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ENGINEERING CORPORATION

AZUSA, CALIFORNIA



FORMAL REPORT OF PROGRESS

15 December 1952

TO: Office of Naval Research
Department of the Navy
Washington 25, D. C.

VIA: Bureau of Aeronautics Representative
Pasadena
c/o Aerojet Engineering Corporation
6352 No. Irwindale
Azusa, California

SUBJECT: Research, Development, and Testing
of Underwater Propulsion Devices

CONTRACT: N6ori-10, Task Order I
Project NR 220 003

PERIOD COVERED: 1 November through 30 November 1952

This informal monthly progress report is submitted in partial fulfillment of the contract.

AEROJET ENGINEERING CORPORATION

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c-N6ori-10
1 copy ea # 12-13
2 receipts ack 12/23/52

C. A. Gongwer
C. A. Gongwer, Manager
Underwater Engine Division

NOTE: The information contained herein is regarded as preliminary and subject to further checking, verification, and analysis.

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I. ALCLO MOTOR

A. TEST VEHICLE MOTOR USING 3.75-IN.-DIA GRAIN

1. Testing of the motor fitted with a short combustion chamber was continued. Several types of turbulators and combinations of turbulators were tested. The configurations that were effective in producing better mixing, as evidenced by the specific impulse which approached that of the standard motor, also caused erosion of the turbulator and heavy deposition of the reaction products. Work is being directed toward obtaining effective mixing without erosion and deposition of the reaction products.

2. Four grains, wrapped with glass tape in place of the linen tape regularly used, were tested in the motor using the standard-length combustion chamber. This glass-tape restriction functioned well but showed no improvement over the standard linen-tape restriction. Further investigation of the glass-tape restriction is being carried out.

3. Three grains which had been stored at a temperature of 180°F for 59 days were tested in the motor using the standard-length combustion chamber. The performance (specific impulse and burning rate) of these stored grains was normal and showed no signs of deterioration due to the long storage at high temperature.

4. Three pairs of standard grains were tested in the motor using the standard-length combustion chamber. One of each pair of grains was temperature-cycled from -10°F to +140°F for five complete cycles; and the other grain of each pair was stored at ambient temperature as a control. The performance of the temperature-cycled grains was satisfactory. There were no indications of any adverse characteristics in burning or performance.

5. In some of the recent test-firings there have been signs of failure of the grain restriction as evidenced by abnormally high chamber pressure for the last 25 to 30% of the run. Investigation revealed that the batch of Selectron resin currently being used had deteriorated with age. This batch of resin was discarded and fresh material was substituted. A maximum shelf-storage period of two months has been set for this material, and if it has not been catalyzed and applied to grains during this period, it will be discarded. There has been no evidence of restriction failure during any of the runs made since the fresh resin was put into use.

B. SINGLE-WALL MOTOR USING 4.75-IN.-DIA GRAIN

This motor is complete and ready for testing.

II. STEAM-INJECTOR CONDENSER

Owing to an abnormal plant steam load and frequent boiler shutdowns for repairs, no steam has been available for condenser testing. Preparations are being made for the installation of a full-scale steam-injector condenser test setup, utilizing the present Alcloc motor using a 3.75-in.-dia grain.

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III. ALCLO-FIRED TEST STEAM GENERATOR FOR SUBMARINE

A. The boiler tubes appear to stay relatively clean and free of deposits during Alclo-fired steaming tests. The potassium chloride slag stays within the furnace.

B. Efforts were continued to obtain more complete combustion with the burner which is now being used. This is necessary before the gas recirculating system can be closed. A new burner that is expected to promote intimate mixing of the burning materials is being fabricated.

IV. ALCLO STUDIES

A. PROPELLANT STUDIES

1. Continuing in the effort to test such factors as the influence of particle size and shape on the burning rate of Alclo, three different grades of Alcoa aluminum powder were received and subjected to preliminary testing for burning rate. These grades were selected because of the fineness of the powder. Their descriptions are tabulated below together with data for Grade 606 which is used in the standard Alclo grains.

Alcoa No.	Mesh Designation and Type	Average Mesh Size Data	Burning Rate at Atmos. Press, in./sec
408	325-Mesh polished powder	98.5% Min through 325	0.43
422	400-Mesh polished powder	100% through 325, 98% through 400	0.56
552	325-Mesh polished powder (low grease)	97% through 325 (less than 0.2% on 100-mesh)	0.63
606	100-Mesh unpolished powder (low grease)	90% through 325	0.52

Chemical analyses showed that Grades 408 and 422 contained 3.06 and 4.03% grease, respectively, but that Grade 552 contained only 0.76% grease. These values may be compared with the 0.5% grease in Grade 606. Using the standard formulation (31.4% Al, 55.8% $KClO_4$, 12.8% Pb), the burning rates were checked at atmospheric pressure and are tabulated above. The mixture containing Grade 552 shows considerable promise in that the grease content is low and the burning rate is 21% greater than that of standard Alclo. The burning rate of this mixture will be investigated over a range of pressures in order to fully determine its burning characteristics.

2. A Patterson-Kelley Twin-Shell laboratory blender was received on loan and tried in connection with blending of the constituents of Alclo. The

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mixing action of this device was not severe enough to break up the agglomeration of $KClO_4$ (the $KClO_4$ is not a free-flowing powder). The blender was returned to the manufacturer's representative.

3. In connection with a series of hazard-classification tests, a 1.0-in.-dia hole was drilled axially through a 3.75-in.-dia x 8.25-in.-long grain of $AlCl_3$. This operation was done remotely on a specially constructed drill. A special cutter was used which was rotated at 173 rpm with a feed rate of approximately 0.3 in./min.

B. 400-TON PRESS

1. Sixty-nine 3.75-in.-dia grains were pressed during the month of November. The grains averaged about 8.25 in. in length and weighed about 9 lb each.

2. Except for the weekly routine cleanup, the press was kept in operation the entire period covered by this report, working two 9-hr shifts per day, two men on each shift. An average of 4.05 grains per day (or 2.02 grains per shift) were produced.

V. GASOLINE AND COMPRESSED-AIR HYDROPULSE

A. Continuous upstream injection onto the wick-type fuel evaporator was tested further. Oscillograph pressure records showed results roughly comparable to those obtained previously with atomizing injectors located in the combustion chamber. It was decided to concentrate on the wick evaporator because of the simplicity of continuous injection and the possibility of improved vaporization.

B. For durability, the first set of wicks, made of heavy fabric supported on coarse wire screen, spaced 0.75 in. apart, was replaced by a new set composed of 40-mesh brass screen wire spaced 0.125 in. apart, with the fabric omitted.

C. Shorting-out of the high-tension ignition cable (after sustained immersion in water) caused some difficulty. The cable is now pulled through metal conduit to a point above water level, thus eliminating the trouble.

D. Further testing is now waiting availability of the boom facility.