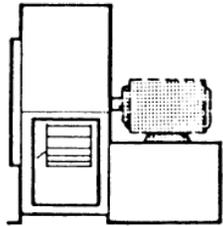


Robinson Fans, Inc.



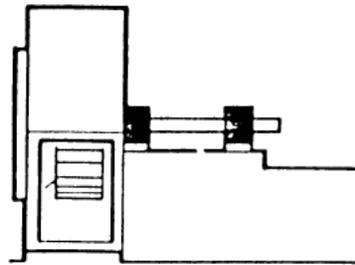
Fan Nomenclature

Overhung Wheels Single Width Single Inlet (SWSI)



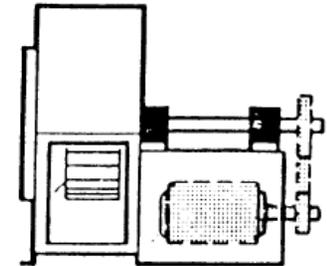
ARR. 4 SWSI

For direct drive. Impeller overhung on prime mover shaft. No bearings on fan. Prime mover base mounted or integrally directly connected.



ARR. 8 SWSI

For belt drive or direct connection. Arrangement 1 plus extended base for prime mover.

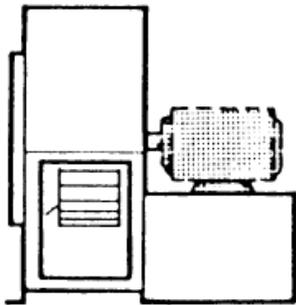


ARR. 9 SWSI

For belt drive. Impeller overhung, two bearings, with prime mover outside base.

Fan Nomenclature

Overhung Wheels Single Width Single Inlet (SWSI)



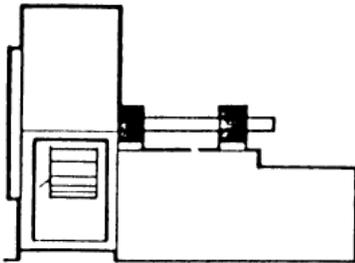
ARR. 4 SWSI

For direct drive. Impeller overhung on prime mover shaft. No bearings on fan. Prime mover base mounted or integrally directly connected.



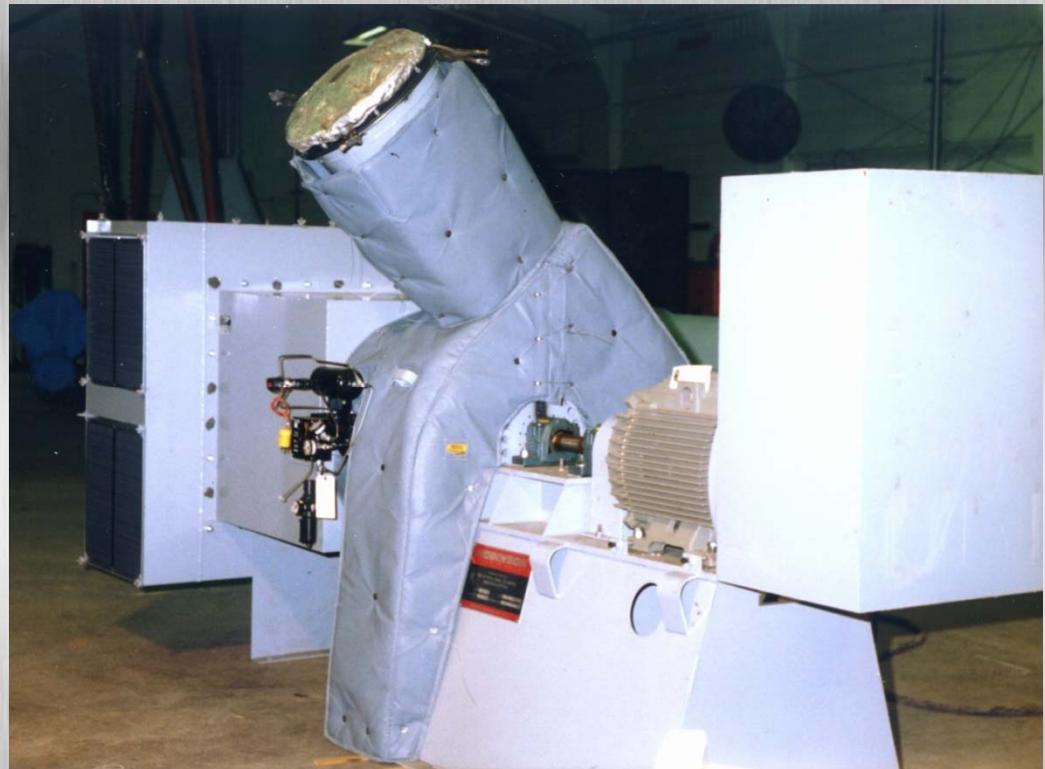
Fan Nomenclature

Overhung Wheels Single Width Single Inlet (SWSI)



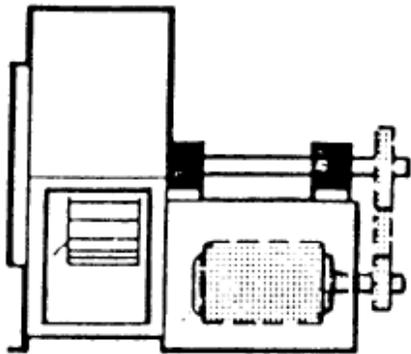
ARR. 8 SWSI

For belt drive or direct connection. Arrangement 1 plus extended base for prime mover.



Fan Nomenclature

Overhung Wheels Single Width Single Inlet (SWSI)



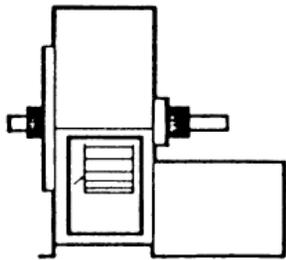
ARR. 9 SWSI

For belt drive. Impeller overhung,
two bearings, with prime mover
outside base.



Fan Nomenclature

Centerhung Wheels Single Width Single Inlet (SWSI)



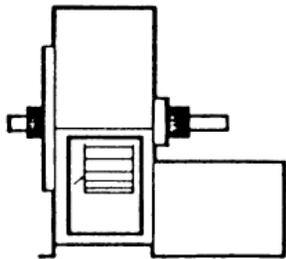
ARR. 7 SWSI

For belt drive or direct connection. Arrangement 3 plus base for prime mover.



Fan Nomenclature

Centerhung Wheels Single Width Single Inlet (SWSI)



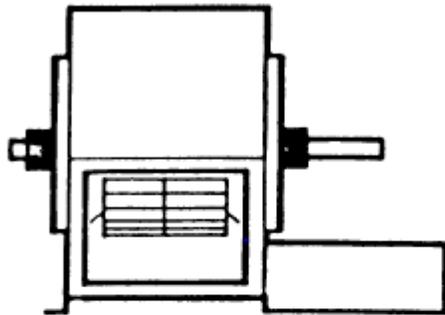
ARR. 7 SWSI

For belt drive or direct connection. Arrangement 3 plus base for prime mover.



Fan Nomenclature

Centerhung Wheels Double Width Double Inlet (DWDI)



ARR. 7 DWDI

For belt drive or direct connection. Arrangement 3 plus base for prime mover.



Arr. #7 DWDI Center-Support

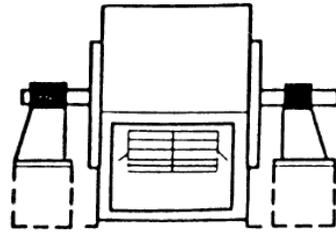


Arr. #7 DWDI Center-Support



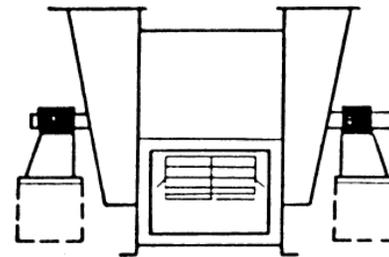
Fan Nomenclature

Centerhung Wheels Double Width Double Inlet (DWDI)



ARR. 3 DWDI WITH INDEPENDENT PEDESTAL

For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals.



ARR. 3 DWDI WITH INLET BOX AND INDEPENDENT PEDESTALS

For belt drive or direct connection fan. Housing is self-supporting. One bearing on each side supported by independent pedestals with shaft extending through inlet box.

Fan Nomenclature

Centerhung Wheels

Double Width Double Inlet (DWDI)



Fan Nomenclature

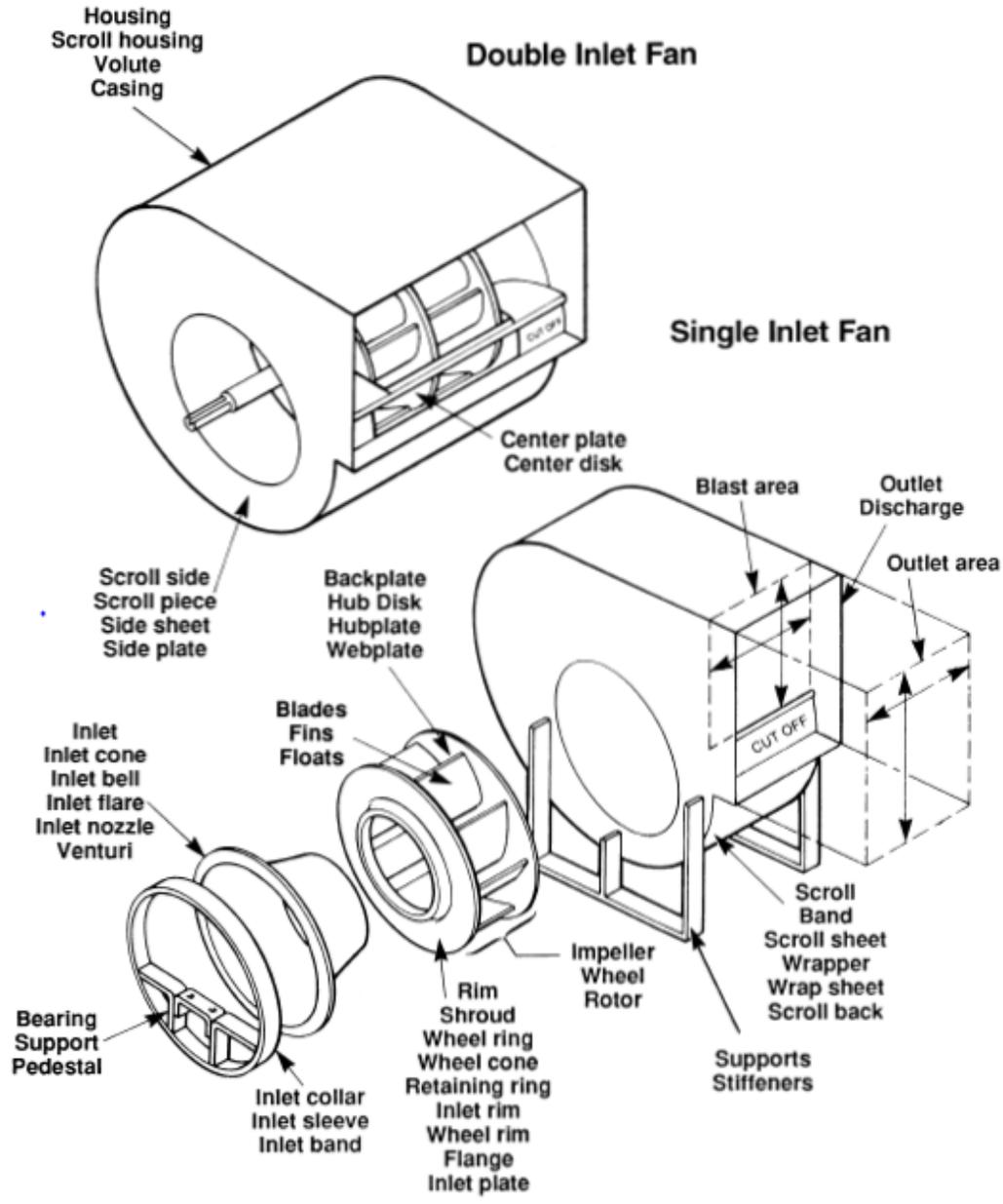
Centerhung Wheels

Double Width Double Inlet (DWDI)



Wheel Diameter / Tip Width



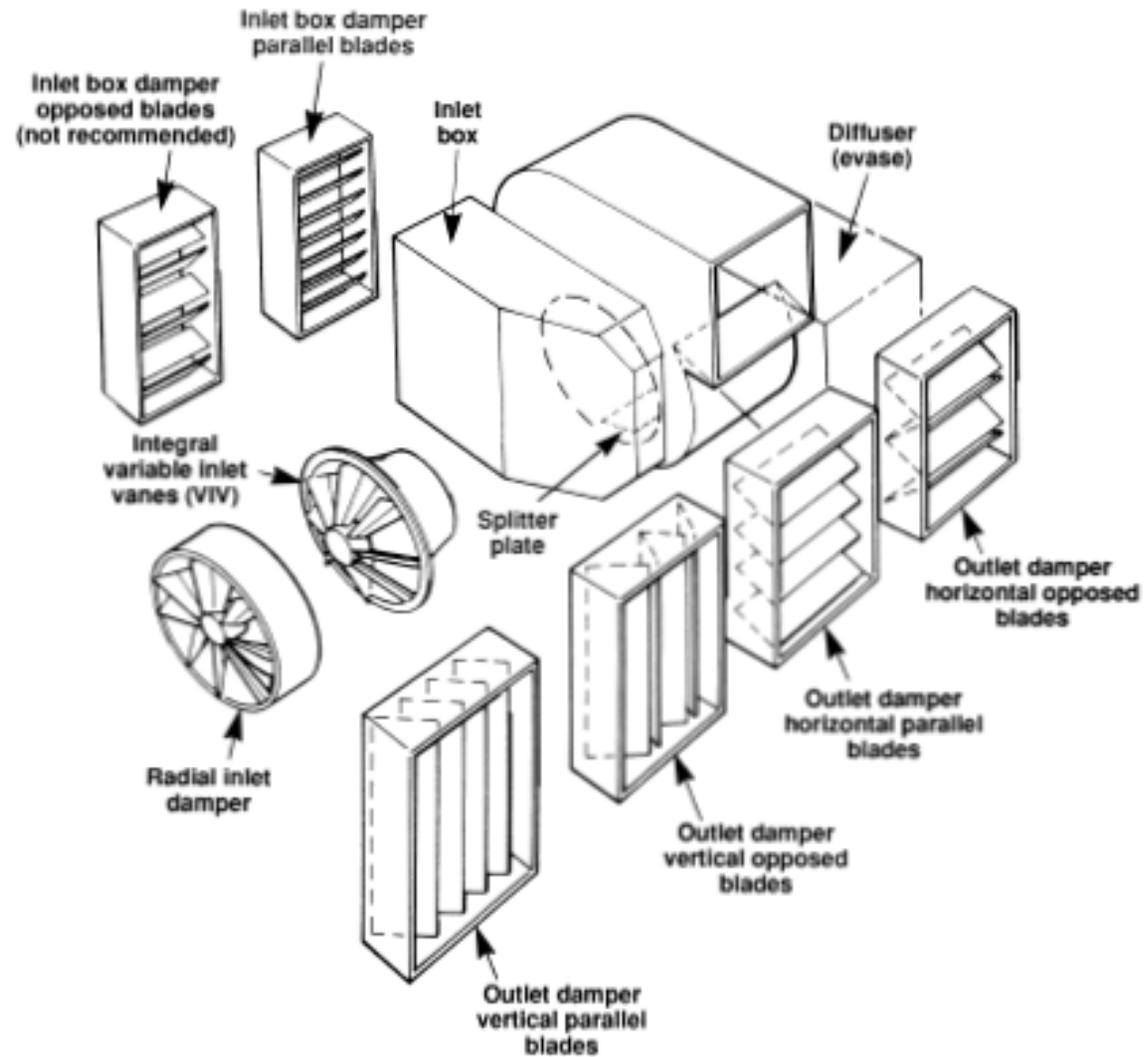


Common Centrifugal Fan Parts



Common Terminology for Centrifugal Fan Appurtenances

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Centrifugal Fan Appurtenances





Arr. #3

Holcim - DWDI Airfoil



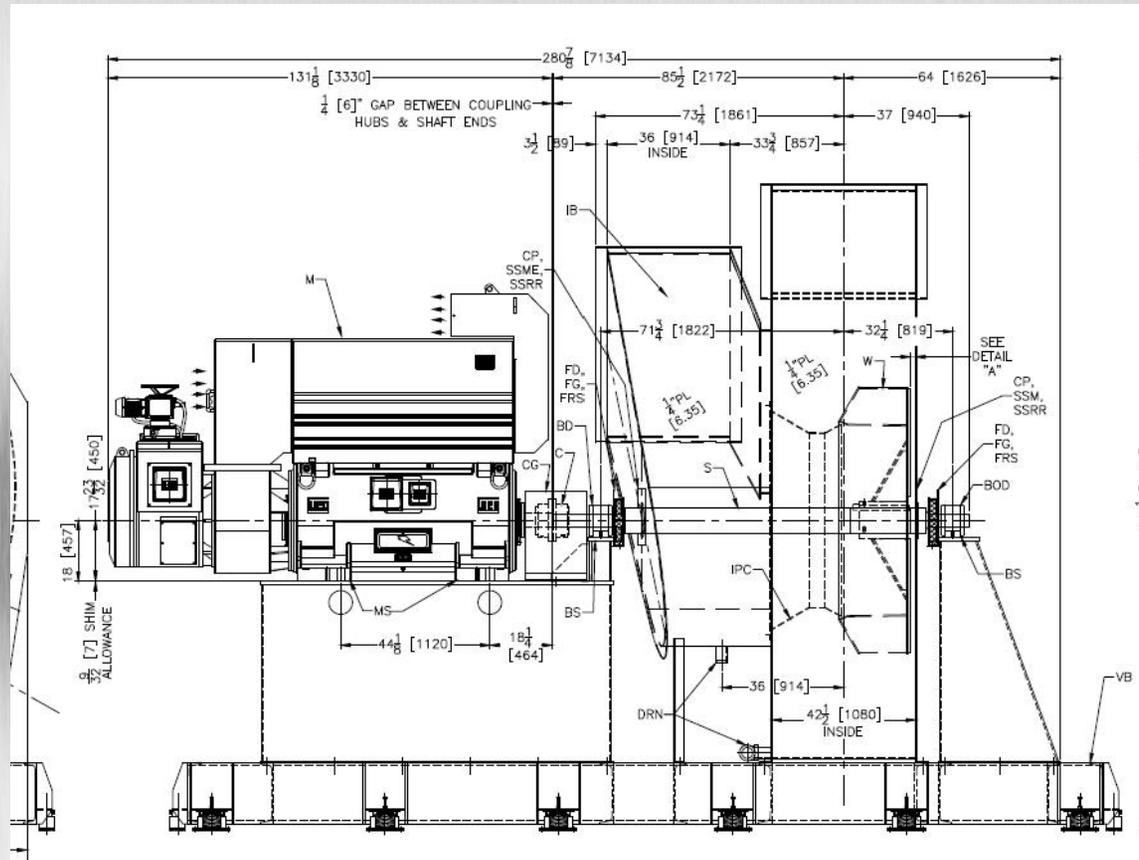
Arr. #7

SWSI with VIV Damper



Arr. #7

Insulation clips, sub base, aluminum guards.



Arr. #7

UNACEM- Inlet Box on drive side with Inertia Base



Arr. #8

Plug design- wheel removal from back of casing



Inlet Cone- SO 1208553

Special finish – Mineral Oil -customer request

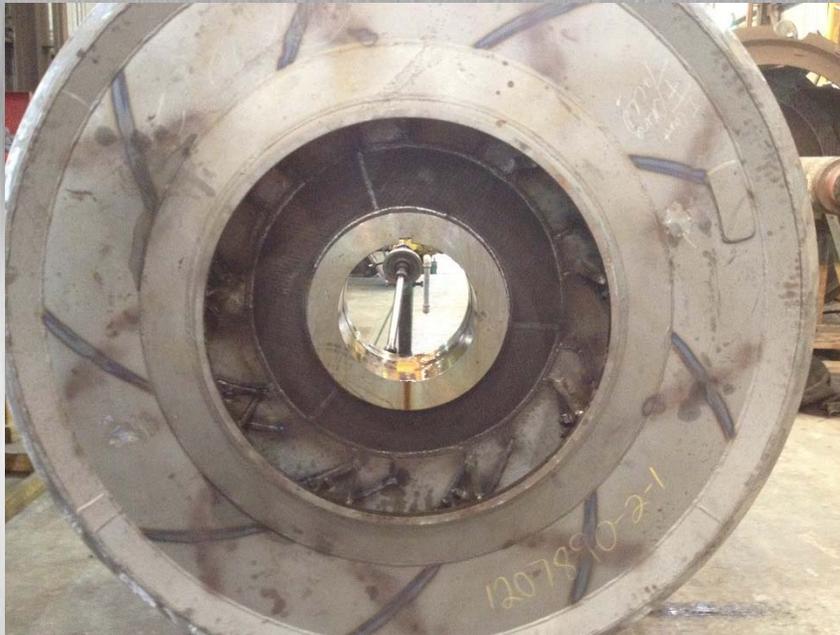


Arr. #3

Chrome Carbide Inlet Cones- can also be supplied in AR400 material.

Conforma Clad Blade Liners

Arawak Cement- Raw Mill



Chrome Carbide Blade Liners

Holcim



Raw Mill





Arr. #3- RB1216

Cemex- Ibague- Chrome Carbide Blade Liners

System Resistance & Fan Curves

System Resistance

ROBINSON INDUSTRIES

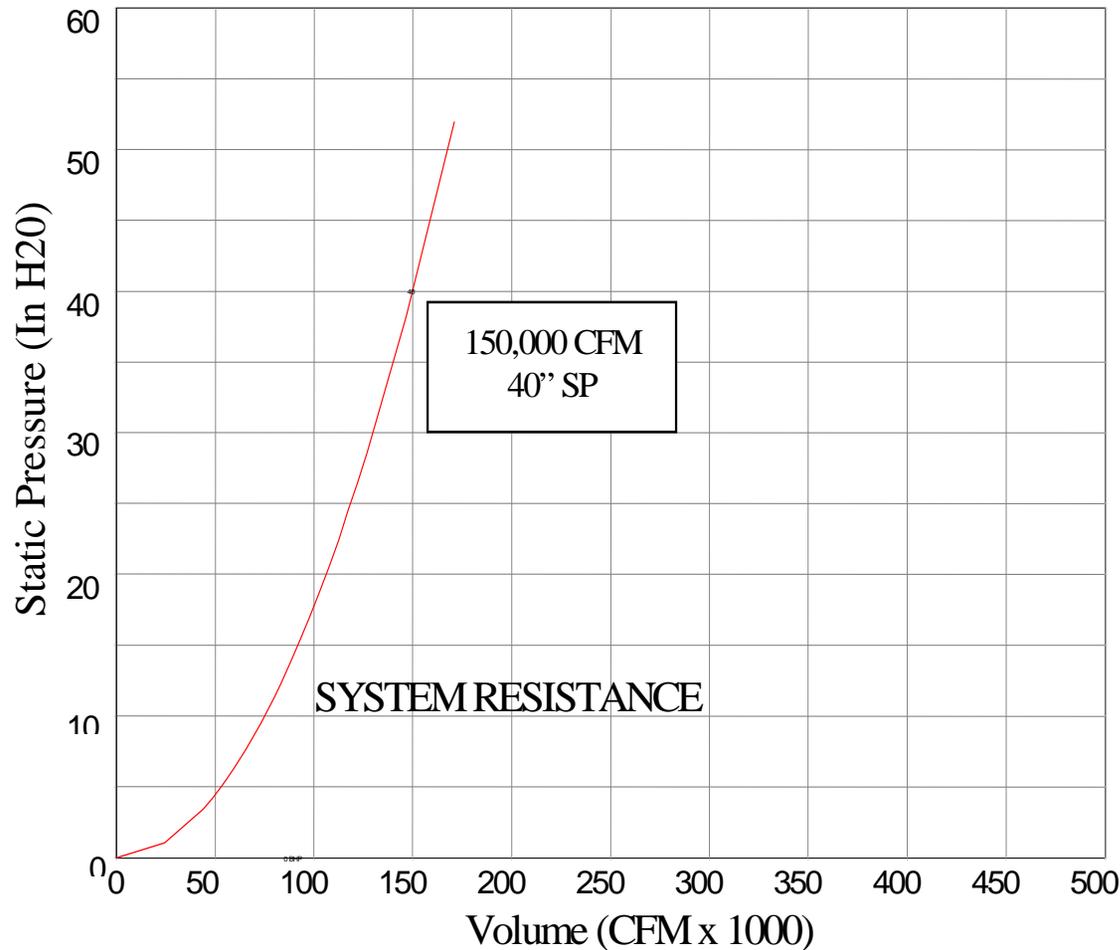
FAN : 83" x 14.38" FRD

FOR : Basic Fan Laws I

FAN SPEED : 1180

TEMP. : 70

DENSITY : 0.075



- Every system has resistance to flow. Most gas systems can be approximated by an equivalent orifice. The flow is turbulent and the pressure (P) required varies as a function of the square of the volume flow-rate (Q).
- $P = kQ^2$ (k is a system resistance constant.)

Fan Performance

The fan will operate where the fan curve intersects the system resistance curve.

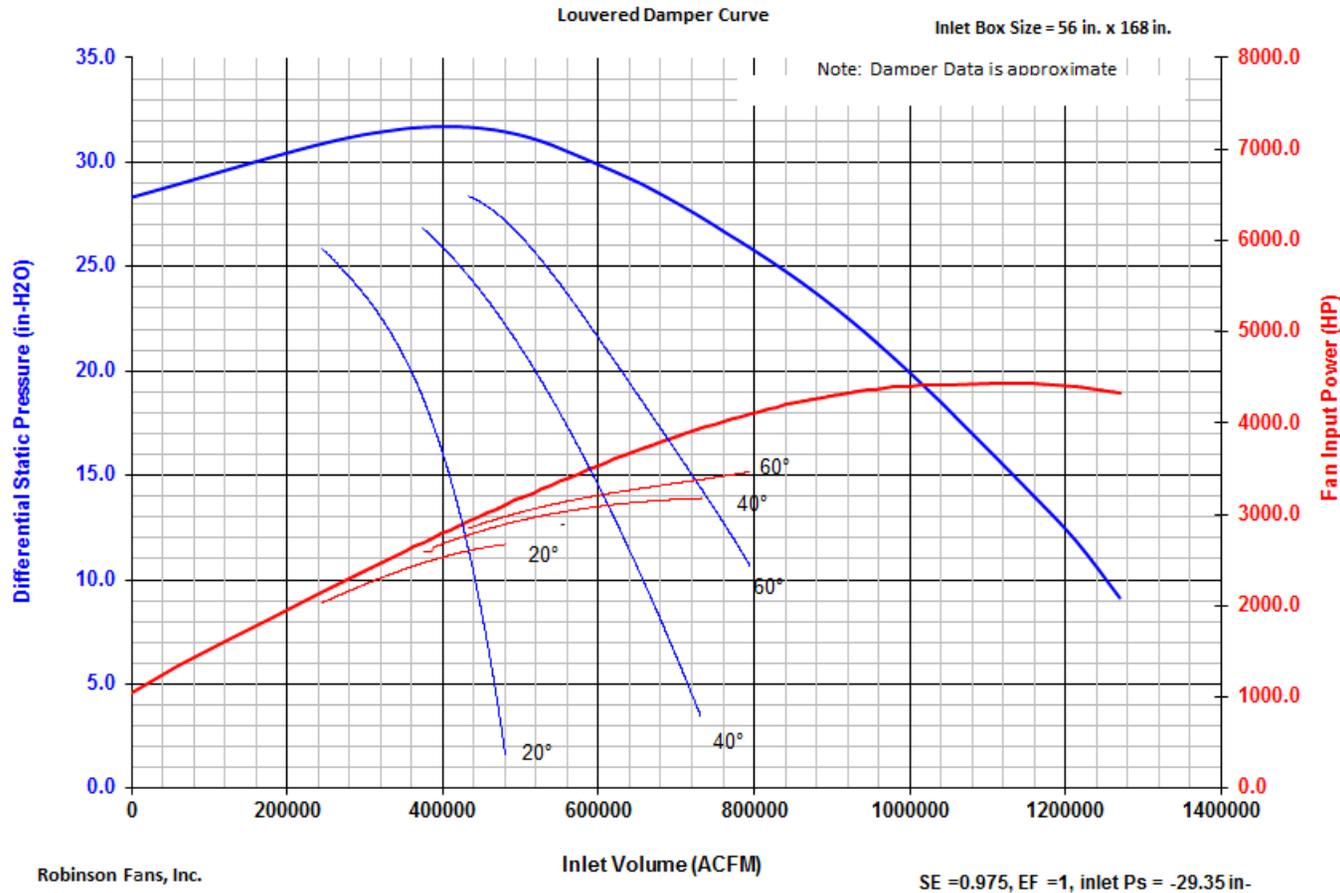
Fan Curve

Fan: 133 in x 50.75 in DWDI BC0924-9
For: Holcim

Temperature: 752 °F
Density: 0.0327 lbs/ft³

Fan Speed: 880 rpm

8/27/2012 11:11
User: DLW



Fan and System Curves

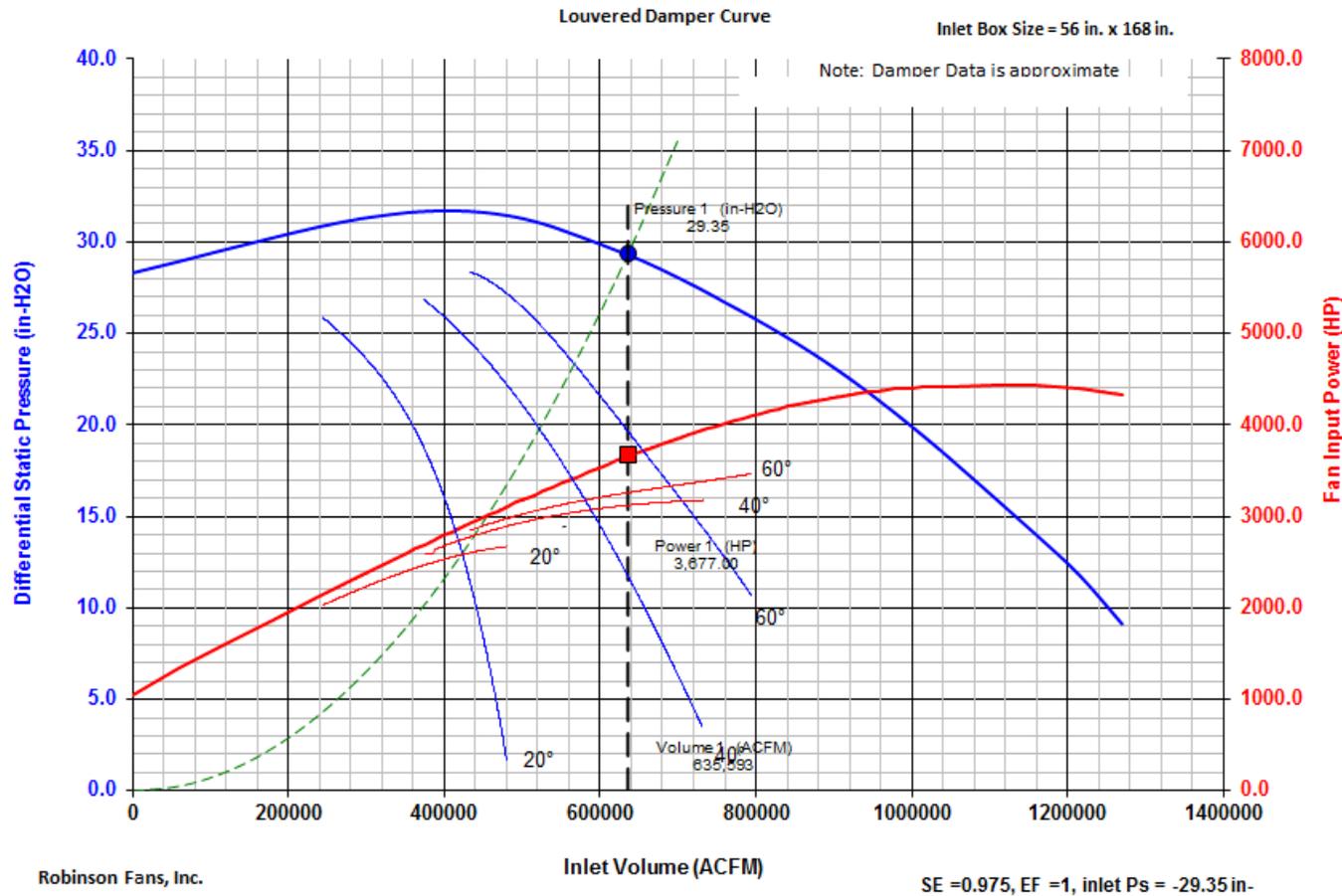
Fan: 133 in x 50.75 in DWDI BC0924-9
For: Holcim

Temperature: 752 °F
Density: 0.0327 lbs/ft³

Fan Speed: 880 rpm

8/27/2012 11:09

User: DLW

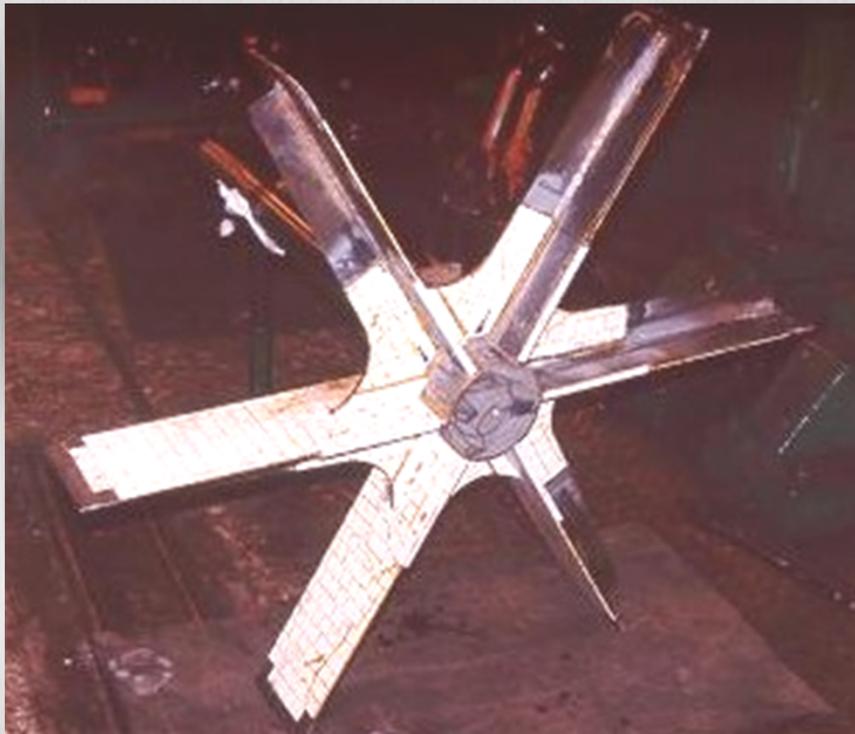


- The actual operating point will be the intersection of the system resistance curve and the fan curve.

Fan Types

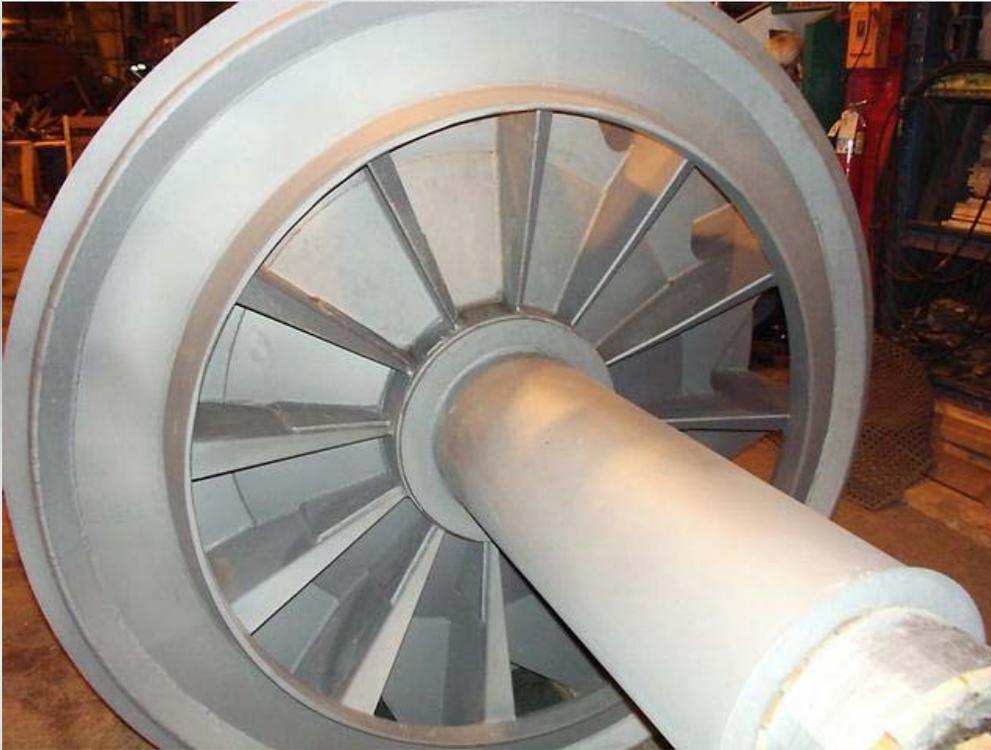
Fan Wheel Types ~ PW

Paddle Wheel:



- Open Design / No Shroud
- 60~65% Static Efficiency
- Inexpensive, Simple Design
- Good for High Temperature or Highly Erosive Applications
- Medium to High Pressure, Low Volume Capability

Fan Wheel Types ~ RB



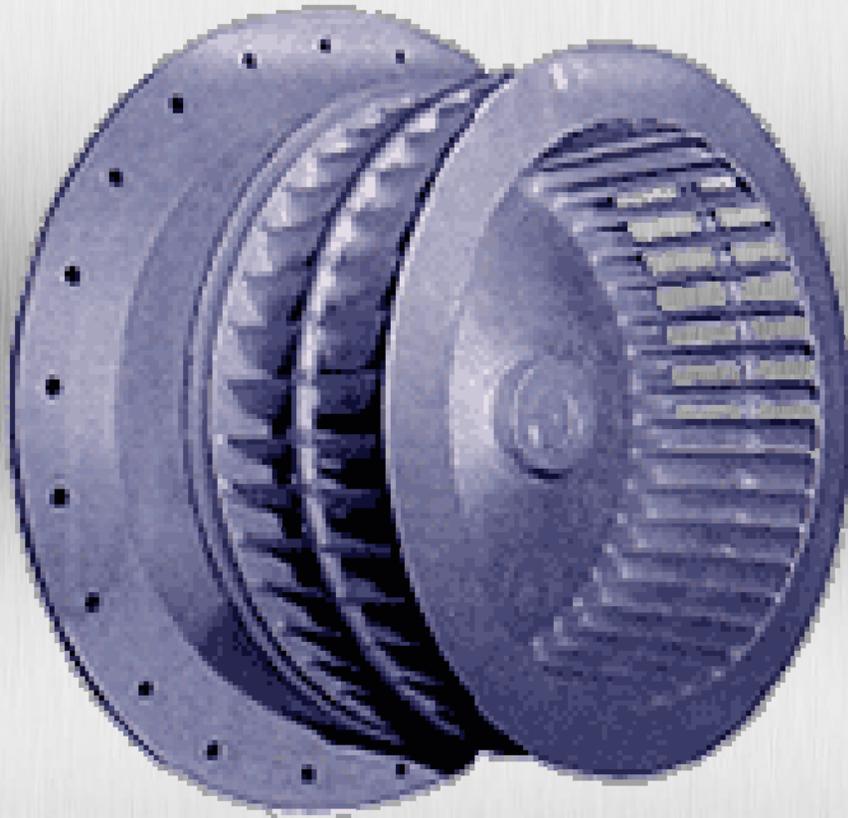
- Static Efficiency up to 78%
- High Tip Speed Capabilities
- Best for Erosive or Sticky Particulate Applications
- Straightforward Design w/ Large Running Clearances
- Very High Pressure, Low to Medium Volume Capability

Fan Wheel Types - RT



- Static Efficiency up to 78%
- Medium to High Tip Speed Capabilities
- Good for High Specific Speed / High Erosion Applications
- Tighter Running Clearances than RB Type
- Medium Pressure, Medium to High Volume Capability

Fan Wheel Types ~ FC



- 55~65% Static Efficiency
- Smallest Dia. Wheel for a given pressure
- High Volume Capability
- Excellent Design for High Temperature Applications

Fan Wheel Types ~ BI



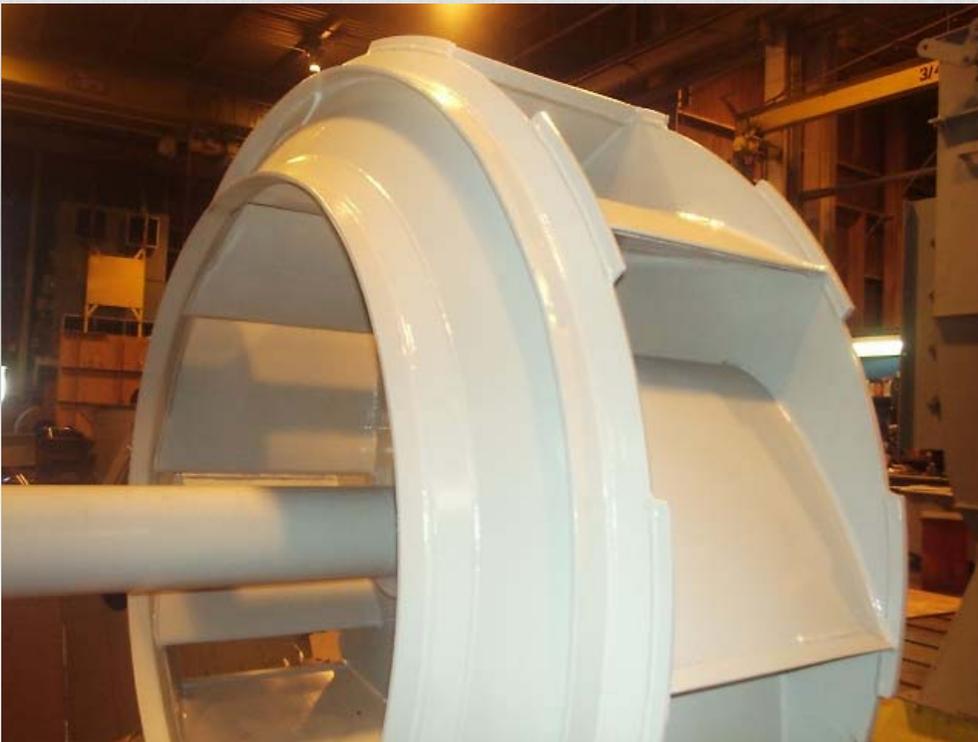
- Static Efficiency up to 81%
- Low to Medium Tip Speed Capabilities
- Good for Medium to High Specific Speed Applications
- Tight Running Clearances
- Low Pressure, High Volume Capability

Fan Wheel Types ~ BC



- Static Efficiency up to 83%
- Medium to High Tip Speed Capabilities
- Good for Clean or Dirty Airstream Applications
- Solid One-Piece Blade Design
- Tight Running Clearances
- Low to Medium Volume and Pressure Capabilities

Fan Wheel Types ~ AF



- Highest Static Efficiency- up to 87% Es
- Medium to High Tip Speed Capabilities
- For Clean Airstream Applications Only
- Tightest Running Clearances of All Designs
- Low to Medium Pressure, High Volume Capability

Hard Surface Materials (Liners)

Hard Surface Materials

- [AR360/400](#)
- [Chromium Carbide](#)
- [Conforma Clad](#)

- [Wear testing](#)

AR360/400

- Relatively low cost.
- Improves wear capabilities beyond mild steel.
- Lost 33% of the material that was lost by mild steel in comparative wear testing (outlined in a later slide).
- Typically supplied as a liner that is bolted or welded to the base blade.



Chromium Carbide

- Medium cost.
- Improves wear capabilities beyond mild steel and AR plate.
- Lost 2% of the material that was lost by mild steel in comparative wear testing (outlined in a later slide).
- Typically supplied as a liner that is bolted or welded to the base blade.



Conforma Clad

- Medium cost.
- Improves wear capabilities beyond chromium carbide.
- Lost 0.6% of the material that was lost by mild steel in comparative wear testing (outlined in a later slide).
- Blade liners are cut/rolled/formed and then sent to the supplier for cladding.
- Cladding process is a metallurgical baking process that fuses the hard surface material to the base metal.



Comparative Wear Testing

Test display at Robinson Fans in Zelienople, PA



Bearings

Typical Fan Bearing Types

- Anti-friction (Roller) Bearings
 - [Ball Bearings](#)
 - [Monoblock Style](#)
 - [Spherical Roller Bearings](#)
 - [SKF CARB Bearings](#)
- Fluid Bearings (Oil-film or Sleeveoil)
 - [Dodge RTL](#)
 - [Renk Type E](#)

Anti-friction (Roller) Bearings

Ball bearings

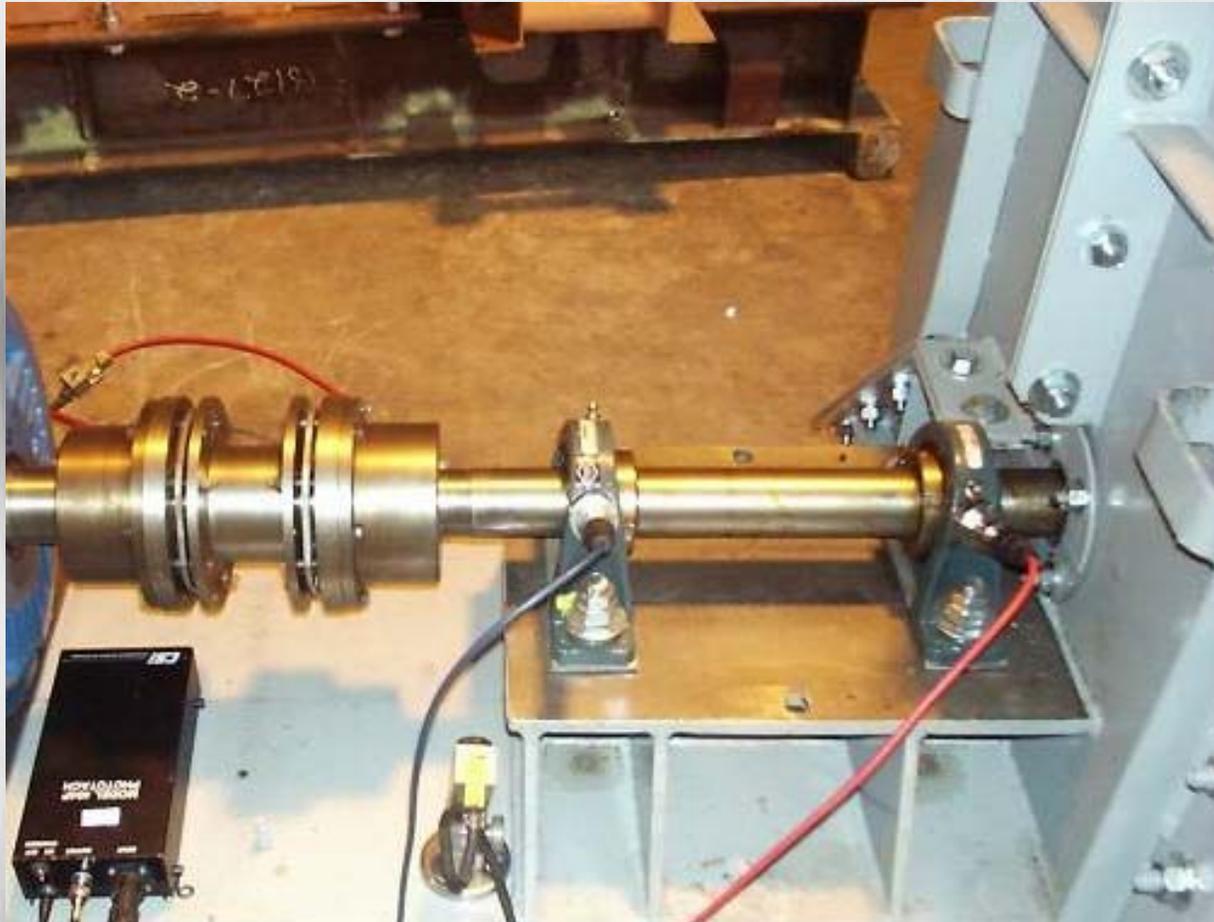
- Pillow block style housing.
- Typical for smaller and/or higher speed fans.
- Fairly simple installation.
- Grease lubricated
- Typical selection: Dodge Grip Tight



Additional bearing information can be found at
http://www.baldor.com/pdf/ca3000_catalog/ca3000a.pdf

Anti-friction (Roller) Bearings

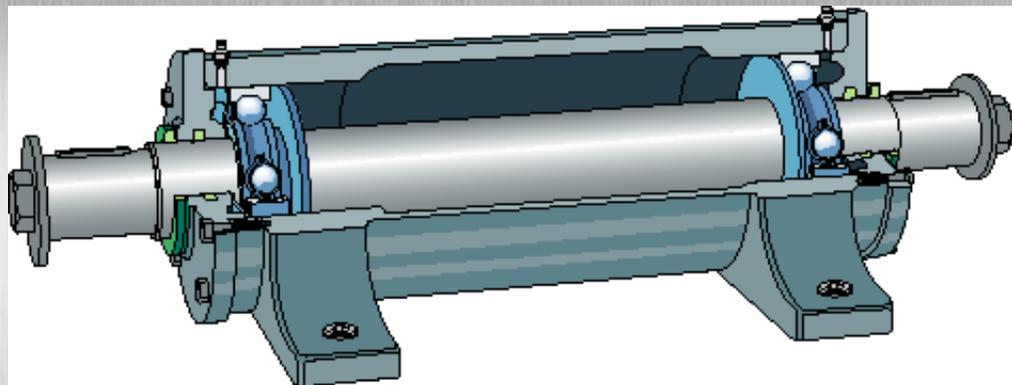
Ball bearings



Anti-friction (Roller) Bearings

PDN Bearing

- Monoblock style housing.
- Used with small to medium sized fans.
- High speed capability.
- Bearings pressed on shaft.
- Single housing eliminates misalignment.
- Accept ball bearings or cylindrical roller bearings
- Grease lubricated.



PDN bearing information:

<http://www.skf.com/group/products/bearings-units-housings/bearing-units/two-bearing-units/standard-designs/pdnb-two-bearing-units/index.html>

Anti-friction (Roller) Bearings



BLO Bearing

- Monoblock style housing.
- Robust Design
- Used with small to medium sized fans.
- High speed capability.
- Bearings pressed on shaft.
- Single housing eliminates misalignment.
- Accept ball bearings or cylindrical roller bearings
- Oil lubricated.

Anti-friction (Roller) Bearings

BLO Bearing



Anti-friction (Roller) Bearings

Spherical Roller

- Fits in USAF pillow block style housing.
- FIXED or FLOAT bearing.
- Used with medium to large sized fans.
- Medium speed capability.
- Typically adapter mounted.
- Split housing for easy access to rolling element.
- Grease or oil lubricated.



Additional bearing information can be found at
http://www.baldor.com/pdf/ca3000_catalog/ca3000a.pdf

Anti-friction (Roller) Bearings

Spherical Roller



Anti-friction (Roller) Bearings

SKF CARB

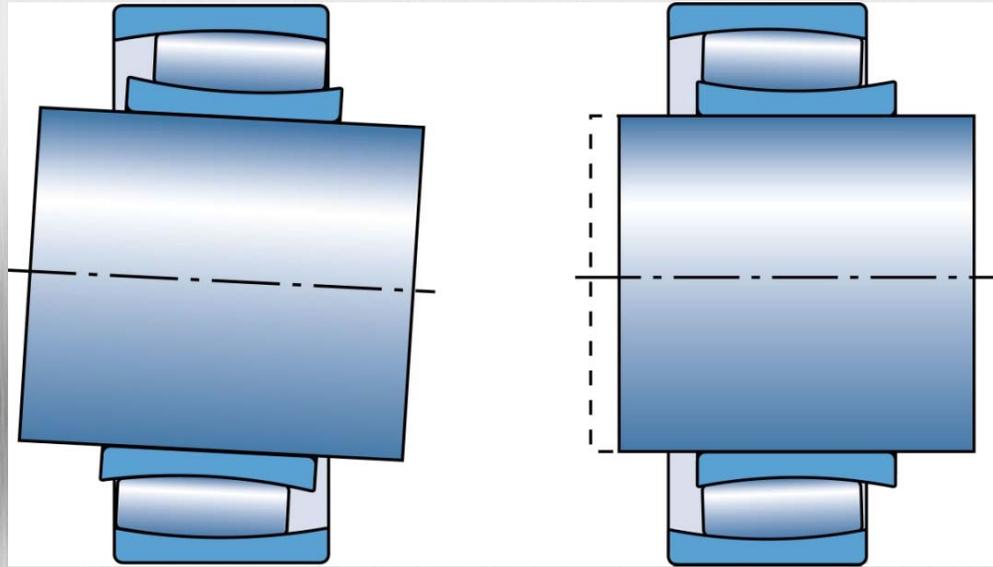
- Fits in USAF pillow block style housing.
- Used as FLOAT bearing only.
- Has smooth float capability. Rollers and inner race can travel relative to outer race.
- Used with high temperature fans to accommodate shaft thermal growth.
- Used with medium to large sized fans.
- Medium speed capability.
- Adapter mounted.
- Grease or oil lubricated.



Additional bearing information can be found at <http://www.skf.com/group/products/bearings-units-housings/roller-bearings/carb-toroidal-roller-bearings/index.html>

SKF CARB Bearing

“Three bearings in one”



Self-aligning

Spherical roller bearings

Accommodates axial displacement

Cylindrical roller bearings

Allows compact designs

Needle roller bearings

Fluid Bearings (Oil-film or Sleeveoil)

Dodge RTL

- Shaft rides on and is supported by an oil film.
- Used as FIXED or FLOAT bearing.
- Has smooth float capability. No rollers/races to travel.
- Used with medium to very large sized fans.
- Speed and loading must be balanced. Special bearing checkout programs used for selection.
- Oil lubricated.
- Provisions for water cooling of bearing liner.
- Capable of accommodating several different accessories.



Fluid Bearings (Oil-film or Sleeveoil)

Standard Features

- Housing machined for...
 - Thermocouples (2 locations)
 - Vibration adapter kit (2" spotface)
 - Circulating oil inlet kit
 - Controlled level circulating oil drain
 - Oil Gauge
 - Heater
 - Thermostat
 - Auxilliary seals
 - End Cap Kit
- Liner machined for...
 - Thermocouples (2 locations)
 - Circulating oil inlet kit



Dodge RTL Manual:

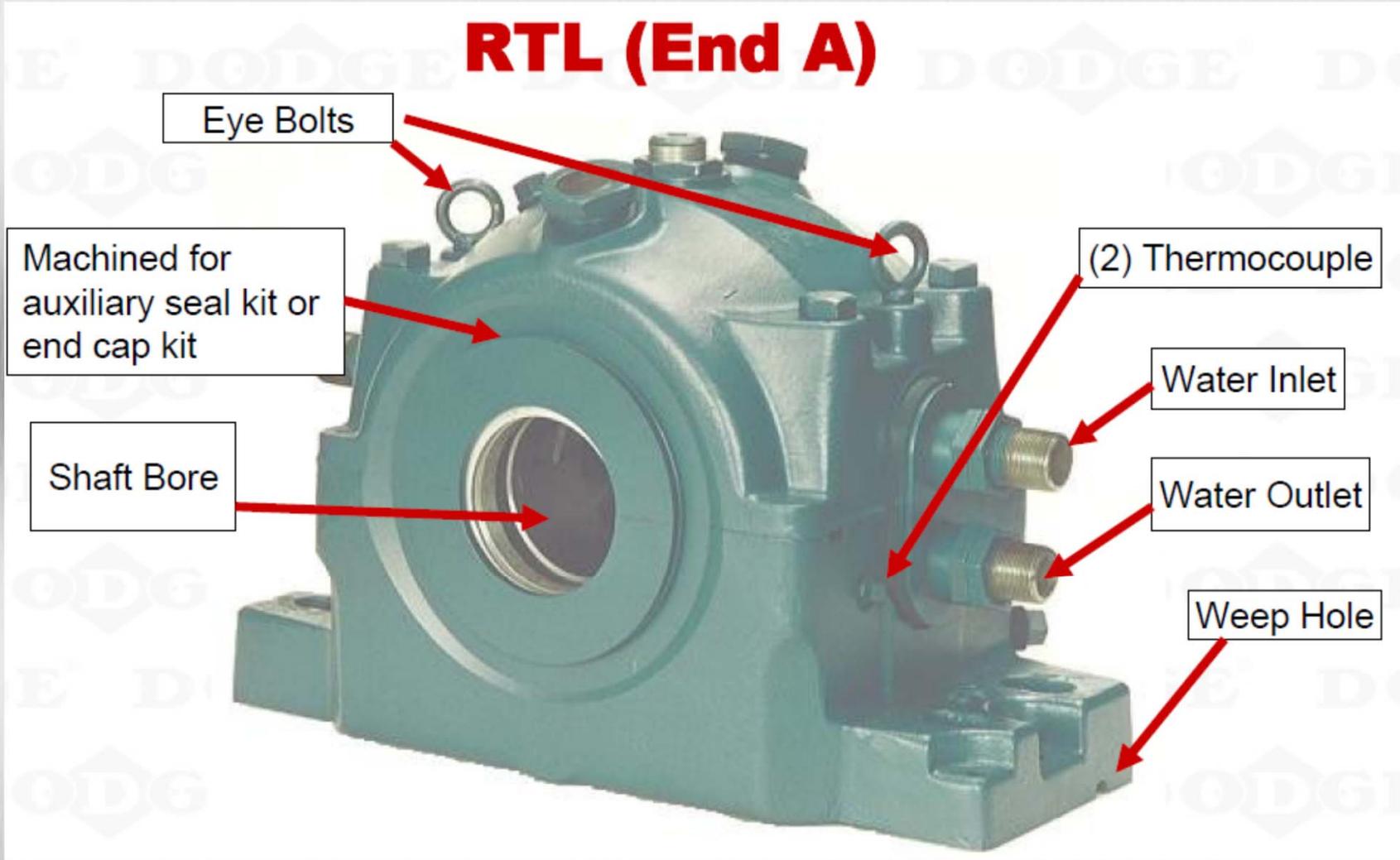
[http://www05.abb.com/global/scot/scot342.nsf/veritydisplay/60deb32c8f85d84a85257b4400558c27/\\$file/MN3060_0813_web.pdf](http://www05.abb.com/global/scot/scot342.nsf/veritydisplay/60deb32c8f85d84a85257b4400558c27/$file/MN3060_0813_web.pdf)

Fluid Bearings (Oil-film or Sleeveoil)

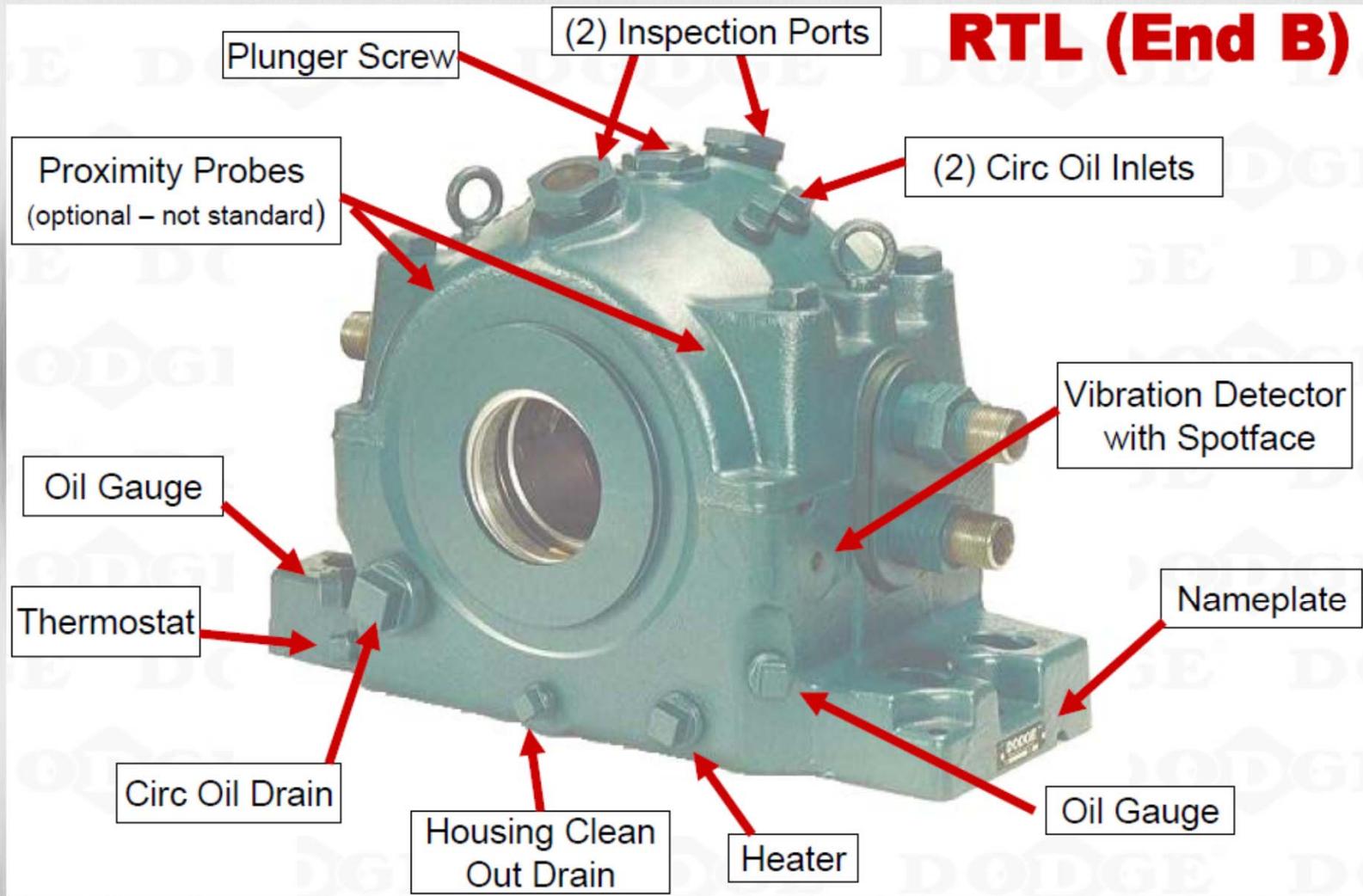
Dodge RTL



Fluid Bearings (Oil-film or Sleeveoil)



Fluid Bearings (Oil-film or Sleeveoil)



Fluid Bearings (Oil-film or Sleeveoil)

Renk Type E

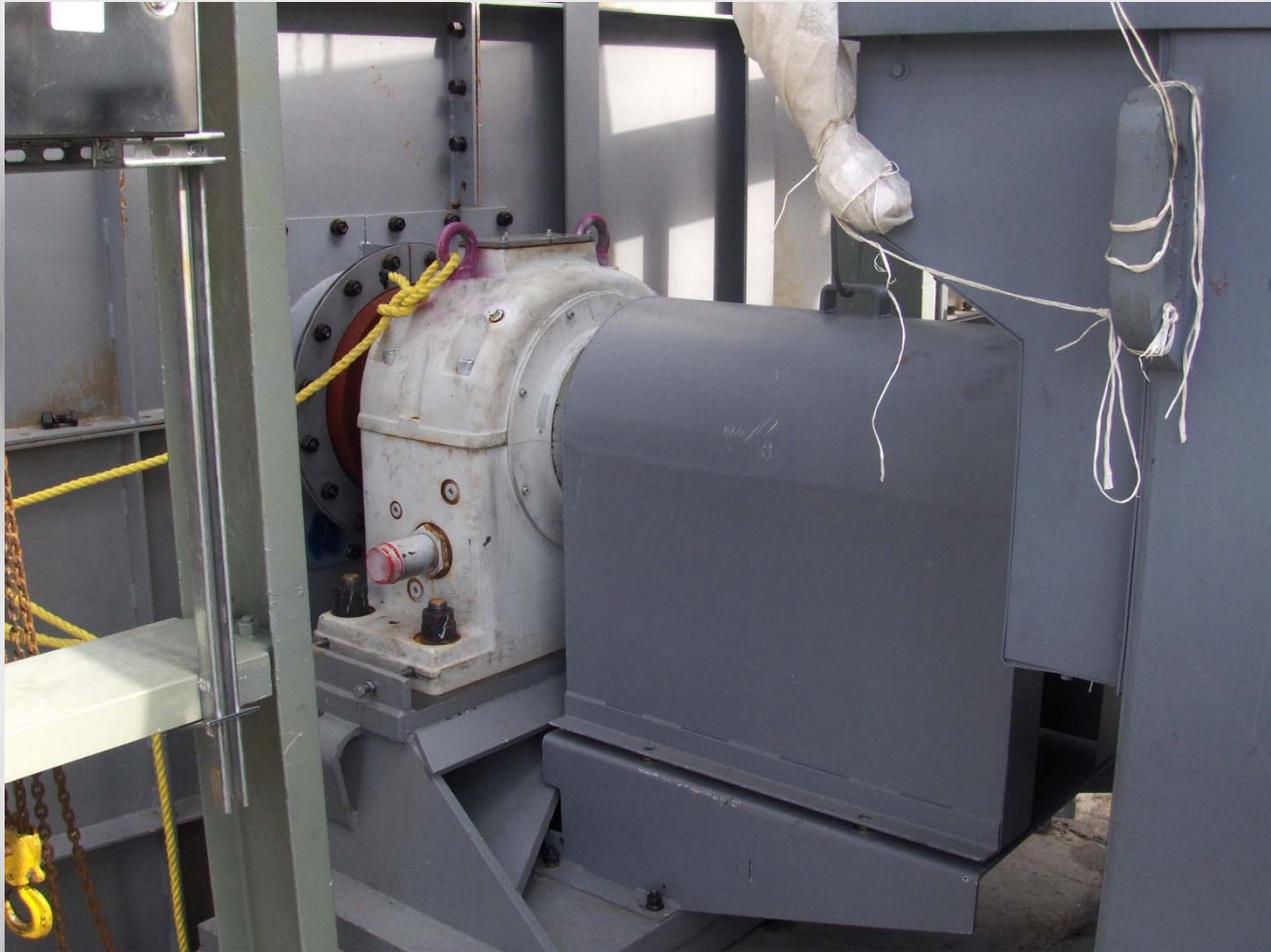
- Similar to RTL
 - Shaft rides on and is supported by an oil film.
 - Used as FIXED or FLOAT bearing.
 - Has smooth float capability. No rollers/races to travel.
 - Used with medium to very large sized fans.
 - Speed and loading must be balanced. Renk checks bearing loads.
 - Oil lubricated.
 - Capable of accommodating several different accessories.



Additional bearing information can be found at <http://www.renk.biz/slide-bearings.html>

Fluid Bearings (Oil-film or Sleeveoil)

Renk Type E

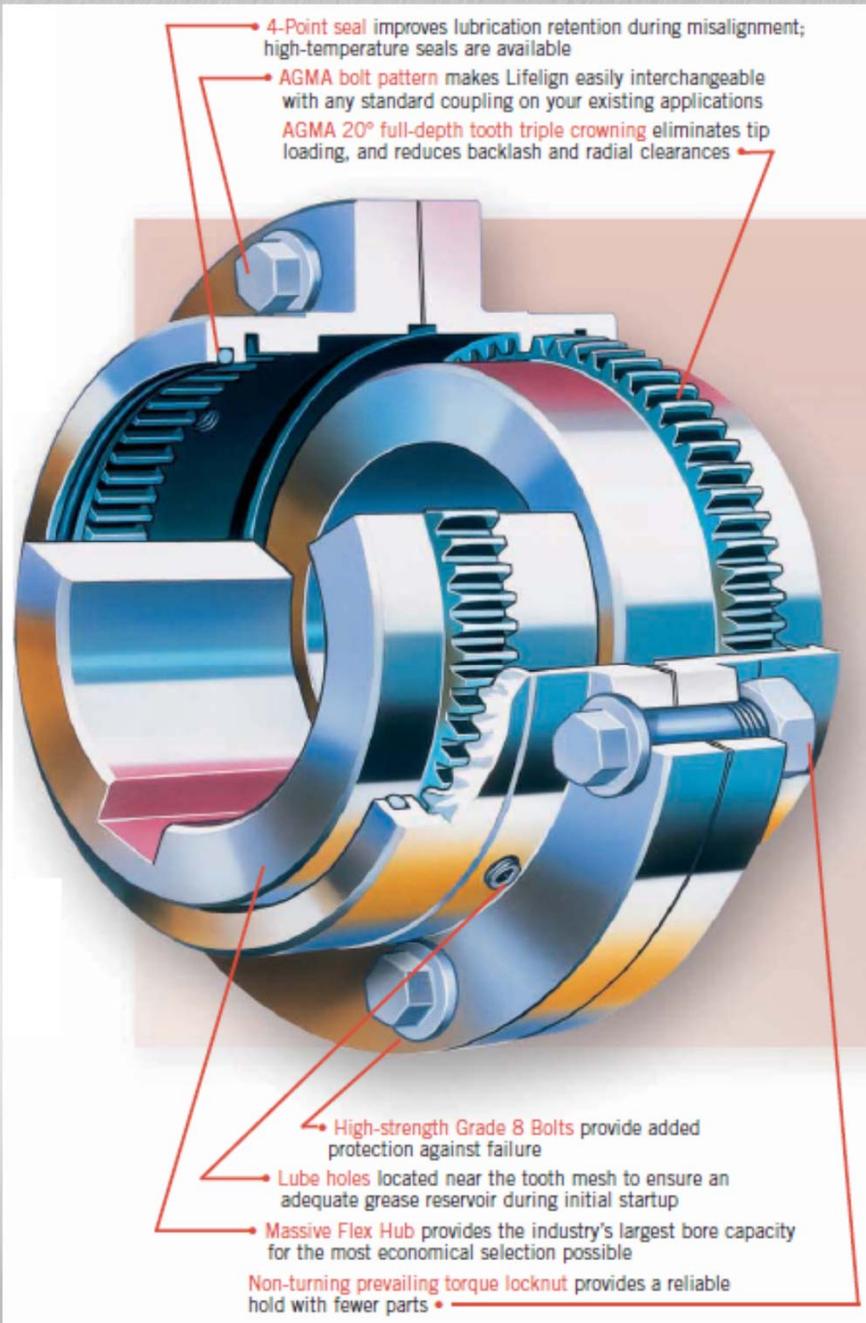


Couplings

Typical Fan Coupling Types

- [Gear Couplings](#)
- [Grid Couplings](#)
- [Disc Couplings](#)
- [Elastomeric Couplings](#)

- [Additional coupling information](#)



Gear Couplings

- Power transmitted through hub/cover gear teeth.
- Requires lubrication
- Spacer version available
- Falk G20 (typical) has range of bores up to 11-3/8" (approx.)
- Low-priced
- Not recommended for variable speed applications.
- Common coupling on small to medium sized fans.

Additional Information:

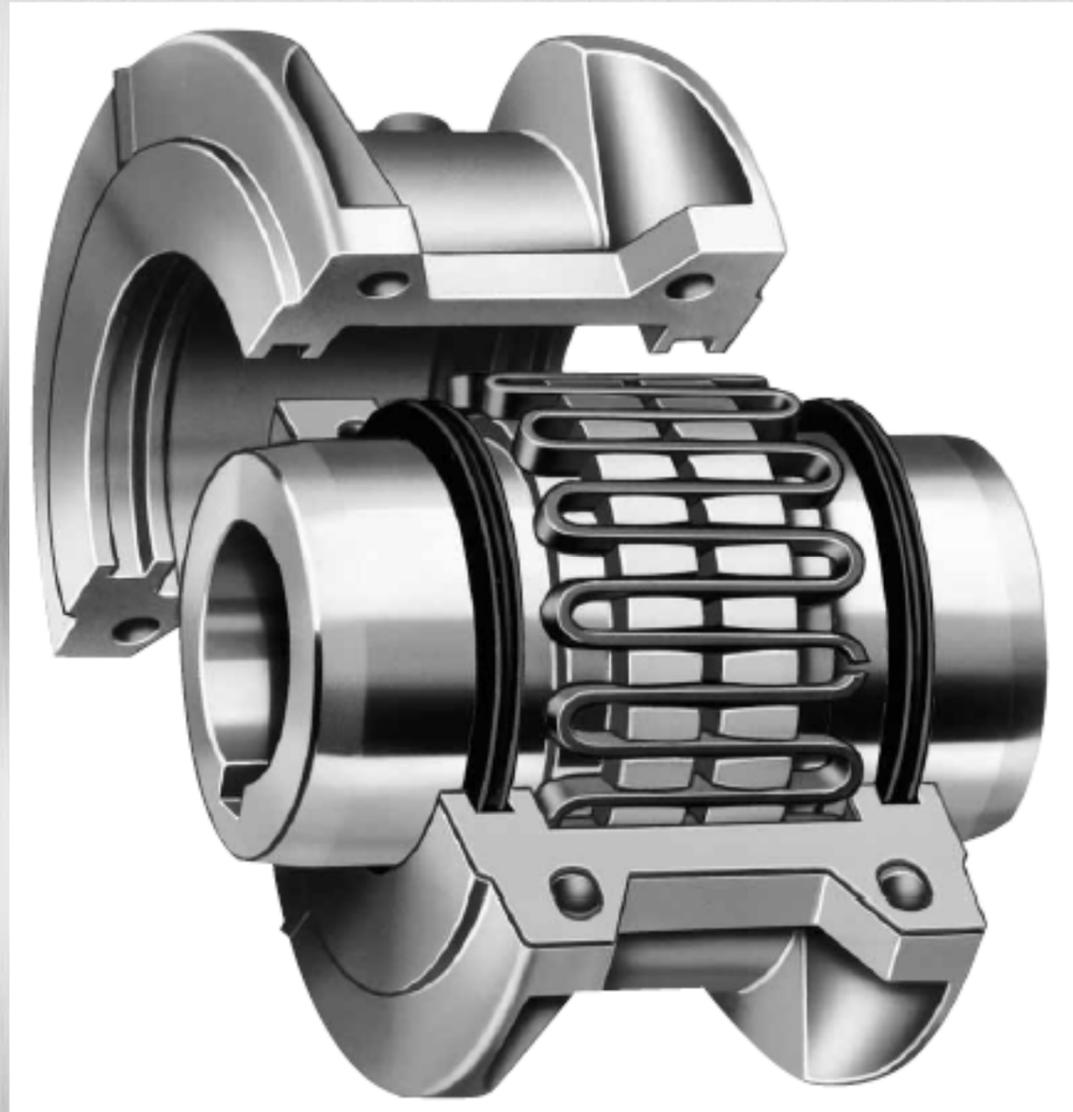
- <http://www.rexnord.com/sites/process/Pages/CouplingHierarchy.aspx?platformkey=1&businessunitkey=30&nodekey=202057>
- http://www.rexnord.com/rexnord_web_media_prod/pdfs/451110.pdf

Grid Couplings

- Power transmitted through hub/spring grid.
- Requires lubrication
- Falk T20 (typical) has range of bores up to 10" (approx.)
- Low-priced
- Variable speed capable up to approximately 600 hp (depending on fan parameters).
- Common coupling on small to medium sized fans.

Additional Information:

- <http://www.rexnord.com/sites/process/Pages/FalkSteelFlexGridCouplings.aspx?platformkey=1&businessunitkey=30&nodekey=198613>
- http://www.rexnord.com/rexnord_web_media_prod/pdfs/421110.pdf

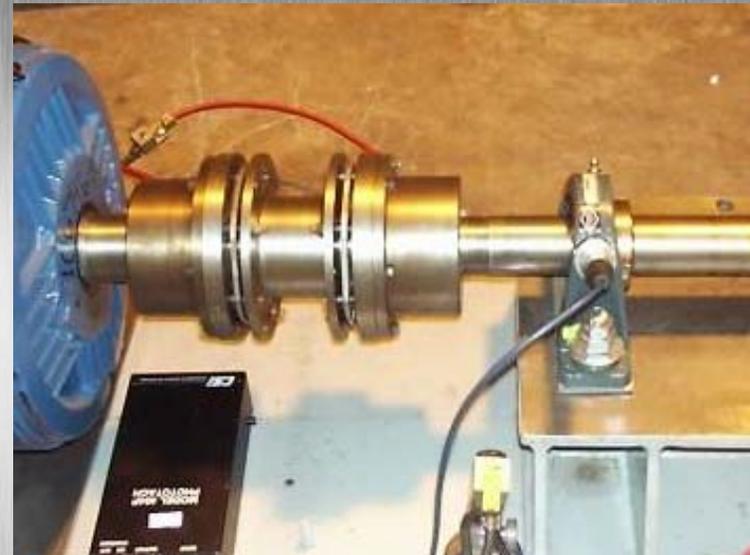


Disc Couplings

- Power transmitted through hubs and disc packs.
- Lubrication not required.
- Thomas Series 71 (typical) has range of bores up to 16" (approx.)
- Variable speed capable. (Robinson engineering should review).
- Common coupling on small to large sized fans.
- Higher torque with less mass and higher speed.
- Easy removal of center assembly using jacking bolts.
- Common on API Designed equipment.

Additional Information:

- <http://www.rexnord.eu/index.php?id=281>
- http://rexnord.eu/fileadmin/Rexnord_Coupling/PDF/Manual/Thomas_Series_71_UK.pdf

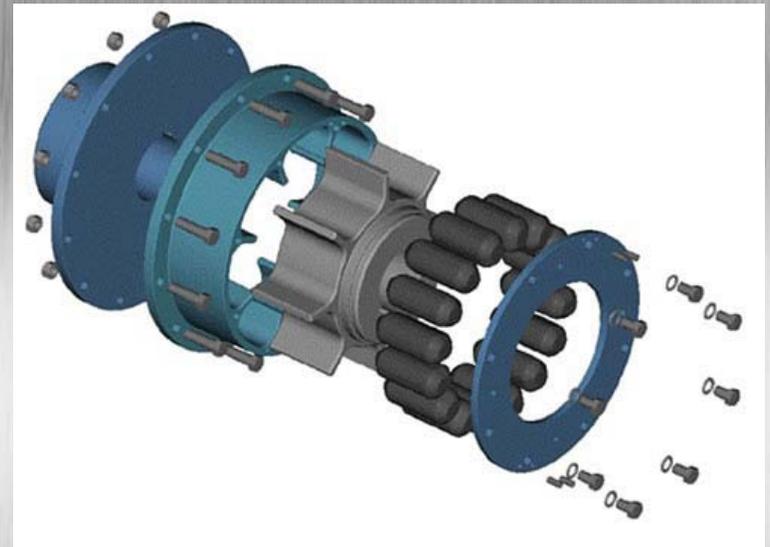


Elastomeric Couplings

- Power transmitted through hubs and rubber elements.
- Lubrication not required.
- First recommendation for variable speed applications.
- Best protection against high transient torques.
 - Torque pulsations are common in variable frequency drives.
- Typically used on medium to large sized fans.
- Rubber elements with a choice of grade and hardness (durometer).
- Renold PM and RB is typical selection.
- Renold offers torsional analyses.

Additional Information:

- <http://www.renold.com/nmsruntime/saveasdialog.asp?ID=1559&slD=3216>



Coupling Notes:

- Coupling selection is fan dependent (VFD, Across-the-line, etc.) and also customer dependent. What features are important to the client?
- A torsional analysis is recommended for all variable speed applications.
- For larger motors with oil film bearings, couplings must include a limited end float feature to prevent the motor shaft from contacting the fan shaft at start-up/shut-down. (Non-equilibrium state when motor rotor is not at magnetic center).
- For motors with oil film bearings, coupling alignment requires that the motor shaft be at it's magnetic center.



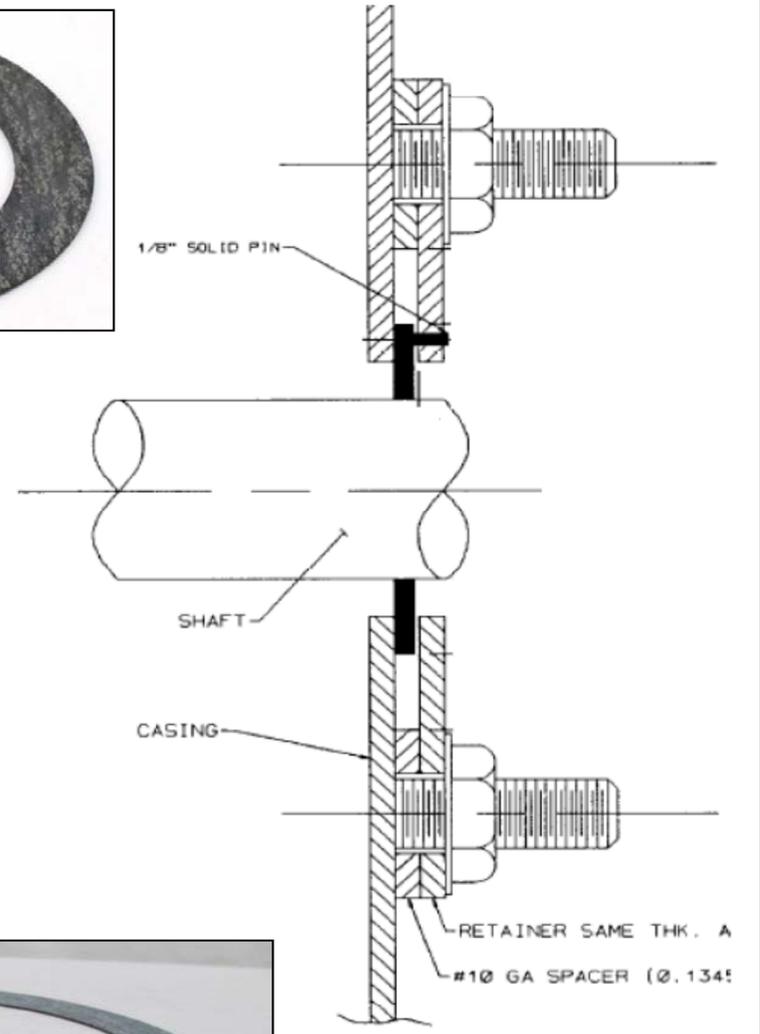
Shaft Seals

Fan Housing Shaft Seals

- [Standard Shaft Seal](#)
- [High Temperature Seals](#)
- [Carbon Ring Seal](#)
 - Contacting
 - Non-contacting

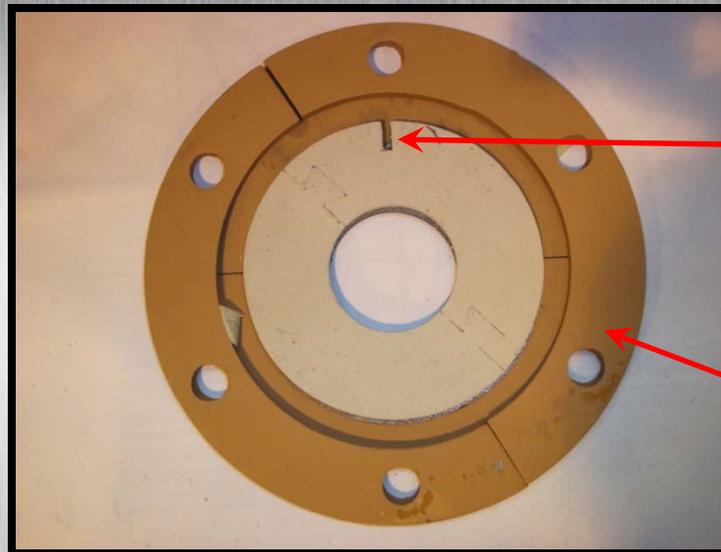
Standard Shaft Seal

- Different Materials
 - Garlock #9800
 - Garlock#2900
 - Teflon
- Simple Design
- Non-floating designs for low temperature.
- Floating designs for >1/8" casing growth.
- Low-cost



High Temperature Two Piece Floating Seal

- Made of (1) piece of insulation and (1) high temp gasketing
- Provides extended life over standard (1) piece gasket seals
- Dovetail split for ease of installation
- Requires a spacer ring and anti-rotation pin to allow float
- Longer mounting studs usually required for installation



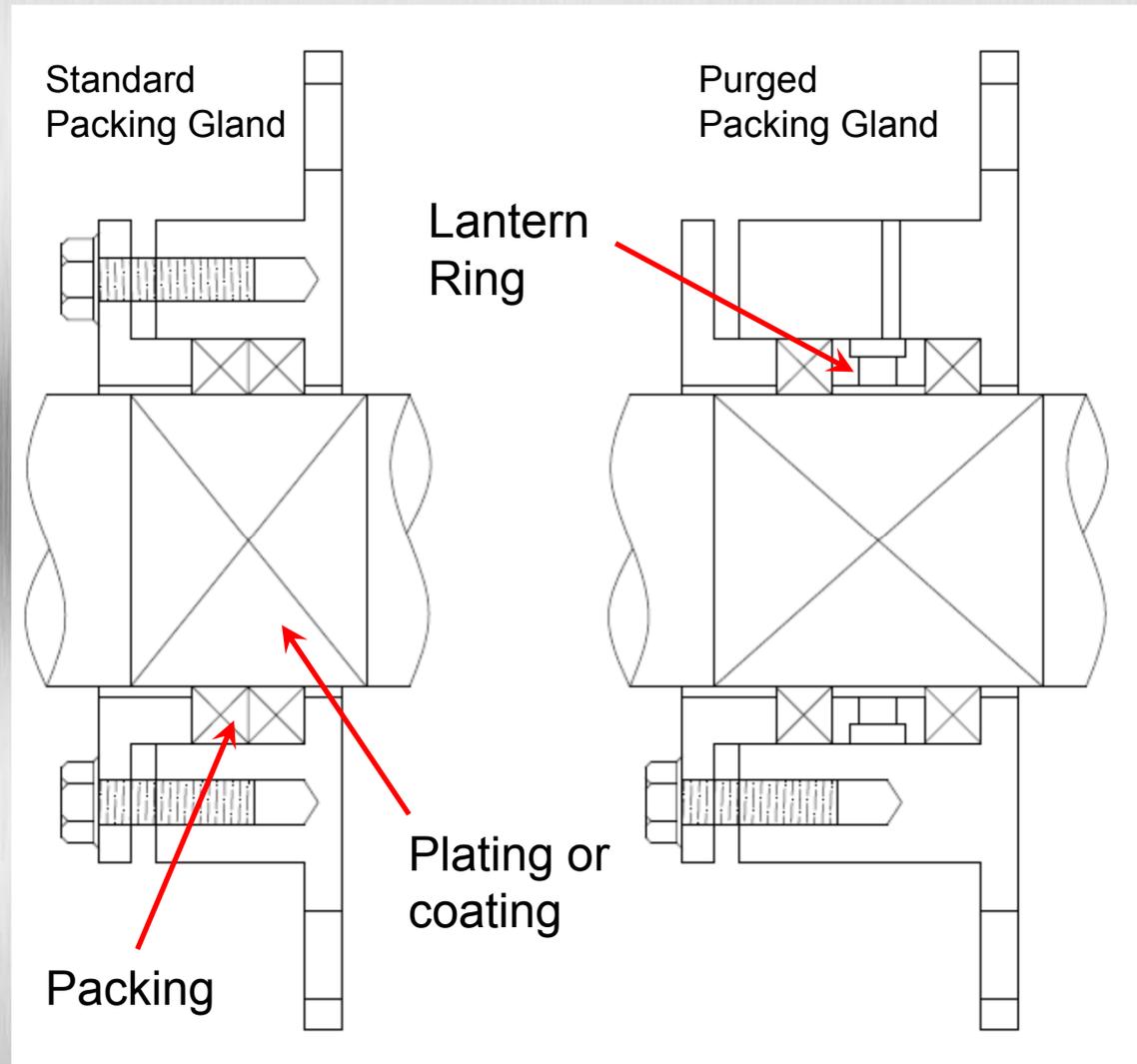
Anti-Rotation Pin

Spacer Ring

Seal assembly shown from fan side

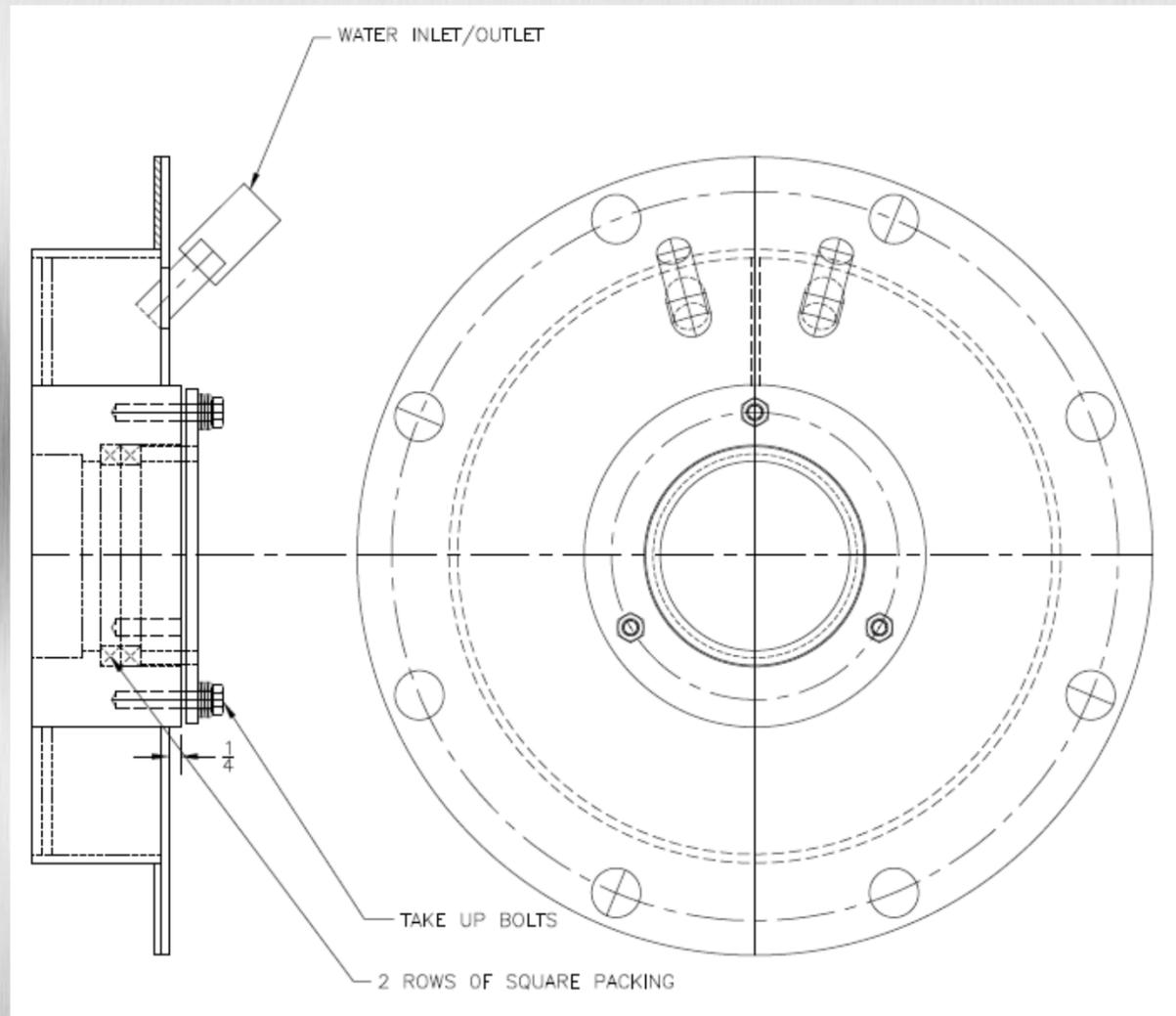
Packing Gland

- Stuffed with packing material (Garlock or Chesterton typical)
- Relatively simple Design
- Standard and purged designs available.
- Fairly low-cost



Water Cooled Packing Gland

- Typical for plug fans installed in furnace applications.
- Same basic design as packing gland but includes water jacket for cooling.
- Each unit is pressure tested.



Carbon Ring Seal

- Available a single row, double row, or multiple row.
 - Complex Design
 - Provides good sealing for volatile process gasses.
 - Available as purged and non-purged seal.
-
- See next slides for non-contacting vs. contacting carbon rings.



Carbon Ring Seal

Non-contacting

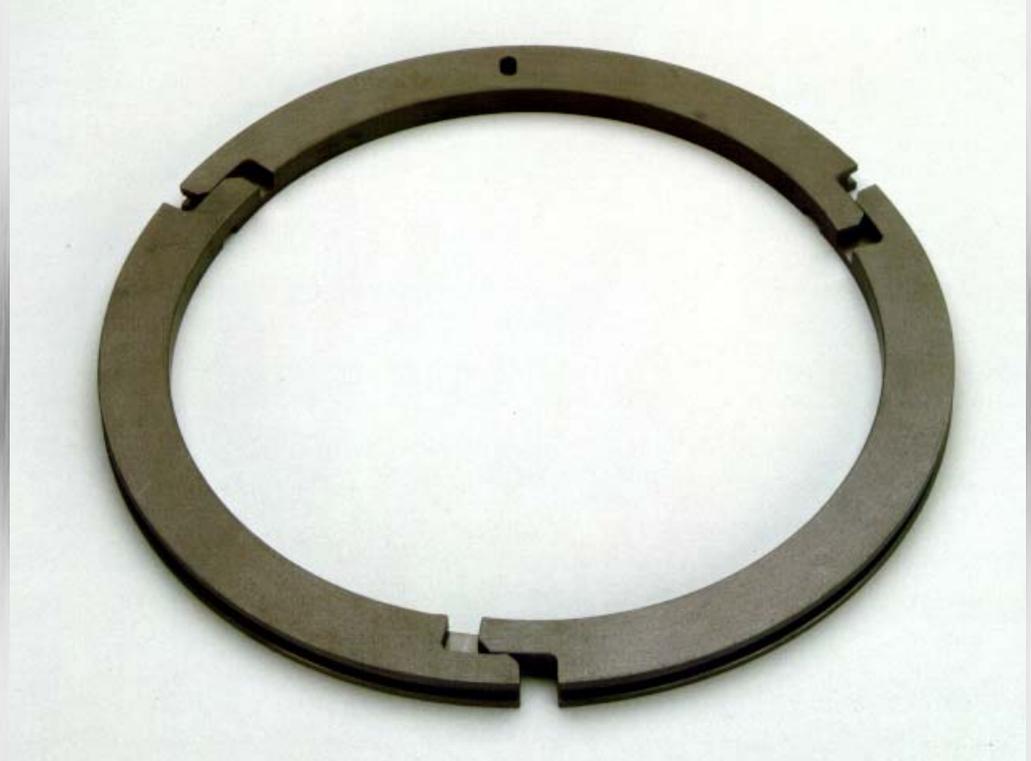
- Radially cut ring design.
- Small gap between ring and shaft.
- Gap becomes smaller as you progress toward operating temperature.



Carbon Ring Seal

Contacting

- Overlapped design.
- Essentially no gap between ring and shaft.
- Requires a shaft sleeve or hardened shaft coating for wear resistance.



Actuators

Typical Fan Damper Actuators

- Electric
 - Typical Brands:
 - Auma
 - Beck
- Pneumatic
 - Typical Brands:
 - Kinetrol
 - Bettis

Electric Actuators

(Auma style)

- 120/240 V power typical.
- Driven by an electric motor. 3 phase, AC, asynchronous motor is standard.
- Controlled by integral actuator controls.
- Limitation of travel is governed by internal limit switches in both end positions.
- Position feedback with potentiometer OR 4-20 mA return signal.
- Mechanical position indicators available. (Gauge with symbols OPEN/CLOSED and incremental markings).
- Adjustable torque switching.
- Fault communication to control room including power failure, phase failure, motor trip protection, torque trip in mid-travel, etc.



Electric Actuators

(Auma style – cont'd)

- Standard operating temperature: -25 °C to 60 °C (-13 °F to 140 °F)
- Low temp. and extreme low temp. versions available to -60 °C (-75 °F)

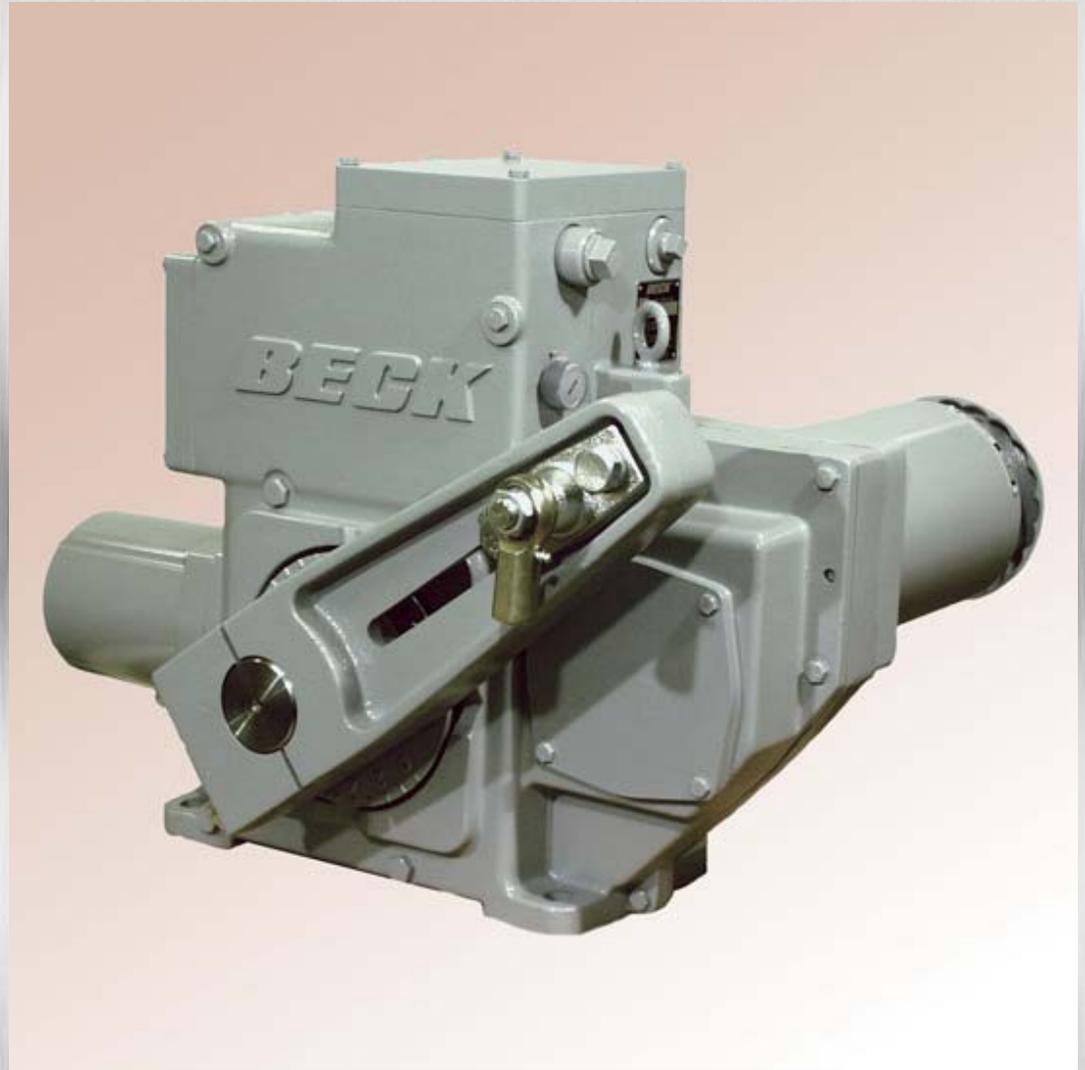
- See Auma literature for more information. Available at www.auma.com



Electric Actuators

(Beck style)

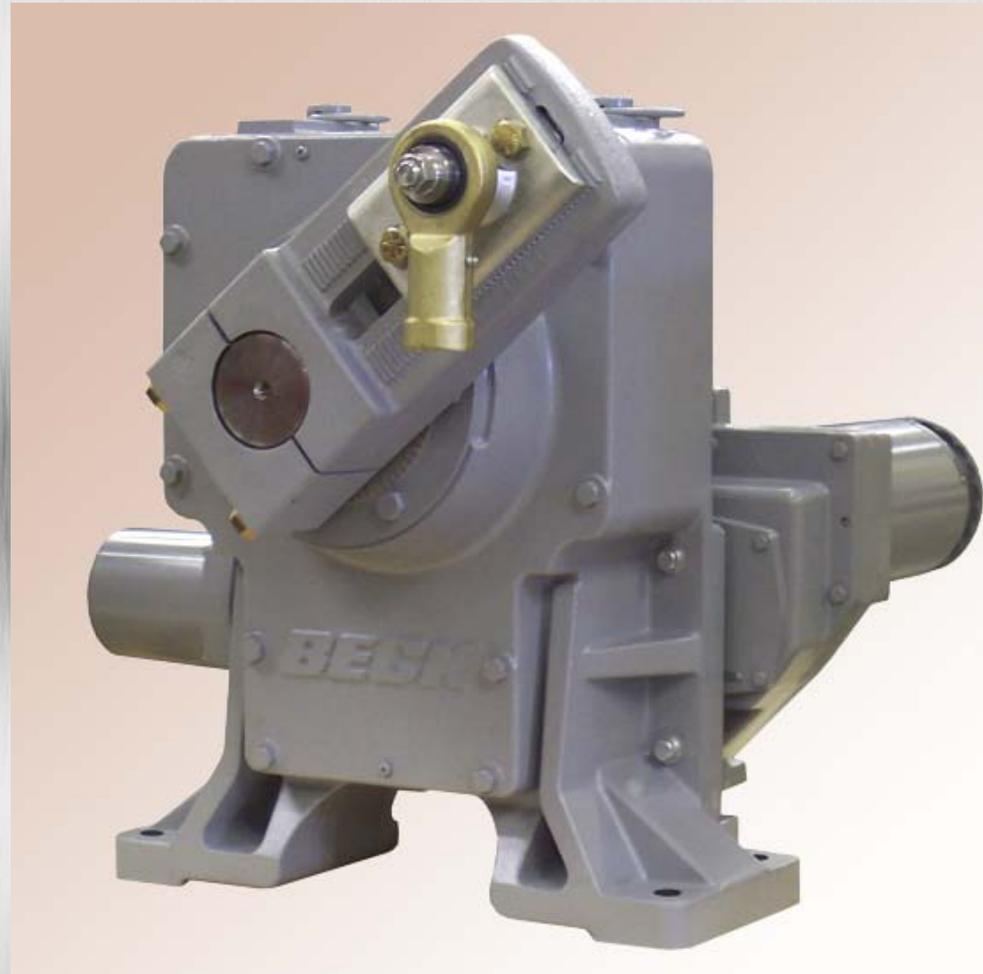
- 120/240 V power typical.
- Driven by an electric motor. 120 V, AC, Single phase is standard.
- Demand input signal 4-20 mA, 1-5 V dc.
- Position feedback 4-20 mA return signal.
- Failure Actions
 - Loss of Power: Stays in last position
 - Loss of Input Signal: Stays in place or drives to preset position.
- (2) SPDT limit switches. One for CW and one for CCW limit of shaft travel.
- 100 degrees travel typical.
- Stall protection and over-torque protection optional.



Electric Actuators

(Beck style – cont'd)

- Standard operating temperature: -40 °C to 85 °C (-40 °F to 185 °F)
 - 0-100% humidity operation.
 - CSA listed and CE compliant.
-
- See Beck literature for more information. Available at www.haroldbeck.com



Pneumatic Actuators

(Kinetrol style)

- Pneumatically driven. 80 psi plant air is typical. Also compatible with 40, 60, and 100 psi.
- Controlled by I/P controller. 4-20 mA input signal controls main air supply.
- Electro-pneumatic positioner available.
- Actuators have range of 72°-102° depending on model.
- Mechanical position indicator gauge show OPEN/CLOSED.
- Easily adjusted mechanical limit devices limit range of travel.
- Spring return available.
- Other options include:
 - Universal limit switch box, Bus communication, AP positioner, geared manual override, etc.



Circulating Oil Systems

Circulating Oil Systems – Basic Overview

- Oil Filtration Systems
- Circulating Oil Systems (with cooling)
 - Basic systems to advanced circ. oil systems.
 - Example brands: Baldor, Lube Power, Howard Marten, etc.

Baldor-Dodge OLF-2

- OLF: Oil Level & Filtration
- Motor typically 230/460 V, 3 Phase.
- Optional heater/thermostat.
- Supports enough oil flow for two bearings (Dodge RTL).
- Strictly used for oil filtration and oil delivery to bearings. Cooling water may be necessary for proper heat removal from the bearings.
- Low cost.



Baldor-Dodge OLF-2

- 1 Three Gallon Tank
- 2 Pump Supply Line
- 3 Pressure Gauge and Clog Indicator
- 4 Spin On Filter
- 5 Standard NEMA Motor
- 6 Return Line Connection –
1" NPT Coupling with two inlets (not Shown)
- 7 Removable Tank Cover Bolts (4 places) (not shown)
- 8 Oil Level Gauge (not shown)
- 9 Filtered Breather (not shown)



- For additional information, refer to http://www.baldor.com/pdf/literature/fl3000_filtration_1011_web.pdf

Baldor-Dodge Cool Lube Unit (Small duty)

CIRCULATING OIL SYSTEM FEATURES

- 5 Gallon Tank with Removable Cover
- Pump 2.0 GPM Flow
- In-line Filter with Clog Indicator and Clog Auto-Bypass
- 3-way valve to change filter while unit is in operation
- Pump Safety Relief Valve
- Bearing Line Relief Valve
- Filter and Bearing Supply Pressure Gauges
- Air to Oil Heat Exchanger
- Two Supply Line Needle Valves and Flow Meters
 - Range 0.05 to 0.50 GPM (0.1 to 1.0 GPM available upon request)
- Temperature Gauge
- Oil Sight Gauge
- Reservoir Breather Cap
- Baldor NEMA Motor
- All Components Mounted to a Base Plate

Optional Features:

- 260 Watt Oil Heater with Thermostat
- p/n 434725 – 260 watt x 120v Heater
- p/n 434726 – 260 watt x 240v Heater
- Oil Level Switch
- Temperature Switch
- Duplex Dual Filter Arrangement

NOTE: Replacement Filter Part Number 078358



Cool-Lube - 2

One (1) - C-L 2 system for 2 mounted roller bearings:

Part Numbers:

- **078325** for three phase motor
- **078326** for single phase motor
- **078327** for XP (Exp. Proof) three phase motor
- **078328** for 575 VAC three phase motor

Baldor-Dodge Cool Lube Unit Installation:

- Sugar Cane Process Plant Fan
- 4-7/16" Spherical Roller bearing continuously ran over 200 °F and failed often.
- Dodge Cool Lube System was added.
- Dodge USAF bearings with a oil flow rate of 0.3gpm:
 - Fixed bearing temp 148F
 - Float bearing temp 143F



Circulating Oil System – Lube Power LI Series

(Small/medium duty)

- Flow capacities: 0.5 – 8 GPM
- Heat rejection up to 75,000 BTU/HR
- Fairly compact design.
- Electric heater/thermostat for bringing oil to proper temperature before start-up (cold conditions).
- Moderately priced.
- Can be built API 614 compliant.



Circulating Oil System – Howard Marten LOS

(Advanced duty)

- Oil grades ISO VG32 to VG680
 - ISO VG32 to VG68 typical for fan/motor bearing application.
- Anti-friction, Sleeve, and Multi-pad bearing types
- Advanced designs to meet API 614 standard.
- Also can be built to meet industry standards such as ISO & MSHA.
- Specific jurisdiction requirements and certifications including CE, GOST, AS, etc.
- Custom built to customer-specific design requirements.



Additional circ. oil system information

- The oil system is selected/designed based on the parameters required including but not limited to:
 - The number of bearings that are requiring oil lubrication (1 fan and motor, multiple fans/motors).
 - The amount of oil that needs to supply all bearings.
 - The amount of heat that needs to be removed from the bearings.
 - Environmental conditions.
 - Customer Specification requirements. (API, etc.)

Thank You,