NASA TECH BRIEF

Solenoid Magnetic Fields Calculated from Superposed Semi-infinite Solenoids

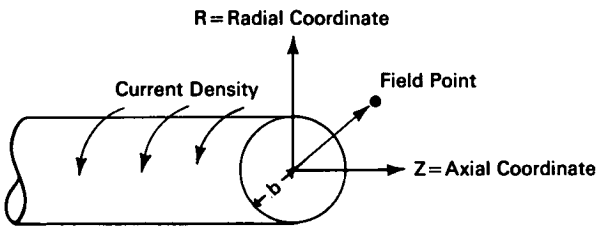

FIGURE 1

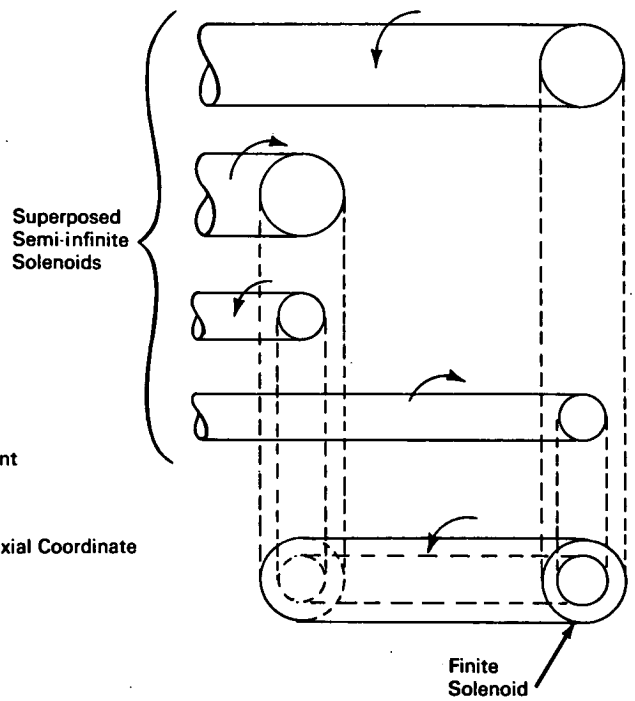

FIGURE 2

The problem:

The design of solenoid coils requires knowledge of the magnetic fields produced by a particular coil configuration. Field calculations are complicated by the effects of four variables: the radial and axial coordinates of the field point; the ratio of the solenoid's outer diameter to its inner diameter; and the ratio of the solenoid's length to its inner diameter. This variable complication also makes field component graphs or tables impractical because of the infinite tabulations required for all possible coil designs.

The solution:

A calculation of a thick solenoid's field components in terms of only two variables is made by a superposition of the fields produced by four solenoids of infinite length and zero inner radius (semi-infinite solenoids). The field produced by a semi-infinite solenoid is dependent on only two variables, the radial and axial

(continued overleaf)

field point coordinates expressed in terms of the solenoid's radius.

How it's done:

The semi-infinite solenoid of Figure 1 has an axially symmetric, uniform, azimuthal current density that extends from the axis of a cylindrical coordinate system to R equals b and from Z equals zero to Z equals infinity. Each field component of this semi-infinite solenoid can be expressed nondimensionally, computed electronically, and tabulated as a function of the nondimensional field-point coordinates where the radial equals R/b and the axial equals Z/b. The finite solenoid of Figure 2 can be considered a superposition of the four semi-infinite solenoids and its field can be obtained by adding four numbers derived from the tabulation.

Notes:

1. This innovation should be of interest to designers of field-producing solenoids.
2. Further information concerning this innovation is presented in NASA TN D-2494, "Superposition Calculation of Thick Solenoid Fields from Semi-infinite Solenoid Tables" by Gerald V. Brown and Lawrence Flax, September 1964, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $1.25. Inquiries may also be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B66-10490

Patent status:

No patent action is contemplated by NASA.

Source: Gerald V. Brown and Lawrence Flax (Lewis-184)