PROCESS FOR MANUFACTURING AMMUNITION BODIES

Filed July 11, 1962 2 Sheets-Sheet 1

Fig.1

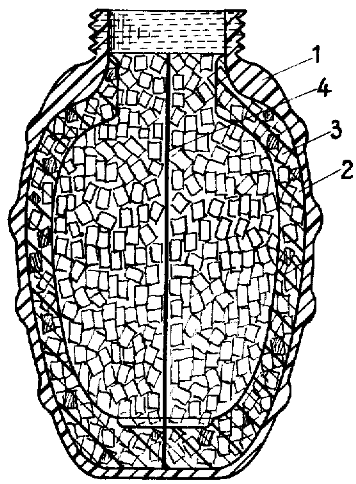


Fig.2

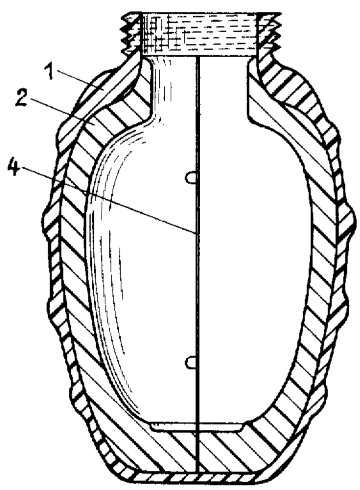


Fig.3

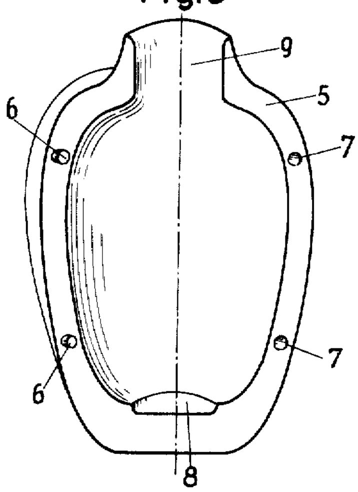
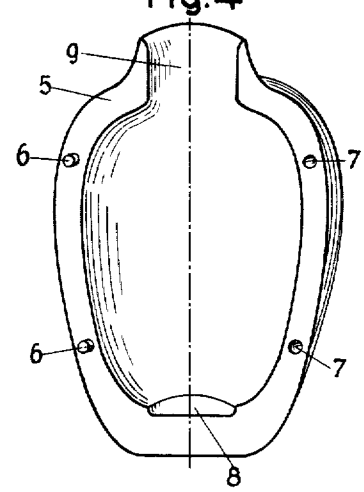


Fig.4



Nov. 8, 1966 **H. ASSMANN** **3,284,559**

PROCESS FOR MANUFACTURING AMMUNITION BODIES

Filed July 11, 1962 2 Sheets-Sheet 2

Fig. 5

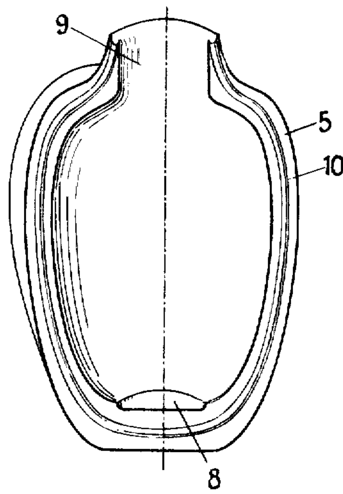


Fig. 6

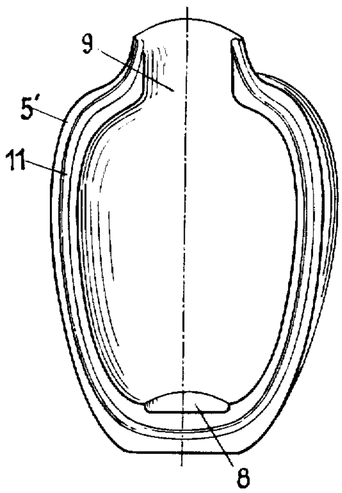
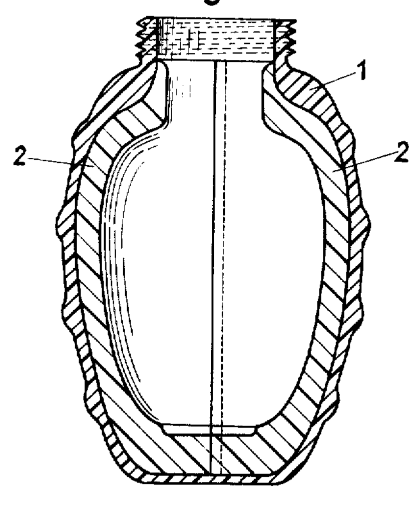


Fig. 7



United States Patent Office

3,284,559

Patented Nov. 8, 1966

3,284,559
PROCESS FOR MANUFACTURING AMMUNITION BODIES

Hans Assmann, Kaufing, near Schwanenstadt, Upper Austria, Austria

Filed July 11, 1962, Ser. No. 209,162
Claims priority, application Switzerland, Dec. 22, 1961, 14,894/61
1 Claim. (Cl. 264—250)

This invention relates to a process for the manufacture of ammunition bodies and to ammunition bodies manufactured according to this process wherein the ammunition bodies have an outer shell jacket and an inner jacket forming the inner wall of the outer shell jacket.

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

Moreover, the inner jacket may be used to influence the stability of the ammunition body. By way of example, the inner jacket can serve as a supporting layer for the outer shell jacket.

Particularly, in the case of ammunition bodies with approximately ovoid or tear-shaped outer shell jackets, the arrangement of the inner jacket forming 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 with the exception of a small opening provided to introduce the fuse parts.

According to this invention, these difficulties are overcome by manufacturing first of all the inner jacket which is then put as a core into a blanking tool, whereat the material of the outer shell jacket is applied on the inner jacket; the core serving as an inner jacket and remaining 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 tight fitting between the outer shell jacket and the 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-shaped, 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., casting processes, compression methods, etc. The inner jacket consists, at least to some extent, of a high-polymer, preferably, thermoplastic material, whereby an injection moulding process 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 the connection is made by jointing the preferably shell-shaped parts 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 employed as such a prestressed form-locking connection, whereby the engaging form-locking elements undergo an elastic deformation when the preferably shell-shaped components of the inner jacket are fitted into each other and are thus subjected to an initial stress which causes the form-closing elements fitting into one another to be locked.

A further possibility is the use of 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 the wedge taper and the 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 respects as proper form-locking elements which are provided at the connecting surfaces of the preferably shell-shaped parts of the inner jacket.

A groove-and-tongue connection acting as a prestressed form-locking connection can be obtained either by selecting 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 a way, the prestressed form-locking connection according to the invention acts simultaneously also as a tight uninterrupted joint between the connecting surfaces of the shell-shaped parts 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 shell-shaped parts lie in a plane passing through the axis of the ammunition body and have an approximately U-shaped form. Correspondingly, also the grooves and tongues are U-shaped in this case.

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 shell-shaped components of the inner jacket are manufactured by one of the different shaping processes, 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.

The material of the outer shell jacket is preferably a high-polymer material, and the injection moulding process, can be used to apply the outer shell jacket on the inner jacket.

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 for an ammunition body produces 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 should be 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 very low, if one chooses an isotropic high-polymer material and constructs shells of small wall thickness, as mentioned before. This jacket requires therefore the arrangement of an inner jacket as a supporting layer; evidently, also this inner jacket must not require a substantial energy expenditure for its decomposition. This can be obtained by using a relatively brittle high-polymer material to manufacture the inner jacket.

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

The process according to this invention provides a favorable manufacturing method for connecting an outer shell jacket with the inner jacket. However, not only are manufacturing advantages obtained from the process according to the invention, but also the quality of the connection between the inner jacket and the outer shell jacket is particularly good when high-polymer materials are employed. These high-polymer materials have the property of shrinking 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 fit 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 compound body.

In the foregoing, there has been employed terminology including the following in connection with high-polymer materials: tough-elastic, highly-tough-elastic, brittle, and rigid. In this specification, a material is called a tough-elastic high-polymer material, if its impact strength exceeds 50 cmkg./cm.^{2}; a highly tough-elastic material is a material with an impact strength of more than 100 cmkg./cm.^{2} materials having an impact strength of less than 50 cmkg./cm.^{2}, preferably less than 20 cmkg./cm.^{2}, are considered as brittle high-polymer materials; a rigid high-polymer material 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 embodiments without being restricted to them.

FIG. 1 is a longitudinal section of a hand grenade body the inner jacket of which contains metal particles;

FIG. 2 shows another 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 shell-shaped half of the inner jacket and

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

FIG. 5 is a diagrammatic view of a further embodiment of one shell-shaped half of the inner jacket of a hand grenade body and

FIG. 6 represents diagrammatically the other half of the inner jacket;

FIG. 7 is a longitudinal section of a hand grenade body the inner jacket of which consists of the 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 consists 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 a 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 equally 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 has not yet been screwed on.

The hand grenade body according to FIG. 1 belongs to a so-called defensive hand grenade of which is a good fragmentation effect is required for military tactical reasons. In the case of FIG. 1, the effective fragments are the embedded iron particles **3** in the inner jacket **2**. Thus, the inner jacket serves mainly as a carrier layer for the fragments. From 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). Owing to the tough-elastic outer shell jacket **1**, such a hand grenade body has, however, also substantial resistance to shock stresses caused in transport and resistance to impact with the target, while it is not easily deformed because of the relatively rigid inner jacket **2**. Thus, the inner jacket has also a supporting effect.

These properties are equally true for the hand grenade body according to FIG. 2 which is intended as a so-called assault hand grenade (offensive hand grenade) meant to achieve psychological effects 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 to the air and causes compression shocks which produce an impressive acoustic effect.

Such hand grenade bodies can be manufactured according to an example of the technique described as follows:

In a first stage of the process, the shell-shaped 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-shaped halves of the inner jacket. For the hand grenade body of the 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 moulding) 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 hole **7** of the other half effecting a centering of the two halves by fitting into one another. Butyl acetate may be used 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 the 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 the core and the innerwall of the tool cavity.

Thus, there is obtained a completely seamless outer shell jacket fitting closely against 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 set 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 compound body.

A further advantage is that any desired shape of 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 as large a quantity of fragments as possible.

Furthermore, the process according to the invention permits obtaining outer shell jackets with walls of any desired 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 ($D/h>15$).

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 in 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 over the connecting surface **5** and runs continously 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 shell-shaped halves of the inner jacket are assembled, whereby a prestressed form-locking connection is obtained between the two shell-shaped 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 inside the inner jacket owing to the fact that the tongue **10** and the groove **11** run without interruption along the connecting surfaces.

The shell-shaped halves of the inner jacket thus assembled shows a throat-like mouthpiece **9** and a recess **8** in the wall opposite said mouthpiece. The assembled inner jacket 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 the section of which is represented in FIG. 7. The two shell-shaped 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.

An inner jacket consisting of more than two, preferably shell-shaped, 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. Alternative 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 shell-shaped parts 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 employed as a carrier layer for other effective agents (incendiary agents, smoke-producing agents, etc.).

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 also be manufactured by the process described in the present specification.

What I claim is:

A process for manufacturing an ammunition body having an inner jacket and an outer jacket fitted on said inner jacket, said process comprising forming by a molding process at least two parts cooperatively defining the shape of a shell and constituted at least to some extent of high-polymer material, said shell being formed with a narrow throat-like mouthpiece and with an increased thickness and a recess at a location in the wall opposite said mouthpiece, connecting together the thus formed parts so as to form the inner jacket for said ammunition body, and injecting high-polymer material into an injection molding tool in which said inner jacket is supported as a core by engagement of said recess and said mouthpiece in such manner that the thus injected material forms an outer jacket on said core and becomes joined thereon.

References Cited by the Examiner

UNITED STATES PATENTS

751,089	2/1904	Malette	264—128
2,199,144	4/1940	Tegarty	18—55
2,269,953	1/1942	Morin et al.	18—55
2,564,751	8/1951	Cook	102—64
2,762,303	9/1956	Fawcett	102—64
2,773,657	12/1956	Morin	264—271
2,903,389	9/1959	Fujita	264—128
3,037,652	6/1962	Wallace	264—279
3,090,620	5/1963	Consalloy	264—265

FOREIGN PATENTS

617,519 4/1961 Canada.

ALEXANDER H. BRODMERKEL, *Primary Examiner.*

BENJAMIN A. BORCHELT, ROBERT F. WHITE, ALFRED L. LEAVITT, *Examiners.*

W. E. STEWART, T. J. CARVIS, *Assistant Examiners.*