How to mount encoders for 100% inspection systems?

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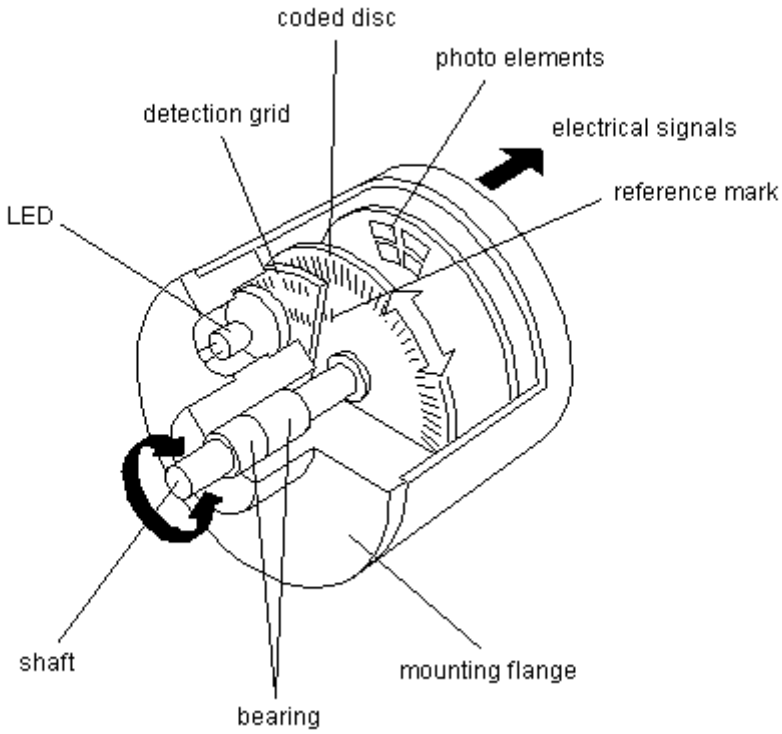
Encoders are the physical connection between the inspection system and the product. We need to understand why we use them, how they work, how to mount an encoder and finally how to select an encoder.

- Encoders allow control and feedback loops to be established.
- Encoders supply data for position and/or speed. It is impossible to maintain accuracy and control without this feedback.

The mechanical workings of an encoder are straightforward. A shaft rotates a coded disc. The disc has an array of holes that an LED will then shine through to a detector. This is then converted to an electrical signal. The frequency of this signal is a direct match to the rotating speed of the disc and this the shaft.



Now let’s examine the different ways to mount an encoder

Belt driven – This is where an encoder is coupled to a motor or rotating shaft using a belt. There may be gearing involved, but this is also known as an indirect mounting.

The two biggest issues with a belt mounting are:

- Belt too loose: over time a belt can stretch or the belt can be poorly fitted from the start, this can quite easily result in the encoder rotating at differing speeds than the drive roller (usually an idler) causing stretching and contraction of the acquired image.
- Worn belt: pulleys, whether smooth or toothed, will wear over time and will cause a similar phenomenon to that of a loose belt.

Surface mounted or friction mounting - These encoders simply lie on top of an idler and rotates as the idler rotates. The encoder assembly is normally spring mounted. Actual contact is made by a rubber O-ring which has far better contact properties than aluminium or steel.

The issues that may arise:

- **Uneven wearing of the O-ring:** uneven wear over time causes a variation in the instantaneous radius of the encoder wheel. This in turn caused the encoders angular velocity to fluctuate thus stretching and contracting the image.
- **Rolling encoders tend to be placed on the web as it passes over the roller:** This is to ensure that any slippage over the roller by the web will not affect the encoder's position (this can be a problem with shaft mounted encoders, see later). The problem here is that any severe deformities in the material will affect the encoder e.g. a splice may cause the unit to jump.

Shaft mounted - This is the most common and most reliable encoder mounting assembly. The assembly is mounted to the shaft of an idler usually through a coupling device as show below

The issues that can occur with this assembly are:

- Eccentricity in the idler, idler shaft (journal) or coupling. If the surface of the idler is not parallel to the support shaft, the resulting angular velocity variation will distort the image. If the idler shaft and encoder shaft are not concentric the encoder will very quickly be destroyed by the variation hence the use of a coupling. Even with the use of a coupling, large eccentricity will cause encoder failure.
- The second major problem encountered is with web slippage. This occurs where the angle of wrap around the idler does not develop enough surface friction to drive it.

When this happens the web slides along the idler, the encoder cannot register this movement as the idler drives it.

Selecting an encoder:

The following are considerations for selection of an encoder that will work reliably. Encoders with corrosion resistant shafts and a low TIR (Total Indicated Run) 0.01mm or less are generally required.

1. **Heavy Loads**
   Excessive radial (side) loading on the encoder shaft can shorten bearing life. Therefore, encoders should be specified in accordance with the anticipated side loading. Preferably a mounting arrangement should be derived to isolate the encoder from any such external radial forces to eliminate encoder damage that would affect image acquisition.
2. **Vibration**
   Even with the appropriate encoder; shaft, bearings, and disc, it is important that it does not encounter too much shock and abuse. In particular, the bearings or code disc can be damaged if the encoder is dropped or if the idler it is attached to is not balanced (as the subsequent variation in inertia can cause vibration)
3. **Temperature Extremes**
   The temperature specification of the selected encoder must be consistent with the application. It is important that the location of the encoder is known prior to specification. In many plants the ambient temperature can reach levels in excess of 40° such high enforced operational temperatures can seriously impair an encoder's performance.
4. **Electrically Noisy Environments**
   The use of drives and motors create Electromagnetic Interference (EMI). It is important that the encoder and data lines be isolated by the use of shielded cables, especially in conjunction with the use of twisted pair conductors.
5. **Corrosive Environments**
   A hard anodized finish especially on the mounting assembly is essential. A second reason is due to the fact that food or medical grade applications may require wash down from time to time.
6. **Wet or Dry Environments**
   Adequate sealing is a "**must**" to ensure against contamination from liquids or dust,

particularly through the shaft/bearing assembly. Contaminants that infiltrate the shaft bearing can rapidly degrade encoder performance; they may also work their way to the encoder interior where they can disrupt the optical components or damage the circuit board. A shaft seal is recommended in general, and must be used in applications where liquids are present.

Summary

The encoder often left as an afterthought is usually the only mechanical element in what is otherwise a solid state machine. It is often the least understood by suppliers and users alike and can be the single point of failure. Spend the time to understand the best way to mount and never buy cheap.

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