

APPLICATION GUIDELINE #32

(Alignment of Belted Applications)

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As noted in Application Guideline #2 titled 'Belt Tension'.

“Although the problems are far from epidemic, it appears that a high percentage of motor failures on belt drive applications are bearing related and a majority of these failures could be easily eliminated if care is taken with the specification and installation of these applications.”

The guideline talked more about the importance of belt tensioning, and sheave placement and only suggested more caution be given to alignment issues rather than describe the issue in detail. A recent article in Electrical Apparatus, June 2002 issue describes the issue in more detail and is summarized as follows in this Application Guideline:

Failed Bearings, damaging vibration, even broken shafts, are the well-known consequences of misalignment between direct coupled shafts. Alignment between pulleys or sheaves in belted applications has also become a concern, and should be checked each time belts are replaced. Pulley alignment tools have recently been developed that use the same laser technology so effective in dealing with direct coupled applications.

In a direct coupled drive, misalignment takes only two forms: parallel or offset (in which the centerlines of the two shafts are parallel but do not coincide), and angular (in which the two shafts are not parallel). Belt pulley misalignment occurs in one or more of three different ways: offset, angular, and twist, as illustrated in Figure 2:

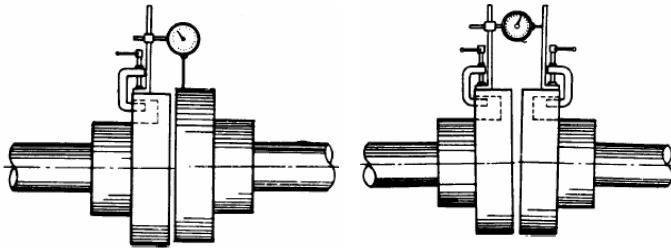


Figure 1: Direct Coupled Misalignment

1. Offset
2. Parallel

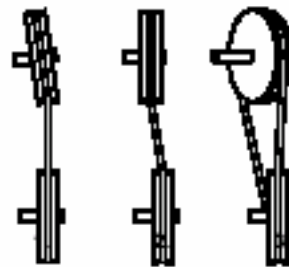


Figure 2: Belt Misalignment

1. Angular
2. Offset
3. Twist

Pulley alignment is further complicated by wide variations in both pulley diameters and center distance. For direct coupled shafts, although coupling types and sizes vary, the surfaces usable for alignment are always relatively close together, allowing the use of simple dial indicator methods if laser tools are not available. Unable to make use of the accurate dial indicator method of shaft alignment, earlier pulley alignment involved nothing more than a straightedge or a length of cord (where no available straightedge was long enough). The procedure is to span the distance between the sides or faces of each pulley with the straightedge (or taut string, or steel tape), as shown in below in Figure 3.

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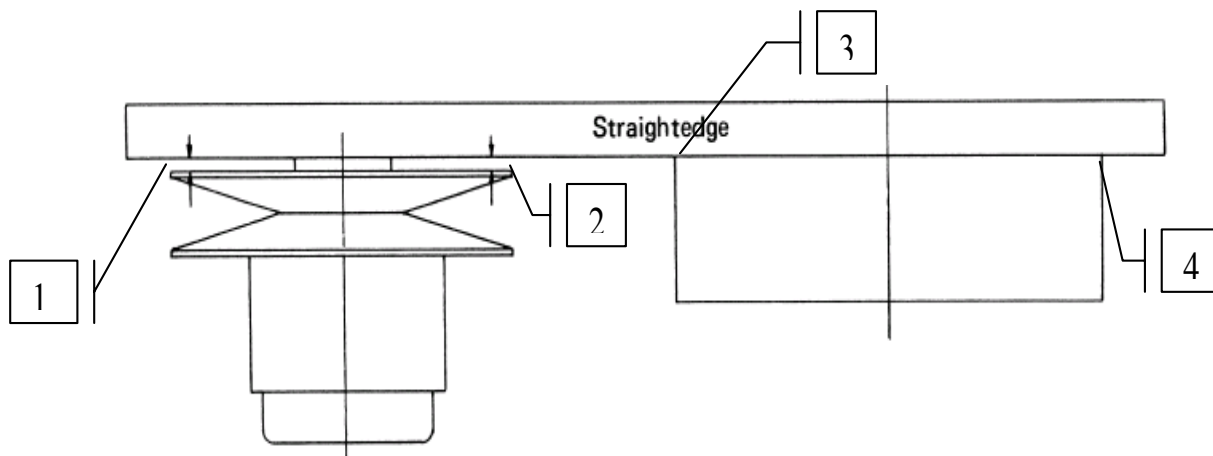


Figure 3: Checking Alignment with the use of a Straightedge

Ideally the straightedge will contact both pulleys at the four points shown in figure 3. This presumes, of course, that the sidewalls of both pulleys are of equal thickness. Otherwise, pulley alignment does not mean the belt grooves themselves will line up. Such a check will not necessarily reveal misalignment of the twist mode (laying a spirit level on the two shafts is often recommended for that purpose). The process is repeated after rotating the pulleys half a turn. Any gap between straightedge and pulley face during this process, at any of the four points in figure 3, indicates misalignment. Measuring the size of that gap determines the amount of misalignment. However applied, the straightedge/string method of alignment checking is most practical before the belts are installed and tensioned. Afterward, the nature of the machinery may preclude rotating the pulleys by hand for a complete check. Also, when the center distance is large more than one operator will be needed.

These limitations largely disappear when the newest laser alignment tools are used instead. Not only do they offer increased accuracy and greater flexibility; they may permit checking all three types of misalignment simultaneously. Pulley rotation is not usually required. The equipment is typically usable with pulleys from 2.5" to 60" in diameter, at center distances up to 10-20'. Several different versions of this equipment are available. The most common (figure 4 below) includes a set of three "target" for attachment 90° apart on the outer edge of one pulley face, and a laser beam transmitter fixed to the other pulley face.

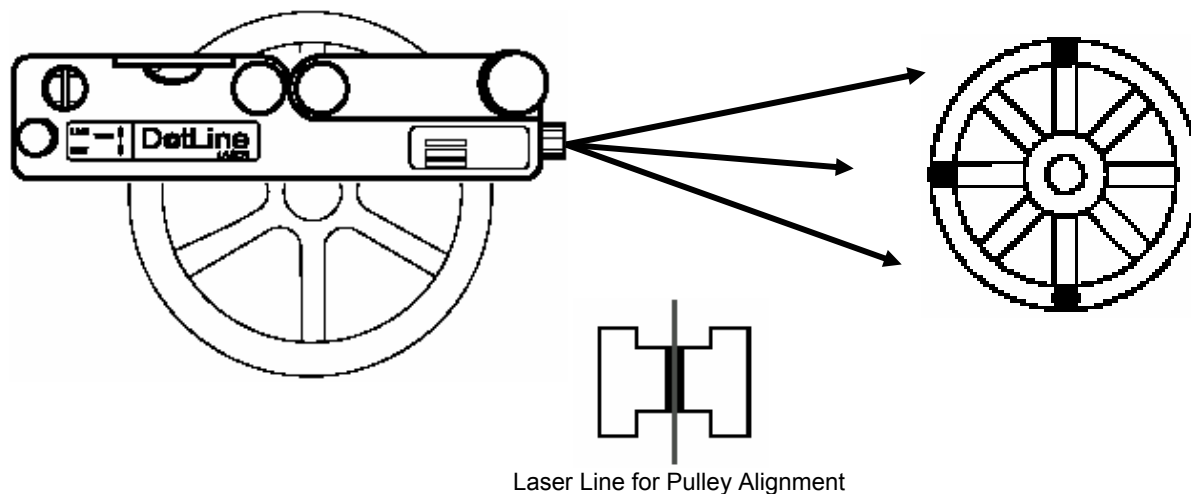


Figure 4: Three target pulley alignment laser tool

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The beam can be formed into a fan shape creating a flat plane aimed at the targets. With properly positioned pulleys, the "laser line" will strike all three targets. Two targets mounted diametrically opposite may be used instead of three, but a complete check necessitates a quarter turn of the associated pulley. The same method can be used with a dot laser but requires rotating one pulley to aim the dot at each target in turn which may not be possible with some drive trains. The spread between the target and the plane of the laser beam measures the extent of misalignment. One make of alignment tool involves reflection of the beam from the target back towards the transmitter, magnifying that spread to increase the accuracy of measurement.

Any such procedures presume that the pulley faces are flat and parallel with the belt grooves in the pulley rim-normally true, but not guaranteed (no standard tolerances exist on pulley face flatness or parallelism). A second type of laser alignment tool therefore uses laser transmitter and target components that are centered in those grooves rather than being located on pulley faces.

To most effectively carry out laser alignment , it is recommended that the following steps be taken:

1. Correct any twist by shimming the driver.
2. Correct horizontal angularity by using lateral jackscrews to slide the driver.
3. Correct any offset either by using axial jackscrews to move the driver or by shifting the position of one pulley on its shaft.
4. Because any one of these adjustments will affect the others, the process may require several repetitions- for which the fan-line laser is ideal because it monitors all three misalignment condition simultaneously.

Others have reported that although such a procedure can take two hours or more using the straightedge method, laser equipment cuts the required time to no more than half an hour. Maximum efficiency of any type of coupled application, as well as long belt life, depends on proper belt tension and operating environment. But alignment of driving and driven pulleys is equally important.

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