September 1969 Brief 69-10397

NASA TECH BRIEF

Magnetic Forming of Resistive Materials

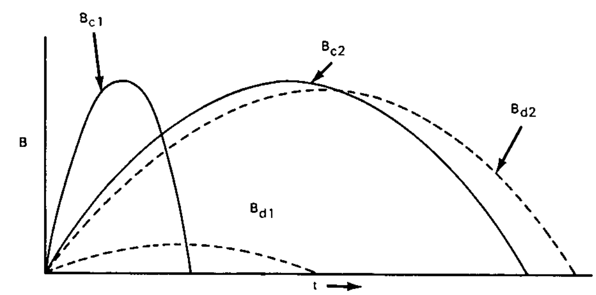

Fig. 1

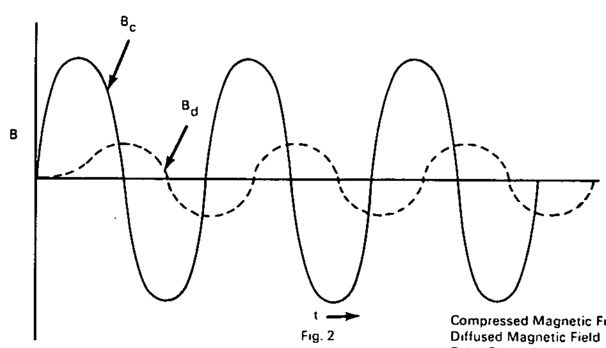

Fig. 2

Compressed Magnetic Field B_c
Diffused Magnetic Field B_d
Pulse Time t

A Single Pulse (Figure 1) Produces About The Same Time-Integral Of The Effective Pressure, Since Either The Duration Is Short (B_{c1}, B_{d1}), Or Else The Pressure Differential Small (B_{c2}, B_{d2}). A Train Of Fast Pulses (Figure 2) Combines The Advantages Of Large Pressure Differential And Long Duration.

The treatment of magnetic stresses applied to cylindrical boundaries has been lacking and no useful engineering data are yet available for the swaging of metallic tubing. The intent of the present work is to provide the necessary theoretical foundation for this operation with particular emphasis on the use of such high-resistivity materials as stainless steel and Hastelloy.

The principal problem in swaging high-resistive materials, such as Hastelloy, is that the diffused magnetic field on the inside of the tube comes up to nearly the strength of the compressed magnetic field quite readily and in the cases studied, the resulting effective magnetic pressure is typically only one-third of what the maximum possible pressure would be in the absence of a diffused field. The objective then was to reduce the diffused magnetic field.

Two possibilities for reducing the diffused magnetic field were initially apparent. The first, which has been demonstrated experimentally, was to reduce the

(continued overleaf)

diffused field (B_{d1}) by reducing the pulse time (t) as illustrated in figure 1. This method would not be desirable however, because a reduced pulse time would also reduce the duration of the pressure pulse, consequently off setting the net effect of radial compression on the tube. A second possibility was to employ a slow capacitor bank inside the tube to set up an initial reverse magnetic field. This reverse magnetic field would annihilate the diffusing magnetic field, and thus reduce the back pressure. A third possibility is now suggested which has the advantage of a shorter pulse time and is a stronger step in the direction of an initial reverse magnetic field. This possibility is illustrated in figure 2 and shows that the desirable effects can be achieved by applying a number of cycles of oscillating magnetic field. With the pulse time reduced to 5μ sec or less and the oscillations prolonged through N cycles, the effective pressure pulse will increase directly with the number of cycles.

The most promising approach for forming resistive materials is to use a highly oscillatory pulse with a pulse time of 3 to 5 μ sec, lasting at large amplitudes for approximately 30 to 50 μ sec. In the event the approach appears successful but the oscillation is too quickly damped, a special circuit could be used, firing a succession of separate capacitor bank units to maintain the oscillation by forcing it.

It is to be expected that the oscillation approach will certainly increase the radial compression, possibly by large factors.

Notes:

1. This development is in the conceptual stage only, and as of date of publication of this Tech Brief, neither a model nor prototype has been constructed.
2. No further documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B69-10397

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D. C. 20546.

Source: R. W. Waniek of
Advanced Kinetics Inc.
under contract to
Marshall Space Flight Center
(MFS-20417)