Understanding Metals Industry Position Feedback Devices

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Position Sensors

The Dictionary.com and Dictionary of Engineering.com definition for Position Sensor:

[puh-zish-uh n] [sen-sawr, -ser]
a device or instrument which detects the position of one or more objects, and converts these into signals suitable for processing, transmission, control or the like.

So position sensors are position measurement devices. Their use in the metals industry goes back decades and is tied to the development of analog, rolling mill, screw-down control systems.

This blog will introduce the three main types of position feedback devices from a historical perspective and discuss their uses in metals processes.

Selsyns-State-of-the-art…..in 1950!!

For many years, the standard type of position feedback device used was the Selsyn shown in Figure 1.

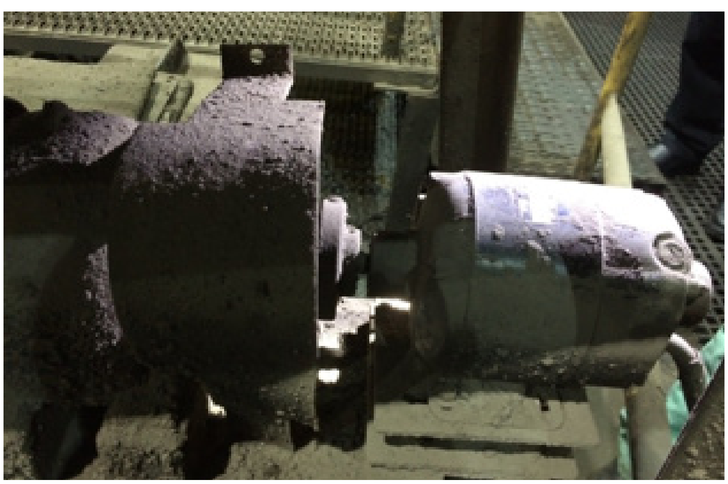

Figure 1-A Selsyn shown foot-mounted and coupled to a metals process

The selsyn uses a three-phase stator and a one-phase rotor winding as shown in Figure 2. With this arrangement and the rotor energized by AC, the stator voltages will be proportional to the angular position of the rotor.

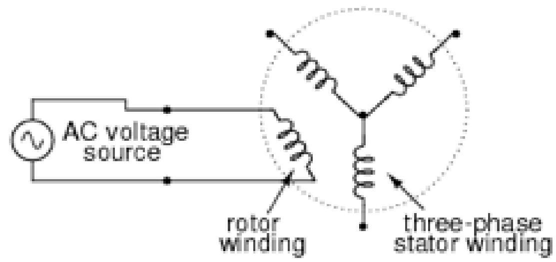

Figure 2-A circuit diagram of a selsyn

The selsyn was used as part of a two-selsyn synchro-system. A block diagram of a typical selsyn synchro-system is shown in Figure 3. The first selsyn, called the transmitter, was coupled to the metals process requiring position measurement. It transmitted stator voltages proportional to the position of its rotor. The transmitting selsyn was electrically coupled to a second selsyn, called the receiver.

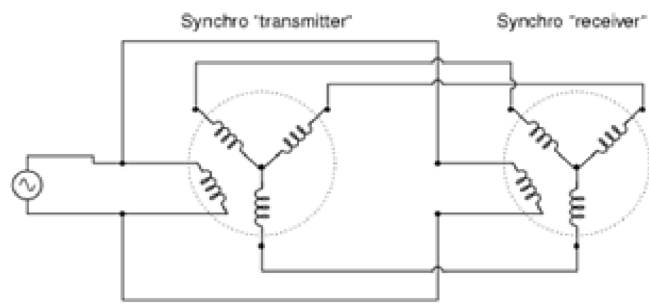

Figure 3-Typical selsyn-based synchro-system

In the circuit above, the receiver rotor will rotate to match the position of the transmitter. The receiver rotor was coupled to a potentiometer that converted the position to an analog DC voltage to be fed to the control system. The overall result was an analog DC voltage directly proportional to the position of the mill process variable, which was used to provide positon feedback to the closed-loop controller driving the metals process.

The inherent problems with this arrangement were it required two sensors and it used the analog rotary potentiometer as feedback. Any inherent inaccuracy or drift directly translated to inaccuracy and drift in the position control and degraded the performance of the metals process.

The selsyn solution did have position memory in the event of a transient or a power loss to the system. The last voltage transmitted from the potentiometer would also be transmitted when power was restored. And the correct voltage value was generated upon power-up even if the selsyns rotated while the power was off.

Resolvers-State-of-the-art…..in 1980!!

The selsyn was eventually replaced by the rotating resolver like the example shown in Figure 4.

Figure 4-A resolver shown face-mounted and coupled to a motor

The resolver uses a two-phase stator and a one-phase rotor winding as shown in Figure 5. Because the stator windings on the resolver are displaced by 90°, a resolver produces outputs which are the sine and the cosine of the reference. These sine and cosine outputs amplitude–modulate the high frequency reference to values between 0 and the reference voltage as the resolver rotates.

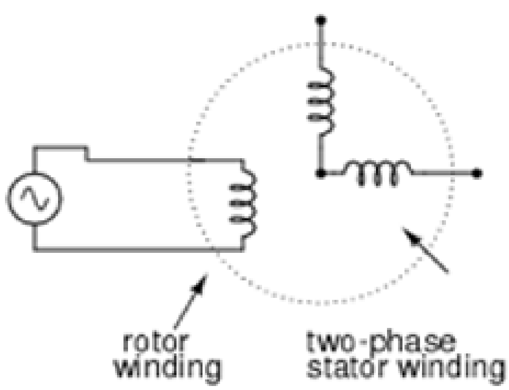

Figure 5-A circuit diagram of a resolver

The output is a signal directly proportional to the rotary position of the resolver. The magnitude (voltage) of these AC signals can be easily measured by the control system. It allowed the elimination of the second sensor and the rotary potentiometer from the control system thereby reducing system complexity and maintenance. The limitation was the accuracy which could be attained from the combination of the device and the corresponding input of the controller.

Absolute Encoders – Direct Position Feedback with Memory – Today's State-of-the-Art

Newer, fully-digital drives and control systems accept positon feedback directly from an absolute encoder like the one shown in Figure 6.

Figure 6-An absolute encoder shown with hollow-shaft mounting

The absolute encoder solution provides a unique signal for each 360° rotary position without the need for voltage conversion or decoding. The typical output is shown in Figure 7. It is a series of digital bits corresponding to binary 000…0 to 111…1 for the 0 to 360° rotation and another series of bits to track the numbers of turns made by the device.

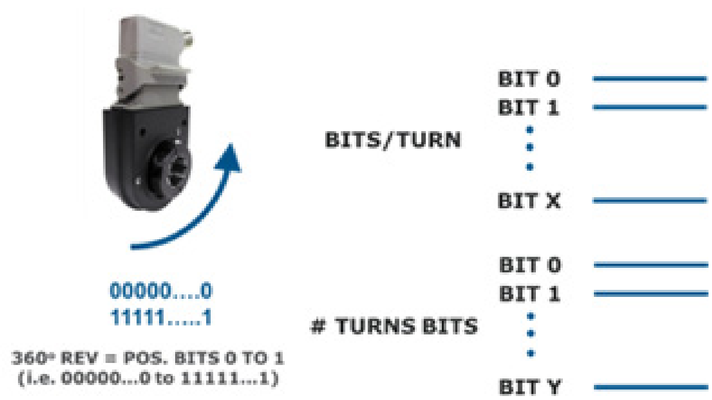

Figure 6-An absolute encoder shown with hollow-shaft mounting

The absolute encoder will transmit the correct position upon power-up after a transient or power loss even if the device is rotated with the power off. The signals are typically transmitted to the control system via a communication network like SSI, Ethernet or Profibus.

The resolutions available with today's devices allow for more accurate closed-loop position control in metals application like Rolling Mill Screwdowns. This, in turn, has allowed for tighter gauge and flatness control tolerances to be achieved for metals customers.

For more information about this article or encoders & tachometers in general, contact:

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