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SYSTEM FOR DEAERATION AND CASTING OF ELASTOMER BONDED PROPELLANTS

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Fig. 1.

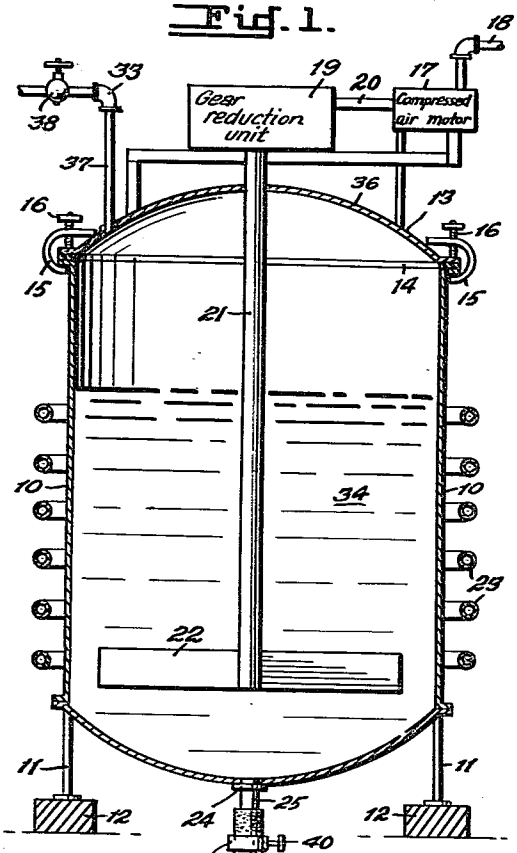


Fig. 3.

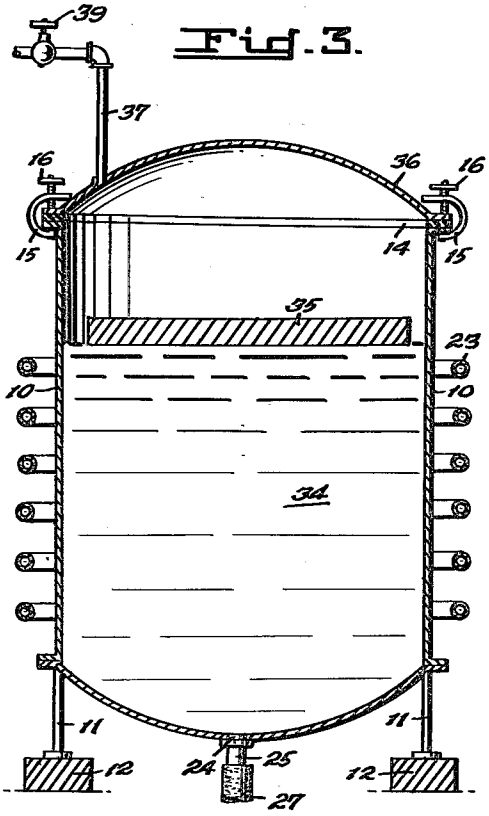
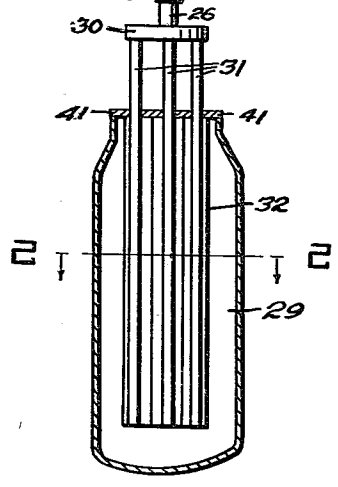


Fig. 4.



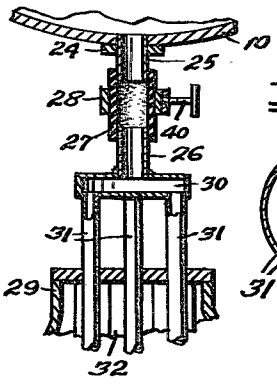
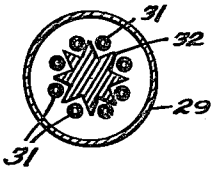


Fig. 2.



INVENTOR.

W. M. Mebane

BY

S. J. Rotondi, A. J. Dupont + E. C. Gott

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SYSTEM FOR DEAERATION AND CASTING OF ELASTOMER BONDED PROPELLANTS

William M. Mebane, Morrisville, Pa., assignor to the United States of America as represented by the Secretary of the Army

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2 Claims. (Cl. 86—20)

This invention relates to a method and apparatus for deaeration and casting of elastomer bonded propellants.

Heretofore it has been found that voids, bubbles, or interstices in a rocket compound cause irregular and erratic performances of a rocket, which naturally lessen the value of the rocket as a missile.

The condition for the continuous and uniform combustion after ignition of a propelling compound inclosed in a rocket is that the area of the discharge-opening of the rocket should bear a certain proportion to the largest surface of combustion occurring in the propelling compound. In case of too small a discharge-opening the pressure in the gas chamber will rise continuously until the chamber expands and bursts. The same will, of course, be the case if the combustion-surface should for any reason become larger than is calculated for the determined discharge-opening. Such a dangerous enlargement of the combustion surface will take place if cracks, bubbles, or interstices are formed in the compound itself or between the compound and the walls of the chamber in which it is inclosed. Such interstices may be formed in the propelling compound if the chamber or casing expands more than the compound from an increase of temperature, or if the propelling compound shrinks more than the casing from a decrease of temperature. Also if the propelling compound has been moist when cast in the motor casing and afterward has been allowed to dry, or if the compound consists of compressed powder the volume of which shrinks during storage, and finally, if the rocket with inclosed propelling compound is subjected to violence or shocks during handling and in transportation.

The object of this invention is a system for rendering the propelling charge of rockets and the like independent of all such circumstances, which may cause cracks, bubbles, or interstices to be formed in the propelling charge. This is attained by making the propellant charge elastic throughout, and with a binder that will bond it upon solidification when packed or pressed into the motor casing. The system of this invention is concerned with a prepared mixture of propellants, hereinafter referred to as elastomer-bonded propellants, its treatment prior to casting in the motor casing, and means employed to accomplish the desired results.

In the accompanying drawing,

FIGURE 1 shows a diagrammatical view partly in section of the apparatus employed to carry out the treatment of this invention;

FIGURE 2 is cross-section of the rocket motor taken on the II—II line of FIGURE 1;

FIGURE 3 is a section showing the propellant container without the stirring apparatus; and

FIGURE 4 is an enlarged sectional view of the connection between the treating vessel and the rocket motor.

Referring to the drawing, the air tight vessel **10** is supported by legs **11** on an elevated platform as represented schematically by **12**. The vacuum pressure vessel **10** has a cover **13** which with the rubber seal **14** makes the vessel air tight when the clamps **15** are tightened by the screws **16**. Supported on the cover **13** is a motor **17** operated by compressed air furnished through the line **18**. The motor **17** is connected to the gear reduction unit **19** by the shaft **20**, the unit **19** also being supported on the cover **13**. A stirring shaft **21** extends through the cover

13 and is connected to the gear reduction unit **19** at one end and at the other end to the paddles **22**. Around the vessel **10** is a copper coil **23** through which a heating fluid may be circulated to control the temperature of the material within the vessel. At the bottom of the vessel is an outlet **24**, through which the vessel may be emptied through the pipe **25** into the pipe **26**, with a rubberized section **27** interposed between, whereby the flow may be shut off by a control valve or a clamp **28** by tightening the screw **40** on the elastic section **27**. When the propellants are being cast in the rocket motor **29**, the flow is directed through the hollow header **30** to the bayonet spouts **31**, which in this instance are arranged as shown in FIGURE 2 about the star mandrel **32**. The mandrel **32** is suspended from the top of the rocket motor by the lips **41**, which permit the mandrel to be properly centered therein. In some cases where other than star-shaped grains are used or other rocket geometry desired, the rocket motors are filled to an appropriate level using the same system except that a single tube bayonet spout is employed and the appropriate mandrel is inserted after casting. In the top of the cover **13** is a line **33** controlled by a valve **38** and connected to a vacuum pump (not shown) permitting the vessel to be deaerated, while the paddles **22** are stirring the mixtures of propellants **34** to be treated.

When the material in the vessel has been deaerated, the cover **13** is removed as are the paddles **22**, the gear reduction unit **19**, and the air motor **17**. Referring to FIGURE 3, a float **35** made of wood covered with synthetic rubber and of a diameter to fit the cylindrical vessel, is placed on the deaerated material. An air tight cover **36** is placed on the vessel **10**, and is provided with a connection **37** which is used to supply air under a pressure of 20 to 70 p.s.i.g., and is controlled by a valve **39**.

In operation the vessel **10** is filled with the mixture of propellants **34**, and the cover **13** is fitted securely to make an air tight seal. Hot water is circulated through the coils **23** to maintain the material **34** at a suitable viscosity, and the paddles **22** are placed in operation by admitting compressed air to the motor **17**. While material **34** is fluid and being constantly stirred the vacuum line **33** is opened by the valve **38**, and the system of agitation and deaeration of the mixture is continued for ten to thirty minutes. At this point in the process, experience indicates that the propellant is sufficiently "debubblized" to permit casting into the rocket motor. The cover **13** supporting the air motor **17**, the reduction gear unit **19**, and the stirrer paddles **22** are then removed and a synthetic rubber covered wooden float **35** of the same general shape as the vessel **10** is placed on top of the propellant mixture. A second cover **36**, containing a single compressed air inlet **37**, is attached to the vessel and the propellant mixture **34** is subjected to an air pressure of 20–70 p.s.i.g. depending on the particular type of mixture to be cast. The pressure on the float **35** and the mass of material **34**, will force the mixture through the outlet **24**, when the clamp **28** is released, and further through the header **30** and into the rocket motor **28** by means of the bayonet spouts **31** arranged as shown in FIGURE 2. The tips of the bayonet spouts, during the extrusion of the propellants, are submerged below the propellant level in the rocket during casting so that there will not be any air introduced during the motor filling process. The cast motor rocket upon cooling contains no cracks or crevices and is completely "debubblized."

This system of rocket motor production insures (1) that the propellant will be properly deaerated prior to casting and (2) prohibits any introduction of air during the motor filling process as the tip or tips of the pouring bayonet spouts are maintained submerged below the propellant level in the rocket during casting. The maintenance of the proper depth of submergence of the bayonet

tips is accomplished by raising the bayonet assembly at a rate corresponding to the rate of rise of the propellant in the motor being cast. Thus a rocket motor is cast which has no cracks, bubbles, or interstices and which by its resultant uniform combustion will permit a more reliable performance of the missile.

What is claimed is:

1. A method of molding a propellant grain assembly from elastomer bonded propellants comprising, heating and stirring the propellants in a closed vessel, with-drawing the air from the vessel to deaerate the fluid propellant mass, replacing the stirring apparatus with a float resting on the fluid mass and conformed to the interior of the vessel, applying pressure to the float to extrude the deaerated mass from the bottom of the vessel, feeding the extruded material through bayonet spouts discharging below the surface of the fluid propellant in a closed motor case to prevent the absorption of air, and cooling the mass to form a bubble free grain of elastomer bonded propellants.

2. An apparatus for producing a propellant grain assembly comprising an air-tight vessel containing elastomer bonded propellants, a heating coil around said vessel to control the temperature of the contained propellants, two interchangeable covers for said vessel with an agitator and a vacuum line attached to one of said covers and a high pressure air line attached to the other cover by which air pressure may be supplied to the top of a disc float conforming to the sides of the interior of said vessel, an outlet in the bottom of said vessel connected to a multiplicity of bayonet pouring spouts, and a control valve interposed between said outlet and said bayonet spouts.

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