March 3, 1953 J. W. PERRY ET AL 2,630,041

APPARATUS FOR COMPACTING EXPLOSIVE AND PROPELLENT MATERIAL

Filed Oct. 30, 1947

Fig. 1.

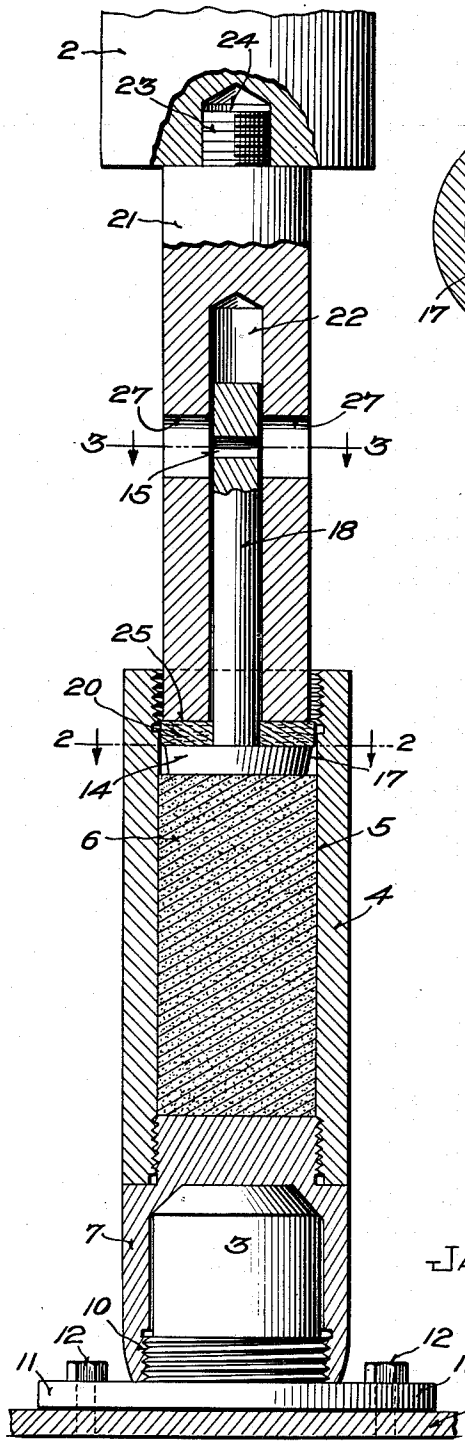


Fig. 2.

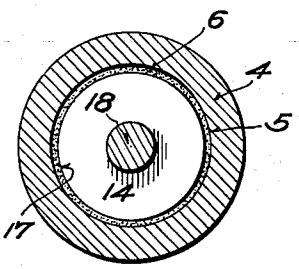


Fig. 3.

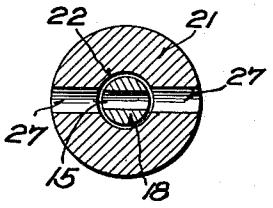
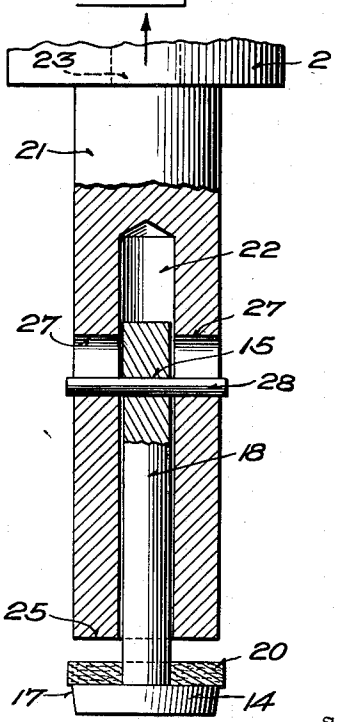


Fig. 4.



Inventors

JAMES W. PERRY, WILLIAM R. JOHNSON,

JOSEPH H. FRAZER,

By G. J. Rossevich, J. W. Church & H. C. Hilbodeau

Attorneys

Patented Mar. 3, 1953 2,630,041

UNITED STATES PATENT OFFICE

2,630,041

APPARATUS FOR COMPACTING EXPLOSIVE AND PROPELLENT MATERIAL

James W. Perry, Newton Center, Mass., William R. Johnson, Texas City, Tex., and Joseph H. Frazer, Havre de Grace, Md.

Application October 30, 1947, Serial No. 783,033

3 Claims. (Cl. 86—30)

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

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to apparatus for compacting or pressing finely divided explosive material, particularly finely divided solid explosive material which might be ignited, or is subject to ignition, by friction.

More particularly the present invention is concerned with the provision of apparatus for effectively compacting finely divided propellent material in rockets or the chambers thereof intended to contain propellent material.

Among the objects of the present invention is the provision of apparatus for compacting finely divided solid explosive material, which might be ignited, or is subject to ignition, by friction, into chambers, such as propellent chambers of rockets, having lateral walls of metal, such as steel.

A further object of the present invention is the provision of apparatus which is safe to use in compacting under high pressure finely divided solid explosive material which might be ignited by friction between relatively moving metal parts.

In order that the operation and use of the apparatus hereinafter described in detail may be fully appreciated, an example of a finely divided solid explosive material which may be effectively compacted in apparatus made in accordance with the present invention is given hereinafter, although it is to be understood that the use of the apparatus is not confined to this example of finely divided explosive material, since it may be used, as will be understood by persons skilled in the art, to press or compact many other finely divided solid explosive materials.

The example of finely divided explosive material referred to in the preceding paragraph, and which is used by way of illustration in describing the present invention, consists of an intimate mixture of the following ingredients in the indicated proportions:

1754 grams of finely divided granular potassium perchlorate previously dried in an oven at 100 to 110° C.;
482 grams of powdered or finely divided graphite;
222 grams of finely powdered metallic titanium;
109 grams of finely powdered Vinylite of VYNU grade manufactured by Carbide and Carbon Chemicals Corp.;
163 grams of liquid tributyl "Cellosolve" phosphate.

2

In mixing these ingredients, it is preferred to mix intimately the solid components together as a preliminary step in the formation of the final mixture and then to mix intimately into this mixture of solid components the tributyl "Cellosolve" phosphate. These two mixing operations are advantageously conducted at a temperature of about 50° F. to about 90° F. The final mixture resembles in appearance a dark colored, finely grained, slightly moist sand, which retains this appearance even after storing for several months at ambient temperatures.

The Vinylite referred to above is a high molecular weight copolymer of vinyl chloride and minor amounts of vinyl acetate. It is a thermoplastic non-heat hardening plastic material. The tributyl "Cellosolve" phosphate used is the neutral phosphoric acid ester of monobutyl ether of ethylene glycol of the formula

$$OP(OCH_2CH_2OC_4H_9)_3$$

and physically combines as a plasticizer with the Vinylite at the temperature of pressing or compacting of the mixture. The plasticized Vinylite serves as a thermoplastic non-heathardening binder for the other components of the mixture and functions as a matrix for the other components.

Referring now to the drawings accompanying and forming part of this written description,

Figure 1 is a longitudinal central section of apparatus embodying the present invention;

Figure 2 is a cross-section on the line 2—2 of Figure 1;

Figure 3 is a cross-section on the line 3—3 of Figure 1; and

Figure 4 is a portion of Figure 1 showing the relation of parts during the removal of the pressing head of the apparatus from the compacted material.

The numerals 1 and 2 in the accompanying drawings indicate respectively the press table and ram of a hydraulic press. The hydraulic press is of the type that its ram 2 may exert a pressure in one direction, for example downwardly as viewed in Figure 1, and a pull in the opposite direction. Hydraulic presses of this type are well known, and their details of construction are not necessary to an understanding of the present invention. The relationship of the present invention to press table 1 and the ram 2 of a hydraulic press of the type described is fully shown in the accompanying drawings and explained in this description.

To the press table 1, is secured a holder 3 for

the body 4 having the chamber 5 into or in which the finely divided solid explosive material 6 of the characteristics referred to above is to be pressed or compacted, for example under a pressure of from 7,000 p. s. i. to 15,000 p. s. i. For the purposes of illustration and description, the body 4 is shown as a portion of a spin stabilized rocket. The portion shown comprises the chamber 5 which holds the propellant. Chamber 5 therefore also represents the propellent chamber in the portion 4 of a rocket. The part 4 of the rocket shown is wholly formed of steel, and therefore the lateral cylindrical interior wall of the chamber 5 which is presented to the finely divided solid explosive material, and to the pressing head and obturator hereinafter described, is metallic. As viewed in Figure 1, the lower end of chamber 5 is closed by part 7, which also is a part of a rocket, located in advance of its propelling charge which is indicated by the numeral 6.

The holder 3 is formed to fit exactly within the cavity in part 7 and engages the latter by means of screw threads 13. The holder 3 is provided with a flange 11 which is secured by means of bolts 12 to the press table 1. The construction is preferably such that the holder 3 entirely fills the space of the cavity within the part 7, so that the body or portion 4 of the rocket is held in a fixed rigid position at all times during the application of pressure, as hereinafter described, to the explosive or propellent material 6.

The pressing head 14, by means of which the finely divided explosive or propellent material 6 is compacted in the chamber 5, is formed as a slightly tapered steel disc coated with brass, especially on its bottom and circumferential portion where it makes contact with the explosive or propellent material 6. The periphery 17 of pressing head 14 is, at all points thereof, slightly spaced from the periphery of the chamber 5, in order to provide a clearance between the periphery of the pressing head and the periphery of the chamber. This clearance may be of the order of magnitude of one thirty-second of an inch.

Integrally attached to the pressing head 14 is steel stem 18. The stem 18 is coaxial with pressing head 14. Stem 18 is provided with a hole 15 which runs diametrically across it for the purpose explained below.

Adjacent the rear of pressing head 14 and surrounding the stem 18 is the annular obturator 20. The periphery of this obturator conforms with the contour of the interior metallic wall of chamber 5 and has a close enough fit with it to block the passage of finely divided material through the clearance between the periphery of the pressing head 14 and the periphery of the interior cylindrical wall of the chamber 5 when the pressing head 14 compacts the finely divided explosive material 6. The obturator 20 is formed of a non-gritty material which is soft enough to avoid ignition by friction of any finely divided explosive material between it and the interior steel wall of chamber 5. Examples of materials of which the obturator 20 may be formed are: hard dense grainless cellulose fibre board, hard dense laminated paper board, and hard dense asbestos board free of gritty material. The dense cellulose fibre board known in commerce as "Masonite" may be advantageously used as the material of the obturator.

A plunger 21, provided with an axial bore 22, is provided with a threaded stud 23 which engages a threaded socket 24 in the ram 2 of a hydraulic press of the type referred to above. The plunger 21 is by the means described rigidly fixed to the ram 2 and moves with it. The bore 22 is somewhat larger in diameter and longer than stem 18, so that the plunger 21 can slide or descend freely over the stem 18 and its squared-off free end 25 abut against the obturator 20. The dimensions of the cross section of plunger 21 are such that it may freely enter the chamber 5 while providing a large face at its free end 25. The face at the free end 25 in the embodiment of the invention shown has the same diameter as the top or rear of the pressing head 14.

The plunger 21 is provided with two diametrically oppositely disposed slots 27, which are so positioned that the hole 15 in stem 18 registers with them about midway between their ends when the end 25 of the plunger is in abutting relationship with the obturator 20 as shown in Figure 1. A pin or bar 28 may be inserted, as shown in Figure 4, through both slots 27 and through the hole 15 in order to enable the plunger 21 to exert a pulling action upon the stem 18 and the pressing head 14.

Operation.—Finely divided solid explosive or rocket propellent material, for example of the composition specifically described above, is placed within the chamber 5, filling it to a point just short of the threads at its open end. Thereafter the body 4 and the contents of the chamber 5 are heated to raise the temperature of the finely divided explosive material to about 250° to 300° F. At this temperature the plasticizer in the explosive or propellent composition physically combines with the Vinylite. This heating of the composition is advantageously accomplished before the body 4 is attached in pressing position on the holder 3. This heating may be done in any suitable oven or by means of an electric heating coil placed about the body 4.

The ram 2 and the plunger 21 are moved sufficiently away from the press table 1 in order to permit the body 4 to be secured on the holder 3. After securing the body 4 on the holder 3 the assembly of the pressing head and obturator is placed within the chamber 5 above the explosive or propellent composition and the plunger 21 moved downwardly, as viewed in Figure 1, within the chamber 5 of body 4. Further downward motion of ram 2 of the hydraulic press causes plunger 21 to press against obturator 20 which in turn transmits the pressure to pressing head 14. The downward motion of pressing head 14 compacts or compresses the heated explosive or propellent composition 6 and causes the thermoplastic non-heat hardening binder, formed by the physical combination of the plasticizer and Vinylite, to be pressed into the interstices between the other components of the composition being compacted.

After the necessary pressure has been applied for sufficient time to compact the composition the desired amount, the ram 2 and plunger 21 may be raised sufficiently above the stem 18 to permit the body 4 together with the assembly of pressing head 14, stem 18 and obturator 20 to be detached from holder 3 and cooled in any suitable way to bring the composition to ambient room temperature. The pressing head 14 is not removed before the cooling step, since otherwise the adherence between the compacted hot composition and the wall means of the chamber may be so disturbed by the removal of pressing head 14 that the compacted hot composition is re-

moved from the chamber either completely as a unit or partly as a detached fragment. In the case of the specific explosive or propellant described above, a pressure of about 15,000 p. s. i. is applied for about three minutes in compacting the propellant in the propellent chamber of a rocket.

After the above mentioned cooling, the body 4 is again secured on holder 3 and the plunger 21 again brought down over the stem 18, whereupon the pin or bar 28 is passed through the two slots 27 in the plunger 21 and through the hole 20 in the stem 18. Upward motion is now imparted to the ram 2 and plunger 21, and as a consequence the lower ends of slots 27 engage the pin 28 and thereafter further upward motion of the plunger 21 pulls the stem 18 and the pressing head 14 away from the cooled compacted material 6 and out of the chamber 5. The obturator 26 at the rear of pressing head 14 moves out of chamber 5 together with the pressing head 14 and stem 18. The body 4 is now detached from the holder 3, and the apparatus is now ready to receive another body 4 filled with finely divided explosive or propellent material to be compacted.

We claim:

1. Apparatus for compacting finely divided solid material, which is subject to ignition by friction, into a chamber formed by a cylindrical body open at one end and having lateral metallic walls, comprising a circular, metallic pressing head having a diameter slightly smaller than the inside diameter of said cylindrical body, a stem having a transverse bore, said stem being affixed to said pressing head in coaxial alignment therewith, a non-metallic obturator fitting over said stem having a diameter as nearly equal to the inside of diameter of said cylindrical body as possible to block passage of said material between said walls and said non-metallic obturator and yet permit free axial movement thereof within said chamber, and means for applying pressure to said non-metallic obturator whereby compacting pressure is applied to said metallic pressing head through said non-metallic obturator, said last-mentioned means including a plunger having an axial bore of greater axial dimension than said stem and of sufficiently large diametric dimension to receive said stem, said plunger being further provided with diametrically opposite slots

positioned in predetermined relationship to said transverse bore.

2. The apparatus according to claim 1 wherein said slots and said transverse bore are so positioned with respect to each other that said transverse bore registers about midway between said slots with said plunger abutting against said obturator.

3. Apparatus for compacting finely divided, solid material, which is subject to ignition by friction, into a chamber formed by a cylindrical body open at one end and having, lateral metallic walls, comprising first means having a diameter smaller than the inside diameter of said body to produce a clearance between said walls and said first means, a cylindrical stem affixed to said first means nearer said opened end and in axial alignment therewith, second means made of hard, dense, non-gritty material adjacent said first means nearer said open end and having a diameter as nearly equal to the inside of said body as possible to prevent escape of said material through said open end and yet permit free axial movement of said second means within said chamber, said second means having a bore large enough to receive said stem, and third means for applying pressure to said second means whereby pressure is imparted to said first means, said third means including a cylindrical plunger having a diameter approximately equal to the diameter of said first means and a central bore of a diameter slightly larger than said stem whereby said plunger may slide freely over said stem and abut said second means, said stem and said plunger including each one diametric hole.

JAMES W. PERRY.
WILLIAM R. JOHNSON.
JOSEPH H. FRAZER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,457,988	Miller	June 5, 1923
1,518,272	Olmstead	Dec. 9, 1924
2,168,396	Davis	Aug. 8, 1939
2,287,277	Ryder	June 23, 1942
2,380,167	Grim	July 10, 1945