NATIONAL TURBINE CORPORATION

ORIGINAL INSTRUCTIONS- ENGLISH VERSION

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS
CENTURION™ SERIES MULTI STAGE CENTRIFUGAL BLOWERS AND EXHAUSTERS

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I. INTRODUCTION

Thank you for your purchase of a National Turbine cast iron multi stage centrifugal unit.

Our on going commitment to your satisfaction begins with the proper handling and installation of your new equipment.

Please take the time to review this manual in it's entirety to assure that you are familiar with all the requirements and features of your equipment.

Proper installation, operation and maintenance will assure the user of years of trouble-free service.

Always refer to your specific model number and serial number, which are stamped on the nameplate attached to the inlet head.

Equipment description

Multi stage centrifugal units are used to provide a constant pressure or vacuum under variable volumetric conditions.

II. INSPECTION

Immediately upon receipt, thoroughly examine the equipment. Both motor and blower shafts should rotate freely. There should be no evidence of damage, cracked casings, bent tie rods or any other unusual observations. Check the packing list to verify that the shipment is complete, noting receipt of miscellaneous items in crates or boxes. If any damage has occurred, or any material is missing, make a note on the carrier's freight bill and make sure that the driver signs on the same receiving copy. Notify the delivering carrier at once and also notify National Turbine immediately.

III. HANDLING

The unloading and handling of the centrifugal blower is the user's responsibility, and should be performed by personnel experienced in handling heavy machinery.

The complete assembly can be lifted from beneath the steel base (see figure 1) or with the lifting eyes if provided (see figure 2). Slings should be located near the ends of the base as shown in Figure 1. Bare machines can be lifted at the tie rods as shown in Figure 3. Never lift with the sling around shaft or flange as damage may occur to the machine.

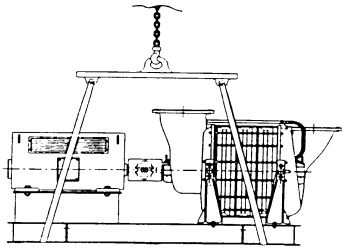


Figure 1

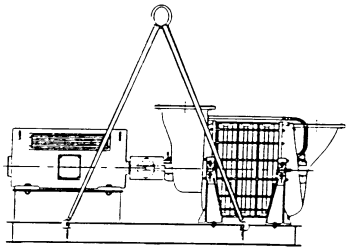


Figure 2

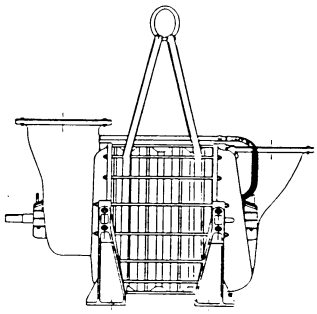


Figure 3

Eye bolts are NOT supplied with the machine. If eye bolts will be used to lift the blower, we recommend the use of drop forged, weldless shoulder pattern eye bolts, using full size flat washer and nut, screwed all the way down and properly seated. **DO NOT attempt to lift the unit with eye bolts threaded into the flanges.**

Failure to follow good safety practices when handling the machine could result in injury or death !

CAUTION-- There is no such thing as a "safe" eye bolt. Eye bolts can fail due to mishandling, improper use, alteration, excessive heat, paint or wear. Always stand clear of the load when handling and lifting.

IV. STORAGE - SHORT TERM (UP TO 90 DAYS)

Your centrifugal machine should be stored in a clean, dry, well ventilated area. Keep equipment covered (canvas preferred over plastic) and out of the elements. The storage area should be heated to prevent condensation. Rotate the blower and motor shaft at least once a week to prevent bearings from taking a set and to keep lubrication evenly distributed in bearing during idle periods. Be sure to keep a log of shaft rotations to ensure machine warranty protection.

V. STORAGE--LONG TERM

Several precautions must be observed when storing equipment for longer than 90 days:

a. Rotate shaft at least once a week and record in appropriate log. **FAILURE TO ROTATE CAN VOID YOUR WARRANTY.**
b. Suspend a bag of silica gel in the inlet and outlet heads to absorb excess moisture. Change bags periodically.
c. Coat exposed machined surfaces (e.g. shaft extensions) with protective grease.
d. Cover inlet and outlet flanges with a protective lid, if required.
e. Energize motor space heater (if provided).

NOTE--All Grease Lubricated Machines are shipped with lubrication in the bearings. On oil lubricated machines, install the oilers and fill to proper level. Periodically inspect some oil and check for moisture or contaminants, which may have entered the oil over an extended storage period. If evident, drain reservoirs completely and replenish with recommended oil.

Be sure to follow the motor manufacturer's instructions to properly maintain the motor during the storage period. Contact factory personnel for any special instructions regarding your particular blower equipment.

VI. INSTALLATION

A. Location

1. The location selected should be clean, dry, properly drained and adequately ventilated.
2. Indoor locations are preferable.
3. Plan ahead. Ample room is required for maintenance, lubrication and the removal of the machine or driver for servicing.

B. Foundation

The structural design of this unit and the smooth operation inherent in centrifugal machinery eliminates the need for massive foundations and costly site preparation. All that is required is a reinforced concrete floor or pad of sufficient strength to support the weight of the unit and ensure long term stability. Avoid mezzanines or catwalks. Also avoid hollow floors.

C. Positioning

Each unit is shipped with 4-6 resilient mounting pads. Locate one under each side of the base (see figure 4). Use shims (equal or larger in width than the base pads) between the base and pads if required to level the unit (see figure 5). It is especially important to ensure that the unit is level for oil lubricated machines.

DO NOT BOLT THE BASE DOWN!

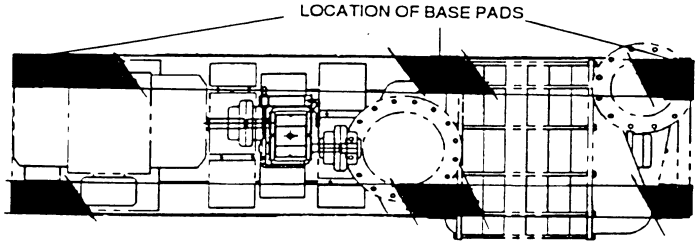


Figure 4

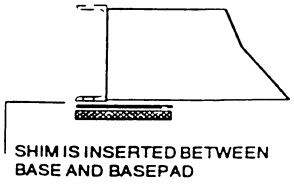


Figure 5

Locating studs may be used to position the machine but should not be used to anchor the unit.

Anchoring the unit (or worse yet, grouting the base in concrete) greatly increases the support stiffness and may result in increased levels of vibration measured at the bearings. It is unnecessary, costly and may degrade mechanical performance.

GROUTING IN CONCRETE MAY VOID WARRANTY.

NATIONAL TURBINE STRONGLY DISCOURAGES GROUTING OF THE UNIT BASE

If grouting must be done, follow these procedures:

1. Install the unit approximately 1" (25 mm) above the floor or foundation pad. Level the unit and firmly bolt the base to the foundation using spacer blocks in place of the resilient base pads. Align the motor to the blower/exhauster.

2. Non-shrinking or epoxy type grout is recommended. Follow the grout manufacturer's recommendation for foundation preparation. Typically, a rough surface with a caustic or acid etch after cleaning is suggested. Thorough wetting with water may also be recommended.

3. Build a form or dam around the base to contain the grout within the desired area. Pour the grout inside the dam and pack in place. Do not grout too deeply over the bottom of the base, allow removal of the equipment if the need arises. If grout is not used under the center of the base, remember to provide drain paths for any water that may accumulate.

D. Piping

NOTE: Isolation sleeves must be used to isolate blower from piping system.

Expansion joints or flexible sleeves should be used on the inlet and outlet. Restraining rods are not normally recommended. If used, do not bolt up hard on both sides of the flanges as thermal movement will be restricted, causing elevated vibration levels.

Do not allow machine flanges to carry substantial unsupported weight. All piping must be independently supported.

E. Accessories

a. Butterfly or Throttle Valve

We recommend throttling your centrifugal blower/exhauster on the inlet side of the machine to maximize the efficiency of the unit/motor.

Carefully remove shipping flange covers prior to assembling accessories. Make sure no foreign material enters the unit. When mounting the butterfly valve on the inlet, the valve should be positioned such that the valve shaft is at a right angle to the blower shaft and opens away from the body of the blower to allow smooth air entry to the blower. The rush of air should never be directed toward the first stage impeller (see figure 8).

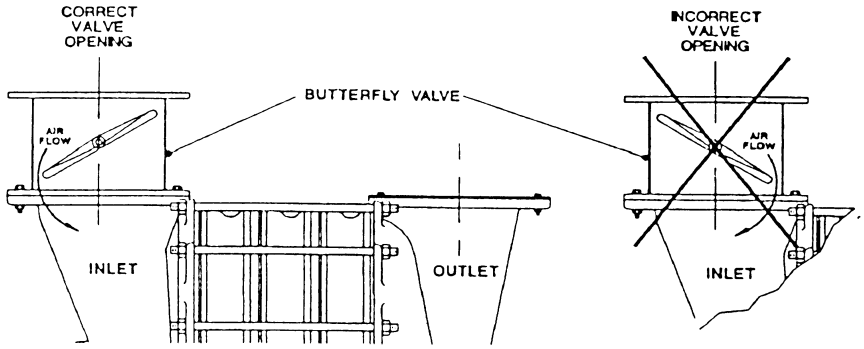


Figure 8

Always start blower with inlet valve closed. Open slowly after machine comes up to speed.

b. Check Valves

Check valves must be installed in the discharge piping to prevent reverse air flow from other blowers in the piping system. The check valve must be located downstream of any blow off lines.

If exhausters are operated in parallel, a check valve should be installed in the inlet piping of each machine and must be upstream of any bleed in the system.

c. Inlet Filter (Blowers)

National Turbine recommends the use of an inlet filter to keep foreign material from entering the machine. Abrasive, wet or bulky material will damage the machine's internal parts and could cause catastrophic failure. Consult factory for recommendations on inlet filter types and sizing

It is extremely important to keep inlet filters clean. Dirty or plugged filters will cause a low flow or surge condition which will result in substantial damage to your machine. Units damaged from running in surge are NOT covered under warranty.

d. Bleed Air or Surge Control Systems

If you plan to operate the unit near its surge point, then some type of surge protection is required. Contact factory for recommendations.

e. Drivers

Electric - Read and comply with motor manufacturer's installation and operation instructions which are attached to the motor. Make sure that the motor nameplate requirements agree with the available power supply at job site. All wiring **MUST** be done by a licensed electrician in accordance with the National Electrical Code (ANSI/NFPA 70), and other applicable national and local regulations.

Turbine, Diesel, Gasoline, Natural Gas - Read and follow manufacturer's installation and operation manual supplied with driver.

VII. ALIGNMENT

The following procedure is applicable to direct driven machines. For belt driven alignment, see Section VII B.

A. Direct Drive

Correct shaft alignment ensures long life and trouble-free service for your centrifugal blower. Misalignment is one of the most common causes of machine vibration and premature bearing failure. Proper alignment means establishing, as near as possible, a common axis of rotation for both driver and driven shaft. **Final shaft alignment is the responsibility of the installer/owner.**

1. All blowers, whether direct or belt driven, are cold aligned at the factory for mechanical testing purposes.
2. It is the nature of all centrifugals to grow thermally during operation due to the heat generated by compression and air/gas movement through the machine. This thermal growth causes misalignment from the original factory set "cold" condition.

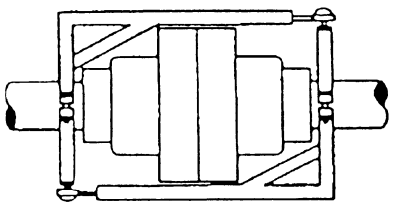
Alignment corrections must be made with the machine at operating conditions.

Centrifugal rotating equipment must have time to stabilize. This is the period of time required for the machine to reach operating conditions and temperature. This can take up to 1-2 hours. During this time, it is not unusual to experience higher than normal vibration levels while the machine is setting in and stabilizing; therefore, it may be necessary to disable vibration sensors during this period to avoid premature shutdown.

Alignment can be achieved using several methods. **Laser alignment** is the most accurate and quickest method of shaft alignment.

An alternate to laser alignment, **the reverse dial indicator** method is commonly used to achieve alignment. The reverse indicator method involves use of two brackets measuring directly off the shafts (see figure 9).

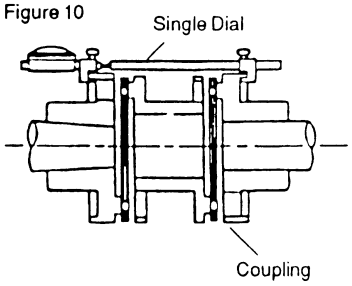
Figure 9



Single dial indicator method - used to measure parallel and angular misalignment. An alternative method is by use of a single dial indicator to measure both parallel and angular misalignment (see figures 10,11 & 12).

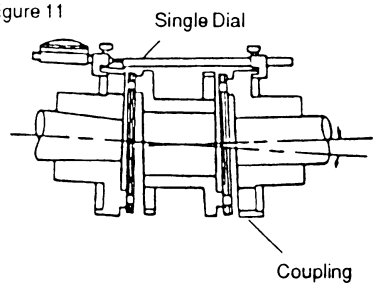
Caliper and straight edge method - is simple and effective if done correctly but cannot achieve desired tolerance (see figures 13, 14 & 15).

Figure 10



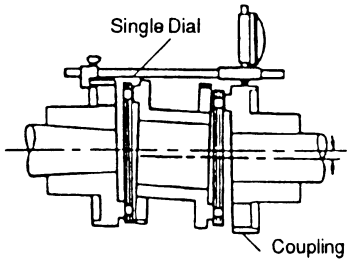
Coupling in Alignment

Figure 11



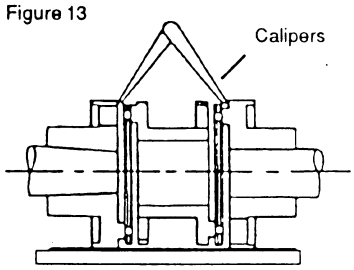
Angular Misalignment

Figure 12



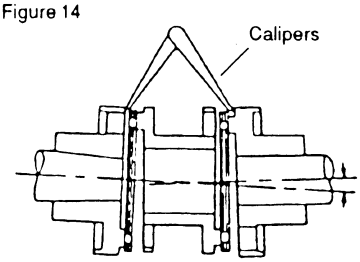
Parallel Misalignment

Figure 13



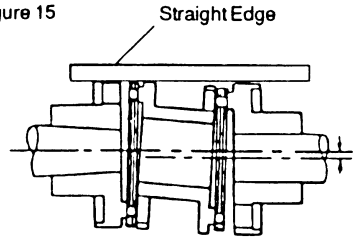
Coupling in Alignment

Figure 14



Angular Misalignment

Figure 15



Parallel Misalignment

After stabilization (when temperature rise has ceased), final alignment corrections should be made.

Recommended alignment tolerance is +/- .002 inches (.0508mm) parallel and ¼ degree angular.

The following conditions can affect alignment and can be a factor in trying to achieve good alignment:

a. Base and foundation must be level and smooth.
b. Piping must be isolated using flexible sleeves or expansion joints.
c. Pay particular care to outlet driven machines with horizontal discharge heads as thermal expansion can be multi-directional.
d. Machine structural base should be mounted on resilient vibration pads, as supplied, and should not be hard grouted (see section VI-C). Do not bolt down hard.

e. Check for soft foot. All driver (motor) support feet must be in the same plane. When one or more feet are higher than the others, a “soft foot” condition (table-leg effect) exists that must be corrected to allow for a more exact alignment.

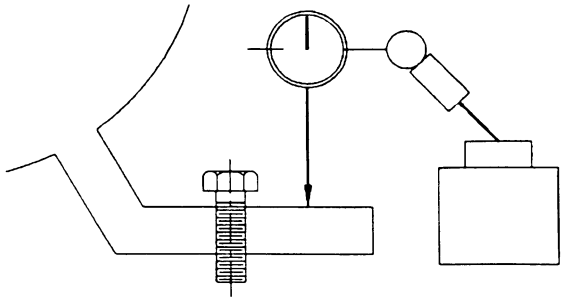


Figure 16

To check for soft foot:
With all motor hold down bolts tight, set dial indicator at tip surface of foot and zero it. Loosen that foot, noting the indicator movement. Tighten that foot. Perform same procedure on the adjacent foot. Add shims to the foot showing the highest reading. When the reading is brought to a value of less than .003 inches (0.076mm), check the foot that was checked first, to ascertain that a new soft foot has not been created. An acceptable reading would be less than .003 in (0.076mm).
Good alignment is critical to long bearing life. Lack of vibration at start up does not necessarily indicate good alignment.

IMPORTANT: Always lockout starter or motor control center when working on or near any rotating equipment

B. Belt Drive Alignment

Prior to alignment of belt driven systems, inspect piping system and installation to be sure it is in accordance with factory recommended specifications. Sheaves and belts must be clean and dry. Do not apply belt dressing.

Alignment is checked by placing a straight edge across the faces of both sheaves. If properly aligned (see figure 17), the straight edge will contact both sheave faces squarely. Incorrect alignment (see figures 18 & 19) can be adjusted by moving the motor into proper position.

Proper belt tension is important to ensure maximum belt and bearing life. Follow the instructions supplied with the tension meter (if used) to determine the proper belt tension. Belts may stretch slightly when first placed into service; therefore, recheck belt tension after the machine has been operated for a few hours.

When replacing V-belts, always replace with same type, manufacturer, and matching belts. Never mix new and used belts on a drive. Replace all belts with a matched set. Never force belts over the sheave. Remove tension from belts when out of service for lengthy periods.

Belt tension:

1. The best tension for a V-belt is the lowest tension at which the belts will not slip under the highest load condition.
2. Check the tension frequently during the first day of operation.
3. Check the tension periodically thereafter.
4. Too much tension shortens belt and bearing life
5. Keep belts and sheaves free of any foreign material which may cause slip.
6. If a belt slips, tighten it.

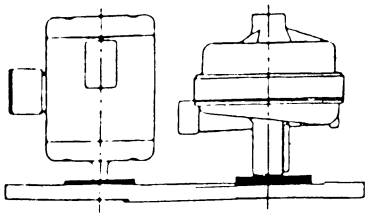


Figure 17
Proper Alignment

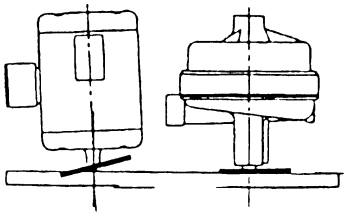


Figure 18
Angular

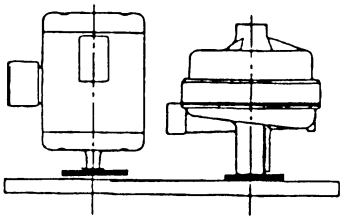


Figure 19
Parallel

IMPORTANT: Always lockout starter or motor control center when working on or near any rotating equipment

VIII. OPERATION

A. Pre-startup Checks:

1. Visible Damage (see Section II)
   Check for any evidence of shipping and/or installation damages, such as cracked castings, scrapes, bent tie rods, etc.

2. Verify Proper Installation (see Section VI)
   Ensure vibration pads installed, sufficient foundation, no grout, not bolted down, piping correctly installed and isolated from unit, inlet filters installed, all blind flanges removed. **Be sure all motor and machine hold down bolts (NOT BASE BOLTS) have been tightened securely.**

3. Coupling Alignment (see Section VII)
   Alignment of the motor/machine **must always be checked** prior to initial startup.

4. Belt Alignment (see Section VII)
   Always realign sheaves and re-tension belts prior to initial startup. Be sure belts are clean and dry. Recheck belt tension after the first couple of hours of operation.

5. Lubrication (see Section IX)
   Coupling must be lubricated per manufacturer's recommendations if lube type coupling is used. Motor bearings are to be lubricated per manufacturer's recommendations. Ensure that blower bearings on grease lubricated machines have been sufficiently lubricated for approximately 1500 hours of normal operation. Verify no water condensation has collected in the bearing housing by removing the housing cover and inspecting for moisture inside. If water is present, National Turbine recommends replacing the bearings to ensure warranty coverage in the event of bearing failure.

   Bearings of oil lubricated machines may require the addition of recommended oil to the oiler bottles. The oil level adjuster has been preset at the factory, but should be checked prior to start-up. (See Figure 20).

6. Safety Guards

   Coupling (or belt on belt drive) and motor fan guards should always be in place and tightened securely during operation. Do not operate machine with motor junction box open or any other electrical safeguard not in place. Make sure all starters or motor control centers are locked out.

7. Electrical Connections

Motor must be wired per nameplate and the control panel connected per electrical drawing. All accessories, such as valves, actuators, temperature sensors, etc. must be correctly wired per manufacturer's instructions.

 ***Large electrical motors may interfere with implantable medical devices such as pace makers***

Check current transformer for correct number of turns of motor lead through the "doughnut" for the ammeter and meter relay, if supplied. Consult factory if information is not readily available.

8. Initial Startup Checklist

Have you cleared with Operations Personnel?
No downstream maintenance being performed?
Shaft spins free by hand?
Coupling guards and safety devices in place?
Diffuser valves open, if applicable?
Outlet butterfly valve open?
Inlet butterfly valve closed?
Piping system ready for flow of air or gas?
Atmospheric bypass valves open, if present?
Energize control panel?
Momentarily "bump" motor to verify proper rotation as indicated by arrow cast into inlet head?

B. Operation

Press start button. Unit should reach full motor RPM in approximately 10 seconds. If not, de-energize control panel and investigate.

NOTE: Motor starting amperage draw will momentarily "peg" ammeter (if supplied).

-When full motor RPM is reached and amperage draw decreases, slowly open inlet valve to butterfly achieve desired air flow (or amps).
-Allow machine to reach its operating temperature (see next page) and then re-adjust flow rates as they may have decreased due to temperature variations.
-Adjust bypass valves (if present)
-Monitor vibration and temperature levels at the bearing housing and note any drastic or constant increases.

Although it may vary depending on size of unit and application, normal operating levels are:

Vibration:	Less than .0015 in. (.0381mm) in the vertical plane at each rod.
Temperature Range:	Inlet = 85°F to 120°F (29°C to 49°C)
	Outlet = 170°F to 235°F (77°C to 113°C)

1. Shutdown (Normal and Emergency)
   - Press Stop Button
   - Open bypass valves (if present)

NOTE: It is normal to hear "clacking" of the check valve during coast down.

- In the event of an electrical malfunction, during an emergency shutdown, de-energizing the control panel is recommended.

2. Operating Temperatures

   It is the nature of centrifugal compressors to run hot due to heat of compression and internal friction caused by movement of air. The higher temperatures will be on the discharge side of the machine. The following information will serve as a guide in determining acceptable temperature limitations under normal operating conditions. For specific applications, or operating temperatures outside of the figures shown, contact the factory.

3. Bearing Temperatures

   Bearings used in your centrifugal blower are designed to operate continuously in temperatures in excess of 200°F (93°C), measured on the bearing housing. Standard alarm circuitry, if supplied, is set to alarm at 230°F (110°C). If bearing temperature monitors are not supplied, check bearing housing temperatures, periodically, and notify National Turbine if readings exceed 220°F (104°C).

4. Discharge Air Temperature

   Under normal operating conditions, using ambient or atmospheric air, typical discharge air temperatures may also exceed 200°F (93°C) measured in the discharge air stream or on the surface of the discharge (outlet) head.
   Discharge temperature is affected by many factors including efficiency, flow, pressure, altitude, inlet temperature etc. so it is difficult to determine the exact discharge temperature to expect.

   Generally speaking, the discharge air temperature should not exceed 275°F (135°C) under normal operating conditions.

In all cases where other than ambient or atmospheric air is being compressed, or discharge temperatures reach 275°F (135°C), consult factory. Failure to do so could nullify factory warranty.

A NOTE ON NOISE...

Every effort has been made to keep the noise level of operating equipment below 85dBA, the current acceptable limit mandated by OSHA. Although hearing protection in not required by law, the manufacturer suggests the use of hearing protection when operating or working around this equipment.

CAUTION: If your centrifugal blower is being used in a hot application such as steam re-compression, or similar application where inlet temperatures exceed 200°F (93°C), the machine must be preheated slowly to 180°F (82°C) minimum, prior to introduction of hot process air, gas or vapor. Sudden introduction of above without preheating can cause serious damage to the machine and will void the factory warranty.

Information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted.

Blower and motor surfaces can remain hot for an extended period of time after equipment shut down. Exercise caution when working on or around this equipment when hot.

C. System Test

1. Surge Control Test
   Bring machine up to operating speed.

   Set trip point slightly above surge point on meter face. Different types of motors require different set up procedures - consult factory for specifications.

Surge is defined as the “unstable” flow of air through a machine. It can only be caused by a lack or air into, or a restriction of air out of, a blower or exhauster. Surge is harmful to centrifugal machines because the heat of compression within the blower is not allowed to be carried off, resulting in the aluminum impellers expanding to touch the inside walls of the cast iron housing. The heavy pulsating action of a unit in surge will inevitably cause the bearings and machine to fail. In some cases where heavy surge is experienced, a centrifugal machine can fail within a matter of minutes).

2. Amperage Test
   Meter must be checked for correct amperage reading. Compare actual amperage draw of the motor with that registered on the meter.

   With machine in full operation, use a “clamp-on” ammeter to measure actual amperage draw at motor, or motor starter. This amount should be reasonably close to that registered on the meter (within 5%). If amperage draw is not close to that measured or the meter, check to see that ratio stamped on current transformer matches that imprinted on the back of the meter, or check for the correct number of turns through the current transformer.

3. Overload Protection Test
   On units with motor overload protection, a high amps trip point also is on the meter face. This adjustment varies with the type of meter used; consult factory for details. With machine in full operation, adjust the meter, decreasing the set point until it crosses the meter reading. The overload alarm will sound and/or shutdown will occur. Be sure all horns, lights, etc. respond properly to the overload condition.

4. Bearing Temperature Monitors
   All Thermal-Guard systems are calibrated and preset at the factory to trip at approximately 230°F (110°). This high limit bearing temperature set point is sufficient for all equipment and must not be adjusted.

   To ensure accurate temperature detection, the temperature probe “bulb” should be immersed in a grease medium within the thermo well attached to the bearing housing.

   Be sure capillary tubes are secured properly and switch gauges are installed

correctly. Accuracy of the temperature monitor can be checked by immersing in oil heated to at least 230°F.

5. Vibration Monitor System

   Vibration sensors must be installed securely to the blower with all wires shielded and secured according to manufacturer's recommendations.

   Verify the alarm and ensure trip set points are set in accordance with manufacturer's recommendations. National Turbine recommends minimum settings of .003 inches (.076mm) (.45in/sec) for alarm and .004 inches (.1016mm) (.75in/sec) for shutdown. Test of vibration protection system varies with each manufacturer; therefore, consult manufacturer's installation manual for correct procedure for verifying proper operation.

IX. BEARING LUBRICATION

Proper maintenance and lubrication are of extreme importance to ensure long, reliable service from your machine. National Turbine centrifugal blowers are lubricated using grease or oil. The most common causes of overheating, noise and premature bearing failure are over-lubricating, use of the wrong type of lubricant, or use of contaminated lubricant.

A. Oil Lubricated

National Turbine centrifugal blowers are supplied with Oil-Rite Oilers. Trico oilers are non-standard and may be installed on a repaired or rebuilt unit. A premium hydraulic oil, ISO 68 (SAE 20) (either natural or synthetic) oil is required in oil lubricated machines up to and including the 126 series. ISO 46 (SAE 15) oil is recommended for the 1441 series. **Use of any other grade or weight of oil without explicit approval of the National Turbine will automatically VOID the machine warranty.**

Prior to shipment, the oil reservoirs are emptied. They **MUST** be refilled prior to start-up.

1. To check Trico Oiler (non-standard) oil levels:
    a. Be sure oiler base is perfectly level and the oiler bottle is positioned correctly on the oiler base.
    b. The distance between the edge of the oiler bottle collar and a theoretical line drawn through the center of the ribs on the oil reservoir cap is listed in the table below and in Figure 20 on the following page.

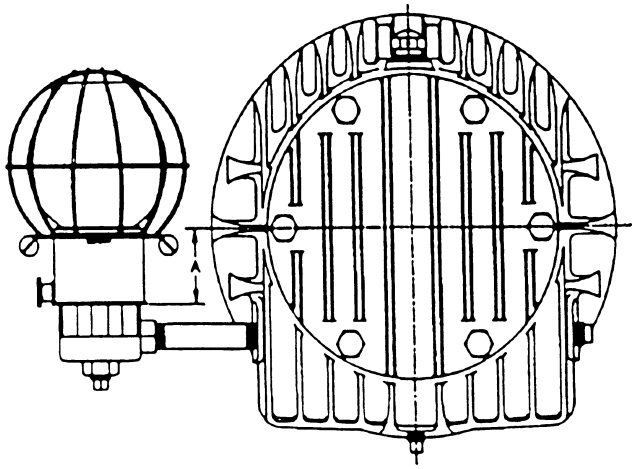
Model/Series	Dimension "A"	OIL
551/552/553/541	1-5/8" (41mm)	ISO 68 (SAE 20)
881/882/883/884	1-15/16" (49mm)	ISO 68 (SAE 20)
1221/1222/1223/1226	1-15/16" (49mm)	ISO 68 (SAE 20)
1441	2- 5/8" (67mm)	ISO 46 (SAE 15)

To measure, place straight edge horizontally along bottom edge of oil bottle collar and measure up to approximately center of rib.

NOTE: The level of oil in the glass oiler bottle is NOT an indication of oil level in the reservoir. It indicates only that there is an adequate supply of oil for the bearing reservoir.

c. If adjustment is required, proceed as follows:
   i. Remove oiler bottle and lift out the micrometer leveling rod located loose inside the oiler base.
   ii. Adjust the wing type leveling nut (upper) up or down as necessary. Lock in place with locking nut (lower).
   iii. Replace micrometer leveling rod inside oiler base.
   iv. Drain at least 1 cup of oil out of reservoir.
   v. Fill oiler bottle with approved oil and invert into oiler base (a quick motion will minimize spillage). Lock in place with thumb screw on oiler bottle collar.

Figure 20



Whenever refilling system with oil, NEVER pour oil directly into oiler base. Always fill oiler bottle and invert onto oiler base. Never interchange micrometer leveling rods.

2. To check Oil-Rite Oiler Levels:

   Oil-Rite Oilers are provided with a sight glass in the oiler base. The sight glass has a "full" mark etched horizontally. Regardless of the oil level in the glass reservoir, the sight glass full mark is the indication of the correct oil level. The Oil-Rite Oilers are factory preset; no field setting is needed.

CAUTION: For Oil-Rite Oilers, the vent hose must be connected between the oiler base and the top of the machine bearing housing.

To add oil to the bearing housing, remove the screw cap attached to the top of the Oil-Rite Oiler. Fill bottle with oil. Replace screw top until it is snug against the top of the oiler. This will permit the oil to flow into the bearing housing. A bubbling action will take place as long as the bearing requires oil. Repeat the filling of the Oil-Rite Oiler bottle until this bubbling action stops. When the bubbles stop, it is an indication that the bearing housing has the proper amount of oil. Note: It can take as long as 8 hours to fully fill the oil reservoir !

FILLING INSTRUCTIONS

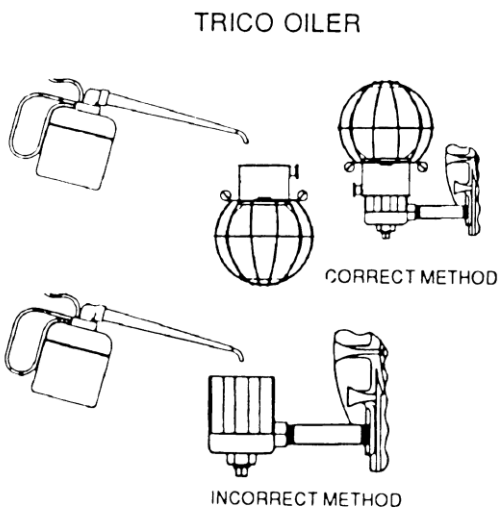


Figure 21

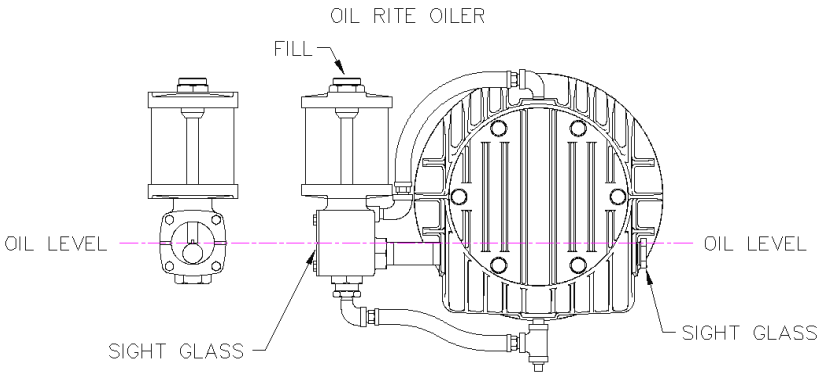


FIGURE 22

3. <u>Maintenance:</u>

Add oil as often as needed. Once every year of normal operation, drain oil completely and refill with clean fresh oil. During the re-lubrication process, it is of critical importance to protect both the lubricant and the bearing from contamination by dust, dirt, or any foreign materials. Each oil reservoir has a magnetic drain plug. Check plug periodically for any material that may be present. If metal shavings or particles are observed, consult factory. In some climates, idle machines may experience condensed moisture in the reservoirs. It is important to drain a small amount of oil and check for water before placing these machines in service.

B. Grease Lubrication

The greatest cause of bearing failure is over greasing rather than under greasing. For this reason, National Turbine does not recommend use of permanently installed grease fittings as they invite over greasing.

A special high speed grease is required in grease-lubricated machines. Use of any other type of grease without explicit approval of National Turbine will automatically **VOID THE MACHINERY WARRANTY.**

GREASE SPECIFICATIONS

NLGI GRADE ..... NO. 2
THICKENER TYPE ..... POLYUREA
THICKENER % 9.5
OIL ..... MINERAL OIL
VISCOSITY ..... 11O CST @ 40°C
VISCOSITY INDEX 90
DROPPING POINT (ASTM D2265) ..... 470°F (243°C)
ADDITIVES ..... .OXIDATION & RUST INHIBITORS
TEMPERATURE RANGE ..... -22°F (-30°C) TO 347°F (175°C)
TEXTURE ..... .SMOOTH, BUTTERY
COLOR ..... BLUE-GREEN

Prior to shipment, blower/exhauster bearings are adequately lubricated for 1500 hours of operation under normal operating conditions. If three months or more have elapsed since shipment from the factory, remove bearing housing covers and inspect for moisture due to condensation.

To add grease during operation:

i. Remove plugs from top of bearing housing and bottom of bearing cap or packing housing. (see diagram on page 32 for gas blowers, page 33 for air handling machines). Install grease fitting into the top of the bearing housing.
ii. Bring blower/exhauster up to a stabilized operating temperature. **On gas handling machines, turn off blower or gas may escape-** air handling units may be lubricated when running.
iii. Add grease through the top opening in the specified amount (see table 3)
iv. Remove Grease fitting and reinsert plug in top opening
v. After thirty minutes wipe off expelled grease and reinstall bottom plug.

Alternate Greasing Procedures:

Recommended every two years of normal operation or six months of abnormal operating conditions such as high speed operation (V-belt drives above 3550 RPM, dirty environment, high pressure and temperature.

i. With the machine fully stopped, remove bearing cover and plugs.
ii. Remove all old grease from bearings, housing and cover by flushing with a clean solvent.
iii. Repack face of bearing by hand and add remainder of specified amount to bottom half of bearing cover.
iv. Reinstall plugs and bearing cover and start unit.

Table 3: Grease Quantities

Series	Full Replacement	Periodic Addition
331	1.6 oz. (45g)	1 oz. (28g)
551/552/553/541	3.1 oz. (87g)	2 oz. (56g)
881/882/883/884	5.5 oz. (154g)	3 oz. (84g)
1221/1222/1226	5.5 oz. (154g)	3 oz. (84g)
1223	7.0 oz. (196g)	4 oz. (112g)

 **IMPORTANT: Always lockout starter or motor control center when working on or near any rotating equipment for maintenance or repairs.**

X. MAINTENANCE

Some simple maintenance procedures will help prolong the life of your centrifugal equipment:

1. Periodically inspect foundation and correct if deficiencies are found. Check for level condition and correct as necessary.
2. Check condition of isolation pads and replace as necessary.
3. Make sure lubrication maintenance schedule is established and adhered to.
4. Periodically check all valves in system. A stuck or broken valve can cause severe damage to equipment.
5. Alignment should be checked and corrected twice yearly.
6. Check pipe supports and adjust if necessary.
7. Keep equipment clean. If machine is oil lubricated, be sure to keep oiler bottle clean so oil, or lack of, can be seen. Keep oil breather cleaned to prevent leaks.
8. Follow motor manufacturer's recommendations for motor maintenance.
9. Vibration readings and bearing temperature readings should be taken periodically to monitor the condition of the machine bearings which are the most critical component in your machine. If equipment to do this is not available, consult National Turbine for service rates.

 **IMPORTANT: Always lockout starter or motor control center when working on or near any rotating equipment for maintenance or repairs.**

XI. SERVICE

There are some service functions that can be easily performed on your centrifugal blower. These include bearing changes, seal changes, coupling service and some other external type repairs.

Major repairs usually require dismantling of the machine. This should only be performed by a Factory Service Technician. In all cases, you should contact National Turbine at 1+888-293-7434 (1+315-455-5591)

Failure to notify National Turbine prior to working on your centrifugal for any reason within the warranty period can void the factory warranty.

A. Bearing removal and replacement:
This section applies to inlet and outlet, motor or belt driven machines for air or gas service.

On all centrifugals, the inlet bearing is the fixed bearing. If changing both bearings, always change inlet bearing first. When complete, change outlet bearing.

1. Drive end bearing:

a. If a direct driven machine, remove motor (or in case of spacer-type couplings you need only remove spacer). Next, remove the coupling hub by loosening set screws and applying heat to hub. NOTE: Do not apply excessive heat. The hub needs only 40-50°F(4.5-10 C) temperature differential over ambient for normal removal. For hubs that are press fit (special applications only) more heat will be required. Use standard puller to remove hub. Do not try to pry or hammer off.

b. If belt driven machine, remove sheave.

c. If the unit is a gas machine and grease lubricated, it will have a packing gland at the drive end. Remove packing gland, packing, and packing housing.

NOTE: Some gas tight machines, regardless of lubrication, have purged shaft seals. The purge connections will be visible through the openings in the bearing housing. These connections should be removed at this time.

d. If oil lubricated:
   i. Remove drain plug in bottom of housing and drain oil. Remove oiler bottle assembly. If Trico Oiler, remove leveling cross arm assembly in bottom of oiler cup.
   ii. Remove oil reservoir cap, gasket, bearing locknut, bearing lock washer, oil slinger, and spacer if present.

e If grease lubricated:
   i. Remove bearing cap and gasket.
   ii. Remove bearing locknut and lock washer.

f. Bearing housing and bearing are now ready for removal. At this time loosen the bolts that fasten the labyrinth or carbon ring seal to the head. This is necessary to prevent damage to the seals since the shaft will drop somewhat when the bearing is removed. **When removing bearing and housing, pay careful attention to procedure. All centrifugals have inlet (suction) side bearing as fixed bearing. Outlet (discharge) bearing is free end bearing and as such may have wavy (or thrust) washers under bearing outer race and shims under bearing inner race. A grease slinger may also be present under the inner race of inlet and outlet bearing. It is important to note the type and quantity of hardware removed with the bearing because the bearing must be re-installed in exactly the same manner.**

g. Remove bolts that fasten the bearing housing to the head.

h. Use a puller to pull the bearing housing away from the head. The bearing will come off with the housing. Do not use wedges or hammer to pry housing as damage may result.

i. Remove gasket.

j. Carefully invert bearing housing on a clean surface and lightly tap on back of bearing until it drops out of housing.

k. Thoroughly clean all parts. At this time, it is important to inspect all parts removed, and replace those which show wear or damage

A bearing, once removed for any reason, must always be replaced, regardless of its condition or appearance. Removal poses the risk of damage or contamination. All gaskets must be replaced with factory replacements regardless of appearance or condition. The thickness of the gaskets is critical to component spacing.

Failure to adhere to above may void factory warranty.

2. **Opposite drive end bearing**
   Delete steps a, b, and c above and proceed as outlined in steps d through k.

3. **Bearing replacement:**
   a. To complete bearing reassembly, reverse the procedure for removal.

   b. Place new gasket between head and bearing housing and hold in place with a small amount of grease. National Turbine does not recommend adhesive since it will make future replacement difficult.

   c. Bolt bearing housing firmly to head making sure that oil return hole in the brass labyrinth is on the bottom. Tighten bolts slowly and evenly in an alternating pattern.

      Use the following procedures while installing the new bearing to facilitate installation and minimize damage to the bearing.
      * Keep all parts, work areas, installation tools clean and free from debris.
      * Apply a light coat of oil or grease to housing bore, shaft journal and lands of brass labyrinth. Apply a light coat of grease or oil to the bearing surfaces only.
      Bearing should be lightly tapped into position by applying force to the inner and outer race simultaneously. Always use a soft drift or mounting sleeve. Never hammer on a bearing or use excessive force for installation.
      *Do not apply excessive amounts of heat to bearing. It is not necessary. A light heating may be used if desired.

   d. After bearing change is complete, start machine and re-tighten the labyrinth seals.

B. Seal removal and replacement

Labyrinth seals are a non-contact air seal at the shaft. Their replacement is necessary when air begins to escape from inside the centrifugal. A slight amount of leakage is normal and is not cause for seal replacement.

1. To replace seals, the bearing housings must be removed. Follow the procedure in Section XI-A for bearing and bearing housing removal.

2. After the bearing housing is removed, the seal can be removed.

NOTE: There are no gaskets under the labyrinth seal.

3. To replace seal, apply a coating of grease to the lands of the labyrinth and CAREFULLY slide seal over shaft. Too much grease will negate the effectiveness of seal. Do not fill grooves. The labyrinth is a zinc/aluminum bearing material and is soft. Mishandling will result in damage.

4. Bolt seal to head HAND TIGHT only. The seal should only be tightened after the machine is completely reassembled and while the machine is running.

5. On gas machines, the seal (OUTLET END ONLY) must be installed with spring washers, and the mounting bolts must be coated with “Loctite. Tighten the screws just enough to allow the seal to self center when the bearing is installed. The “Loctite” will lock the mounting bolts in place so that the seal stays centered on the shaft.

C. Coupling maintenance:

Centrifugals use a variety of couplings and belt drives. Proper use and maintenance is critical to the operation of the machine and safety of personnel. Prior to starting machine, coupling alignment must always be performed by installer of equipment (see Section VII).

1. After alignment and at periodic intervals thereafter, check to make sure set screws are tight.

2. Check center element or disc packs for wear and replace worn parts immediately.

3. If coupling is a lubricated type coupling, be sure to follow manufacturer’s

lubrication schedule.

4. Check and correct as necessary shaft and hub spacing.

5. Always operate machinery with coupling guard in place.

6. Always check coupling spacing at shaft separation. Improper spacing will cause elevated vibration readings.

7. On sleeve bearing motors, be sure motor shaft is in correct axial position.

D. V-Belt maintenance:

1. After initial run-in period, re-tension belts as necessary (see Section VII).

2. Always use matched belts.

3. Never install belts by rolling them over the sheave as this will shorten life considerably. Loosen motor and move sheaves closer together to remove and install belts.

4. Inspect belts for cracks or heat glazing and replace if evident.

5. Never use belt dressing.

6. Use only belts identical to those originally supplied.

E. Carbon Ring maintenance:

1. For removal of carbon ring assemblies, see Section XI-B on labyrinth seal repair and removal and follow the same procedure.

2. Use caution when working with carbon rings as they are extremely brittle and break easily. Check for cracks or chips and replace as necessary.

3. Typical labyrinth and carbon ring arrangements are shown on drawings included with these instructions..

F. Parts for Replacement:

Most replacement parts are available from factory inventory for same day shipment. When ordering replacement parts, please have available the machine serial number

and catalog or model number, as well as any additional information such as special application, etc., which will help expedite your parts shipment. The illustration in Appendix A will assist in determining which replacement parts are needed as well as serve as a guide to do some simple maintenance.

XII. TROUBLESHOOTING GUIDE

Problem: (A) Low Air Flow or Loss of Pressure	**for more information see…**	
	Section	**Paragraph**
1. Incorrect machine rotation	VIII	A.8
2. Restricted inlet piping	CHECK SYSTEM	
--Valve not full open	VI	E.a
--Dirty filters	VI	E.c
--Shipping covers not removed	VI	E.a
3. Partially blocked outlet piping	CHECK SYSTEM	
--Open all outlet valves	VIII	A.8
--Check valve in proper direction	VI	E.b
--Clogged diffusers	VI	E.c
4. Gauge not reading accurately	VIII	C.2
5. Decreased motor speed	VI	
--Incorrect voltage	VI	E.e
--Incorrect phasing	VI	E.e
6. Incorrect reassembly of machine	XI	A-E
7. Increased inlet temperature	VIII	B.4
8. Increased inlet pressure	VIII	B.4
9. Improper design, or assembly, of the piping system	VI	D
10. Worn impellers	CONSULT FACTORY	
11. Foreign material in machine	VI	E.c

Problem: (B) Excessive Vibration	**for more information see…**	
	Section	**Paragraph**
1. Baseplate must never be bolted down or grouted in	VI	C
2. Isolation pads	VI	C
--Positioned incorrectly	VI	C
--Improperly sized	VI	C
3. Expansion joints	VI	D
--Machine must be isolated from system piping by flexible sleeves or expansion joints. **NEVER** bolt piping directly to blower.	VI	D
4. Misalignment	VII	
--The number one cause of excessive vibration in Equipment.	VII	A-B
5. Foundation	VI	B
--Machine must be mounted on a SOLID, level foundation.		

Recommend 6” thick concrete pad on a solid ground floor.	VI	B
6. Unsupported piping	VI	D
--The piping system must be adequately supported above the flexible connections.	VI	D
7. Loose hold-down bolts		
--The motor and machine hold-down bolts may have loosened.	CONSULT FACTORY	
8. Foreign material in machine		
--Liquids (such as water, etc.)	CONSULT FACTORY	
--Hardware (such as bolts, filter pieces, etc.)	CONSULT FACTORY	
--Dirt and grease buildup over time	CONSULT FACTORY	
9. Surge		
--Adjust valves to keep blower from operating in the surge range.	CONSULT FACTORY	
--Blocked inlet or outlet piping	CONSULT FACTORY	
10. Motor vibration		
--Improper voltage	VI	E.e
--Failing motor bearing	CONSULT FACTORY	
--Imbalance within motor (such as broken fan, etc.)	CONSULT FACTORY	
11. Centrifugal bearings		
--Damaged during replacement	XI	A
--Over lubrication, or wrong type of lubricant	VIII	A.5
--Wrong type of bearings	CONSULT FACTORY	
--Inadequate storage maintenance	IV, V	
12. Coupling		
--Improper lubrication	VIII	A.5
--Incorrect shaft spacing	XI	C
--Imbalance (such as damaged coupling or wrong key size)	CONSULT FACTORY	
--Loosened set screws	CONSULT FACTORY	
13.Imbalance		
--Motor (due to rotor, bearings, or fan)	CONSULT FACTORY	
--Coupling	CONSULT FACTORY	
--Centrifugal (due to impellers, shaft, or bearings)	CONSULT FACTORY	

Problem: (C) Noisy Machine	**for more information see… Section**	**Paragraph**
1. Noisy bearings (motor or machine)		
--Too much grease – bearings hot	VIII	A.5
--Too little grease – bearings dry	VIII	A.5
--Bearings failing	CONSULT FACTORY	
--Retainer/locknut loosened	XI	A
--Bearing housing worn	XI	A
--Bearing overload, excessive thrust due to higher density of air	CONSULT FACTORY	

	Section	Paragraph
--Incorrect installation	XI	A
2. Coupling spacing incorrect	CONSULT FACTORY	
3. Foreign material in machine	CONSULT FACTORY	
4. Foreign material in piping	CONSULT FACTORY	
5. Surge	VIII	C
6. Labyrinth seal(s) contacting shaft	XI	B
7. Noisy motor		
--Incorrect voltage	CONSULT FACTORY	
--Low voltage (+10% of nameplate)	CONSULT FACTORY	
--Voltage imbalance (+10% between legs)	CONSULT FACTORY	
--Low frequency (60 Hz v. 50 Hz)	CONSULT FACTORY	
--Damaged bearings	CONSULT FACTORY	
--Defective fan	CONSULT FACTORY	
--Loose internal parts	CONSULT FACTORY	
--Excessive amperage draw (must not exceed nameplate)	CONSULT FACTORY	
8. Inadequate shaft spacing	CONSULT FACTORY	
9. Loose or damaged coupling	CONSULT FACTORY	

Problem: (D) Oil Leakage	**for more information see… Section**	**Paragraph**
1. Oil level too high	IX	A
--Operator or maintenance personnel overfilling oilers	IX	A
--Improper oil level adjustment (Trico oilers)	IX	A
--Incorrect replenishing procedure	IX	A
2. Wrong type of oil (use recommended oils ONLY)	CONSULT FACTORY	
3. Breather vent clogged (Trico oilers), or vent hose clogged or pinched (Oil-rite oilers)	CONSULT FACTORY	
4. Air labyrinth seal leaking excessively	CONSULT FACTORY	
5. Incorrect bearing assembly	XI	A
--Oil slinger bent or not positioned properly	CONSULT FACTORY	
--Housing gasket loosened or damaged	CONSULT FACTORY	
--Gasket blocking oil return hold	CONSULT FACTORY	
--Brass labyrinth seal oil drain holes not at bottom, or labyrinth loose in bearing housing	CONSULT FACTORY	
6. Shaft not concentric with seal	CONSULT FACTORY	
7. Thumbscrew/Feed stem not seated all the way down (Oil-rite oilers)	CONSULT OILER O & M	
8. Oil reservoir glass cracked (Oil-rite oilers)	CONSULT FACTORY	
9. Loose connections to oiler	CONSULT OILER O & M	
10. Oilers located on wrong side of machine	CONSULT FACTORY	

Problem: (E) Overheating	**for more information see.. Section**	**Paragraph**
1. Overheating machine		

--Surge		
--Inadequate air flow	SEE PROBLEM A	
--Clogged intake air filters	VI	E.c
Machine being back-pressured excessively by downstream process	CHECK SYSTEM	
--Inadequate ventilation in room	CHECK SYSTEM	
--intake too hot	CHECK SYSTEM	
2. Overheating bearings		
--Damaged bearings		
--Excessive lubrication, or wrong type	IX	A,B
--Incorrect class of bearings	XI	A
--Improper assembly procedure	XI	A,B
--High ambient temperatures	VIII	B
3. Of motor		
--High ambient temperatures	VIII	B
--Incorrect voltage	VI	E.e
--Unbalanced voltage supply	VI	E.e
--Restricted air flow (for cooling)	CHECK SURROUNDINGS	
--Motor overloaded – motor too small for system	CONSULT FACTORY	
--Improperly tensioned belts on V-belt drive systems	VII	B
--Fuses improperly sized	VI	E.e
--Bearing failure	VI	E.e
--Motor overload – heaters improperly sized	VI	E.e
--Shorted starter windings	CONSULT FACTORY	
--Too frequent starting	CONSULT FACTORY	
--Motor fan rotation incorrect	CONSULT FACTORY	

Problem: (F) Repeated bearing failure	**for more information see… Section**	**Paragraph**
1. Not using proper bearings	CONSULT FACTORY	
2. Not using recommended lubricant	IX	A,B
3. Excessive lubrication	IX	A,B
4. Improper assembly	XI	A
--Correct number of bearing shims	XI	A
--Wavy washer positioned properly	XI	A
--Oil and grease slingers positioned properly	XI	A
--All gaskets to original thickness	XI	A
5. Bearing housing worn excessively, shaft journal worn	CONSULT FACTORY	
6. Coupling alignment	VII	A
--Coupling manufacturer specs followed for:		
--hub-to-hub spacing	CONSULT O & M	
--shaft-to-shaft axial clearance	CONSULT O & M	
7. Shafts not rotated weekly on idle units	V	a
8. NOTE: Many non-mechanical problems can lead to frequent or repeated bearing failure. They may include improper installation, application or operation of machine.	CONSULT FACTORY	

Problem: (G) Surge	For more information see… Section Paragraph
1. Restricted inlet piping	VI, VII
2. Blocked outlet piping	CHECK SYSTEM
3. Increased fluid level in aeration tank	CONSULT FACTORY
4. System imbalance	CONSULT FACTORY
5. Incorrect valves or valve timing	CONSULT FACTORY

XIII. WARANTY

National Turbine warrants products manufactured by it to be free from defects in materials and workmanship under normal use and proper maintenance for a period of one (1) year from date of shipment, unless otherwise noted. If within that period any such products shall be proved to National Turbine's reasonable satisfaction to be defective, such products shall be repaired or replaced at National Turbine's option.

National Turbine's obligation and Purchasers exclusive remedy shall be limited to such repair and replacement following Purchasers written notice of any defect no later than ten (10) days after its discovery, and at National Turbine's option, the return of such products to National Turbine, F.O.B. factory. National Turbine reserves the right to satisfy its warranty obligation in full by reimbursing the Purchaser for the equipment's full purchase price.

Components manufactured by others are not warranted by National Turbine, however, to the extent possible, the Company shall provide Purchaser with such other manufacturers' warranties as are available. National Turbine makes no warranty with respect to wear or use items, such as belts, filters, bearings, or gaskets, which are sold strictly as is.

THESE WARRANTIES ARE EXPRESSLY IN LIEU OF ANY OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ANY OTHER OBLIGATION ON THE PART OF NATIONAL TURBINE.

XIIII. PRODUCT SAFETY

Products designed and manufactured by National Turbine are capable of being used in a safe manner, but National Turbine cannot warrant their safety under all circumstances. Purchaser must install and use the products in a safe and lawful manner in compliance with applicable health and safety regulations and laws and general standards of reasonable care.

SURGE IN CENTRIFUGAL COMPRESSORS (BLOWERS AND EXHAUSTERS)

A centrifugal blower is normally connected to a piping system and delivers air through that system for ultimate use on some required operation. If the demand of this operation (and consequently of the piping system) gradually or suddenly decreases, the pressure from the blower and in the piping system will increase until it reaches the highest pressure peak of which the blower is capable.

If the load or volume requirement (demand) decreases still further, the blower delivery pressure tends to decrease from its peak, resulting in the pressure in the piping system becoming greater than the pressure from the blower. Air then tends to reverse its direction and flow back into the blower until both pressures become equalized and the blower can again resume its normal function of pumping air into the system.

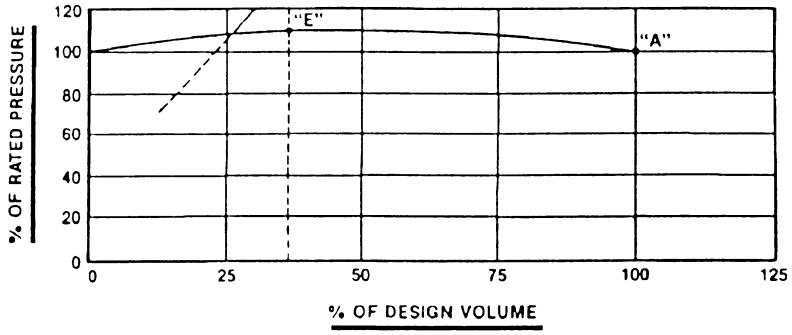
Until demand requirements increase, this backward and then forward flow of air – this pulsation or surge – will continue. It can cause undue strains on the blower and possibly failure of bearings and/or rotating assembly due to repetitive thrust strain and overheating. It is costly and dangerous to permit volume (load) requirements to drop so low as to cause surge.

Perhaps the foregoing will be more easily understood by reference to the sketch below, which is a typical pressure volume curve of a centrifugal blower. Point “A” indicates the normal operating point of a blower. Point “E” is the high point on the curve. Stable conditions will always be experienced when the volume demand is to the right of this point. Under actual operation, surge is not a factor until the volume demand of the system drops to a point to the left of point “E”, and until pressure consequently drops below that at point “E”.

The frequency and intensity of pulsation or surge depend upon the slope of the characteristic curve of the blower involved, the rate at which the air is being removed, the pressure in the blower, and the volume of the piping system to which the blower is delivering air. Backward curved impellers have a lower volume than units with radial vane impellers. Occasionally a blower will deliver air to a system so balanced that resonance occurs; in this case, even a slight surge will build up forces to significant amounts.

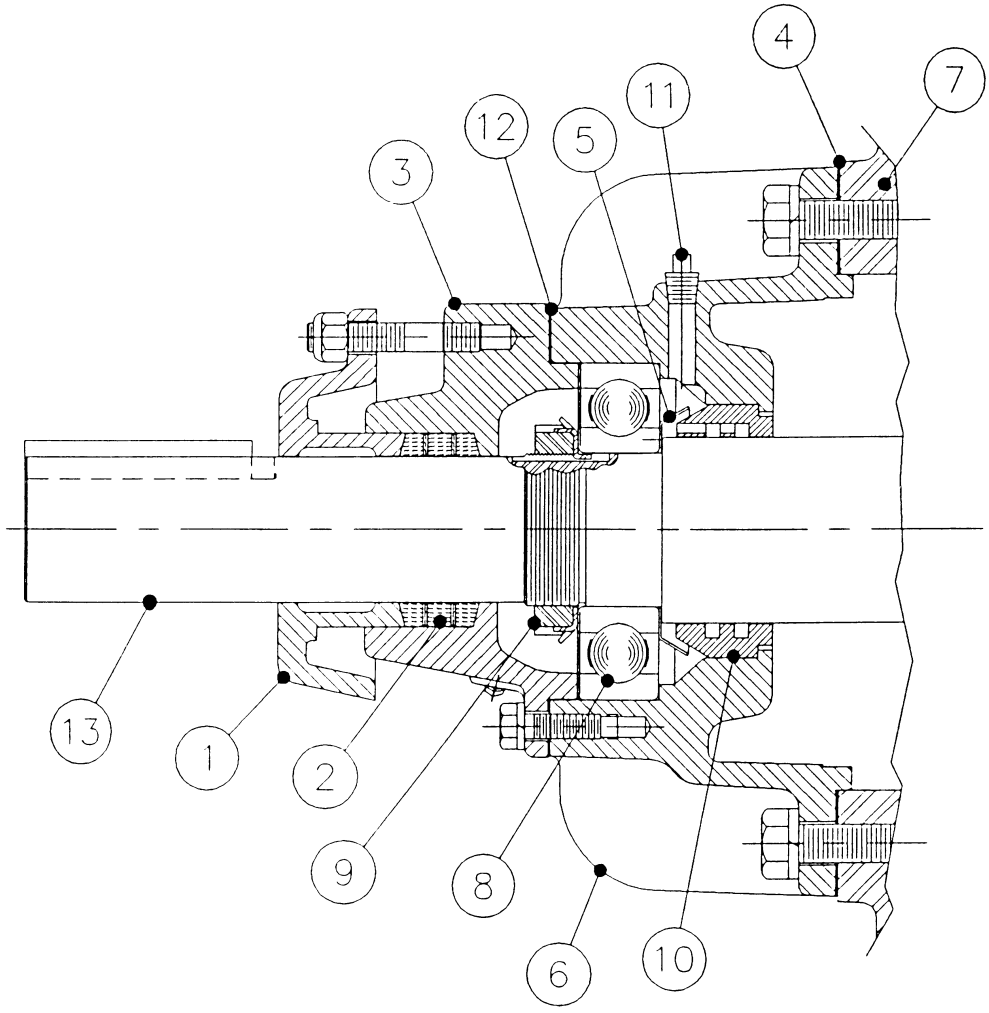
These same principles apply whether a centrifugal unit is operating as a blower or an exhauster.

The approximate surge point is commonly shown on blower and exhauster performance curves as the first data volume point.

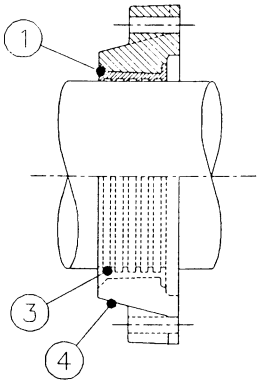


APPENDIX A

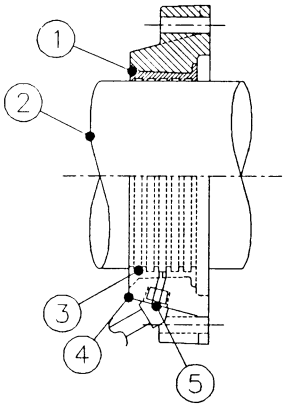
GAS ASSEMBLY



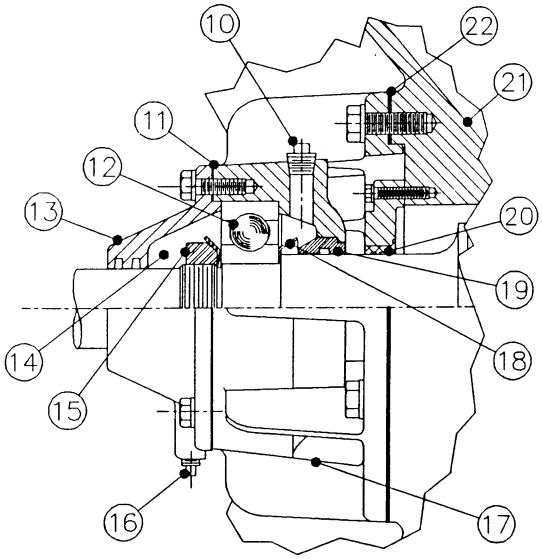
1 PACKING GLAND
2 PACKING
3 PACKING HOUSING
4 HEAD GASKET
5 GREASE SLINGER
6 BEARING HOUSING
7 CAST IRON INLET/OUTLET HD.
8 BALL BEARING
9 BEARING L'WASHER & L'NUT
10 NON-SCORING LAB'Y SEAL & STANDBY SHAFT SUPPORT
11 GREASE INJECTION PORT
12 CAP GASKET
13 SHAFT



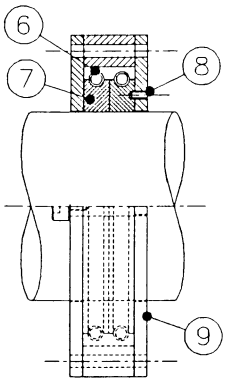
LABYRINTH SEAL



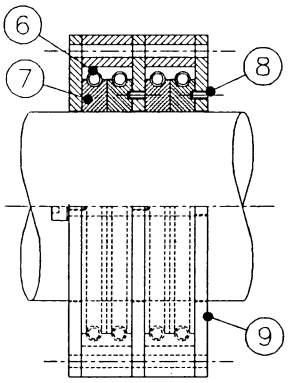
PURGED
LABYRINTH SEAL



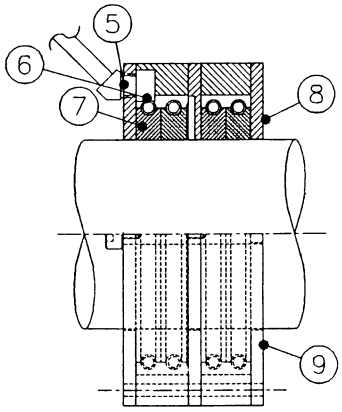
BRG. HOUSING / LABYRINTH SEAL ASSY.



SINGLE
CARBON RING SEAL



DOUBLE
CARBON RING SEAL



PURGED DOUBLE
CARBON RING SEAL

1 BABBITT LABYRINTH SEAL
2 SHAFT
3 LANDS & GROOVES
4 CAST IRON HOUSING
5 PURGE CONNECTION
6 S/S GARTER SPRING
7 SEGMENTED CARBON ELEMENTS
8 ELEMENT LOCKING PIN
9 STEEL HOUSING
10 GREASE INJECTION PORT
11 CAP GASKET
12 BALL BEARING
13 CAST IRON BEARING CAP
14 GREASE RESERVOIR
15 BRG. L'WASHER & L'NUT
16 GREASE PURGE PORT
17 CAST IRON BEARING HSG.
18 GREASE SLINGER
19 NON-SCORING LAB'Y SEAL & STANDBY SHAFT SUPPORT
20 BABBITT LABYRINTH SEAL
21 CAST IRON INLET/OUTLET HEAD
22 HEAD GASKET, HEAT BARRIER TYPE