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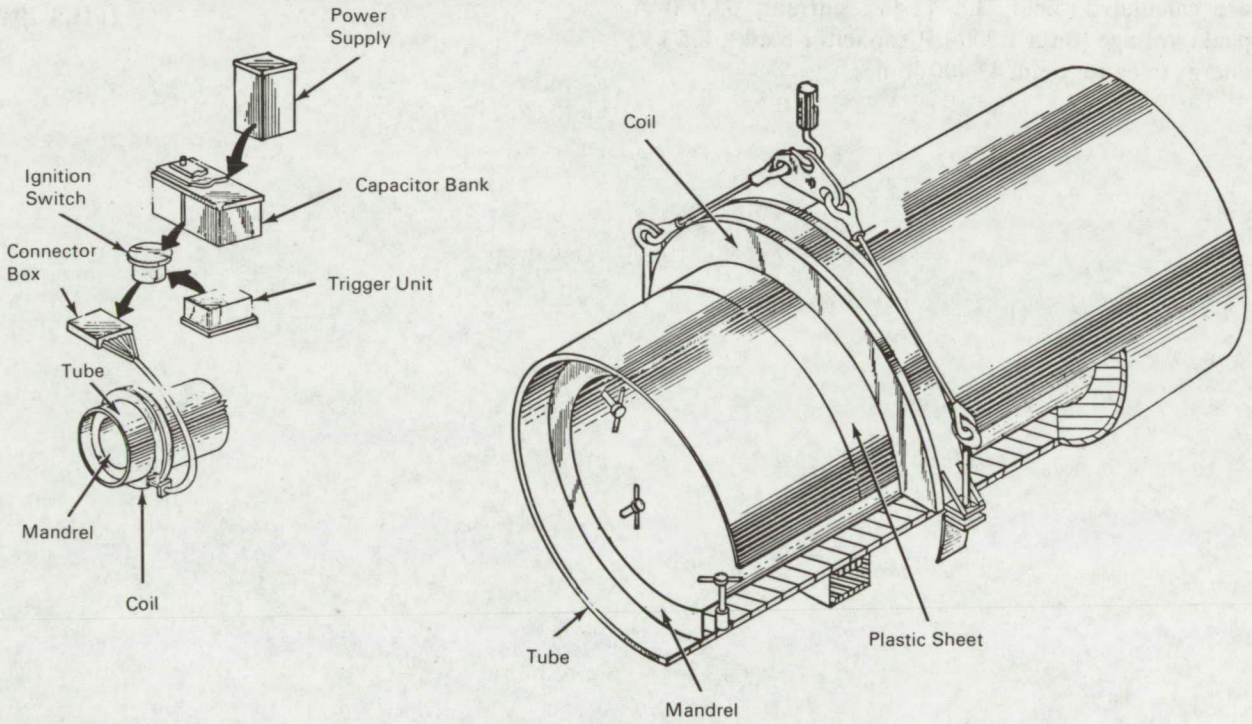
# NASA TECH BRIEF



## Magnetomotive Forming for Precision Sizing and Joining of Large-Diameter Tubes




### The problem:

To develop a method and related portable apparatus for high-precision expansion or constriction and joining of large-diameter metal tubes.

### The solution:

A portable electromagnetic coil, positioned coaxially with the tube inside or outside, enables expansion or shrinkage of the tube's diameter or forming of convolutes. A nonconducting mandrel or forming die is used on the side of the tube's wall opposite the coil. The coil is insulated from the tube by a thin plastic sleeve; also between them is a carefully calculated air space.

### How it's done:

A pulse of power from a bank of fast-discharge capacitors energizes the coil which induces an opposite current in the tube. The field associated with this induced current, reacting against the magnetic field about the coil, generates intense forces between the coil and the tube. Since the tube is less

(continued overleaf)

rigid than the coil, it is forced against the mandrel. The tube's diameter can be changed incrementally by a series of pulses.

The tube's surface is not marred, nor is there any appreciable change in its grain structure. All the faults associated with heating or mechanical working are avoided and the tube is worked in its hardened, high-strength condition. Essentially the apparatus has no moving parts. The principle can be applied many ways: For example, typically the 25-inch diameter of a tube of aluminum alloy, with wall thickness of 0.224 inch, has to be shrunk by 0.100 inch. Its longitudinal and transverse yields are approximately 47,000 and 46,000 psi respectively. A radial magnetic pressure of 840 psi produces hoop stress which matches the yield strength, and any greater pressure will result in metal deformation. The following requirements are calculated: field, 3.8 Teslas; current, 64,000 A peak; voltage (on a 1,200-$\mu$F capacitor bank), 8.5 kV; energy to cause yield, 43,400 Joules.

## Notes:

1. The innovation may interest layers of pipelines and the metals-forming industry.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10422

## Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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