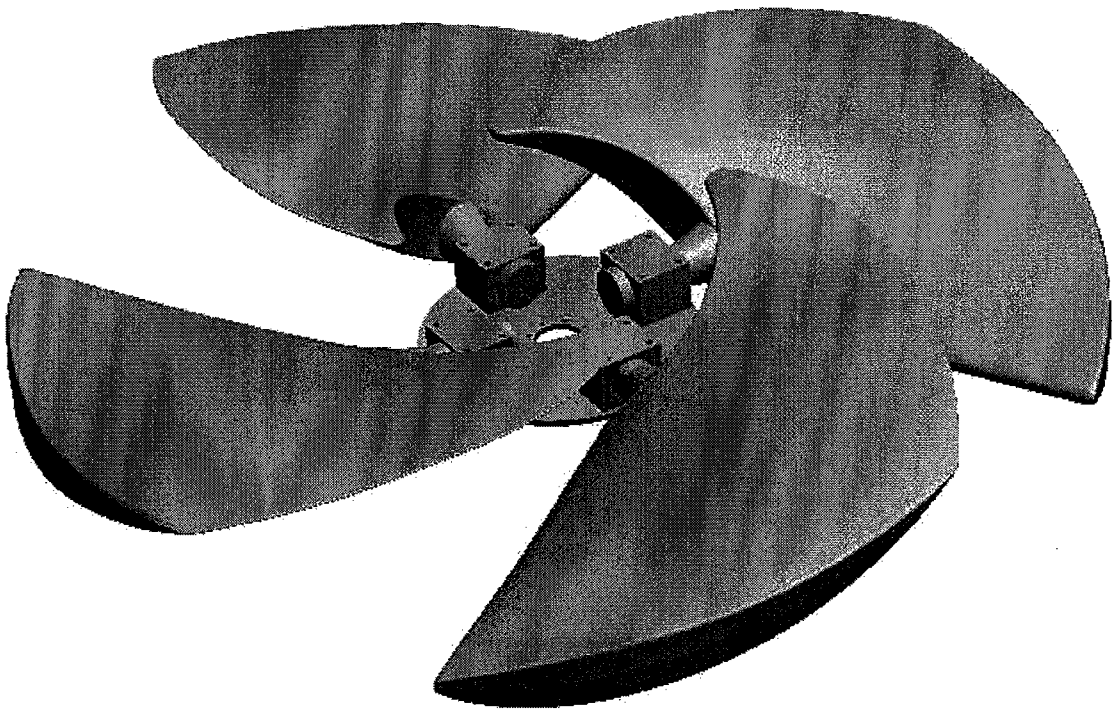
COFIMCO AXIAL FANS FOR THE WORLD	CX/AX – 1.0	GB

Manual for the Installation, Maintenance and Operation of

COFIMCO CX series Fans



September 2006

Read carefully all the content of this manual, before starting the installation of the fan.

INDEX

1 GENERAL INFORMATIONS

1.1 Description of COFIMCO CX series Fans

The COFIMCO CX series fans represent the top in the new generation of super low noise fans: the frp CX blades have been developed to meet the most stringent noise limitations. The CX series fans permit variable pitch adjustment at standstill and features a simplified design: each blade is fixed to the hub with two bolted aluminum pillow blocks.

The Cofimco CX series fans are available in two different installations:

- The fan "stands" on the drive shaft: fan type CX/AX
- The fan in "hanged" to the drive shaft: reverse fan type CX/AXR

The figure 1 shows the two configurations.

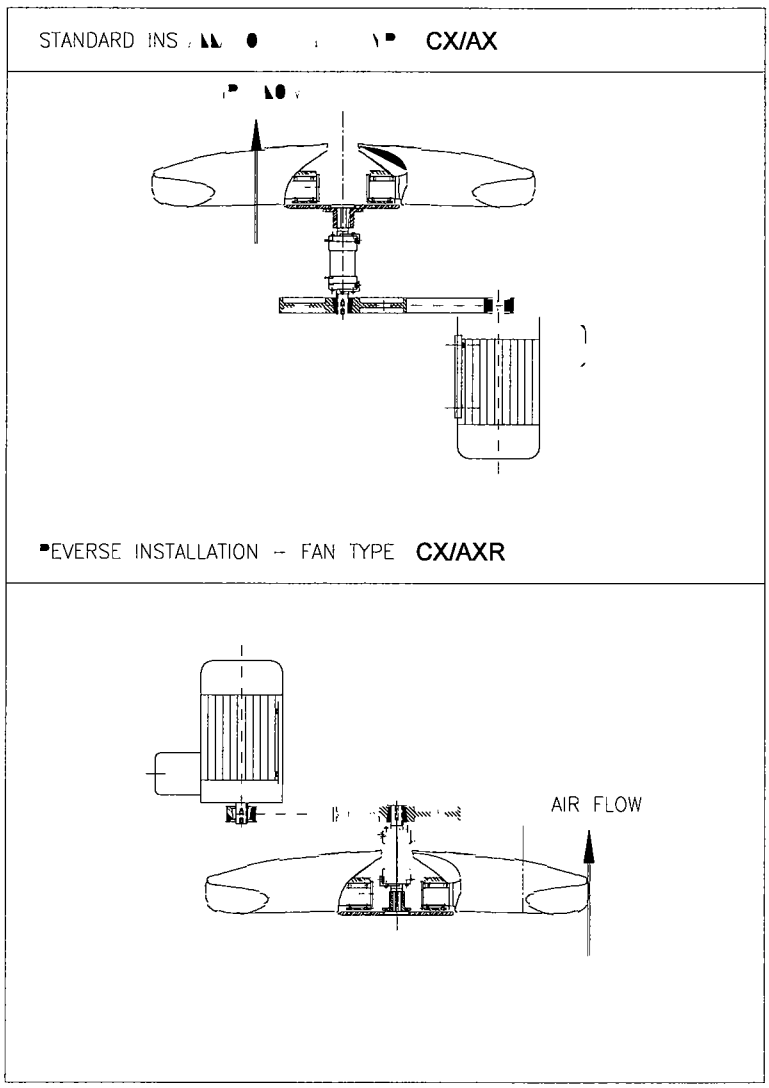


Figure 1: Installation Type

1.2 Cofimco fan identification numbers

All Cofimco rotors have an identification plate attached to the hub, permitting fast and accurate identification.

On the identification plate (see next example), the following information are listed:

F/T	Fan type designation: **XXXX XX CX XY** Hub Type: AX Blade Type: CX Number of blades Fan Diameter (mm)
C/R	Refers a COFIMCO reference and is followed by an internal code number.
P.O.	Refers to the Purchase Order.
I	Refers to the fan item number in the job.
A°	Refers to the blade pitch angle and it is followed by degree of angle.

Example: F/T 4267-04-CX/AX

COFIMCO S.R.L. - ITALY Via A. Gramsci, 62 - 28050 POMBIA (NO)	
F/T	4267/04/CX/AX
C/R	12345/678
P.O.	PO123456
I	E-1234
A°	10.5
BLADE PAT. N° 4618313 HUB PAT. N° 4715784	

The identification plate makes reference to a 4267mm diameter fan, having 4 blades with manual pitch adjustment at standstill, CX airfoil type and an AX hub type.

WARNING: the identification plate above, is showed as an example and do not correspond to the identification plate of the purchased fan in any way.

1.3 Balancing

Unless otherwise specified, all Cofimco fans are balanced as follows:

- When the rotor is dispatched in assembled form, each unit is dynamically balanced within a degree of G = 6.3 in accordance with ISO 1940/1.
- When the fan is dispatched disassembled, the hub is dynamically balanced and the blades are statically balanced so that the reassembled unit correspond to a degree of G = 6.3 in accordance with ISO 1940/1. In this case, the blades have the same static moment, so that can be positioned in any order on the hub; the blades of the same supply, are interchangeable.

1.4 Storage

Upon unloading the Cofimco fan, inspect it for any damage. If damage occurred, file a claim immediately against the carrier and mark the bill of loading accordingly.

After the fan delivery, check the full compliance between order and delivered goods. Shortages or unconformities have to be reported to Cofimco S.r.l. within two weeks from receipt of shipment at destination.

If not installed immediately, it is recommended to store the fan in a dry and shaded area, and do not put any heavy materials of any kind upon the blades. For long-term storage, it is necessary to check the condition of the corrosion preventive coating on all machined surfaces.

2 INSTALLATION

2.1 Rotation and flow direction

The rotation direction is right when the airflow moves from the convex back (suction surface) of the blade, to the concave side (pressure surface). Fig.2 shows the conventional clockwise direction of rotation and normal direction of airflow as viewed from the discharge face of the rotor. On demand, Cofimco S.r.l. can provide fans having the same direction of airflow, but with counter clockwise rotation.

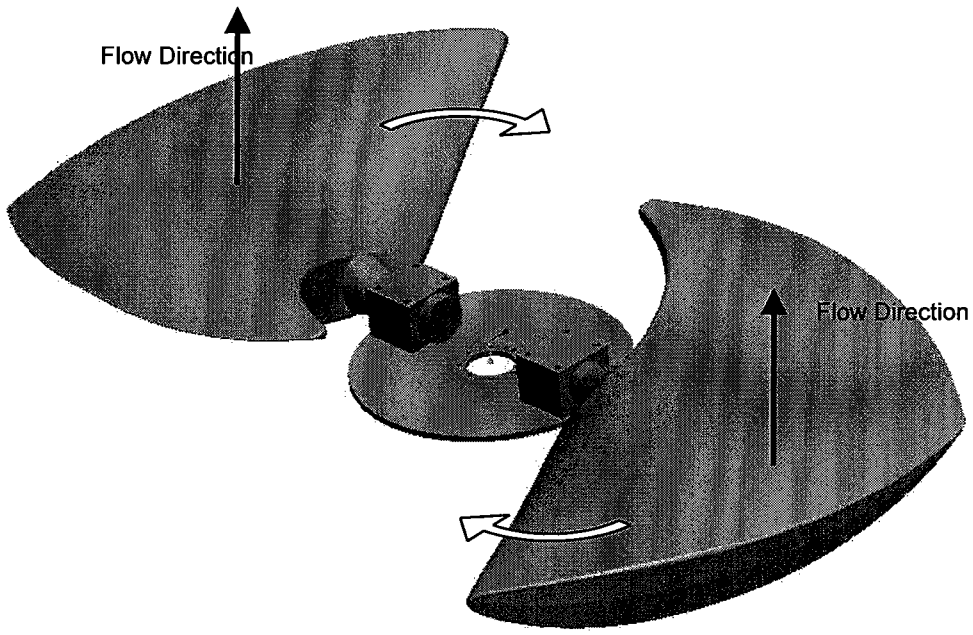


Figure 2

2.2 Installation instructions of COFIMCO CX series Fans

Make sure the motor is disconnected from its power source and refer to the following instruction.

a) Remove blade pillow block and fateners (4), (5), (6), (7), (15) from the hub disk, one set a time (figure 3).

b) If the hub has not been supplied already assembled to the flange, install the coupling flange (2) on the disk (3), complying with torque setting, bolt orientation, tightening order, and pins as shown in following figure 3.

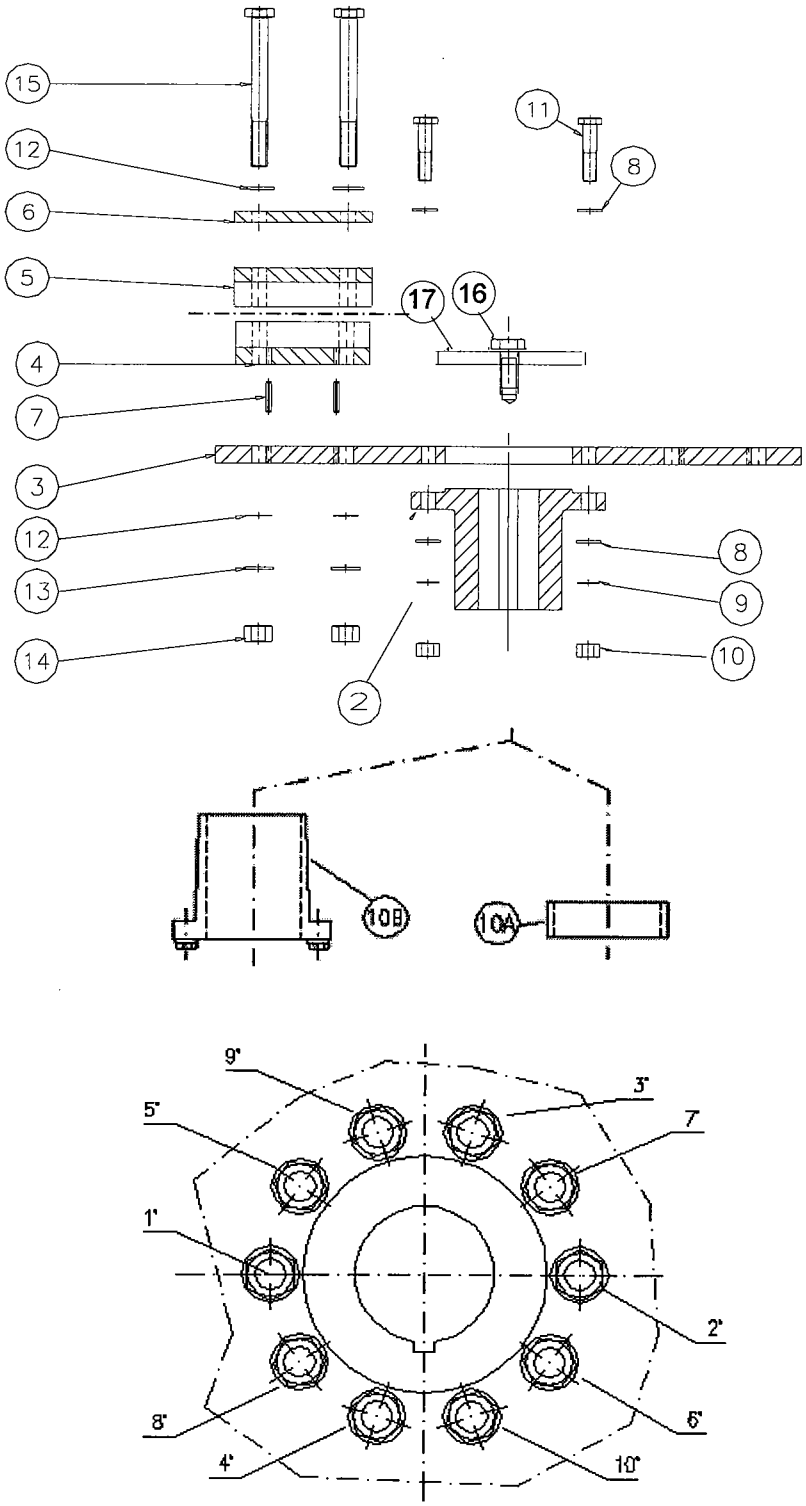


Figure 3

Torque hub assembly bolts (11) according to the following table:

FAN DIAMETER (ft)	FLANGE TYPE	BOLT TYPE	BOLT TORQUE (ft / lbs)
7 ~ 8	Type 115	A325, Type 1 (5/8")	120
9 ~ 12	Type 190	A325, Type 1 (3/4")	170

c) Hub into driveshaft installation (Figure 3)

- As for the hub with cilindrical bore, the hub is bored to attack directly to the drive shaft.

  In this case, coat the output drive shaft with a thin layer of sicon grease.

  If a spacering (10A) is supplied, drive it into the drive shaft until it comes in contact with the drive shaft shoulder.

  Drive the hub with cilindrycal bore into the drive shaft until it comes in contact with the drive shaft shoulder (or space ring shoulder if supplied)

  Please note the drive shaft end must remain recessed at least 5 mm in the hub bore to prevent dangerous rotor vertical translation once retaining bolt (16) will be tightened to the shaft end.

  Warning: never power the drive shaft with special washer (16) and the retaing bolt (17) missing or loosen.

- As for the hub with taperd bushing hole, be sure **drive shaft, bushing and hub bore are not greased**. Slide the bushing into the drive shaft to your design position.

  Position the hub core over the busching taper; insert busching screws through the buschino flange into the threaded hole in the hub coupling; torque bushing screws according to the following table.

BUSHING TYPE	SCREW TORQUE	
	N * m	Lb * ft
Q1 and Q2	39,2	28,9
R1 and R2	39,2	28,9

Please note the drive shaft end must remain recessed at least 5 mm in the hub bore to prevent dangerous rotor vertical translation once retaining bolt (16) will be tightened to the shaft end.

Warning: never power the drive shaft with bushing bolts not torqued or bushing improperly positioned.

d) Blade installation.

Sandwich the blade shank between the pillow blocks (4) (5), ensuring both the pins (7) are in proper position (figure 3).

Fit pillow blocks (4) (5), pins (7), pillow block plate (6), blade and pillow block fasteners (15) on hub disk as shown in previous figure 3 without tightening bolts.

Rotate fan to check tip clearance is in accordance with the specified value (tip clearance ratio x/D, where x = the distance from the blade tip to the fan ring and D = the rotor diameter). The gap between blade tip and fan ring must be measured along blade axis.

Tighten the pillow block bolts (15), to hold the blade in extended position, leaving enough clearance to allow blade rotation on its own axis for pitch setting.

e) Blade pitch setting.

The pitch angle of each blade has to be set at the A° value specified in the rotor identification plate (section 1.2) with a 0.5° maximum tolerance: in order to set the pitch, the quotes shown in following figure 4 must be observeded; note these quotes are shown on the fan data sheet, and are specific for each diameter of the CX fan.

If a different pitch angle is required in order to modify fan performances, the new pitch angle must be approved by Cofimco.

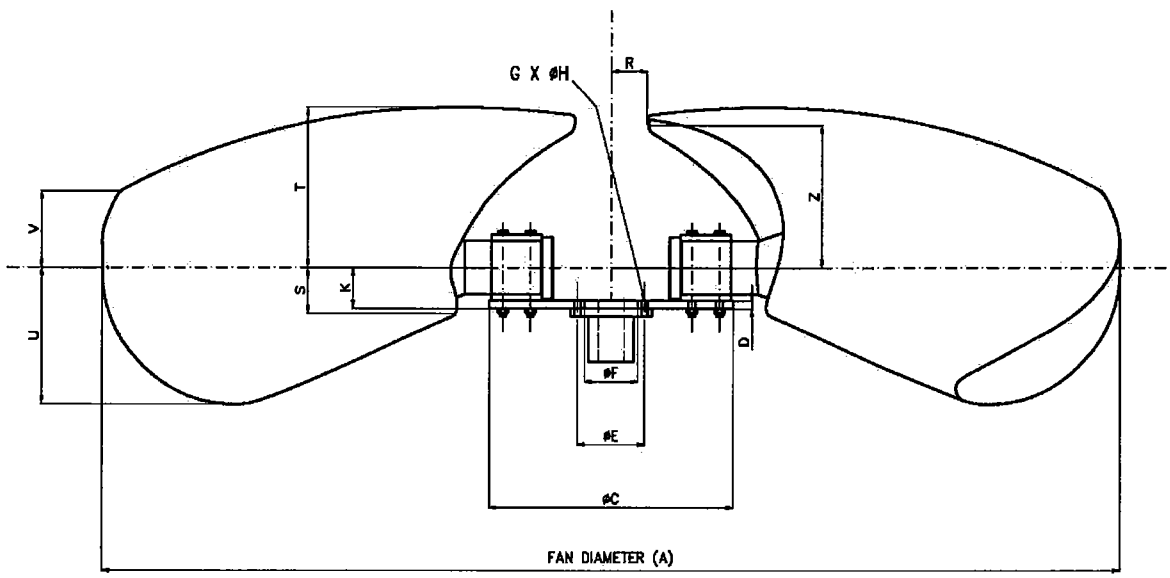
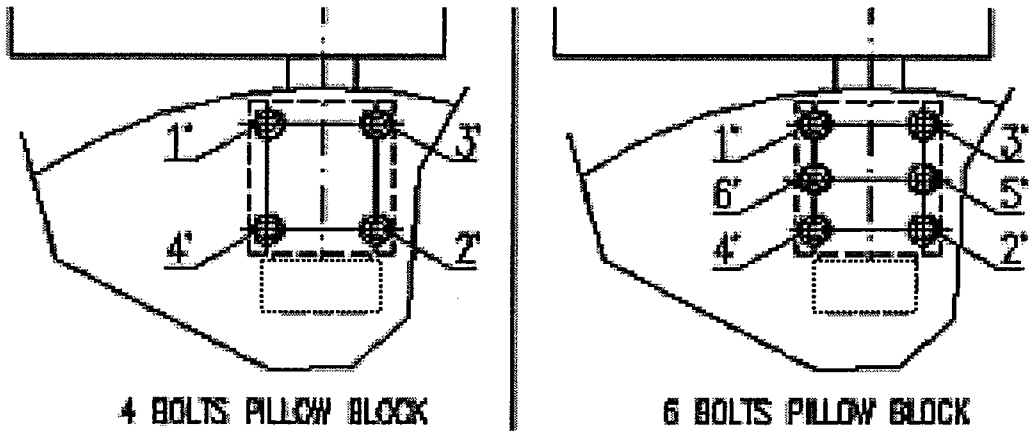


Figure 4

Rotate the blade on its axis until the required pitch angle is obtained.

Check there is no gap between each blade shaft shoulder and corresponding pillow block.

Torque pillow blocks bolts (15) according to the following tables, complying with bolt orientation and tightening order as shown in following figure 5.



DIAGONAL TIGHTENING ORDER

Figure 5

f) Repeat for each blade steps described in points d) and e). Before starting the pitch angle setting procedure, turn the fan till the blade to be set is at the same point in the fan ring where previous pitch angle was set.

In order to determine the torque setting of standard bolts (15), with the 8.8 stamping, search in the following table the bolt type set for the diameter of the fan in object (this information is shown on the identification plate of the fan).

FAN DIAMETER (ft)	BOLT TYPE	BOLT TORQUE (ft / lbs)
7 ~ 8	A325, Type 1 (3/4")	205
9 ~ 10	A325, Type 1 (3/4")	250
11 ~ 12	A325, Type 1 (3/4")	295
13 ~ 14	TBD	TBD

WARNING: in case of a structure equipped with more fans, before setting to all the fans the blade pitch angle shown on the identification plate, set the pitch on one fan only, and follow the operating instructions of chapter 3.

3 OPERATING INSTRUCTIONS

3.1 Prior to start-up

a) Make sure all the pillow blocks are fixed to hub boss: if any movement of the blockers is detected, do not operate the fan and check the torque of screws (15).

b) Rotate fan to check tip clearance is in accordance with the specified value (tip clearance ratio x/D, where x = the distance from the blade tip to the fan ring and D = the rotor diameter). The gap between blade tip and fan ring must be measured along blade axis.

c) Check gear box oil level or belt tension to be as indicated by the manufacturer

d) Remove all tools from area.

e) Connect motor to power supply.

f) Start fan for a few seconds, and then switch it off. While the fan is still turning, check that the direction of the blade rotation is correct (see section 2.1).

3.2 Post start-up

a) Check power aborption: if excessive, **reduce** the **blade pitch angle** until the desired power is achieved (set the new pitch on all the fans of a same structure); if lower than predicted, **increase** the **blade pitch angle** until the desired power is achieved (set the new pitch angle on all the fans of a same structure).

   Warning: power absorption varies in inverse proportion to the air temperature.

b) Check the vibrations level in the position shown in Fig.6 do not exceed the most restrictive amplitude values between the limits imposed by the normative of the structure where the fan is installed and the limits imposed by the VDI 2056 normative. In this case, shut down the unit and trace the cause of such excessive vibration by referring to section 4.3 of the following chapter.

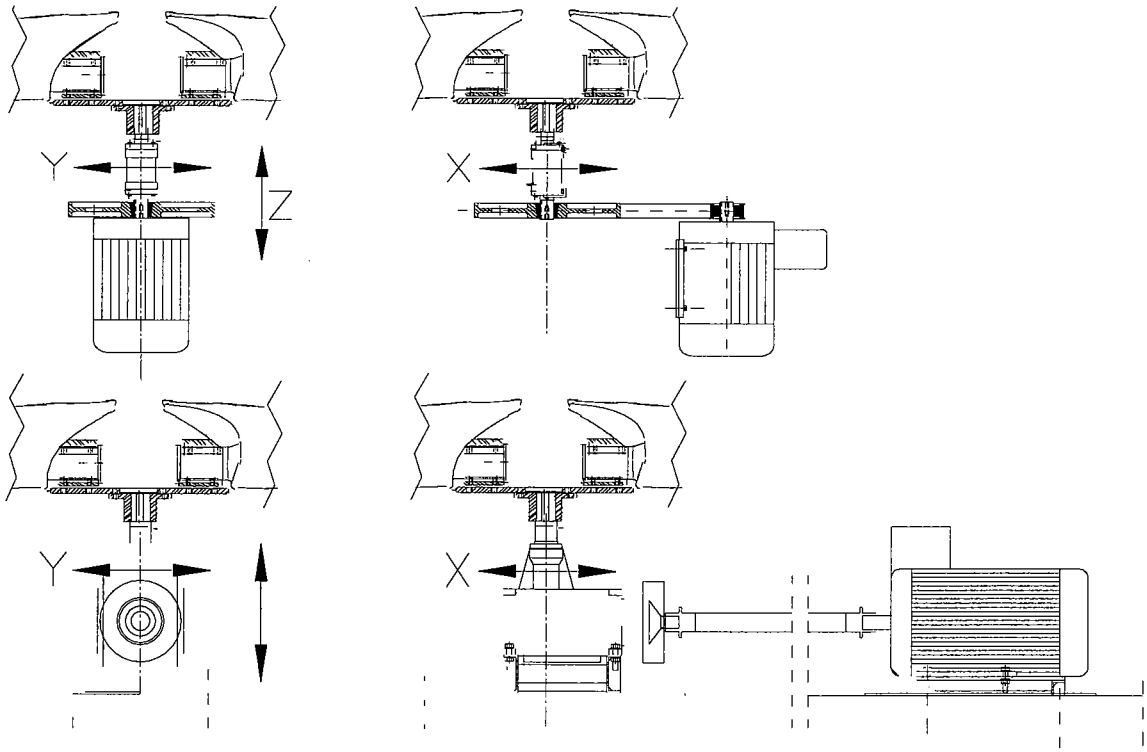


Fig.6

c) After the rotor has been running for one hour, check the torque of the hub screws (15).

d) Repeat the check of screws (15) after 24 hours from start-up.

4 PREVENTIVE MAINTENANCE

4.1 Maintenance and operation

a) Inspect the overall fan condition periodically.

Inspection intervals depend on fan operating conditions and may vary from a minimum of 2 weeks to a maximum of 6 months.

The following components should be specifically inspected when inspecting the overall fan conditions:

- screw torque;
- fasteners corrosion;
- general condition of blades surface.

It may become necessary to clean the rotor blades to maintain proper balance.

b) Ice formation on the blades of operating fans must be strictly avoided.

c) If ice has formed on a stationary fan, it must be removed prior to start-up to avoid damaging the blades. The snow formed on a stationary fan must be periodically removed, according to the snow accumulation itself.

d) Turn-off 2-speed motor for at least 30 seconds before switching to low speed.

e) Stop the unit completely before reversing the direction of fan.

f) Check the vibrations level in the position shown in Fig.6 at regular intervals.

The vibration level must not exceed the most restrictive amplitude values between the limits imposed by the normative of the structure where the fan is installed and the limits imposed by the VDI 2056 normative. In this case, shut down the unit and trace the cause of such excessive vibration by referring to section 4.3.

It is advisable to keep a record of the readings taken on each occasion for comparison.
Always take readings at the same positions and in the same manner.
Observe the safety precautions insuring power supply is turned off.
The fan vibration levels constitute an invaluable indication of the state of the plant and should be monitored frequently (e.g. monthly).

4.2 Temperature range

COFIMCO CX series fans are designed to operate at the following temperatures:

Minimum - 20 °C (-4 °F)

Maximum CX blades:
+ 82 °C (+180 °F)

4.3 Possible causes of vibration

The actual causes of vibration may change considerably: some of the most common are as follows:

a) Unbalance of one or more blades: the vibration caused by blade imbalance occurs on the tip path plane with a frequency equal to the fan RPM and at an amplitude which is dependent on the degree of imbalance and the square of the rotational speed.

b) Blade pitch angle not included in the ± 0.5° tolerance: this condition causes vibration outside the tip path plane at a frequency equal to the fan RPM and at an amplitude which is dependent on the square of the rotational speed.

c) Blades too close to supports (periodic aerodynamic turbulence): this condition is characterized by vibration outside the tip path plane at a frequency equal to the product of the number of fan blades and RPM. The amplitude depends upon the extent of the aerodynamic turbulence.

d) Resonance between one of the possible forcing frequencies of the fan and one or more of the vibration modes of the structure on which it is installed.
The main forcing frequencies generated by the fan, normally correspond to the following frequencies:

- Fan RPM
- The product of fan RPM and the number of blades
- The product of fan RPM and the number of structural supports capable of generating aerodynamic turbulence (if they are arranged in an axial-geometric fashion).

e) Vibration transmitted by the structure on which the fan is installed: the frequencies of such vibration depend on both the external forcing frequencies and the resonant frequencies of the structure.

f) Resonance of the blades with one of the possible forcing frequencies; in the vast majority of cases the vibration occurs outside of the tip path plane.

g) Misalignment of the drive shaft: this generates vibration with a frequency that is once or twice the RPM.

h) Loosening of blade and/or speed reducer fixing bolts. The behavior of the rotor under these circumstances is totally unpredictable, as it depends upon the extent and location of the loosening.

i) Worn output shaft bearing: this condition generates vibration on the tip path plane at a frequency equal to the rotor RPM.

j) The fan and/of the structure bolts are not tightened: in this case all the bolts have to be tightened.

k) The draining holes of the blades are obstructed: they have to be opened.

WARNING: the amplitude of the fan vibrations is determined by the rigidity of its support. Vibration that would not be critical to a fan supported by a sufficiently rigid structure is amplified by an overly flexible support. This support rigidity may also cause unexpected variations in the resonant frequencies of the blades.

5 HUB REMOVAL

Remove bolt (16) from the hub; remove the hub from the flange.

6 GUARANTEE

Cofimco guarantees that all materials and workmanship of Cofimco fans shall be of high quality and free of defects.

If, until 18 months from the date of dispatch from our works or until the end of the first year of operation, a Cofimco fan has been determined to be defective in any way due to materials or manufacturing, Cofimco reserves the option to repair or replace the defective unit, without charge, whichever occurs first.
All repairs and/or replacements shall be provided at Cofimco or a designated location. Freight costs to and from Cofimco shall not be covered.

The Cofimco warranty shall be considered void if the fan has been altered or damaged due to improper installation and/or operation.
Cofimco will not reimburse the cost of repairs that have been performed without proper authorization.

Under no circumstances shall Cofimco be held liable for consequential or incidental damage of any kind resulting from the manufacture, sale, installation or use of any Cofimco products.

7 CONTACTS

AXIAL FANS FOR THE WORLD

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http://www.cofimco.com

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8 TROUBLE SHOOTING

For any problem, contact COFIMCO S.r.l. specifying the purchase order number shown on the identification plate of the hub.

TROUBLE SHOOTING		
Problem	**Possible Cause**	**Possible Solution**
Low air flow Low power absorption	System congestion.	Clean the entire system.
	Obstacles to the air flow.	Check the real obstacles area and the inlet shape towards the original design.
		In dry-coolers the minimum free height of the inlet area has to be 1 time the fan diameter at least; this height has to be higher in case of multiple units in line.
	Static pressure higher than the specified one.	Increase blade pitch angle (till 3 deg. After checking the data sheet selection).
	Pitch angle lowered by blade rotation (e.g. screw (15) not tightened at the right torque)	Set the right pitch angle and refer to the operation manual to set the right torque of screws and bolts.
	Temperature higher than the designed one.	Increase blade pitch angle (till 3 deg. After checking the data sheet selection).
High power absorption	Temperature lower than the designed one.	Decrease blade pitch angle (till 3 deg. After checking the data sheet selection).
	Static Pressure lower than the designed one.	Decrease blade pitch angle (till 3 deg. After checking the data sheet selection).
Rubbing between the blades and the fan ring	Screws and bolts of the fan and/or the structure loosened.	Torque all screws and bolts.
	Fan not centered. Tip clearance too small.	Center the fan. Increase the fan ring diameter.
Scratch or little damages	...	Contact Cofimco.
Thin crack on a blade surface	...	Contact Cofimco.

Problem	Possible cause	Possible Solution
High vibration level	Unbalance of one or more blades.	Contact Cofimco.
	Blade pitch angle not included in the 0.5 deg. tolerance.	Set right blade pitch angle.
	Blades too close to supports (periodic aerodynamic turbulence).	Contact Cofimco.
	Resonance between one of the possible forcing frequencies of the fan and one or more of the vibration modes of the structure on which it is installed.	Contact Cofimco.
	Vibration transmitted by the structure on which the fan is installed.	Contact Cofimco.
	Resonance of the blades with one of the possible forcing frequencies.	Contact Cofimco.
	Misalignment of the drive shaft.	Realign the drive shaft.
	Worn output shaft bearing	Contact the supplier.
	The fan and/or the structure bolts are not tightened	Tighten screws and bolts at the right torque.
	The draining holes of the blades are obstructed	Open the draining holes.

10 PART LIST

PART LIST			
Item (Fig.7)	**Description**	**Std. Material**	**Std. Protection**
1	Blade	FRP	-
2	Coupling flange	Steel	Epoxy paint
3	Hub disk	Steel	Epoxy paint
4	Lower Pillow block	Alluminium	-
5	Upper Pillow block	Alluminium	-
6	Pillow block plate	Steel	Epoxy paint
7	Pins	Steel	Zinc Plated
8	Coupling flange washer	Steel	HDG
9	Coupling flange lockwasher	Steel	HDG
10	Coupling flange nut	Steel	HDG
10A	Space ring (if needed)	Steel	Zinc Plated
10B	Taper Bushing (only if required)	Melleable cast iron	Burnished
11	Coupling flange bolt	Steel	HDG
12	Pillow block washer	Steel	HDG
13	Pillow block lockwasher	Steel	HDG
14	Pillow block nut	Steel	HDG
15	Pillow block bolt	Steel	HDG
16	Screw (Not supplied by Cofimco)	-	-
17	Washer (Not supplied by Cofimco)	-	-
'CX' SERIES FAN ASSEMBLY (Standard)			

WARNING: for special applications, materials and protective coatings could be different; in this case, make reference to the fan documentation.

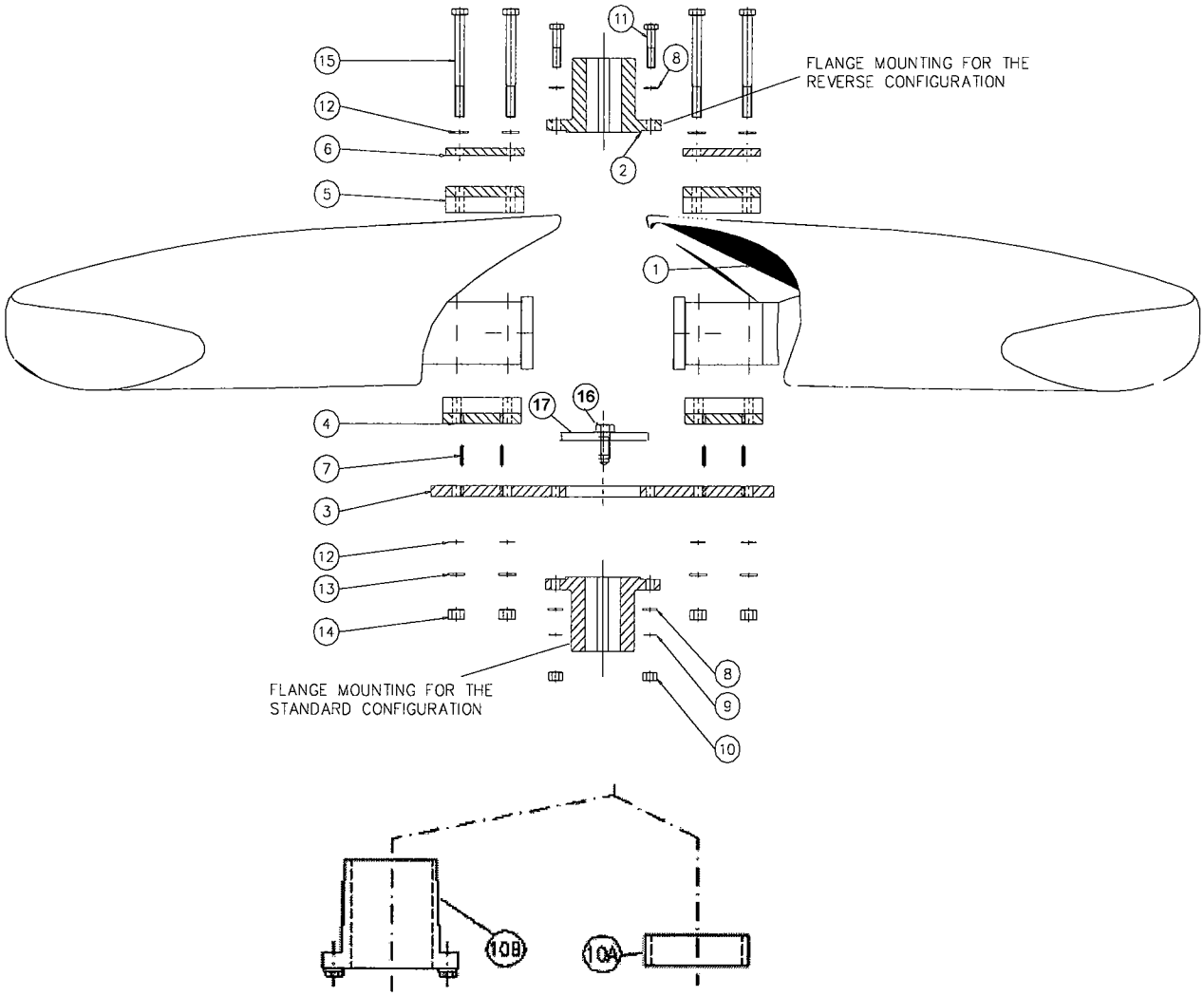

Fig. 7