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TECHNICAL SUPPORT PACKAGE

On

LITHOGRAPHIC FABRICATION OF MESOSCALE ELECTROMAGNET COILS

for 07/01/2002

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from

JPL NEW TECHNOLOGY REPORT NPO− 20966

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pp. i, 1

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Lithographic Fabrication of Mesoscale Electromagnet Coils

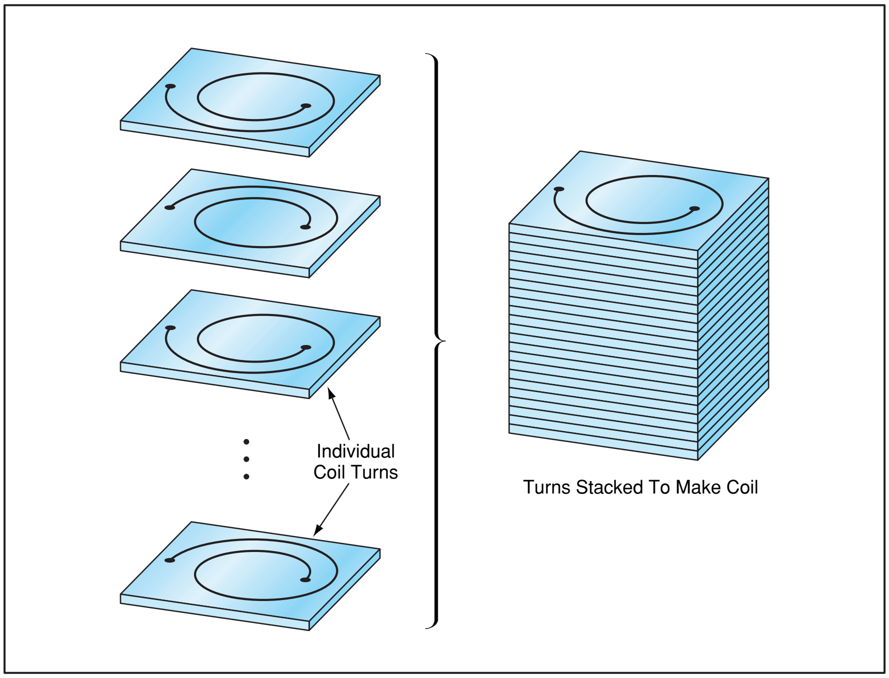
Fabrication should be faster and cheaper than in conventional winding.

NASA's Jet Propulsion Laboratory, Pasadena, California

A partly lithographic method of fabrication is being developed to enable the economical mass production of mesoscale electrically conductive coils for miniature electromagnets, solenoids, electric motors, and the like. This or a similar method is needed to overcome the limitations of prior techniques:

- The practical limit of fabricating miniature coils by conventional winding has been reached at a minimum wire width of ≈25 μm. At this limit, fabrication is a slow, expensive process that requires very skilled technicians.
- Current techniques of microfabrication (e.g., those used to make microelectromechanical devices and integrated circuits) are limited to coils of no more than about 25 turns. This number of turns is insufficient for many anticipated applications in which hundreds of turns would be needed to generate sufficient magnetic flux.

In the present developmental method, thick-film optical lithography is used to generate a series of spiral patterns, and copper is plated into the patterns, thereby forming individual turns of a coil. Then the turns are freed, stacked, and bonded together with the turns electrically connected in series (see figure). It should be possible to make coils of hundreds of turns in very small packages. It should also be possible to scale coils down to sizes smaller than those achievable by conventional winding. This method is compatible with batch fabrication and is expected to cost much less than does fabrication of the smallest conventionally wound coils.



Coil Turns are formed lithographically, then stacked and bonded together to make coils.

This work was done by Victor White, Juergen Mueller, and Dean Wiberg of Caltech for **NASA's Jet Propulsion Laboratory**.

NPO-20966

JPL **NTR Inventor's Report**

NASA CASE NO. **20966**
JPL CASE NO. **0563b**

PLEASE BE AS CLEAR AND SPECIFIC AS POSSIBLE, AS THIS REPORT MAY BE MADE AVAILABLE THROUGH TECH BRIEFS

Sections 1 (Novelty), 2A (Problem), and 2B (Solution) must be completed fully. Your published paper may be attached to satisfy Section 2C (Description and Explanation).

1. Novelty - Describe what is new and different about your work and its improvements over the prior art.
   We are proposing using thick film optical lithography to generate a series of spiral patterns, and plate up copper into the forms. Then, the coils would be freed, and stacked and bonded together. This technique is compatible with batch fabrication, and would be potentially much cheaper than winding the smallest of conventionally wound coils. Plus, the size could be scaled down below that of existing techniques if need be.

2. Technical Disclosure

   A. Problem - Motivation that led to development or problem that was solved.

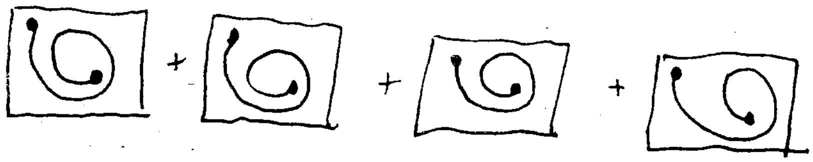
   Conventional coil winding is very difficult and very expensive for wires of ~ 25u. Commercial fabrication would be cost effective.

   B. Solution

   Batch fabricated, bonded stacks of lithographically generated micro-coils.

   C. Detailed Description and Explanation

   A series of coils such as:



Could be bonded together so the winding add in series. Hundreds of turns could be possible in a very small package.

“The work described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautics and Space Administration.”