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300° C ROTATING RECTIFIER ALTERNATOR
PHASE II

DESIGN, FABRICATION, AND TEST OF ALTERNATOR

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300° C ROTATING RECTIFIER ALTERNATOR
PHASE II

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ABSTRACT

Work is continuting on the Phase II effort of the contract. Phase II is the design, fabrication, and test of a 300° C ambient brushless alternator using a silicon carbide rotating rectifier.

During the reporting period, detail drawings of the generator were completed. At the present time manufacturing information is being prepared from the detailed drawings so that manufacture can begin in the shop. While the detailed drawings were being prepared, a design change was made such that the pole heads of the main rotating field are now removable. This change allows the rotating field coils to be placed directly on the poles with a minimum of handling and without requiring the field turns to be "spiraled" over the pole heads. It is very desirable to keep the handling of the Anadur[1] wire insulation to a minimum.

During the reporting period, special manufacturing processes were developed which include: etching, plating, and welding nickel-clad silver; plasma-arc spraying alumina on steel punchings for interlaminar insulation.

The nickel-clad silver wire was shipped to Anaconda for application of the Anadur insulation.

Manufacturing information is scheduled to be available to the Shop, 26 January 1969.

[1] Anaconda Company (Muskegon, Michigan) wire insulation.

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SECTION I

INTRODUCTION

The purpose of this project is to determine the feasibility of using silicon carbide diodes in a rotating rectifier assembly in a brushless three-phase alternating current generator. The generator is to radiate its heat to a 300° C ambient. The diodes will operate at approximately 430° C.

Originally, 14 silicon carbide diodes were supplied to Lima Westinghouse by the Air Force. Tests were made on these diodes at Lima and it was determined by these tests that the supplied diodes were unsuitable for application into a generator design. This was Phase I-a of the study.

As a result of the unsuitable diodes, the original plans were modified to include a Phase I-b. The objective of Phase I-b was to procure a minimum of 15 new diodes and to evaluate these diodes by test. The following is a summary of the phases of the study.

Phase I-a - Test evaluate 14 silicon carbide diodes supplied by the Air Force. (This phase is complete and is documented in Technical Report AFAPL-TR-66-75, August 15, 1966.)

Phase I-b - Procure and test evaluate a minimum of 15 silicon carbide diodes. (Reference Technical Report AFAPL-TR-68-74, June 1968.)

Phase II - Complete design, build, and test a brushless alternating current generator utilizing rotating silicon carbide diodes.

This Interim Report covers the second three months of Phase II of the project. The technical efforts of the period were directed toward completing the detailed drawings, and to start tool drawings and manufacturing information for the Shop.

SECTION II

DESIGN SUMMARY

A. DESIGN CHANGES - ROTATING POLE CHANGE

The use of a fired glass insulation system, to withstand the high operating temperatures for the field coil windings, necessitates the separate winding and firing of the coils. This process is required to allow for an insulation shrinkage and obviate the need for wire joints in the coil. However, in order to assemble the coils on the relatively wide poles without damaging this brittle insulation, a removable pole head configuration has been developed. (See figure 1'. A primary arrangement was designed to hold the pole heads in place after the coils have been assembled on the poles. This concept has been used successfully on standard aircraft generators.

Stress and assembly limitations dictated the use of three approximately 0.110 inch diameter pins per pole. The pins hold alternating bundles of ten pole head laminations to the main rotor assembly. The remaining ten alternating pole head lamination bundles are held in place by CUBE copper damper bars.

B. MANUFACTURING PROCESSES

The completion of detail drawings and the initiation of manufacturing information and tool design for the prototype model has required the development of special manufacturing processes. These processes include:

a) The procedures for etching, plating and welding the nickel clad silver conductors. This is needed to provide a positive, permanent conductor connection at the high operating temperatures. A normal conductor braze will not suffice due to high temperature silver migration.

b) The plasma-arc spraying of alumina interlaminar insulation procedures for the stator and rotor stacks. A 2.4-mil coating on one side of the 8-mil punchings has been required to give the proper electrical, mechanical and thermal characteristics.

c) A pyroceram coating procedure for the excitor rotor banding rings.

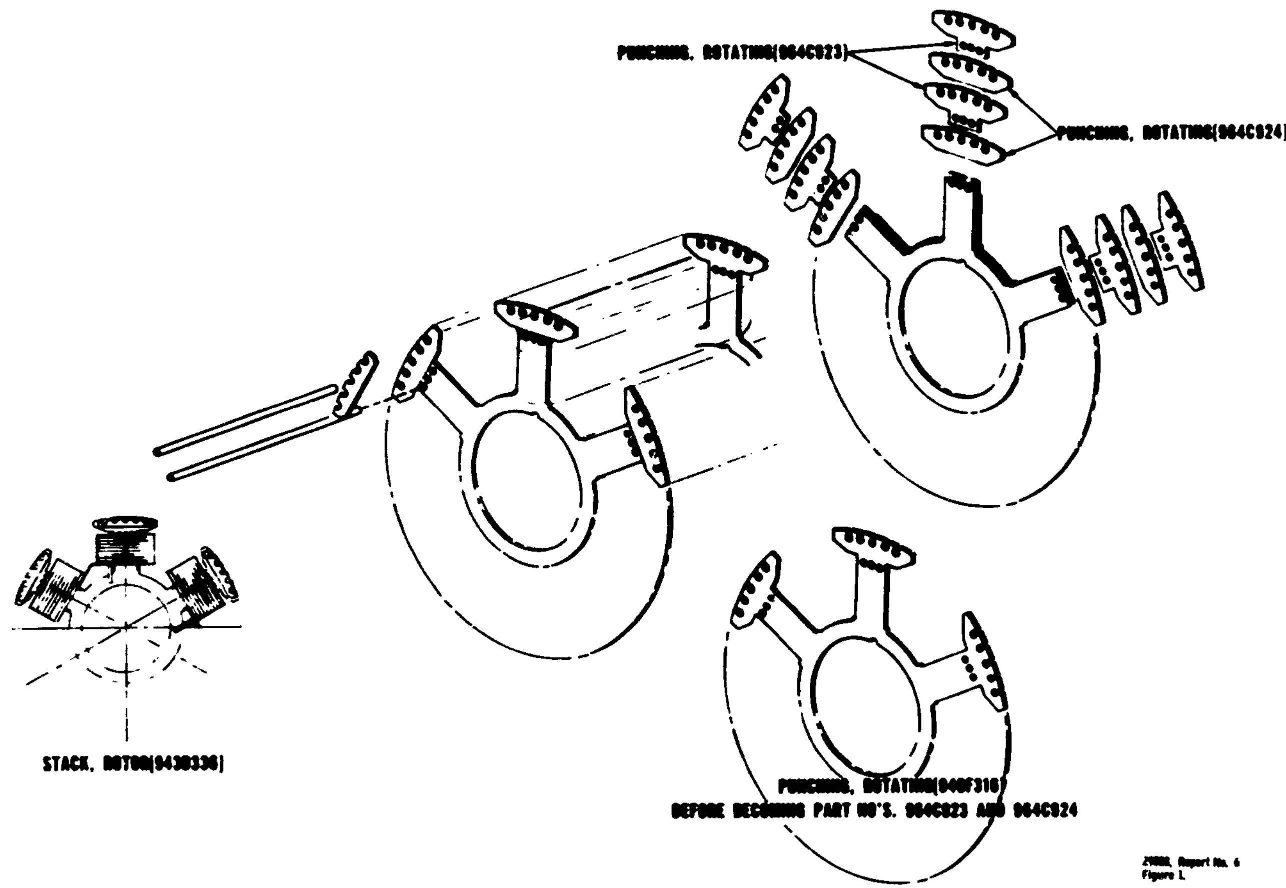

Figure 1. Main Rotating Field Stock

C. NICKEL-CLAD SILVER CONDUCTORS

The nickel-clad silver conductors were received from the supplier, and table I gives their inspection results. The inspections proved satisfactory and the wire was then shipped out to have the glass insulation applied. Other criteria not listed in table I used at inspection included manufacturing techniques, chemical composition, clodding cross section area, temper, apperance, surface condition, electrical resistivity, physical size tolerances, and packaging.

Table I. Nickel-Clad Silver Conductor Inspection Results

Sample No.	Area (in^2)	Yield Strength 0.2% offset (psi)	Ultimate Strength (psi)	Elongation	
				10 in. gage (%)	12 in. gage (%)
0.081 in. Diameter					
1	0.00506	11646	28000	18.75	18.75
2	0.00506	9800	27800	18.75	19.27
0.040 in. Diameter					
1	0.00124	12016	32016	28.12	28.12
2	0.00124	12016	32177	28.12	26.64
0.023 in. by 0.098 in.					
1	0.00219	6849	30593	35.0	35.4
2	0.00219	6849	30776	35.6	35.4
3	0.00219	7990	31270	34.3	34.6
0.032 in. by 0.081 in.					
1	0.00258	7751	30620	36.2	35.4
2	0.00258	7751	30310	35.0	35.4
3	0.00258	7751	30620	35.6	35.8

SECTION III

PLANS

The test program to develop the manufacturing and assembly techniques for the rotor and stator stacks will be undertaken so as to eliminate any possible problems during the prototype assembly schedule.

A simplification of the field wire routing through the hollow rotor shaft will be attempted so as to totally eliminate any possible electrical discontinuity from occurring during operation. All manufacturing information should be completed within the next quarter and tool drawings should be available. All unfinished process specifications will be completed and recorded so as to avoid any delay in manufacture.