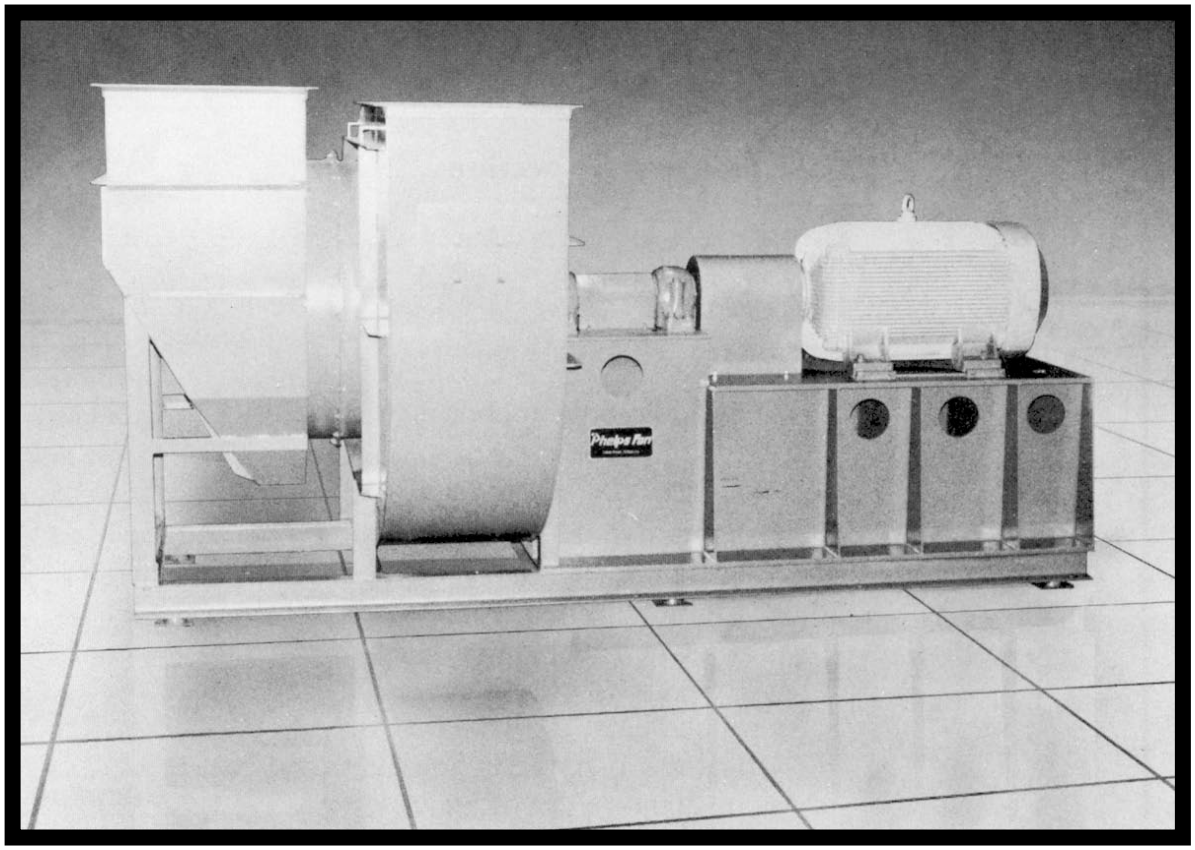
Catalogue #M-2-92

Phelps Fan®

EXPERIENCE AND EXCELLENCE SINCE 1915

Fan Service Manual



Rugged, Dependable, Quality Industrial Fans

Phelps Fan Manufacturing Company, Inc.

Phelps Fan®

EXPERIENCE AND EXCELLENCE SINCE 1915

I. Introduction

This manual has been prepared to help you install and properly maintain your **PHELPS FAN**. It is not intended to cover detailed installation of all fan types due to the wide variety involved. Each heavy duty fan customer is furnished with a detailed assembly drawing of his particular fan and this should be used to determine any special features involved.

II. Receiving and Inspection

Upon receiving equipment, check to see all items on the order or bill of lading have been received in good condition. Customer must note any damage on a claim filed with the carrier. When a shipment is opened and damage found which was not evident externally, it is mandatory the consignee request an immediate inspection by the carrier.

III. Handling

Units Shipped Assembled:

Fans arriving at the jobsite completely assembled can be picked up using slings and spreaders to avoid damage. Always use lifting eyes when provided. Never put slings or timbers through the inlets of the fan housings. Never lift a fan by it's shaft.

Units Shipped Disassembled

When lifting a rotor always use a spreader bar and lift by the shaft on either side of the hub.

The following will insure that no damage occurs during handling:

1) Never lift a rotor by it's blades or flanges.
2) Never roll rotor on it's flanges.

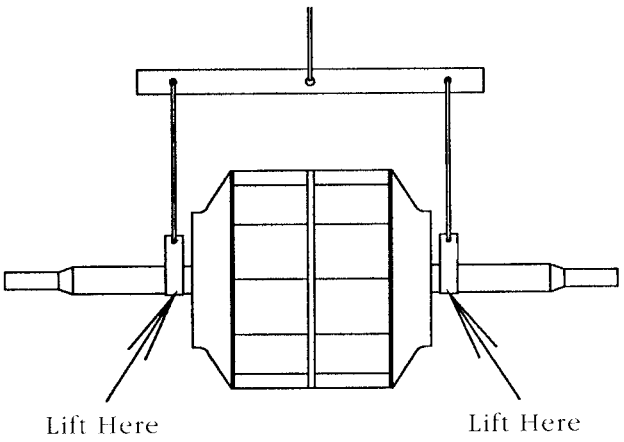


Fig. 1

3) Never set rotor down so that it supports the shaft; use wood supports under shaft to support rotor by shaft.
4) Never ship rotor leaning over and supported by it's shaft. A bent shaft can result.
5) Never rest entire rotor weight on the housing side plates.
6) Never lift double width, double inlet housing by putting timber or sling through inlets. To lift use skid under housing, or sling around housing or through lifting lugs in the bracing.
7) Never lift fan by shaft sleeves or in bearing journal area.

IV. Storage

Short Term

PHELPS FANS are suitably prepared at the factory to protect them during shipment to the jobsite and for a reasonable period before installation. One month is suggested as being

the maximum length of time without more extensive storage precautions.

Bearings

All grease lubricated bearings are prelubricated before leaving the factory and will require no lubrication prior to start up. All oil lubricated bearings must be lubricated prior to start up in accordance with directions provided with each fan. After a short run in period the bearing lubricant should be checked and added as required. Do not over lubricate grease type bearings. It is possible to rupture the seals and shorten the life of the bearing. Refer to the attached lubrication instructions or consult factory.

Long Term

If fans are to be stored for an extended period, the storage building should be clean, dry, well ventilated, and temperature controlled between 60° and 90° Fahrenheit. Sufficient space should be left around the fan for inspection, lubrication and rotating the wheel by hand. This should be done weekly on an assembled fan so as to distribute the grease and moisture within the bearings. Once a month, the grease should be purged by carefully pumping in grease while slowly rotating the impeller by hand. This is done until a small amount of grease is purged out around the seals.

If units are shipped disassembled, note that bearings are shipped with a preservative only and bearing must be lubricated before operation. If unit is not to be placed in service immediately, pillow block and bearing should be hand packed with grease or filled completely with oil. You should insure that no moisture or dirt are entrapped during this lubrication. Label the bearing as containing too much lubricant for operation and cover with waterproof paper. When getting ready for operation, the bearing cap must be removed and the excess lubricant taken out. Use a clean instrument to do this. Follow the bearing manufacturers recommendations for relubricating.

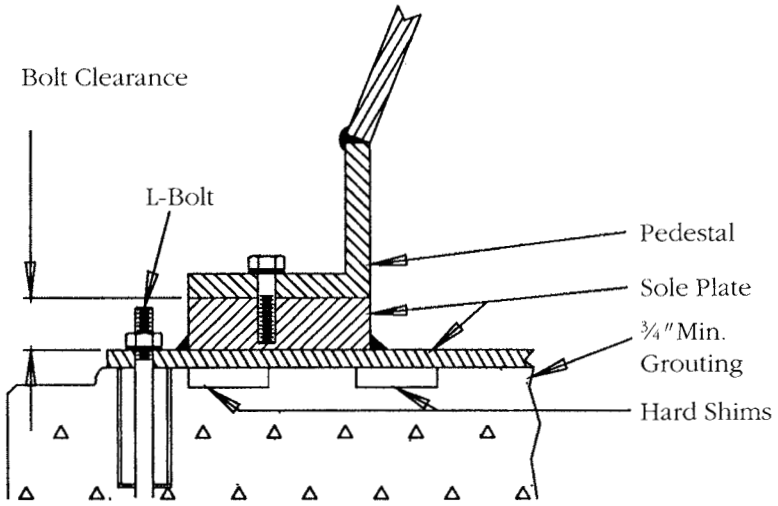


Fig. 2

V. Erection

Foundation

A rigid, level base is essential to smooth, vibration free operation. It should weigh from three to five times as much as the fan to be mounted on it. The sub-foundation whether soil, stone or rock should be firm enough to prevent uneven settling of the foundation. A properly designed foundation reduces vibration, and insures that alignment is maintained.

Reinforced, poured concrete is the preferred foundation for industrial fans. The mass of the foundation serves as an inertia block to absorb

any vibration. Preferably, the bottom of the concrete base will be larger than the top with a taper to the top. The edges should extend

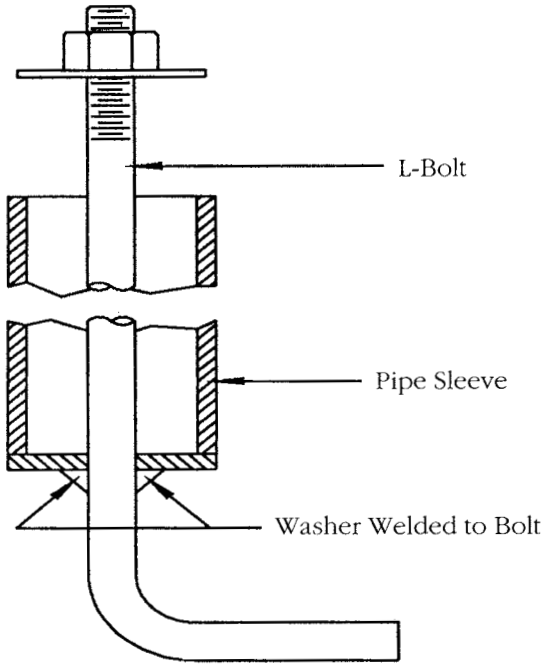


Fig. 3

at least 6″ beyond the fan base. A minimum of 1″ should be allowed for shimming and grouting when the top of the foundation is determined.

Sole plates under the fan bearing pedestals and motor are recommended for use on concrete foundations. This allows easy disassembly without disturbing cement, grout or alignment.

"L" shaped hold down bolts should be placed in the concrete in a metal sleeve (or pipe) having a diameter 2 ½ times the bolt diameter to allow minor adjustment when the concrete has cured. When determining the length of the bolts, be sure to allow for shims, grout and metal thickness.

If necessary to install the fan on a structural steel foundation, it should be sufficiently rigid to assure permanent alignment. It should be designed to carry the weight of the loads imposed by centrifugal forces caused by the rotating elements as well as the weight of the fan itself.

Fans installed above ground should be located near to or directly above a rigid wall or column. An overhead platform must have adequate cross-bracing.

Ducts

Some sort of flexible joints are essential between the duct and fan inlet and outlet to isolate fans from temperature expansion loads, duct static loads and vibration. It is also important to know that flexible joints most likely will "leak" sound which might negate the benefit of a silencer.

Shimming

If the fan housing is split, the lower half should be moved over the anchor bolts on skids to prevent their damage. When the housing is in position, it should be lifted or jacked up one side at a time, the skids removed and housing lowered onto the foundation. Shims should be placed under the base of the fan to assist in leveling and aligning. Steel shims at least 6 inches long and 2 or more inches wide are recommended. These give a bearing surface sufficient to insure stability and prevent slipping when the anchor bolts are tightened.

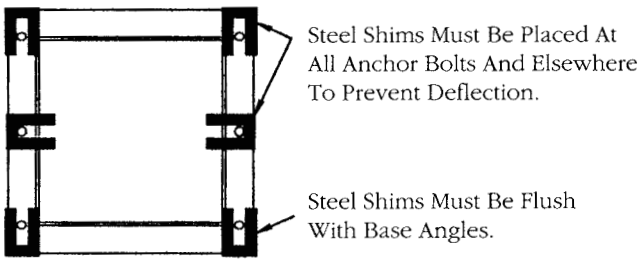


Fig. 4

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Usually more than three points of support are necessary for leveling. The size and outline of the base will usually indicate the necessary points of support. If the fan is first leveled and aligned using points on the centerlines as points of support, additional supports must be added near each anchor bolt to carry the weight and prevent warping the base when the anchor bolts are tightened.

Grouting

The grouting of fan base and bearing plates and of anchoring/aligning equipment to a foundation are low cost approaches that provide a high quality machine to foundation connection. A successful installation depends on proper grout selection and it's application. Most fan installation experts recommend and use an epoxy grout.

The epoxy grout consists typically of a base resin and hardener that are mixed at the jobsite immediately before placement. Epoxy grouts have the ability to withstand significantly higher shock loads than cementitious materials.

The concrete surfaces to which the grout will be applied must be carefully cleaned, leaving the surface free of all foreign material, grease, oil, etc.

In preparing forms for retaining fluid grout, keep in mind that the most effective means of achieving a good machine base to grout contact is to place the grout from one side only. The grout should flow under the fan and while it is flowing, contact between the upper surface of the advancing grout and the fan base should be maintained. It is important that grout fills the sole plate grout holes. This will provide a solid anchor for the fan.

Alignment

Setting and alignment of bearing pedestals:

1. Use thin shims to bring bearing pedestals in place and approximate proper bearing centerline height.
2. Level the driveside bearing using flat shims under the sole plate. Allow approximately .125" for shimming between pedestal top and bearing. A spirit level or surveyors transit are useful for precise alignment.
3. Adjustment of sole plate leveling bolts is next followed by placing hard shims next to each leveling bolt before grouting.
4. Temporarily bolt down bearing pedestals. (Shims running the full length and half the width of the bearing sole plate and slotted to fit around the mounting bolts provide the most solid mounting arrangement for later mounting of bearings).

Flexible Coupling Alignment

Coupling alignment can be achieved by means of (1) a dial indicator or (2) a straight edge and a feeler gauge. The preferred method is to use a dial indicator because of its increased accuracy. Quantitative readings make it possible to determine exactly what shim adjustments are necessary.

The following instructions pertain only to the standard gear or grid spring type of couplings similar to the "Fast," "Waldron" or "Falk". For other types, refer to the manufacturers instructions. Before attempting to mount the coupling, the shaft diameter and coupling bore should be measured with micro-meters. The coupling should have a slight interference fit with the shaft. The hub may be heated by immersion in oil heated to about 300°F or by

placement in a furnace. Do not apply flame to hub teeth.

Slide the heated hub onto the shaft so that it is flush with the end of the shaft. Insert the key flush with the end of the shaft before the hub cools.

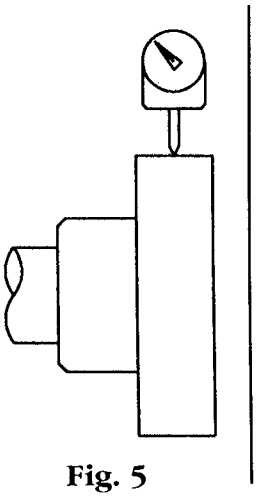


Fig. 5

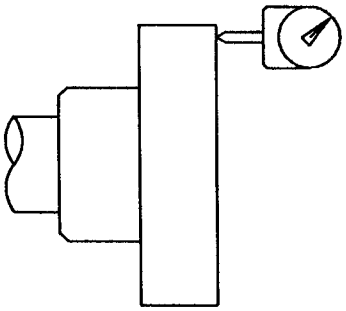


Fig. 6

Great care should be exercised in lining up couplings, whether they are flexible or solid type. If this is not done, vibration, noise and premature bearing failure can result.

The coupling hubs should first be tested to make sure they are concentric. This can be done by the use of an indicator as shown in Fig. 5. The indicator can be placed on the hub and the shaft rotated slowly. Any off center of the hub and bore will be shown by a deflection of the indicator pointer. If the hub is bored true there will be very little deflection of the pointer. Both the fan half and the driver half of the coupling should be tested in this way. Next, the indicator should be placed so that it indicates whether or not the coupling face is square with the axis of rotation, (see Fig. 6). The indicator should show practically no variation in this reading when the shaft is slowly rotated. This must be done for both coupling halves.

With the knowledge that the coupling halves are square and concentric with the shaft, the actual alignment may begin with a straightedge and feeler gages. Lay the straight edge across the coupling hubs and if it does not set true as shown in Fig. 7 adjustments must be made. Due to the fact that the position of the fan half of the coupling is determined when the fan shaft and bearings are aligned, any necessary adjustment will usually have to be made by moving the driver. Raise or lower the driver by means of shimming until the straightedge lies true as shown in Fig. 8. When the coupling halves are in line, the straightedge must lie true at four 90° points around the hubs as shown in Fig. 9. Next, the coupling alignment can be further checked with thickness gages to determine whether the gap between hubs is uniform as shown in Fig. 10, or by wedges as shown in Fig. 11. Again, trials must be taken at the four 90° points.

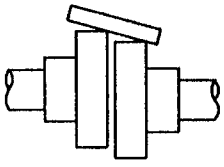


Fig. 7

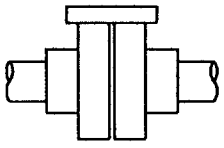


Fig. 8

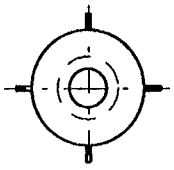


Fig. 9

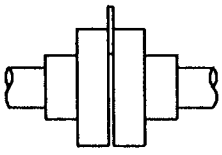


Fig. 10

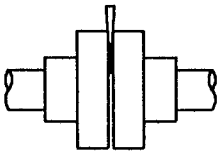


Fig. 11

In cases where sizable motors or turbines are used as drivers, the driver half of the coupling

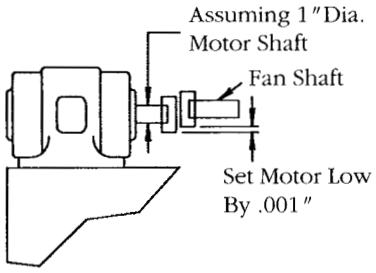


Fig. 12

should be set low by a few thousandths. When the driver heats up under operating conditions it will expand and bring the coupling into line (see Fig. 12). The exact amount to allow for expansion cannot be given since it depends on the temperature, size and shape of the driver; but in general, the larger the driver and the higher the temperature, the larger the expansion allowance must be. Fine tuning the alignment can occur after experience has been gained in operation. A rule of thumb to use as a trial setting would be .001 per inch of motor shaft.

V-Belt Drives

V-Belt drives provided by the factory are aligned and no maintenance should be required during the first few hours of operation. It generally becomes necessary to tighten the belts after a brief run-in period or when they become worn. To accomplish this use the procedure shown below courtesy "T.B.Woods."

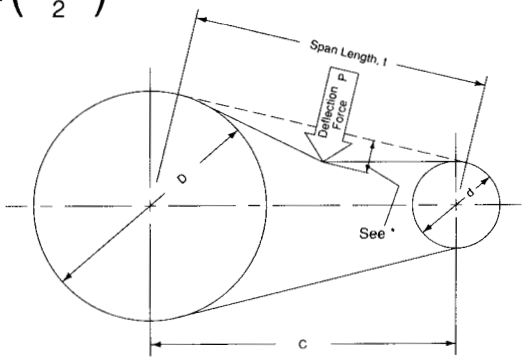
Tensioning V-Belt Drives

Force Deflection Method

This method should be used only for tensioning drives on which the grade of belt, rated belt capacity, service factor, design horsepower, etc., are known. If the drive has been designed in strict accordance with the procedures, instructions, and horsepower ratings in Wood's current catalog, the force deflection values are valid. However, if the drive was designed from editions dated prior to 1980 or using information other than that contained in these catalogs, excessive loads on bearings or excessive shaft deflections may result.

$$t = \sqrt{C^2 - \left(\frac{D-d}{2}\right)^2}$$

$$h = \frac{1}{64}$$



where t = Span length inches
C = Center distance Inches
D = Larger sheave diameter, inches
d = Smaller sheave diameter Inches

* Deflection height h = 1/64 per inch of span

Fig. 13

Step 1: Measure span length (t) in inches as shown in Figure 13, or calculate using formula.

Step 2: From Figure 13 the deflection height (h) is always 1/64" per inch of span length (t). For example, a 32" span length would require a deflection of 32/64" or 1/2".

Step 3: Determine the minimum, maximum, and initial recommended pounds force using Table 1 or calculate based on the required Static Strand Tension (T). Note: The initial recommended force is used only for installing new belts which have not seated themselves into the sheave grooves and where initial belt stretch has not taken place.

Step 4: Using a spring scale, apply a perpendicular force to any ONE of the belts at the

mid point of the span as shown in Figure 13. Compare this deflection force with the values found in Step 3.

a. If the deflection force is below the minimum, the belts are too loose and the tension should be increased by increasing the center distance.
b. If the deflection force is higher than the maximum, the belts are too tight and the tension should be decreased.

When new V-belts are installed on a drive the *initial* tension will drop rapidly during the first few hours. Check tension during the first 24 hours of operation. Subsequent retensioning should fall between the minimum and maximum force.

To determine the deflection distance from normal position, use a straightedge or stretch a cord from sheave to sheave to use as a reference.

Housing Alignment

The inlet orifice must be placed over the shaft end before mounting the rotor assembly in the housing. If variable inlet vanes are provided, check for proper rotation. Inlet vanes in a nearly closed position must prespin the air in the direction of rotor rotation. DWDI fans have one clockwise and one counter-clockwise. They must not be reversed.

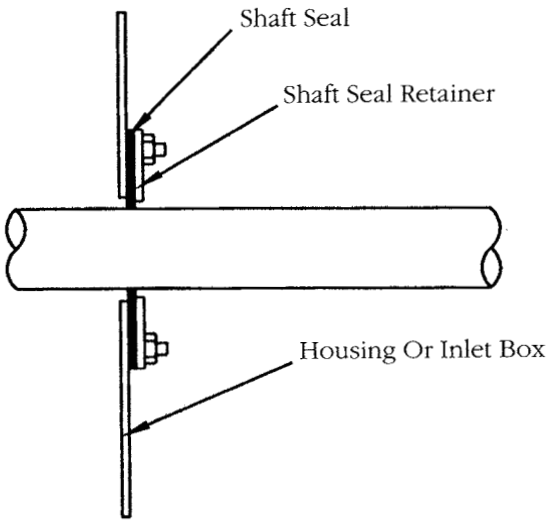
After the alignment of the rotor assembly, coupling and drives is complete, the inlet orifices or INLET VANE CONTROLS should be re-positioned to give proper clearance. Center the orifices on the inlet of the rotor. At this time, the IVC linkage should be assembled as required. Details of linkage arrangement are supplied on the fan assembly drawing supplied with the fan. Install gasketing in housing split and install the split on the lower housing. Allowance must be made for expansion when operating at elevated temperatures. Tighten all fasteners including setscrews. Use the torque values listed below to check bearing setscrews and rotor hub setscrews.

Table 1 Recommended Minimum Force Per Belt

Belt Section		Small Sheave		Drive Ratio			
		Speed Range	Dia.	1.0	1.5	2.0	4.0 & over
Ultra-V	3V	1200-3600	2.65	2	2.4	2.6	3
		1200-3600	3.65	3.8	3.6	3.8	4.2
		1200-3600	4.75	3.8	4.2	4.4	4.8
		1200-3600	5.6	4.2	4.6	4.8	5.4
		1200-3600	6.9	4.6	5	5.2	5.6
	5V	900-1800	7.1	8.5	9.5	10	11
		900-1800	9	10	11	12	13
		900-1800	14	12	13	14	15
		700-1200	21.2	14	15	16	17
	8V	900-1800	12.5	18	21	23	25
		900-1800	14.0	21	23	24	28
		700-1500	17.0	24	26	28	30
		700-1200	21.2	28	30	32	34
		400-1000	24.8	31	32	34	36
Ultra-V Cog	3VX	1200-3600	2.20	2.2	2.5	2.7	3.0
		1200-3600	2.50	2.6	2.9	3.1	3.6
		1200-3600	3.00	3.1	3.5	3.7	4.2
		1200-3600	4.12	3.9	4.3	4.5	5.1
		1200-3600	5.30	4.6	4.9	5.1	5.7
		1200-3600	6.9	5.0	5.4	5.6	6.2
	5VX	1200-3600	4.4	6.5	7.5	8.0	9.0
		1200-3600	5.2	8.0	9.0	9.5	10
		1200-3600	6.3	9.5	10	11	12
		1200-3600	7.1	10	11	12	13
		900-1800	9.0	12	13	14	15
		900-1800	14.0	14	15	16	17
Sure-Grip Premium	AP	1800-3600	3.0	2.0	2.3	2.4	2.6
		1800-3600	4.0	2.6	2.8	3.0	3.3
		1800-3600	5.0	3.0	3.3	3.4	3.7
		1800-3600	7.0	3.5	3.7	3.8	4.3
	BP	1200-1800	4.6	3.7	4.3	4.5	5.0
		1200-1800	5.0	4.1	4.6	4.8	5.6
		1200-1800	6.0	4.8	5.3	5.5	6.3
		1200-1800	8.0	5.7	6.2	6.4	7.2
	CP	900-1800	7.0	6.5	7.0	8.0	9.0
		900-1800	9.0	8.0	93.0	10	11
		900-1800	12.0	10	11	12	13
		700-1500	16.0	12	13	13	14
	DP	900-1800	12.0	13	15	16	17
		900-1800	15.0	16	18	19	21
		700-1200	18.0	19	21	22	24
		700-1200	22.0	22	23	24	26
Torque-Flex	AX	1800-3600	3.0	2.5	2.8	3.0	3.3
		1800-3600	4.0	3.3	3.6	3.8	4.2
		1800-3600	5.0	3.7	4.1	4.3	4.6
		1800-3600	7.0	4.3	4.6	4.8	5.3
	BX	1200-1800	4.6	5.2	5.8	6.0	6.9
		1200-1800	5.0	5.4	6.0	6.3	7.1
		1200-1800	6.0	6.0	6.4	6.7	7.7
		1200-1800	8.0	6.6	7.1	7.5	8.2
	CX	900-1800	7.0	10	11	12	13
		900-1800	9.0	11	12	13	14
		900-1800	12.0	12	13	13	14
		700-1500	16.0	13	14	14	15
	DX	900-1800	12.0	16	18	19	20
		900-1800	15.0	19	21	22	24
		700-1200	18.0	22	24	25	27
		700-1200	22.0	25	27	28	30

Shaft Seals

If shaft seals are provided, they should now be installed and aligned on the shaft.



Shaft Cooling Wheels

These should be installed between the shaft seal and the bearing with the vanes next to the bearing. In addition to convection dissipation of heat, the vanes pull a cooling flow of air over the bearing.

Insulation

Field insulation is usually done by others over factory installed insulation clips. Be sure that field mounted insulation does not restrict movement of inlet or outlet expansion joints. The additional weight added by the insulation should be considered in sizing isolators when they are used. Be sure to leave adequate clearance in the area around the heat slinger for proper air circulation.

Access Doors

Access doors are included on fan housings and inlet boxes to allow inspection and/or cleaning of the fan interior. Access doors are to be opened only after the fan has come to a complete stop and it's electrical switch locked out.

Some access doors that open vertically can become quite heavy. The weight of the door should be determined from the drawing and supplemental mechanical assistance used if necessary to open or close the door. All hinges and hinge pins should be checked periodically and lubricated.

Motor

After the motor has been aligned and bolted down, wire to power supply through a disconnect switch, short circuit protection and suitable magnetic starter with overload protection. All wiring should be in accordance with the National Electric code and local requirements.

Most single speed fans will achieve full operating speed in 25 seconds or less. Longer starting times can result in motor damage. The following are typical causes of excessive starting time:

1) Motor torque not adequate for fan rotor WR^2.
2) Low voltage, causing reduction in motor torque capability.
3) Partially open fan inlet damper causing increase in torque requirement.
4) Low temperature or high density gas in airstream causing increase in torque requirement.
5) Driver speed torque curve not matched to fan torque requirement. This can be particularly troublesome with gasoline and diesel engines.

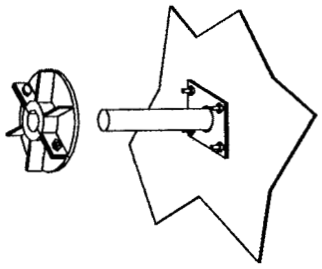


Fig. 15

SETSCREW TORQUE VALUES

Setscrew Size	Bearing	Wheel
	Setscrew Torque Ft. Lbs.	
#10	3	3
.250	6	6
.3125	13	11
.375	23	22
.4375	36	33
.500	51	50
.5625	–	75
.625	110	100
.750	179	170
.875	428	300
1.000	584	400
1.125	–	517
1.250	–	800
1.375	–	833
1.500	–	1000

"Across the line" starting initially connects the motor directly to the power lines. The advantages of this method are it's low cost, high starting torque, low maintenance and the fact that it can be used with any standard motor.

Note the full load amperage and the motor service factor as listed on the motor nameplate. Monitor the motor current and do not operate the motor in an overcurrent condition. In most cases the motor is sized to operate the fan at design conditions. However, in most cases, the fan must be connected to the system ductwork and/or dampers closed to provide a system resistance before operating the fan.

In general, motors above 200 HP do not restart more than once every 30 minutes.

VI. Start-up

When you have finished assembling and aligning the fan, rotate the impeller by hand and note any scraping or rubbing noises.

Bump Start

Once the motor is wired to the power line, you should "bump" the starter to check impeller rotation. Fig. 17 shows typical centrifugal fan impellers. Be sure the wheel rotation is correct since even a backward turning fan wheel will

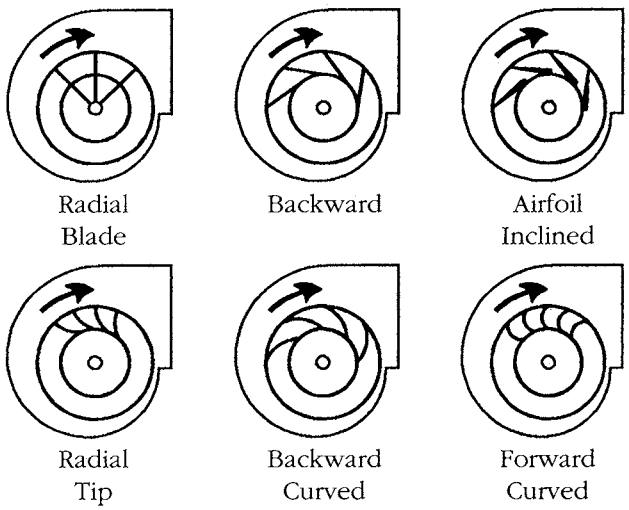


Fig. 17

deliver some air. The problem is that this will consume inordinate amounts of power.

Vibration

Fan manufacturers can guarantee balance and vibration at the factory before the fan is shipped. It is difficult, if not impossible, to predict vibration levels when the fan is installed in the customers system. It is possible for even a well balanced fan to experience a high level of vibration if mounted on a loose or poorly designed foundation.

Balance Tolerance Guide

PHELPS FAN uses ANSI S2.19-1975 and 1940 standards for determining balance tolerances. These standards define the various rotor types of rotating machinery and their appropriate balance quality grades. Fans fall into grade 6.3.

Overall Vibration Severity

ISO STANDARD 2375-1974E is the standard adopted for overall severity at **PHELPS FAN**.

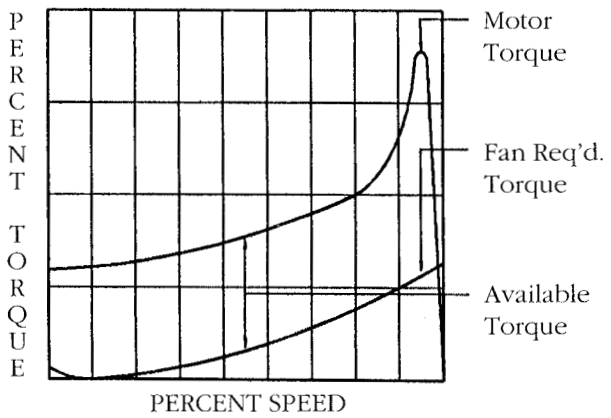


Fig. 16

This standard classifies fans as falling into Class IV type of machines. The range classification corresponds to the band titled "good" on the "General Machinery Vibration Severity Chart" universally used in the USA. See Fig. 18.

Possible causes of excessive vibration after the fan leaves the factory are listed below:

1. Dropped during shipment—bent shaft.
2. Loose anchor bolts, bearing bolts, motor bolts.
3. Foundation structure not adequate.
4. Material buildup on the wheel.
5. Fan wheel set screws loose.
6. Inlet orifice rubbing fan wheel.
7. Wear on wheel and/or bearings.
8. Defective bearing, motor, control, etc.
9. Duct binding fan housing.
10. Aerodynamic pulsation caused by system design.

It is strongly recommended that bearings be equipped with seismic vibration detectors mounted on the bearing housing or bearing pedestal. Vitec model #438 electronic vibration alarm/switch is typical of the type recommended and is one of several high quality detectors available.

The operation of these vibration pickups should be checked monthly and calibrated at least every 6 months. The use of these detectors is highly recommended as operation at high vibration levels may result in catastrophic failure with resultant damage to equipment and possible injury to personnel.

Figure 18 shows recommended velocity levels for alarm and shutdown. These levels are shown in terms of velocity so as to eliminate the RPM consideration.

Sound

Sound power levels provided by the fan manufacturer are expressed in decibels referred to 10^{-12} watt and obtained in accordance with

Vibration Frequency Chart

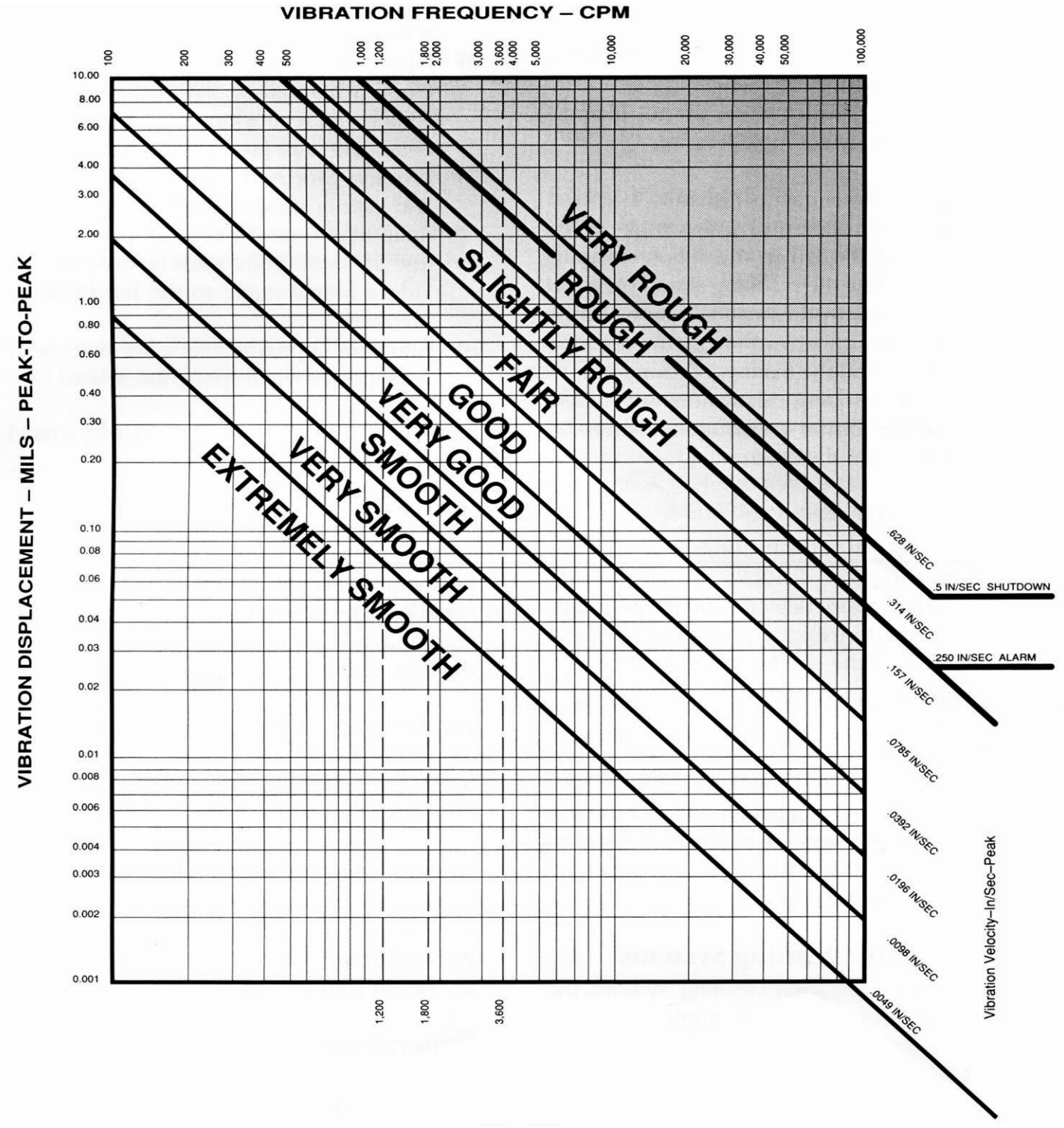


Fig. 18

AMCA Standard 300. Sound power levels for each band and dBA are calculated per AMCA Standard 301. Levels shown do not include motor or auxiliary equipment noise.

Sound power level data is primarily intended to be used by an acoustical design engineer for evaluation of the fan in the whole system. While computing the resulting sound pressure levels at various worker stations, he will consider the acoustical environment, the distance to the listener and the manner of sound propagation. The resulting calculations will determine whether further sound attenuation measures will need to be taken.

Temperature

The temperature at the bearings is an early indicator of trouble. PHELPS strongly recommends temperature detectors on the bearings. If the temperature exceeds 180 to 190 degrees F, the cause of the overheating should be investigated.

Operation

Fans with air stream temperatures above 500° F should have turning gear installed if there is a possibility of operating at an idle condition. This prevents the shaft from drooping and causing unbalance.

Water Spray Cleaning Systems

When using water spray cleaning systems, the following recommendations apply:

1) Use drinking quality water (40 psig required)
2) Requirements at fan inlet: 1 GPM /16,000 CFM each inlet-full jet spray.
3) Requirement at blades and front flange: 1 GPM/32,000 CFM/each inlet-full jet spray.
4) Use water spray intermittently to determine the exact amount of time (and thus water) required for satisfactory cleaning.
5) A periodic check of the rotor for corrosion is recommended.
6) Piping from supply to spray unit must include a manual or automatic valve for shutoff and regulation; installation is to be consistent with good piping practice.
7) Provide proper drainage from housing and inlet box(es) when using sprays. To drain inlet boxes, a vertical seal loop below the drain point must be used to provide a height equal to the fan negative pressure.
8) Allow for approximately a 5% increase in horsepower when sprays are in use.

Safety

The fan you have purchased is rotating equipment that can become a source of danger and can result in injury or death if misapplied.

Personnel who will maintain or operate this fan should be given a copy of this manual to read and warned of the potential hazards of this equipment.

PHELPS FAN COMPANY strongly endorses the use of safety guards on all rotating parts but it is the ultimate responsibility of the user to see that they are purchased and in place.

When working around fans, be absolutely certain they cannot be started without your knowledge. The best means of insuring this is to put your padlock on the switch and put the key in your pocket

General Safety Precautions

1) Maximum operating temperature and speed for fan equipment must not be exceeded. (Refer to the assembly drawing

furnished with your fan for the maximum speed and temperature).

2) Bearing temperature must not be exceeded. Do not rely on "feel" to determine bearing temperature as an acceptable operating temperature may be hotter than you can tolerate with your hand.
3) Access doors to the fan or ducts must not be opened during fan operation.
4) Protect against electrical hazards related to motor operation. Refer to motor wiring instructions.
5) Protective guards for shaft, heat slinger and belts must be provided and in place during operation.
6) Beware of hot surfaces. Allow system to cool down before starting maintenance work.

For a complete discussion of safety practices, refer to AMCA publication 410.

Nameplate

The nameplate is designed to withstand time and provide essential information such as factory order number, maximum speed and temperature. If records are lost or destroyed, the nameplate will always send you back to **PHELPS** for high quality repair parts or new industrial equipment.

Spare Parts List

Differing operating conditions dictate different spare parts. If the fan is handling abrasive material, it is a good idea to have a spare impeller on hand. This is also true if the fan is handling very hot gasses.

PHELPS recommends the customer have the following spare parts on hand: rotor and shaft, one set of v-belts (or coupling), and one pair of bearings. Refer to the assembly drawing for specific sizes and description of parts.

Additional Material and/or Revisions

In some cases for information on Items supplied by **PHELPS FAN COMPANY**, but manufactured by others, see manufacturer's instructions. These instructions are routinely supplied with the fan at time of shipment. In some cases, additional information may be provided by **PHELPS FAN COMPANY.** Normally, when this is done, you will find handwritten notes and references of such material in the space immediately below. If you still have questions regarding your fan purchase, contact **PHELPS FAN COMPANY.**

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Trouble Shooting Guide

Problem	Check For
VIBRATION	1) Fan wheel out of balance. 2) Improper alignment of coupling. 3) Improper alignment of V-belts. 4) Loose V-belts. 5) Loose bearing mounting bolts. 6) Loose wheel hub setscrews. 7) Improper fan wheel clearance to inlet orifice. 8) Material buildup and or wear of the fan wheel. 9) Improper wheel rotation. 10) Operation near rotating assembly critical speed. 11) Shaft bent or distorted during high temperature shutdown. 12) Defective motor. 13) Resonant frequencies of structural mounting supports. 14) Insure expansion joints are not compressed. 15) Beat frequency with other equipment on common base. 16) Defective bearings. 17) Weld cracking. 18) Loose hub to shaft fit.
POOR PERFORMANCE	1) Poor duct design. Elbow splitters or turning vanes could remedy problem or consider system effects. 2) Fan drive sheaves selected for too low or too high RPM. 3) Incorrect fan rotation. 4) Poor fit up between wheel and inlet orifice. 5) Pre-spin at fan inlet; add splitter plate to inlet box. 6) Inlet damper installed backwards. 7) System resistance is excessive compared to design requirements. (Partially closed damper possible cause) 8) Fan speed too high/low. 9) Density may be different than design density.
NOISE	1) Squeeling V-belts due to misalignment or improper tension. 2) Foreign material in the fan housing. 3) Defective bearings. 4) Misaligned shaft seal. 5) Wheel rubbing inlet or shaft rubbing shaft seal. 6) Heat slinger hitting guard. 7) Coupling failure. 8) Untreated expansion joints. 9) Ductwork sheetmetal too thin.

Trouble Shooting Guide

Phelps Fan
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Problem	Check For
DUCT PULSATION	Pulsation frequently occurs when a centrifugal fan is operated near it's peak static pressure. When the operating point moves to the left of the peak, instability is frequently encountered. Possible solutions include: 1) Increase flow rate. (reduce system resistance) 2) Control volume with a vortex inlet spin damper. 3) Add a damper on discharge venting to atmosphere to reduce resistance. 4) Recirculate a portion of the gas stream back to the fan inlet.
TEMPERATURE	1) Improper ventilation of cooling air to motor. (may be blocked by dirt or debris) 2) Input power problems, especially low voltage. 3) High amperage. 4) High ambient temperature. 5) Motor cooling fan is wrong rotation.
HIGH BEARING TEMPERATURE	1) Defective bearings. 2) Too much lubricant in bearing. 3) Lack of lubrication. 4) Improper or contaminated lubricant. 5) High ambient temperature or direct exposure to sunlight. 6) V-Belts too tight or too loose. 7) Insufficient room for free axial movement of floating bearing in it's housing at elevated temperatures. 8) Low cooling water flow rate. 9) Heat slinger missing.
EXCESSIVE STARTING TIME	1) Motor improperly sized for fan wheel. 2) Inlet dampers not closed during startup. 3) Inlet air temperature is excessively low. (high density) 4) A properly selected time delay starter/fusing required. 5) Inadequate system resistance. 6) Low voltage at the motor.

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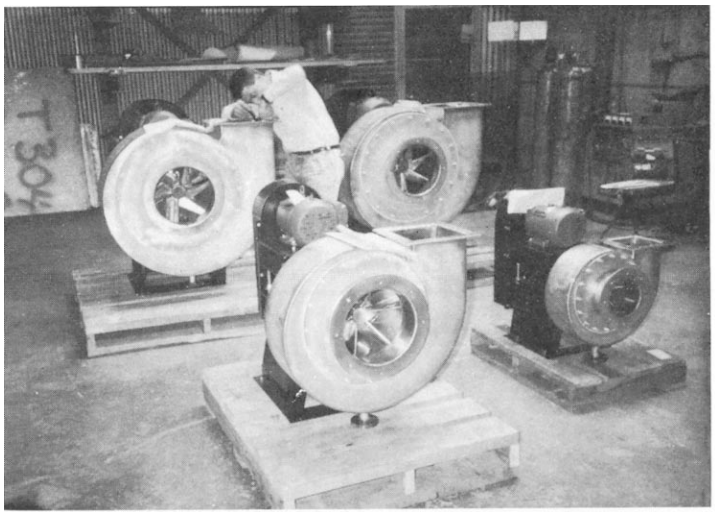
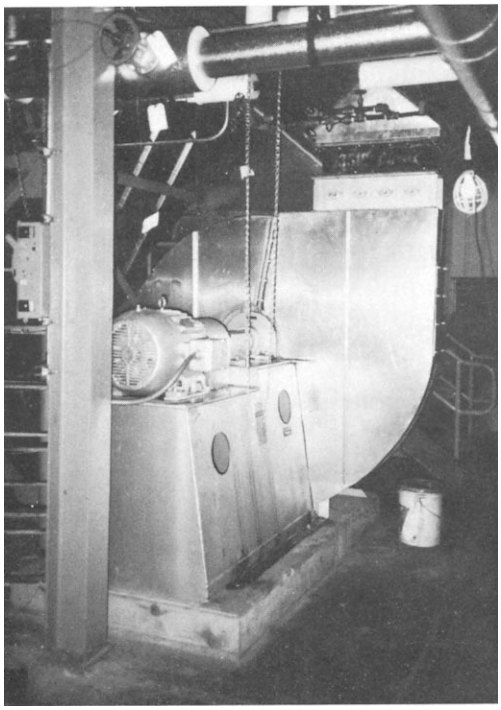
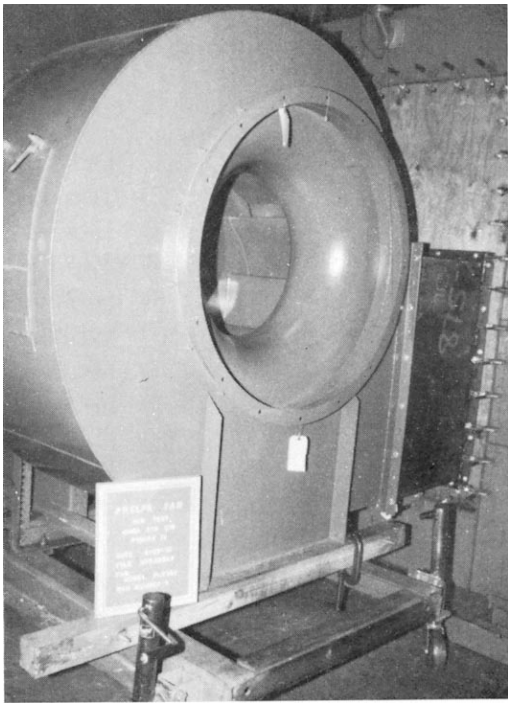


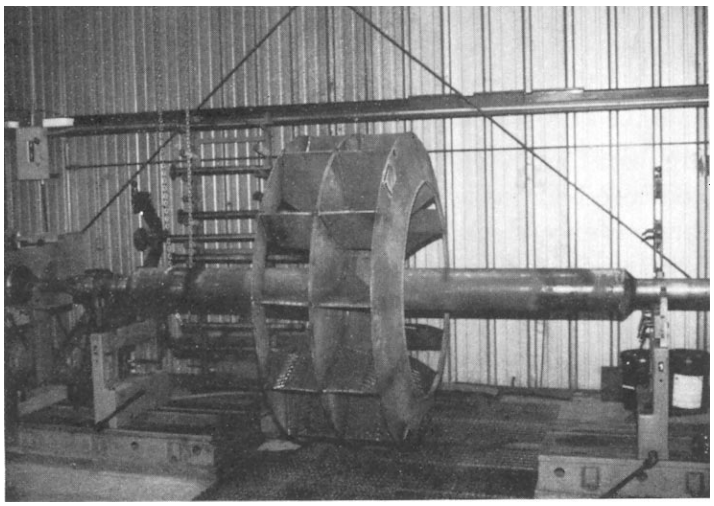
Inspecting very special fans going to a government site



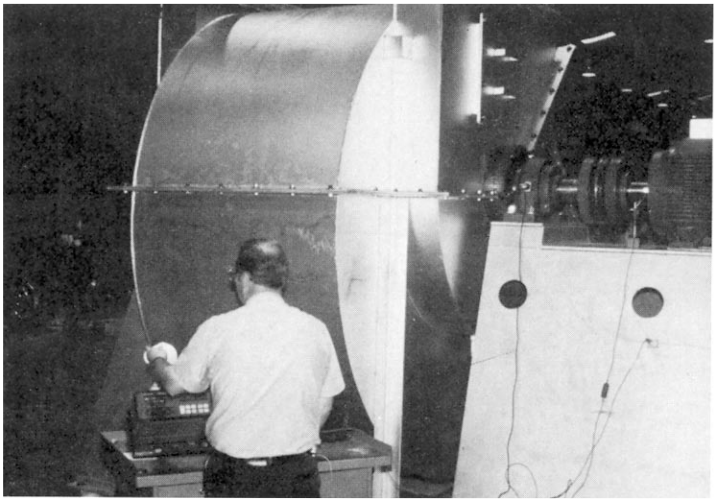
Blower being installed in system.



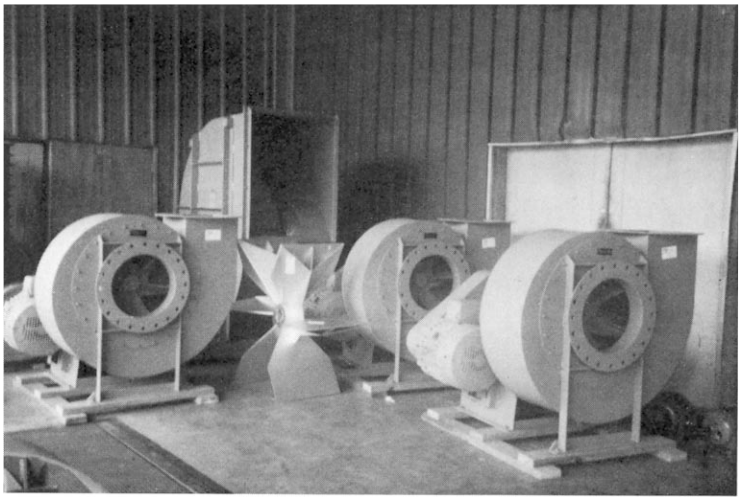
Fan undergoing test on
Phelps "AMCA" test facility



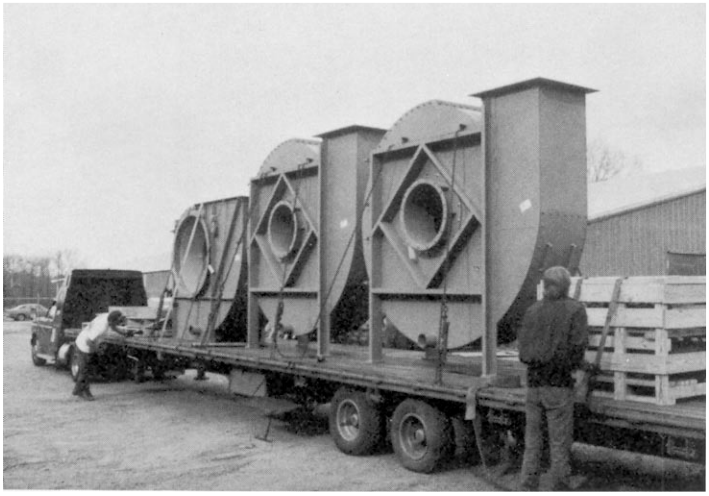
Repaired wheel undergoing balancing



Vibration testing of completed fan



Some of the many Phelps Fan products



Heavy duty fans being readied for shipment

Phelps Fan Manufacturing Company, Inc.
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