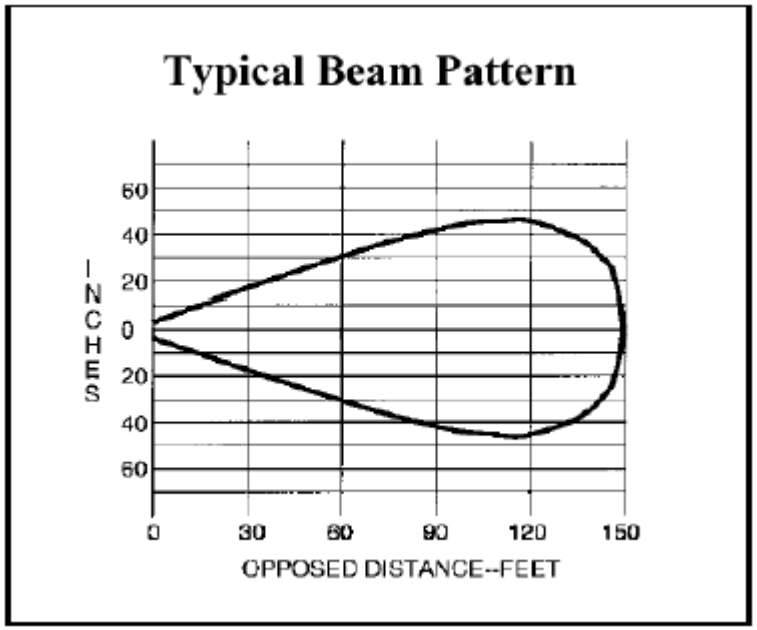
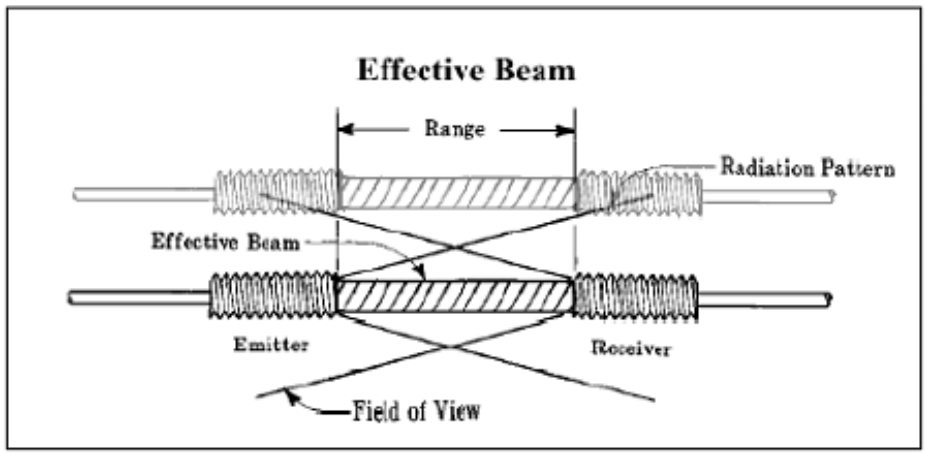
Beam Pattern and Interference

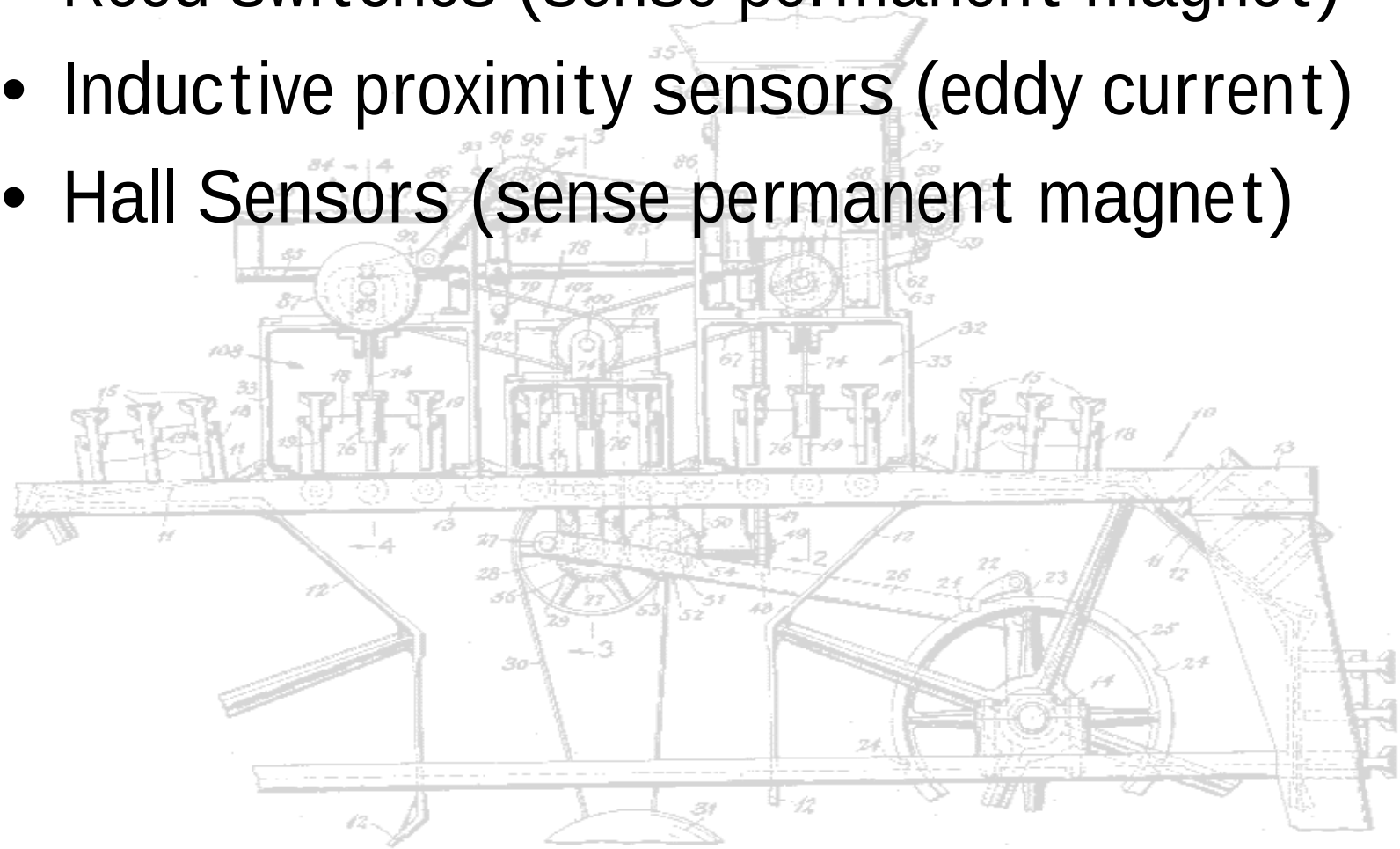


- Modulation helps against ambient light
- Adjacent photo sensors may still interfere!

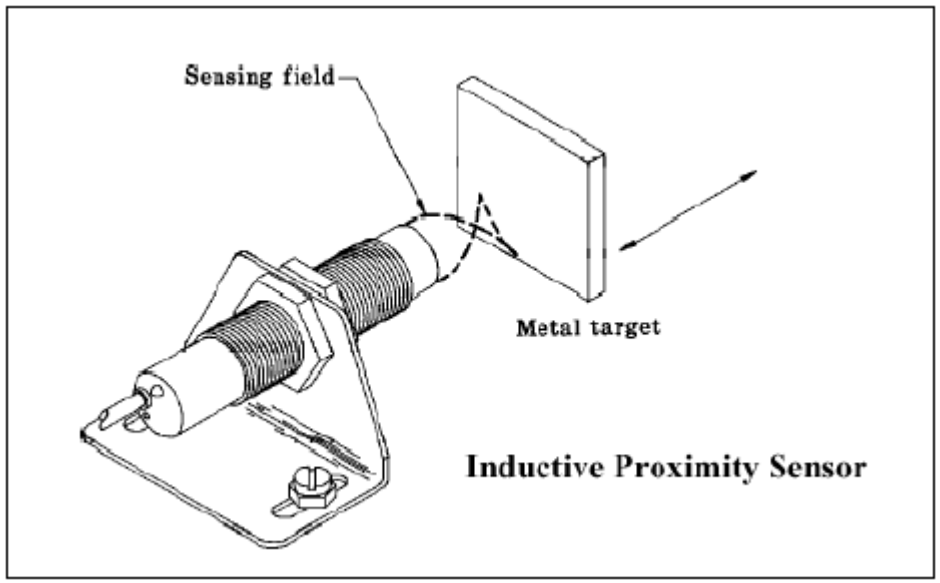


Magnetic Position Sensors

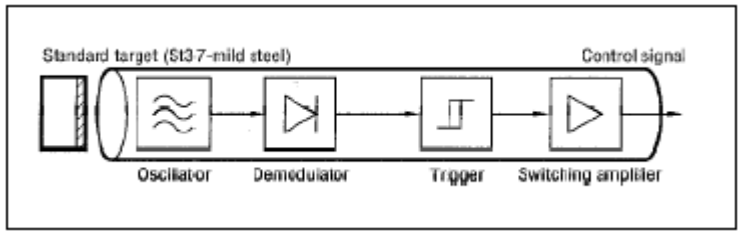
- Reed switches (sense permanent magnet)
- Inductive proximity sensors (eddy current)
- Hall Sensors (sense permanent magnet)

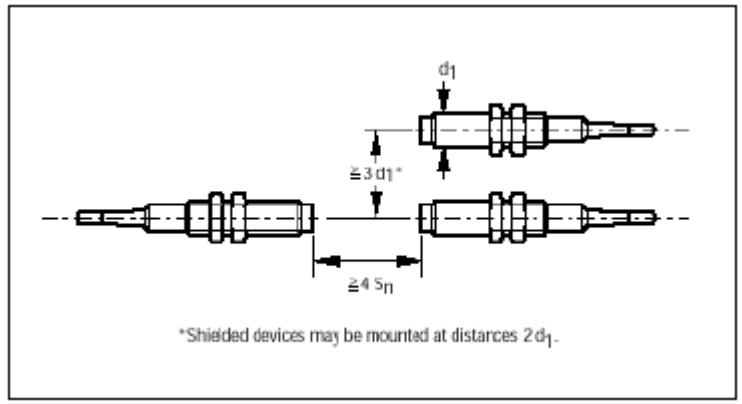


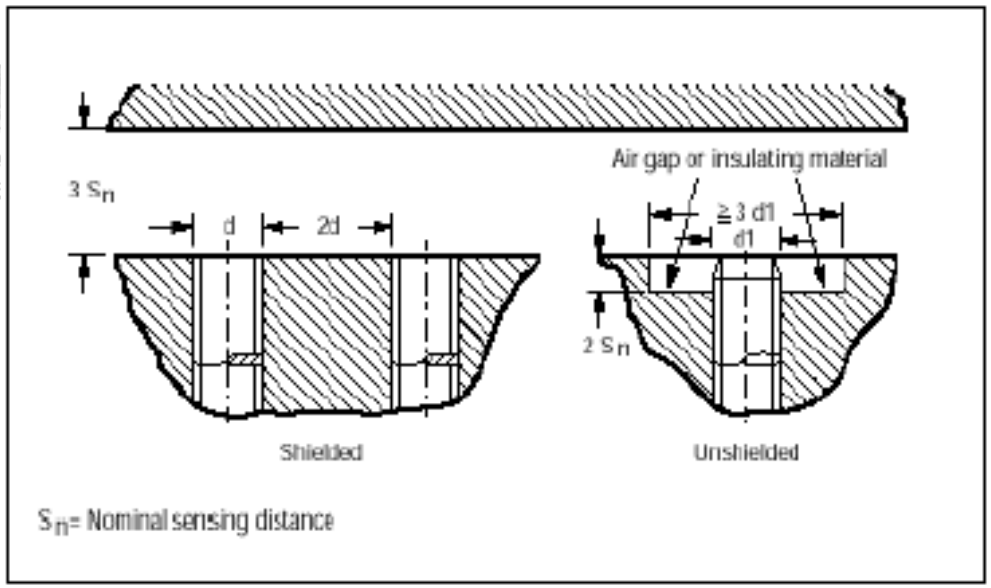
Inductive Proximity Sensor



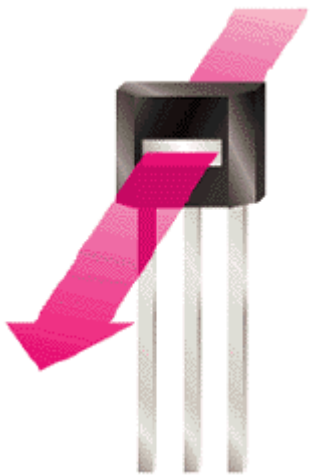
Inductive Proximity Sensors





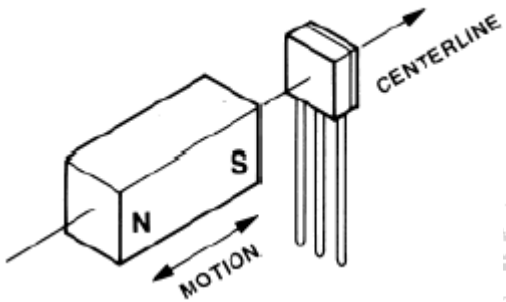


Hall Sensors

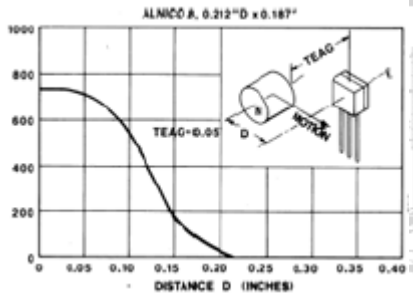


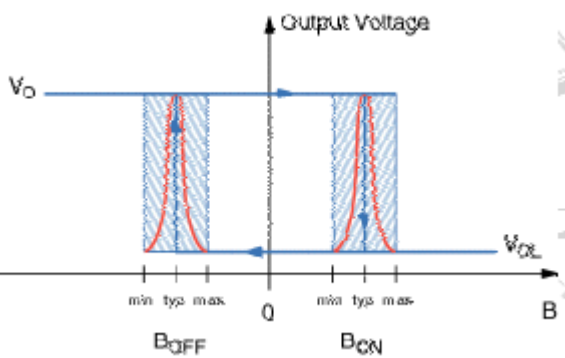
- Hall effect:
  - constant voltage forces a constant current in semiconductor sheet
  - magnetic field flux lines perpendicular to current cause proportional voltage across sheet.
  - discovered by E.F.Hall in 1879
- Linear sensor needs voltage regulator and amplifier
- Switch also needs threshold circuit, with hysteresis

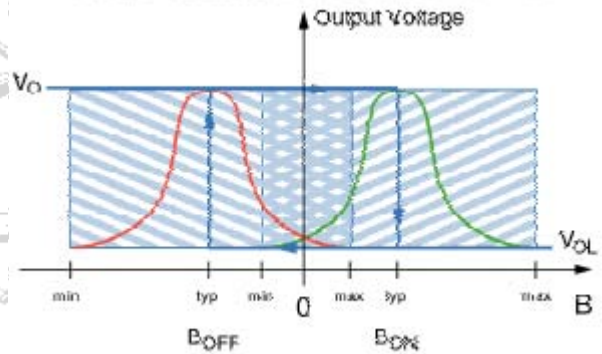
Hall Switch

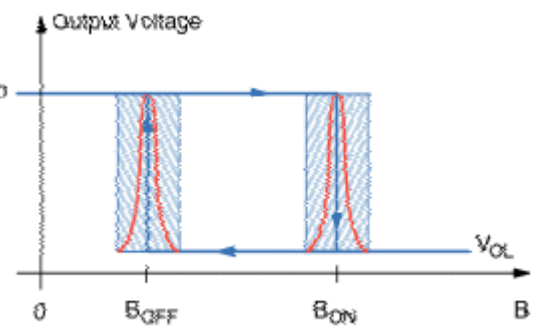


- Magnet motion
  - head-on
  - bypass or slide-by
- Total effective air gap (TEAG)
- Sensitivity, Hysteresis, & Temperature



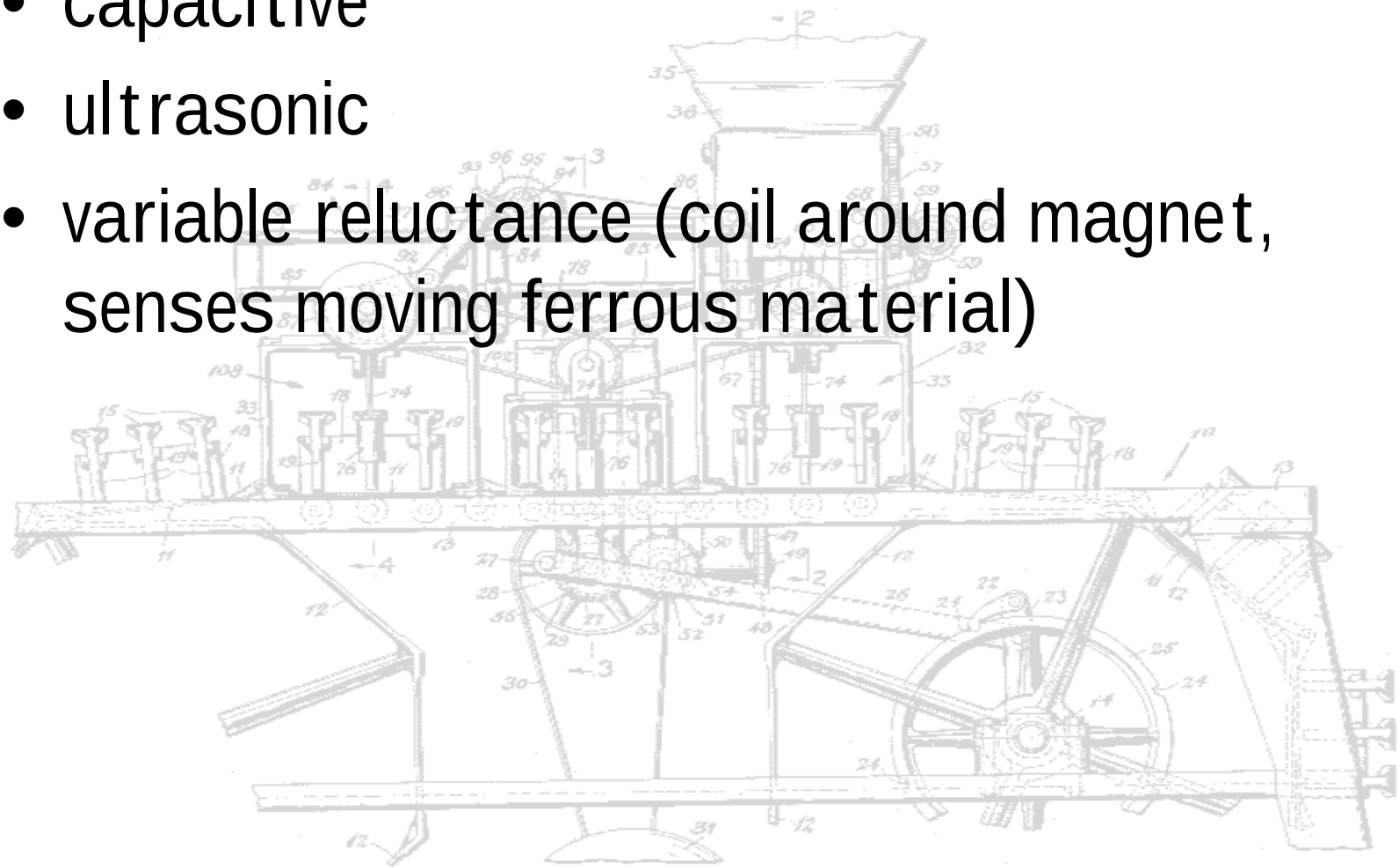






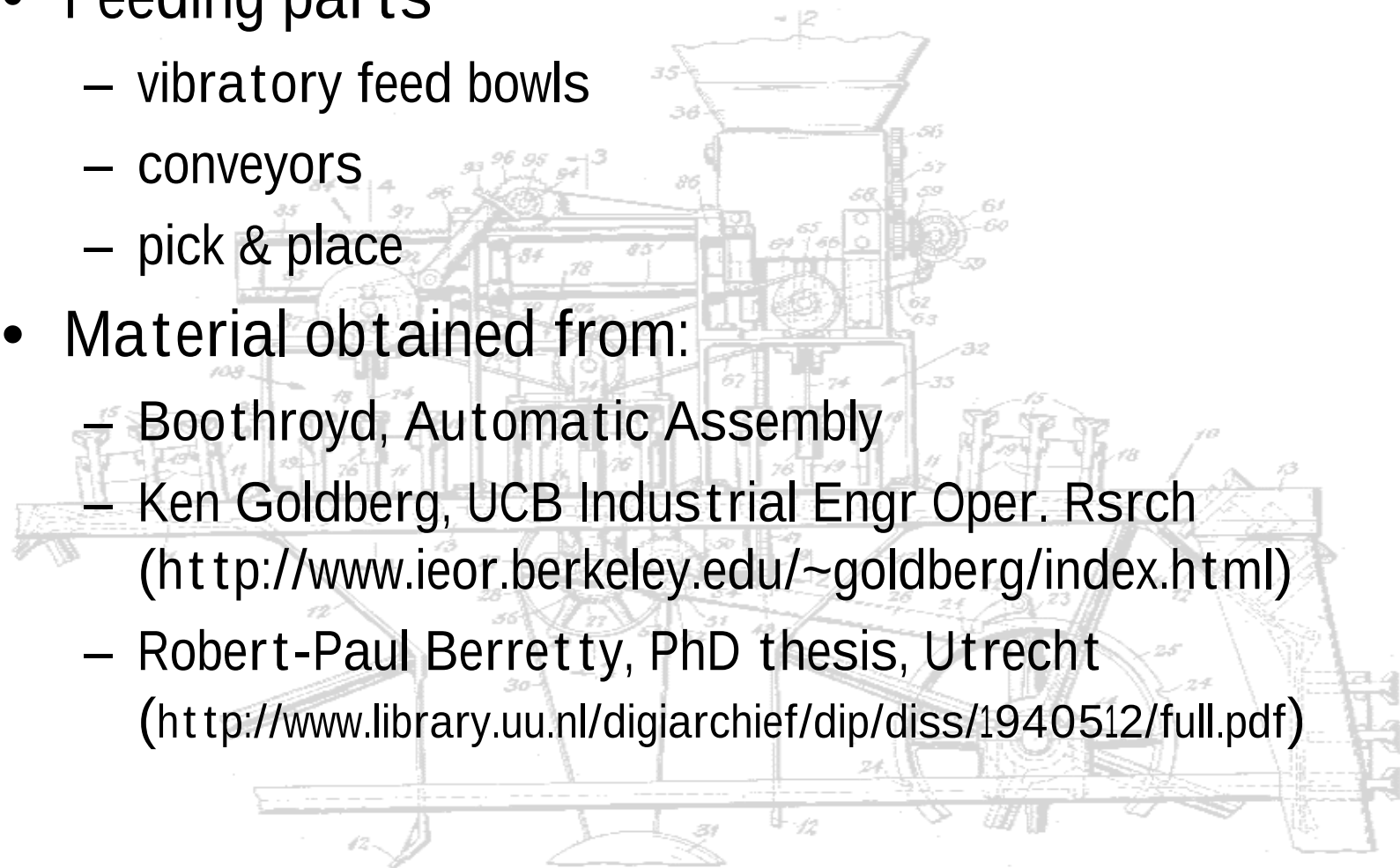
Other Discrete Position Sensors

- capacitive
- ultrasonic
- variable reluctance (coil around magnet, senses moving ferrous material)



Care & Feeding of Machines

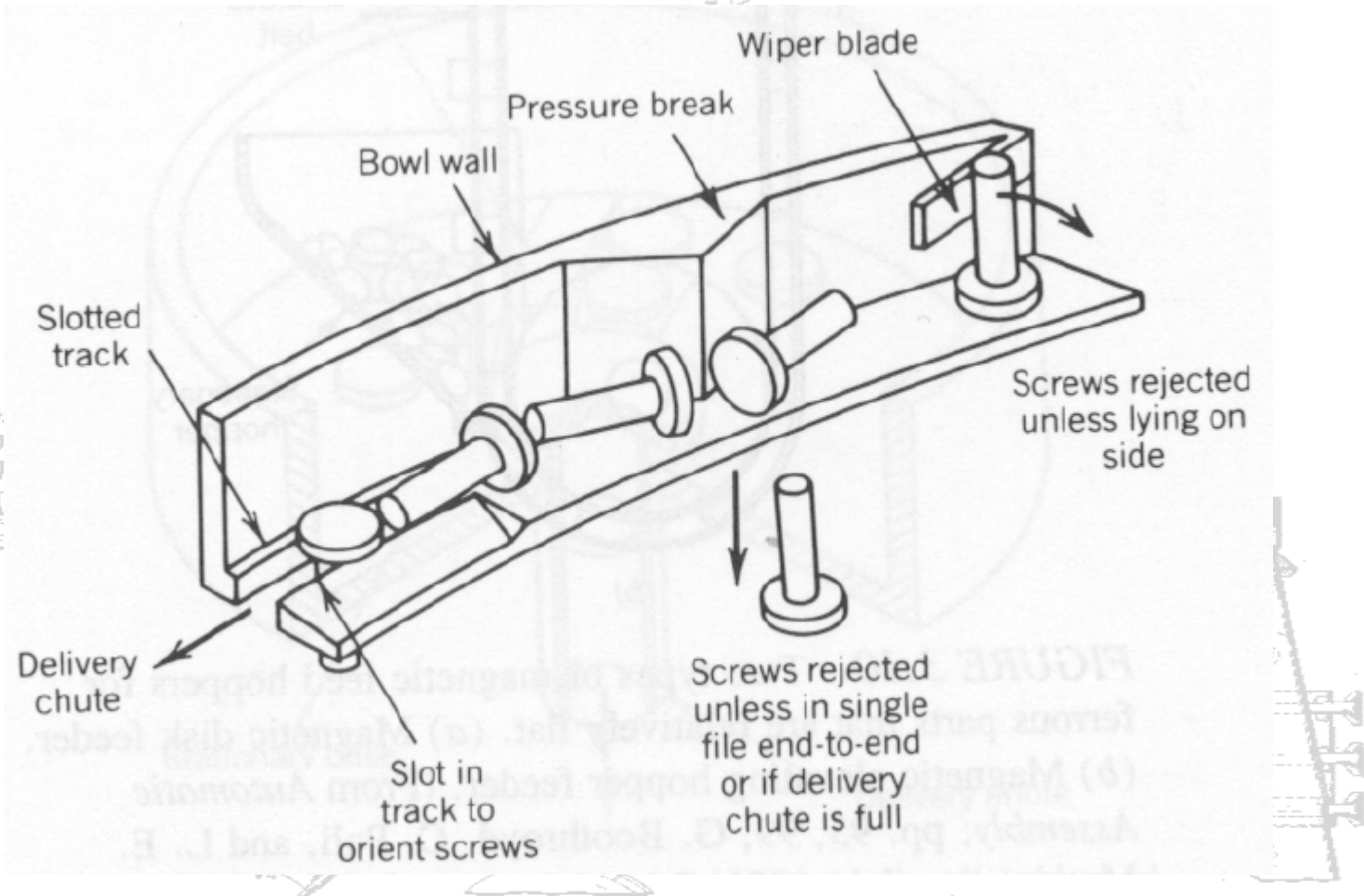
- Feeding parts
  - vibratory feed bowls
  - conveyors
  - pick & place
- Material obtained from:
  - Boothroyd, Automatic Assembly
  - Ken Goldberg, UCB Industrial Engr Oper. Rsrch (http://www.ieor.berkeley.edu/~goldberg/index.html)
  - Robert-Paul Berretty, PhD thesis, Utrecht (http://www.library.uu.nl/digiarchief/dip/diss/1940512/full.pdf)



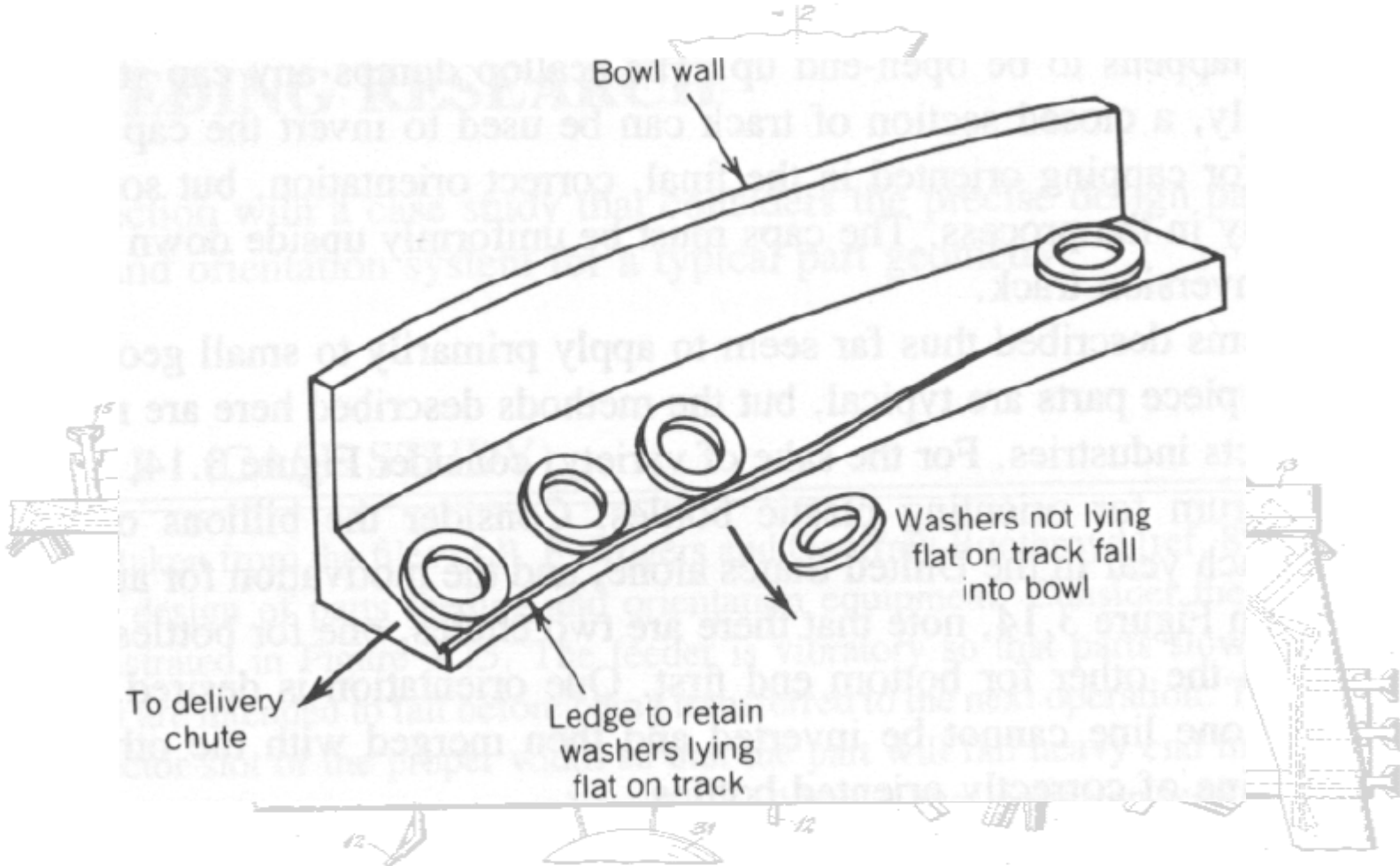
Bowl Feeders

Bowl Feeders

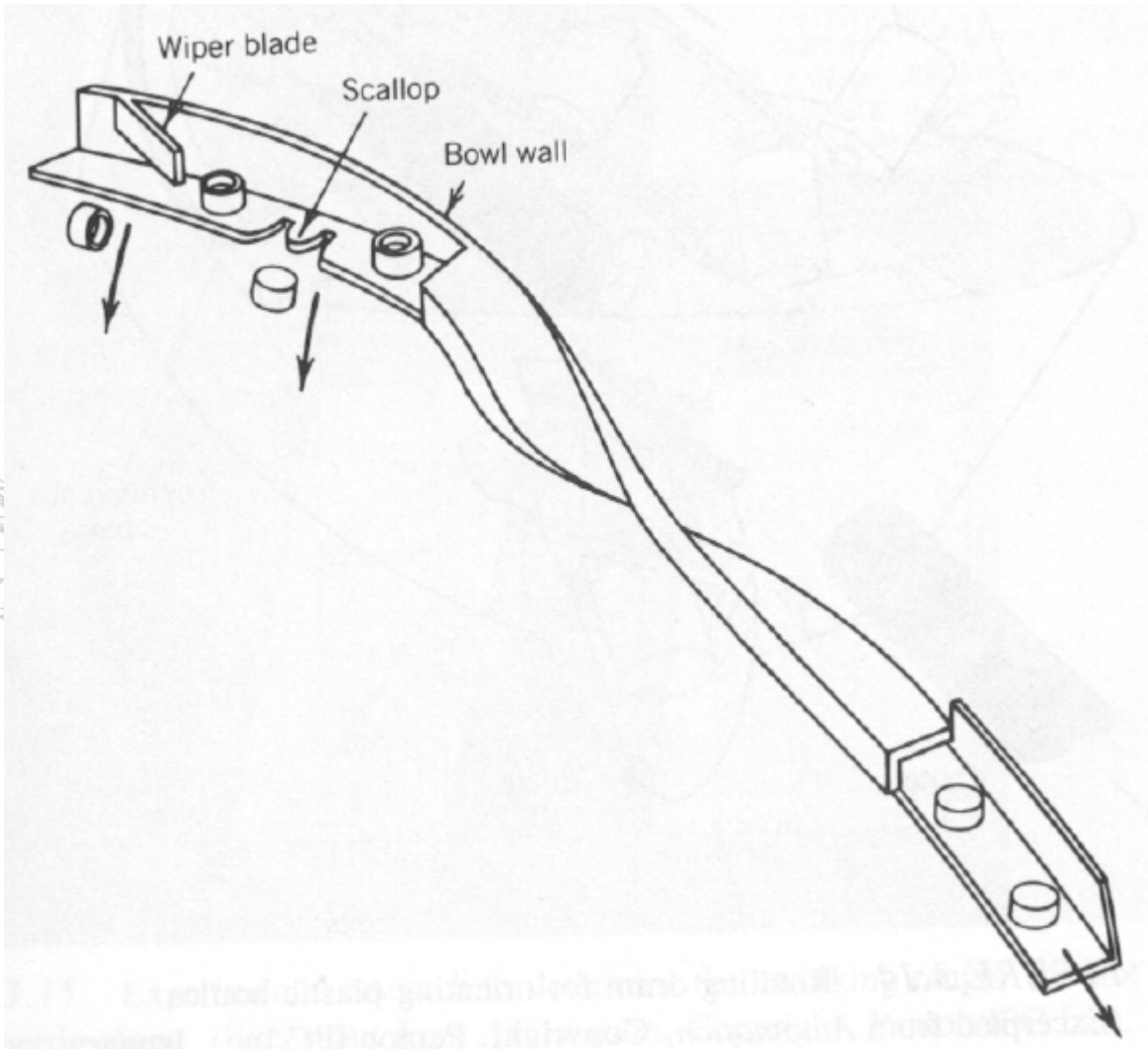
Bowl Feeders



Bowl Feeders



Bowl Feeders



Bowl Feeders

- Design Factors
  - Part symmetry
  - Selector efficiency $E=F_o/F_i$
  - Recirculation effects

$$p_k = \left[\frac{E}{100}\right]\left[1-\frac{E}{100}\right]^k$$