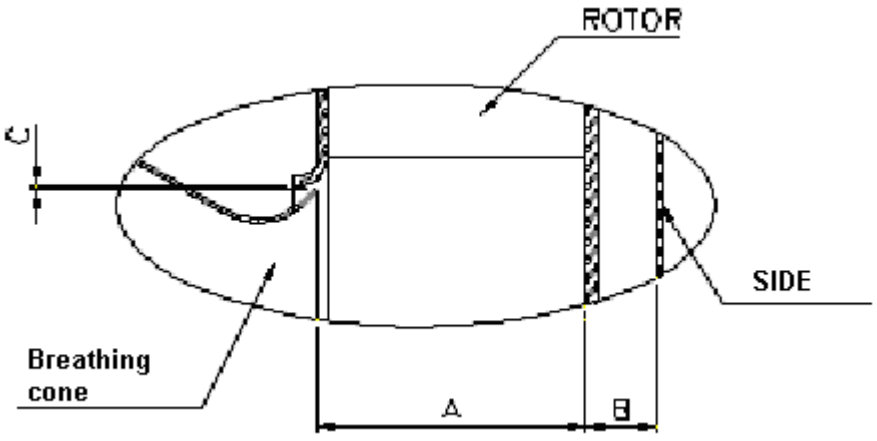
With the set firmly fixed to the operation position, check the following items:
- Correct leveling of rotor axle.
- Alignment of bearings, lubrication, tightening of collar and plays;
- Existence of play between rotor/cone, considering that the rotor must rotate freely (see item 3.5)
- Suitable tightening of bolts of rotor key,
- Correct fixation of transmission elements such as: pulleys / keys / bolts, etc. (see item 3.7):
- Belt alignment and tension (any corrections by the rails/stretchers) (see item 3.7.3);
- Correct fixation of motor.

Connections to pipes must for both type of fans be made only after the fan is ready to operate. Flanges that do not fit should not be forced to prevent body distortions/deformation or misalignment to pipes.

In the event the fan is used at high temperatures, efficient sealing and suitable expansion joints should be provided to avoid additional efforts in pipes or even in the fan.

Never submit the fan to unnecessary effort. Their bodies must never support pipes, filters, chimneys, etc..

4.5 - Inlet cones



4.6 – Valves – Centrifugals Fans

4.6.1 - Rectangular Venetian blind with parallel blades

For use in inlet air boxes, usually to control flow or also used in the function of equipment insulation for starting. Its principle is air centrifugal action at rotor inlet. Besides flow control, it also saves power considerably.

4.6.2 - Rectangular Venetian blind with opposite blades

Used for fan discharge. The key function is equipment insulation for starting. It can be used also as a flow controller, although with less efficiency than parallel blades at inlet, particularly for large flow restrictions. It does not provide energetic gains.

4.6.3 Radial Venetian blinds

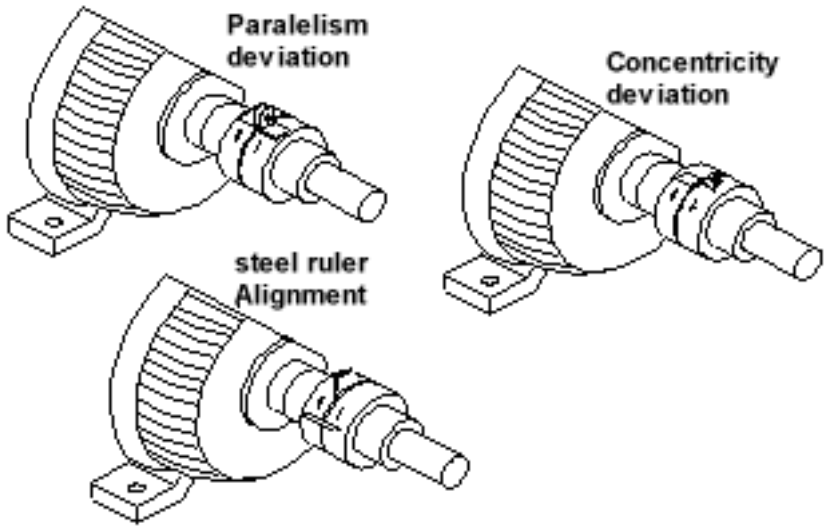
Often used to control flow and for equipment insulation for starting. Its principle is air centrifugal action at rotor inlet. Besides flow control, it also saves power even more than parallel blades.

4.7 Coupling

4.7.1 Direct coupling

In case of transmission in relation to speed, direct coupling via reducers is also usual.

Attention: Align axle ends carefully using a flexible coupling, whenever possible.



4.7.2 Coupling by gears

Coupling made with poorly aligned gears causes jogging, which leads to vibrations in motor transmission.

Therefore care should be taken so that the axles are perfectly aligned, strictly parallel in case of straight gears, and in the right angle in the case of conical or helical gears.

Perfect gearing can be controlled by inserting a sheet of paper, in which appears a complete revolution copy of all teeth.

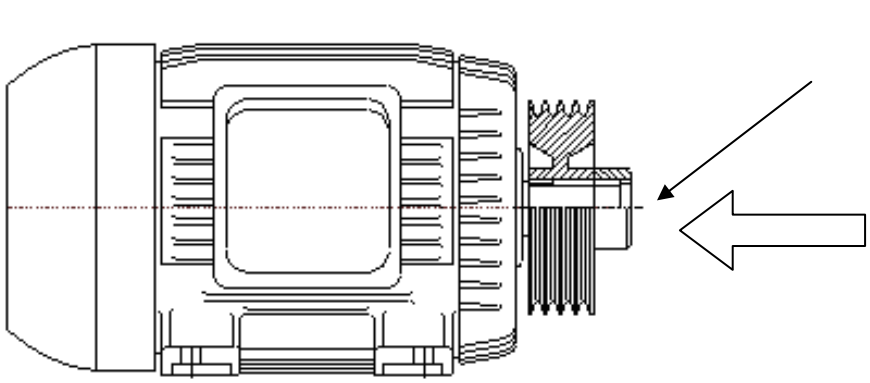
4.7.3 Coupling by mean of pulleys and belts

When a speed ratio is necessary, belt transmission is the most commonly used one.

Assembly of pulley: To assemble pulleys on shaft ends with key beds and threaded holes at the end, it must be fitted up to halfway of the bed key only by manual effort of assembler.

For axles without threaded holes, we recommend to heat the pulley around 80º C or to use an adequate device. It must be avoided to use a hammer in pulley and bearing assembling, because using this procedure, in case of bearing it can cause marks on its tracks These marks, initially small, however can develop to an extent to totally discard the bearings.

The correct pulley positioning is shown on the figure below.

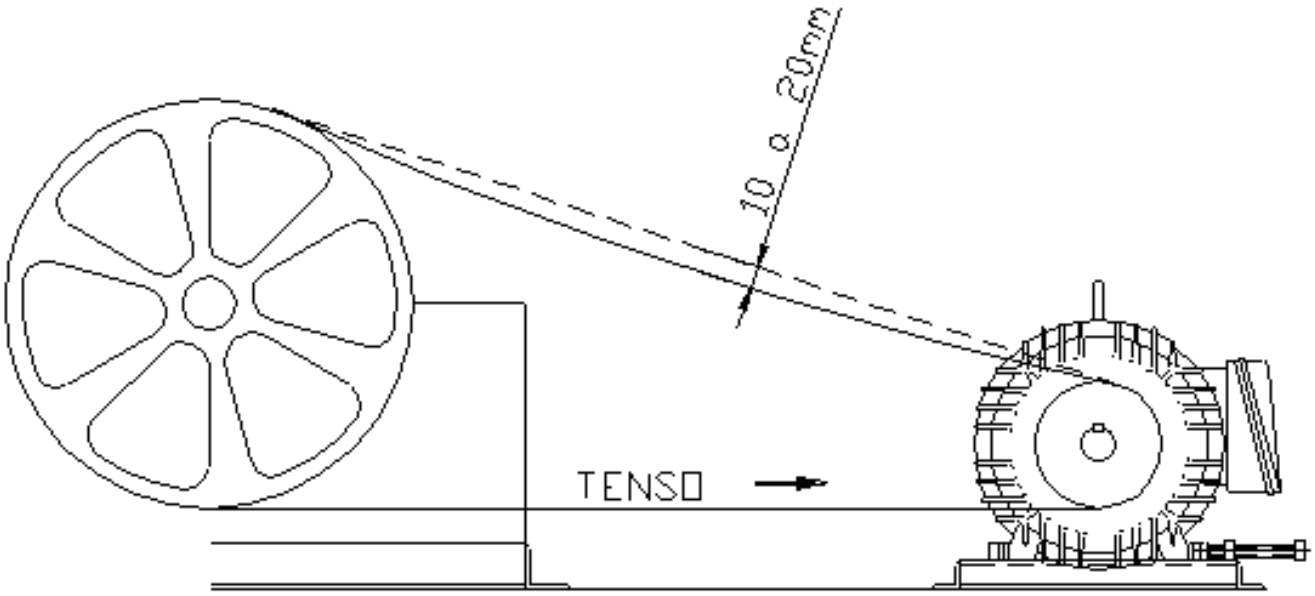


Right mode: If the shaft end is **bigger than pulley use shims**

Remark: Avoid unnecessary radial efforts on bearings by locating the parallel axles between them and the perfectly aligned pulleys.

Belts that work laterally oblique transmit alternated knocks to the rotor and can damage bearing stops. Belt sliding can be avoided by applying a resinous material such as tar.

Belt tension must be only enough to avoid sliding when operating, as shown in the figure below.



4.8 Power supply

Be sure to get from the electric power network a frequency with as little oscillation as possible and tension not exceeding + 10%. For the starting system, it is recommended a minimum protection against short circuits and over charges through appropriate fuses and thermal relays.

Attention must be paid to standards set by power supply companies and to manufacturers' recommendation on the equipment to be used. Additional relay protection against lack of phase and subtension would also be desirable.

4.9 – Axial Fan – Preparation of start

The recommendations, when applicable, are:

- Lubricate the shaft and keyway;
- Put the propeller in place, without foreign, as the adjustments are sliding;
- Correctly set screw plant, using flat washer and lock washer;
- Check the clearance between the propeller and carcass, to make sure they are well distributed.

5 – OPERATION

5.1 – Rotor / Helix

Make sure the rotor turns freely when actuated manually, that is, any noises or blocking must be checked and completely eliminated. The rotor must be centered on the body and perfectly positioned in relation to breathing.

5.2 – Internal part of the body

Check for strange bodies or scraps of material inside the fan body, pipes or valves.

5.3 – External part of the body

Make sure all bolts and nuts are well fixed. Although they are the manufacturer's responsibility, vibrations and efforts produced during transportation, assembly and installation may cause play in the tightening of certain components.

5.4 – Valves

Close all line valves, if any, so that the first start-up of the system is made with the fan operating with no load.

5.5 – Equipment start-up

1- Check if the motor is duly earthed.

2- Watch if motor electric connections are made according to the connecting scheme printed on the identification plate and confirm if all terminal bolts and nuts are duly tightened.

3- Before starting the motor, observe carefully the respective manufacturer instructions.

4- After these procedures, check the correct rotation side, turning quickly on off the motor. The rotor/helix rotation direction must be compatible with indicating arrow fixed on body side. If there is no coincidence the correction can e done simply by inverting the terminal connection to supplying network.

5- Start again, turn off when apparatus reaches nominal rotation and let it run until it reaches the state of rest. Between start-up and rest, watch out for noises and abnormal vibrations.

5.6 – Precautions

1 – Start the set again and, after reaching nominal rotation, make sure the current and tension are correct. Turn off after 5 minutes of operation in the mentioned rotation and evaluate:

1.1- Tightening of the fixing elements;

1.2- Tightening of rotor/helix key fixing bolt;

1.3- Position of the key mentioned above;

1.4- Play between rotor and inlet cone/helix and body;

1.5- Actuate the set again for a period of 1 hour and observe:
- Noise detection and/or abnormal vibrations;
- Motor excessive heat;

- Excess heating of bearings. Initial friction can cause heating above normal. The same will be normal in case you can hold the bearing for 5 seconds. Bearings lubricated with grease can operate with temperature up to 90ºC. In case the temperature is above 90ºC, Ventec Ambiental must be communicated immediately, operation must be interrupted right away if the temperature reaches 110ºC.

1.6- Compare the current absorbed by the motor in the three phases to the one stated on the plate. On a continuous rate, without charge oscillation in the current absorbed, the number should not exceed the nominal current value multiplied by the service factor stated on the plate.

1.7- The valves, when existent, must be opened individually and slowly, at the same time carefully observing the current value absorbed. After this operation is completed, the fan will be operating on charge.

The final value of the absorbed current in the three phases should not exceed the limit set in 1.6.

1.8- Turn off after 1 hour, wait for total rest and repeat the procedures stated in 1.1 to 1.4.

1.9- At the end of the procedures above, the equipment will be ready to operate continuously in a normal rate of operation. However, as a safety measure, it is recommended to do the following:

1.10- During the first 8 hours of operation, check the temperature of bearings every hour;

1.11- After 72 hours of operation, align and stretch the belts correctly, and repeat the procedures stated in 1.1 to 1.4.

6 – MAINTENANCE

6.1 – General Comment

Rotating machines must be inspected at regular intervals. The frequency of these inspections is set according to the characteristics of use, degree of use and type of application.

Fans are manufactured in an extensive range of models and for a wide variety of applications. Therefore, the way and periodicity of maintenance vary from case to case.

As previously shown, you have been supplied with all data required to establish a perfect maintenance program. However it is recommended to acknowledge the below recommendations:

6.2 – Vibrations

All fans manufactured by Ventec Ambiental have their rotors balanced statically and dynamically on a high-sensitivity SCHENCK electronic machine. However, if a rotor works in an abrasive material environment or between materials that stick to the blades, there will be a change in the original balancing conditions.

The consequence will be vibrations causing immediate reduction of bearing service life.

Whenever vibrations appear, the fan must be removed from operation and the rotor/helix must be checked. If it is worn but, if it still can be used, it must be balanced again before assembling. If there is any material adhered to the rotor, good cleaning must solve the problem.

Vibrations can, however, be of aerodynamic nature, caused by turbulence in air or gas flow. Non-recommendable breathing condition such as a wall near and frontal to fan, a breathing curve with a very small radius, etc., can cause this turbulence.

Also if the calculation of resistance of a system is not correct, this phenomenon may happen and the solution to adopt is to decrease this resistance by removing unnecessary valves, increasing the discharge area, curve radius, etc...

6.3 – Rotor/Helix Disassembly

First of all, remove the bolt and washer from shaft end, using an appropriate extractor to disassemble the rotor, when necessitate.

To reassemble, grease the shaft end with oil and introduce the rotor/helix manually as much as possible. Put the key in its position and, with the help of a stop stud, introduce the rest of the hub.

6.4 - Body

All inspection ports must be tightly sealed. Any leaks must be immediately repaired.

Renew external painting whenever necessary to avoid corrosion.

6.5 – Bearings

Because the component is manufactured by third parties, more specific information must be requested to the manufacturer.

Just for guidance, however, below we reproduce some important instructions, which, in most situations, meet fully all maintenance requirements.

The purpose of maintenance of rotors/helixes is to extend service life of bearing systems as much as possible.

Maintenance covers:

a) Observation of general condition of the bearings .

b) Lubrication and cleaning.

c) More careful bearing check.

Bearing noise must be observed in regular intervals from 30 to 60 days. A well-trained ear is perfectly able to distinguish abnormal noises, even using simple ways (a screwdriver, etc.), with no need to resort to stethoscopes normally found in the market. A uniform buzz is a signal that the bearing is working in perfect condition.

Temperature control of a bearing is part of routine maintenance. When a bearing is correctly lubricated, temperature will not exceed 60ºC. Temperature can be permanently controlled with thermometers located outside the bearing or with inserted thermal elements.

Bearings are re-lubricated at general reviews, when bearings are disassembled.

With the bearings disassembled and without removing the bearings from axle, all grease should be removed. Wash the bearings with diesel oil, kerosene or other thinner until they are completely clean. After washing, fill immediately with grease the existing spaces between the rollers or rollers and bearing races. Never rotate dry bearings after washing. To inspect them put some drops of machine oil.

When carrying out these operations, maximum care with cleaning is recommended to avoid penetration of any debris and dust that can damage the core. Note that, when removing bearing cap, it will be necessary to shim the axle.

Bearing disassembling is not difficult, if right tools are used (bearing extractor). Extractor grips must be applied on ringside face to be disassembled or on an adjacent face.

It is essential to disassemble bearings under very clean conditions and this must be made by competent people to assure good operation and avoid damages.

New bearings must only be removed from their package at the time of assembling. Before putting the new bearings it will be necessary to check if fittings have signs of burrs or shocks.

Bearings cannot receive direct shocks during assembly. The support to press or hit the bearing must be applied on the internal ring.

6.6 – Belts

Every belt has a determined service life and this may vary according to its application. Verification of service life should be made visually, i.e., when deviations, twisting or raveling appear, replacement should be made.

It is recommended that, after replacement, alignment and tension of new parts must be carefully checked.

6.7 – Lubrication

In this topic we will talk about the use of grease as lubricant, since it applies to most cases.

Lithium-based grease with (NGLI) 2 consistency, with anti-oxidant additive.

The initial amount of grease is 1/3 of the free volume of the bearing case when he equipment revolution does not exceed 50 % of the maximum rotation allowed by the bearing, or 2/3 when this does not happen. Note that excess grease may lead to over-heating of bearings.

Interval of lubrication is 700 (seven hundreds) hours.

6.8 – Troubleshooting

Items	Causes	Effects							
Installation		A	B	C	D	E	F	G	H
	1- Incorrect assembly	X	X	X					X
	2 - Incorrect electric connection	X	X		X				
Foundation	3- Foundation poorly made	X		X					
	4- Deformed concrete	X	X	X					
Bases	5- Deformation	X	X	X					
Body	6- Strange body								X
	7- Deformation	X						X	X
Rotor/helix	8- Unbalanced	X	X	X					
	9- Erosion or corrosion	X			X		X	X	X
	10- Strange body suction	X			X		X	X	X
	11- Strange body adherence	X							
	12- Inlet cone scraping	X	X	X	X	X		X	
	13- Deformation	X							
	14- Invert construction position				X				
Axle	15- Warped	X	X	X					
	16- Adjustment badly done	X							X
	17- Body scraping	X				X	X		X\
	18- Key with play	X							X
Bearings	19- Play above normal	X		X					X
	20- Play below normal		X	X					
	21- Lubricant dirty or old		X	X					
	22- Inadequate lubricant		X	X					
	23- Excessive lubricant		X	X					
	24- Lack of lubricant		X	X					
	25- Loose bolts	X	X	X					X
	26- Locking ring damaged		X	X					X
	27- Strange body		X	X					X
Pulley And Belts	28- Unbalanced	X		X					
	29- Belt too stretched		X	X	X				X
	30- Loose belt	X					X	X	
	31- Wear belt	X					X	X	
	32- Strange body	X					X	X	
General	33- Revolution above normal	X	X	X	X	X			X
	34- Revolution below normal						X	X	
	35- Inverted rotation						X	X	
	36- Valve working badly				X	X	X	X	
	37- Valve damage				X	X	X	X	
	38- Increase load loss						X	X	
	39- Decrease load loss				X	X			
	40- Unbalanced		X					X	X

A- Vibration increase
B- Bearing over heated
C- Bearing damaged
D- Starting motor over loaded
E- Motor over load in operation
F- Reduce of load in operation of motor
G- Reduction on capacity and/or efficiency of fan
H- Excessive noise

6.9 – List of spare part for 2 years of operation

For fans actuation direct Arrangement 4:
- 01 rotor / helix

For fans actuation indirect Arrangement 3 and 12:
- 01 rotor and axle set
- 02 bearings
- 02 bearings
- 02 bushings
- 01 Belt set

For fans actuation direct Arrangement 8:
- 01 rotor and axle set
- 02 bearings
- 02 bearings
- 02 bushings
- 01 Elastic coupling

Note: See technical data on set drawing.