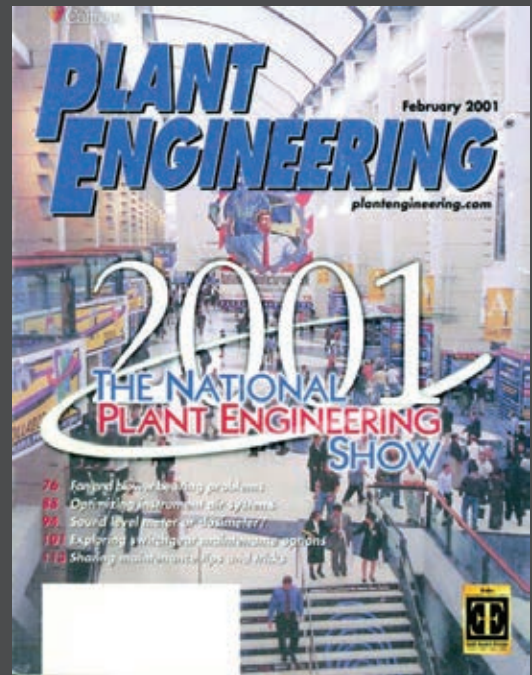


SPECIAL FEATURE

As seen in
Plant Engineering
Magazine

By Nick Agius



Fan and Blower Bearing Problems and Solutions



This report will outline typical fan bearing problems as well as the many unique solutions encountered by the author over the last three decades.

This paper provides information and solutions for millwrights and maintenance engineers working with fans and blowers. The author, through his extensive experience in the field and his interaction with maintenance personnel, has been able to identify and develop some unique ways of solving these problems. Plant engineers who write specifications for fans and blowers should review this paper.

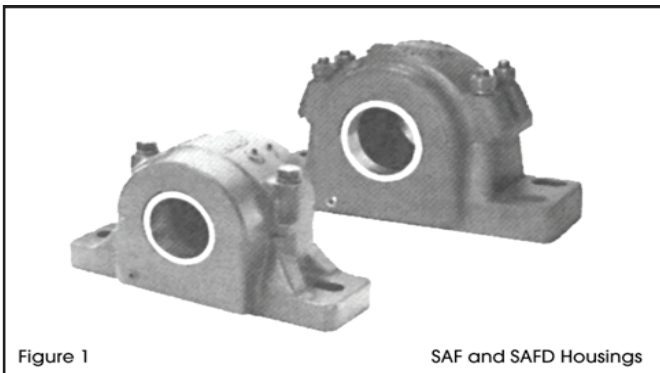
Introduction

Fans and blowers are simple pieces of equipment, yet they demand a lot of maintenance time and cost due to some common misunderstandings. The higher the speed, the more problematic they become. If all fans and blowers ran 1200 RPM, their reliability would be very high. Most run 1800 RPM, and it is not uncommon for them to run 3600 RPM or higher. The most common problems are due to a misunderstanding of the smaller details, which are outlined in this paper.

Many of the reliability problems are centered around the selection of Pillow Block housings, seals, bearings, lubrication and lubrication systems. The following paper is constructed to detail these components and their uses and limitations when it comes to fans and blowers. It has been observed that if the proper components are used, the reliability of your equipment is dramatically increased. This paper also has advanced concept in bearing design for fans and blowers as well as some other common pitfalls and how to avoid them.

SAF and SAFD Housings

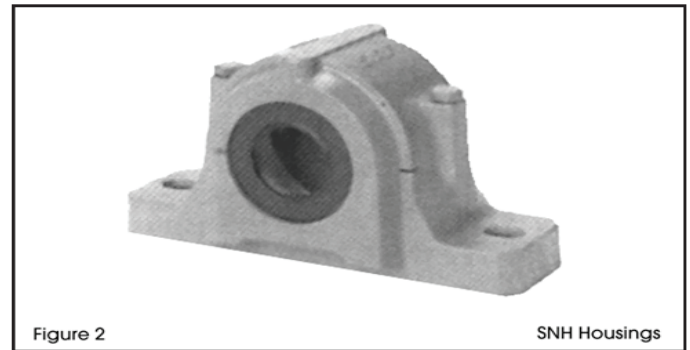
Selecting the correct housing is most critical. The most popular pillow block styles for fans and blowers are the SAF and SAFD housings. In Canada, the SAFD is the more common of the two. Both styles were developed in North America. Although both designs are able to accommodate oil lubrication, the SAFD has a larger lubrication reservoir for shaft sizes greater than 3 1/4". This makes the SAFD superior for fans and blowers. Also, the SAFD has a ductile body, which makes it the first choice for fan service. See Figure 1.



Both styles are equipped with standard aluminum labyrinth seals that are suited for fans because of the non-contact design. This style of seal is ideal for running at higher speeds of 1800 and 3600 RPM. If this standard labyrinth design came with an O-ring in the inner bore it would be a much better design. As of June 1999, SKF has upgraded its LER design to that of a LOR design with an O-ring on the inner bore of the seal. The inner O-ring is particularly useful when the end user decides to use oil instead of grease because the O-ring will seal along the shaft. This sealing concept will be discussed in more detail on page 10 under the heading "[Special Labyrinth Seals for Pillow Blocks](#)."

SNH Housings

Another common pillow block style is the SNH housing. See Figure 2. This is a very popular pillow block style in Europe where it was designed. This style creates two major problems related to lubrication and sealing for fan service.



Due to its shallow lubrication reservoir, the SNH style is really only suited for grease service although the pillow block manufacturers state that this block is made for either grease or oil. Occasionally, end users have tried to convert from grease to oil on the SNH housing. The results have been unsuccessful. The small lubrication reservoir creates a problem when using a standard sight glass in the drain holes. The actual static oil level is not much higher than the center line of the drain hole. This causes a problem because the brass block at the base of the sight glass gets in the way of the actual oil level. Drain holes are not standard on the SNH, so they have to be field drilled. The one way the SNH block would work with oil is if a re-circulating oil system was utilized.

The SNH contact style seal is not well suited for fan service and will cause problems for fan and blower applications. This standard "G" type contact lip seal causes too much heat at higher speeds. On one high-speed fan application at a sodium chlorate plant, the temperature was lowered on the SNH pillow block from 60°C to 40°C. The success was attributed to a seal upgrade. Instead of using the standard "G" type contact lip seal, the JM Clipper labyrinth, non-contact seal was installed, which will be covered in more detail on page 10.

The reason why the SNH pillow block finds its way onto fan applications is that it is priced lower than the SAFD. Because of this, fan OEMs (original equipment manufacturers) will supply the SNH in an attempt to reduce costs and make their overall package more attractive to purchase. End users should review new equipment being supplied to ensure that the correct pillow block styles are specified from the start. By having the proper pillow block housing specified, you will lower operating costs down the road.

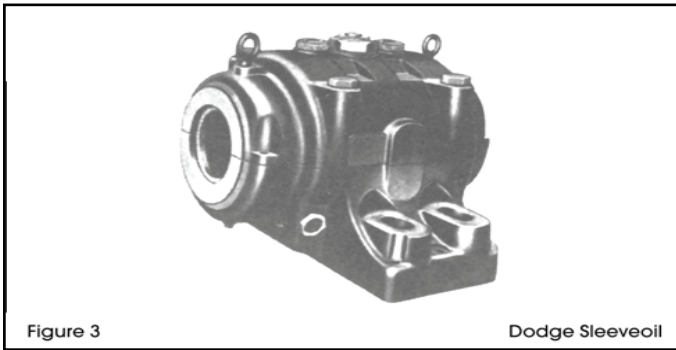
SNL Housings

The SKF Company introduced the SNL housing to supersede the SNH block. All dimensions and parts remain the same as the SNH. In fact, besides the color, it is hard to tell them apart. SKF made some internal changes that would be of interest to the end users. It would have been beneficial for SKF to take advantage of the design change to deepen the lubrication reservoir. This would have allowed the end user to convert SNH and SNL blocks from grease to oil on high-speed fan applications without external oil systems.

Dodge Sleeveoil

Another common fan pillow block is the Dodge Sleeveoil Split Babbit pillow block, which is a very reliable pillow block.

See Figure 3.

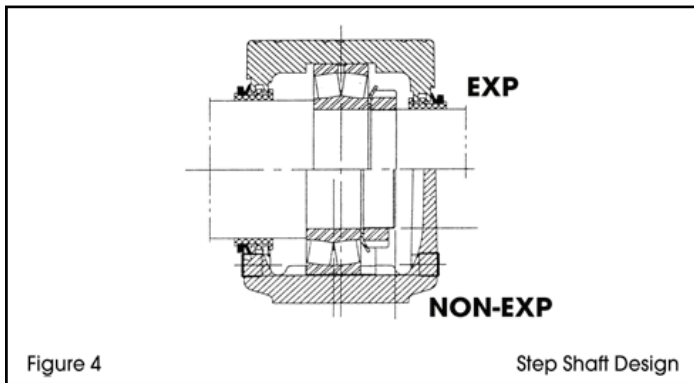


The most common complaint heard is that the seals are no good and they leak oil. This is not a problem caused by the pillow block design. The problem can be traced back to the automatic oiler supplying oil to the housing and where it is located. This will be discussed in more detail on page 6 under the heading “**Sight Glass and Oil Levels.**” This style of block is available with oil lubrication only. The size and overall cost of these units is much more than the SAFD style bearing. (Additional information on “**Dodge Sleeveoil Seals**” on page 11).

Other Pillow Block Styles

All of the pillow block styles discussed so far are those using straight shafts. They use tapered bore bearings with adapter sleeves to mount the bearings correctly. The problems caused by this bearing style are discussed on page 9 under the heading “**Double Row Spherical Roller Bearings and Double Row Ball Bearings.**” Both the SAFD (SAF) and SNH (SNL) are also available with step shaft designs which have some major advantages over their straight shaft cousins.

See Figure 4.

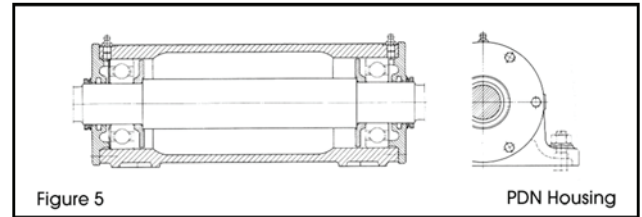


The step shaft might be more expensive to design and build but the advantage is that the human element is taken out of mounting the bearing. There is no hand adjustable adapter required to set the internal clearance in the bearing. A machinist who will utilize a detailed drawing to machine the shaft correctly will now control internal clearance of the bearing. The millwright merely has to heat up the bearing and mount it on the shaft. No feeler gauges, charts, adjustments or measurements are required. The reason the step

shaft style of pillow block is not more commonly used is because of the high up-front costs. It is true that these shafts are more expensive, however these higher costs come with major benefits to the end user down the road.

PDN Pillow Block Styles

Another style of pillow block more common in Europe than in North America is the PDN design, available through both FAG-Schaeffler and SKF (and others). SKF identify it as the PDN two bearing housing. See Figure 5.



Some of the advantages of this design include the large oil reservoir and the step shaft design, which eliminates the problems for the installer that were outlined earlier. The petrochemical industry prefers a labyrinth seal design. The PDN block can easily be modified by machining the end plates to accept a labyrinth seal. Pillow block alignment is much easier with this single housing design.

SONL Housings

The SONL housing is an upgrade of the SOFN housing which is actually part of the SNL family. The main feature with this SONL and SOFN housing is it is designed for oil and it uses oil pick-up rings that deliver the oil to lubricate the bearing. This is a very unique feature as compared to the traditional split pillow block housings. This means the bearings are not submerged in the oil so less heat is generated. See Figure 6. The SONL is a great fan pillow block option.



Split Bearing Styles

The two main manufacturers who build split bearings that fit into standard SAF, SAFD, SNH and SNL styles of split housing pillow blocks are FAG-Schaeffler and Cooper. Both build a high quality split bearing. The advantages of these split bearing designs are already well known to the end users. A split bearing can be replaced in minutes whereas a non-split design can take two good millwrights a whole shift or longer. This kind of downtime can easily pay for the higher costs of the split bearing design.

It is suggested that if you are going to consider changing to a split design, you contact your bearing supplier and have them review your application with both FAG-Schaeffler and Cooper. It is important to get some information to these manufacturers in order for them to determine if the thrust loads and RPM are not too high for the split design.

New Solution for Axial Float Fan Problems

The following bearing solution is very unique and involves a recent invention from SKF: the CARB bearing. See Figure 7.



The CARB bearing is the first toroidal roller bearing. Toroidal refers to the shape of the rollers. This new design offers a roller bearing with several unique features.

It is self-aligning and can accommodate unavoidable shaft misalignment without any reduction of service life. CARB is a true radial bearing and axial displacement of the shaft can take place inside the bearing at very low friction. The high radial carrying capacity increases the reliability of arrangements with CARB bearings.

CARB bearings are interchangeable with self-aligning ball bearings and spherical roller bearings in the non-locating housing only.

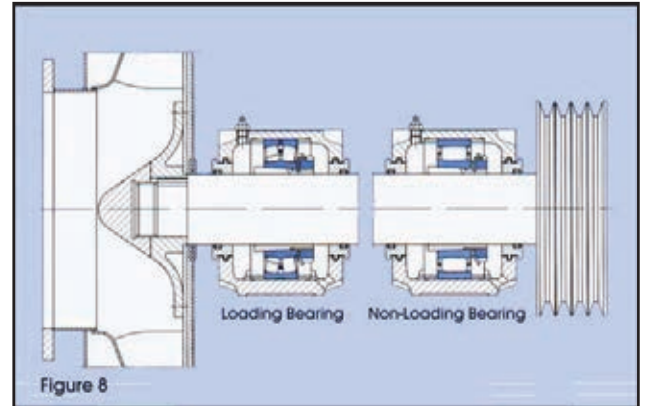
The many advantages of this new CARB bearing design for fan applications are now being discovered. In the traditional fan bearing set up you have a fixed bearing and a floating bearing. The fixed bearing is held and takes the entire axial load. The floating bearing is allowed to float in the housing to accommodate axial growth of the shaft. It has been observed on a number of fans that the floating bearing had failed. It was difficult to determine the reason. It is now believed that the failures were caused by the inability of the floating bearing to float freely.

In a traditional bearing arrangement, this movement takes place between the outer ring and the housing. Increased friction and fretting corrosion will sometimes impede the ring from moving freely. If this occurs, the bearings can be subjected to heavy internal thrust loads, which reduce bearing life and increase temperature, vibration and noise. These disadvantages are avoided completely with the CARB bearing. It accommodates the axial displacement of the shaft inside the bearing under very low friction and negligible thrust loads.

In one situation, axial float was a problem on a hot furnace fan at a large chemical plant. The bearings were approximately 10 feet apart on either side of the fan. By design, the axial growth was 0.5116". The millwrights felt that the floating bearing was not floating as it was designed. They felt that the outer race was getting hung up causing the bearings to load up against each other. As you can imagine, this was difficult to prove by the time a failure would occur. This fan was critical to production and downtime was very costly. The CARB bearing was one of two possible solutions considered. Both the CARB bearing and the Cooper split bearing were considered because of their ability to:

1. Fit the existing housing (at the time Cooper made a bearing to fit SAFD housings but they since discontinued that bearing design so now the Cooper bearing would need its own housing)
2. Float axially within the bearing and not depend on the outer ring to float in the housing

The CARB bearing was selected because there was no need for the higher cost split bearing on this outboard bearing. Also, the CARB bearing design appealed to the end user as it was a new concept (at the time). In fact this was the first CARB bearing supplied in Western Canada. The CARB bearing can not replace both bearings on a fan because it will not take axial loads. It is meant to be the floating bearing only. See Figure 8 for a typical example of CARB fan bearing arrangements.



Momentary axial loads, or changes in gas temperature, will not lead to increased axial vibrations due to the absence of interaction between the locating bearing and non-locating bearing.

Another interesting advantage to the CARB bearing is that its design allows it to function properly where the applied loads are typically lighter than those required by similar size spherical roller bearings. The result is that this CARB bearing is less sensitive to minimum load and roller skidding. (See comments on roller skidding on page 9 under "**Double Row Spherical Roller Bearing and Double Row Ball Bearings.**")

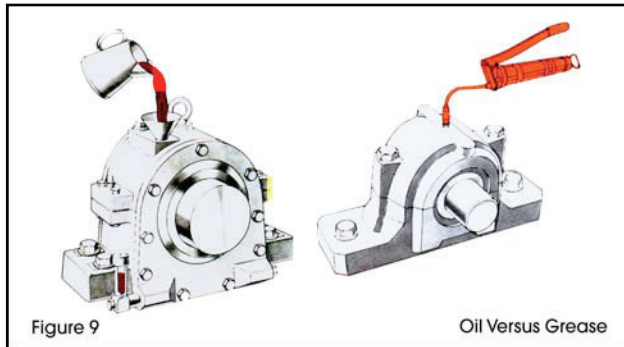
To mount a CARB with a tapered adapter is not difficult. The SKF people say it is the same as mounting a Double Row Spherical. It has been determined from field experience that it is unique to itself. Some of the following observations of the CARB should be noted. The internal construction of a CARB is very different from the Spherical. The CARB radial internal clearance (RIC) changes depending on where the inner ring is in relation to the outer ring. In other words the RIC is less when the inner ring is all the way to one side or the other. When the inner ring is in the center position, the CARB has its greatest RIC. Knowing this, you can see how difficult it would be to use a feeler gauge with any degree of accuracy, unless one is very careful. A feeler gauge can be very accurate on the Double Row Spherical Bearing without extra care.

The best way to mount a CARB is with a hydraulic nut although this is also the best way to mount a Spherical Bearing and anything else with a tapered adapter. The next best way is by utilizing the combination of measuring the axial drive up with a dial indicator and also turning the nut to the correct rotation. Both these values are in the CARB instructions provided by SKF.

Lubrication: Grease Versus Oil

Oil is a much better way to lubricate typical fans for the following reasons:

- When oil is being utilized along with the help of a sight glass, you always know the level and condition of the oil.
- If necessary, this oil can also be changed on the run.
- You can take oil samples without shutting down equipment.
- Pillow blocks lubricated with oil will typically run at slightly lower temperatures than those lubricated with grease.
- Bearings can run at higher speeds when lubricated with oil.
- Oil lubricates better than grease in an extremely cold application. Grease tends to stiffen and not slump into the bearings at cold temperatures, which causes lack of lubrication.
- Oil is a better lubricant than grease in a minimum load condition. Oil doesn't resist the rolling element as much as grease.



The most common complaint when using oil is that it is “messy.” Whenever this occurs, the problem is generally traced back to one of the two following problems:

1. Using the wrong housing. If you are using the SNL/SNH housing, it is not built for oil, which along with the contact seal design can create a big mess
2. The second most common problem is that the end user is using an automatic oiler, which is problematic on any design of pillow block housing. These points are expanded in the next section entitled “[Sight Glasses and Oil Levels](#).”

The major problem observed when using grease is the user's inability to analyze the condition and amount of usable grease inside the pillow block. The only proper and accurate way is to shut down the fan and remove the top cap of the pillow block. This will allow the end user to visually confirm what's happened to the amount of grease and its condition. Another problem is that anyone with a grease gun can add new grease. Each time grease is added, the amount should be recorded and logged so that all Maintenance and Operations staff are aware of what has been done. Some possible concerns are:

- Is the correct grease being used so that it mixes properly with the original grease?
- Is the end of the grease gun clean or dirty?
- Is one person's shot of grease the same as another's?
- Is the bearing running hot because it needs grease or because it just received too much the last time?

The interesting thing about grease and bearings is that as soon as you put new grease into the housing the temperature of the bearing will rise for a short period of time. However if you didn't add enough, it will rise for a long time.

- Did the last person tell anyone they just added grease and how much?
- Did they record the temperature before and after?

If grease is being used as a lubricant, it is strongly recommended that once a year the fan gets shut down and the excess grease gets removed. This will ensure that the build-up of old grease does not cause the bearings to run too hot.

Using oil to lubricate your fan bearings is clearly an advantage especially at the higher speeds. If the running temperature of your fan bearings is still too high for your comfort, there are some options for you to exercise that will help you deal with this issue.

Option one would be to examine the many synthetic oil options available on the market today. These oils can run at much higher temperatures than the standard grades of oil. Standard off-the-shelf oils can have a very low maximum temperature. These can be as low as 66°C (150°F). Some lubricant manufacturers have synthetic oils available to maximum temperatures as high as 288°C (550°F). At these temperatures the bearing is now the weak link. Some bearing manufacturers are able to build a heat stabilized spherical roller bearing up to 250°C. It is strongly recommended that you consult with your lubrication specialist or supplier about the correct base oil viscosity for your operating condition and the different options of synthetic oils available to help solve your high-temperature bearing problem.

Option two would be to install some type of oil system that will lower and control the oil temperature. These systems are designed to deal with this higher temperature problem because they constantly supply new oil to the bearing. This subject is discussed in more detail on pages 7 and 8 under the headings “[Oil Mist](#)” and “[Oil Re-circulation System](#).”

Sight Glasses and Oil Levels

A pillow block that is oil-lubricated actually has two oil levels (static and dynamic). This is a result of the design of the pillow block and the drain hole positions. The direction of shaft rotation will cause a slightly higher dynamic level (higher than its static level) on one side while the fan is running. Conversely, a slightly lower dynamic level (lower than its static level) will appear on the other side.

This is a critical point to understand, in order to avoid adding too much oil and actually causing the problem that is to be eliminated. The sight glass should always be positioned on the side that will be higher in the dynamic running position. This will allow you to have a greater viewing area to see the oil. Also, to avoid confusion, make sure that both sight glasses are on the same side of the pillow block housings.

The static oil level should be clearly marked and once the fan is turned on, the dynamic oil level should also be marked. A metal lubrication tag should be attached to both sight glasses so that the operations staff is shown what both oil levels mean. It is critical to mark both sight glasses in this way. It has been observed that the difference between static and dynamic can be as high as 1/2”. This discrepancy will depend on the RPM, the shaft size, the bearing being used and the pillow block style.



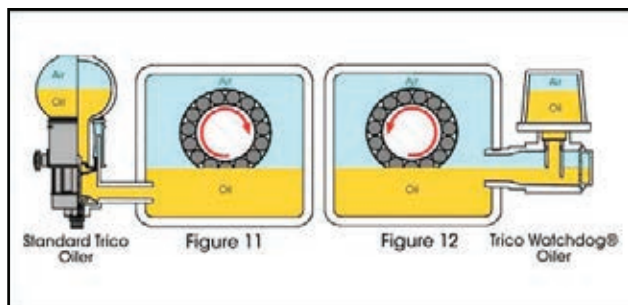


Figure 10a

Figure 10 shows a typical sight glass being used everywhere. At times the small brass block near the bottom gets in the way of the actual oil level and so the operators can't see the oil level and they end up putting too much oil in the housing, which can cause other issues. Figure 10a shows a new style innovative sight glass that works very well for fan pillow block service. As you can see it has no brass block so the oil level is easy to see and mark.

Automatic Oilers Uses and Limitations

Automatic oilers are very common on many pieces of equipment, including pillow blocks. See Figures 11 and 12.



They are ideally suited for use on most centrifugal pumps, however the author strongly questions their use on most styles of pillow block housings. They can be used on the Dodge Sleeveoil Pillow Block as long as you install the oiler into the drain hole directly under the shaft and not in the existing sight glass hole. The existing sight glass hole is designed for a bulls-eye sight glass. The idea of the bulls-eye sight glass is that the oil level, by design, should be at the middle. If you try to use an automatic oiler in the same hole, it is impossible to adjust the level low enough. This is why the complaint that is heard is Dodge Sleeveoils have poor seals and that they leak oil. This problem can be eliminated if you use the oiler in the correct position.

Another option is to install the Trico "Watchdog" in the sight glass hole. See Figure 12. This Trico oiler is designed for bulls-eye type oiler systems and has many other uses in the petrochemical marketplace, especially on pumps and gear boxes. The Watchdog oiler is a closed system design that eliminates contamination getting in through the oiler.

The problem with automatic oilers (on SAFD and SNH housings) is that the actual dynamic oil level is not the same as the static oil level when the shaft is turning. Depending upon which side of the housing the oiler is positioned on, it will either give too much oil at start up or it will allow the oil level to sink too low before the oiler releases oil, which might be too late.

Oil Mist

Oil mist is an extremely good way to lubricate fan and blower bearings. It keeps the bearings both cool and clean. The major objection heard from end users relates to the cost. The cost of down time is much higher than the cost of an oil mist system. Also, the cost has come down over the past several years and the payback can be as low as one year.

End users should explore this option with actual quotations and consultation from oil mist manufacturers through your bearing supplier. Most bearing suppliers have direct access to oil mist manufacturers. You can also consult your local STLE (Society of Tribology and Lubrication Engineers) for more information.

Oil mist has also been used to solve problems on vertical turbines and electric motors in the petrochemical industry.

What It Does...

Oil mist lubrication is an automatic, centralized system that continuously delivers fresh, clean oil to multiple widespread machine elements.

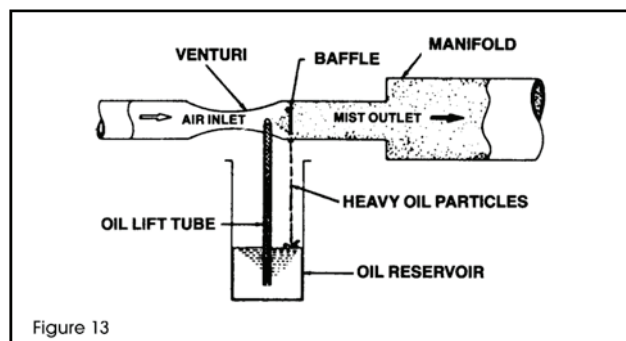
There are numerous advantages to oil mist plus improvements in safety, productivity, housekeeping and lubrication achieved by automatic centralized systems.

In order to ensure an adequate supply between periodic applications, continuous delivery of oil mist closely approximating actual bearing surface requirements, reduces lubricant consumption, which can often be reduced by as much as 80%. In many cases, continuous lubricant delivery by oil mist permits the elimination of energy wasting oil sumps. Reductions in power consumption of more than 25% are common. Bearing temperatures are often lowered dramatically. Not by actual cooling, but because a power consumption reduction represents heat that is not generated in churning excess lubricant.

Pressurization of housings, with continuous airflow, extends machine life by helping to exclude dirt and corrosive atmospheres. Oil Mist is even used to protect equipment on standby and in storage.

How It Works...

At the heart of the system is the Oil Mist generator, in which oil is atomized by high-velocity air. See Figure 13.



Baffles intercept large particles and return them to the reservoir. The remaining, smoke-like suspension of minute oil particles in the air is distributed through pipes, tubes and hoses at low pressure and velocity.

The mist flow is metered to each lubrication point by an application fitting. There are three main types of fittings used: Mist, Spray and Condensing. See Figure 14.

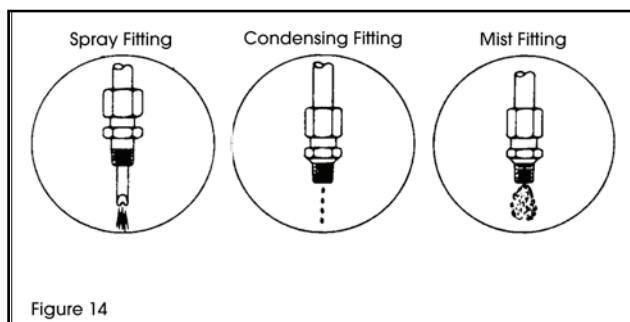


Figure 14

Mist fittings only meter the flow of lubricant; they do not change the characteristics of the mist passing through them. Turbulence in and around rolling element bearings causes oil to “wet out” from the mist directly on to the bearing elements. Spray and condensing fittings not only control flow but also “reclassify” the dry mist into larger droplets. Spray fittings expel oil as fine, wet sprays. Condensing fittings reclassify the oil into larger drops that drip or run down adjacent surfaces.

Oil Re-circulation System

The oil re-circulation systems that are available commercially have made major improvements over the years. Oil re-circulating systems help to ensure that the bearing will run cooler than with any other designs. You also have the ability to clean the oil with a filter.

An innovative and creative solution was used at the Agrium Fertilizer Plant in Fort Saskatchewan to solve a fan lubrication problem. John Navratil and Gary (Lucky) Luyakfassel built their own oil re-circulating system. See Figures 15 and 16.



Figure 15



Figure 16

Their oil re-circulating system still has the original oil sump in the pillow block housings to protect the bearings in the event that the system shuts down for some reason. They also installed the JM Clipper ProTech labyrinth seals to protect the system from outside contamination.

The key for this system to be successful is to drill the drain hole at the correct dynamic level when the bearings are running so that you neither overfill nor drain the sump. The drain hole should be on the high side of the reservoir, not the low side. See Figures 17 and 18.

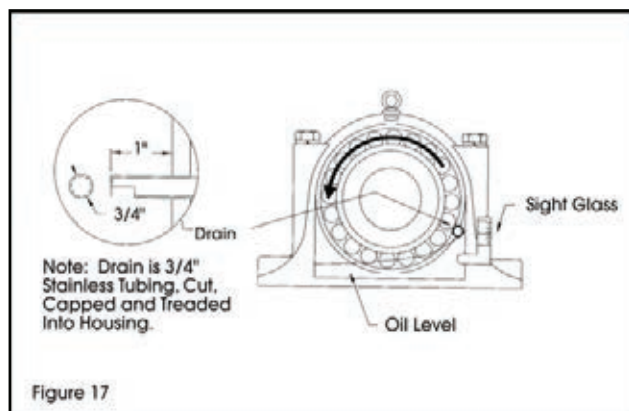


Figure 17

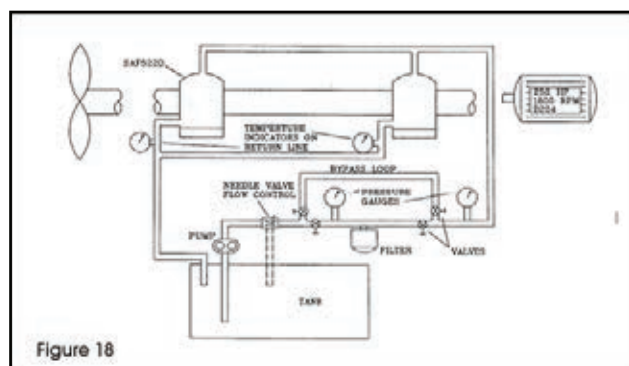


Figure 18

There is a reason for the drain hole to be positioned on the high side. If you drill the drain hole on the low side it will be lower than the static level. This will cause the bearing to drain too much oil when the fan is shut down. When you drill the drain hole on the higher dynamic side it will be slightly higher than the static level. Therefore when the fan is at rest the sump will not drain and the proper oil level will be maintained. If this concept is not clear, review the earlier section entitled “**Sight Glasses and Oil Levels**” on page 6. This section explains how the turning of the shaft affects oil levels inside these housings.

The following is a simple trick for properly locating the drain hole at the correct dynamic level. The first step is to run the system at designed speed and install a sight glass on the high dynamic level side to be drilled. Mark the dynamic level and drill the drain hole accordingly.

WARNING: Exceptions to the Rule

It has been observed that the oil level might have to be lowered if you are running near or above the maximum speed limit of the bearings. At higher speeds, the wet sump can generate heat as well it can cause the seals to leak. If you have a dependable oil system with flow monitors, you can lower or eliminate your sump to avoid the above mentioned problems.

The gravity drain is an important part of the re-circulating system. If the oil return line is from only one side of the housing, another housing modification must be considered. There are two small sumps on either side of the bearing housing. Drilling from one side of the sump to the other will join these two sumps. Drill

two holes using as large a drill as will fit through the existing drain holes but without affecting the bearing seat area. These holes should be parallel to the base under the bearing seat. If this modification is not performed, there is a possibility that the oil could build up on the one side of the bearing housing and leak out the labyrinth seal. The reason for this is that when the bearing is rotating at higher speeds it will resist the passage of oil back through the bearing. This build up will create additional heat, defeating what we are trying to achieve on the fan.

Dodge Sleeveoil External Cooling Options

An excellent alternate idea for cooling the Dodge Sleeveoil pillow blocks commonly used on fan applications was observed at a local refinery. These housings were supplied with water cooling by Dodge. Due to extremely cold outside temperatures, the use of water was found to be problematic. The solution was tapping into the air from the fan and redirecting it into the existing water cooling coils of the Dodge pillow blocks. Using air instead of water to cool the pillow blocks is an effective and environmentally friendly solution. Synthetic oil was selected in anticipation of higher temperatures occurring with this conversion.

For this solution to be effective, the air from the fan must be cold enough to provide adequate cooling. This method should be given careful consideration as water-cooling coils are much smaller than the coils used for air-cooling.

Years ago, Dodge recognized air cooling as an option and began supplying air as well as water and oil circulation Sleeveoil pillow blocks. Coils on aircooled units are much larger than coils on water and re-circulating systems.

Another recommendation from Dodge is to use a small flex-hose connecting section when connecting a water-cooled Sleeveoil. This helps to take the shock out of the system and prevent leaks.

A Simple Solution to Prevent Oil Purge from Pillow Blocks

Double row, self-aligning bearings are commonly oil lubricated when used on high-speed fan shafts. There is often a problem of oil leakage along the shaft. The leakage occurs at one side of the housing and it may be experienced with any seal design. This problem is a result of the pressure differential across the housing caused by the flow of air. High pressure on the “windward” side and low pressure on the “leeward” side combine to force the agitated oil in the housing out along the shaft. *See Figure 19.*

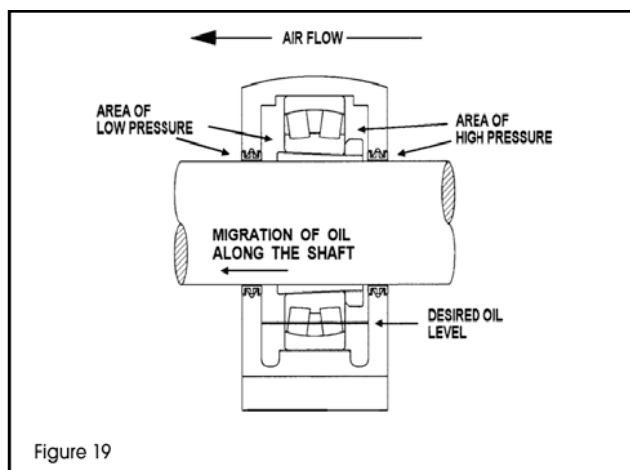


Figure 19

Some users have had success in eliminating this problem by installing a pressure equalizing tube. *See Figure 20.* If both sides of the housing are connected, the internal pressure has to equalize. This eliminates the internal pressure that drives the oil out.

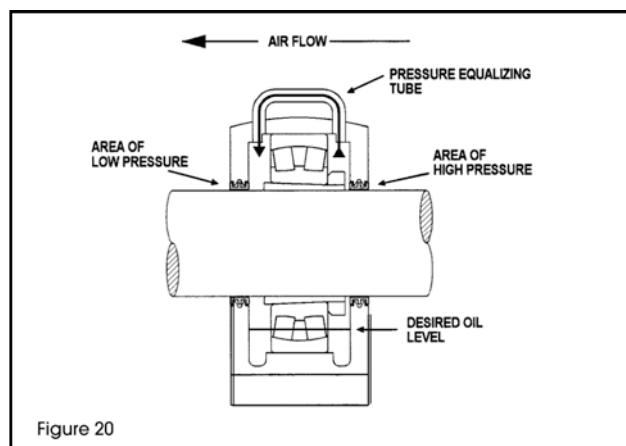


Figure 20

Double Row Spherical Roller Bearing and Double Row Ball Bearings

Both the double row spherical roller bearing and the double row ball bearing are very common on fans. *See Figure 21.* They usually utilize tapered adapters with straight shafts to mount the bearings and control internal bearing clearances.

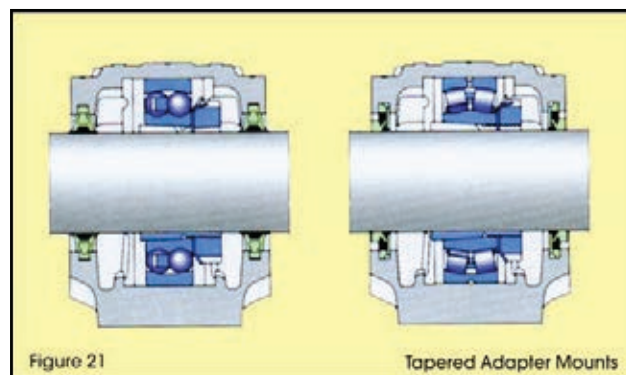


Figure 21

The double row spherical bearing with a tapered adapter is simple to mount and internal clearances are easy to adjust as required. The correct instructions are available through your bearing distributor. These bearings handle higher loads than the double row ball bearing but are limited to lower speeds. The maximum speed should always be double-checked, especially if you are having repeated failures on a particular fan.

One very interesting problem with double row spherical roller bearings is that if the fan load is not high enough you can experience roller skidding which can cause failures. Roller skidding can be avoided by properly sizing the bearing and can be determined by performing a detailed failure analysis on the failed bearing. The bearing manufacturers, through your bearing supplier, can provide this valuable service. These manufacturers have many good solutions to roller skidding depending on the particulars of your fan problem.

Double row ball bearings with tapered bores are the most difficult to set correctly because you cannot use feeler gauges to set the proper clearance. The most common failure observed is where the clearance is totally taken out of the bearing at installation. The

obvious 360° wear path around the outer ring is a dead giveaway to this very common problem.

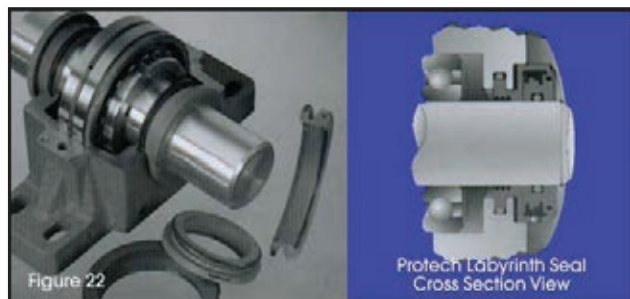
The double row ball bearing is sometimes required because the speed is too high for double row spherical bearings. If the speed is not higher than the maximum speed limit for the double row spherical roller bearing, the author tends to ignore the possible problem of roller skidding and advises the end user to switch to the spherical. They will both fit in the same pillow block with different fixing rings.

Special Labyrinth Seals for Pillow Blocks

Labyrinth seals have been around since the beginning of time – in fact, the Romans even used them on their chariot wheels. Metal labyrinth seals have been available for pumps and pillow blocks for over 20 years. In the last six or seven years, many new suppliers with innovative new materials have entered this market.

The main reason for this new wave of innovations is that the end users are becoming more aware of bearing failures created by contamination. The special labyrinth seals are usually two or three-piece unitized seals. They consist of a rotor that turns with the shaft and a stator that stays stationary with the housing. There is static O-ring seals on the inside of the rotor and the outside of the stator. These seals can be specially designed for many different types of applications. The manufacturers of these seals recognize that there is a market for the SAF, SAFD and SNH housings. These seals are an excellent option available for fans and blowers.

The major benefit of using a labyrinth seal for these pillow blocks on fan bearings is that they are non-contact seals. This means that they do not create heat like a contact seal. The other major advantage is that by design they exclude all contamination, allowing the bearings to run much longer without rebuilds. These special seals fit into the SAF, SAFD and SNH housings without any modification. See Figure 22.



These seals are available split, although at this time the most common form is non-split. There is less of an advantage to the split design unless you are running a split bearing. The argument most maintenance people use to justify a split seal is the ease of replacement. The seal should only have to be replaced if the bearing fails. If, for some reason, you did have to replace a non-split pillow block seal and there was nothing available, you could contact your FAG-Schaeffler Bearing distributor. They make a simple, split labyrinth, low cost seal that works as well as the standard seal that comes with the pillow block. It will not outperform a two-piece labyrinth with rotor and stators fixed with O-rings but it will get you to the next scheduled shut down.

Standard Pillow Block Seal Designs

The standard seals for the SAF and SAFD is the LOR design (since 1999). This is a very good quality aluminum labyrinth seal with an O-ring on the bore to stop oil leaking. See Figure 23b. Prior to 1999, the standard was LER. See Figure 23a.

Figure 23a

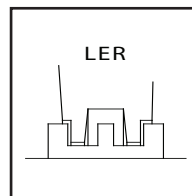
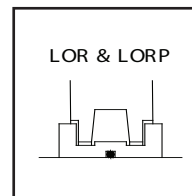


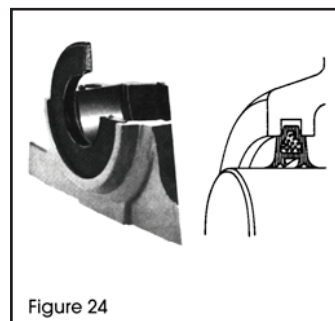
Figure 23b



This is a good standard fan seal because it doesn't generate heat on the shaft and it can handle higher speeds. It is, however, limited in its ability to seal in an extremely dirty environment. There are many other seal options from all the pillow block manufacturers as well as other seal manufacturers when it comes to extremely dirty environments. Check with your local distributor or contact the author for more information.

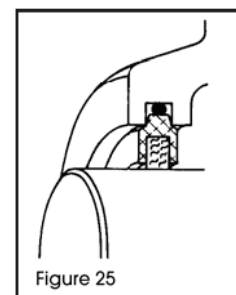
The standard seal for the SNH housing is the "G" split-lip seal. See Figure 24.

This provides good sealing because of the contact design. This contact also creates shaft wear and much higher temperatures at higher speeds. This is the primary reason why it is not a great selection for a fan application.



A very common style seal on older pillow blocks is the felt seal, which has a surprisingly low shaft speed limit of only 800 FPM. See Figure 25.

A lot of these seals are found running much faster with no apparent problem. This is perhaps because the felt has actually worn back so that it is not contacting the shaft and is not causing a heat build-up. At the same time, it is not providing protection by way of sealing. This contact also creates shaft wear and higher temperatures at higher speeds. This is the principal reason why it isn't an ideal selection for a fan application.



Dodge Sleeveoil Seals

As stated earlier in this paper, most Dodge Sleeveoils that are leaking are caused by improper oiler locations. Dodge Sleeveoil pillow blocks can be modified to accept standard labyrinth seals with great success. This has been done in the past because the end users did not feel the standard cork seal supplied with the Dodge sufficiently excluded contamination in the existing dirty environment.

Dodge supplies an auxiliary seal for their pillow blocks that is split and adapts to the existing pillow block with no extra modifications. See Figure 26.

Critics say that it is just one more cork seal but, none the less, it is available. This auxiliary seal is also available with a viton or buna lip seal on request. One day the labyrinth seal manufacturers will realize that there is great potential to seal Dodge Sleeveoil Pillow Blocks. They could build a split labyrinth that would fit existing Dodge Sleeveoil Pillow Blocks without modifications to the end user's equipment. The author has already designed split seals for Dodge blocks with help from JM Protech.

Cooling Pillow Blocks with Air

Using air to cool the outside of a pillow block is the most common mistake made in the field and it seems to be a difficult one to correct. Usually operations will run air to the outside of a pillow block in order to reduce the temperature of the bearings. In fact, what they are doing is increasing the internal temperature by reducing the internal running clearance of the bearings.



Incorrect Way

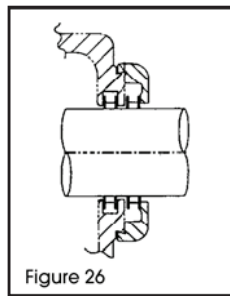


Correct Way

The heat is generated from the inside of the bearing, which causes the shaft and inner ring to expand. The heat is then transferred to the outer ring and the pillow block housing which will also cause them to expand. If you cool the housing with cold air you will restrict expansion, causing more internal heat. If you must use air, direct it toward the shaft not the housing. Instead of using air to cool, explore the many other options that have already been discussed in this paper.

Understanding this heat transfer on outdoor applications is also important in the wintertime. You can solve problems by building protection around the motor and fan bearings and reducing the winter wind chill factor. Many fan bearing failures are caused by the cooling of the housing thus reducing the running clearance of the bearings. If you build protection around the motor and the fan it will actually keep the Pillow Block Bearings in a warmer environment, or at least out of the direct -40°C or -60°C wind chill.

Another wintertime tip if you have to rebuild a set of bearings in a rush and if the pillow blocks are sitting outside during cold



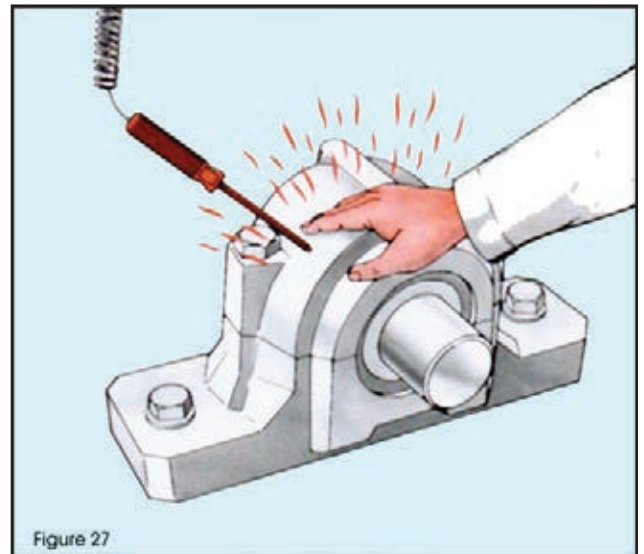
weather is as follows. When you start up the fan you might have to run it up and then shut it down a couple of times before you actually hand it back over to operations. This is important because the heat starts in the inner ring. By starting the fan, letting it run, then shutting it down, you are giving the outer ring and housing a chance to expand from the initial heat transfer. This practice is better than running the fan, sending everyone home and calling them all back again in a few hours when the bearings fail. The cause of this failure is that the bearings are being damaged at start up from the reduction of all the RIC due to the cold housings that did not expand in time.

This seems to be more of a problem with greased pillow blocks than with oil lubricated ones. This is because cold grease does not offer lubrication as effectively as oil does, which causes the inner ring heat-up to be more rapid.

Temperature Measuring Devices

The type of temperature device that you decide to use is very important. If the temperature reading you are getting is not accurate then you will perhaps try to solve a problem that doesn't exist.

When a maintenance person depends on the non-contact infra red laser sight thermometer for readings, they should be careful. The infra red laser guns are great according to their salesmen. The salesman always points it right at the person signing the purchase order and remarkably records their exact temperature at 98°F. The problem with most of these devices is that different surfaces have different emissivities. (There are models that can be adjusted to solve this problem.) Nothing beats a contact temperature device to prevent confusion. See Figure 27.



Using a temperature device is a good preventative maintenance tool. The maintenance staff should record all the running temperatures on a regular basis for all fan bearings and all critical bearings. This helps everyone when problems arise. It might seem that the bearing is running hot, but if the file shows this bearing usually runs hot, then you would not spend time or resources fixing a problem that doesn't exist.

A good trick is to mark an "X" on the pillow block or housing so that the temperature is always taken at the same location. This helps to ensure the consistency and accuracy of these readings, making this information useful for your preventive maintenance program.

Fixed and Floating Bearings

Most shafts have at least two bearings supporting them. It is advisable, and most times, a necessary practice to have only one bearing per shaft fixed. This means that one is locked from axial movement while the other is allowed to float. This is more critical on fans as they tend to run at higher speeds.

When a shaft is rotating at higher speeds, it develops heat, which causes it to grow axially. This axial growth will cause the two bearings to load up against each other if they are both fixed in their housings.

It is advisable, but not necessary, to fix the bearing closest to the drive coupling or belt to ensure that these components are not put through unnecessary stress.

The one time you can ignore this rule of thumb is on belt driven fans where the load is too light. If the load is too light you can develop ball or roller skidding. One way to help eliminate this would be to fix the bearing further away from the belt drive. This way the bearing closest to the drive will take the radial load and the other bearing will then take the axial load. This load sharing may eliminate a minimum load situation and prevent roller or ball skidding on these types of belt driven fans.

All common housings (like SAF, SAFD and SNH) have fixing ring locations where you can add or take out fixing rings to create this fixed and floating arrangement. This sounds simple but it is often overlooked.

You have to be careful with some pillow block designs. The fixed and floating bearing might have different part numbers. Rexnord-Linkbelt makes a series of pillow blocks like this. If the maintenance people are not careful, you can end up with two fixed bearings over time. This will cause a failure as the fan shaft expands and loads both bearings that are fixed on the same shaft.

Fixed and floating are usually required but sometimes not available. For example, if you have small light fans utilizing single row self-aligning pillow block units, they are not as readily available as fixed and floating assemblies. The reason this is not a problem is because the RIC on these bearings is closer to a C4 clearance, which gives them a lot of axial play. Also, the smaller, lighter shafts do not usually grow enough to cause a major problem.

Setscrew Locking Devices

There are many pillow block designs that find their way onto fan applications running at higher speeds. These pillow blocks use a setscrew device to secure the inner ring to the shaft. These are not the best style of locking devices for higher speed shafts.

The inner ring usually has a clearance fit so that you can slide them onto a ground shaft. When you tighten the setscrew you are actually pushing the shaft off center and to one side which causes the assembly to become unbalanced. Also, you do this twice on the same shaft because you have two bearings to lock. Another common device is the eccentric lock collar, which has the same result. There are several quality manufacturers that utilize a squeeze lock device that have a series of splits on the inner ring which, when the lock collar is tightened, allows the shaft to remain in the center. See Figure 28.

These devices are what should be used for smaller fan shafts. The set-screw, eccentric lock and squeeze lock are more common on self-aligning single row ball bearing housings.

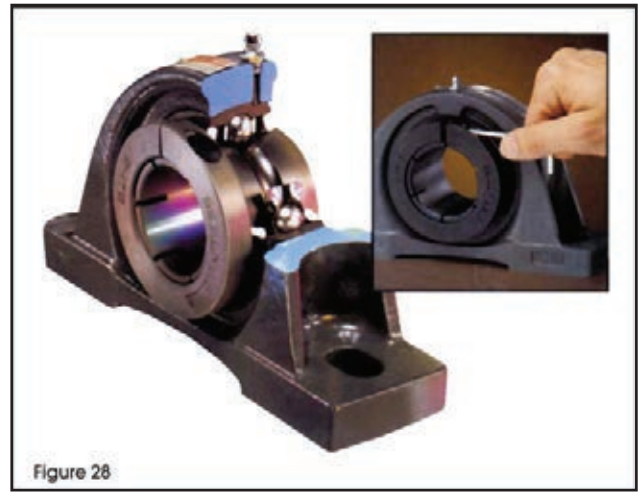


Figure 28

Pedestal and General Fan Base Construction

There are many different styles of bases available for fan pillow blocks. The options available should be fully explored by plant engineers and maintenance staff before a purchase is made. As with most things, “you get what you pay for” applies to this as well.

The following are a few suggestions that one should consider when specifying a fan.

The base pedestal for the pillow block should have a removable base just under the housing that is bolted onto the main frame. Having a removable pedestal concept will help make pillow replacement much easier by allowing room to install components such as bearing adapters and labyrinth seals. Without this feature, maintenance staff must try to wrestle the whole assembly by sliding the housing and seals together along the shaft. Also, if this modification is performed you can utilize a hydraulic nut to assemble the bearings. This is the most accurate, simplest and quickest way to install a bearing. The hydraulic nut cannot be used if the shaft cannot be raised high enough to remove the nut after installation.

In most cases on fans and blowers the shaft cannot be raised so having a removable base offers this same advantage. The thickness of this removable base depends on the size of the pillow block housing. As a rule of thumb, this thickness should be the same as the base to the center height of the housing being supported.

Spacer Couplings

The use of spacer couplings should be automatic on fans and blowers. If a spacer coupling were not utilized, the need to pull the motor off its base would be necessary when a bearing replacement is required. This requires too much extra time and can cost the plant in down time. A large motor re-alignment can take hours to get back in service. This is where there are the most opportunities for split bearings, which are more expensive than standard bearings. If one can eliminate the need for a split bearing by specifying the proper design in the first place, you would be much further ahead.

About the Author

Nick Agius has been in the Bearing and Power Transmission Industry since 1978 and is well known within the petrochemical industry as a troubleshooter with Motion Canada in Fort Saskatchewan, Alberta. He presently holds two patents for an anti-rotation device he invented and developed to solve windmilling problems on fin fans, as well as several other published papers.

Nick has published an extensive [Technical Angular Contact Crossover Catalog](#) which has received international recognition.

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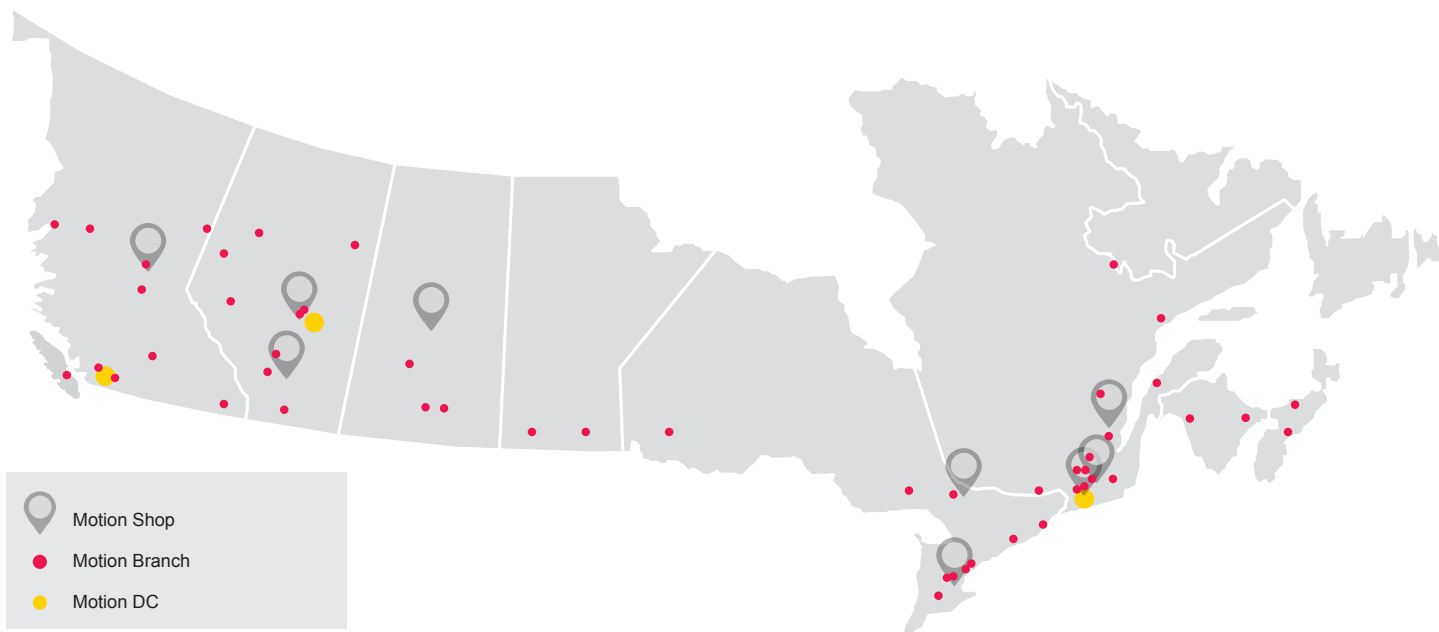
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