Nov. 15, 1960 A. THOMAS 2,960,000

METHODS FOR FILLING SHELLS

Filed Feb. 25, 1954 3 Sheets-Sheet 1

Fig. 1.

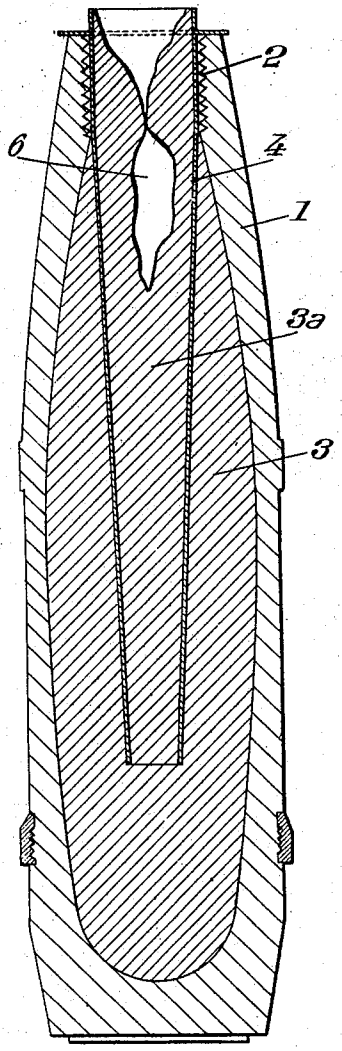
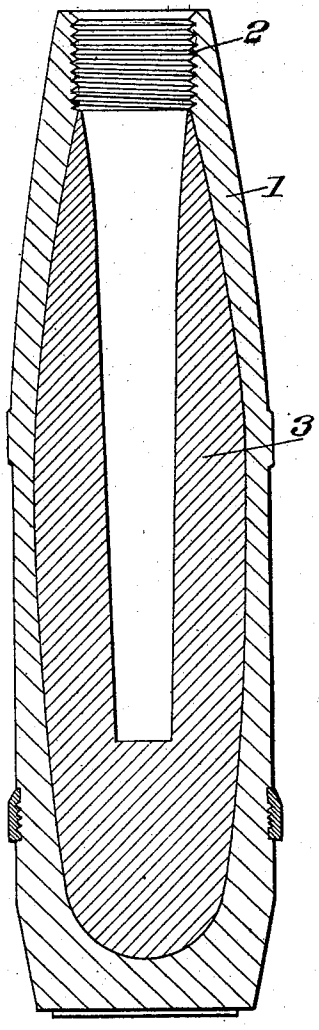


Fig. 2.



Nov. 15, 1960 A. THOMAS 2,960,000

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Filed Feb. 25, 1954 3 Sheets-Sheet 2

Fig. 3.

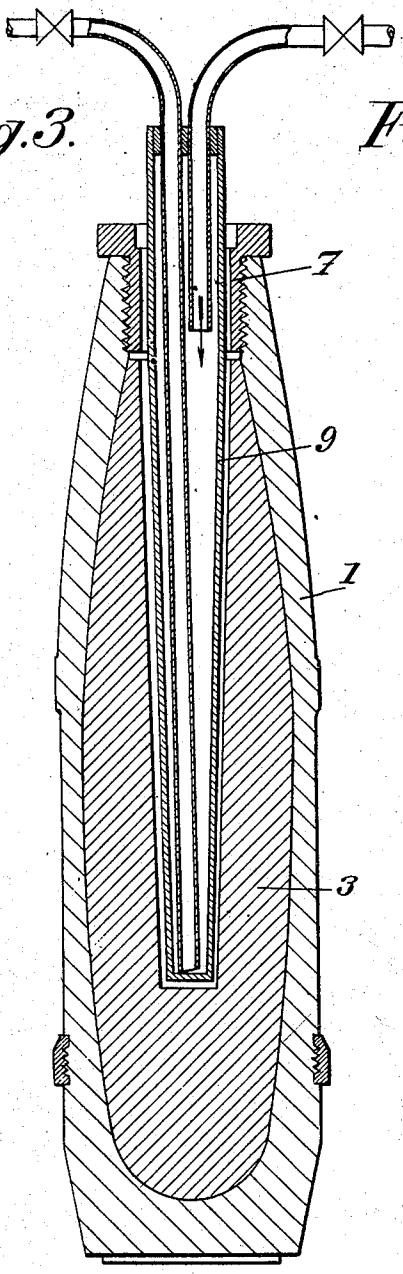
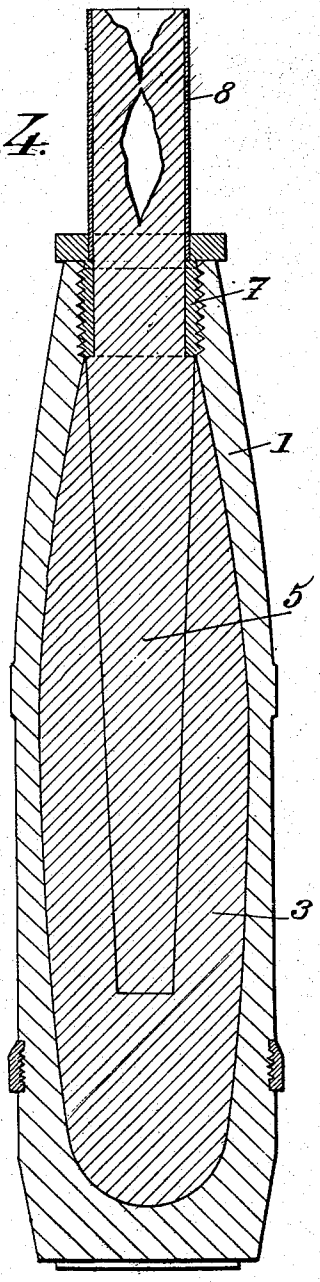


Fig. 4.



Nov. 15, 1960 A. THOMAS 2,960,000

METHODS FOR FILLING SHELLS

Filed Feb. 25, 1954 3 Sheets-Sheet 3

Fig. 5.

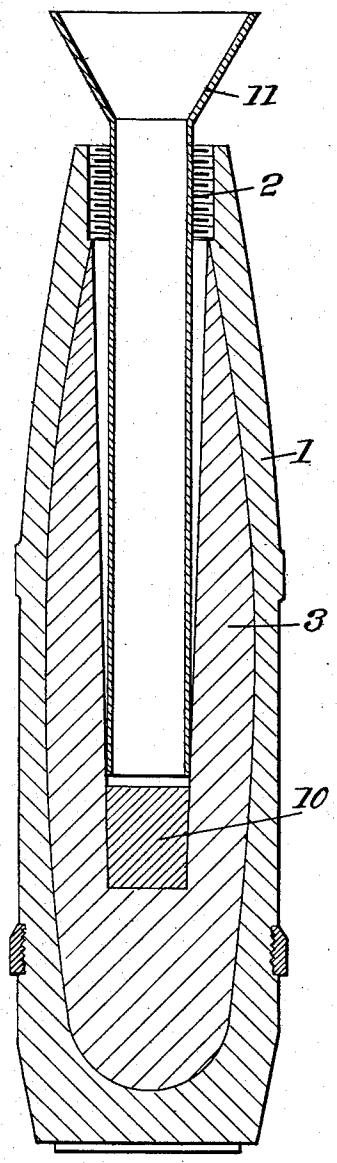
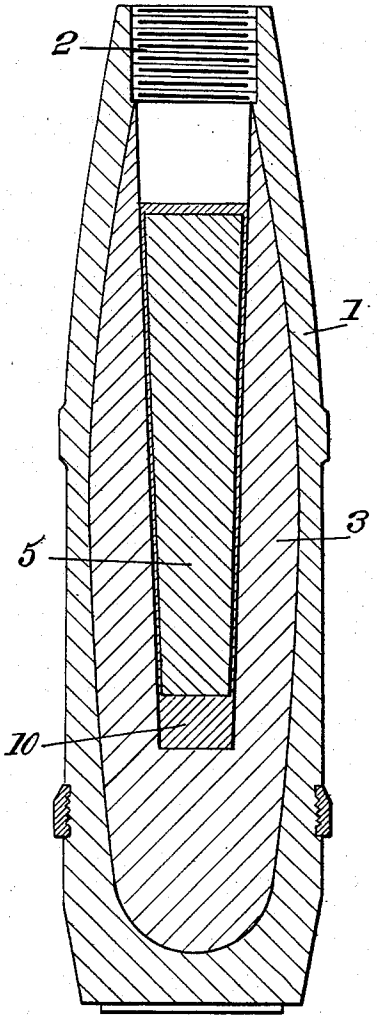


Fig. 6.



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METHODS FOR FILLING SHELLS

André Thomas, Bourges, France, assignor to Societe d'Etudes et de Commerce International, Casablanca, Morocco, a society of France

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8 Claims. (Cl. 86—20)

The present invention relates to methods for filling shells with an explosive which is poured in the liquid state into the cavity of said shell and subsequently solidifies therein.

My invention is more especially concerned with methods of this kind in which the explosive consists of trinitro-toluene or TNT.

It is known that the filling of such shells, and more especially when the explosive consists of TNT, involves, among other difficulties, those resulting from the fact that the important difference between the specific gravity of the explosive in its liquid state and that of the same explosive in the solidified state normally causes the formation of shrinkage holes or pipes in the mass of explosive if special precautions are not taken. In the case of TNT, its specific gravity in the melted state is only 1.47, whereby its specific gravity in the solid state is 1.66.

Now such shrinkage holes must not exist for they may cause the shell to explode when just leaving the gun. They may also cause the shell to explode when it impinges upon the target, which is objectionable if some delayed explosion is desired.

The object of my invention is to provide a method of filling shells which avoids the formation of shrinkage holes in the mass of explosive.

According to my invention, when the melted explosive is poured into the cavity of the shell, I dip into said cavity, through the open hole of the shell, a metallic conical funnel or tube having a thin wall (and which may possibly serve to the introduction of the melted explosive into the shell) in the upper part of which all the shrinkage holes that may form are located. Said tube and the explosive present therein are then pulled away after the charge has solidified and the space thus left free in the mass of explosive is subsequently filled with a melted explosive which may be the same as that first poured into the cavity but is not necessarily so, this complementary mass of explosive being introduced in such a fashion as to eliminate any risk of formation of shrinkage holes in said complementary charge.

Preferred embodiments of my invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example, and in which:

Figs. 1 to 4 show, in axial section, four successive steps of the operation of filling a shell according to my invention.

Figs. 5 and 6 are similar views relating to a modification.

In the following description, it will be supposed that the shell which is to be filled with the explosive is of a conventional type and includes for instance a metallic envelope 1 provided at the front with a screw-threaded hole 2 adapted to receive the shell fuze after said shell has been filled with the explosive.

I will first describe the form of my invention that is illustrated by Figs. 1 to 4.

I dispose a conical tube 4 having a thin wall so that it projects into the cavity intended to receive the explosive charge 3. This tube 4 may be introduced either before the explosive is poured into the shell, in which case it acts as a kind of funnel for filling the shell, or after the explosive has been poured directly through orifice 2, but while this explosive is still in the liquid state.

After solidification of the charge thus poured into the shell, tube 4 and mass 3*a* of explosive contained therein are pulled off from the shell (Fig. 2). The space thus left free inside the shell is then filled with a complementary charge 5 (Fig. 4) of melted explosive which may be either of the same nature as charge 3 (in the above considered example TNT), or of a different nature, in a fashion eliminating any risk of shrinkage holes being formed in said complementary charge.

Thus, when the charge 3 thus poured into the shell is solidifying, the amounts of explosive necessary for compensating for the difference between the density of the explosive in its liquid and solid forms, are supplied by the liquid explosive present inside conical tube 4 and, after solidification, the shrinkage holes 6 or other defects are localized in the upper part of said tube 4. Thus, the mass of explosive remaining in the body of the shell after tube 4 and charge 3*a* have been pulled away therefrom is entirely free from shrinkage holes and since the complementary charge 5 is introduced in a fashion excluding any risk of formation of shrinkage holes, the charge finally obtained inside the shell (and consisting of the main charge 3 and complementary charge 5) is also free from any shrinkage holes.

It should be noted that, both concerning the main charge 3 and the complementary charge 5, it is advantageous to pour the melted TNT in the state where small portions of explosive have already solidified but are embedded in a liquid mass of explosive still in the melted state.

Concerning tube 4, it must of course be so shaped that it can be pulled away from the shell without locally injuring the main charge 3 which is then solidified.

For instance, its top part (corresponding to a height which is substantially that of threaded orifice 2) may be cylindrical and the portion below this top part is conical.

The length of the portion of tube 4 which extends inside the shell cavity (conical portion of tube 4) must preferably be more than one half of the height of the cavity.

On the other hand, the apex angle of the conical portion of tube 4 depends upon the caliber of the shell and this angle must be the smaller as this caliber is greater.

By way of example, it may be indicated that in the case of a 105 mm. shell, tube 4 is to be given a length of 250 mm. and an apex angle of 3° (the apex angle being the angle of the generatrix of the cone with the axis thereof).

In the case of a 155 mm. shell, the length of the conical portion should be 350 mm. and the apex angle 1° 45′.

The wall of tube 4 may be constituted for instance by a metal sheet of a thickness of 2/10 or 3/10 of a millimeter made of aluminum, tinned iron or any other suitable metal.

Concerning now the method of pouring the complementary charge 5, it is advantageous to proceed (as illustrated by Fig. 4) by fixing on the threaded hole 2 of the shell a charging ring 7 provided with a tube 8 extending to a sufficient distance above the top of the shell and through which said complementary charge 5 is introduced, the volume of tube 8 being preferably at least equal to

30% of the volume of complementary charge 5, whereby the whole of the shrinkage holes that may occur is truly localized inside said tube 8.

It should be noted that it is of interest, before pouring the complementary charge 5 of TNT, to heat the wall of the cavity resulting from the tearing off of tube 4, said wall being advantageously heated to a temperature exceeding by 40°–50° C. the melting temperature (of about 80° C.) of TNT, whereby there is truly a welding between the main charge 3 which has already solidified and the complementary charge 5 which is poured into said cavity.

This heating of the wall of said cavity may be obtained by pouring in said cavity melted TNT at a temperature substantially higher than its melting point, for instance at 120–130° C., and letting this melted TNT in this cavity for a sufficient time (for instance from one to five minutes) to obtain that the temperature of the wall can reach the desired value, after which this melted TNT is evacuated and the complementary charge 5 can be finally poured at the melting temperature of the explosive.

I may also, as shown by Fig. 3, make use of a heating device 9 of a general shape corresponding to that of the cavity in which the complementary charge 5 is to be poured, said heating device 9 being for instance kept at the desired temperature by a circulation of steam therein.

The extension tube 8 is then removed and the solidified mass of explosive in the shell is hollowed down so as to form the housing for the shell fuze. Of course, my method applies not only to TNT but also to other explosives, such as melinite, having physical characteristics analogous to those of TNT and in which shrinkage holes are liable to occur.

Figs. 5 and 6 illustrate a modification according to which the complementary charge is constituted by a prefabricated core 5 of general conical shape and such that it can fit, in close contact with the main charge, into the cavity formed in said main charge during the first operation.

In this way, there is no necessity of waiting for the cooling of the complementary charge, as in the embodiment above described, since this charge is already solidified.

This pre-fabricated core is formed in a longitudinal mold of suitable internal shape, for instance of circular cross section, of a size corresponding to that of the core 5 to be obtained and of a length substantially greater than that of said core, whereby any shrinkage holes as may form during the formation of this core are localized in the top part thereof, which, after solidification, is cut away and leaves a core entirely free from any shrinkage holes. The part thus cut away and in which the shrinkage holes may form should preferably be of a length at least equal to one half of the length of the final core.

It is also necessary to provide means for intimately assembling the main charge 3 and core 5.

For this purpose, I may operate as follows:

In the method illustrated by Figs. 5 and 6, I pour into the bottom of the free space intended to receive core 5 a small amount of an explosive 10 of the same nature as the explosive which constitutes the main charge 3 (for instance TNT), this gluing or sticking charge being poured at a temperature substantially higher than the melting temperature of the explosive (for instance at a temperature of about 100° C.).

The conical core 5 is then introduced into said space, whereby the amount of melted explosive 10 intended to assemble the core with the main charge is caused to raise along the walls of the conical housing (Fig. 6).

For pouring charge 10 into the cavity, it is advantageous to make use of a funnel 11 engaged into orifice 2, as shown by Fig. 5.

In all cases, the charge 10 fully surrounds core 5 once the latter has been fully driven into the conical housing formed in the main charge, and said charge 10 assembles said core and said main charge in an intimate fashion.

According to a modification, before placing core 5 into the cavity of the main charge, I may heat the wall of said cavity up to a temperature (averaging 80° C.) which permits the assembly of the core with the main charge. This heating may be performed by means of a heating device heated to the desired temperature, for instance by a circulation of steam therein.

Advantageously, this device is made of a length slightly greater than that of the conical cavity, so as to melt a certain amount of explosive at the bottom of said cavity.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. A method for filling the cavity of a shell with an explosive, said method comprising pouring a melted explosive into the cavity of the shell, placing in said cavity a metallic conical tube open at both ends, the tube having a thin wall and being of a length substantially greater than one half the length of said shell, said tube being introduced before the explosive in the cavity solidifies, allowing the melted explosive to solidify, pulling said tube out of the cavity together with the explosive present in the tube whereby a cavity is formed in the solidified explosive, heating the wall of the latter said cavity to a temperature above the melting point of said explosive, and immediately thereafter filling the latter said cavity with a complementary charge of the same explosive in such manner as to prevent the formation of shrinkage holes in said complementary charge.

2. A method according to claim 1 in which said conical tube is introduced into the cavity of the shell before the liquid of the melted exposive is poured thereinto, said tube thus acting as a guiding funnel for said melted explosive.

3. A method for filling the cavity of a shell with an explosive, said method comprising pouring a melted explosive into the cavity of the shell, placing in said cavity a metallic conical tube open at both ends, the tube having a thin wall and being of a length substantially greater than one half the length of said shell, said tube being introduced before the explosive in the cavity solidifies, allowing the melted explosive to solidify, pulling said tube out of the cavity together with the explosive present in the tube whereby a cavity is formed in the solidified explosive, heating the wall of the latter said cavity to a temperature above the melting point of said exposive, and immediately thereafter filling the latter said cavity with a complementary charge of the same explosive in such manner as to prevent the formation of shrinkage holes in said complementary charge, said complementary charge being poured into said cavity through a tube fixed to the top wall of the shell and extending a substantial distance above the shell whereby any shrinkage holes which may occur are located outside the cavity, said tube being removed when the complementary charge has solidified.

4. A method according to claim 3 in which the wall of the latter said cavity is heated by pouring into the same a quantity of melted explosive.

5. A method according to claim 3 in which the wall of the latter said cavity is heated by means of a heating device introduced into the same.

6. A method for filling the cavity of a shell with an explosive, said method comprising pouring a melted explosive into the cavity of the shell, placing in said cavity a metallic conical tube open at both ends, said tube having a thin wall and being of a length substantially greater than one half of the length of said shell, said tube being made of a metal sheet of a thickness ranging ap-

proximately from 0.2 to 0.3 millimetre, said tube being introduced into said cavity before the explosive in the cavity solidifies, allowing the melted explosive to solidify, pulling said tube out of the cavity together with the explosive present in the tube whereby a cavity is formed in said explosive, heating the wall of the latter said cavity to a temperature above the melting point of said explosive, and immediately thereafter filling the latter said cavity with a complementary charge of the same explosive in such manner as to prevent the formation of shrinkage holes in said complementary charge.

7. A method for filling the cavity of a shell with an explosive, said method comprising pouring a melted explosive into the cavity of the shell, placing in said cavity a metallic conical tube open at both ends, said tube having a thin wall and being of a length substantially greater than one half of the length of said shell, this said tube being introduced while the explosive in the cavity is still liquid, allowing the melted explosive to solidify, pulling said tube out of the cavity together with the explosive present therein whereby a cavity is formed in said explosive, heating the wall of said cavity to a temperature above the melting point of said explosive, and immediately thereafter placing a complementary charge into said

cavity in such manner as to prevent the formation of shrinkage holes in said complementary charge, said complementary charge being introduced into said cavity in the form of a prefabricated solid core of explosive having a shape corresponding to that of said cavity.

8. A method according to claim 7 in which heating of said cavity is effected by pouring a small amount of melted explosive thereinto, after which said core is introduced into said cavity and forced toward the bottom thereof to drive back a quantity of said melted explosive which assembles the core with the solidified explosive constituting the main charge.

References Cited in the file of this patent

UNITED STATES PATENTS

357,286	Nimmo	Feb. 8, 1887
1,011,511	Sokolowski et al.	Dec. 12, 1911
1,054,049	Sokolowski	Feb. 25, 1913
1,329,565	Woodbury	Feb. 3, 1920
1,453,933	Gibbons	May 1, 1923
1,899,095	Knight et al.	Feb. 28, 1933
2,122,996	Williams	July 5, 1938
2,195,429	Shaler	Apr. 2, 1940
2,352,207	Knight	June 27, 1944