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FINAL REPORT
PROCESSING AND PLATING
HELICAL METALLIC COILS

Contract No. NAS5-11675

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N O T I C E

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April 5, 1972

INTRODUCTION

This report concerns the results of the research and development effort to develop an optimized nickel cobalt coating, suitable as a recording medium, directly on a beryllium copper helical coil substrate which is to be used with a helical coil recorder developed by NASA. The specific objectives were: optimization of the coating thickness; establishment of processes and techniques adaptable for the production of finalized plated helical coils; design and fabrication of equipment required for production and testing of the coils; and delivery of finalized helical coils to NASA. Subsequent contract revisions required the development of processes and equipment required to process the coils from the "as formed" configuration to a surface configuration suitable as a preplate recording surface.

The coating thickness evaluation was performed using disc substrates of BeCu which were finished to the desired surface configuration and plated to various thicknesses. Continuous loops of BeCu, the same width and thickness as the coils, were fabricated, plated, and run on a conventional tape test transport to evaluate wear and magnetic performance. Surface configuration and tracking problems caused the reliability of the data obtained to be questionable.

Several of the coil substrates were plated, environmentally cycled, and delivered to NASA. The surface configuration of these coils precluded adequate burnishing operations. An attempt to reduce friction between head and coil by the application of a Moly disulfide coating was performed at NASA request. The plated coils were coated and returned to NASA. Due to the coil surface configuration problem, the contract was revised to concentrate effort on the development of processes and related equipment to finish the coil substrates to an acceptable preplate surface configuration. A modified double disc lapping technique was employed and an apparatus fabricated. Acceptable surfaces were successfully obtained.

LAPPING APPARATUS

A special lapping device was designed and constructed to permit the lapping of both sides of the tape simultaneously. Figure A illustrates the critical functionary components and their relative location with respect to each other.

Two brass discs 3 1/4 inches in diameter are mounted coaxially on a common shaft. Disc A is keyed to the shaft but is free to move axially. The axial loading spring supplies a force to the back face of Disc A. This force is adjustable by varying the spring compression and is maintained by a cylindrical positive stop set screw locked to the shaft.

Disc B is mounted on ball bearings and maintained in its relative position on the shaft by a cylindrical positive stop on the shaft.

This arrangement results in a compression force between the two inner surfaces of the brass disc.

An "0" ring drive is provided on the perimeters of the disc with two turnaround pulleys mounted at right angles to the brass disc. This arrangement transmits the rotary force from the keyed Disc A to bearing mounted Disc B in the opposite direction. In operation, the two discs rotate at equal speeds but in opposite directions. This is a necessary requirement for double side lapping. When the discs are rotated in opposite directions, the net tangential force on the tape between the discs is zero.

Various lapping surfaces were affixed to the inner faces of the disc. The lapping processes will be covered later.

A supply reel and take-up reel are bearing mounted and located above the lapping assembly. The two reels are mounted coaxially on a common shaft and are free turning.

The tape is fed from the supply reel through a combination of guides that precisely guide the tape between the inner surfaces of the two discs. At the output side of the disc, a motor driven pinch roller assembly is provided to continuously pull the tape through the lapping area.

When the tape leaves the pinch roller, it is fed through a simple guide to the take-up reel.

During operation, the tape is removed from the supply reel by the pulling force generated in the tape by the pinch rollers. The supply reel, in turn, rotates the take-up reel. The force required to rotate the supply reel and the take-up reel assembly is extremely small.

The natural curvature of the helical tape is utilized to generate a smooth transition throughout the entire tape path.

Both dry and wet lapping were attempted during this program.

To facilitate the wet lapping, a slurry tank was provided and positioned in a manner to permit gravity feed of the slurry, via copper tubing, to the lapping area. A motor driven agitator was inserted in the slurry tank to keep the abrasive grit dispersed in the lapping liquid during the five-hour process.

LAPPING EXPERIMENTS

Checkout of the lapping apparatus was conducted using short samples of helical coils manufactured by the GSFC and supplied to us for just such system experiments. The surface finish of these samples was in the order of 80μ" peak-to-peak. Initial lapping test revealed that a 12-micron aluminum oxide grit mylar base paper with water flush would yield a surface finish of 20μ" peak-to-peak.

The five full-length coils supplied by the GSFC for this phase of the contract were then examined and representative surface measurements made. These tapes displayed a surface finish in the order of 500μ" peak-to-peak.

A lapping procedure was attempted with the 12-micron grit paper on a full-length coil and it was soon apparent that a much coarser initial lap would be required.

One 3.25 inch diameter by .010 inch thick carbide cutting wheel was cemented to the lapping surface of each of the brass discs. The broad surfaces of the cutting wheels were used in conjunction with water flush in an attempt to coarse lap the tape. This combination worked quite well but still did not remove enough material to eliminate the obvious pits and valleys in the tape surface.

An abrasive slurry consisting of one part 4-micron garnet and 5 parts water was added to the process. The combination of the saw blades and the slurry was sufficient to remove enough material to eliminate most of the pits and valleys. The tape surface was still not in an acceptable condition for the fine lap to be effective.

Thickness measurements made before and after the coarse lapping revealed that .001" had been removed. To achieve a reasonable final finish, even more material removal would be required.

However, at this point it was observed that the diameter of the coil was changing during the coarse lapping process. The first suspicion was that the apparatus was causing the diameter change due to over-stress. Further investigation revealed that the diameter change was not consistent throughout the length of the tape. In some areas the diameter increased and in others it decreased. In appearance, the helical coil after coarse lapping looked very much like an "as rolled" coil before heat treating.

It is believed that the removal of as much as 20% to 25% of the material is generating a gross stress relaxation condition in the coil.

Several short lengths of coil were lapped by the same process with great care taken not to externally stress the tape. In all cases, the diameters changed, again in a varying manner.

This theory is supported by the experience encountered by AMC during an earlier phase of this contract. As reported in the first periodic report dated 7/15/69, beryllium copper discs fabricated for recording tests also warped during the lapping process. In this case, coarse lapping was used in an attempt to achieve flatness of the 5-inch disc. The solution to the disc warping problem was that the discs were ground to the desired flatness before heat treating then heat treated and lastly final lapped.

CONCLUSIONS based on the investigations of the NiCo plating phase of the contract.

1. Best magnetic performance requires a very thin coating.

2. Wear characteristics require a thick coating.

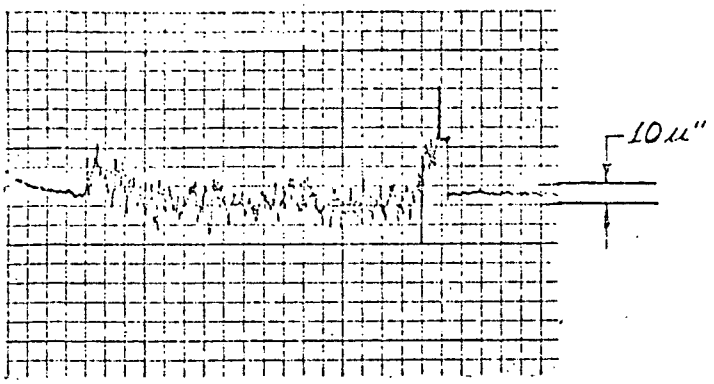
3. Burnishing was not effective due to the inadequate prefinishing of the coil substrates.

4. Suitable preplating surface configurations can be obtained by a lapping process.

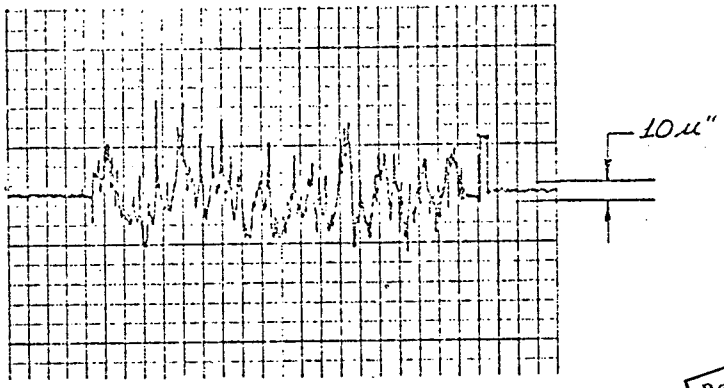
5. NiCo can be successfully plated directly on a BeCu substrate if proper tooling and processes are employed.

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REPRESENTATIVE SURFACE MEASUREMENTS

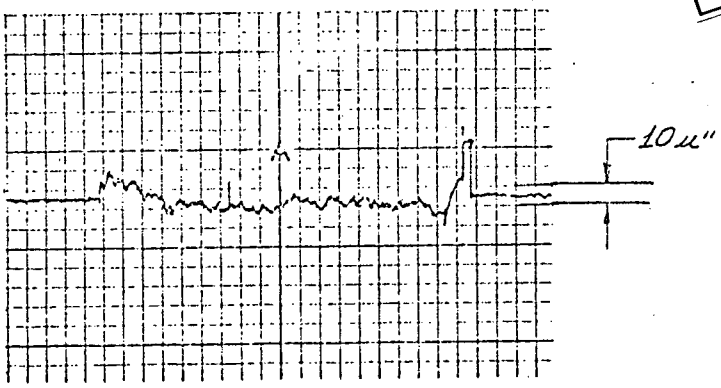


STRAIGHT BERYLLIUM COPPER RIBBON (RAW STOCK) .125" x .005" (BRUSH BERYLLIUM CO.)

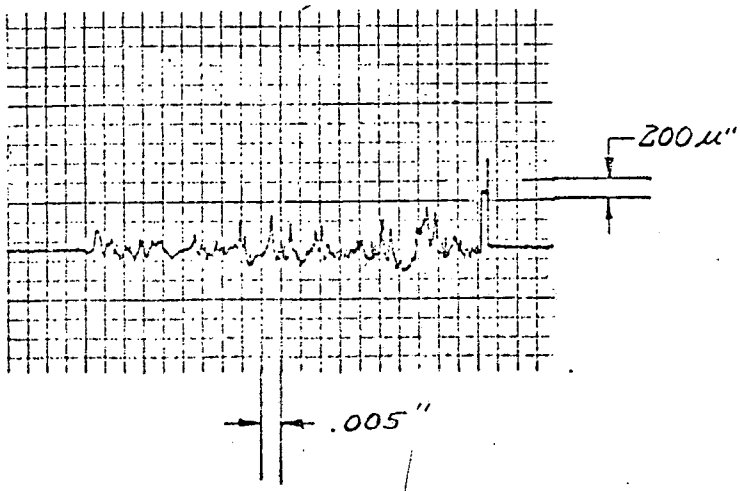


G.S.F.C. MANUFACTURED HELICAL COIL BEFORE LAPPING (SHORT SAMPLES)

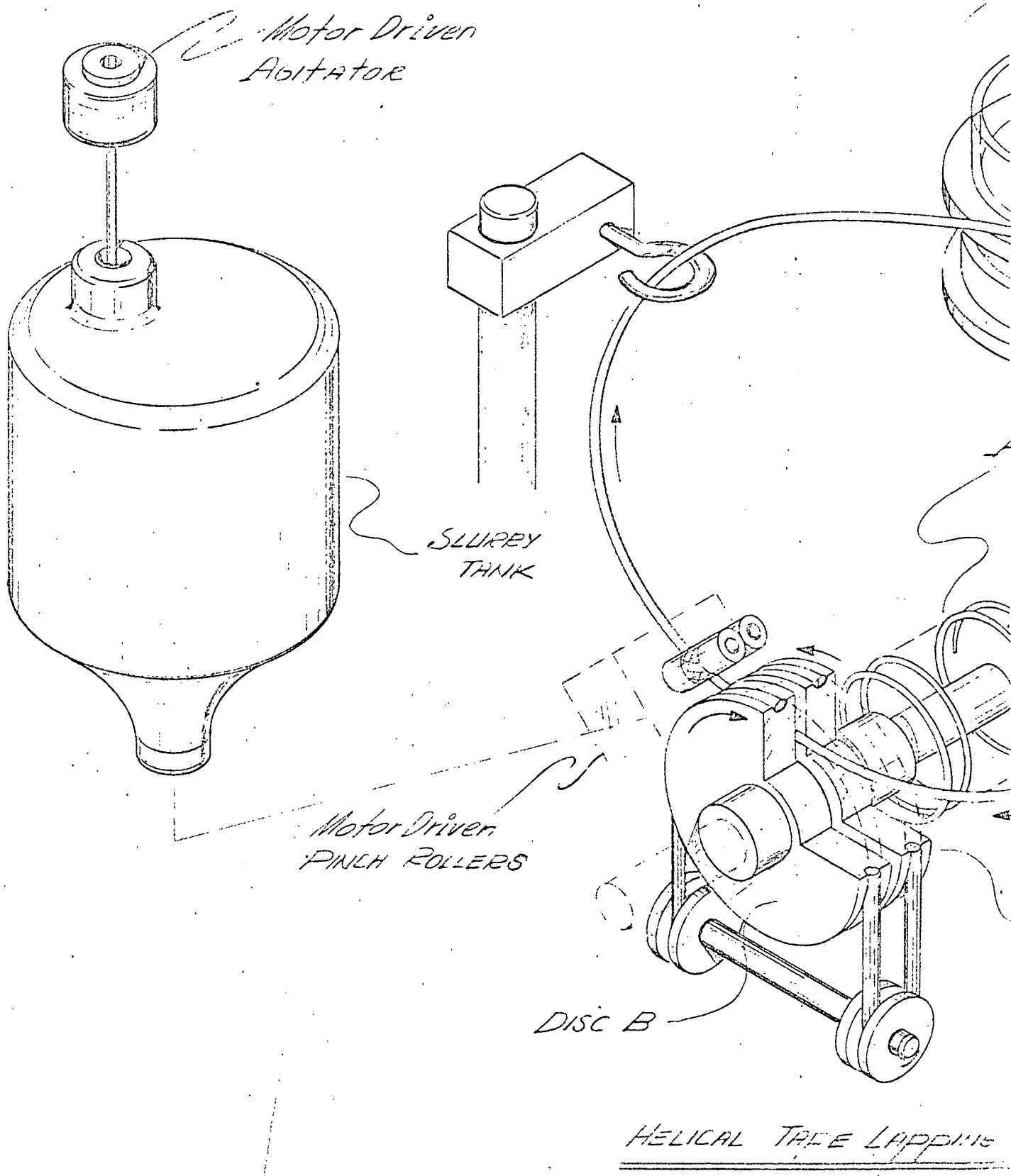
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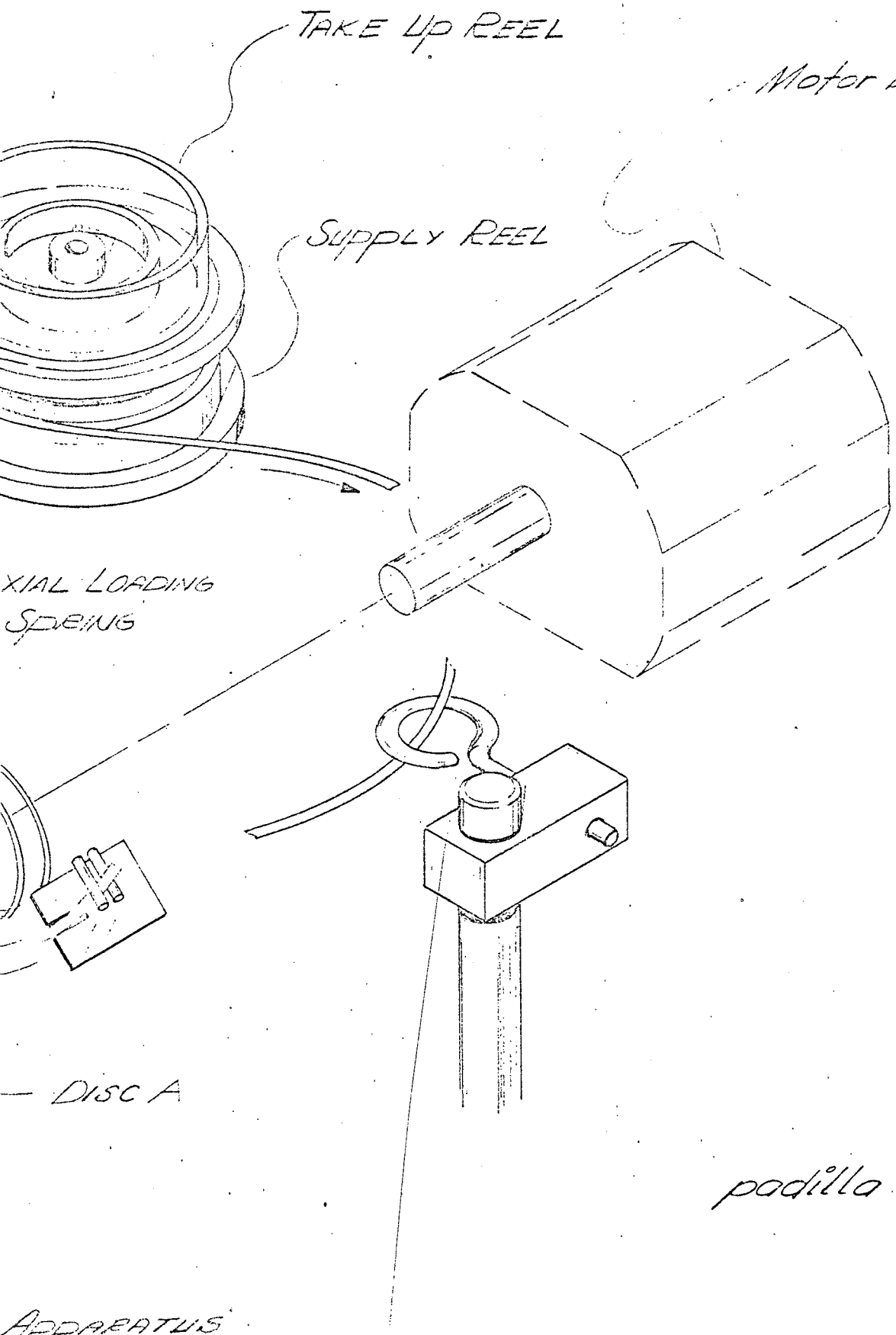
G.S.F.C. MANUFACTURED HELICAL COIL AFTER LAPPING WITH 12 MICRON ALUMINUM OXIDE



HELICAL COIL #52



HELICAL TAPE LAPPING



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APPARATUS

FIGURE A