Installation Manual,
Fan Maintenance and Operation

COFIMCO 35FD G-GR Series

35FD G-GR Series – V 4.1 – EN

January 2023

AXIAL FANS FOR THE WORLD

It is recommended to carefully read all content of this manual, before proceeding with fan installation.

IMPORTANT: for systems containing more than one fan, carry out equipment setting of a single fan and after proper fan operation is identified (as described in this manual), continue setting up all the other fans.

AXIAL FANS FOR THE WORLD

ATTENTION: COFIMCO 35FD G-GR fan series hub and blades are patented components.

Manufacturer Declaration

The manufacturer:

COFIMCO S.r.l. via A. Gramsci 136, 28050 Pombia (NO) ITALIA

States:

each axial fan is considered a component and is constructed to be incorporated into a machine or to be assembled with other machinery to form a machine as requested by 2006/42/EC norm.

GENERAL TERMS AND CONDITIONS OF SALE

I. GENERAL NOTICE

The following general terms and conditions of sale (hereinafter also the “T&Cs”) shall apply to and regulate any purchase order, contract or agreement (hereinafter the “Contract”) resulting between Cofimco s.r.l. ("Cofimco") and any person, whether legal or natural, who orders or purchases or is offered products/equipment from/by Cofimco (hereinafter “Buyer” and, together with Cofimco, the “Parties” or, singularly, the “Party”) and constitute the complete and final agreement between the Parties.

II. TERMS OF PAYMENT

Unless otherwise stated in Cofimco’s order acknowledgment, payment shall become due pro rata as shipments are made and, namely, each payment will be due and payable at the time of the delivery of the equipment to the F.A.S. point specified in the Contract, it being understood that Seller may retain the equipment until payment is made. If Buyer delays shipment, date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If Cofimco’s manufacturing is delayed by Buyer, Buyer shall pay that portion of the purchase price which is equal to the percentage of completion; the balance shall be payable in accordance with the terms as stated above.

III. TITLE AND RISK OF LOSS

Title to the equipment to be supplied hereunder shall pass to Buyer upon full payment or upon delivery to the F.A.S. point specified in the Contract, whichever occurs last. Notwithstanding the foregoing, risk of loss or damage to the equipment shall remain with Cofimco until delivery of the equipment to the F.A.S. point. If Buyer is unable to take delivery when the equipment is ready for shipment, the equipment will be stored at Buyer’s expense and risk of loss shall immediately pass to Buyer.

IV. PROPRIETARY INFORMATION

All documents, drawings or writings ("Information") of any kind or in any form provided to Buyer by Cofimco are and shall remain the property of Cofimco. Buyer acknowledges that the Information may contain trademarked, copyrighted or otherwise proprietary and/or confidential concepts, ideas and data, all of which is and shall remain owned solely by Cofimco. In light of these acknowledgements, Buyer agrees to keep confidential and treat all information as if Buyer itself held a confidential and proprietary interest in the Information; to obtain Cofimco`s written permission prior to any disclosure or distribution of the Information to third parties and/or prior to the incorporation of the Information into any database, network or other computerized system; and to properly identify and attribute Cofimco`s proprietary interest in the Information including all appropriate trademark and/or copyright notices, whenever Information is disclosed or distributed pursuant to this Section. Buyer shall promptly return any Information to Cofimco upon request and Buyer and its agents shall abide by all nondisclosure terms and other reasonable provisions required by Cofimco as a condition of visiting any Cofimco facility. Except to the extent that the Information may be relied upon by Buyer to use and operate the equipment for its intended purpose(s), nothing in this agreement shall be construed as an implicit or explicit license by Cofimco to Buyer to make, use, research and develop, sell, copy, disclose, distribute, or otherwise benefit from the proprietary or confidential nature of the Information. The rights and obligations of this Section ("Proprietary lnformation") shall survive the cancellation, completion or any other termination of this Contract for a period of three (3) years after the date of said event.

V. WARRANTY

Unless expressly agreed otherwise, in writing in Cofimco's order acknowledgment, Cofimco warrants that the equipment delivered hereunder will be free from defects in workmanship and material for a period of one (1) year from the date of initial startup or eighteen (18) months from the date of shipment, whichever occurs first. In case of proved mechanical breakage or defects, Cofimco shall, at its expense, repair or replace, at the F.A.S. point specified in the Contract, the defective (portion of any) equipment, or, alternatively, Cofimco may, at its sole discretion, refund to Buyer the price paid for the defective item(s). For the foregoing remedy to apply, the following conditions shall be met: (i) the defect must occur and be discovered during the warranty period as set forth above, (ii) the use of defective equipment must be promptly discontinued by Buyer, (iii) Buyer must return the defective equipment to Cofimco and (iv) Buyer must give Cofimco written notification within thirty (30) days after Buyer's discovery of the defect, provided that any alleged or purported lack of fitness of the equipment or services supplied hereunder consequential upon the failure by Buyer to supply accurate, complete and reliable information regarding its needs and the technical and performance specifications and requirements of the equipment shall not constitute a defect hereunder. In any event, this warranty and remedy shall apply only subject to the further essential condition that Buyer properly unloads, stores, handles, maintains and installs the equipment, protects the equipment from damaging agents, and operates the equipment in a normal and proper manner within proper hosting premises, plant or facilities, in accordance with all due and appropriate standard procedures, in compliance with any applicable installation, maintenance and operations manual(s) for Cofimco fans and all instructions, recommendations and indications given by Cofimco at any stage, and not in excess of any applicable rating limitations, design specifications or technical, operating and dimensional requirements prescribed by the applicable documentation and drawings. Cofimco makes no warranty whatsoever regarding resistance of materials to corrosion or erosion. The sole liability of Cofimco and the exclusive remedy of Buyer, whether arising under contract, tort (including negligence), strict liability or otherwise, arising out of defects in the services or equipment supplied hereunder, shall be the remedies set forth above. In addition, Cofimco shall obtain for Buyer the warranties and guarantees provided by the manufacturers of equipment provided by others, but Cofimco shall have no further liability or responsibility for any equipment supplied by others. Buyer shall take any and all reasonable actions to mitigate any losses, damages or costs arising out of or in connection with the supply of equipment by Cofimco, this agreement and the Contract and any possible liability of Cofimco shall be limited and reduced accordingly and shall in no event include any losses, damages or costs which could have been prevented, avoided or mitigated by prompt, appropriate and diligent action by Buyer or by giving prompt notice to Cofimco.

Unless expressly agreed otherwise in writing in Cofimco's order acknowledgment, Buyer and Cofimco agree that, in consideration of the express warranties above, all other warranties and guarantees, whether express or implied, whether arising under law, equity or custom of trade, including warranties of merchantability and fitness for a particular purpose, are excluded from these T&C and the Contract.

VI. FORCE MAJEURE AND DELAY IN PERFORMANCE

Except for the payment of monies due hereunder or as otherwise set forth, neither party shall be held liable for any expense, loss, damage, failure to perform, delay in performing, or for any possible mechanical breakage or defect resulting from delay or prevention of performance caused by a Force Majeure Event or other circumstances outside Cofimco's control such as, without limitation, hostilities, restraint of rulers or peoples, revolution, civil commotion, strike, shortages of labor, energy, fuel, machinery or materials, technical or yield failures, epidemic, accident, fire, flood, wind, earthquake, explosion, blockade or embargo, lack or failure of transportation facilities, actions of the other party, failure of the other party to perform required or necessary actions, delays in performance by the other party, or any law, proclamation, regulation or ordinance, demand or requirement of any government or governmental agency having or claiming to have jurisdiction over the work, the materials purchased for the work, or the Parties hereto, or any other cause, whether similar or dissimilar to those enumerated above, beyond the reasonable control of the Party affected. Accordingly, Buyer shall not have any claim against Cofimco in respect of nonperformance, erroneous performance or delay in performance. In the event Cofimco is delayed by reason of any of the foregoing, the time for performance and delivery shall be extended by a period of time equal to the period of delay, and the Contract price shall be increased to compensate the affected party for the increased cost of performance hereunder.

VII. TAXES

The prices for equipment are exclusive of any present or future state, municipal or other sales or use tax or any other present or future excise tax upon, measured by the gross receipts for any transaction hereunder or any allocated portion thereof, or by the gross value of the equipment, or of any present or future property tax or similar charge with respect to the equipment. If Cofimco is required by applicable law or regulation to pay or collect any such tax or taxes on account of the equipment, then such amount of tax and any penalties and interest thereon shall be reimbursed to Cofimco by Buyer.

VIII. TEST OF EQUIPMENT

Any performance test of equipment shall be made in accordance with procedures to be agreed upon in writing between Cofimco and Buyer. Cofimco shall be notified of and may witness any such test. All such tests shall be conducted within the warranty period. Buyer shall obtain Cofimco's written permission prior to any disclosure to a third party concerning the nature or results of such tests.

IX. CANCELLATION

Buyer may cancel orders entered on Cofimco's books only after Cofimco consents thereto and Buyer agrees to pay Cofimco for all costs incurred by Cofimco, all costs to cancel orders by Cofimco for performance, and a reasonable amount for Cofimco's profit.

X. LIMITATION OF LIABILITY

Notwithstanding any other provision to the contrary of these T&Cs, the Contract or at law, neither Cofimco nor its subcontractors shall be held liable to Buyer or any third party for, without limitation, loss of anticipated profits, loss of business reputation or opportunity, loss by reason of plant or other facility shutdown (therein including missing or reduced production), nonoperation or increased expense of operation, service interruptions, cost of purchased or replacement power, claims of customers, loss of use of capital or revenue, cost of money, or for any special, indirect, incidental and/or consequential loss or damage of any nature whatsoever arising at any time from any cause whatsoever in connection with the Contract.

Accordingly, regardless of whether Cofimco has been advised of the possibility of such damages, under no circumstance shall Cofimco be liable for any losses, liabilities, claims, damages and/or expenses howsoever arising as a result of any action or omission by Cofimco under or in connection with the Contract whether under contract, tort (including gross negligence), strict liability or otherwise, except exclusively in the event they are the direct and immediate consequence of willful misconduct or gross negligence by Cofimco resulting in the material breach of essential duties under these T&Cs finally established by a court or arbitral panel of competent jurisdiction after due process of law.

In all cases, any liability of Cofimco arising out of or in connection with these T&Cs or the Contract shall not extend to any damages payable by Buyer to any third parties and shall be limited to such losses, liabilities, claims, damages and/or expenses which had been foreseeable at the time of the execution of the Contract, taking into account the circumstances of which Cofimco was aware at such time; moreover, in no event shall the total liability of Cofimco arising out of the supply of equipment or services hereunder - whether under contract, tort, strict liability or otherwise and regardless of the form of action - exceed the price of the purchase order under which the services or equipment giving rise to liability are provided.

Cofimco’s liability under these T&Cs and within the limits set forth herein, shall be exclusive and in lieu of any provisions, conditions and warranties implied by law, equitable principles or rules and/or custom of trade (including implied warranties of fitness for purpose and merchantability). Accordingly, to the maximum extent permitted and regardless of whether Cofimco has been advised of the possibility of any such loss or damage, Buyer waives any remedies and reliefs provided by the applicable law arising out of, or in connection with, any possible loss of (anticipated) profits and/or any other loss or damage other than as expressly specified under this Article X.

XI. REFUNDS, KICKBACKS, ILLEGAL PAYMENTS

Buyer is prohibited from paying any company funds to any director, officer, employee, or other agent of Cofimco or from otherwise making any payments from the funds that would be illegal under any applicable laws.

XII. GOVERNING LAW

These T&Cs, the Contract and all contractual and non-contractual disputes arising out of, or in connection therewith and with the supply of the equipment or services by Cofimco to Buyer, shall be governed by, and shall be construed solely in accordance with, the substantive laws of the Republic of Italy.

XIII. JURISDICTION

Unless otherwise stated in Cofimco's order acknowledgment, each Party agrees for the benefit of the other Party that the court of Milan, Italy, shall have exclusive jurisdiction to hear and determine any suit, action or proceedings, and to settle any disputes, which may arise out of or in connection with these T&Cs, the Contract or the supply of the equipment or services by Cofimco to Buyer and for such purposes, irrevocably submits to the exclusive jurisdiction of such court.

XIV. ENTIRE AGREEMENT CLAUSE

Together with Cofimco's order acknowledgement, these T&Cs, irrespective of whether they are or will be attached or referred to by other Contract documents, constitute the only general terms and conditions of sale by Cofimco, and purchase by Buyer, of the equipment to be delivered or services to be rendered hereunder. Accordingly, except as provided for under Article XV below, these T&Cs shall supersede all communications, negotiations, arrangements and agreements, whether oral or written, between the Parties with respect to the subject matter of the Contract and, particularly, shall override any terms and conditions stated in any order or acknowledgement or any other document or communication issued, supplied or sent by Buyer.

Cofimco shall not be bound by any terms and conditions stated in Buyer's purchase orders, acknowledgements forms or in any other document(s) or correspondence which vary, limit or add to these T&Cs, which shall prevail notwithstanding the diverging, conflicting or additional terms and conditions that may appear on any of the aforementioned documents unless not expressly incorporated herein. Moreover, it is expressly agreed that if Buyer issues a purchase order or other documents for the supply of the equipment or the services provided under these T&Cs, such document will be deemed to be for Buyer's internal use only, and these T&Cs shall supersede any provision therein. Notice of objection is hereby given to any additional or different terms and conditions and Buyer accepts it.

Finally and in any event, subject to Article XV below acceptance by Buyer of the equipment or the services under the Contract will amount to and be deemed to all effects as an unconditional and final acceptance and approval by Buyer of these T&Cs.

XV. AMENDMENTS TO THE T&Cs

Any amendment or addition to these T&Cs may only be made in writing and shall bear the signatures of the duly authorized representatives of each Party.

SPECIFIC APPROVAL

For purposes of Articles 1341 and 1342 of the Italian Civil Code, Articles V, VI, X, XII, XIII, XIV of the General Terms and Conditions of Sale are hereby expressly and specifically agreed upon and approved by the Buyer.

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Warranty

COFIMCO S.r.l. ensures that labor and all materials used in fan construction are of high-quality.

However, in case of mechanical failure of our fans within the first year of operation or 18 months from factory shipment date, if our inspectors have noticed breakages due to material or workmanship defects, the fan will be repaired or replaced with an identical or equivalent fan , according to our exclusive and unquestionable verdict, at our expense. Possible repairs or replacements will be conducted at our establishment and do not include transport and workmanship costs.

Any warranty given by COFIMCO S.r.l. ceases, if the fan has been tampered with or if breakage is caused by incorrect maneuvers or installation. Expenses for repairs conducted without COFIMCO S.r.l. approval will not be recognized.

In no case COFIMCO S.r.l. may be held responsible for consequential or incidental damage of any type, resulting from construction, sale, installation or use of its product.

Chapter 0

Foreword

The present “Fan Installation, Maintenance and Operation Manual” has the purpose of providing all the necessary information for:

- the correct installation of the fan
- its correct use in safe conditions
- performing maintenance in a correct and safe way
- dismantling the fan in safe conditions and in respect of the regulations in force safeguarding the health of operators and the environment.

WARNING: the people responsible for the device are obliged, under the regulations in force, to carefully read the content of this “Fan Installation, Maintenance and Operation Manual” and of making the people in charge of the installation and maintenance read it in the parts that concern them.

The time employed for this purpose will be widely compensated by the correct functioning of the device and by its use in safe conditions.

This document presupposes that the safety and hygiene regulations in force are fully respected in any plant or space where the fans are installed.

Installation must be performed by qualified personnel.

The instructions, drawings, and documentation contained in the present “Fan Installation, Maintenance and Operation Manual” are of a confidential technical nature and are exclusively owned by the manufacturer. They may therefore not be reproduced in any way, neither entirely or in part.

This “Fan Installation, Maintenance and Operation Manual” needs to be carefully preserved and must accompany the fan in all the changes of ownership that the device might go through in its life cycle.

None of its parts should be removed, torn or arbitrarily modified.

NOTE: COFIMCO holds itself responsible for the descriptions written in Italian. Any translation can never be fully checked and therefore, if any incongruence should arise, only the Italian version will be valid. In case you should detect any imprecision, please contact our Sales office, which will proceed to making any modifications considered appropriate.

Waste disposal and disassembly

Lubricants and spare parts need to be disposed of in respect of the regulations in force in the country where the machine is being employed.

In case of disassembly of the machine, please refer to the disassembly indications for the single components.

Any constructive elements that have been replaced following reparations or any parts of the machine or even the entire machine at the end of the period of use need to be disposed of according to the local provisions in force at that time.

Chapter 1

General information

1.1 35FD G-GR Series COFIMCO fan description

COFIMCO 35FD G-GR fans Series is a truly ingenious design. Fans are offered with blade pitch angle adjustable at standstill.

G hubs consist of two steel discs and an internal hub boss bolted to a central flange which connects the hub to the output shaft. Fan blades are assembled with pillow blocks fitted between the two discs.

Fan blades are available in an aerodynamic fiberglass profile and connected to the fiberglass fan shaft.

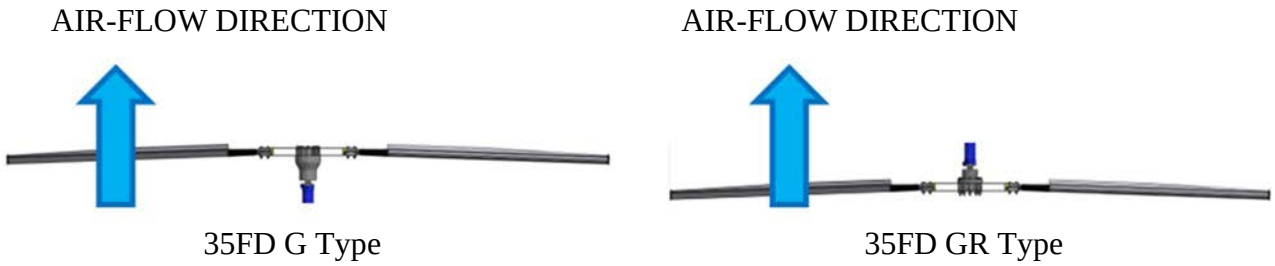


Figure 1.1: fan installation type

35FD G-GR Series COFIMCO fans are available in two different configurations (see figure 1.1 only as an example)

- 35FD G type: fans supported by the drive shaft
- 35FD GR type: fans suspended from the drive shaft

1.2 Fan serial number description

All COFIMCO fans have a label positioned on the hub making them easy to identify.

Label structure is described in figure 1.2; a label example is given in figure 1.3.

F/T	Fan type: fan type is given by a label containing the following: **XXXXX XX XXY XXY** Hub dimensions Hub type Section material: N: Aluminum L: Flap aluminum F: Fiber-glass Profile type Fan blade number Fan diameter in mm Sometimes, after the acronym referring to the hub, the letters R and/or T can be reported, representing the reverse direction mode of installation. It also means that the blades are respectively equipped with a special tip plug.
C/R	COFIMCO manufacture order reference number.
P.O.	Client acquisition number
I	Manufacturing order item number
A°	Blade pitch angle

Figure 1.2: identification label format

Figure 1.3: 9144/08/35FD/G2.2 label example

The example label (fig. 1.3) refers to a 9144 mm diameter fan, equipped with 8 blades, each having a 35FD profile and hub type G with diameter of 2.2 m. Job reference number 12345/678, Purchase Number of Customer PO123456, number of item in the job E1234, 10° blade pitch angle.

ATTENTION: the label shown here is only an example and does not correspond in any way to label data identifying any purchased fan.

ATTENTION: data presented by the identification label must always be forwarded to COFIMCO when spare parts are requested.

1.3 Balancing

Unless otherwise requested, all COFIMCO fans are balanced as shown below:

- Static balancing of the hub and static balancing of blades, to be assembled at quality grade G6.3 according to ISO 21940/1, when the fan is shipped disassembled. In this case the blades have the same moment balanced and, therefore, can be positioned in the hub in any order. The blades of the same item can be interchanged.

1.4 Delivery and storage

As soon as the COFIMCO fan is delivered, it is important that a thorough inspection is conducted in order to identify possible damage caused during transport. In this case, submit a complaint to the transport company and mark the related bill of lading. Immediately after fan delivery, check the perfect correspondence between ordered components and delivered components. In case goods do not comply with order, contact COFIMCO within two weeks from delivery.

Removed fan from its packaging only for installation. If the fan is not installed immediately, storage requirements will be as following:

Short storage period

For a short storage period fan package may be stored in an open area characterized as:

- Covered.
- With good drainage.
- Sufficient placement area bearing capacity.
- Suitable for forklift, truck, crane use.
- Vegetation free.
- Protected from flooding.
- With adequate access roust.

Long storage period

In case of a long storage period, fan package will be preferably stored in an indoor area characterized as following:

- Covered.
- Enclosed on all sides.
- Asphalt or concrete pavement with adequate bearing capacity.
- Suitable for forklift and truck use.
- Parasite free (mice, insects, etc.).
- Protected from flooding.
- With adequate access roust.

Storage temperatures must be in accordance with table 4.1.

Chapter 2

Set-up

This manual refers to 35FD G-GR Series COFIMCO fan set-up. Set-up conditions may not always be the same.

2.1 Handling procedure

The following rules must be respected during the handling, the assembling and maintenance of the fans and its painted components:

- Avoid stacking the hubs over each other; if necessary, place a separator element (wood, rubber, plastic, etc.) between the disks.
- It is forbidden to use any metal tool, chains, hooks, etc. in direct contact with any part of the fan.
- Place the hubs on a non-abrasive surface.
- Avoid rolling or sliding the hubs during the handling.
- Avoid heating the hub hole over 80° C (176° F).
- Avoid heating the painted surfaces with flames to avoid damage to the paint.
- Avoid hitting the coating with any object.
- Loosen all fixing bolts to the hub to facilitate insertion of the blade shaft without scratching the surface. This should be carried out even in the case where it is necessary a blade pitch angle adjustment. The same procedure must also be performed on the bolts of the contiguous blades in order to facilitate the procedure.
- If a painted surface is damaged, perform the paint repair procedure as soon as possible (see the retouching procedure applicable to the job) to avoid the decay of the protection with possible rust and early deterioration of unprotected parts. If this procedure is necessary and is not executed, the warranty on the painting expires.
- Any damage caused during the handling must be immediately reported to COFIMCO in order to assess whether such damages may or may not adversely affect the structural safety or aerodynamic performance of the blade.

WARNING: if the fans are moved assembled or installed on heat exchangers / cooling towers, block the blades so that they do not have the means to hit against each other, against the structure or against other objects.

2.2 Lift procedure

The following rules must be respected for lifting:

- The handling of the material must be minimal once material is removed from its packaging in order to avoid damages to the fan particularly to the coated surfaces.
- The use of any metal device, chains, hooks, etc. is forbidden in direct contact with any parts of the fan.
- The fully assembled fan must be lifted using at least three equally spaced lifting points, anchored on the hub and not on the blades.
  As a suggestion (to avoid spoiling the paint or fiberglass), the fan can be pulled by using circular eyebolts with threaded hole screwed on the corresponding internal lock bolts (the corresponding bolts must be temporarily installed in the opposite direction, complete with washer and nut) by checking that the maximum permissible weight of these eyebolts are overall compatible with the weight of the fan (figure 2.1).

  NOTE: in the case of hot galvanized screws, use eyebolts with larger threading.

  NOTE: the distance between the eyebolts ($d_{eyebolts}$) must be greater than the radius of the hub.

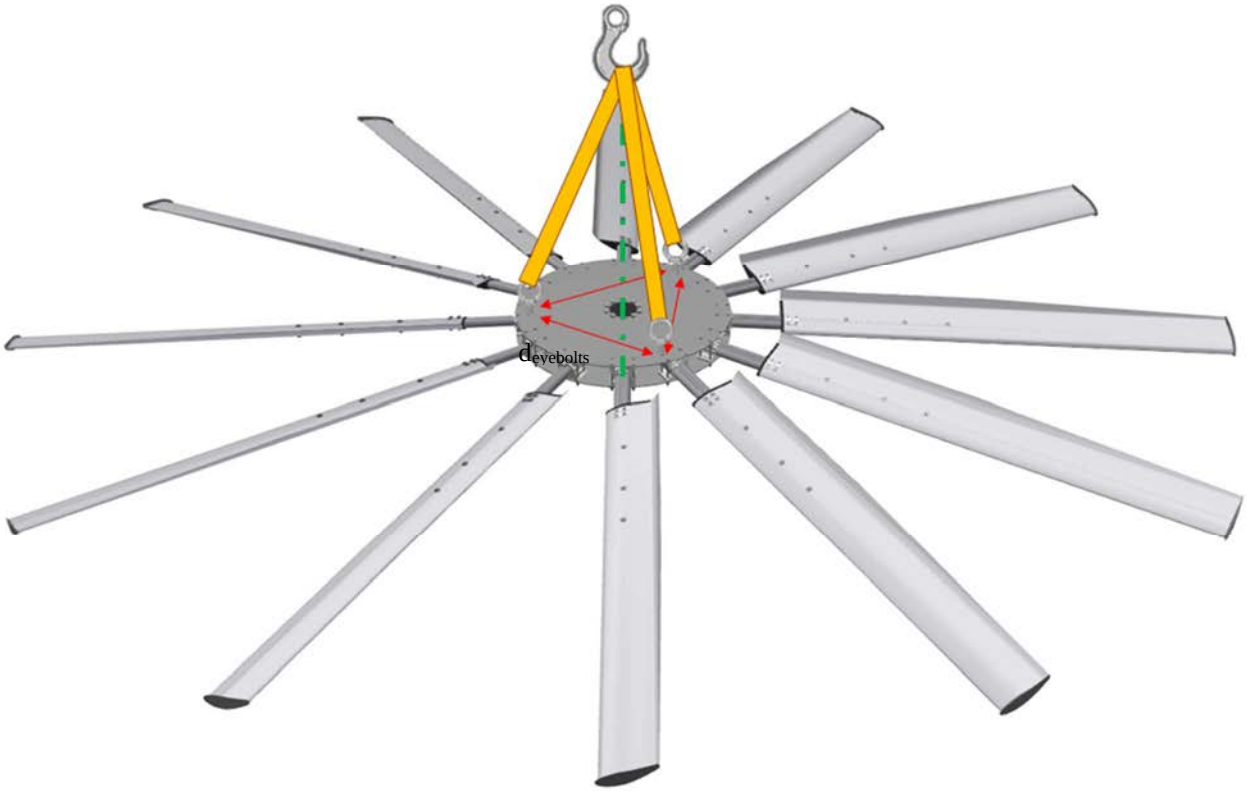


Figure 2.1: fan lift

- The lifting devices used must be suitable for the weight and size of the fans to be lifted.
- Lifting rules must always be respected, both generally and of the installation system and local regulations.
- The blades must always be raised with the profile upright, as shown in Figure 2.2.

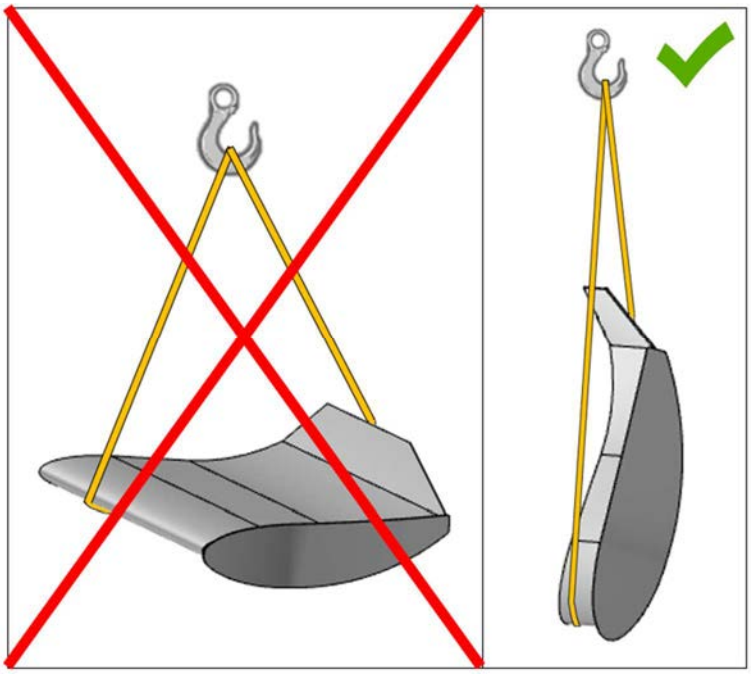


Figure 2.2: blade lift

2.3 Installation required tools

Fan set-up requires the following tools:

- Torque wrench (figure 2.3) used for bolt tightening.
- Digital protractor (figure 2.4) used to give the blade profile pitch needed to achieve desired performance according to procedures described in this chapter. Digital protractor precision must be at least ±0.5° (maximum admissible deviation) to the design pitch angle.

Figure 2.3: torque wrench (example)

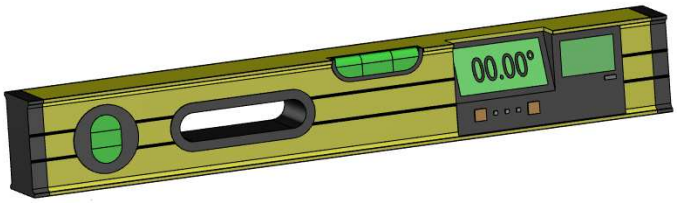


Figure 2.4: digital protractor

If requested, COFIMCO is able to provide assembly necessary tools.

2.4 Inclination of the blade axis

With respect to the rotation plane, blade axis presents a small angle/slope (precone) aimed towards the airflow (see figure 2.5). When in operation, the centrifugal force generates a bending torque opposite the force generated by the aerodynamic force, considerably reducing blade stress. Therefore, it is necessary to make sure the blade axis are directed towards the air flow direction during installation.

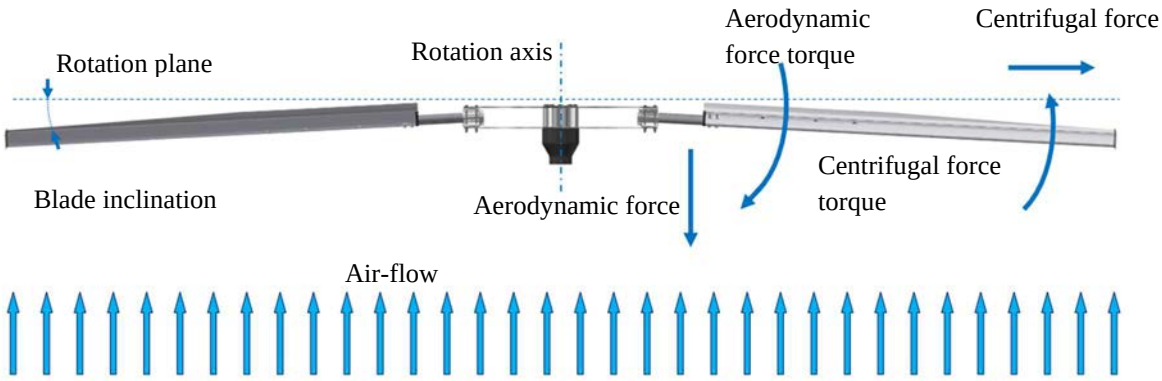


Figure 2.5: blade axis layout

ATTENTION: in case the precone angle is installed incorrectly, or rather the blades are not tilted towards air flow direction, loads stressing the blades considerably increase and may exceed design limits.

For this reason, in case the precone is incorrectly set-up, the warranty is considered void.

2.5 Fan rotation and flow direction

Fan rotation direction is correct when air flow moves from the part with greater curvature (back) to the lower curvature (belly). In the example of figure 2.6 it has a clockwise rotation, seen from the side receiving the flow; upon request, COFIMCO provides fans with counter-clockwise rotation.

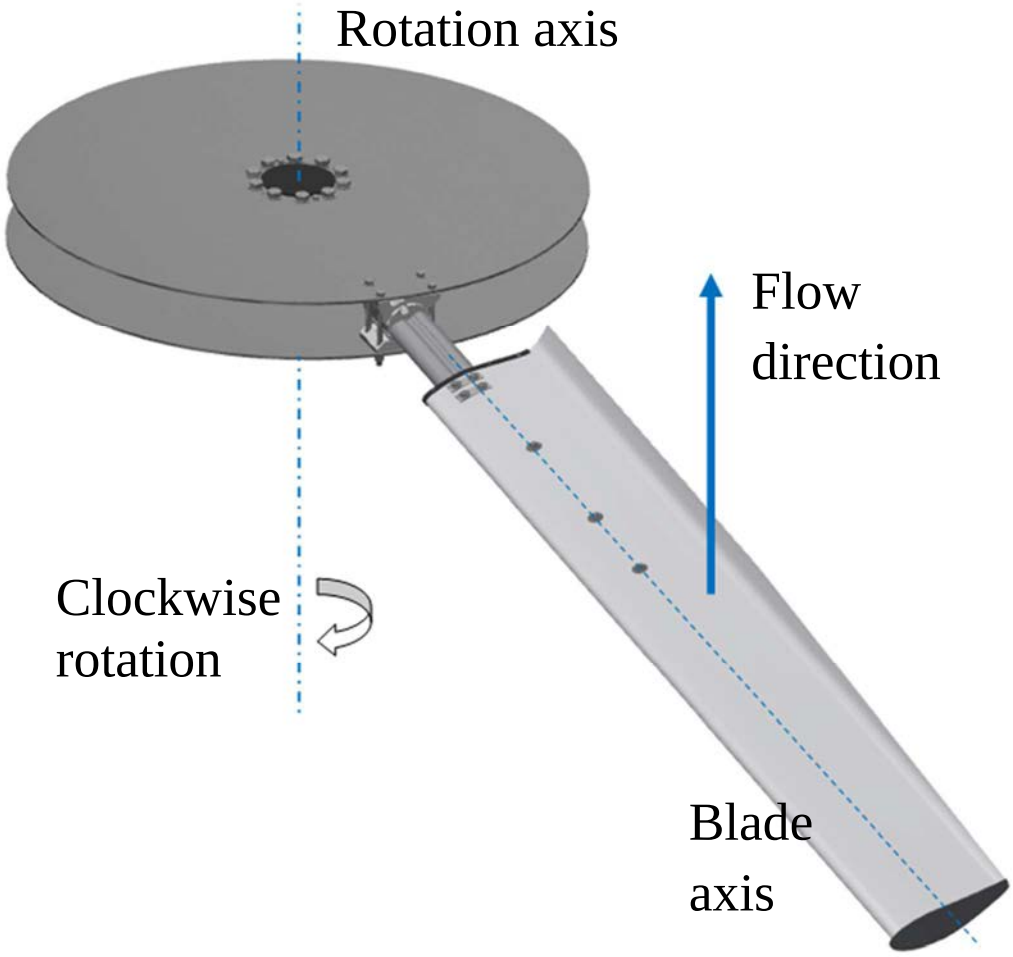


Figure 2.6 blade clockwise rotation

ATTENTION: excessive obstacle closeness may generate a significant aerodynamic load disturbance for any blade, resulting in turbulence, whirlpools, higher fatigue loads and vibrations, depending on obstacle dimensions and distance.

2.6 COFIMCO rotor and G-GR series hub installation procedures

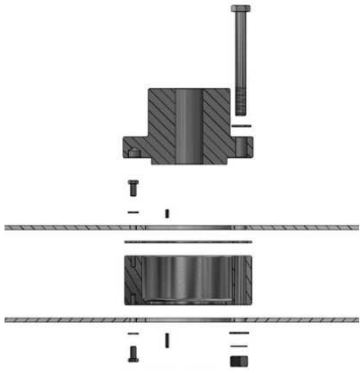
ATTENTION: after making sure that electrical contacts have been cut-off and that the motor may not in any way be started inadvertently, it is allowed to proceed with assembly as follows:

NOTE: Elements present in the part list (see attachment C) are recalled in the text by corresponding number insertion between square brackets.

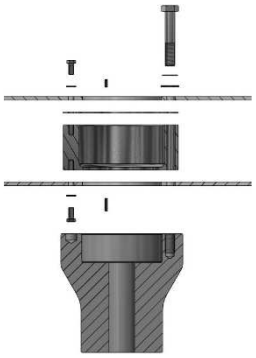
COFIMCO offers three different hub configurations (see figure 2.7):

- hub with external flange; for the installation procedure please refer to section 2.6.1-a;
- hub with external extended flange; for the installation procedure please refer to section 2.6.1-a;
- hub with internal hub boss; for the installation procedure please refer to section 2.6.1-b;

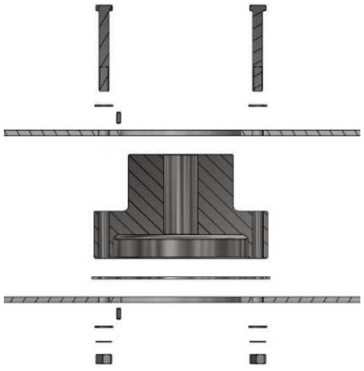
NOTE: configurations (a) and (c) can also be assembled in straight configuration.



(a) configuration of external flange



(b) configuration of external extended flange



(c) configuration with internal hub boss

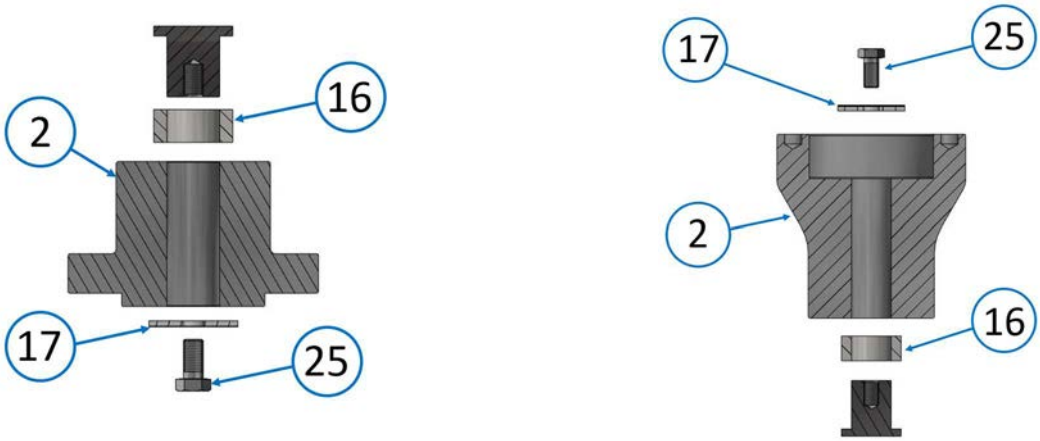
Figure 2.7: configuration of G hub

2.6.1-a Installation of G series hub with external / external extended flange

A. Installation of flange on the shaft

COFIMCO can supply two different types of hub with external flange: with cylindrical bore (see figure 2.8) or with cylindrical bore for bushing installation (see figure 2.9).

1) **<u>Hub with flange with cylindrical bore</u>**: anchored directly to the shaft that transmits the motion; for the procedure please refer to figure 2.8.



(a) external flange (b) external extended flange

Figure 2.8: installation of external flange with cylindrical hole

Coat the shaft with a thin layer of grease. If provided, install the spacer ring [16] by inserting it in the shaft supporting the fan until it comes into contact with its edge.

Push the flange [2] into the shaft until it comes into contact with its edge, with the shaft, or with the spacer ring if any.

The shaft on which the rotor is installed, when the hub/spacer will come into contact with it, must remain inside the hub bore at least 2 mm (a 5 mm distance is recommended) to prevent vertical displacement of the fan when fan fastening plate [25] is tightened.

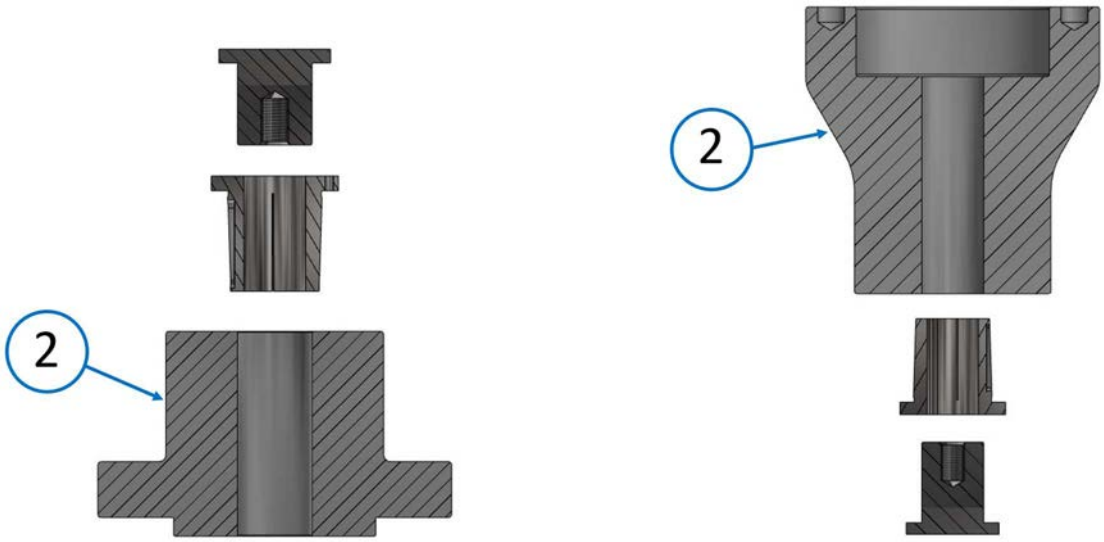
Put the washer [17] on the flange and tighten the bolt [25] to the shaft, as shown in figure 2.8.

NOTE: washer [17] and bolt [25] are not supplied by COFIMCO.

ATTENTION: do not start the fan with central bolt incorrectly tightened.

2) **<u>Hub with flange with bushing</u>**: to fasten it refer to figure 2.9.

ATTENTION: the fan shaft must never be lubricated.



(a) external flange (b) external extended flange

Figure 2.9: installation of external flange with bushing

Insert bushing on the drive shaft to desired anchor position. Bushing should be completely engaged with the output shaft.

Fasten the flange onto the bushing so as the bolt's holes match up.

Once component positioning has been verified, tighten bushing bolts using tightening torques defined in table 2.1 paying attention to bushing type.

Bushing Type	Tightening Torque	
	N m	Lb ft
R1 e R2	39	29
S1 e S2	95	70
U0, U1 e U2	190	140
W1 e W2	339	250
QD-N	407	300
QD-P	610	450

Table 2.1: bushing bolt tightening torque

NOTE: bushings are subject to external agents that can generate a superficial oxide layer on them. This does not provoke any variations in their mechanical features and should be considered normal.

ATTENTION: do not start the fan with bushing bolts incorrectly tightened.

A. Installation of hub on external/external extended flange

COFIMCO supplies the G class hub disc already assembled, see figure 2.10.

NOTE: the blocks (and relative bolts) located at the end of the disc are used to fit the blades to the hub. Such installation (described in the following section 2.6.2) should be carried out after having installed the rotor; therefore, they should not be taken into consideration in this assembly phase.

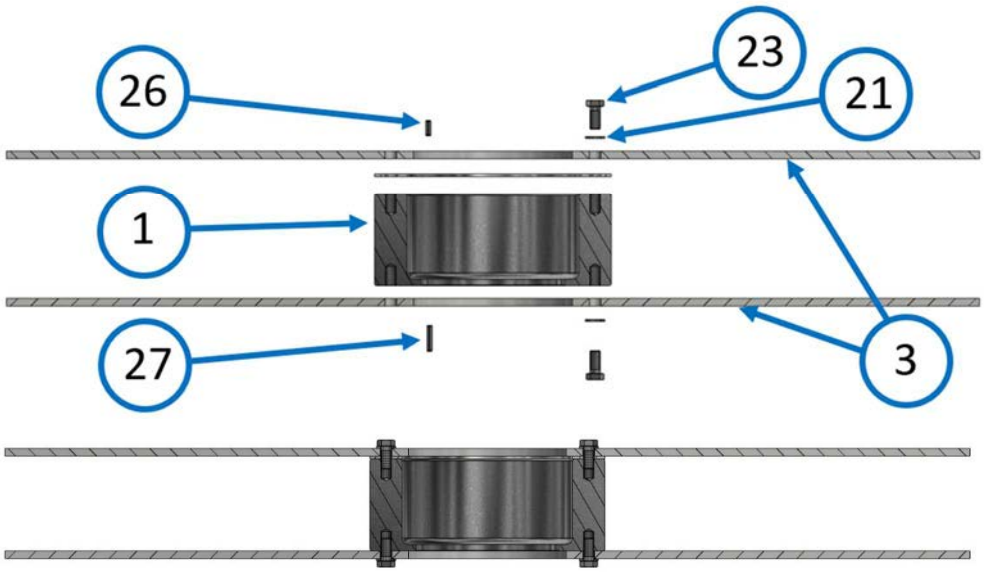


Figure 2.10: hub with external/external extended flange mounted

ATTENTION: the bolt to be fitted on the hub [23] (figure 2.10) should not be loose or removed.

Install the hub to the flange tightening the hub bolts [5], see figure 2.11.

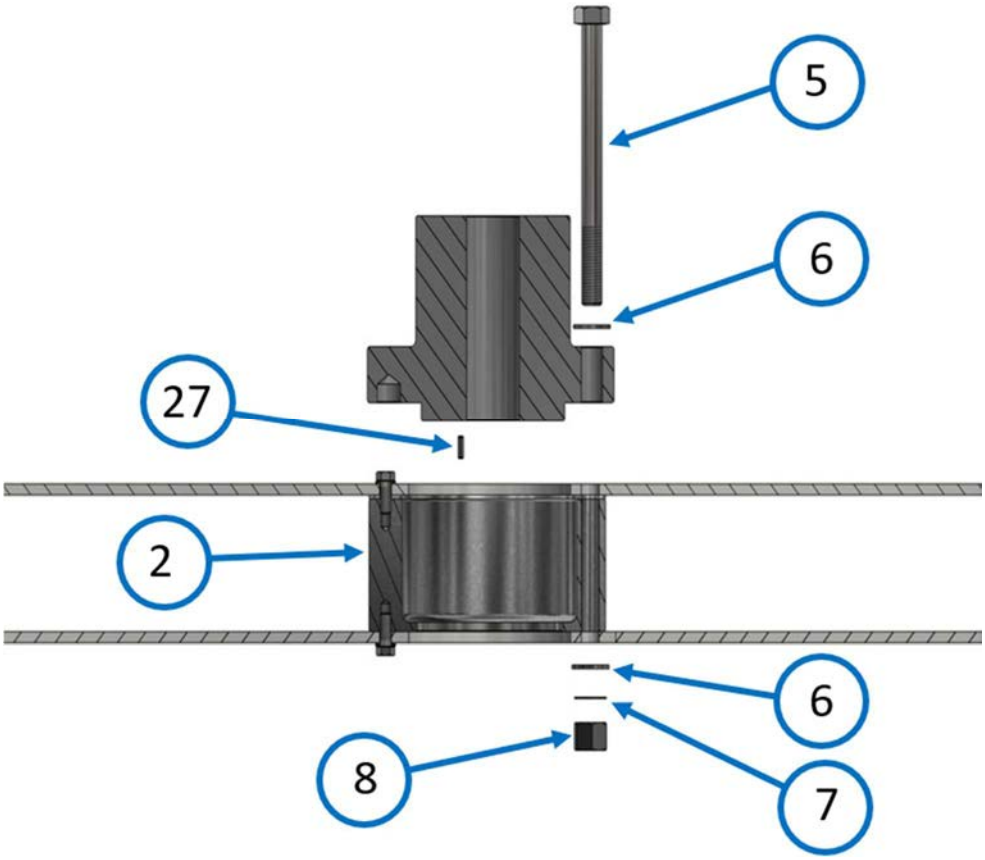
NOTE: installation between flange and hub is effected by the centering pins [26].

Tighten the hub bolts [5] following the diagonal tightening order, see figure 2.12.

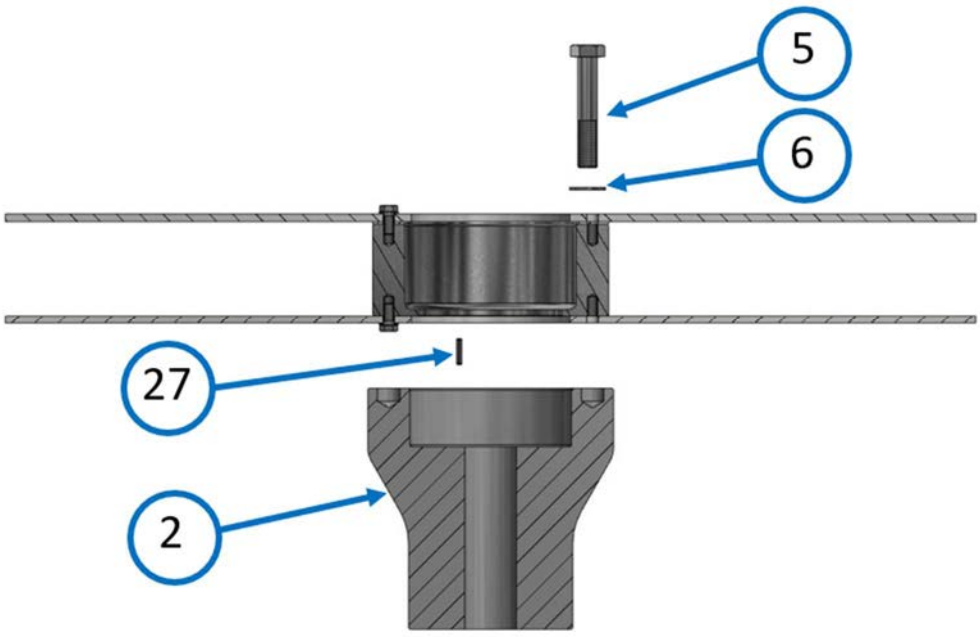
Bolt tightening torques depend on utility class: use torques from table 2.2

ATTENTION: the stainless steel bolts (class A2/A4) must be tightened without using automatic/high speed screwdrivers in order to avoid galling.

NOTE: hub type is indicated on the identification label while bolt class is identified by bolt head.



(a) configuration of external flange



(b) configuration of external extended flange

Figure 2.11: hub coupling to external flange

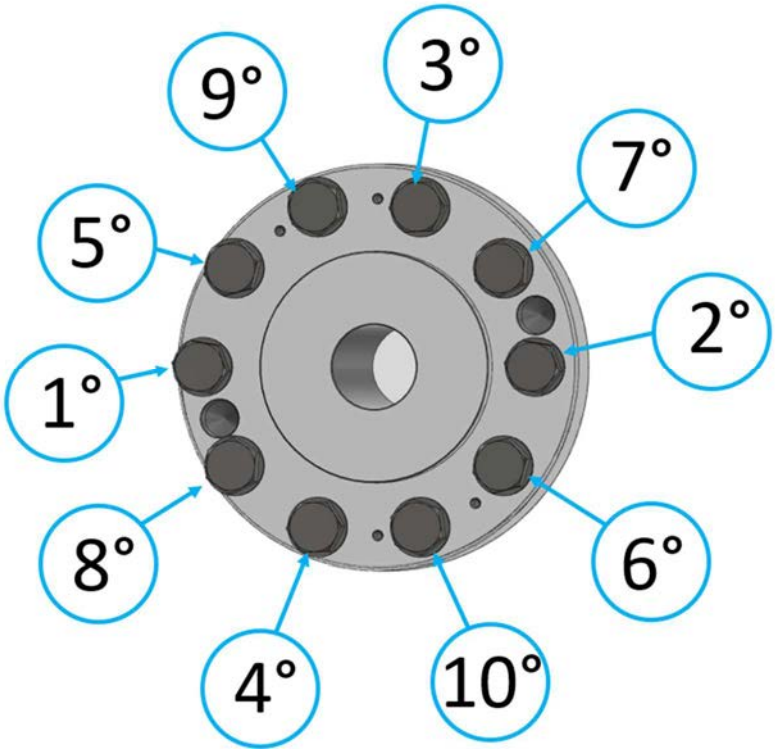


Figure 2.12: Bolt tightening order

Bolt Type	Tightening Torque					
	Class 8.8 - **dry**		A2/A4-70 - **lubricated**		A2/A4-80 - **lubricated**	
	N m	Lb ft	N m	Lb ft	N m	Lb ft
M30	1633	1204	920	679	1000	738

Table 2.2: guided bolt tightening torque [5]

ATTENTION: stainless steel bolts (A2/A4-70 and A2/A4-80) apply lubricant.

2.6.1-b Installation of G series hub with internal hub boss

COFIMCO supplies the G class hub disc already assembled, see figure 2.13.

NOTE: the blocks (and relative bolts) located at the end of the disc are used to fit the blades to the hub. Such installation (described in the following section 2.6.2) should be carried out after having installed the rotor; therefore, they should not be taken into consideration in this assembly phase.

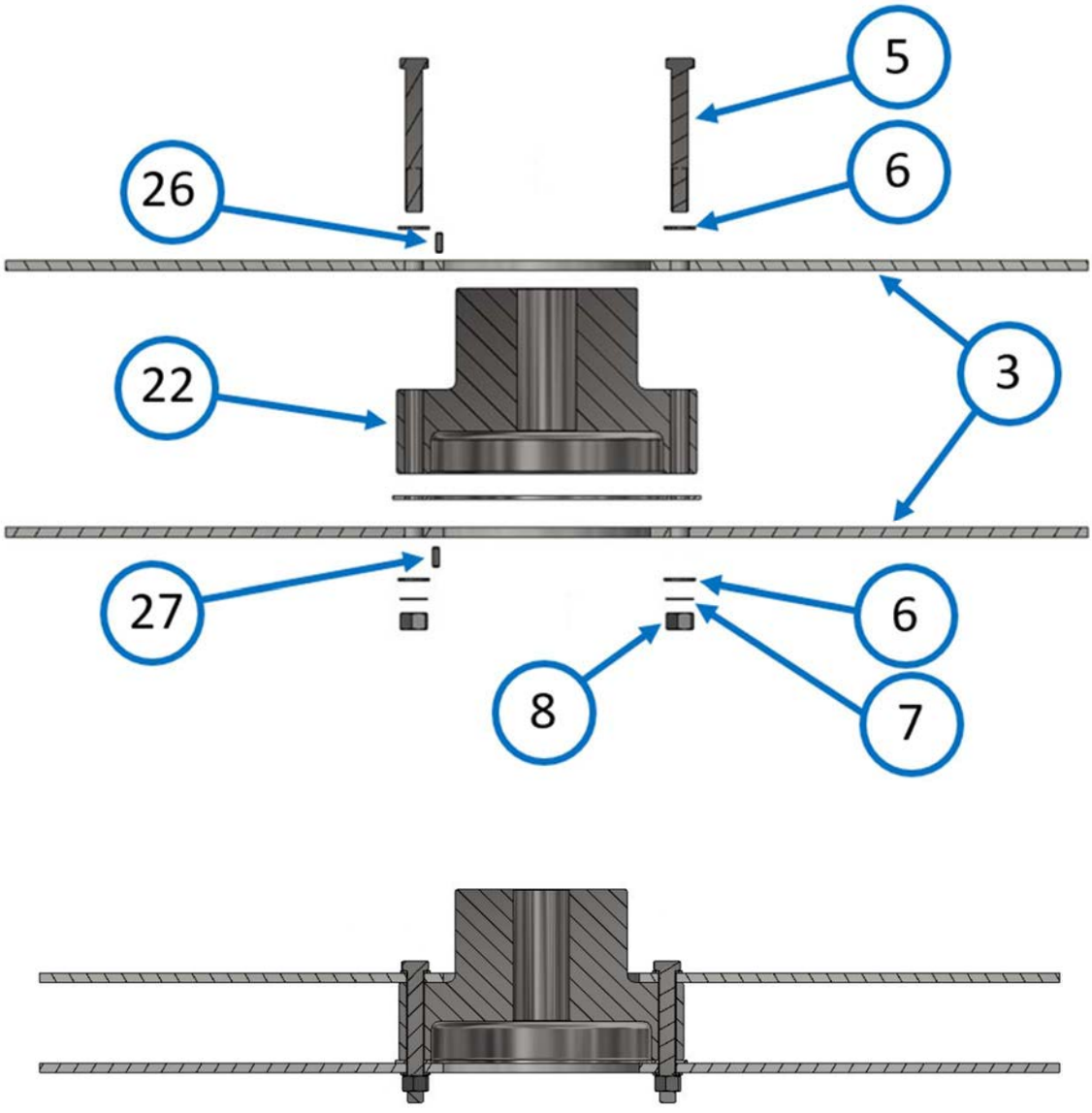


Figure 2.13: hub with internal hub boss mounted

ATTENTION: do not loosen or remove the bolts used to mount the hub [5].

Should it be required to tighten again one or more hub bolts [5] follow the diagonal bolt tightening order, see figure 2.14.

Bolt tightening torques depend on utility class: use torques from table 2.3

ATTENTION: the stainless steel bolts (class A2/A4) must be tightened without using automatic/high speed screwdrivers in order to avoid galling.

NOTE: hub type is indicated on the identification label while bolt class is identified by bolt head.

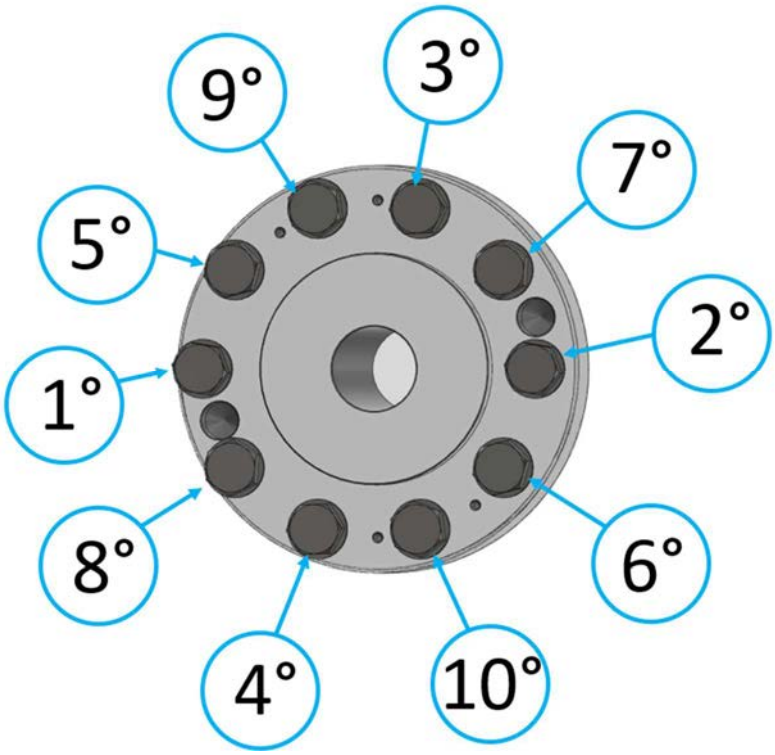


Figure 2.14: Bolt tightening order

Bolt Type	Tightening Torque			
	Class 8.8 - **dry**		A2/A4-70 - **lubricated**	
	N m	Lb ft	N m	Lb ft
M20	472	348	250	184

Table 2.3: guided bolt tightening torque [5]

ATTENTION: stainless steel bolts (A2/A4-70) apply lubricant.

COFIMCO can supply two different types of hub with internal hub boss: with cylindrical bore (see figure 2.15) or with cylindrical bore for bush installation (see figure 2.16).

1) **<u>Hub with internal hub boss with cylindrical bore</u>**: anchored directly to the shaft that transmits the motion; for the procedure please refer to figure 2.15.

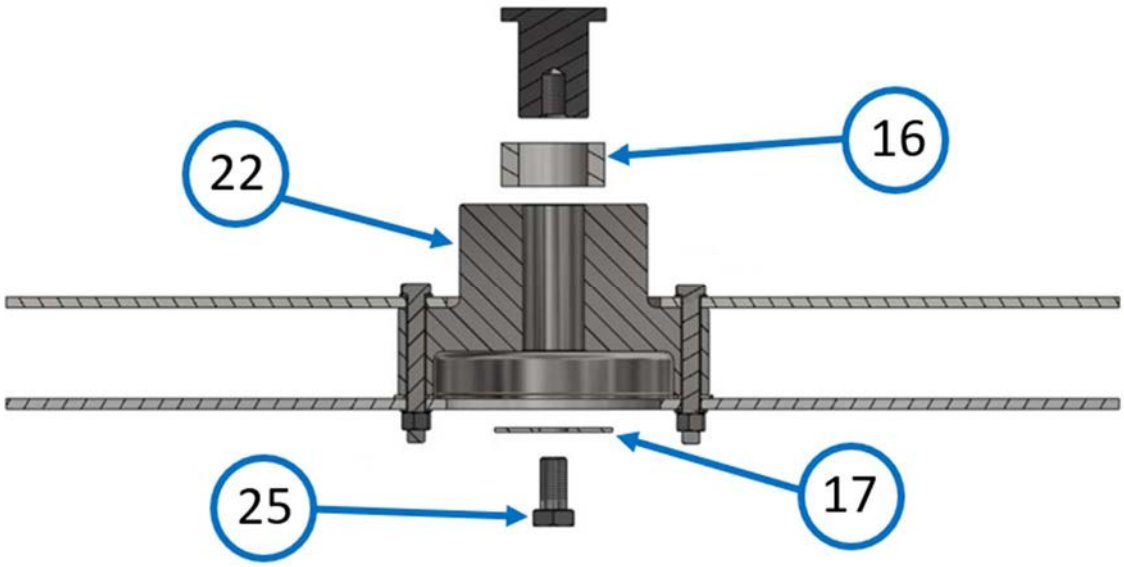


Figure 2.15: installation of hub with internal hub boss and cylindrical bore

Coat the shaft with a thin layer of grease. If provided, install the spacer ring [16] by inserting it in the shaft supporting the fan until it comes into contact with its edge.

Push the flange [22] into the shaft until it comes into contact with its edge, with the shaft, or with the spacer ring if any.

The shaft on which the rotor is installed, when the hub/spacer will come into contact with it, must remain inside the hub bore at least 2mm (a 5 mm distance is recommended) to prevent vertical displacement of the fan when fan fastening plate [25] is tightened.

Put the washer [17] on the flange and tighten the bolt [25] to the shaft, as shown in figure 2.15.

NOTE: washer [17] and bolt [25] are not supplied by COFIMCO.

ATTENTION: do not start the fan with central bolt incorrectly tightened.

2) **<u>Hub with internal hub boss and bushing</u>**: to fasten it refers to figure 2.16.

ATTENTION: the shaft to which you shall secure the fan should not be lubricated for any reason.

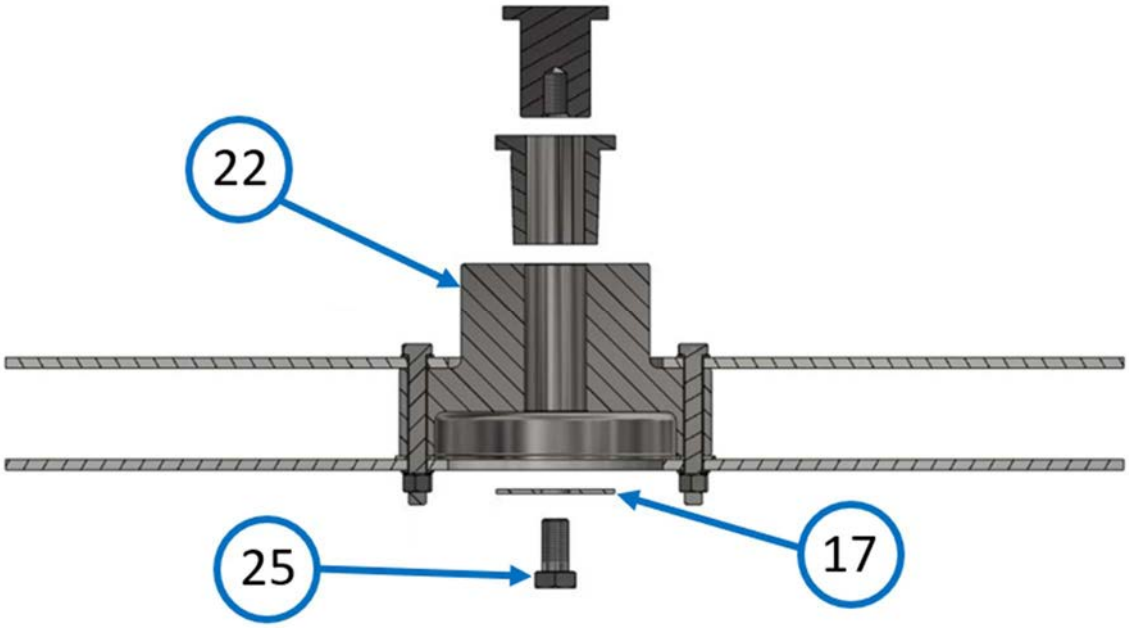


Figure 2.16: installation of hub with internal hub boss and bushing

Insert bushing in the drive shaft to desired anchor position; drive shaft extremity should not find itself inside the bushing. Fasten the flange to the bushing so that the holes between the two parts match. Once component positioning has been verified, tighten bushing bolts using tightening torques defined in table 2.4 paying attention to bushing type.

Bushing type	Tightening Torque	
	N m	Lb ft
R1 e R2	39	29
S1 e S2	95	70
U0, U1 e U2	190	140
W1 e W2	339	250
QD-N	407	300
QD-P	610	450

Table 2.4: bushing bolt tightening torque

NOTE: bushings are subject to external agents that can generate a superficial oxide layer on them. This does not provoke any variations in their mechanical features and should be considered normal.

ATTENTION: do not start the fan with guiding bolts incorrectly tightened.

ATTENTION: in the case of special coating, the washers [6] can be replaced with special plates to protect the coating (given in figure 2.17) supplied by COFIMCO, if required.

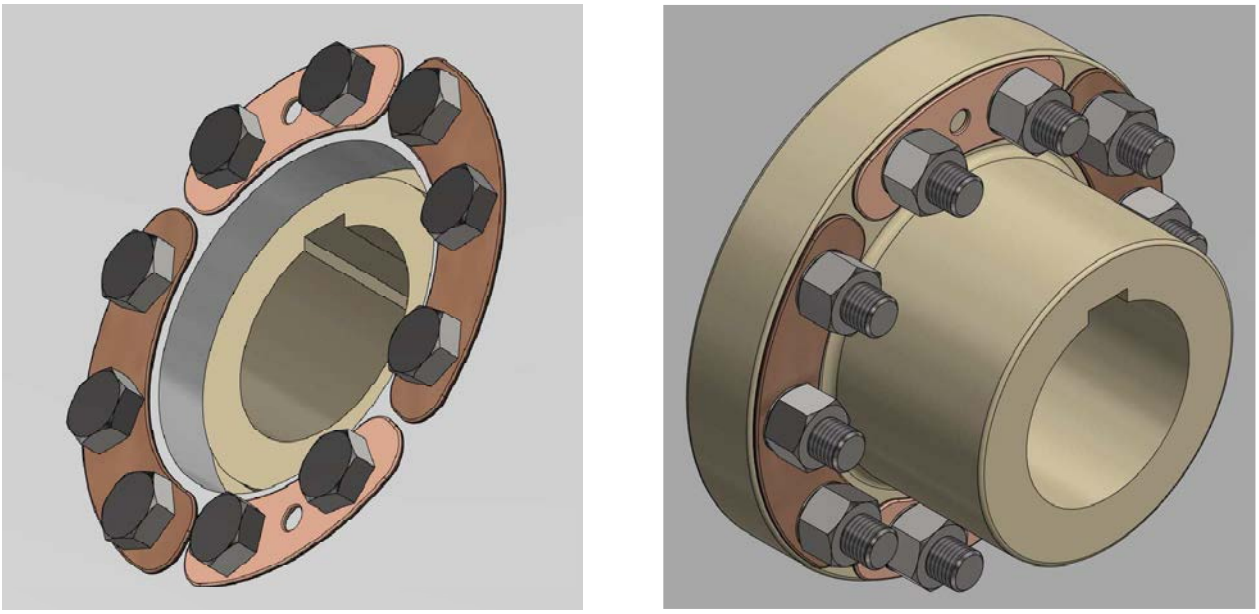


Figure 2.17: special coating protective plates

2.6.2 Blade installation and pitch angle setting

For the installation of the blades please follow the instructions described below and referring to figure 2.18.

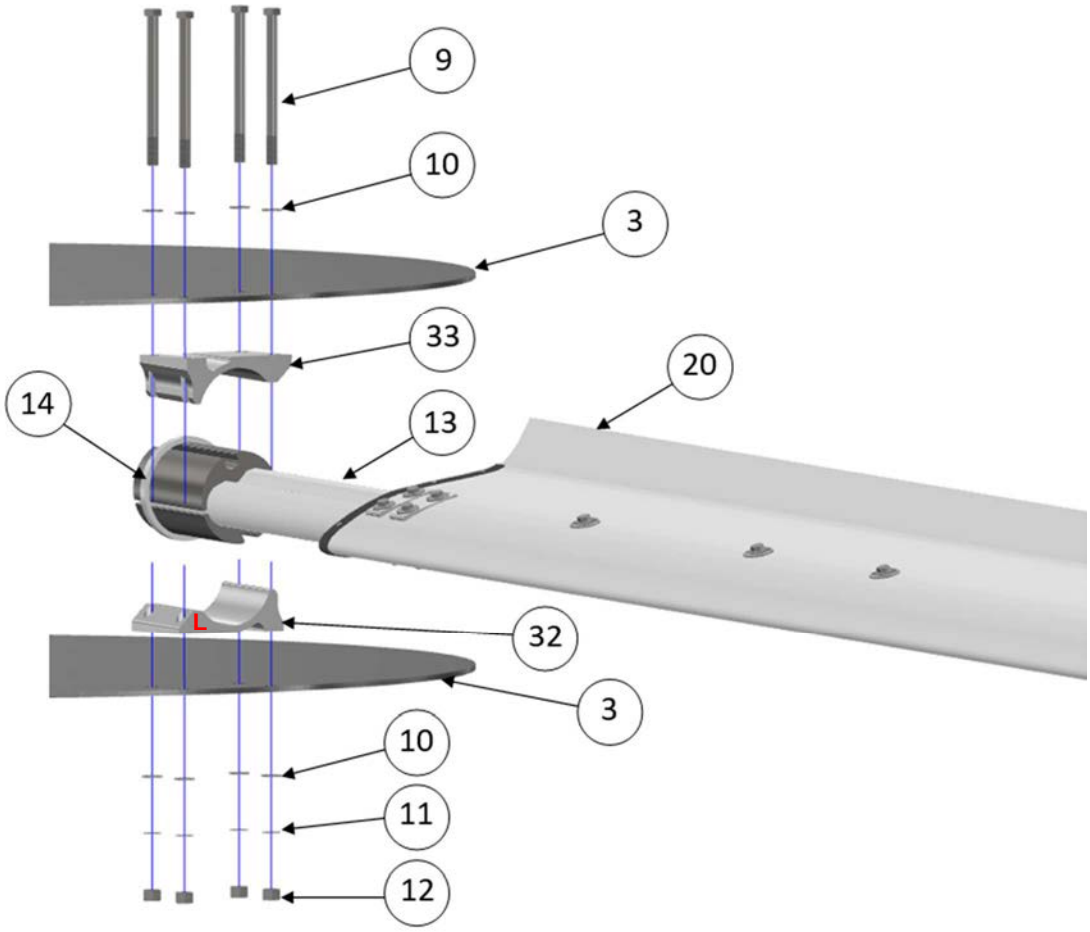


Figure 2.18a: blade installation on hub: exploded view

Figure 2.18b: blade installation on hub: mounted

1. Remove, for every blade, all bolts [9] of tightening blocks [4], then place the blocks on blade shaft [13] paying attention to prevent the retaining ring [14] from jamming between the blocks.

   WARNING: in case the block [4] is equipped with a precone, make sure that both parts are correctly positioned: the two parts need to have the same inclination (figure 2.18c).

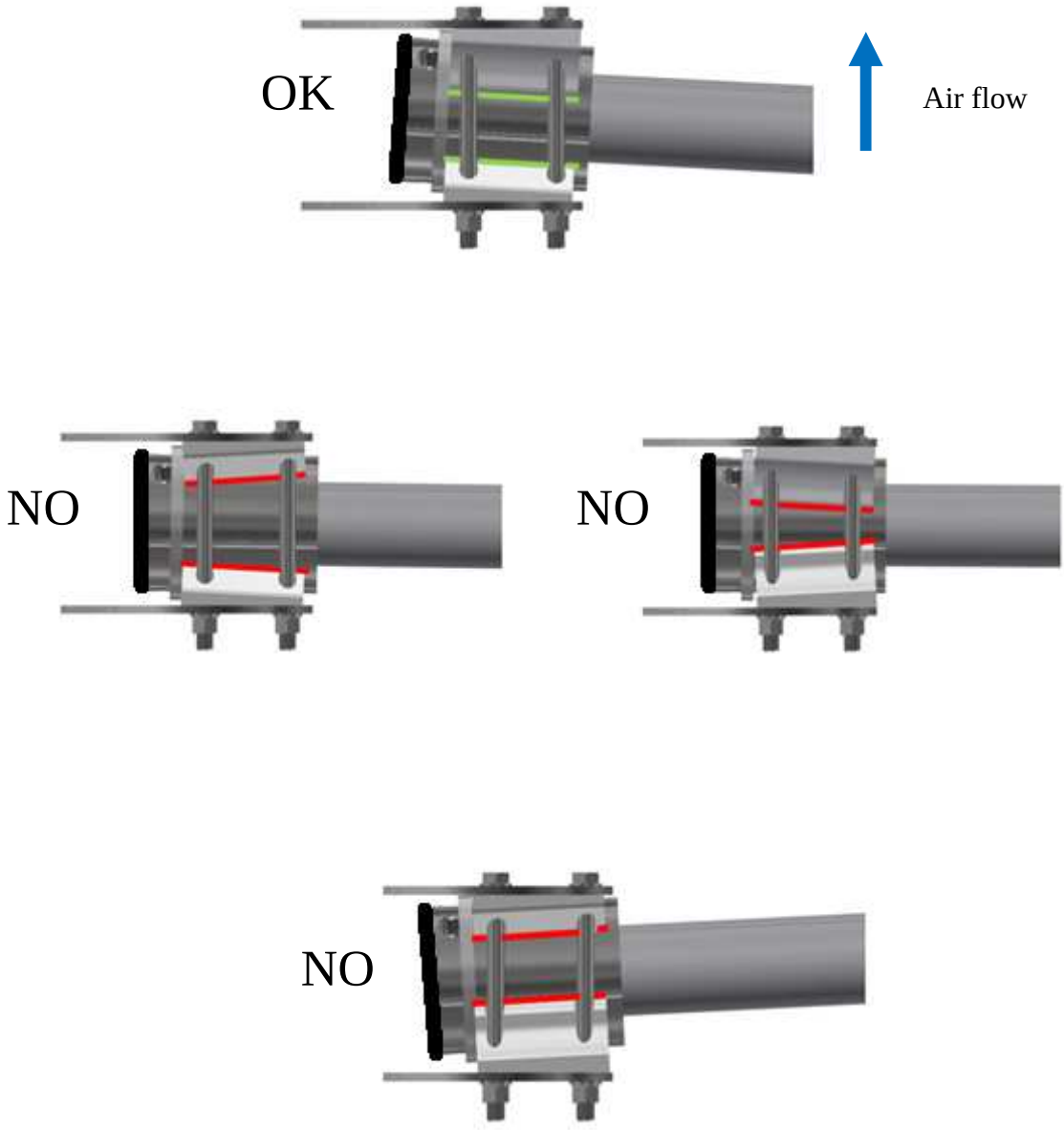


Figure 2.18c: correct position of the blocks

WARNING: make sure that the marked "L" (figure 2.18d) is correctly positioned: the marked "L" must always and only be on the bottom block [32] on left side, facing the block on the side of the blade.

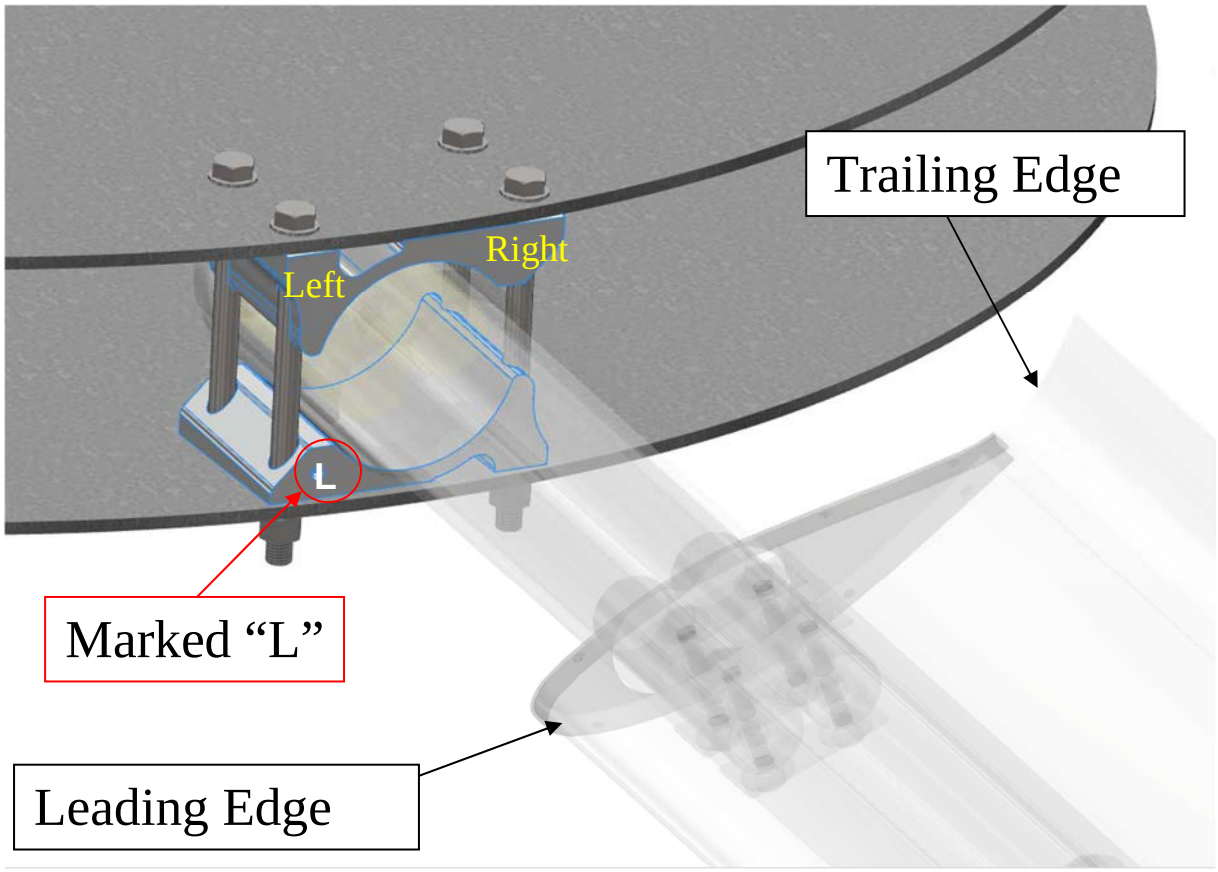


Figure 2.18d: correct position of the blocks

ATTENTION: loosen all block bolts to facilitate blade shaft insertion and avoid scratching the surface. This should also be performed if the blade needs to be fastened again. The same procedure should be performed on the two adjacent blocks to facilitate the operation.

2. Insert the block-blade group inside the hub observing the profile direction as shown in figure 2.6.
3. Bolt in the block-hub group using the bolts [9] to enable the rotation of the blades for the next locking adjustment and its movement along the axis.
4. Pull the blade outwards until the retaining ring comes into contact with the block.

   ATTENTION: during installation and when you bolt in bolts for fastening the blade to the hub keep the blades raised (so that they are not subjected to gravity).
5. Use the digital protractor (figure 2.4) to set pitch angle.

   Place the digital protractor on the upper blade side 5 mm away from the tip cap perpendicular to blade axis as shown in figure 2.19.

Figure 2.19: positioning of protractor on blade

In case the profile is very wide and the protractor length is insufficient, rest a rigid bar of adequate length onto the blade so both profile points (leading edge and trailing edge) are reached and rest the digital protractor on top. See figure 2.20 for correct measuring position.

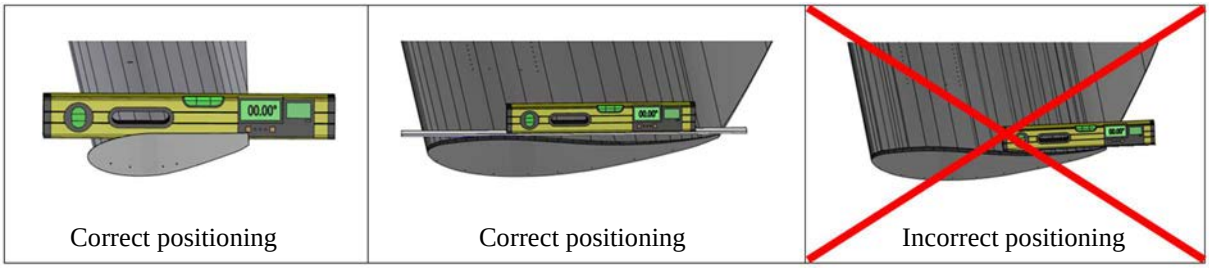


Figure 2.20: digital protractor correct positioning

Rotate the blades around their own axis until the pitch angle is reached (A°), angle described by the identification label. Maximum allowed tolerance is ±0.5°.

6. Check that there is no backlash between the assembled parts, especially between the retaining ring [14] and the blocks [4].

   Tighten the bolts [9] (gradually using the torque/dynamometric wrench), following the cross-order shown in figure 2.21, while maintaining the upper block parallel to the bottom one, avoiding to have an imbalance between the two blocks.

   Bolt tightening torques depend on utility class: use torque values from table 2.5.

   ATTENTION: during blade installation, keep the blades elevated when tightening bolts (so blade position is not affected by its own weight).

   ATTENTION: the stainless steel bolts (class A2/A4) must be tightened without using automatic/high speed screwdrivers in order to avoid galling.

   NOTE: hub type is indicated on the identification label while bolt class is identified by bolt head.

   WARNING: as reported in item 4 above, the bolts of the block must be fastened to the torque by keeping the sealing ring on the block, to avoid pressure on inappropriate areas on the rod and affect its structural integrity.

   For this reason, if the blade is mounted with the sealing ring not on the block, the guarantee shall expire.

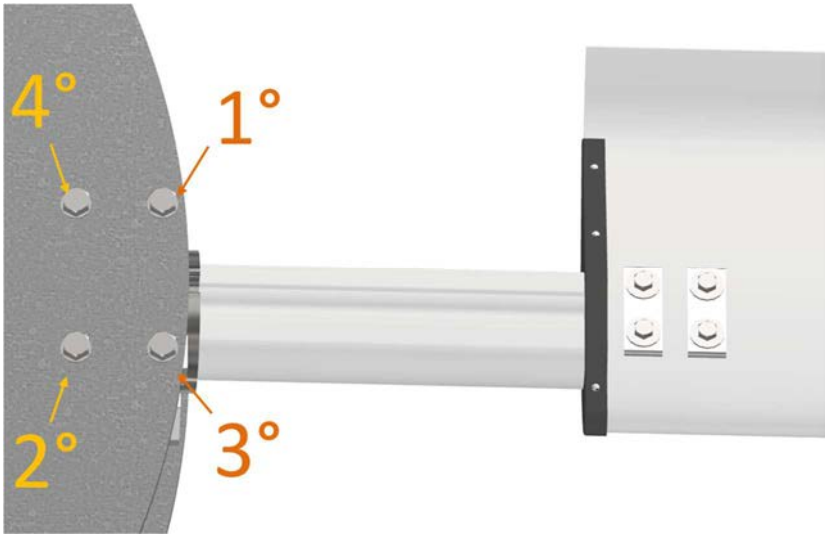


Figure 2.21: Bolt tightening order [9]

Bolt Type	Tightening Torque			
	Class 8.8 - **dry**		A2/A4-80 - **lubricated**	
	N m	Lb ft	N m	Lb ft
M20	275	203	275	203

Table 2.5: guided bolt tightening torque [9]

ATTENTION: stainless steel bolts (A2/A4-70) apply lubricant.

ATTENTION: after 50-75 hours of rotor operation, check bolt torque values on the blades [9].

Repeat above described operations for each blade. Before initiating new blade pitch adjustment, rotate the fan until the new blade reaches previous blade coupling adjustment position. By doing so, possible small variations due to eventual rotation axis verticality imperfections are compensated.

ATTENTION: if the cover plug [31] has been supplied, install it; if it is already installed, make sure it is positioned correctly and forced in its housing (see figure 2.22).

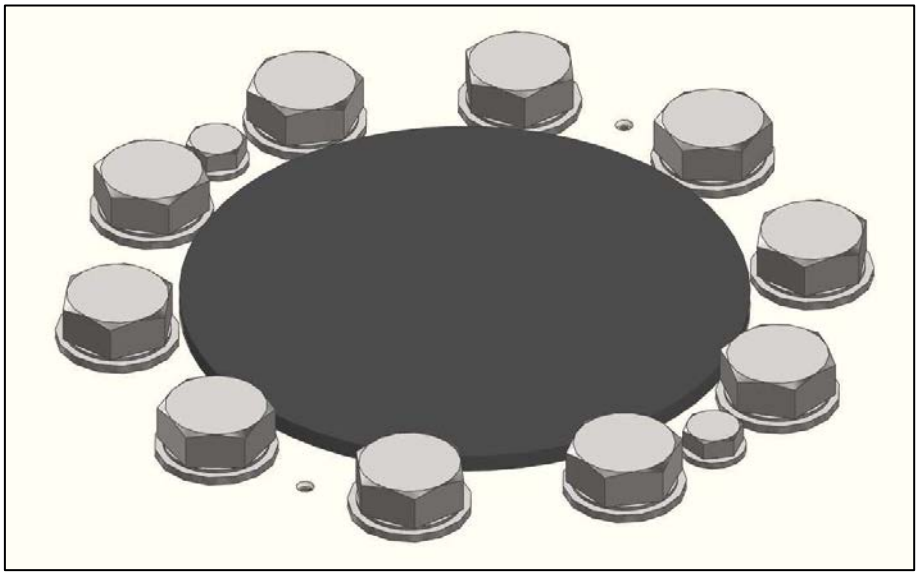


Figure 2.22: cover plug

ATTENTION: in case of a multiple fan system, before proceeding with pitch angle adjustment, angle described by the identification label placed on all blades, adjust the angle for one fan and follow chapter 3 instructions.

Chapter 3

3 Start-up instructions

3.1 Operations implemented before start-up

1. Before operating the fan, make sure that all components are well fixed and that there is no wobble between blade shaft and hub, otherwise check the torque value applied at the bolts.
2. Turn the fan manually for at least one turn to make sure that the fan does not interfere with the surrounding structure.
3. Check that the distance δ (distance between the fixed blade and the closest obstacle) matches the following equation:

$$\delta \geq 200mm + X$$

   where X (deflexion) is a value given in fan data sheet.

   NOTE: $250mm$ for diameter > 34ft.
4. Turn the fan to check that the gap between blade tip and fan ring is included in design ratio x/D, where x is the distance between blade tip and fan ring and D is fan diameter. The distance between blade tip and fan ring must be measured along blade axis.

   ATTENTION: all operations on the screw [15] of retaining ring are prohibited, any unauthorized modification on the screw [15] and on the retaining ring [14] will void the warranty.

   If needed to vary the diameter of the fan please contact COFIMCO.
5. Check if blade axis respect angle pitch defined by the datasheet (see paragraph 2.4).
6. In case a painted surface is damaged (during transport, set-up, pitch angle adjustment, bolt constant tightening or other reasons), carry out paint repair operations as soon as possible (see touch up procedure applicable to the contract) In case above mentioned procedure is necessary but is not carried out, the warranty is declared void.

7. assess whether such damage may or may not affect blade structural safety or aerodynamic performance.
8. Remove all equipment from fan surrounding area.
9. Power on the fan for a few seconds and then shut it off. During the shut off phase check if blade rotation is correct as described in paragraph 2.5.

3.2 Operations implemented after start-up

1. Check motor HP consumption. If excessive, gradually reduce blade pitch angle until desired HP consumption is reached. If motor HP consumption is lower than provided, increase blade pitch angle until desired HP consumption is reached. Adjust the pitch angle on all system fans.

   NOTE: a few angle degree deviation from design angle is considered normal.

   ATTENTION: power absorption is inversely proportional to ambient air temperature.
2. Check that fan vibration level, measured on the fan bearing block, in positions indicated by figure 3.1, do not exceed amplitudes of 7mm/s RMS (overall).

   ATTENTION: for vibrations contained in 7-12 mm/s RMS (overall) range, the fan may remain operational for the time necessary for problem solving.

   ATTENTION: this vibration limit is valid for translational vibrations, i.e. constant direction vibrations with reference to the fan-motor-transmission reference axis (in case of excessive rotational or rocking vibrations, contact COFIMCO).

   ATTENTION: for whole structure admissible vibration level refer to structure supplier. Refer to international standards such as ISO-10816-1 directive.

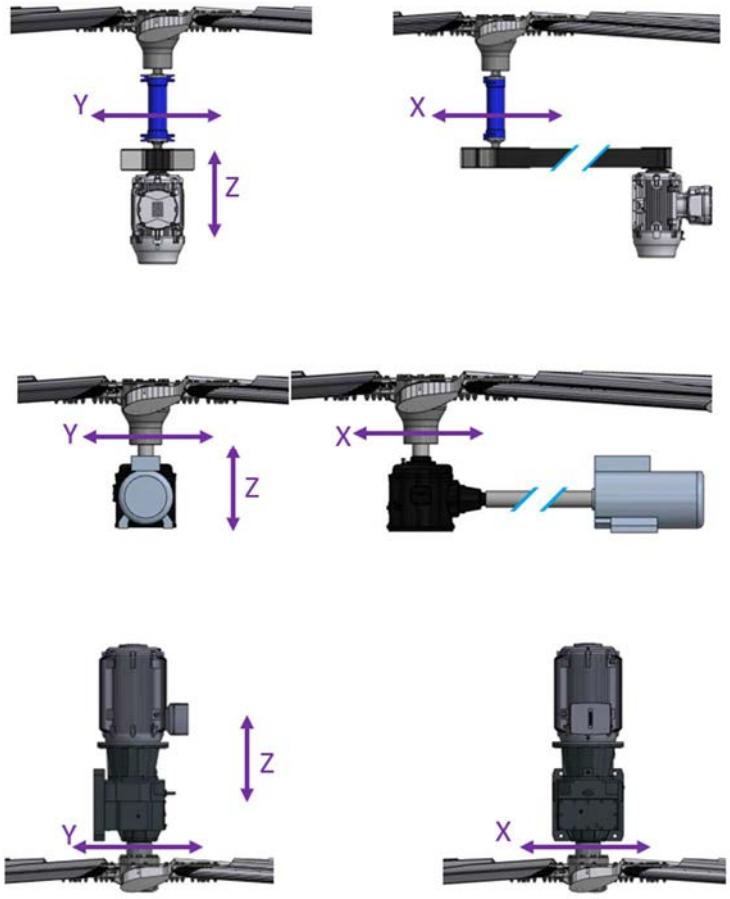


Figure 3.1: vibration control positioning schematics

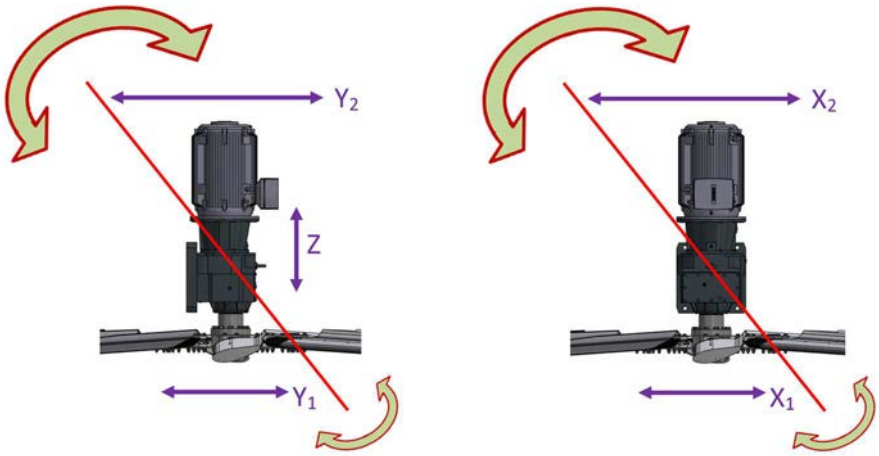


Figure 3.2: rotational vibrations

3. After 50-75 hours of rotor operation, check bolt torque values on the blades [9].

   We recommend you check the tightening torque of the bolts M14 (see table 3.1) that couple the FRP profile to FRP shaft. There are 7 or 10 bolts on each side of the profile (in case of high speed configurations), see figure 3.3.

Type of Bolt	Tightening Torque	
	N m	Lb ft
M14 Class 10.9	105	77
M14 A4-80	105	77

Table 3.1: tightening torque of blade-shaft bolts

NOTE: if the tightening torque of blade bolts is slightly below the nominal value, this is absolutely normal due to specific creep of composite material.

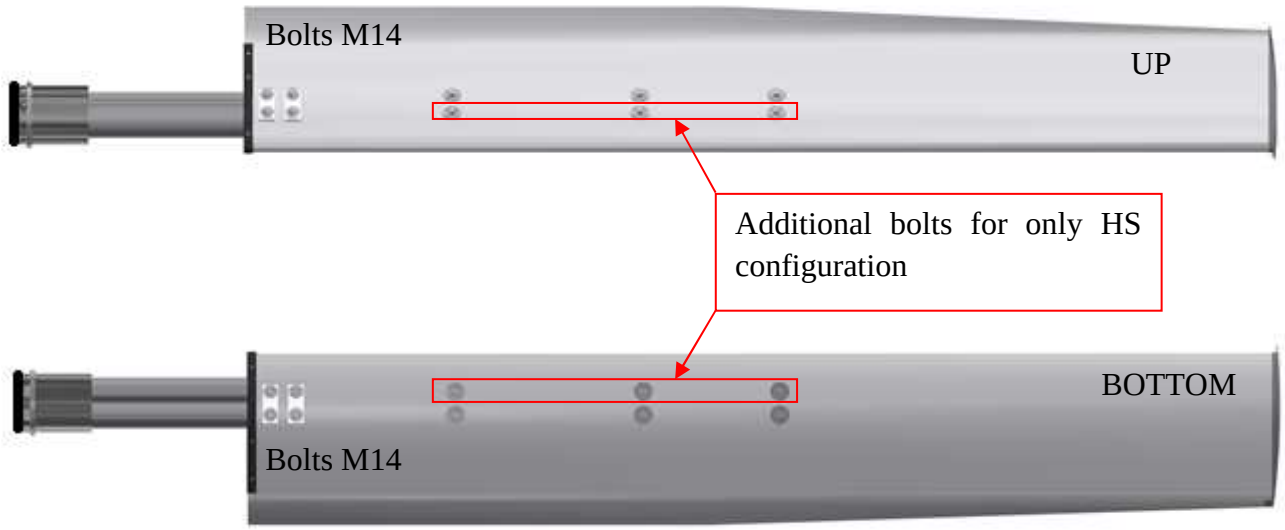


Figure 3.3: blade bolts to be checked

3.3 Profile exterior appearance

ATTENTION: the fiberglass reinforced profiles (FRP) used in COFIMCO blades are obtained through pultrusion procedures.
Because of the intrinsic process nature, during production small formations of reinforcement layer may form (figure 3.4) filled with resin (resin rich area). The same resin, once hardened, becomes fragile causing superficial irregularities (mostly on the leading edge) as shown in figures 3.5 and 3.6 even on blades that have never been operational. Above mentioned irregularities are not considered defects and, heaving only an aesthetic value, do not compromise in any way blade structural characteristics. In fact, these irregularities are analyzed in the supply chapter and are subjected to acceptance standards defined during design phases.

The "resin rich" may be observed rather a long time after production (for example after transport) and in some cases after a few operation hours.

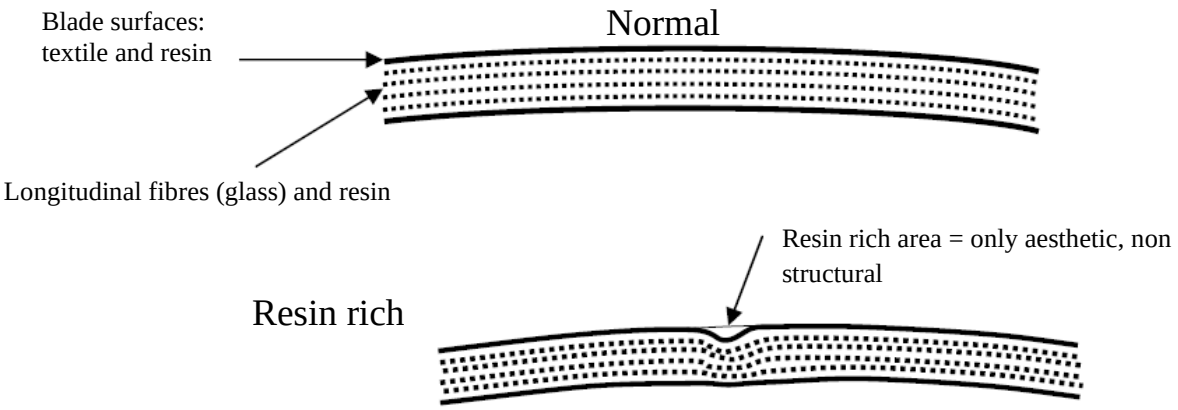


Figure 3.4: resin rich area

Figure 3.5: resin rich area (real section)

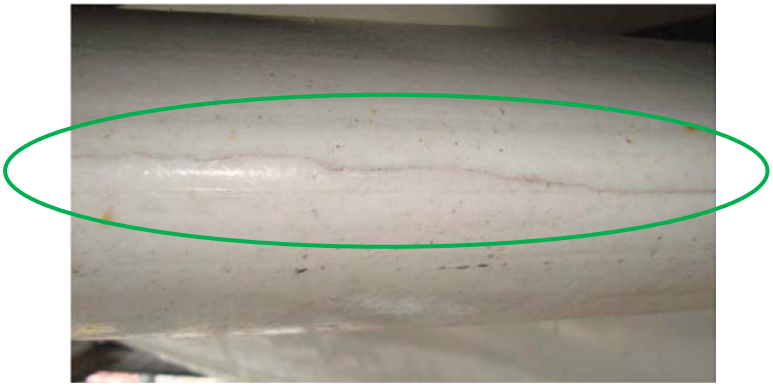


Figure 3.6: resin rich

NOTE: The reinforced fiberglass (FRP) is sensitive to UV rays, causing a profile progressive discoloration with the passing of time (until it stabilizes), it does not induce blade mechanical property variation and is considered normal.

Chapter 4

Maintenance Preventive Measures

4.1 Maintenance and operation

A. Check periodically fan general condition. The inspection interval depends on the fan's operation conditions. In normal conditions, the inspection is recommended to be conducted once every 6 months. During these inspections check:

   - bolt tightness;
   - possible corrosion;
   - blade coupling and profile general status;

   If necessary, clean blades to avoid dirt accumulation that could induce improper operation.

   ATTENTION: when cleaning the blades do not use high pressure jets in order to avoid painted and/or fiberglass part damage.

   NOTE: due to blade FPR component manufacturing process, surface imperfections may be contained in the same component but they do not influence the blade's structural integrity. Any blade is individually controlled during assembly, transport and packaging, thus presenting a conformity warranty once the product is released.

B. Ice formation on moving fan elements must absolutely be avoided.

   Ice presence on non-operating fan blades must be removed before rotor start-up, avoiding blade damage.

   Snow accumulation on a non-operating fan must periodically be removed depending on snow accumulation abundance.

   In order to avoid constant blade snow cleaning, when fan operation is stopped for long periods of time in particularly snowing areas, rotate the blade around their shaft axis until they reach a vertical position is recommended.

   ATTENTION: before moving the blades in a vertical position check if obstacles block the blade's path.

C. In case of a two-speed motor system, before switching to the low speed, stop the motor for the time required for the fan to reach a speed lower than the operating speed, then power on the fan.

D. In case a fan is provided with two-way operation, power down the fan before changing rotation direction.

E. Inspect periodically the painted parts in order to promptly stop the beginning of any corrosion. Particularly, in cooling towers, the blade leading edge is subjected to intense wear when stainless steel is not applied; it is advised to check protection every six months. Damaged protections must immediately be reconditioned, mainly those on the leading edge of the blades.

   ATTENTION: painted parts and protective treatments are subject to wear, independent of fan operation. Inspections and possible reconditioning are, therefore, appropriate when necessary. In case a painted surface is damaged, carry out paint repair procedures as soon as possible (see contract applicable touch up procedure) in order to avoid production decline with possible rust appearance and premature deterioration of unprotected parts. Periodic inspection absence makes the paint warranty invalid.

F. In case of lack of fan operation for long time periods, start-up the equipment (once every three months) for a few minutes in order to drain possible water / condensate accumulated inside of the blades that could produce excessive corrosion of any particular components.

G. Check that fan vibration level, measured according to fan shaft bearing assembly, in positions indicated by figure 3.1, do not exceed amplitudes of 7mm/s RMS (overall). In case the limit is surpassed, shut down the fan and search for the excessive vibration cause referring to paragraph 4.3 (possible cause of vibration).

   NOTE: the vibration level is a good indicator for the system's condition, thus carrying out frequent inspections is considered appropriate. If the fan is provided with tools for rapid and automatic vibration detection, it's recommended to carry out such inspections once a month, otherwise it is advisable to conduct a vibration check every time the fan periodic inspection is carried out.

   Recording of the measurement is recommended to be carried out each time so comparison with previous readings is possible (is always performed in the same locations, which can be identified through paint signs or other). During vibration measurements, conduct the usual safety measures and in particular do not approach a running fan, but lock the fan before approaching it and the transducer (accelerometer) installation, perform the measurement from a safe position, out of reach the moving parts.

4.2 Temperature Limits

35FD G Series COFIMCO fans are designed to operate with the following temperatures:

Minimum	- 20 °C (-4 °F) with standard materials - 50 °C (-58 °F) with special materials
Maximum	+ 80 °C (+ 176 °F) operational fan + 120 °C (+ 248 °F) nonoperational fan – for short periods

Table 4.1: limit temperatures

4.3 Possible vibration causes

The cause of fan vibrations may vary. Below are listed the most common:

A. Imbalance of one or more blades: this causes vibrations in the rotor plane of rotation, with a frequency equal to the number of fan revolutions and with linear amplitude dependent on the amount of imbalance and the square of the speed of rotation.

B. Blade pitch angle is not between ±0.5° tolerance: this causes vibrations outside the plane of rotation at a frequency equal to the number of fan revolutions, and amplitude depending on the square value of the speed of rotation.

C. Blade position to obstacles (periodicals aerodynamic disturbances): this causes vibrations outside the plane of rotation, with a frequency equal to the product between the number of blades and the number of laps, the amplitude depends on aerodynamic noise extent.

D. Resonance between one possible forces acting upon the fan is one (or more) way that the fan supporting structure vibrates.

   Main vibration generating forces usually have the following frequencies:

   - fan rpm;
   - product between fan rpm and fan blade number;
   - product between fan rpm and number of structural supports able to generate aerodynamic interference (if placed symmetrical to the axis), the value of this force is inversely proportional to obstacle distance to the blades.

E. Vibrations transmitted from the structure that the fan is installed on: the frequency of such vibrations depends on the frequency of external forces and on structure natural frequencies.

F. Blade resonance with one possible forcing loads: in the vast majority of cases, the vibration is manifested outside of the plane of rotation.

G. Drive shaft misalignment: in the vast majority of cases, the vibration is manifested outside of the plane of rotation.

H. Blade and/or speed reducer mounting bolt loosening: fan behavior in these conditions is unpredictable because it depends on loosening extent and location.

I. Slow shaft bearing wear: it produces vibrations within the plane of rotation with a frequency equal to the number of fan turns.

J. The fan or support structure's nuts and bolts are loosened: in this case it's necessary to tighten bolts.

K. Blade drain slots are clogged: in this case unclogging is necessary to remove obstructions from drain slots.

L. Incorrect assembly of the hub: the hub must be installed correctly, as shown in the installation manual.

M. Incorrect assembly of the blades in the hub: the blades must be installed correctly, as shown in the installation manual.

ATTENTION: fan vibration amplitude depends on fan support stiffness. Not critical vibrations for a fan supported by a sufficiently rigid structure, are amplified and can become dangerous for the integrity of the rotor, if the fan support is too flexible. In addition, support flexibility causes a blade resonance frequency variation.

Appendix A

Hub removal

ATTENTION: Before removing the hub must make sure that the motor's power supply is disconnected and also make sure that the motor will not become operational inadvertently.

Hub removal may be carried out with the blades still attached or with detached blades.

ATTENTION: during removal, the fan must be secure in order to avoid a falling.

Hub can be removed very easy using the G hub extractor, given in figure A.1 (a), A.2 (a) and A.3 (a), not included in fan standard equipment.

NOTE: in the case of hot-mounted hub boss / flanges, the use of this extractor is not applicable.

Based on the type of hub, carry out the procedures described below:

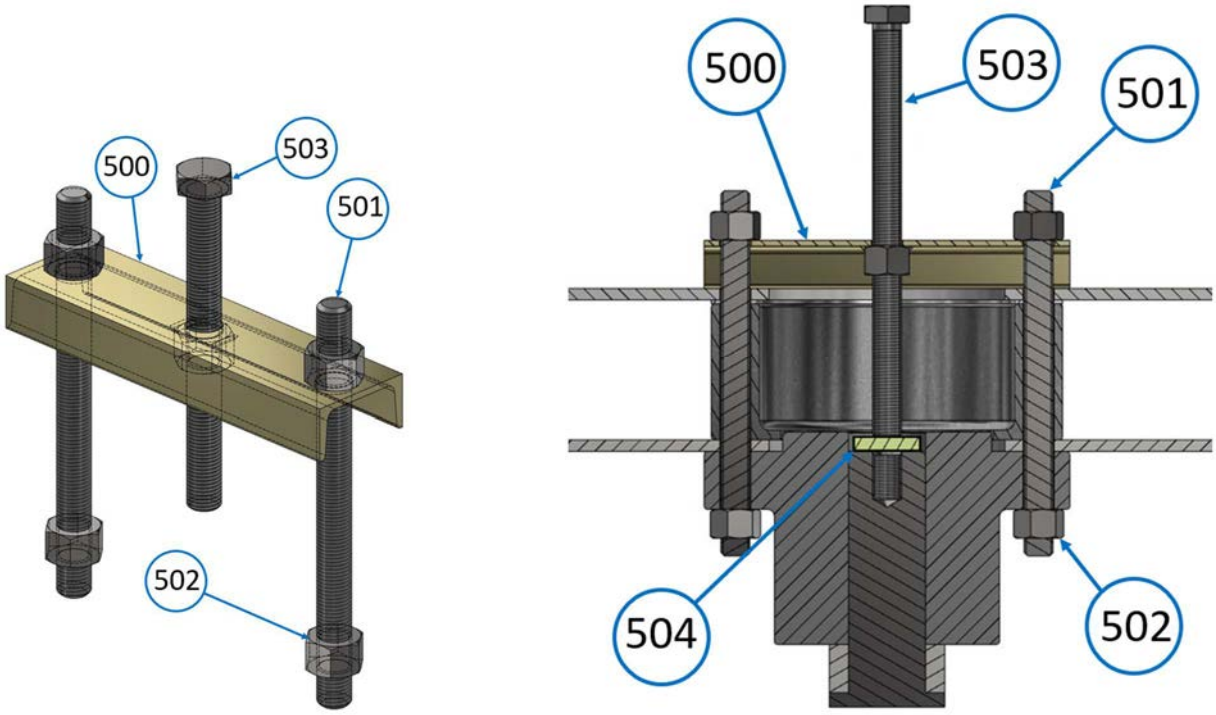
- A.1 Hub with external flange;
- A.2 Hub with external extended flange;
- A.3 Hub with internal hub boss.

A.1 Hub with external flange

Remove the bolt [25] if the cylindrical flange or the bushing (if you use it) bolts.

To remove the hub follow the procedure referring to figure A.1.

1. Remove the two opposite bolts [5] (see part list, annex C).
2. Insert a round plate [504] to prevent damages to motor shaft head. The sizes of the plate depend on the hole (it should have a diameter slightly smaller than the hole and minimum thickness of 5 mm).
3. Secure the extractor into the two free holes of the disc and tighten the bolts [501].
4. Tighten the bolt [503] until it reaches the round plate; remove the entire hub tightening the bolt [503] until the hub is completely removed from the shaft.
5. Once you have completed the extraction, remove the extractor and tighten the bolts again [5] to the correct tightening torque.



(a) extractor (b) hub removal

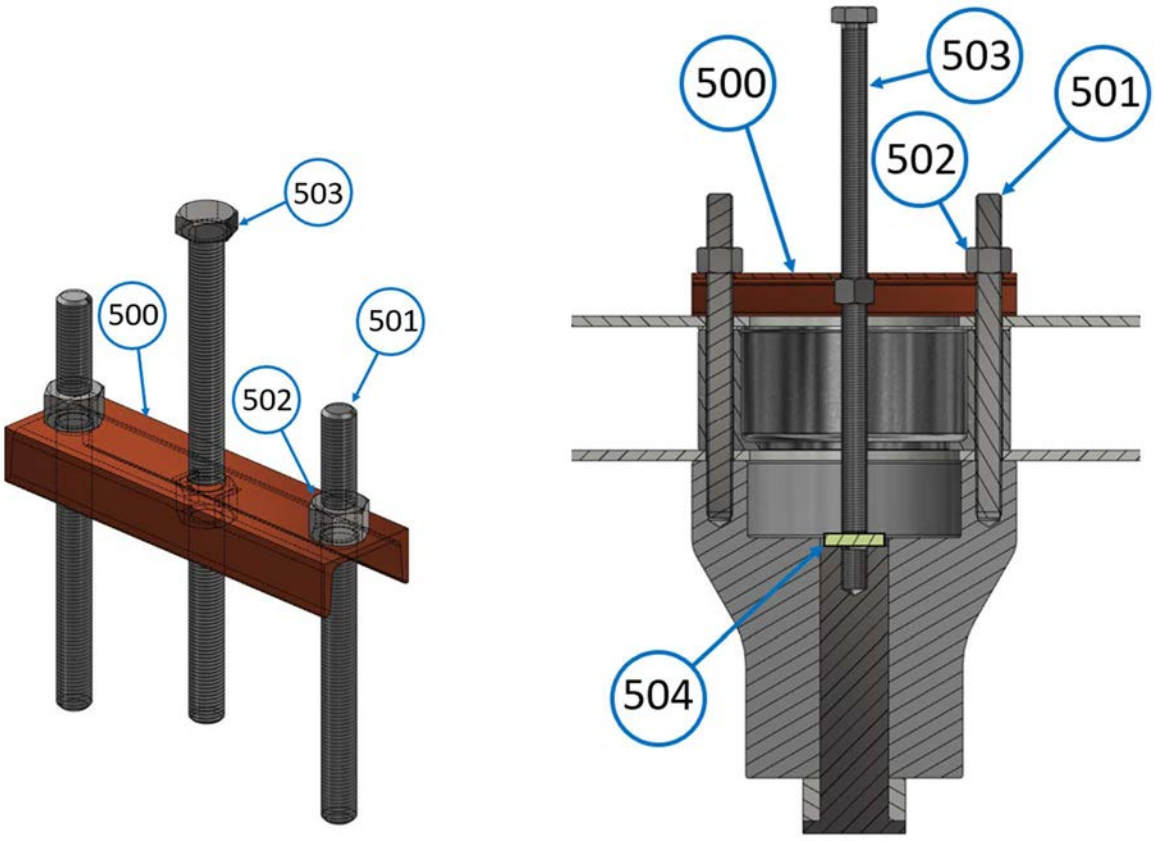
Figure A.1: diagram of hub removal with external flange

A.2 Hub with external extended flange

Remove the bolt [25] if the cylindrical flange or the bushing (if you use it) bolts.

To remove the hub follow the procedure referring to figure A.1.

1. Remove the two opposite bolts [5] (see part list, annex C).
2. Insert a round plate [504] to prevent damages to motor shaft head. The sizes of the plate depend on the hole (it should have a diameter slightly smaller than the hole and minimum thickness of 5 mm).
3. Secure the extractor into the two free holes of the disc and tighten the bolts [501].
4. Tighten the bolt [503] until it reaches the round plate; remove the entire hub tightening the bolt [503] until the hub is completely removed from the shaft.
5. Once you have completed the extraction, remove the extractor and tighten the bolts again [5] to the correct tightening torque.



(a) extractor (b) hub removal

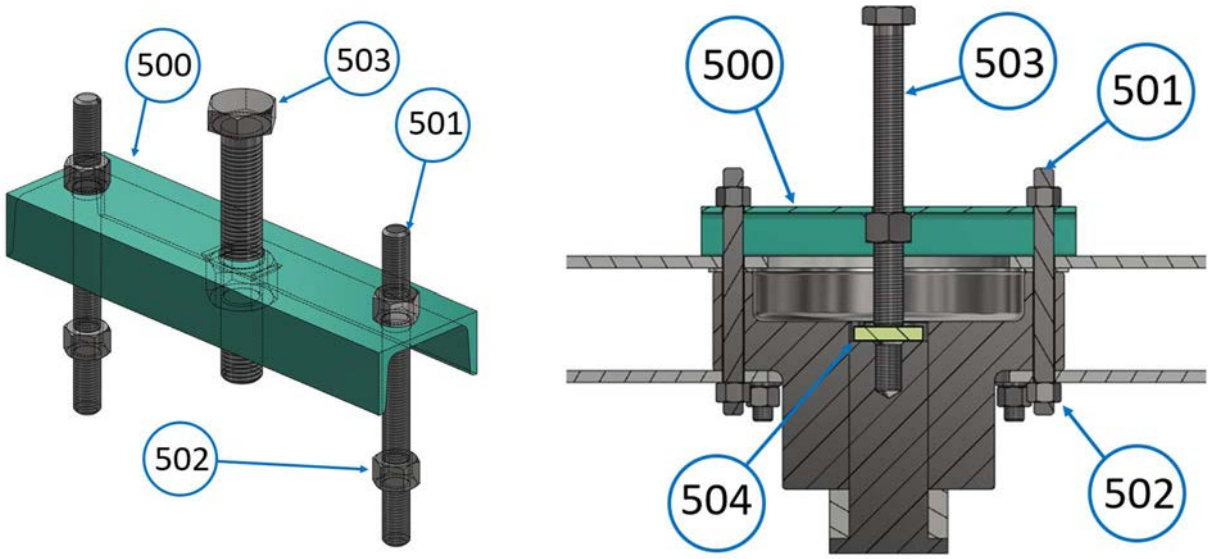
Figure A.2: diagram of hub removal with external extended flange

A.3 Hub with internal hub boss

Remove the bolt [25] if the cylindrical flange or the bushing (if you use it) bolts.

To remove the hub follow the procedure referring to figure A.1.

1. Remove the two opposite bolts [5] (see part list, annex C).
2. Insert a round plate [504] to prevent damages to motor shaft head. The sizes of the plate depend on the hole (it should have a diameter slightly smaller than the hole and minimum thickness of 5 mm).
3. Secure the extractor into the two free holes of the disc and tighten the bolts [501].
4. Tighten the bolt [503] until it reaches the round plate; remove the entire hub tightening the bolt [503] until the hub is completely removed from the shaft.
5. Once you have completed the extraction, remove the extractor and tighten the bolts again [5] to the correct tightening torque.



(a) extractor (b) hub removal

Figure A.3: diagram of hub removal with internal hub boss

Appendix B

Troubleshooting

TROUBLESHOOTING		
Problem	**Possible cause**	**Possible Solution**
Low volumetric flow rate Low power consumption	System jam.	Clean the whole system.
	Obstacles to the air flow sucked / delivered by the fan.	Check the obstacle's total effective area and fan inlet shape with regard to the original.
		Dry-cooler's required minimum free inlet area height must be equal to at least one fan diameter; this height must be larger than in the case of multiple units in a row.
	Fan static pressure higher than design one.	Increase blade pitch angle (up to 3 degrees is acceptable, over contact COFIMCO).
	Blade pitch angle decreased due to blade rotation (for example if the bolt tightening torque has not been respected)	Correct blade pitch angle and refer to the instruction manual for correct bolt tightening torque.
	Temperature of the air at the fan inlet higher than design one.	Increase blade pitch angle (up to 3 degrees is acceptable, over contact COFIMCO).
High power absorption	Temperature of the air at the fan inlet lower than design one.	Decrease blade pitch angle (up to 3 degrees is acceptable, over contact COFIMCO).
	Fan static pressure lower than design one.	Decrease blade pitch angle (up to 3 degrees is acceptable, over contact COFIMCO).

Problem	Possible cause	Possible Solution
The fan tip rubs against the fan ring	Fan and/or support structure nuts and bolts is loose.	Tighten all bolts.
	Rotor is not centered. Tip clearance to small.	Centre the rotor. Increase fan casing diameter.
Scratches or small damage	…	Contact COFIMCO
Fine cracks on blade surface	…	Contact COFIMCO
High vibration level	One or more blades are unbalanced.	Contact COFIMCO
	Blade average pitch angle not included in ± 0.5 °tolerance.	Adjust blade angle.
	Excessive blade closeness to obstacles (periodical aerodynamic disturbances).	Contact COFIMCO
	Resonance between one possible forces acting upon the fan is one (or more) way that the fan supporting structure vibrates.	Contact COFIMCO
	Vibrations transmitted from the fan support structure.	Contact COFIMCO
	Resonance of the blades with one possible forcing frequencies.	Contact COFIMCO
	Drive shaft misalignment.	Realign the shaft.
	Output shaft bearing wear.	Contact supplier.
	Fan ring not perfectly cylindrical or fan not perfectly centered.	Contact supplier.
	Fan and/or support structure nuts and bolts is loose.	Tighten bolts with the correct tightening torque.
	Blade drain slots are clogged.	Remove obstructions from drain slots.

For any problem, please contact COFIMCO specifying purchase order number indicated on the tag attached on the hub.

Appendix C

Component list

ATTENTION: the part list refers to a standard 35FD G-GR series fan, for special applications refer to the documentation supplied with the fan.

PART LIST			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	SPACER	17	WASHER (NOT SUPPLIED BY COFIMCO)
2	EXTERNAL FLANGE / EXTERNAL EXTENDED FLANGE	18	BUSHING
		19	BUSHING BOLTS
3	HUB DISC	20	BLADE PROFILE IN FRP
5	BOLT	21	WASHER
6	WASHER	23	BOLT
7	FLEXIBLE WASHER	25	BOLT (NOT SUPPLIED BY COFIMCO)
8	NUT	26	CENTERING PINS
9	BOLT	29	NUT
10	WASHER	30	WASHER
11	FLEXIBLE WASHER	31	COVER PLUG
12	NUT	32	LOWER BLOCK
13	BLADE SHAFT IN FRP	33	UPPER BLOCK
14	RETAINING RING	34	LOWER SPACER
15	BOLT	35	UPPER SPACER
16	SPACER	36	SHAFT PLUG
35FD G-GR SERIES FAN COMPONENTS			

Table C: part list (see figure C.1, C.2 and C.3)

NOTE: table C refers both to the hub with external flange/ external extended flange and internal hub boss.

C.1 Hub with external flange

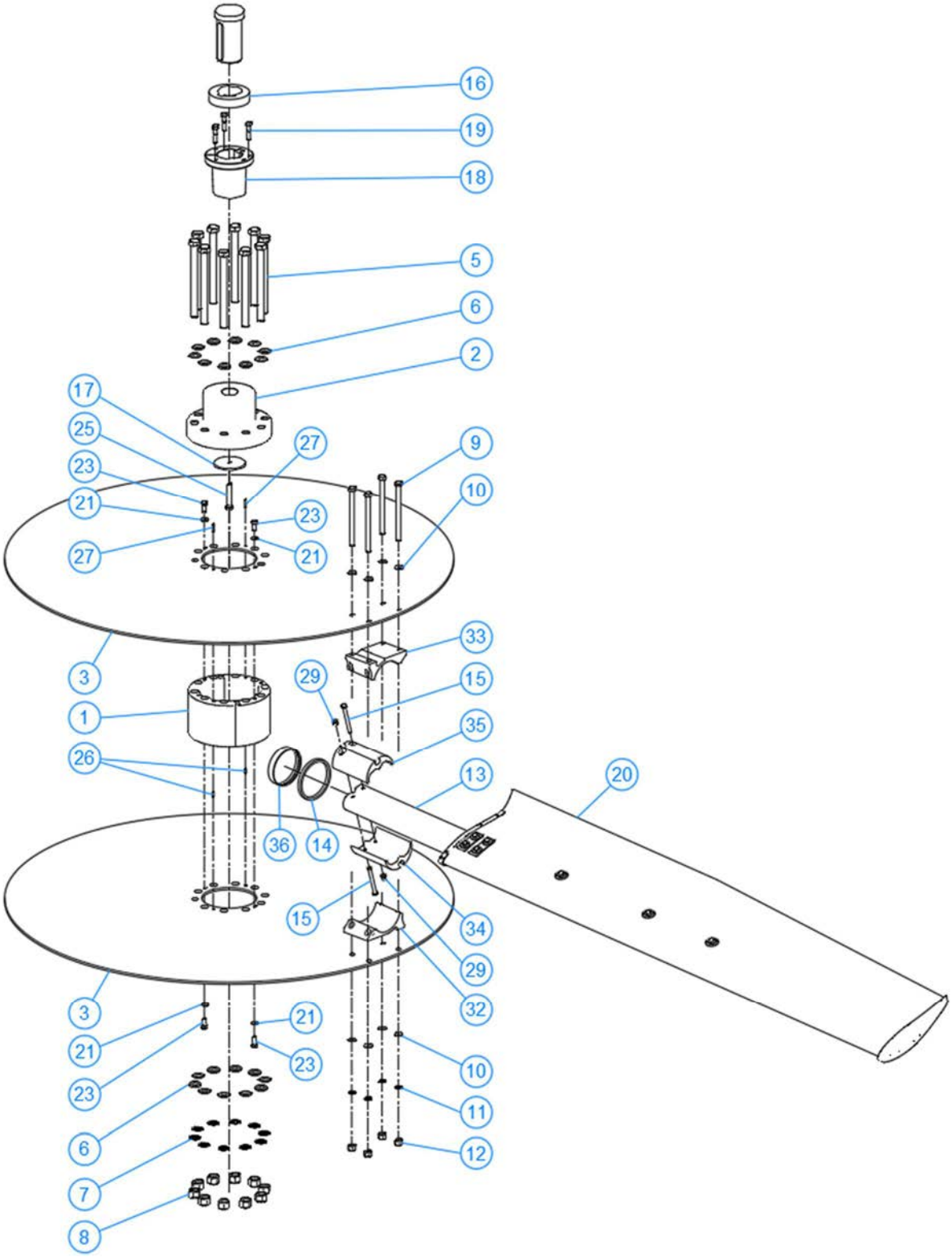


Figure C.1: exploded view of hub mounting parts with external flange

NOTE: figure C.1 refers to the configuration with cylindrical bore and also to that with bushing.

C.2 Hub with external extended flange

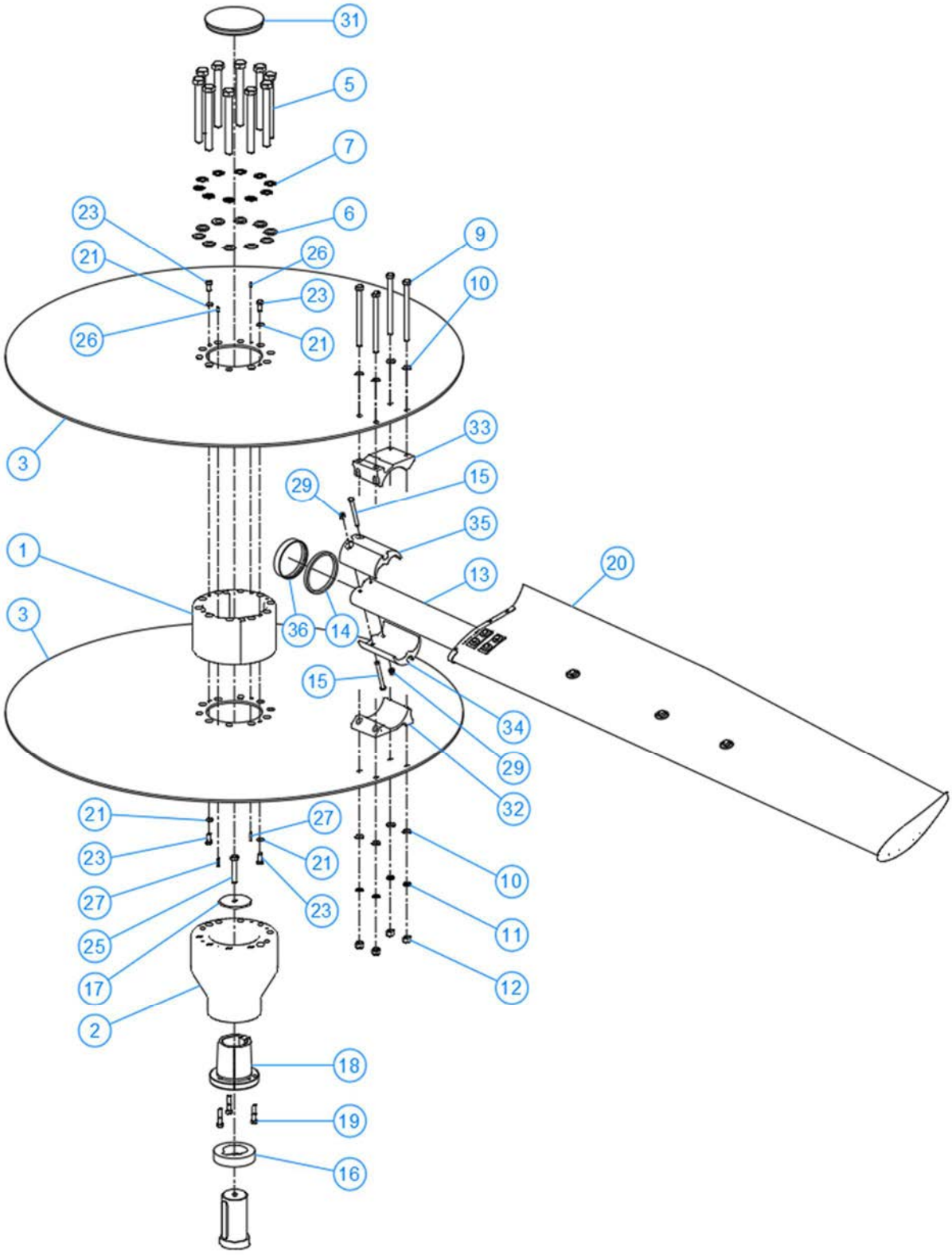


Figure C.2: exploded view of hub mounting parts with external extended flange

NOTE: figure C.2 refers to the configuration with cylindrical bore and also to that with bushing.

C.3 Hub with internal hub boss

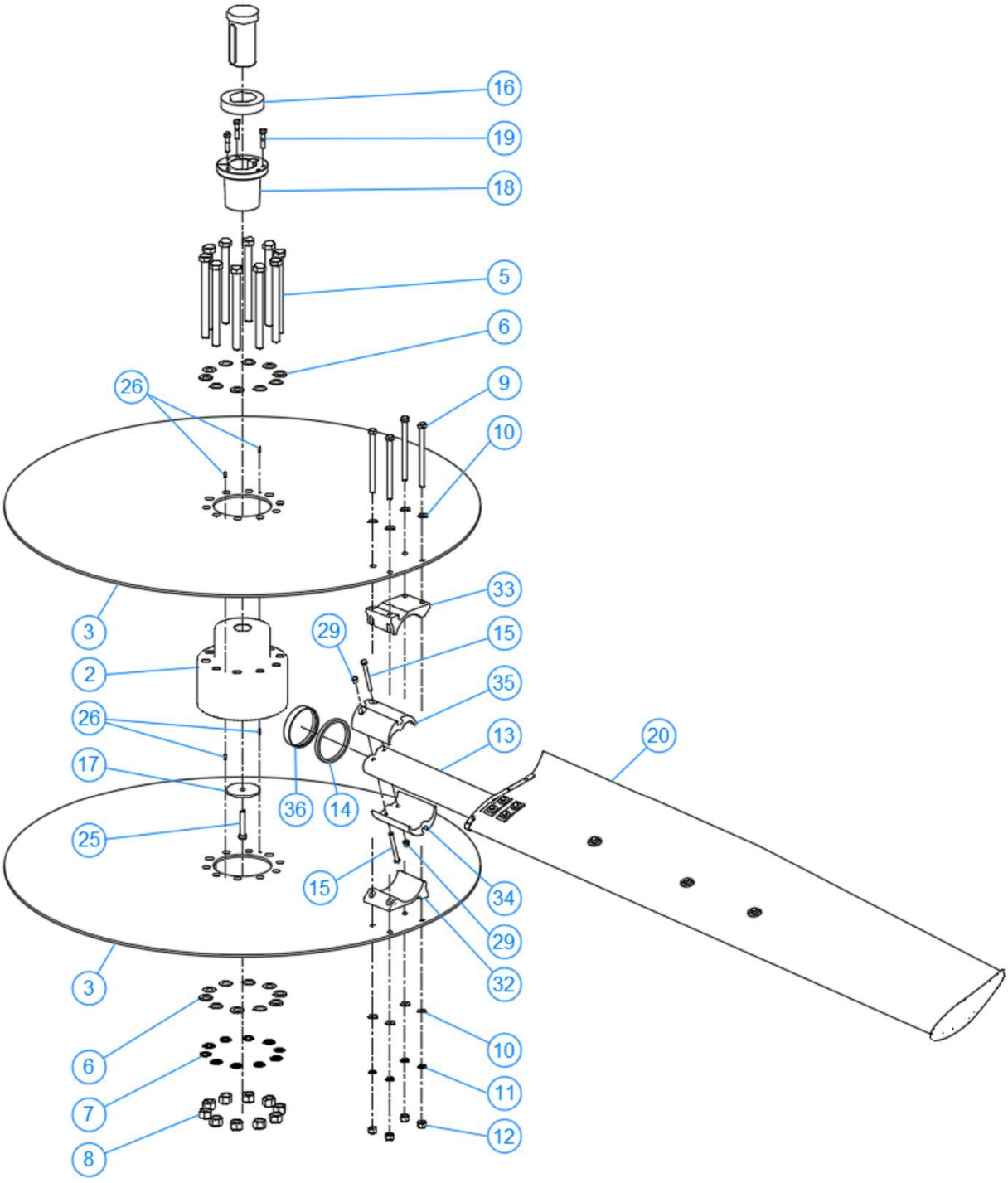


Figure C.3: exploded view of hub mounting parts with internal hub boss

NOTE: figure C.3 refers to the configuration with cylindrical bore and also to that with bushing.

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