April 23, 1968 W. N. HEWSON ETAL 3,379,796

CASTING PROPELLANT CHARGES

Filed April 8, 1954 2 Sheets-Sheet 1

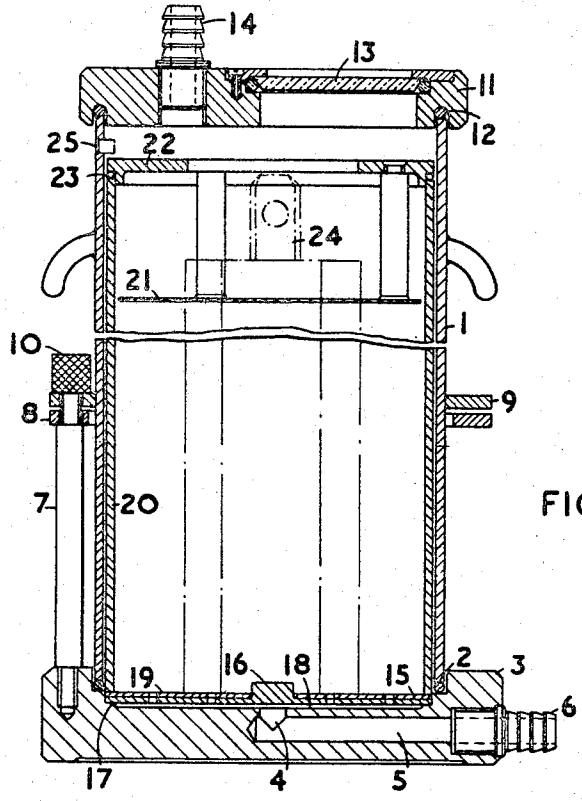


FIG. 1

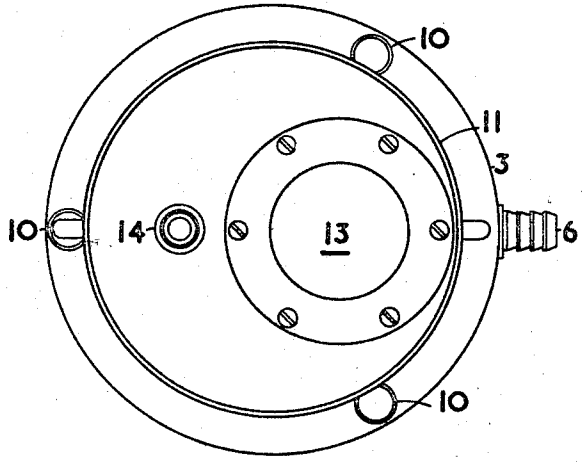


FIG. 2

Inventors
WALTER NORMAN HEWSON
DAVID VICTOR CLIFFORD

By G. O. O'Brien Attorney

April 23, 1968 W. N. HEWSON ETAL 3,379,796

CASTING PROPELLANT CHARGES

Filed April 8, 1954 2 Sheets-Sheet 2

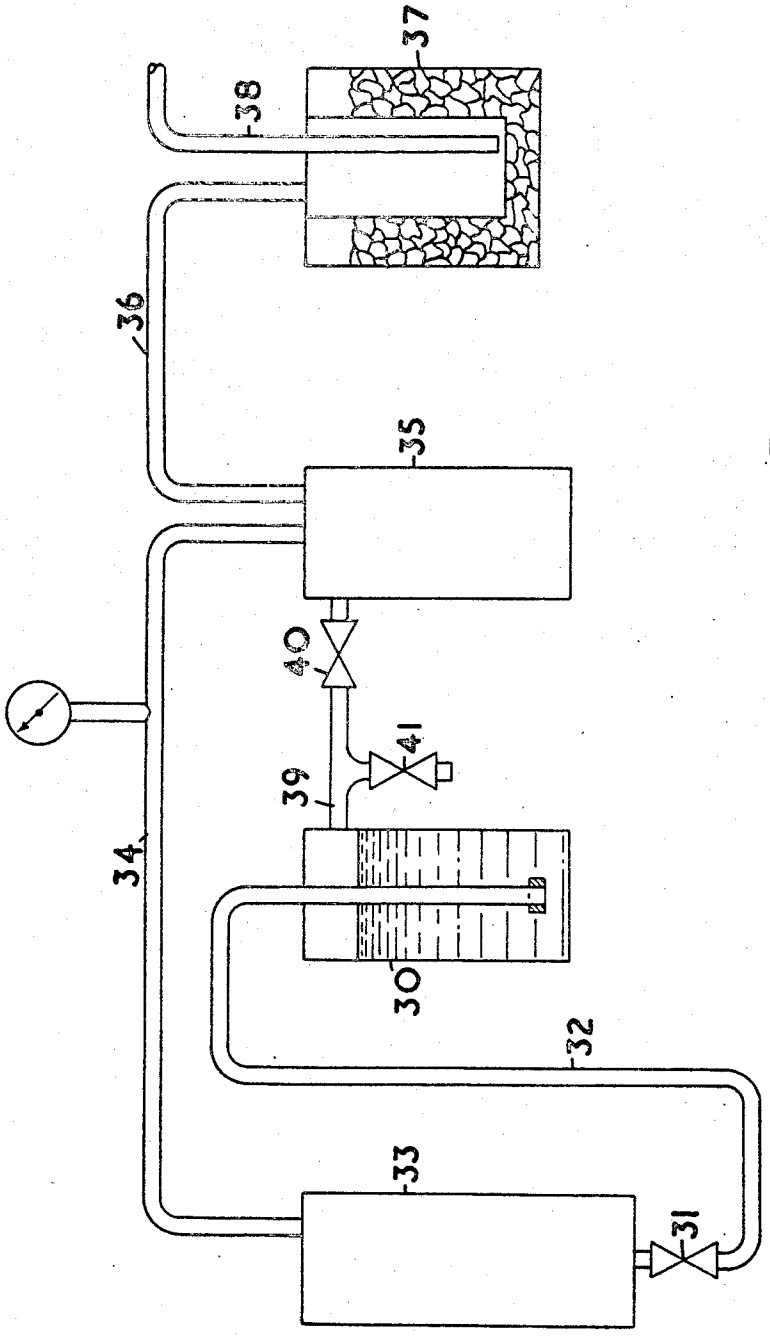


FIG. 3

Inventors
WALTER NORMAN HEWSON
DAVID VICTOR CLIFFORD
By A. D. O'Brien Attorney

United States Patent Office 3,379,796 Patented Apr. 23, 1968

3,379,796

CASTING PROPELLANT CHARGES

Walter N. Hewson, Blackheath, London, and David V. Clifford, Waltham Abbey, England, assignors to the Minister of Supply in Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England

Filed Apr. 8, 1954, Ser. No. 421,848
Claims priority, application Great Britain, Apr. 11, 1953, 9,922/53
2 Claims. (Cl. 264—3)

This invention relates to the casting of propellant charges and to an application of the property of nitrocellulose powders to swell and coalesce into a coherent mass when treated with a suitable solvent and plasticiser. More particularly the invention relates to the so called base addition process of casting charges, in which process the casting powder is packed into a container and a suitable solvent under pressure is admitted to it through an orifice situated in the base of the container.

This casting process has a wide range of application and may be used with advantage for casting charges of a size or shape difficult to produce by extrusion involving the use of heavy presses, by block pressing or by the fabrication of segmented charges. The invention is particularly applicable to the production of end burning charges and of charges of complicated cross-section, such as those of multi-concentric form and also to the formation of large size rocket charges for such applications as assisted take-off of aircraft, and for other purposes.

It is customary to cast propellant charges in a tubular container of suitable transparent plastic material which bonds itself to the charge and forms a restrictive and rigid coating. The plastic containers inhibit burning on the outer surface of the charge and because of their transparency allow the charge to be inspected for good consolidation and adhesion. Tubular containers have been moulded of cellulose acetate, plasticised with mixed dimethyl and diethyl-phthalates whilst other containers have been made by the convolute winding of thin sheet subsequently cemented with acetone.

Hitherto it has been the practice to support the plastic container in a halved mould or corset, the two halves being bolted together to maintain the shape of the charge during evacuation, casting and curing and unbolted to remove the charge. A disadvantage of this procedure is that it involves the screwing and unscrewing of nuts and bolts, which operation introduces an element of danger because an explosion may be caused if the screw threads are contaminated with liquid explosive used in the process. In addition such a construction of corset is difficult to seal for the purpose of obtaining a reduced pressure within the corset prior to the casting of each charge. Also hitherto the casting powder and casting solvent have been separately vacuum treated for a number of hours to remove volatile matter and absorbed gases, and then returned to atmospheric pressure before the liquid has been introduced into the interstices of the powder.

The present invention has for its object to provide an improved method of casting propellant charges with a minimum amount of gas entrapped within the charge. A further object of the invention is to provide an improved construction of corset which will reduce danger and the work normally involved in setting up the corset in preparation for each casting operation.

In accordance with the method of the present invention a propellant charge is produced by subjecting a charge of explosive in the form of powder to a reduced pressure in an enclosure and a casting solvent additive is drawn under the reduced pressure through the interstices of the said charge to saturate the same.

Further the rate of admission of the solvent to the casting powder is controlled so that the solvent is completely introduced into the enclosure before the charge solidifies.

Apparatus for use in carrying out the invention comprises a base plate adapted to be detachably connected to the base of a tubular body to form a sealed joint, a lid adapted to close the upper end of the said tubular body and to form a sealed joint therewith, an inlet in said base plate for the admission of casting solvent and an outlet in said lid for exhausting gaseous media from the interior of the said tubular body.

The tubular body may be secured to the base plate by rods which are attached to the base plate and are held at their upper ends to fixing means on the outside of the tubular body and a removable former may be inserted within the tubular body for producing propellant charges having internal burning surfaces.

The invention is hereinafter described, by way of example, with reference to the accompanying drawings wherein FIGURE 1 shows a sectional elevation and FIGURE 2 shows a plan view of the corset assembly, and FIGURE 3 shows a diagrammatic view of the essential components in the vacuum casting plant.

Referring now to FIGURES 1 and 2, a tubular stainless steel corset **1** is supported on a jointing ring **2** located on a shoulder of a recessed bronze base plate **3**. This base plate has a central hole **4** communicating with a radial channel **5** leading to a nozzle **6** protruding from the circumference of the base. Three studs **7** which are screwed into the flange of the base plate **3** extend through a locating ring **8** and protrude through a ring **9** welded to the body of the corset, and are secured in position by cap nuts **10**. The upper end of the corset **1** is closed by a lid **11** with a jointing ring **12** of sealing material, for example rubber, interposed between the lid and the edge of the corset. This lid is provided with a circular sight glass **13**, hermetically sealed in a recess located in the lid, and also has a protruding nozzle **14** which communicates with the interior of the corset. A perforated disc **15** having a central locating boss **16** rests on a shoulder **17** of the base plate **3** so that a clearance space **18** exists between the underside of the disc **15** and the upper face of the base plate. A perforated brass plate **19** rests on the disc **15** and is surmounted by a cellulose acetate tubular container **20**. A perforated disc **21** rests on the upper surface of the powder when the container is filled and is positioned below a three-legged stool **22** which is supported by a resilient ring **23** interposed between it and the end of the tubular container **20**. This disc **21** may be slotted so as to locate a shaped former **24** positioned vertically within the corset. Three pins **25** fixed at the same height in the corset wall are equally spaced circumferentially around it.

Referring now to FIGURE 3, the casting liquid, which may consist of a mixture of nitric ester, plasticiser and stabiliser, is maintained in a storage vessel **30** which is connected, through a gun metal inlet valve **31**, by means of a copper pipe line **32** to a corset assembly **33** which is directly connected by a copper pipe line **34** to an overflow trap **35**. This overflow trap is connected by the copper line **36** to a gun metal freezing trap **37** which is connected by the pipe line **38** to a vacuum pump (not shown) and which has its lower portion cooled with a mixture of carbon dioxide and acetone so as to protect the pump from explosive vapours and to avoid contaminating the pump oil with low boiling constituents. The overflow trap **35** is connected through a cast gun metal valve **40** by a copper pipe **39** to the storage vessel **30** and is large enough to take all the casting liquid should this be displaced from the vessel **30** by a sudden inrush of air resulting from an accidental break in the system. A cast gun metal valve **41** which leads to the atmosphere is connected in the pipe line **39**.

In accordance with the invention the container **20** is partly filled with a weighed quantity of casting powder which is poured through a distributor head (not shown) consisting of a series of plates perforated with holes of predetermined size and spacing so as to cause the powder to fall evenly into the container. The perforated disc **21** is placed on the surface of the powder and the stool **22** positioned on the upper end of the cellulose acetate container **20**. The corset assembly is connected to the casting system which, with valve **40** open and valve **31** and **41** closed, is then exhausted by a vacuum pump to remove gas and volatile matter from the casting powder and casting liquid. Valve **40** is then closed and valves **31** and **41** are opened and the casting liquid allowed to flow from the storage vessel **30** into the corset base plate and upwards through the casting powder whilst the casting charge is maintained under reduced pressure. The combined effect of the external atmospheric pressure and the weight of the lid **11** is sufficient to provide a good vacuum seal between the lid and the corset during the time the air pressure within the corset is reduced. The admission of the casting liquid to the casting powder is controlled so that the liquid is completely introduced before the charge solidifies, otherwise the flow of liquid will cease before the interstices at the top of the charge have been filled with casting liquid. The ring **23** prevents any casting liquid splashing between the container **20** and the wall of the corset **1** but allows evacuation of the annular gap between these two components during exhaustion of the assembly and allows an upward expansion of the container relative to the corset assembly during curing. Any lifting of the stool **22** due to the upward force caused by swelling of the casting powder is regulated by the pins **25**. Before the charge solidifies the pressure within the corset assembly is returned to normal pressure so that any small pockets of rarefied air which may have been occluded are collapsed to a negligible volume before the charge sets. The casting operation is carried out under reduced pressure so that the casting powder and casting liquid are protected from the readsorption of moistures and gases from the atmosphere. After the casting operation the corset assembly is removed to a stove where the curing of the charge is completed by maintaining it at an elevated temperature. When the charge has been cured and allowed to cool the cured charge consisting of propellant bonded to its cellulose acetate container is easily released from the corset because the differential expansion between the corset and the charge causes it to become a slack fit permitting ready separation.

The vessel **30** containing the casting liquid is of sufficient volume to allow for considerable frothing which takes place during the early stage of evacuation and may be conveniently graduated in order to follow the flow of casting liquid through the interstices of the casting powder.

The legs of the stool **22** are made of a compressible material, such as a reinforced phenolformaldehyde plastic and these legs, resisting the expansion of the charge relative to the metal corset assembly during curing, exert on the charge a pressure which improves its consolidation. The legs are, however, sufficiently elastic to be compressed before the metal components are permanently strained.

Suitable removable formers may be previously inserted within the space for the casting powder to produce internal burning surfaces of uniform or tapered cross section.

During evacuation there is no appreciable difference in pressure between the inside and outside of the cellulose acetate container so there is no tendency for it to collapse under the effect of the reduced pressure; consequently the process is particularly well suited to the casting of large diameter charges.

We claim:

1. A process of making a double base propellant grain which comprises the steps of delivering a desired quantity of casting powder containing nitrocellulose to a tubular container, the inside of which defines the outside shape of the grain, placing said container in a closed chamber, reducing the pressure in the chamber below atmospheric pressure, the pressure inside the container being substantially the same as outside of the container to prevent its collapse, flowing a liquid containing a nitric ester and a plasticizer through the powder under the influence of the difference in pressure between the inside of the chamber and the atmosphere, and at a rate to completely saturate the powder before the powder and liquid coalesce into a solid mass, resuming atmospheric pressure on the mass after the powder has been completely saturated and prior to coalescence of same, thereby effecting collapse of occluded rarefied air pockets in the mass to negligible volume, and thereafter curing the grain at elevated temperature.

2. A process in accordance with claim **1** including the step of resisting expansion of the grain during curing to produce compressive consolidating forces thereon.

References Cited

UNITED STATES PATENTS

2,495,640	1/1950	Muskat	86—20.5
987,629	3/1911	Ketcheson	117—61

BENJAMIN A. BORCHELT, *Primary Examiner.*

SAMUEL BOYD, ARTHUR M. HORTON, *Examiners.*

S. H. GOLDMAN, R. F. CUSTARD, R. F. STAHL, *Assistant Examiners.*