FLAW DETECTION BY USE OF PROBE TYPE EDDY CURRENT SYSTEMS

PRINCIPLES OF OPERATION

Surface seams and cracks in metallic materials can be reliably detected by using eddy current technology. Eddy currents are induced by one or more test probes which traverse the surface of the material under test.

To conduct a test using probe type eddy current instruments, the probes are excited by an alternating current of a given frequency which induces a flow of eddy currents in the metal beneath them. As the test probes pass over a flaw, the flaw causes a change in the flow of eddy currents, and it is this change which is detected by the instrument's electronics. The change in the flow of eddy currents as the probes pass over the defect is generally proportional to the depth of the defect. It is therefore possible to estimate the depth with proper electronic calibration.

Relative motion between the test probe and the material being inspected is a requirement in this type of test. Although the probe can be hand held as the piece under test is examined, this method is usually too slow and unreliable. The usual method is to rotate the part past a fixed probe, or rotate the probe around the part as it is fed through. In either case, the examined area is a helix with a pitch determined by the speed of rotation and the linear throughput speed.

Figure 1 illustrates that a surface defect will not be consistently detected if it is shorter in length than the helical pitch. The helical pitch is a function of the rotational speed of the probes and throughput speed of the material. Increasing the speed of the probes, or using multiple probes decreases the pitch, enabling shorter defects to be detected at the same throughput speed.

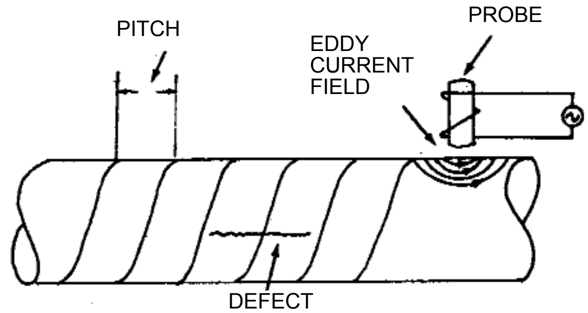


Figure 1

Decreasing the linear throughput speed also lessens the helical pitch.

In using eddy current techniques for detecting flaws, other so called "false indications" caused by surface conditions and normal metallurgical variations ("noise"), may be detected. To eliminate these unwanted indications, various selective circuits can be added to the basic instrumentation.

SELECTIVE CIRCUITS

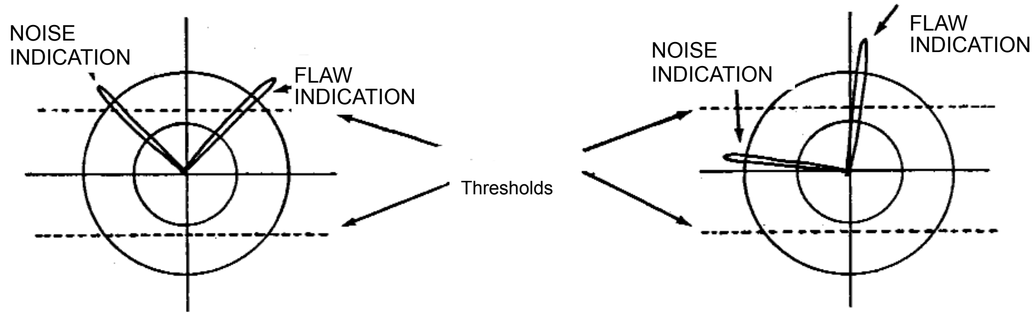
Frequency Selection

The ability to select between several different frequencies permits variation in the depth of penetration on given specimens of the same material. It is also often possible to generate a phase shift between the signal for noise and the signal for a defect by changing the excitation (test) frequency.

Phase Selection

The phase control permits 360 degree rotation of all signals. This allows the tester to discriminate between signals caused by extraneous noise and those for defect signals. If there is a phase difference between the noise and the defect signals, the output to markers,horns etc., can be modified to indicate only those signals in the selected phase.

FIGURE 2



Display before phase modification where both flaw and noise indications pass above the threshold

Display after use of phase selection circuit to rotate the phase so only the flaw indication passes the threshold

Filter Selection

The speed at which the probe passes over the defect causes the change in the flow of eddy currents to occur at a very distinct rate. This rate of change can be equated to a given frequency. Therefore, if circuits are used that only permit these frequencies to enter the instrument, signals generated at other frequencies will tend to be ignored. The circuits that do this are called filters.

Sensitivity Selection

The sensitivity control permits adjustment of the level of defect signal at which the alarm circuits will function.

Probe Selection

The test probes can be connected in either the absolute or differential (null) mode. When the probes are used in the absolute mode, one or more connected in parallel, the equipment is biased on a “good” portion of material and variations in the eddy current flow within the network are detected. When the probes are connected in the differential mode, there must be at least two probes, although they may be configured as one. These two probes electrically subtract from each other. In effect, they compare what one senses with what the other senses. The resulting difference is fed into the instrument electronics and evaluated.

Theoretically, probes connected in the differential mode produce a better flaw signal to noise ratio. The probes may also be designed with various configurations and physical characteristics to enhance the testing of different products.

Practical application of this test system requires that the probe and material under test be moved in a controlled manner in relation to each other. For example, cylindrical shaped material can be inspected by rotating a probe around it, or by spinning the material past a stationary probe. A suitable flaw detection system, therefore, consists of an electronic indicator and control unit and (1) a rotary mechanism to spin the probes; or (2) a fixed probe, spin-feed mechanism which moves the test piece. Principle systems available from MAC include:

Systems for Inspecting Rod and Wire:
Rotomac® electronics with a rotary mechanism that spins the test probes. These systems detect surface defects in magnetic or non magnetic grades of rod and wire.

Systems for Inspecting Bar:
Rotomac® electronics and rotary mechanism are combined with mechanical handling components for moving cut lengths of round or shaped bars through the test. Detects surface defects in bar stock, often as an off-line separate test station.

Helitester Systems for Parts:
Incorporates the Rotomac® electronics with a stationary mechanism for holding the test probes constant while the material is rotated past them. Suitable for inspecting cylindrical parts.