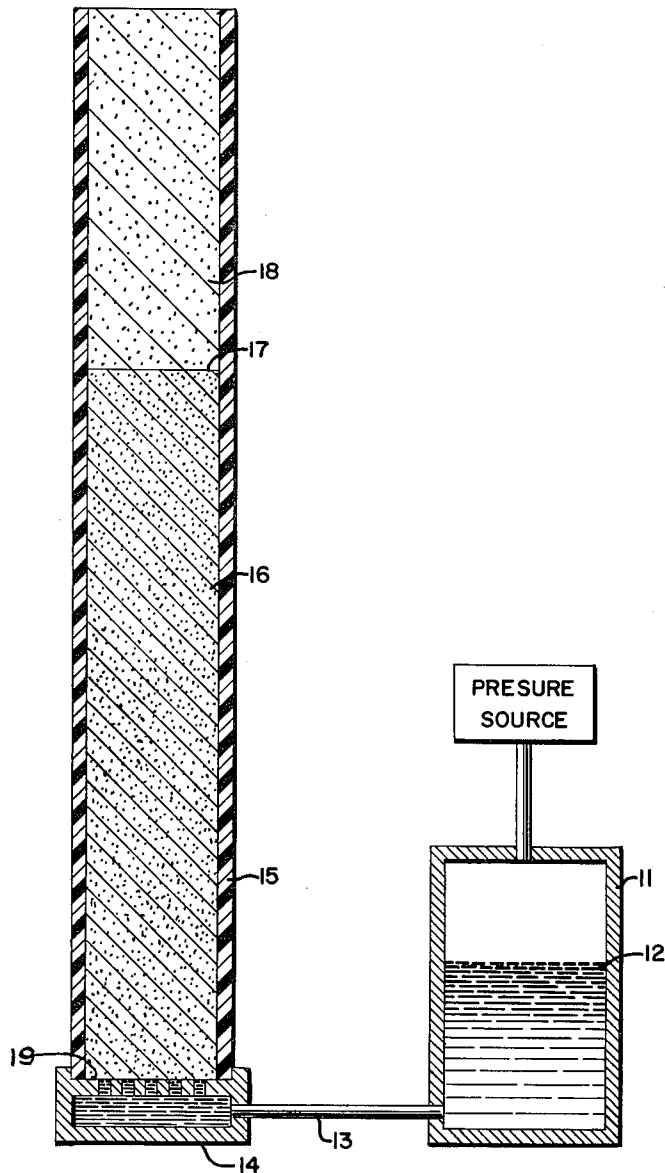


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F. S. VONDERSMITH ET AL
BOTTOM CASTING PROCESS USING COATED DOUBLE
BASE PROPELLANT GRANULES
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INVENTORS.

F. S. VONDERSMITH
C. D. COX
S. I. RAIDER
M. A. SCHONER

BY *W. O. Quisenberry*
Ralph W. Lamm
Chodges

ATTYS.

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BOTTOM CASTING PROCESS USING COATED
DOUBLE BASE PROPELLANT GRANULES

Fletcher S. Vondersmith, McLean, Va., Charles D. Cox,
Indian Head, Md., Stanley I. Raider, Syracuse, N.Y.,
and Malcolm A. Schoner, Oxon Hill, Md., assignors to
the United States of America as represented by the
Secretary of the Navy

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(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to new methods of manufacturing large propellant grains; more specifically the invention is directed to the casting of double base grains.

The older method comprised forcing the casting solvent (nitroglycerin plus a small amount of plasticizer) through a packed bed of nitrocellulose grains in a cylindrical mold. The casting solvent was forced in slowly from the bottom of the mold to avoid the entrapment of air which would cause voids in the cured grain.

The height or length of a suitable casting made by the foregoing method is limited by two factors. First, the casting solvent becomes more viscous as it rises in the mold due to the dissolution of nitrocellulose in the solvent. Second, the packed nitrocellulose grains swell due to the action of the solvent. Both factors restrict solvent flow through the packed column.

It is therefore an object of this invention to provide a method for making cast double base propellant grains larger than heretofore possible with conventional bottom casting techniques.

Another object is to provide a method for bottom-casting large propellant grains using lower casting pressures than previously employed.

Yet another object is to provide a method of making large cast grains with no sacrifice in the physical and chemical properties of the grain.

Still another object is to provide a method whereby the foregoing objects are accomplished at modest cost.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing which shows apparatus, partly in section, with which the instant invention is carried out and which is also generally similar to apparatus used in the casting methods of the prior art.

Referring now to the drawing, there is shown a pressure source suitably connected to pressure vessel 11 which contains casting solvent 12 such, for example, as nitroglycerin plus plasticizer. Vessel 11 has an exit port near the bottom thereof. Tube 13 communicates between the exit port of pressure vessel 11 and an entry port in mold base 14 which supports mold 15. The entry port communicates with a chamber in mold base 14, the upper wall 19 of the chamber having a multiplicity of apertures or perforations. Mold 15 is tubular and its lower end is closed by the multiperforated wall 19 of mold base 14 when mold 15 is positioned upon base 14. Packed inside mold 15 is any conventional casting powder such as nitrocellulose. Casting solvent 12 reaches height 17 upon being forced upward at a given pressure through the casting powder. Consequently, the casting powder indicated at 16 is wet with solvent while the powder 18 above the level 17 remains dry. Casting powder 18 is above height 17 in the mold 15. The height to which the casting solvent will rise is a function of the pressure

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applied, the time of application of the pressure, and the temperature of the casting solvent and is known as the castability of the material.

Prior to packing in the mold, the dry grains of casting powder are coated with a material which temporarily retards the action of the casting solvent, yet ultimately dissolves to permit the solvent to gel the casting powder.

Materials suitable for use as precoating agents for casting powders are: methyl cellulose, polyvinyl alcohol, corn starch, silicone resins, gelatin, hide glue, acid-catalyzed varnish type phenolic resins, copolymers of methyl vinyl ether and maleic anhydride, polyvinyl pyrrolidone, and maleic polyester resins. Such materials are characterized by their limited solubility in and compatibility with nitroglycerin and are hereinafter referred to as limited-nitroglycerin-soluble materials. The plasticizer employed with the coating is not critical.

The preferred materials, however, considering the effectiveness of and the ease of application of the coatings, are the maleic polyester resins.

The coating materials of this invention are easily applied to the grains of casting powder by direct application or by dissolving or suspending the coating material in a medium, thoroughly wetting the casting powder with the material, solution or suspension, and drying the wetted grains.

Solvents for the limited-nitroglycerin-soluble materials are given below in Table I.

Table I

Material	Solvent or Diluent
1. Methyl cellulose.....	Water.
2. Polyvinyl alcohol.....	Do.
3. Polyvinyl chloride.....	Methyl ethyl ketone.
4. Polyvinyl pyrrolidone.....	Ethyl alcohol.
5. Phenolic resins.....	None.
6. Copolymer of methyl vinyl ether and maleic anhydride.....	Ethyl alcohol.
7. Methyl ethoxy silane.....	None.
8. Gelatin, hide glue.....	Water.
9. Corn starch.....	Do.
10. Maleic polyester resins.....	Ethyl alcohol or ammoniacal soln.

The thickness of the coating influences the effectiveness of the coating as a gel-retarder and will vary with the particular coating material selected. The thickness is controlled in the case of a solution or suspension, by controlling the concentration of material in the solution or suspension which is used to wet the base grains. It has been found that solutions containing from about 1% to about 5% of maleic polyester resins by weight produce the most satisfactory coatings; however, other concentrations may be used.

All the coating materials contemplated by this invention have been chosen for their demonstrated ability to retard the gelation of nitrocellulose base grains by casting solvent. The use of the instant coating agents has led to an increase of up to almost 100% in castability over uncoated grains of the same dimensions.

Subsequent tests performed upon grains prepared according to the instant method show essentially unaltered physical, ballistic, and stability properties. Moreover, the castability of various powder lots is more uniform with the instant coatings than with uncoated grains.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In the process of bottom casting large double base

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propellant grains wherein casting solvent is admitted under pressure into a mold base and is thereafter forced upward to fill the mold and dissolve the casting powder contained in the mold and wherein the height of the casting is limited due to the casting solvent becoming extremely viscous because of the dissolution of the casting powder therein and thereby difficult to force beyond a certain height, the improvement which comprises pre-coating the grains of the casting powder with a limited-nitroglycerin-soluble material selected from the group consisting of polyvinyl alcohol, silicone resins, hide glue, copolymers of methyl vinyl ether and maleic anhydride, polyvinyl pyrrolidone and maleic polyester resins before applying the casting solvent.

2. The process of claim 1 in which the said material is dissolved in a solvent, wetting the grains of casting

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powder therewith and evaporating the solvent from the coated grains.

3. The process of claim 2 in which the solvent is an aqueous ammoniacal solution.

4. The process of claim 2 in which the solvent is ethyl alcohol.

References Cited in the file of this patent

UNITED STATES PATENTS

2,198,746	Spurlin et al.	Apr. 30, 1940
2,335,804	Silk	Nov. 30, 1943
2,946,673	Grassie	July 26, 1960

OTHER REFERENCES

Warren: "Rocket Propellants," Reinhold Publishing Co., New York (1958), pp. 58-60.