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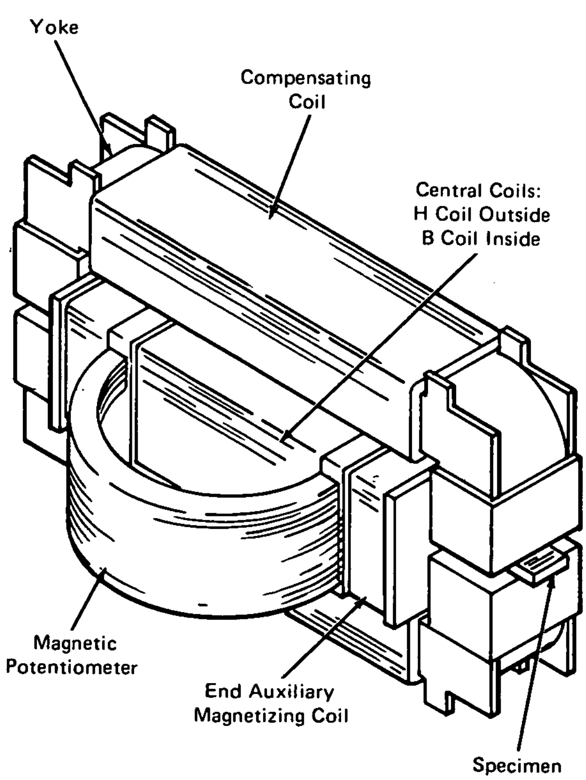
NASA TECH BRIEF

Lewis Research Center

High Temperature Permeameter for Measuring Magnetic Properties

The problem:

To measure the magnetic properties of materials at temperatures up to 1000°C. In heat treating materials for stress relief and tempering, measurements of residual strain and hardness can be derived from the measurement of magnetic permeability. A permeameter placed in the heat treating furnace with the material being processed could provide continuous monitoring of these material properties, however, conventional permeameters are not suited for such use. Design and materials of construction limit their use to moderate and unvarying temperature conditions.



The solution:

A new permeameter which measures the magnetizing force and the corresponding magnetic induction of a specimen at temperatures up to 1000°C in a vacuum or an inert atmosphere.

How it's done:

The new permeameter is shown in the figure. The specimen may be a rod of solid material or a bundle of sheet material. Two symmetrical yokes close the magnetic path around the specimen. A coil (H) surrounding the specimen supplies the magnetizing force. A separate coil (B) is used to measure the magnetic induction. The end auxiliary coils are electrically and magnetically in series with the H coil and provide additional magnetizing force resulting in a uniform longitudinal flux distribution in the specimen. The magnetizing force is calculated from the coil current, while a fluxmeter is used to measure the induction. The permeameter uses the magnetic potentiometer principle with yoke compensating coils to cancel the effects of the reluctance of the yoke and the joint gaps.

Each of the two symmetrical yokes consist of a compensating coil wound on a magnetic core. The cores are made of a specially processed alloy of 9-percent iron and 91-percent cobalt, a high temperature soft magnetic material. The central and end coils are wound on alumina bobbins that surround the specimen. All coils have rectangular cross sections and are made by slipping short sections of alumina tubing over nickel wire. The weight of the upper yoke is supported primarily by the alumina bobbin of the central coil to minimize the introduction of undesirable stresses into the specimen. The magnetic potentiometer is a coil wound on a core of the same alloy as is used in the yokes. The ends of the magnetic strips are extended to the specimen surface through cutouts in the alumina bobbin.

(continued overleaf)

Electrically, a compensating coil current reversing switch is ganged to the magnetizing current reversing switch so that the two currents are switched simultaneously. The compensating coil current is adjusted to obtain zero magnetic potentiometer output at each value of magnetizing current.

In use, the permeameter and the specimen are heated together in the furnace. Electrical leads connect to the read-out instruments outside the furnace.

Notes:

1. Although the permeameter described is of the static type, a dynamic or ac version can be similary constructed.
2. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference: NASA TN-D-6659 (N72-17422), Permeameter for High-Temperature Magnetic Measurements
3. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10443

Patent status:

No patent action is contemplated by NASA.

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