

Feb. 3, 1970

H. ASSMANN
AMMUNITION BODY

3,493,142

Original Filed July 11, 1962

2 Sheets-Sheet 1

Fig.1

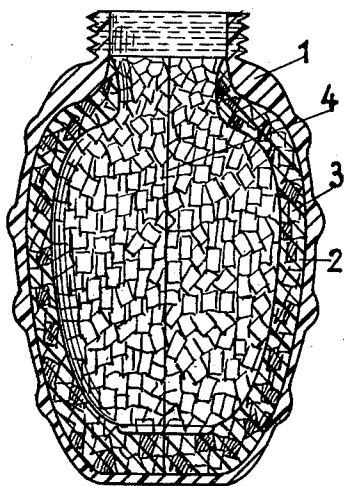


Fig.2

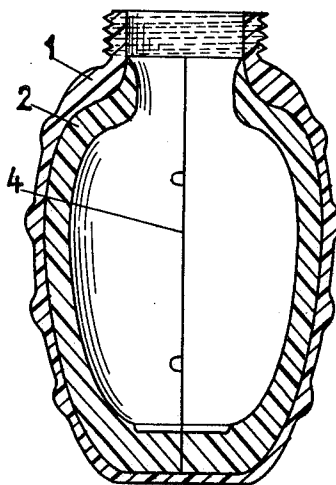


Fig.3

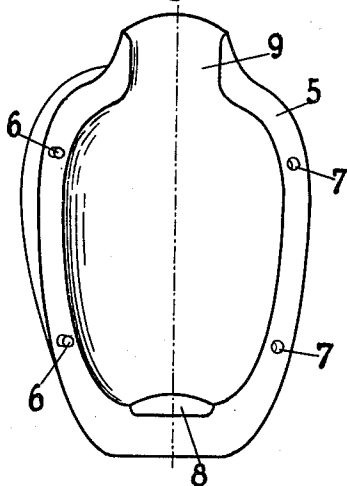
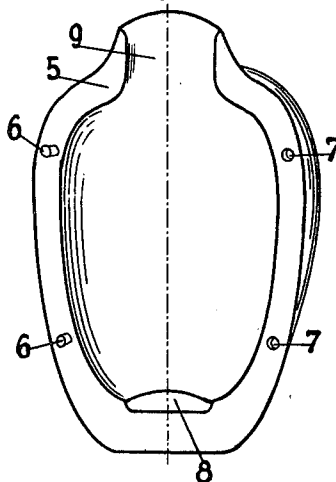


Fig.4



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Fig.5

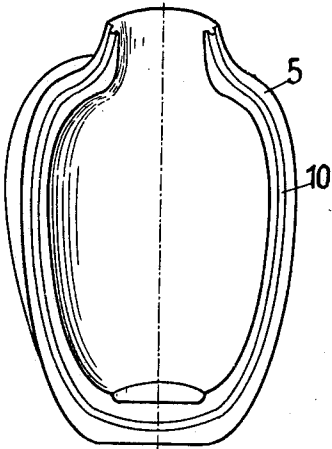


Fig.6

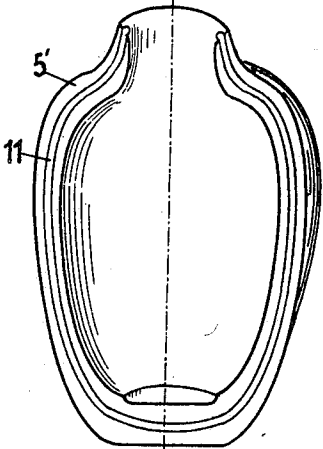
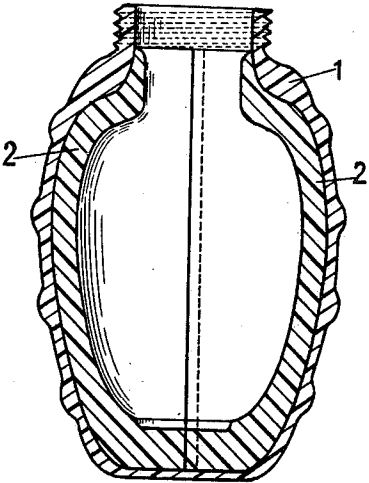


Fig.7



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2

3,493,142

AMMUNITION BODY

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Original application July 11, 1962, Ser. No. 209,162, now
Patent No. 3,284,559. Divided and this application Apr.

21, 1966, Ser. No. 560,399

Claims priority, application Switzerland, Dec. 22, 1961,
14,894/61

Int. Cl. B65d 7/04, 7/12

U.S. Cl. 220—4

12 Claims

ABSTRACT OF THE DISCLOSURE

An ammunition body having an inner jacket constituted of two shell portions assembled together along mating surfaces by tongue and groove connection and a one-piece outer jacket moulded over and enclosing the inner jacket.

CROSS RELATED APPLICATION

This application is a division of my earlier application Ser. No. 209,162, filed July 11, 1962 and now issued as U.S. Patent 3,284,559.

This invention relates to ammunition bodies which have an outer shell jacket and an inner jacket mounted in the inner wall of the outer shell jacket.

The inner jacket can serve as a carrier for certain agents which vary with the use of the ammunition body, such as particles of metal, etc.

Moreover, the inner jacket can influence the stability of the ammunition body, in certain respects. By way of example, the inner jacket can serve as a support for the outer shell jacket.

However, in the case of ammunition bodies and particularly those with approximately ovoid or tear-shaped outer shell jacket, the arrangement of the inner jacket closely fitted within the inner wall of the outer shell jacket provides difficulties in manufacture. These difficulties are mainly due to the fact that the outer shell jacket should essentially be a homogeneous body in one piece, which is closed except for a small opening provided to introduce the fuse parts.

According to the invention, these difficulties are overcome by first manufacturing the inner jacket which is then put as core into a blanking tool, where the material of the outer shell jacket is applied on the inner jacket. The core serves as the inner jacket and remains in the ammunition body.

With the aid of the technique according to the invention, it is possible to apply an outer shell jacket without interruptions and seams, respectively, on an inner jacket of random outer form, whereby also a tight fitting relation between outer shell jacket and inner jacket is guaranteed.

Since the inner jacket has to be provided with a cavity in the case of ammunition bodies containing an explosive charge and this cavity should be in many cases neither prismatic nor cylindrical, is useful, for reasons of manufacture, to assemble the inner jacket from two or more, preferably shell parts. The separating faces thus formed between the different, preferably shell-shaped, parts are covered by the outer jacket applied on the inner jacket.

Several moulding processes are suitable for manufacturing the inner jacket, e.g., a casting process, the press method, etc. As the inner jacket consists at least to some extent, of a high-polymer, preferably, thermoplastic material, the injection moulding technique can be advantageously used to manufacture the inner jacket and its shell-shaped parts, respectively.

The connection of the different parts of the inner jacket can be obtained by different means, e.g., by bonding, but preferably by joining the shells of the inner jacket by a prestressed form-locking connection, before the material of the outer shell jacket is applied.

For instance, plugged connections can be used as such prestressed form-locking connection, whereby the engaging form-locking elements undergo an elastic deformation when the shells of the inner jacket are interengaged and are thus subjected to an initial stress which locks the shells together.

A further possibility is a wedge-type connection which is equally a prestressed form-locking connection and in which the initial stress is based on the combined effect of wedge taper and friction between the wedge surfaces pressed together.

For the prestressed form-locking connections according to the invention, grooves and tongues are specially suitable in structural respect as proper form-locking elements which are provided at the connecting surfaces of the shells of the inner jacket.

A groove-and-tongue connection acting actually as prestressed form-locking connection can be obtained either by choosing the width of the tongue somewhat larger than the width of the groove (plug connection) or by providing the tongue with tapered lateral faces (wedge connection).

It is advisable to provide the tongues and grooves along the entire connecting surfaces of the shell-shaped parts of the inner jacket. In such way, the prestressed form-locking connection according to the invention acts simultaneously also as a tight uninterrupted joint between the connecting surfaces of the shells of the inner jacket.

This effect can be achieved most efficiently, if the inner jacket consists of two shell-shaped parts, the connecting surface of one part being provided with a groove running continuously along this entire connecting surface; whereas the connecting surface of the other part has a tongue also running continuously along the entire connecting surface.

If the inner jacket has a longitudinal division, the connecting surfaces of the two shells lie in a plane passing through the axis of the ammunition body and the connecting surfaces have an approximately U-shaped form. Correspondingly, also the grooves and tongues are U-shaped.

If the inner jacket has, however, a transverse division, the connecting surfaces of the two shell-shaped parts of the inner jacket lie in a plane at right angles to the axis of the ammunition body and have the shape of circular ring surfaces. Consequently, the tongues and grooves will follow in this case a closed circle.

When the shells of the inner jacket are manufactured by a moulding process, the form-locking elements according to the invention can be produced simultaneously with the moulding of the shell-shaped parts so that a subsequent shaping of the form-locking elements by machine tools becomes unnecessary.

For the application of the outer shell jacket on the inner jacket, different procedures can be used. It is particularly advantageous to apply the outer shell jacket in a closed mould into which the inner jacket has been inserted as a core before the mould is closed, the material of the outer shell jacket being introduced in liquid state into the closed mould. Thus, there is obtained an outer shell jacket in one piece, which encloses completely the inner jacket.

As the material of the outer shell jacket is a high-polymer material, the moulding procedures adapted to treat high-polymer materials, particularly the injection moulding process, can be used to apply the outer shell jacket on the inner jacket.

Although the process according to the present inven-

tion is not limited to the processing of high-polymer materials, it is especially useful in the manufacture of ammunition bodies from high-polymer materials. In the case of ammunition bodies of high-polymer materials, the use of two different types of material is advantageous, because one type of material hardly satisfies alone all the requirements. Therefore, a multilayer construction is often preferred for a shell jacket made of high-polymer materials.

The use of tough-elastic and highly tough-elastic high-polymer materials for the outer shell jacket of an ammunition body give, for instance, satisfactory results. The resistance of such an ammunition body to impact stresses is very good. A disadvantage of most tough-elastic and highly tough-elastic high-polymer materials is, however, their relatively low rigidity under static load. In general, these tough-elastic and highly tough-elastic high-polymer materials are thus easily deformed so that the position and pressure sensitive parts of the fuse and the explosive charge, respectively, which are enclosed in the cavity of the shell body, are insufficiently protected.

Thus, it is convenient in such a case to provide an inner jacket of better static stability, which is made preferably of a relatively rigid material which can be also a high-polymer material.

Moreover, it has proved favorable to construct the outer shell jacket of tough-elastic or highly tough-elastic high-polymer material with relatively thin walls and to use an isotropic, thus not fiber-reinforced, high-polymer material. The reason therefore is that on detonation of the explosive charge only a low energy expenditure is required to decompose the shell jacket so that the major part of the explosive energy is transferred to the effective substances enclosed inside the ammunition body, e.g., metal particles. With a shell jacket made of tough-elastic or highly tough-elastic high-polymer material this energy expenditure to decompose the shell jacket is only low, if an isotropic high-polymer material is used and the shells are of small wall thickness, as mentioned before. This case requires therefore all the more the arrangement of an inner jacket as a support; evidently, this inner jacket also does not require a substantial energy expenditure for its decomposition. This can be obtained by using a relatively brittle high-polymer material for the inner jacket.

Moreover, the inner jacket is also used as a carrier for the effective agents, e.g., metal particles.

The procedure according to this invention provides a favorable manufacturing method for connecting an outer shell jacket with the inner jacket. However, not only manufacturing advantages result from the technique according to the invention, but also the quality of the connection between the inner jacket and the outer shell jacket is particularly good when the method according to the invention is used and above all when high-polymer materials are employed. These high-polymer materials have the property of shrinking to a relatively large extent after being processed. In general, this is a disadvantage; but in the present case it is an advantage, since the shrinking results in a close fitting relation between the high-polymer material of the outer shell jacket and the inner jacket after the former has been applied to the latter as a core.

If, moreover, thermoplastic high-polymer materials are used for the outer shell jacket as well as for the inner jacket, the processing according to this invention results in a fusion of these two materials so that the outer shell jacket and the inner jacket practically form a uniform composite body.

In the foregoing, terms such as tough-elastic, highly-tough-elastic, brittle, and rigid are frequently used in connection with high-polymer materials. In this specification, a material is called a tough-elastic high-polymer material, if its impact strength exceeds 50 cm. kg./cm.²; a highly tough-elastic material is a material with an impact strength of more than 100 cm. kg./cm.²; materials having

an impact strength of less than 50 cm. kg./cm.²; preferably less than 20 cm. kg./cm.²; are considered as brittle high-polymer materials; a rigid high-polymer materials is characterized by a modulus of elasticity exceeding 150 kg./mm.², preferably exceeding 300 kg./mm.².

In the accompanying drawings, the invention is explained in detail by reference to several embodiments without being restricted to them.

FIG. 1 is a longitudinal section through a hand grenade body having an inner jacket which contains metal particles:

FIG. 2 shows an other hand grenade body in longitudinal section the inner jacket of which does not contain any metal particles;

FIG. 3 represents diagrammatically an embodiment of one half shell of the inner jacket;

FIG. 4 is a diagrammatic representation of the other half shell of the inner jacket belonging to the hand grenade body according to FIGS. 1 and 2;

FIG. 5 is a diagrammatic illustration of a further embodiment of half shell of the inner jacket of a hand grenade body;

FIG. 6 represents diagrammatically the other half through the inner jacket; and

FIG. 7 is a longitudinal section of a hand grenade body the inner jacket of which consists of two halves represented in FIGS. 5 and 6.

The hand grenade body according to FIG. 1 has an outer shell jacket 1 made of polyethylene. At the inner wall of the outer shell jacket 1 an inner jacket 2 is provided which is constituted of polystyrene with embedded iron particles 3. In the case of FIG. 1, the iron particles 3 are visible at the inner surface of the inner jacket 2; this is due to the fact that transparent polystyrene is used.

The inner jacket 2 consists of two parts separated in longitudinal direction of the hand grenade body. The two parts of the inner jacket are bonded together along the separating line 4.

The hand grenade body shown in FIG. 2 differs from that according to FIG. 1 merely with respect to the inner jacket 2 which is also made of polystyrene, but does not contain any iron particles.

The hand grenade bodies according to FIGS. 1 and 2 are not yet filled with the explosive charge and the fuse is not yet screwed on.

The hand grenade body according to FIG. 1 belongs to a class of so-called defensive hand grenades of which a good fragmentation effect is required for military tactical reasons. In the case of FIG. 1, the effective fragments are embedded as iron particles 3 in the inner jacket 2. Thus, the inner jacket serves mainly as a carrier for the fragments. With a hand grenade as shown in FIG. 1 a very good fragmentation effect (fragment penetration) can be expected, since the energy expenditure for decomposing the outer shell jacket and the inner jacket on detonation of the explosive charge is very low so that a maximum part of the energy of the explosive is transferred to the effective fragments. This is due to the use of a relatively brittle material (polystyrene) for the inner jacket 2 and to the relatively small wall thickness of the outer shell jacket 1 made of tough-elastic material (polyethylene). Due to the tough-elastic outer shell jacket 1, such a hand grenade body shows, however, also a sufficient resistance to shock stresses caused in transport and by impact with the target, and is not easily deformed because of the relatively rigid inner jacket 2. Thus, the inner jacket has also a supporting effect.

These conditions equally hold for the hand grenade body according to FIG. 2 which is intended for a so-called assault hand grenade (offensive hand grenade) meant to achieve a morale effect only. Also in this case, very little energy is lost in decomposing the hand grenade body. The energy of the explosive charge, however, is not transferred to the fragments, but is released in the air and causes compressions shocks which produce an intense acoustic effect,

Such hand grenade bodies can be manufactured by the following method:

In a first stage of the process, the shell halves of the inner jacket (FIG. 3, FIG. 4) are manufactured in an injection moulding tool. Plugs 6 and holes 7 are provided at the connecting surfaces 5 of the shell halves of the inner jacket. For the hand grenade body of a defensive hand grenade (FIG. 1) iron particles 3 are injected simultaneously with the moulding of the shell-shaped halves of the inner jacket (by injection molding) by filling, preferably jar-ramming, them into the tool cavity of the injection moulding tool, before the plastic material is injected.

In a second stage of the process, two completed halves each of the inner jacket are bonded together, the plugs 6 of the one half and the holes 7 of the other half effecting a centering of the two halves by fitting into one another. Butyl acetate may be employed as a bonding agent.

Then the inner jacket thus formed is inserted as a core into a further injection moulding tool.

The inner jacket serving as a core is fixed by a bolt connected with the injection moulding tool, which is supported inside the inner jacket in a recess 8 at the bottom and in the throat 9 of the inner jacket.

Then, the inner jacket is covered with the material of the outer shell jacket, i.e., this material is injected in liquid state into the space between the outer wall of the inner jacket serving as a core and the innerwall of the tool cavity.

Thus, there is obtained a completely seamless outer shell jacket closely fitted on the inner jacket owing to the shrinkage of the injected material of the outer shell jacket after the processing.

Moreover, a fusion of the materials of the outer shell jacket and the inner jacket will be effected due to the heat influence during the injection of the covering material, the outer shell jacket and the inner jacket being united to form a uniform composite body.

A further advantage is that any desired shape for the inner jacket can be obtained without difficulty. For instance, it is possible without more—as shown in FIGS. 1 and 2—to provide the inner jacket with a strong bottom and a throat-like mouthpiece at the top, which not only increases the supporting effect of the inner jacket, but also makes possible the insertion of a large quantity of fragments.

Furthermore, the process according to the invention permits the obtaining of outer shell jackets with walls of any thickness. Particularly, when tough-elastic and highly tough-elastic high-polymer materials are used, a thin-walled outer shell jacket will be provided. The shell jacket is termed thin-walled, if the ratio of the diameter D of the outer shell jacket (calibre) to the wall thickness h exceeds 15

$$\left(\frac{D}{h}\right) \gg 15$$

Thus, a hand grenade body of 60 mm. in diameter has a thin-walled shell jacket, if its wall thickness is less than 4 mm.

A further embodiment of the invention is described with reference to FIGS. 5 to 7. The half of the inner jacket of a hand grenade body represented in FIG. 5 shows a tongue 10 at the connecting surface 5, which projects from the connecting surface 5 and runs continuously along the approximately U-shaped connecting surface 5.

The connecting surface 5' of the other half of the inner jacket shown in FIG. 6 is provided with a groove 11 which also runs continuously along the U-shaped connecting surface 5'.

The tongue 10 (FIG. 5) has a somewhat larger width than the groove 11 (FIG. 6).

The two halves of the inner jacket according to FIGS. 5 and 6 are of polystyrene and are manufactured by injection moulding. Subsequently, the two halves of the

inner jacket are assembled, whereby a prestressed form-locking connection is obtained between the two halves of the inner jacket by the engagement of the tongue 10 and the groove 11. Simultaneously, the tongue-groove connection ensures a hermetic closure of the cavity formed inside the inner jacket due to the fact that the tongue 10 and the groove 11 extend without interruption along the connecting surfaces.

The halves of the inner jacket thus assembled can be subsequently inserted without delay into the tool cavity of a further injection moulding tool so that the outer shell jacket of polyethylene can be applied. No waiting time is required.

The result of this final stage of the process is a hand grenade body which is represented in FIG. 7. The two halves of the inner jacket 2 and the outer jacket 1 applied to the inner jacket 2 are evident from FIG. 7.

Compared with the embodiment described, various alternatives as to material, construction, manufacturing procedure, and use, are feasible within the scope of the invention. In the following, some of these alternatives are mentioned, the invention is, however, not exclusively restricted to them:

Besides polyethylene, other high-polymer, particularly, highly tough-elastic materials (e.g. polyamide) or tough-elastic materials (e.g. tough-elastic polystyrene) are specially suitable materials for the outer shell jacket.

Moreover, the inner jacket can be made of polymethacrylic methyl ester.

Within the scope of the invention, materials which are not high-polymer can be used for the outer shell jacket and/or the inner jacket, e.g., concrete for the inner jacket.

An inner jacket consisting of more than two shell components may be mentioned as a constructional alternative. Moreover, it is not absolutely necessary that the division of the inner jacket be a longitudinal division; it can be also a transverse division. Additionally, the inner jacket can be made in one piece. Alternatively to the embodiment represented in FIGS. 5 to 7, a noncontinuous course can be chosen for the tongue and groove running along the connecting surfaces of the shells of the inner jacket.

As already mentioned, metal particles can be embedded in the inner jacket (e.g., iron particles of square or cylindrical form). Moreover, the inner jacket can be utilized as a carrier for other effective agents (incendiary agents, smoke-producing agents, etc.).

As to technique, injection molding is by no means the only process suitable for manufacturing the inner jacket and for applying the outer shell jacket thereon. Other moulding processes, such as the press method can be equally used.

Finally, the invention is not only of interest for the production of hand grenade bodies. Other ammunition bodies, such as shell bodies for mortar shells and other explosive missiles, can be manufactured with the process described hereinabove.

What I claim is:

1. An ammunition body comprising an inner jacket constituted of two assembled shell portions having mating surfaces, one of said shell portions including tongue means and the other shell portion having groove means, said shell portions being assembled by the engagement of the tongue means in the groove means, and a one-piece outer shell jacket moulded over and enclosing said inner jacket.

2. An ammunition body as claimed in claim 1 wherein said tongue means extends continuously along the entire mating surface of said one shell portion, and the groove means extends continuously along the mating surface of the other shell portion.

3. An ammunition body as claimed in claim 2 wherein said groove means is a continuous groove having a determinable width and said tongue means is constituted by a tongue having a thickness which is greater than the width of the groove.

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4. An ammunition body as claimed in claim 2 wherein said tongue and groove means are interengageable to form a hermetically sealed enclosure within the inner jacket.

5. An ammunition body as claimed in claim 3 wherein said shell portions are symmetrical and their mating surfaces when joined lie along a longitudinal plane of symmetry of the body.

6. An ammunition body as claimed in claim 3 wherein said tongue and groove means are interengageable to form a prestressed form locking connection.

7. An ammunition body as claimed in claim 1 wherein the inner and outer jackets are constituted of high polymer material.

8. An ammunition body as claimed in claim 7 wherein the said high polymer material is thermoplastic.

9. An ammunition body as claimed in claim 7 wherein the high polymer material outer jacket is tough-elastic.

10. An ammunition body as claimed in claim 1 wherein the inner jacket has a wall thickness which is substantially less than that of the outer jacket.

11. An ammunition body as claimed in claim 7 wherein the high polymer material of the inner jacket is rigid.

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12. An ammunition body as claimed in claim 7 wherein the high polymer material of the inner jacket is brittle.

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GEORGE E. LOWRANCE, Primary Examiner

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102—64; 220—60; 264—250