Amerigear
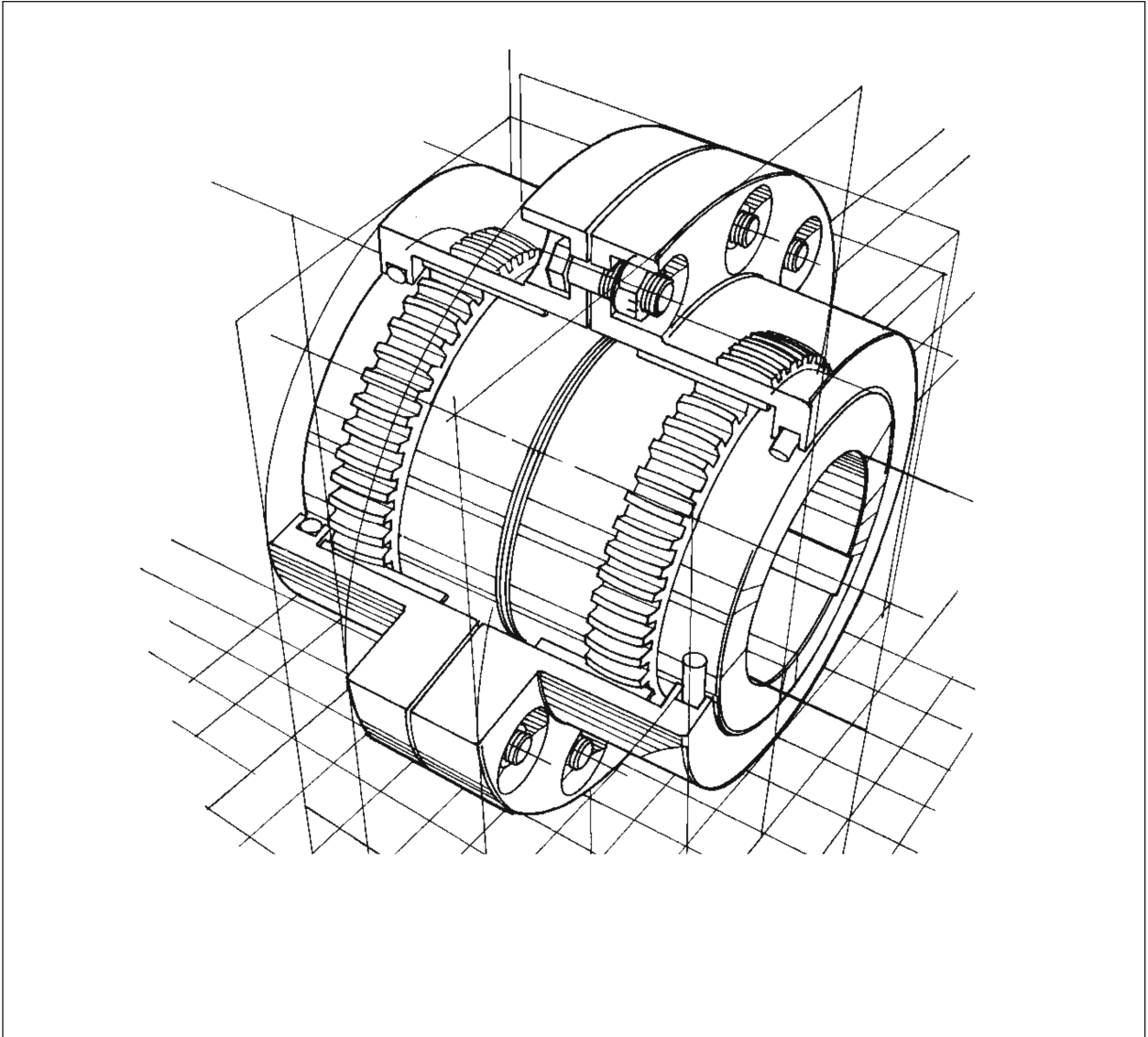# General Purpose Couplings

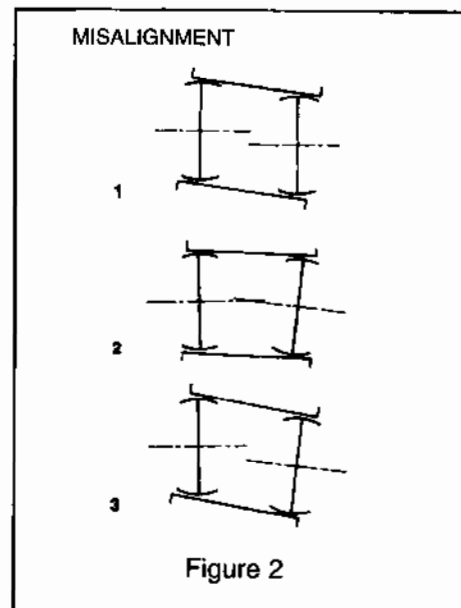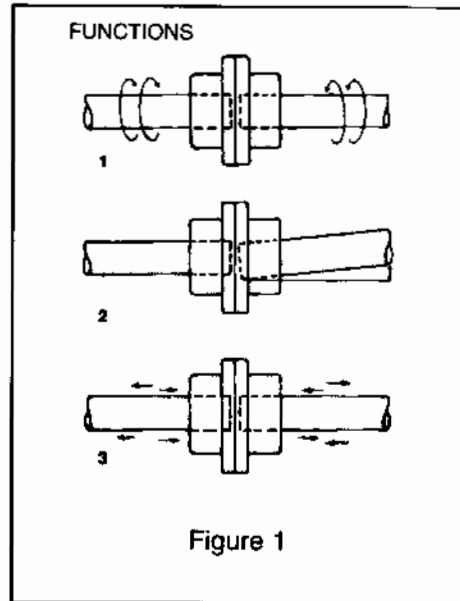**AMERIDRIVES**™

A REGAL REXNORD BRAND

Amerigear General Purpose Gear Couplings
Maintenance Guide

FUNCTIONS

Figure 1

MISALIGNMENT

Figure 2

Coupling Basics

The flexible coupling method of connecting rotating shafts is a vital and necessary technique. A flexible coupling must provide three basic functions (Fig. 1):

1. Physically couple together two rotating shafts for efficient transmission of mechanical power, transferring the torque of one shaft to the other directly and with constant velocity.

2. Compensate for all types of misalignment between rotating connected shafts without inducing detrimental stresses and loads on connected equipment and without tangible loss of power.

3. Compensate for end or axial movement of the coupled shafts, preventing either shaft from exerting excessive thrust on the other and allowing each to rotate in its normal position.

There are three types of misalignment that a flexible coupling must effectively accommodate (Fig. 2):

1. Parallel Offset

   Axes of connected shafts are parallel, but not in the same straight line.

2. Angular

   Axes of shafts intersect at center point of coupling, but not in the same straight line.

3. Combined Angular and Offset

   Axes of shafts do not intersect at center point of coupling and are not parallel.

The third type, combined angular and offset, is the most common condition.

Gear Couplings

The gear coupling is one type of mechanically flexing coupling. Mechanical element couplings accomplish their function through the rolling and sliding action of loose fitting parts. As a result of this movement, gear couplings require adequate lubrication. The gear coupling is most commonly used because of its high torque capacity and simple design.

Gear couplings incorporate many different variables in the design that affect the performance of the coupling. The original gear coupling, invented by Guston Fast and still available today, uses a straight sided gear tooth.

Clearance in the gear mesh accommodates shaft misalignment in this gear coupling design. The point of contact between the gear teeth is at the end of the gear tooth, which unfortunately is the weakest point of the gear tooth. This can lead to premature wear and coupling failure. (**Fig. 3**)

Today most couplings use a variation of the crowned or shaped gear tooth originally patented by Zurn Industries, Inc. This design helps to reduce the clearance required in the gear mesh and improves the load distribution on the gear tooth. The crowned flank or face of the gear tooth increases the contact area and eliminates end loading. Required backlash is minimal regardless of the angle of misalignment. (**Fig. 4**)

The Fast style gear coupling uses a labyrinth style seal. (**Fig. 5**) This was used because no other type of seal available at the time was acceptable. A
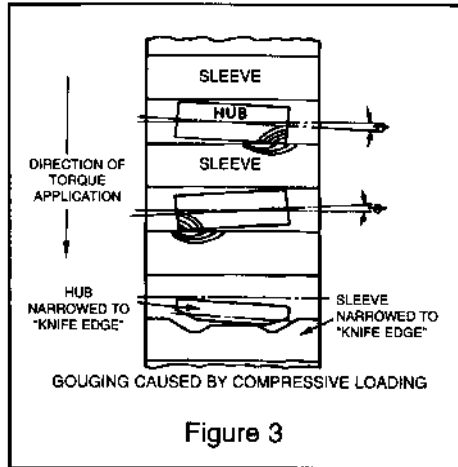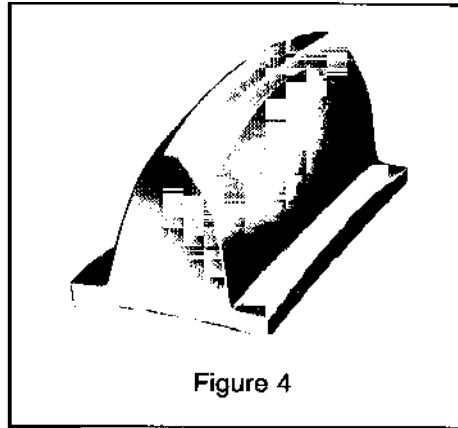

GOUGING CAUSED BY COMPRESSIVE LOADING
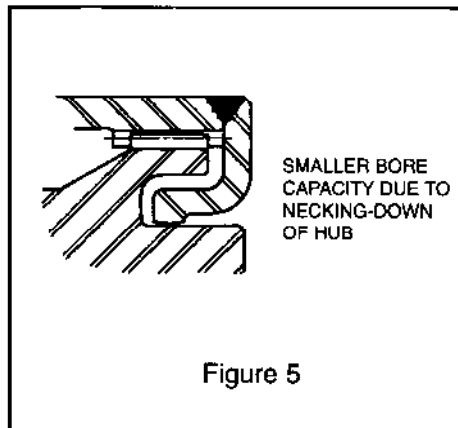
Figure 3

Figure 4

labyrinth seal is not a positive seal, resulting in the loss and contamination of the lubricant especially while not in operation. This design is also costly to manufacture and limits the bore capacity of the coupling. The labyrinth seal does create a larger cavity around the gear mesh and greater lubricant capacity than other types of seal designs. Because this seal is all metallic, it is less sensitive to heat.

Most couplings today use some type of synthetic seal such as an o-ring. This seal is more compact and allows for greater bore capacity verses the labyrinth seal design. (**Fig. 6**) This design provides a positive, dust-tight seal that keeps lubricant in and contamination out. Buna-N seals, the most common seal material available, are designed to accommodate temperatures up to 250° F. Viton seals are capable of withstanding intermittent temperatures up to 550° F. These temperatures are usually much higher than what the lubricants are capable of withstanding.
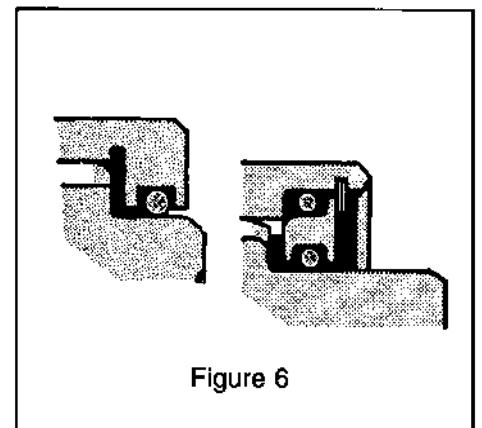

SMALLER BORE CAPACITY DUE TO NECKING-DOWN OF HUB

Figure 5

Figure 6

Coupling Selection

The selection of a standard gear coupling is usually very basic, provided that there are no special considerations. The first criteria to check is TORQUE CAPACITY. The selected coupling must be able to transmit the torque for the given application. The following formula is used to calculate torque:

$$\text{TORQUE} = \frac{HP \times 63025 \times \text{Service Factor}}{RPM} \text{ (in-lb)}$$

In this equation, the HP (horsepower) and RPM (speed) are the values that the coupling will experience at its location in the drivetrain. The Service Factor is a value used to adjust the selection torque for characteristics in the equipment that may increase the torque during operation. The American Gear Manufacturers Association (AGMA), an industrial trade association, and coupling manufacturers furnish suggested service factors for many operating conditions. The torque should be calculated for both normal and peak operating conditions. Gear couplings by design are very *torque dense*. For the given physical coupling size, the torque capacity is very high when compared to other similar types of couplings. Because of this attribute, torque is infrequently the determining factor in coupling selection. Torque values are critical for situations where extreme service conditions create unusually high torque. Therefore torque should be calculated for all applications.

The hub BORE CAPACITY is the next factor to consider. Shaft sizes of driving and driven equipment must be com-

Table 1 Common gear coupling sizes by Manufacturer			
AMERIGEAR	FAST	KOP-FLEX-H	FALK
201.5	1½	1½H	1015
202	2	2H	1020
202.5	2½	2½H	1025
203	3	3H	1030
203.5	3½	3½H	1035
204	4	4H	1040
204.5	4½	4½H	1045
205	5	5H	1050
205.5	5½	5½H	1055
206	6	6H	1060
207	7	7H	1070
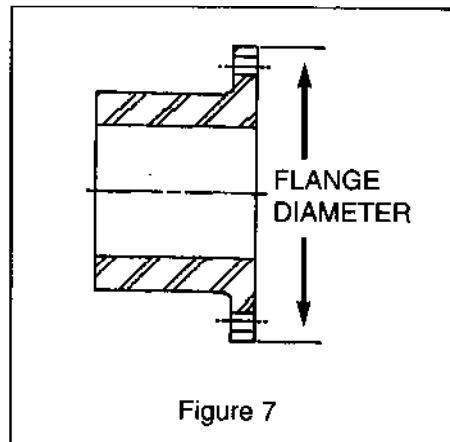
FLANGE DIAMETER

Figure 7

Table 2 Flange Diameters		
FAST # 2	=	7 inch Diameter
KOP-FLEX 2H	=	7 inch Diameter
AMERIGEAR 202	=	7 inch Diameter
FALK 1020	=	7 inch Diameter

pared to the maximum bore capacity of the specific gear coupling size. Shaft size usually becomes the determining factor in coupling selection because of the gear couplings high torque capacity.

Interchangeability

Gear couplings operate for many years in most applications. Often, coupling selection is based upon replacing a coupling that is currently in service. Because gear couplings have been available for over 70 years, interchangeability has developed between gear coupling manufacturers.

The original Fast coupling used a size designation or numbering system that was related to the pitch diameter of the gear teeth. The numerical size was also roughly equal to the maximum bore capacity of the coupling. As other companies began to manufacture gear couplings, similar numbering systems were used. Today most manufactures use a version of this original system. (Table 1)

Many gear coupling dimensions have become standard between manufactures. One typically standard dimension is the flange diameter. (Fig. 7) For a given size coupling, the flange diameter is the same for most major manufacturers. (Table 2) This provides a quick and easy way to identify the size of a coupling in the field. Manufactures' identification markings on the sleeves quickly become illegible due to service and environmental conditions. Measuring the diameter of the flange will identify the coupling size. However the specific coupling manufacturer would not be known.

Along with flange diameter, the number of bolt holes, the bolt size and the DBC are also common between coupling manufactures. This allows for interchangeability between standard couplings. Standard gear couplings are considered half-for-half interchangeable. As a set (or coupling half) the hub and sleeve of one manufacturer can be bolted to the equivalent size of another manufacturer. (**Fig. 8**) The individual components, (i.e. hubs and sleeves) cannot be interchanged because of differences in the gearing.

This feature is very beneficial since the user does not have to maintain a spare coupling for each installation by manufacturer. It allows the user to select replacement couplings offered by other manufactures for design and cost advantages .

Bores and Keyways

Now that the coupling is selected, it is ready for installation. The first step is to machine it to fit the shaft. Clearance fit, interference fit, taper bore, tapered bushings and hydraulic bore are just some of the many ways to fit a coupling to a shaft. The most common interface for a standard gear coupling is an interference fit. This means that the hub is machined slightly smaller than the shaft. The hub is expanded, usually with heat, and is then installed onto the shaft. A recommended interference fit may be obtained from AGMA who has formalized many industry standards. The interference fit standard for most gear couplings made of

Figure 8

Figure 9

Figure 10
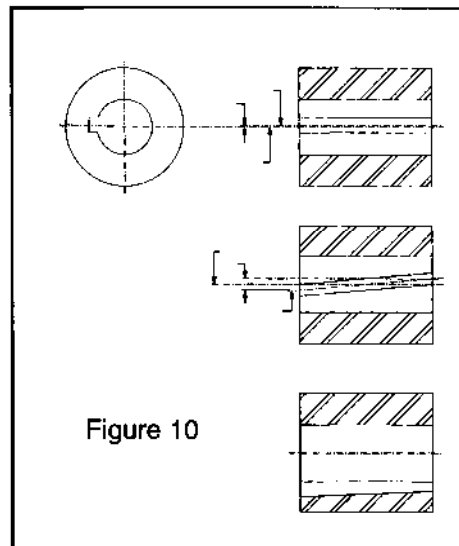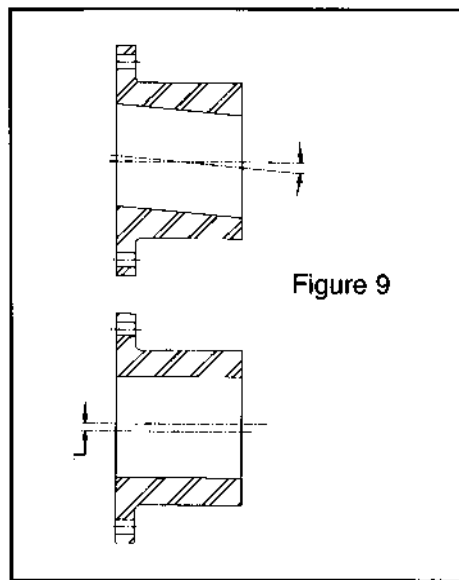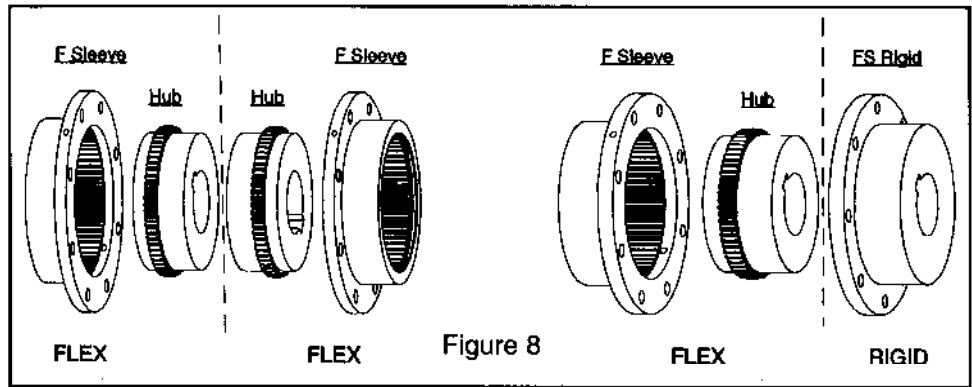
medium-carbon steel is:
* .00050 - .00075 interference per inch of shaft diameter up to 1800 RPM
* .00075 - .00100 interference per inch of shaft diameter per inch over 1800 RPM

It is important to remember that the key is also critical in the successful transmission of the torque. The bore and keyway in the hub should be checked before installation. The bore should have a surface finish of 63 to 125 microinches and cannot be eccentric or skewed. (**Fig. 9**) If the bore is machined eccentric to the hub axis, the coupling may cause vibration during operation. A bore machined skewed to the axis will increase the misalignment for which the coupling must compensate.

The keyways in a coupling hub can also be the source of many problems that include: (**Fig. 10**)

1) The centerline of the keyway is offset from the centerline of the bore.
2) The centerlines of the hub and keyway are at an angle to each other.
3) Incorrect or inconsistent keyway height.

The inability to install the coupling onto the shaft and excessive stress in the key may result from these conditions. A keyway that is too wide may allow the key to rollover when a load is applied to the equipment. (**Fig. 11**)

A shallow keyway can cause different problems. The key, acting as a wedge between the shaft and the hub, can distort the shape of the hub. (**Fig. 12**) This wedging effect may exert enough force to cause the hub to crack usually over the corners of the keyway.
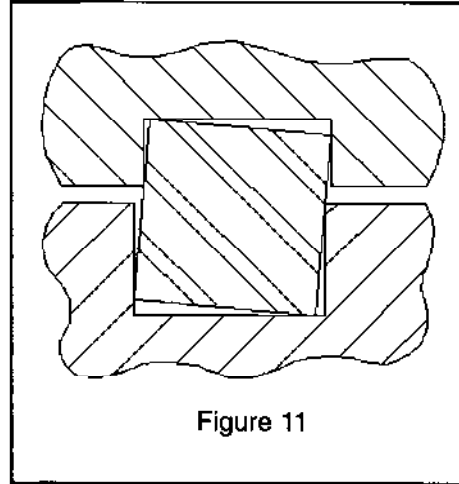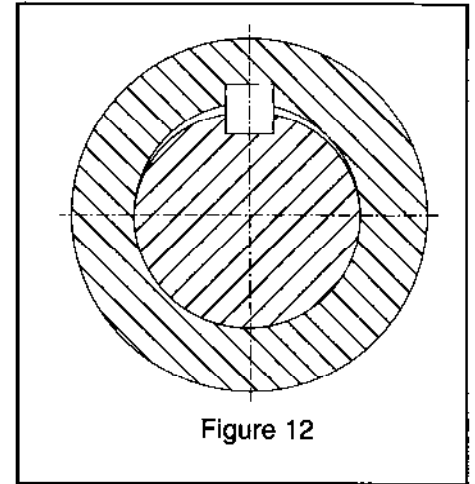
Installation

Interference fit hubs require expansion for installation, usually accomplished by heating the hub. The amount of heat required to expand a standard coupling hub is relatively low and is calculated as shown in the example.

This result is the temperature change required, or how much hotter the hub must be compared to the shaft temperature and the room temperature. This is a *minimum temperature* as there are other factors to be considered. This includes allowance for hub cooling when removed from the heat, handling during installation and heat loss resulting from the contact with the colder shaft at installation. Compensation must also be made for errors or variances in shaft tolerances, bore tolerances, and temperature readings. The recommended maximum temperature to heat a hub to is 350° F.

Most manufactures recommend a uniform heat source such as an oil bath, induction heater or oven for hub heating. Common practice is to use a torch. It is

Figure 11

Figure 12

Example: A gear coupling for a 3 inch diameter shaft is bore for .002 inch interference. What is the minimum temperature change required to expand the hub to fit on the shaft?

$$\text{Temperature Change Required} = \frac{\text{Interference}}{\text{Shaft Diameter}} \times 160{,}000 \ (°F)$$

$$\text{Temperature Change Required} = \frac{.002}{3} \times 160{,}000 \ (°F)$$

$$\text{Temperature Change Required} = .00067 \times 160{,}000 \ (°F)$$

$$\text{Temperature Change Required} = 107°F$$

important to understand the reasons for uniform heat source. To achieve the proper expansion of the hub the entire piece must be heated to the desired temperature. This can be very difficult to accomplish with a torch. The local heat source of the flame will heat one area more than another causing uneven expansion. A torch can also create localized hot spots and actually reduce the strength of the hub material. The goal is to have a smooth even distribution of heat through the entire piece.

Under no circumstances should a standard gear coupling hub be heated above

600° F. Above this temperature, changes occur to the hub material and the hub dimensions. The hub may not return to original dimensions and will not perform correctly. The hub material may also be weakened leading to failure during operation.

Alignment

Once the hubs are mounted on the shafts they then must be aligned. Standard practices recommend that misalignment at installation does not exceed 1/3 of catalog rated misalignment. (**Fig. 13 and Fig. 14**)
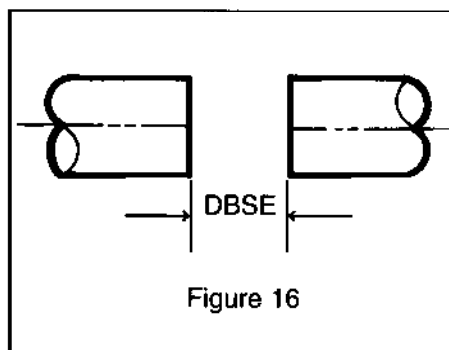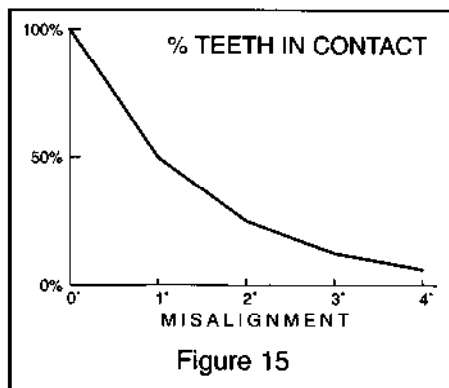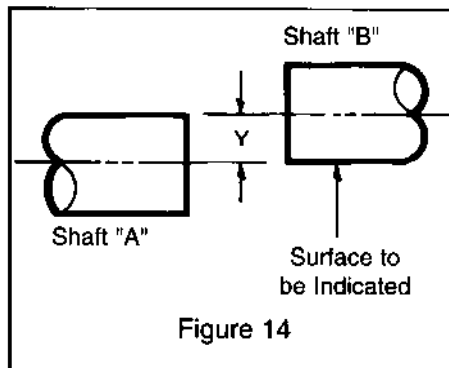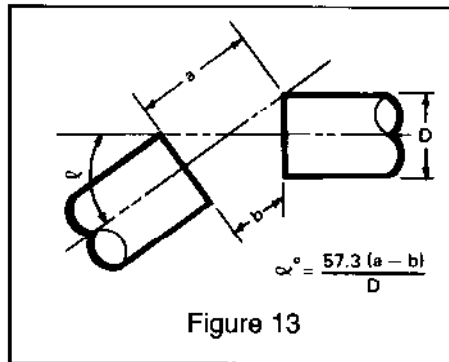
As coupling misalignment increases, fewer gear teeth are engaged to transmit torque. If a coupling is misaligned 1°, about 50% of the gear teeth are carrying the load. (**Fig. 15**) The better a coupling is aligned, the better it will perform.

One often forgotten portion of alignment is the distance (DBSE) between shafts. If the shafts and hubs are not positioned the correct distance apart from one another, the gear teeth will not be in proper engagement. Couplings are designed for certain DBSE and may lock up outside their design limits. Many manufactures have variations in design and assembly allowing for different shaft separations. (**Fig. 16**) Capacities vary with each manufacturer and should be checked for the specific coupling.

Lubrication

Lubrication has the biggest impact on the overall performance and life of a gear coupling. Most gear coupling manufacturers recommend some type of grease for lubrication of standard gear couplings. AGMA has issued Standard 9001 for coupling lubrication. This standard outlines the general properties a lubricant should have for successful gear coupling performance in its operating environment.

At installation the coupling must be

$$\alpha° = \frac{57.3 (a - b)}{D}$$

Figure 13

Shaft "B"

Y

Shaft "A"

Surface to be Indicated

Figure 14

% TEETH IN CONTACT

100%

50%

0%

0°   1°   2°   3°   4°

M I S A L I G N M E N T

Figure 15

DBSE

Figure 16

greased with the correct amount of lubricant in addition to using the proper grease. First coat the gear teeth of the hubs and the sleeves with grease before final installation. This ensures that at initial start-up the gear teeth are operating on a film of lubricant. Some studies have shown that this alone can significantly increase the life of the coupling. After installation, pump the correct amount of lubrication into the coupling before operation.

Just as too little grease can cause the coupling to fail, too much grease can impede the circulation of the lubricant within the coupling and restrict the flexing action of the coupling. The grease will not be able to circulate through the gear mesh and dissipate the heat. It is not uncommon for a failed coupling to have clean grease on either side of the gear mesh, while the grease in the mesh has separated and broken down. This is an example of over lubrication.

The correct amount of lubrication can be obtained from the coupling manufacturer. The amount recommended is often surprisingly low, since the internal space of the coupling is occupied by the shaft, the key, the hub and gear teeth. A good rule of thumb is to place the lube plugs, usually drilled 180° apart on the flange, on the horizontal. Remove both lube plugs and fill from one side. When lubricant begins to discharge from the opposite lube port, there is sufficient grease in the coupling and the lube plugs can be reinstalled.

Inspection

Most often a failed gear coupling operates until it experiences a complete failure and torque is not transmitted through the drive system. A routine inspection is recommended based upon the operation requirements of the machine to prevent an unexpected failure. A good wear pattern on the hub gear tooth is shown. **(Fig. 17)** A majority of the load should be carried by the center portion of the gear tooth.

Pitting, spalling and cold welding are possible signs of high contact stresses. This usually means that the torque load is too high, that the lubricant has broken down or the lubricant is inadequate for the application. **(Fig. 18)** When the wear extends beyond the normal area, it is usually a sign of alignment problems. Wear on the ends or tips of the teeth and possible breaks or fractures in the same areas is an indicator of excessive misalignment. The gear mesh in the sleeve should also be checked. This will show if proper engagement is occurring in the gear mesh. The function of the coupling can only occur if the gear teeth are properly engaged. After inspection, all the old lubricant should be removed from the coupling and be replaced with fresh lubricant. An alignment check is also beneficial to see if the connected equipment has moved on its foundation.

Conclusion

The best maintenance is preventative. Knowledge of the coupling and how it works can help to make smart maintenance decisions for your organization. Your coupling manufacturer is the best source for information regarding all your coupling questions.
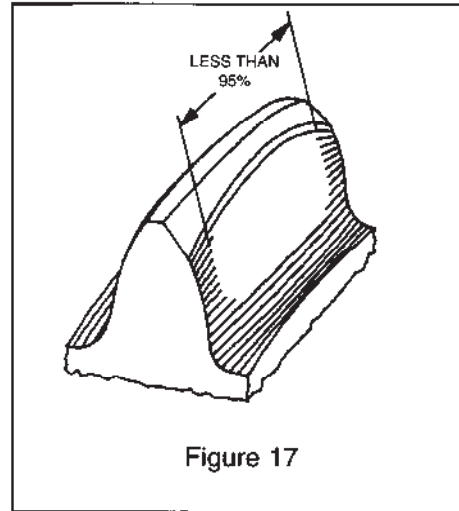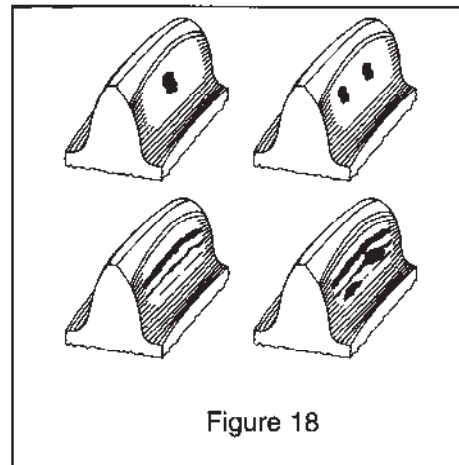

Figure 17

Figure 18

For more information refer to the following:

AGMA, *Bores and Keyways for Flexible Couplings (Inch Series)*, AGMA Standard 9002.

AGMA, *Load Classification and Service Factors*, Information Sheet AGMA 922.

AGMA *Flange Standards, Dimensions for Gear Coupling Flanges (Inch Series)*, ANSI/AGMA 9008.

AGMA *Lubrication Of Flexible Couplings*, Standard ANSI/AGMA 9001.

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