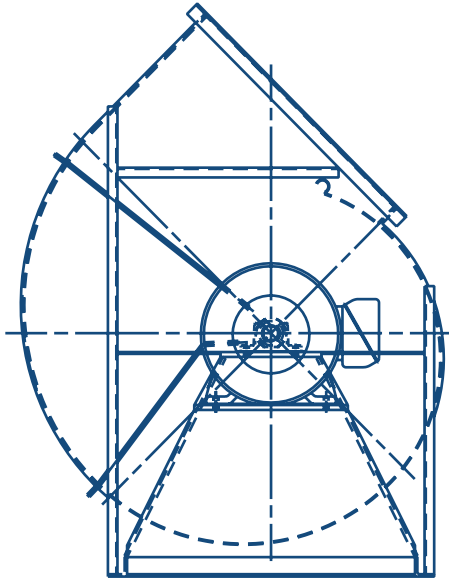
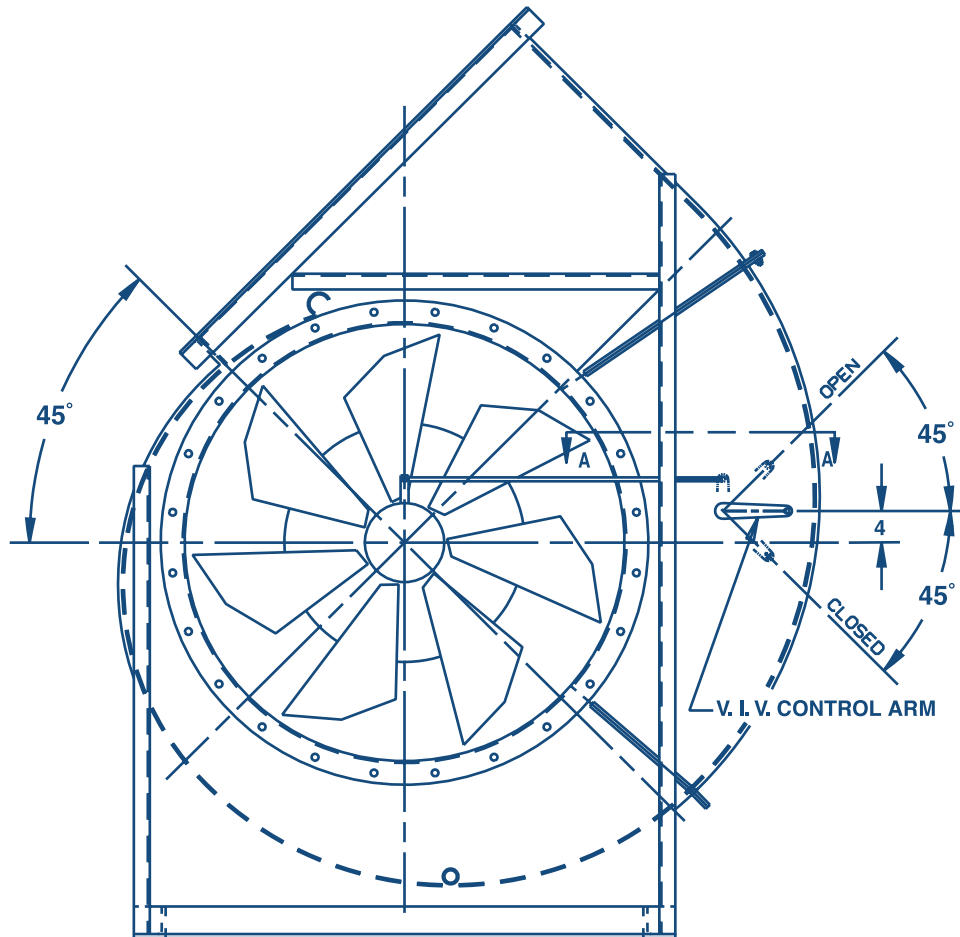


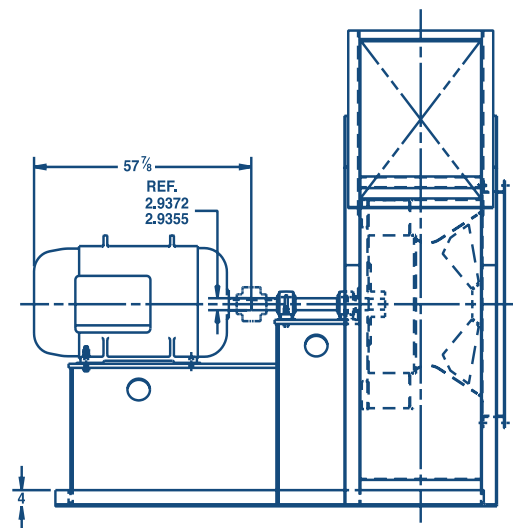


HEAVY DUTY FAN EQUIPMENT OPERATION MANUAL

Fan Serial No _____



**NORTHERN
BLOWER®**



NB Publication: 01665

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Warranty

Northern Blower Inc. (the "Seller") warrants products of its manufacture (the "product", "equipment" or "fan") to be free of defects in material and workmanship if properly installed, and cared for, and operated under normal conditions, and with competent supervision, all in accordance with the Seller's Operation Manual. If any questions exist as to whether the proposed operation of the Seller's equipment is within "normal conditions" for such equipment, details of such proposed operation should be provided to the Seller at its Winnipeg factory. The Seller will review the proposed operation of the equipment (at a fee) and advise if the proposed operation is acceptable.

(1) The Seller's obligation under this warranty is limited to the repair or replacement, at its option at its Winnipeg factory, of any defective part or parts which shall within one (1) year after shipment thereof to the original Customer (the "Customer"), be returned to its Winnipeg factory with transportation charges prepaid by the Customer and upon such repair or replacement the Seller shall have fulfilled all its obligations to the Customer. The Seller will not be liable, in any circumstances, for costs or expenses incurred by the Customer or any person claiming through the Customer in the removal or replacement of equipment alleged to be defective. Except as specifically provided herein, the Seller will not be liable, in any circumstances, for any loss or damage of whatever nature or kind (including, without limiting the generality of the foregoing, direct, indirect, incidental or consequential loss or damage or damage resulting from business interruption) should the equipment be so defective as to preclude the remedy of warranted defects by repair or replacement. In such event, the Customer's sole and exclusive remedy shall be the refund of the purchase price paid by the Customer for all the defective equipment.

(2) The Seller shall not be liable for the repair or replacement of any such defective part or parts, or for loss, damage, or any expense of repairs when any adjustment, alteration or repair shall have been made or attempted outside of its factory, except if such adjustment, alteration or repair outside its factory is made or attempted after the Seller's written consent is first obtained.

(3) The Seller shall not be liable for any corrosion or fouling caused by any foreign substance deposited in or on the equipment.

(4) Because the Seller is unaware of any forms of construction, materials, alloys or coatings which will successfully resist all abrasion, erosion, corrosion, or deterioration from excessive heat, the Seller's warranty does not apply when any of its products or equipment are subjected to conditions which cause such abrasion, erosion, corrosion or deterioration from excessive heat or any damages similar or related thereto.

(5) The performance of the Seller's fan equipment outside of the laboratory may vary widely and differ from the performance specifications contained in its sales literature. Therefore, the Seller cannot and does not guarantee or warrant the performance of its fan equipment at the Customer's location.

(6) ALL WARRANTIES OF THE SELLER, EXPRESS OR IMPLIED, WITH RESPECT TO MOTORS, SWITCHES, CONTROLS OR OTHER ACCESSORIES NOT MANUFACTURED BY THE SELLER, INCLUDING WARRANTIES OF MERCHANTABILITY, QUALITY OR FITNESS FOR ANY PARTICULAR PURPOSE, ARE HEREBY EXCLUDED.

(7) The Seller shall have no liability under the terms of this Warranty or otherwise where the Customer undertakes the responsibility of mounting the fan wheel directly to the motor or turbine shafts without the Seller having inspected and tested the assembled unit (at a fee) before the fan is operated in any fashion. If the Seller does not inspect and test the assembled unit within ten (10) days of being requested to do so by the Customer and receipt of payment of the aforementioned fee, the Seller shall be deemed to have waived its requirement to inspect and test the assembled unit.

(8) The Seller shall have no liability under the terms of this warranty or otherwise until the Customer has made full payment to the Seller for the product or equipment to which this warranty is to apply.

(9) NO WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY, QUALITY OR FITNESS FOR ANY PARTICULAR PURPOSE, ARE MADE BY THE SELLER EXCEPT AS EXPRESSLY PROVIDED HEREIN.

(10) The terms of this warranty may not be modified except by written agreement signed by the General Manager or Sales Manager of the Seller. The Seller's failure to object to provisions contained in the Customer's purchase orders or other communications shall not be deemed waiver of the terms and conditions hereof nor acceptance of such provisions. No representations or warranties other than those contained herein shall be binding upon the Seller unless made in writing and signed by the General Manager or General Sales Manager of the Seller. Without restricting the generality of the foregoing, agents and sales representatives of the Seller do not have authority to modify the terms of this Warranty or make representations or warranties other than those contained herein.

NORTHERN BLOWER INC.

OPERATION MANUAL - FAN EQUIPMENT

FAN EQUIPMENT CAN BECOME A SOURCE OF INJURY AND DEATH IF NOT PROPERLY INSTALLED, OPERATED OR MAINTAINED. Do not exceed the maximum operating temperature or speed limits for which the fan equipment was designed. Limits for some lines of fan equipment are given in Northern Blower Inc. ("Northern") catalogues. Limits for non-catalogued lines of fan equipment should be obtained in writing from the Northern Winnipeg factory and not otherwise. Do not rely on limits obtained in any other manner.

THE RESPONSIBILITY FOR PROVIDING SAFETY ACCESSORIES FOR FAN EQUIPMENT SUPPLIED BY NORTHERN IS THAT OF THE USER OF THE FAN EQUIPMENT. Northern sells its fan equipment with or without safety accessories, and accordingly, it can supply standard safety accessories upon receipt of an order. Ensure that all necessary safety accessories have been installed before operation or the fan equipment.

The user should make all personnel who operate or maintain the fan equipment aware of all possible hazards.

The warning notice set out below should be affixed upon the fan equipment.

NORTHERN BLOWER INC.

WARNING

This fan has rotating parts and may be hot. Keep body, hands and foreign objects away from inlet and outlet. Do not touch fan or motor during operation.

Operate, install and maintain only in strict accordance with safety practices and instructions in manufacturer's Operation Manual. Do not exceed the maximum operating temperature, speed, or vibration level identified in the manufacturer's catalogues and Operation Manual. Untrained personnel should never operate, install, adjust or maintain fan or motor.

ADDITIONAL SAFETY ACCESSORIES FOR THE FAN EQUIPMENT ARE AVAILABLE FROM THE MANUFACTURER. THE RESPONSIBILITY FOR PROVIDING SUCH ADDITIONAL SAFETY ACCESSORIES IS THAT OF THE USER OF THE FAN EQUIPMENT. CONSULT THE MANUFACTURER'S OPERATION MANUAL FOR GUIDANCE.

Before starting maintenance work, lock disconnect switch in the off position, de-energize and disconnect all power sources to the motor and to accessory devices and secure fan impeller. Cleanout doors must be secure during operation. Unsecured cleanout doors may shoot open during operation because of pressure build up inside the fan.

Do not start-up when fan impeller is rotating backwards.

FAILURE TO FOLLOW MANUFACTURER'S INSTRUCTIONS AS TO OPERATION, INSTALLATION, ADJUSTMENT, MAINTENANCE, SAFETY EQUIPMENT OR APPROPRIATE OPERATING CONDITIONS COULD RESULT IN DAMAGE TO THIS EQUIPMENT, DAMAGE TO OTHER EQUIPMENT, PERSONAL INJURY OR DEATH.

Should the warning notice not be affixed to the fan equipment purchased, Northern will supply such a warning notice upon request made to its head office.

The user of the fan equipment, in making its determination as to the appropriate safety accessories to be installed and any additional warning notices to be affixed upon the fan equipment, should consider, (1) the location of the installation of the fan equipment, (2) the accessibility of employees and other persons to the fan equipment, (3) any adjacent equipment, (4)

applicable building codes, and (5) applicable health and safety legislation.

Users and installers of the fan equipment should read "RECOMMENDED SAFETY PRACTICES FOR AIR MOVING DEVICES" which is published by the Air Movement and Control Association, 30 West University Drive, Arlington Heights, Illinois, 60004.

INSTALLATION, OPERATION & MAINTENANCE

INTRODUCTION

Northern Blower Inc. designs and manufactures equipment for specific purpose specified. The receipt, handling, installation and maintenance of such equipment is the responsibility of the purchaser. It is recommended that the installation and start-up of the equipment be supervised or checked by personnel experienced in such work and equipment. Personnel trained in erection and field service are available at Northern Blower Inc., and arrangements for such service can be made through your local representative or at the company's headquarters office. Much of the equipment is manufactured to meet specific applications and is necessarily of special design. These instructions are intended to supplement good erection techniques and are not to be considered as covering all possible conditions, because, of necessity, these instructions are general in nature. Pertinent data and information for the equipment purchased is shown on the drawing which is furnished. Special features of construction are covered by special instructions. Before starting to assemble or install the equipment, this drawing should be studied carefully.

SHIPMENT & RECEIVING

Northern Blower Inc. has thoroughly inspected the equipment at its factory and prepared same for shipment in accordance with the uniform freight classification followed by all carriers. It should be in perfect condition when received, unless damaged in transit. Upon acceptance by the Carrier, as evidenced by a signed Bill of Lading, the Carrier accepts responsibility for all damage of shortages, whether concealed or evident. Claims covering shortages or damage must be made to the Carrier by the Purchaser. Any shortage or damage should be noted on the delivery receipt, and inspection should be requested by the Carrier for all damage, whether evident or concealed.

HANDLING

During unloading and handling, care must be exercised to prevent damage or distortion which may make installation difficult or affect operation of the unit. The various parts are designed with sufficient strength for operating conditions, but when not unitized, may be damaged by rough handling. The rotor assembly has been designed to be supported by the shaft, and should be lifted by slings around the shaft, as close as possible to the hub on each side of the wheel. Slings should not press against the side plates of the wheel, as this may damage and distort the wheel. A spreader bar should be used. The rotor should never rest on the plates or blades, nor should the rotor be lifted by any components of the fan wheel. To do so may damage the rotor assembly, and destroy the dynamic balance that is necessary for vibration free operation. If this balance is destroyed, rebalancing of the rotor assembly will be necessary. If the wheel and shaft

have not been assembled, the fan wheel may be lifted by a timber or wrapped bar passed through the hub. The finished bore of the hub must be protected from damage. Also the finished hub and bearing surfaces of the shaft must be protected from damage.

When handling the housing and other parts of this equipment, good rigging techniques should be applied. Avoid any concentrated stresses that will cause distortion and damage. Use of spreader bars is recommended.

If the fan is to be stored before erection, it should be stored in a dry location. Bearings, shaft, and any other machined surfaces should be protected against physical damage, moisture, dust, and corrosion. If the fan must be stored outside, care must be taken to protect the equipment from the elements, particularly the bearings and the bearing journals on the shaft. Frequent inspections should be made to ascertain that protection is adequate, and equipment is not being damaged by the elements.

ERECTION INSTRUCTIONS

The dimensions and details of the fan base are shown on the customer's drawing which has been supplied. These should be studied carefully. The fan should be mounted on a rigid and substantial foundation. Reinforced poured concrete is recommended. The foundation should be at least five to six times the weight of the fan it supports. It is desirable that the bottom of the foundation be longer and wider than the top. If sides are vertical, substantial footings are desirable. When designing foundations, at least 3/4" should be allowed for grouting.

Anchor bolts of suitable size, preferably in pipe sleeves to allow for minor bolt adjustment, should be accurately located before the concrete is poured. Allow 1" to 1-1/2" extra when determining bolt length to allow for grout, leveling, washers, nuts, etc.

If fans are to be installed above the ground, the same 5 to 1 ratio applies. A rigid support should be supplied sufficient to support the equipment and absorb any vibration that might develop. If possible, installation should be on or near walls, beams or supporting columns.

SETTING THE FAN

Instructions that follow are for fans with independent bearing pedestals and split housing. This equipment is the most complicated type to install. Other types of fans will use the same basic techniques, but will not require every step listed.

The lower part of the fan housing should be installed on the foundation in the proper position. To assist in leveling and aligning, and to provide room for grout, steel shims should be installed between the frame and foundation. These shims should be large enough to support the unit and prevent slipping when bolts are tightened. Bottom part should be fastened down temporarily. Bearing pedestals should now be positioned on the foundation. Again, steel shims of sufficient size should be used between the sole plate and foundation, close to the foundation bolts and also through the center of the sole plate. Be sure to allow sufficient room for grout Bolt pedestals temporarily.

BEARINGS

Bearings should be installed following the instructions of the manufacturer. As a caution, when disassembling bearings, do not mix parts from different bearings; they are not normally interchangeable. Do not work on bearings in a dirty or dusty atmosphere. All bearing parts should be thoroughly cleaned before installation. Locate position of fixed and floating bearings from drawing. To provide for final alignment provide a full shim, 1/8 inch thick or more for each bearing. The following instructions are peculiar to each type of bearing.

RING OILED SLEEVE BEARINGS: Install base of pillow block in position on bearing pedestal. Align and level. Position bottom half of bearing in pillow block. Align with pillow block base. Oil bearing surfaces to avoid damage to the bearing when shaft is rotated. Protect the bearing surfaces from damage and cover to prevent foreign matter marring the surfaces.

SPLIT PILLOW BLOCK-ANTI FRICTION BEARINGS:

Install bottom half of pillow block on the pedestal. Align and level. Bolt down temporarily. Remember to install bearing inserts on shaft before installing rotor assembly.

SOLID PILLOW BLOCK - ANTI FRICTION BEARINGS:

Install solid pillow block bearings on the shaft and install with rotor assembly.

ROTOR ASSEMBLY

If wheel and shaft are not assembled, using care not to damage wheel, set it on the floor and brace. If shaft and hub have a protective coating, remove with proper solvent. Check for nicks, damage, rust, or corrosion. Clean up with crocus cloth. Never use emery cloth on bearing surfaces or wheel machined surfaces. Coat wheel bore with oil, loosen all set screws, remove keys. Determine how shaft should be installed for proper rotation. Rotation is determined as when viewed from drive side. On unit with dual drive, it is from the fixed bearing end

Install inlet cones over shaft. If there are inlet volume controls with fan be sure to install in the correct rotation. Vanes should spin the air in the direction of the wheel rotation when properly installed.

If the bearings are of the solid pillow block type, they should now be located on the shaft. Be sure the fixed and floating bearings are on the proper location.

If sleeve bearings are used, be sure that bearings and shaft at bearing lands are well oiled. Lower complete rotor assembly carefully into the bearings. Guide the rotor so that shaft will go into bearing sleeves about square with the base to prevent upsetting the babbitt.

If the rotor assembly is large and very heavy and controlling same is difficult, it can be lowered down to, but not into the bearings. The bearings can now be lifted into place round the shaft. The rotor assembly, complete with bearings, can now be gently lowered onto the pedestals in the proper place.

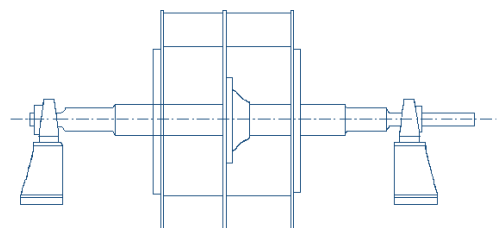
ALIGNMENT OF COMPONENTS

In order to prevent damage and contamination of the bearings, components should be aligned at this time so that bearing caps can be put into place.

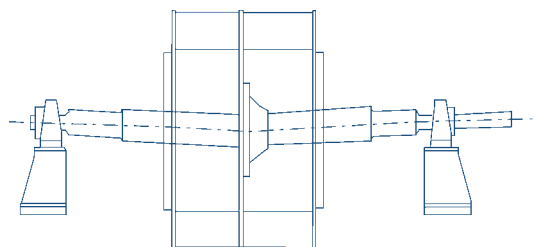
Line up the rotor assembly and fan housing by shifting either the housing or pedestals or both. Bolt inlet cones to housing. Make sure housing wheel and cones are in the correct position. Check that clearances can be maintained. Pedestals may be adjusted at this time to maintain any critical coupling dimension from the floor or base.

If fan is to be operated under conditions of temperature, allowances must be made for expansion. Fan housing will expand up in a vertical direction. Shaft will expand toward the "floating" or "free" bearing. Usually away from the drive.

To align the components, first level the shaft. Allowance must be made for shaft deflection, when aligning motor (or other drive mechanism) to the fan shaft.



This sketch shows a fan with the rotor and two bearings in a straight line.



Actually, such a condition does not exist. What does exist is illustrated by this sketch (exaggerated).

What we are trying to illustrate is that the shaft deflects with the weight of the wheel and runs in such condition. Bearings must be aligned to conform to the bend in the shaft AND WILL NOT BE LEVEL. It hangs in a catenary.

Alignment of Arrangement 3 fans (wheel between the two bearings) can be done in two ways.

METHOD 1: All of the shaft deflection can be compensated for at one end of the shaft. This is the most simple method, and hence is recommended. From the drive end, the motor, coupling, fixed bearing and fan wheel are all level. The floating or free bearing is shimmed to compensate for shaft deflection. Level the drive end of the shaft by raising or lowering the other end. Shims are to be placed under outboard bearing and pedestal until such time as bearing surface is lined up with the shaft. Tighten pedestal foundation bolts and bearing bolts. Level and align the motor with the fan shaft.

METHOD 2: Here the deflection is divided equally between the two shaft ends. The motor and both fan bearings must be shimmed until in alignment with the fan shaft. A spirit level should be placed near each bearing. When the same reading is shown on each end, the deflection is divided equally. When this is the case, all pedestal foundation bolts and bearing bolts should be tightened.

For Arrangement 1 or 8 fans, where the bearings are on one pedestal and the fan wheel is overhung, a level should be placed between the bearings on the shaft. Shims can now be placed either under the pedestal or the bearings until the shaft is level. Tighten all hold down bolts. Bearing caps should now be installed and tightened.

The split portion should now be installed in the housing. Remember to put the gasketing on the flanges. Adjust the inlet cones or inlet volume controls to the fan wheel by moving so that they are centered on the inlet of the fan wheel. If fan is to be operated under temperature conditions, allowance must be made for expansion. Remember, the housing expands vertically up, so cone should be set tight to the fan wheel at the bottom.

Tighten all bolts on housing, pedestals, etc. If shaft seals are supplied, install same. Turn rotor assembly by hand. It should run freely. If not, further adjustments may be necessary.

When you are satisfied that alignment is correct, unit should be grouted. Do not remove shims. Tamp and level the grout. Double check alignment after grout has set.

Efficient operation of the fan is dependent on properly designed duct work. If temperature is involved, expansion joints in both inlet and outlet duct should be installed to prevent distortion or strains caused by expansion of the duct and/or fan.

Unless purposely designed for same, the dead weight of flues, stacks, duct, silencers, or other equipment, should not be carried by the fan housing. Care must be taken not to subject the unit to any external strains which will cause distortion and the loss of proper clearance between the fan wheel and the fan inlets.

MOUNTING AND ALIGNMENT OF COUPLINGS

These instructions are intended to be general in nature and cover gear, pin or grid type flexible couplings such as Falk, Fast, etc. For instructions on other types of couplings, and in case of conflict or question, refer to the manufacturer's instruction.

Check that all necessary parts such as bearings, shaft seals, etc., have been installed on the shaft before mounting the coupling. Put coupling sleeve and seals on the shaft. Check to see that key fits keyway in shaft and hub before starting to fit hub to shaft. Heat hub in oil to expand bore for sufficient clearance. Mount hub to shaft. Position correctly, and install key in keyway while hub is hot. Let cool completely before attempting to align.

Incorrect alignment of coupling may cause bearings to overheat, unit to operate rough, and damage to bearings and/or coupling resulting in unnecessary expense. Be very careful when aligning the coupling.

Check drawing or manufacturer's instructions for proper clearance between the faces of the coupling. If motor is of the sleeve bearing type, locate the coupling so that when the rotor of the motor is closest to the fan, the faces of the coupling will not touch. If the magnetic center of the motor is marked, align in this position. If the magnetic center is not marked, determine the maximum play. Divide by two. Set motor at this dimension and align from here. When the clearance between the faces is correct, bearing locking collars should be tightened.

A straight edge should be placed across the hubs of the coupling. If it does not set true, adjust accordingly. Remember the fan half of the coupling was set when the bearings and shaft were aligned. To move the fan half will destroy such alignment. Adjustments must be made by raising or lowering the motor until straight edge is true. Alignment is correct when straight edge is true around the coupling when measured at 90° intervals.

A further check can be made with wedge or feeler gauges between the faces of the hub. Readings which are practically the same at 90° intervals indicate that the faces of the coupling are parallel.

Coupling can also be checked with a dial indicator. As a guide, a "rule of the thumb," the coupling faces should be parallel within .002", and the hubs should be concentric within .002": both measurements when checked at 90° intervals around the hubs.

To check whether faces of coupling are parallel, fasten the dial indicator to the machined surface of one hub, with the button on the dial contacting the machined surface on the other hub. Rotate the shaft to which the indicator is fastened, taking readings at 90° intervals, starting at the top. Differences between the readings top to bottom indicate that motor must be raised or lowered. Differences between the readings side to side indicate that motor must be shifted left or right. To correct top to bottom differences, shims must be added or removed as required. Amount of shims is one half of the difference between the two readings.

To check the angular alignment of the faces, fasten a bracket on each hub, with indicator between the brackets. Rotate both shafts together, stopping at 90° intervals. Readings should always be taken between the same two points. When readings are the same all around the coupling, faces are now equidistant and parallel.

As an addendum, when large motors are used, and to allow for the heating up of the motor, and the resultant expansion which will bring the coupling into line, the coupling half of the motor should be set low. A common practice is to set the motor half of the coupling low by .001" for each inch of shaft diameter.

On steam turbines the same rules apply, except the turbine should be set low by .001" per inch of turbine height from the mounting feet to the shaft center line.

Coupling can now be lubricated and made up by installing the sleeves, gaskets and hardware.

FINAL FASTENING OF COMPONENTS

Equipment should be operated under normal conditions for approximately 30 days, to allow for any settling or shifting. At this time all alignments should be re-checked and adjusted if necessary. Bearings, etc., can then be fixed in their locations by dowel pins, shear blocks, or other methods.

OPERATION OF EQUIPMENT

- 1) Check that bearings are properly aligned and lubricated, with special attention to the locking collars and set screws, cleanliness, and possible corrosion.
- 2) Check set screws and keys in wheel.
- 3) Check foundation bolts and other hardware for tightness.
- 4) Check housing, duct, etc., for foreign objects.
- 5) Check that all access doors are secure.
- 6) Recheck wheel/inlet cone clearance. Turn wheel by hand, make sure it rotates freely.

- 7) If equipped with damper or inlet volume controls, close same to lessen starting load on motor.
- 8) Bump unit to check for proper rotation.
- 9) Start unit. Follow instructions of motor and starter manufacturer.
- 10) Allow unit to come up to speed. Turn off. Check for any unusual noise or mechanical action. If any noticed, locate cause and correct.
- 11) Recheck tightness of all set screws, keys, and hold down bolts. The initial start up will tend to relieve these and they may require re-tightening.
- 12) On sleeve bearings, check oil rings through inspection caps when unit is running. The rings should rotate freely and carry oil.

Once it has been determined that unit is operating satisfactorily, it should be operated, if practical, for at least eight hours. Operation should be monitored at least once each hour during this period. Check should be made for any change of operation during this period. Some bearings will have to "run in" and will heat up during this period. If the bare hand can be held on the bearing cap for five seconds, there is no cause for alarm.

MAINTENANCE

For trouble free operation and long life, frequent and regular checks should be made of the lubrication of bearings and couplings. These must be maintained and lubricated as recommended by the manufacturer.

At least three times a year the unit, and particularly the rotating parts, should be checked for wear. In dirty atmospheres, inspection should be more frequent, and particular attention should be paid to possible erosion.

In the event excessive vibration is noted, check for the following possibilities:

- 1) Build up of dirt on wheel.
- 2) Bolts loose on motor, housing or bearings.
- 3) Drives out of alignment or belts loose.
- 4) Improper bearing alignment or clearance.
- 5) Improper coupling alignment.
- 6) Wheel not tight on shaft.
- 7) Wheel, shaft and bearings are damaged from foreign object entering wheel.
- 8) Is vibration from other than the fan?
- 9) Check clearance between wheel and inlet cones.

If the fan is to be idle and not operated for an extended period of time, bearings should be protected as recommended by the manufacturer. Shaft should be turned in the bearings at frequent intervals to prevent corrosion of the bearings. Exposed machined surfaces should be covered with a protective coating to prevent corrosion and damage.

FAN TROUBLE-SHOOTING CHART

PROBLEMS	PROBABLE CAUSES
INSUFFICIENT AIR FLOW	. duct elbows near fan inlet or outlet . restricted fan inlet or outlet . impeller rotating in wrong direction . fan speed lower than design . system resistance higher than design . dampers shut . faulty ductwork . dirty or clogged filters and/or coils . inlet or outlet screens clogged
EXCESSIVE AIR FLOW	. system resistance less than design . fan speed too high . filters not in place . registers or grilles not installed . improper damper adjustment
EXCESSIVE HORSEPOWER DRAW	. fan speed higher than design . gas density higher than design . impeller rotating in wrong direction . static pressure less than anticipated . fan size or type not appropriate for application
EXCESSIVE VIBRATION	. accumulated material on impeller . worn or corroded impeller . bent shaft . impeller or sheaves loose on shaft . motor out of balance . impeller out of balance . sheaves eccentric or out of balance . bearing or drive misalignment . mismatched belts . belts too loose or too tight . loose or worn bearings . loose bearing bolts . loose fan mounting bolts . weak or resonant foundation . foundation unlevel . structures not crossbraced . fan operating in unstable system condition
INOPERATIVE FAN	. blown fuse . broken belts . loose sheave . motor too small . wrong voltage



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