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531 800
Lyon Inc. -- Detroit, Mich.
Deep Drawn
A2 1st Stage Polaris Motor
Chamber and Aft Closure
Contract NOW 60-0630(FBM)
General Report #13
September 30, 1961

62-2-1
XEROX



Copy No. 12

LYON INCORPORATED
DETROIT, MICHIGAN

General Report No. 13
for the period
August 31 through September 30, 1961
on

DEEP DRAWN
PRE-PRODUCTION UNITS
A2 1ST STAGE POLARIS ROCKET MOTOR CHAMBERS
AND
A2 1ST STAGE POLARIS AFT CLOSURES

Submitted to:

Bureau of Naval Weapons
Code SP-271
Contract: NOw 60-0630(FBM)





INCORPORATED

ORDNANCE PRODUCTS DIVISION

MANUFACTURERS
OF

CARTRIDGE CASES • BOMBS • ROCKET MOTOR CHAMBERS
AND MISSILE COMPONENTS

13881 WEST CHICAGO BOULEVARD
DETROIT 28, MICHIGAN

September 30, 1961

Director, Special Projects
Bureau of Naval Weapons
Department of the Navy
Washington 25, D. C.

Attention: Special Projects Office (Code SP-271)

Subject: General Report No. 13 on deep-drawn pre-production
units of the A2 1st stage Polaris rocket motor
chambers and A2 1st stage Polaris aft closures

Reference: Contract NOW 60-0630(FBM)
Supplies and Services - Item 3

Gentlemen:

This report summarizes the progress made during the
period of August 31 through September 30, 1961, in the design, develop-
ment, fabrication and/or procurement and installation of special production
tooling to deep draw the Polaris A2 1st stage rocket motor chamber and A2
1st stage aft closure.

Copies of this General Report are being distributed according
to the attached Distribution List for Metal Parts as specified in the contract.

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I Special Tooling -- Material and Fabrication

(A) A2 1st Stage Aft Closure #1976585 (integral nozzle sleeves)

1. Thrust Port Sizing Die -- D-20063

Fabrication of the components needed for this die assembly has been completed and the die placed in operation.

2. Final Nozzle Sleeve Sizing Die -- D-20064

Fabrication of the componets needed for this die assembly has been completed and the die placed in operation.

II Special Tooling -- Tryout and Development

(A) A2 1st Stage Aft Closure #1976585 (integral nozzle sleeves)

1. Review of Past Development

It will be recalled that during the last report period, the development of the five restrike operations on aft closure #AX-6 had indicated that certain modifications of the upset rings were necessary to increase the support of the nozzle sleeve during forming. These modifications were made in the final days of the last report period. In addition, the remaining five aft closures had been processed through the first restrike operation. Two of these five aft closures, AX-2 and AX-3, were selected for development of the restrike operations with the above modifications and for the development of the nozzle sleeve final sizing die.

2. Development of Restrike Operations

Processing of aft closures through the second, third, fourth, and fifth restrike operations with modified upset rings was

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started on September 2, 1961, and the initial development of these operations was completed by September 12, 1961. The modified upset rings were found to provide the necessary support needed to maintain and establish the height of the sleeve on the convex or outer side of the membrane. During this processing, the componet details of the thrust port sizing die and the final nozzle sleeve sizing die were received, carefully inspected and their dimensions recorded. It should be noted that the punches and inserts for the sizing operations were designed to work with the present contoured die sections used for clamping. Set up of the sizing operations is similar to the restrike operations and requires only replacement of the punches and inserts. No extensive dismantling or set up of the dies is necessary for these operations.

3. Nozzle Sleeve Sizing Operation

On September 13, 1961, the nozzle sleeve sizing die was installed in the press and the development was completed by September 14, 1961. The function of this operation is to iron the inner diameter of the sleeve to obtain the necessary length of nozzle sleeve on the concave or inner side of the membrane. In addition, the two ribs present on the outboard portion of the nozzle sleeve (at the 4 o'clock and 8 o'clock positions) on the convex side are brought closer to size.

4. Final Nozzle Sleeve Sizing Operation

Development of this operation was started on September 16 and completed on closure AX-2 on September 20, 1961. The

- 4 -

function of this operation is to size the outer diameter surfaces of the nozzle sleeve and to provide additional sleeve length on the convex or outer side of the membrane. The initial development on this die was done with aft closure #AX-6. After completion of this sizing operation AX-6 was submitted to our Ordnance laboratory for metallurgical evaluation of grain flow pattern and other factors. The results of this evaluation will be presented in a future report. Processing through the final sizing was started on aft closure #AX-2 and after completion of the press operations it was dimensionally inspected and submitted for rough machining prior to heat treatment. Processing of aft closure #AX-3 through the final sizing operation was then started. We expect to eliminate one of the sizing operations in the future.

5. Processing Balance of Aft Closures

Following the development of the final sizing operation, processing of aft closures #AX-4 and AX-5 through the restrike operations was started. At the end of this report period these aft closures had been brought up through the third restrike operation. Pancaked blanks #AY-1 through AY-6, inclusive, should be ready for processing and further development work by the next report period.

III Rough Machining and Magnetic Particle Inspection

A careful dimensional inspection of aft closure #AX-2 was made after rough machining and the dimensions were recorded. The aft closure was then subjected to magnetic particle inspection (in accordance with specification MIL-I-6868A) to insure the absence of defects prior to being heat treated. This inspection revealed that no defects were present.

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IV Heat Treat Procedure

The heat treatment cycle used to harden aft closure #AX-2 was as follows:

1. Preheated in a salt bath furnace at 1275° F. for 30 minutes
2. Heated in a salt bath furnace at 1625° for 2 hours
3. Quenched in an agitated salt bath at 325° F. for 5 minutes
4. Double tempered in a salt bath furnace at 475° F. for 2 hours each cycle

Following heat treatment, the aft closure was again given a magnetic particle inspection and, in addition, was subjected to complete ultrasonic and radiographic inspection. Both the magnetic particle inspection and the radiography were conducted in accordance with the applicable government specifications. Because immersion ultrasonic testing equipment is not available in this area, the sonic testing was performed by contact methods using the same quality criteria required in OS9426A. No defects were found during any of the above nondestructive testing.

Both radial and tangential test strips were heat treated with aft closure #AX-2 and were tested for mechanical properties and depth of decarburization. The results obtained on these test strips were as follows.

	<u>Required</u>	<u>AX2-R</u>	<u>AX2-T</u>
0.2% Yield Strength-psi	200,000 to 220,000	201,500	199,500
Ultimate Strength-psi	Not specified	241,000	238,000
Elongation - % in 2 ins.	6.0	10.0	9.5
Core Rockwell "C" hardness	Not specified	49.5	49.5
Depth of Partial Decarburization - ins.	0.004 max.	0.016	0.016

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It will be noted that a marginal condition exists in yield strength. Prior tests on the heat treatment response of this material indicated a maximum yield strength of about 210,000 psi when the surfaces of the test specimen are not partially decarburized. The presence of partial surface decarburization will of course reduce yield strength. This reduction, however, is justified when consideration is given to the substantial increase afforded in fracture toughness by desensitization of the surface.

We have done considerable work on the control of salt bath oxide level and are sure that we can lower the amount of partial decarburization. For proper desensitization of the membrane thickness a layer of partial decarburization, 0.006"-0.010" in depth, should be present after hardening. Tests to establish the effect of partial decarburization upon yield strength are in process and will be presented in the next report. In addition, the test data pertaining to the control limits required for oxide content of the liquid salt are being compiled and will also be presented in the next report.

V Finish Machining

Aft closure #AX-2 was submitted for finish machining near the end of this report period. Machining and final inspection of the closure should be completed in time for shipment to Aerojet-General for hydrostatic pressure testing in the first week of October.

Sincerely yours,

Wayne A. Martin

Wayne A. Martin, Director
Lyon Ord. Res. and Mfg.

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