

APPLICATIONS OF VIBRATION TRANSDUCERS

1) Measurements on Structures or Machinery Casings: Accelerometers and Velocity Sensors

Used in gas turbines, axial compressors, small and mid-size pumps.

These sensors detect high frequency vibration signals related to bearing supports, casing and foundation resonances, vibration in turbine/compressor vanes, defective roller or ball bearings, noise in gears, etc.

2) Displacement measurements relative to rotating shafts: Proximity Probes (capacitance or eddy-current)

Used in turbomachinery supported on fluid film bearings, centrifugal compressors, gears and transmissions, electric motors, large pumps (>300HP), some turbines and fans.

These sensors detect shaft static displacements, unbalance response, misalignment, shaft bending, excessive loads in bearings, dynamic instabilities, etc.

ACCELEROMETERS

Advantages

- Simple to install
- Good response at high frequencies
- Stand high Temperature
- Small size

Disadvantages

- Sensitive to high frequency noise
- Require external power
- Require electronic integration for velocity and displacement

VELOCITY SENSORS

Advantages

- Simple to install
- Good response in middle range frequencies
- Stand high temperature
- Do not require external power
- Lowest cost

Disadvantages

- Low resonant frequency & phase shift
- Cross noise
- Big and heavy
- Require electronic integration for displacement

PROXIMITY SENSORS

Advantages

- Measure static and dynamic displacements
- Exact response at low frequencies
- No wear
- Small and low cost

Disadvantages

- Electrical and mechanical noise
- Bounded by high frequencies
- Not calibrated for unknown metal materials
- Require external power
- Difficult to install

Novel types: **OPTICAL FIBERS and LASER BEAMS**. Their performance is not well known yet.

From **Reference:** Harry N. Norton, Handbook of transducers, Prentice Hall, Chap:5,6,7

VELOCITY SENSORS

Electromagnetic linear velocity transducers : Typically used to measure oscillatory velocity. A permanent magnet moving back and forth within a coil winding induces an *emf* in the winding. This *emf* is proportional to the velocity of oscillation of the magnet. This permanent magnet may be attached to the vibrating object to measure its velocity.

Electromagnetic tachometer generators : Used to measure the angular velocity of vibrating objects. They provide an output voltage/frequency that is proportional to the angular velocity. *DC tachometers* use a permanent magnet or magneto, while the *AC tachometers* operate as a variable coupling transformer, with the coupling coefficient proportional to the rotary speed.

ACCELERATION SENSORS

Capacitive accelerometers : Used generally in those that have diaphragm supported seismic mass as a moving electrode and one/two fixed electrodes. The signal generated due to change in capacitance is post-processed using LC circuits etc., to output a measurable entity.

Piezoelectric accelerometers : Acceleration acting on a seismic mass exerts a force on the piezoelectric crystals, which then produce a proportional electric charge. The piezoelectric crystals are usually preloaded so that either an increase or decrease in acceleration causes a change in the charge produced by them. But they are not reliable at very low frequencies.

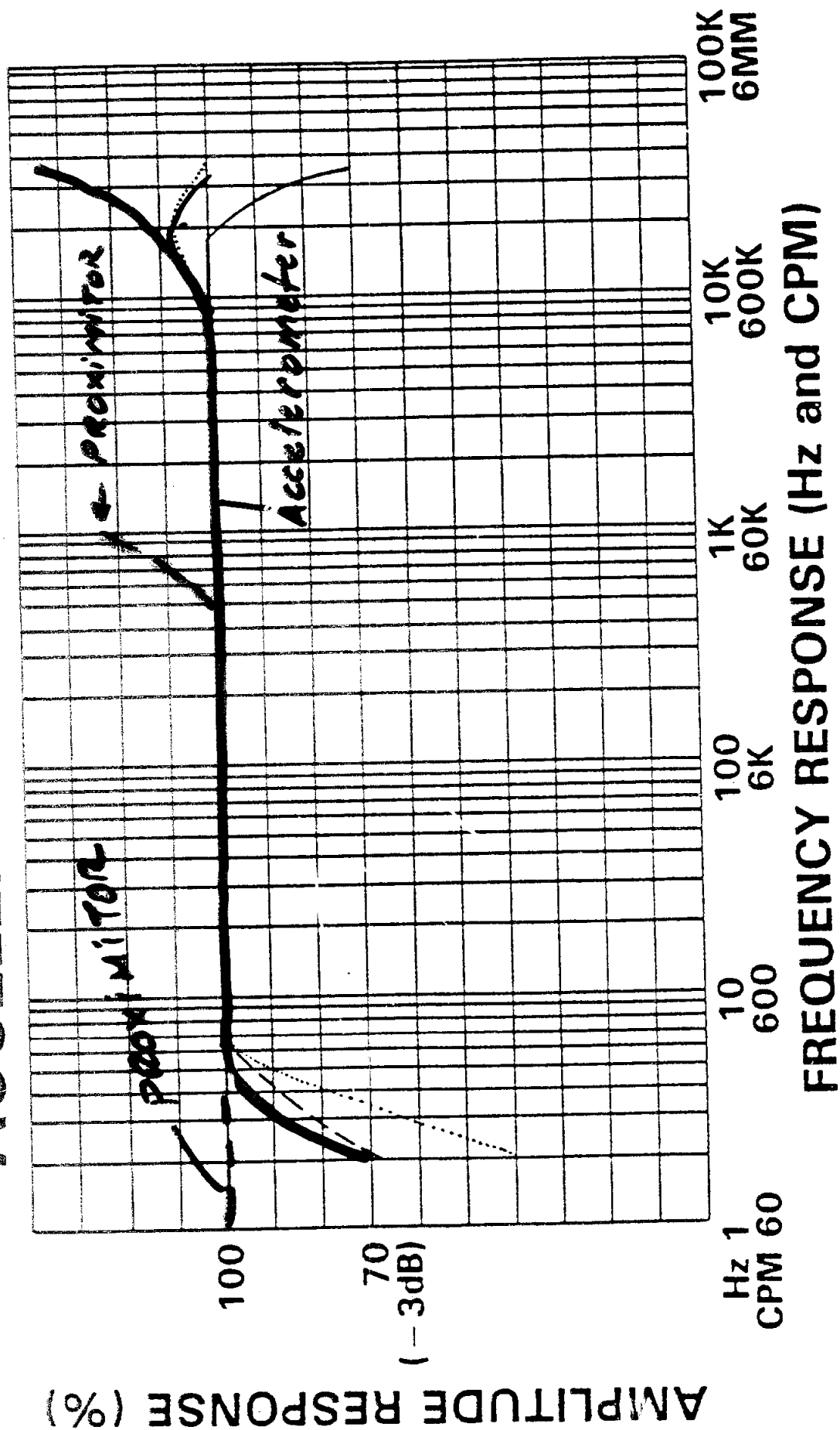
Potentiometric accelerometers : Relatively cheap and used where slowly varying acceleration is to be measured with a fair amount of accuracy. In these, the displacement of a spring mass system is mechanically linked to a wiper arm, which moves along a potentiometric resistive element. Various designs may have either viscous, magnetic or gas damping.

Reluctive accelerometers : They compose accelerometers of the differential transformer type or the inductance bridge type. The AC outputs of these vary in phase as well as amplitude. They are converted into DC by means of a phase-sensitive demodulator.

Servo accelerometers : These use the closed loop servo systems of force-balance, torque-balance or null-balance to provide close accuracy. Acceleration causes a seismic mass to move. The motion is detected by one of the motion-detection devices, which generate a signal that acts as an error signal in the servo-loop. The demodulated and amplified signal is then passed through a passive damping network and then applied to the torquing coil located at the axis of rotation of the mass. The torque is proportional to the coil current, which is in turn proportional to the acceleration.

Strain Gage accelerators : these can be made very small in size and mass. The displacement of the spring-mass system is converted into a change in resistance, due to strain, in four arms of a Wheatstone bridge. The signal is then post-processed to read the acceleration.

ACCELEROMETER RESPONSE

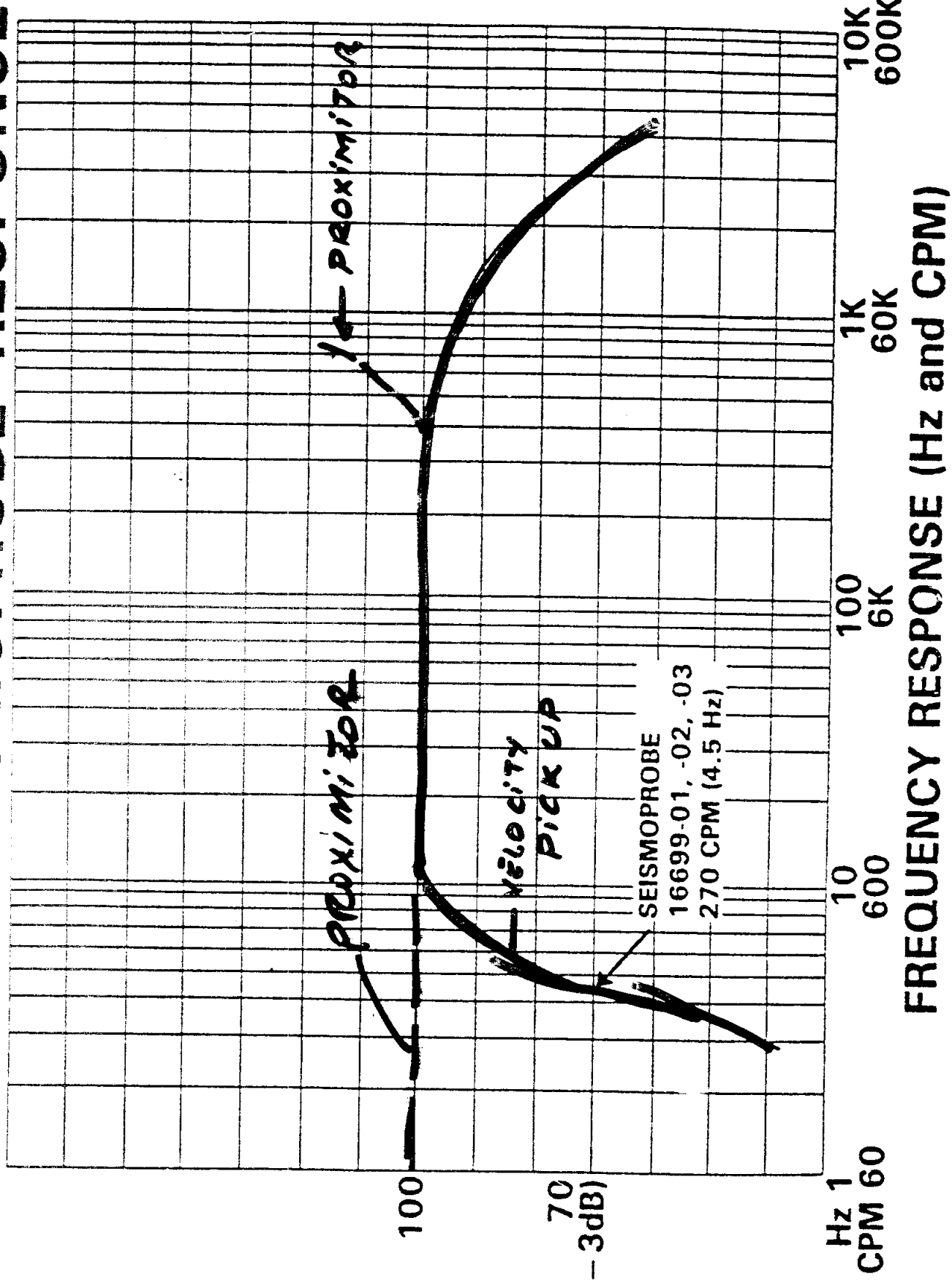


KEY

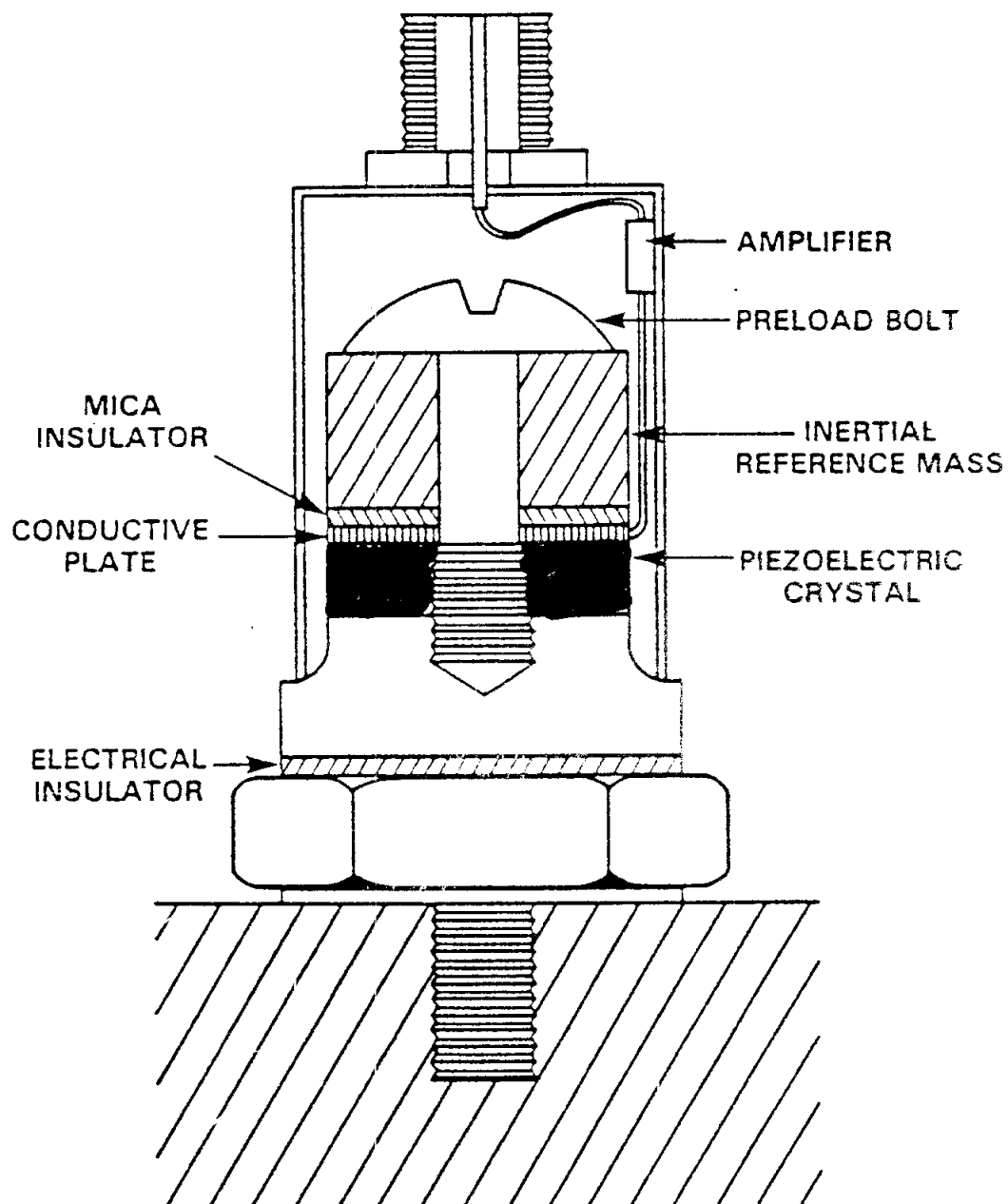
Interface amplifier
INTERFACE MODULE ONLY
ACCELEROMETER ONLY -----
SYSTEM _____

VELOCITY SEISMOPROBE RESPONSE

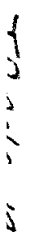
AMPLITUDE RESPONSE (%)

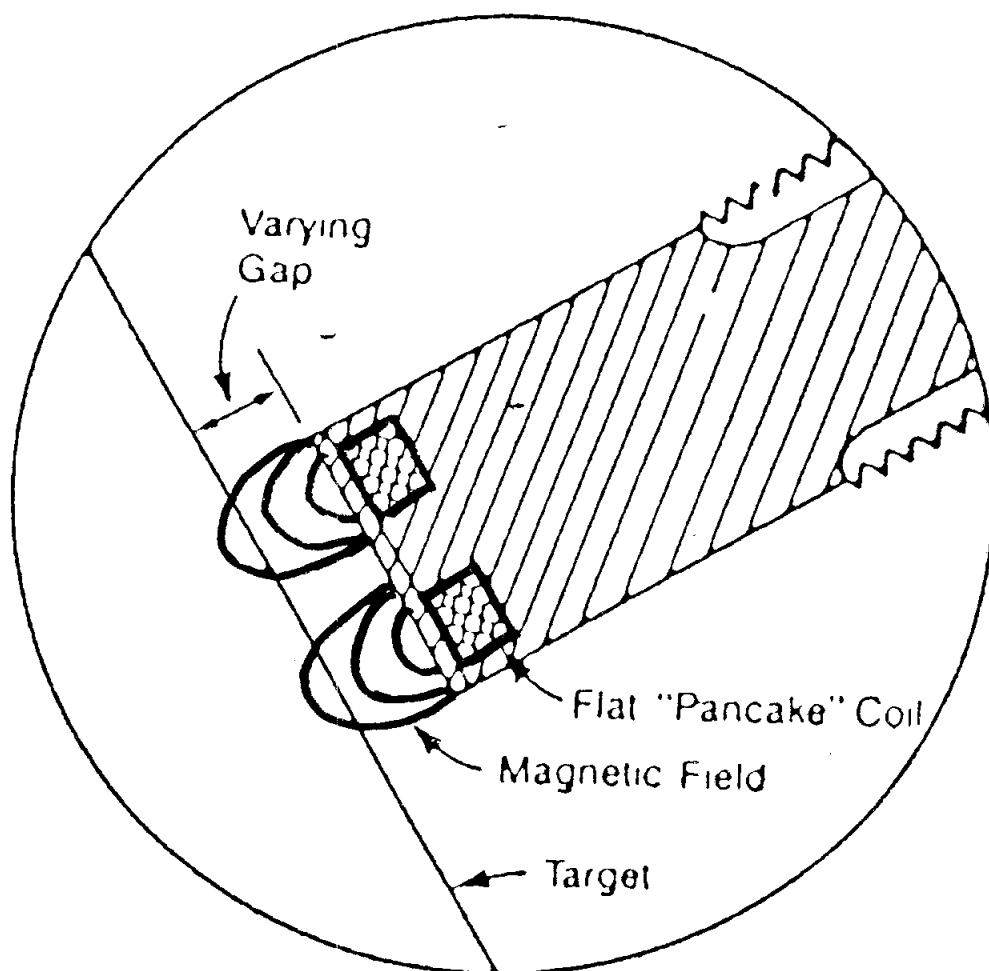


Accelerometer



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Eddy Probe Tip

RADIAL VIBRATION MEASUREMENT

