PUBLISHED
JUNE 22, 1943.
BY A. P. C.

J. TRICOU
MUNITION SHELLS OF ORGANIC MATERIALS AND PROCESSES FOR MANUFACTURING SAME
Filed Jan. 22, 1940

Serial No.
315,074
4 Sheets-Sheet 1

FIG. 1

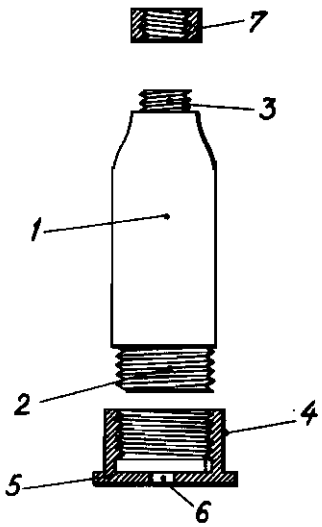

FIG. 2

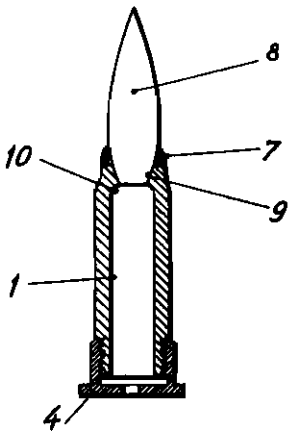

FIG. 3

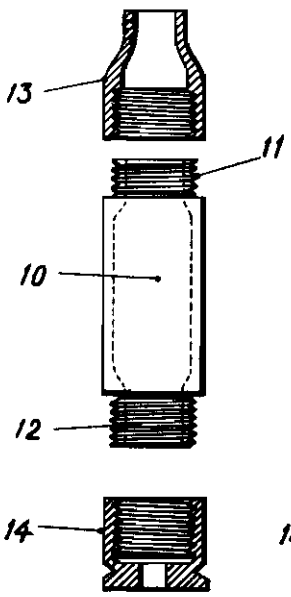

FIG. 4

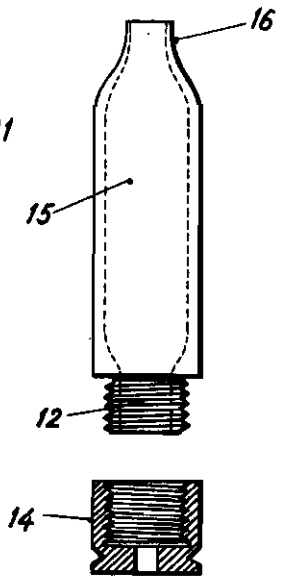

FIG. 5

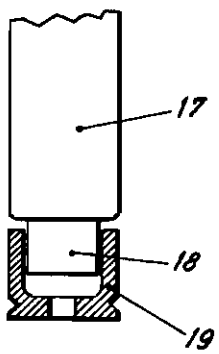

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FIG. 6

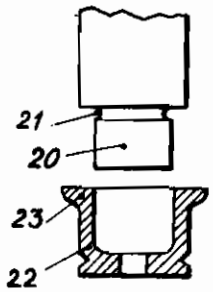

FIG. 7

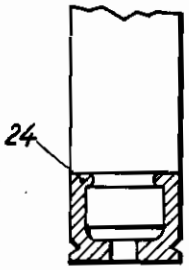

FIG. 8

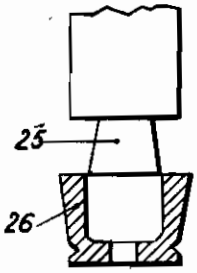

FIG. 9

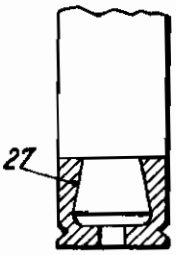

FIG. 10

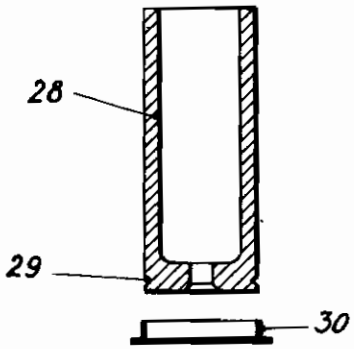

FIG. 11

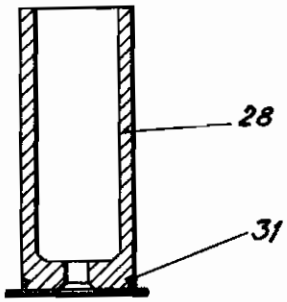

FIG. 12

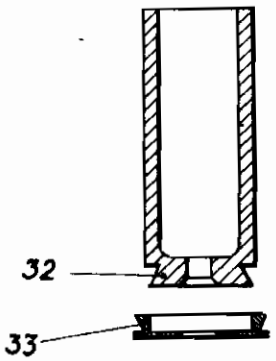

FIG. 13

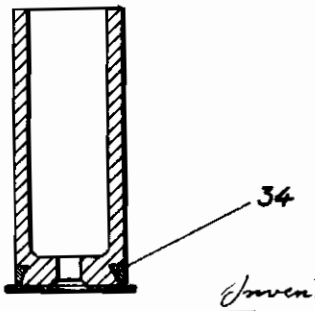

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FIG. 14

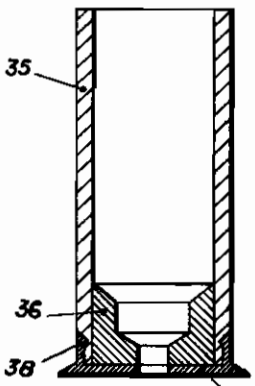

FIG. 15

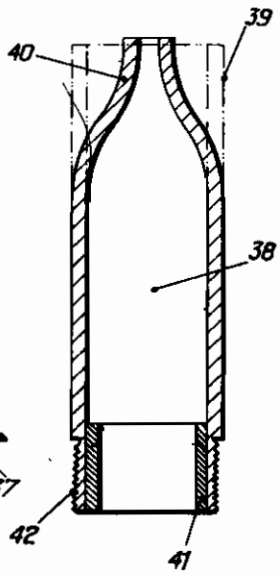

FIG. 16

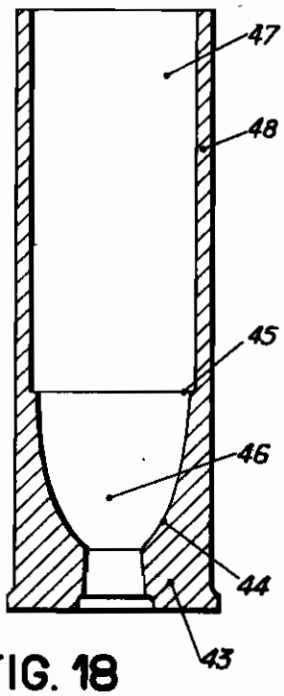

FIG. 17

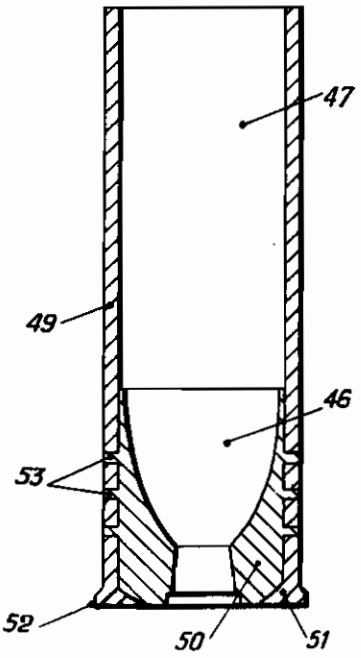

FIG. 18

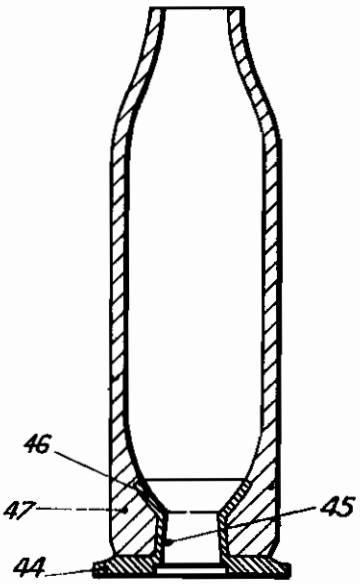

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FIG. 19

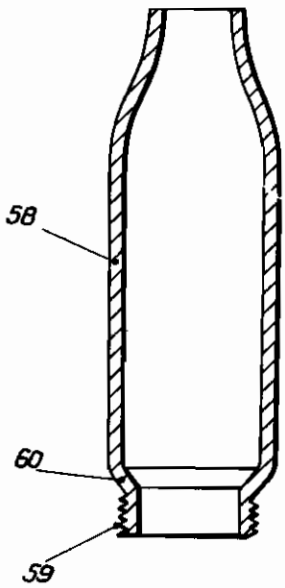


FIG. 20

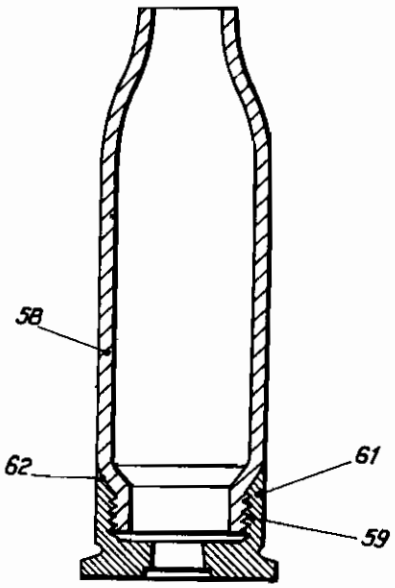
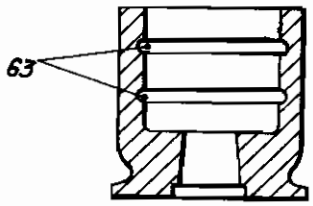


FIG. 21



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Published June 22, 1943 Serial No. 315,074

ALIEN PROPERTY CUSTODIAN

MUNITION SHELLS OF ORGANIC MATERIALS AND PROCESSES FOR MANUFACTURING SAME

Jacques Tricou, Paris, France; vested in the Alien Property Custodian

Application filed January 22, 1940

The present invention relates to munition shells of organic materials for all kinds of firearms and for all uses such as petards, for example, constructed in such a manner as to respond to all the necessities of use. It also includes various processes of manufacture proposed for the production thereof. Up to the present there have been used for the manufacture of munition or like cases, for shells, bullets and so forth, metals capable of receiving the desired shape by stamping, drawing and so forth in such a manner that one portion will have a thin wall, as reduced a weight as possible and a low cost of production and on the other hand of possessing a resistance, a precision and an elasticity sufficient so as to be capable of resisting the explosion and to enable the case to be extracted easily in the case where it is employed in a firearm.

For sporting cartridges in particular there have been utilized, for the purpose of obtaining a low cost, cases of cardboard with a base reinforced by metal settings. These casings have the disadvantage of a low resistance and being very sensitive to water and moisture and of being porous.

It has therefore been proposed to form the cases of various other materials such as those with bases of acetate of cellulose, cesein, rubber, ebonite, by moulding.

Unfortunately the various processes proposed result in a material which is insufficiently resilient and resistant so as to withstand the violent and sudden forces of the explosion, or in materials of a high cost or to materials which do not enable some operations, such as the setting of the ball, or the lead for sport or of the shell and the extraction thereof after firing, to be carried out efficaciously. These processes of manufacture which have been proposed result either in materials lacking in homogenity and uniformity as regards resiliency (moulding the powder or the granular material whilst hot), or a hammer hardening of the material (moulding more or less plastic materials or materials in a humid state, whilst cold, which involves a deformation on drying).

Cellulose esters, synthetic resins, casein and so forth thus treated have only given deceptive results and in spite of the interest attached to the production of cases of this type no appreciable manufacture has been possible up to the present time. Meanwhile as the metal mainly employed for cartridges is brass, which in a number of countries is only produced in small quantities, it is of interest to replace it by a material which is available in all countries, which can easily be stocked and is of low cost; but above all this material must have the mechanical properties of elasticity and resistance, it must be resistant to humidity and heat, it should also be capable of being worked easily and to enable manufacture of cartridges in large quantities at a low cost. Finally the brass employed, besides its rarity in some countries has the disadvantage of being heavy. An alleviation in munitions is of considerable interest, it relieves the soldier, facilitates revictualling and is of considerable value for aviation. It is therefore of advantage in this sense to utilize light materials.

It may also be of advantage to use a transparent material. In fact it is often useful for the cartridge to be transparent so that its charge can be verified, which facilitates its control, thus permitting of seeing the condition of its charge. It is thus easy, besides the marks made on the base to see the quality of the cartridge and the balls and its charge in the interior. Especially in the case of sporting cartridges the transparency is particularly important as it enables a user to verify what he is purchasing and avoids errors as regards the nature of the powder, the lead and the wad. To this must be added that in this particular case, the use of a material, which is more rigid than cardboard is insensitive to moisture, entrains a considerable improvement in a sporting cartridge.

Advantageously the material employed, whatever its nature, may be easily coloured whether it is transparent or not, by the addition of colouring agents to the mass.

The colours of the material are so selected that they increase the filtering action of cellulose acetates or other organic products employed relatively to rays capable of acting on the contents of the cartridge (for example ultra-violet rays or infra red rays) so as to avoid as far as possible any destructive action on the material itself and on the contents of the cartridges by these radiations.

It is also possible to use a scale of shades with reference to the nature of the charges, the date of manufacture, the place of manufacture, the projectile and so forth.

The present invention relates to cases for munitions, for all uses, constituted particularly or entirely of an organic material which responds to all the requirements of their use and which in addition has all the qualities referred to above or solely some of these qualities.

The main feature of the material according to the invention is to combine the following conditions: high elastic limit, a sufficiently high rate of expansion so as to remain under the influence of the violent and sudden forces of the explosion in the zone of elastic deformation whilst obviating permanent deformations, frequently accompanied by fractures (inertia to shocks).

It has been found that all the materials with a base of nitro-cellulose, aceto-celulose and more generally simple or compound esters or ethers of cellulose, as also those with a base of natural

or artificial resins (coumaric phenolic, ureic and so forth), of natural or artificial albuminoid substances (casein, gelatine, fibroin, ossein and so forth) which are natural or artificial by treatment or by addition, little sensitive to the action of moisture and heat on condition that the constituents of the mixtures are suitably selected and suitably proportioned and treated so as to respond to the mechanical conditions enumerated above.

The dimensions should be suitably selected in accordance with the following considerations:—

Experience has shown that plastic cases should have dimensions different from ordinary cases of brass or of cardboard. Their dimensions should be nearer to the dimensions of the chamber of the rifle or gun.

In the case of small calibres this leads to about $\frac{1}{10}$ more in diameter.

Further the length should be exactly that of the chamber of the fire-arm for war cases where the ball is secured to the case.

In particular it is possible to employ also artificial resins resulting from:

1. either from condensations:

of the type phenol-aldehyde (phenoplastic)

for example: phenol-formol, phenol-furfurol and so forth

of the type amine-aldehyde (aminoplastics)

for example: urea formol, aliline-formol glycerophthalic resins

the superpolyamides (condensation of poly acids with polyamines, such as for example the condensation of hexanediamine with sebacic acid, pentamethyleneamine with sebacic acid and so forth)

thiothanic and arylethanic resins.

2. either products of polymerisation

coumarine and indene

of vinylic carbides (for example polystyrolenes) polyisolefines)

of vinylic esters and derivatives (such as polyacetates and derivatives, poly-chlorides and copolymers)

acrylic resins (such as metacrylate of methyl, acrylate of methyl and higher metacrylates)

butadienic derivatives (such as copolymers of butadien, polymers of chloroprene) and so forth.

It is also advantageous, according to the methods of carrying out adopted, to apply particular processes of manufacture, which also form part of the invention and which are set out hereinafter.

The question of inflammability of the material has been considered by the applicants as of secondary importance; the velocity of deflagration is such that any danger of ignition in the weapon is obviated, even in the case of materials which are more inflammable than celluloid which has been recognized as being suitable and is claimed by the applicants. Nevertheless it is preferable to utilize a material which is only slightly combustible and is practically non-inflammable for the purpose of security for storage and transport.

As a modification of the present invention it is possible on the contrary to provide an organic material for constituting the case of such a nature that it burns at the same time as charge. In this case there are used cellulose materials such as nitro-cellulose which has a degree of nitrification sufficient to be capable of burning whilst leaving only a small residue. Also in the case of artillery in particular, wherein the cleaning of the explosion chamber is easy, it will be of advantage to utilize these combustible and explosive cases which avoids the necessity of looking after used cases especially of large calibre.

For facilitating manufacture it will be of advantage to utilize a thermoplastic mass, that is to say a mass which when suitably treated and suitably proportioned may be placed in a hot mould and receive under pressure modifications in shape comparable with those of a metal stamping serving here only as a secondary means for forming the powders placed into a mould and compressed under heat by reason of the fact that there are available materials which are less elastic, less homogeneous and less resistant.

Meanwhile moulding by injection gives acceptable intermediate results.

The thermoplastic mass for the case of products composed especially of cellulose acetates contains initially also:

a. A solvent or a solvent mixture, more or less volatile, appertaining principally to one of the following groups of the aliphatic or acromatic series: Hydrocarbons (essence of petroleum, petrol ethers, benzene, toluene, xylene and so forth)

Halogenated hydrocarbons (acetylenetrichloride, methylenechloride, chloroform, chlorbenzene, dichlorethylele and so forth)

Nitrated hydrocarbons (nitromethane and so forth)

Alcohols (methanol, ethanol, butanol and so forth)

Ketones (acetone, methylethylketone, cyclohexanone and so forth).

Ethers (glycolic ethers, dioxanes and so forth)

Esters (methylformiate, ethylacetate, acetylacetic ester, acetates of glycolic ethers and so forth),

Acids (formic acid, acetic acid and so forth).

All compounds which may be solvents which can be used alone or in binary, tertiary and so forth compounds.

b. One or more plastifiers or heavy solvents which are preferably not or only slightly volatile, selected in such a manner as to increase the resistance to atmospheric agents and more generally to external agents.

c. Eventually one or more preproof agents.

These plastifiers, heavy and fireproof solvents being organic compounds of the acyclic and cyclic series with alcohol, phenol, ketone, aldehyde, amide, amine functions, ethers, esters, such as acetates (triacetine, diacetine, acetates of polyglycerides, acetates, erythrite, diacetate of resorcin and so forth) as also their homologues, derivatives and substituted products of the same chain or nucleous; chlorides, (dichlorhydrine, epichlorhydrine and so forth) citrates of ethyl, of methyl, of butyl, of amyl and so forth) of lactates, butyrates, oleates. tertrates (of methyl, butyl and so forth) ricinoleates, cetylates, stearates (butyl stearate for example); adipates (of methyl, ethyl, cyclohexanol, methyl adipate of methylcyclohexanol and so forth); phthalates (of methyl, ethyl, butyl, benzyl and so forth) of phosphates (of methyl, ethyl, butyl, phenyl, cresyl, urea and so forth) as also their substituted derivatives (chlorophosphates) for example: paratoluane sulphamide, ethyl paratoluene sulphamide and their homologues or derivatives, heavy alcohols (benzyl alcohol, cetyl alcohol, cyclohexanol and

so forth); dicresylene, synthetic gums or resins (glycerophthalic gums and so forth).

The various products which have been mentioned do not in any way constitute limiting lists.

The primary material and the various additions should be selected in such a manner that after the usual operation of kneading of the plastic material and suitable drying, the resultant material remains perfectly indifferent to atmospheric and external agents as also to ageing.

Experiments of the applicants, especially with cases of materials with a base of cellulose acetate, have enabled them to establish that for obtaining a satisfactory result it is necessary for the material employed to satisfy the following conditions which constitute a feature of the invention.

1. Have a proportion of acetyl above 48% preferably in the neighbourhood of 53% (diacetate); and in the neighbourhood of 59% (triacetate) (it is known that the maximum proportion is 62.3%).

2. In the constitution of the mass there are allowed to intervene various plastifiers, binders or loaders in the smallest possible proportion so as to obtain the desired result by the addition of each plastifier, binder or loader. In fact the addition has as a result to reduce the life of the final product and consequently its elastic limit. The process therefore consists in reducing the plastifiers, binders and loaders and even to omit them whenever it is possible.

This feature does not apply to the volatile solvents as the said volatile solvents do not exist by reason of the fact that they are easily eliminated by drying.

It is to be noted that it is generally necessary to add a plastifier or a heavy solvent in as little an amount as possible according to the plastic nature of the material for producing the mass and for kneading it.

When according to another method there is used a certain quantity of volatile solvents for forming the mixture the said solvents are eliminated at the desired moment by evaporation and subsequent recovery, and in certain cases it is possible to reduce to an extremely small proportion the plastifiers or heavy solvents by utilizing the thermoplastic properties of the product before the complete expulsion of the volatile solvents, the expulsion of the remainder of the solvent taking place whilst the article remains in a shape ensuring the precision of the finished product. This method is particularly applicable to the case of a material with a high degree of acetyl such as triacetates.

The applicants have found that the products with a base of acetate of cellulose, according to the invention, should have, before working and drying, a composition comprised between the following limits.

	Parts
Cellulose acetate of a suitable degree of acetyl	100
Volatile solvents	50 to 400
Plastifiers from	5 to 30
Fireproof substances (not indispensable from)	0 to 15
Soluble colouring agent (eventually) from	0.01 to 0.5

By way of indication there are given some formulae of compositions which have been tested by the applicants and which have enabled them to obtain thermoplastic materials after kneading, rolling, drying and so forth, adapted to produce by processes of manufacture which will be described hereinafter, cases for munitions according to the invention.

Example 1

	Kilograms
Cellulose acetate	100
Triphenylphosphate	9 to 11
Monoethylparatoluenesulphamide	9 to 11
Triacetine	10 to 12
Glycerine	0.5
Acetone	20
Alcohol	15
Benzine	32
Soluble organic colouring agent (eventually)	0.05

Example 2

	Kilograms
Cellulose acetate	100
Paratoluenesulphamide	2 to 5
Monoethylparatoluenesulphamide	10 to 15
Triphenylphosphate	7 to 12
Methyl phthalate	3 to 5
Acetone	40
Alcohol	20
Benzine	40
Soluble organic colouring agent (eventually)	0.05

Example 3

	Kilograms
Cellulose acetate	100
Chlorethylphosphate	3 to 5
Diacetin	5 to 8
Benzylic alcohol	1 to 3
Methylene chloride	400 to 60
Absolute ethanol	30 to 50
Soluble organic colouring agent (eventually)	0.05

The content in plastifiers may be considerably greater than that indicated above when dealing with certain products such as cellulose acetates or their complex esters (acetonitrates, acetobutyrates, acetopropionates and so forth).

In fact the applicants have found that it is possible for products of a high specific viscosity and more generally of good quality from a physical and mechanical point of view, to increase the proportion of plastifiers and loaders in very substantial proportions, up to 100 of these products to 100 of cellulose ester and this whilst maintaining the limits of elastic and plastic properties necessary for the satisfactory use in the barrel of a firearm of the case obtained.

In this case the rate of elastic expansion is increased without the limit of elasticity (yield point) dropping too low.

The composition of the final product may therefore enter the following type.

	Parts
Cellulose acetate of a specific viscosity above 200 poises (proportion of acetyl 55 to 60)	100
Plastifiers and heavy solvents	5 to 100

There is taken for example the following final composition:

	Parts
Cellulose acetate	100
Triphenylphosphate	15 to 30
Tricresylphosphate	15 to 30
Ethylparatoluenesulphamide	20 to 60

For a total of 80 to 85 parts of plastifiers (one of the plastifiers may however be omitted or replaced).

The processes of manufacture utilizing the above mentioned products may be varied considerably. Nevertheless they may be summarized by stating that cartridge cases may be obtained by a suitable shaping which, according to the case, may be casting a molten material, moulding under pressure plastic or thermoplastic masses having a more or less high viscosity, moulding by compression or injection powders for moulding or injection or materials which are liquid, viscous or not, drying concentrated solutions and so forth.

Here is a formula of a powder to be employed in the process by injection. This powder is composed in the following manner.

	Parts
Cellulose acetate	50 to 60
Triphenylphosphate	3 to 5
Monoethylparatoluenesulphamide	5 to 10
Triacetin	3 to 5
Glycerine	0 to 0.5
Acetone	250 to 500

It is heated and precipitated by water or any other precipitating agent as the volatile solvent distils.

It is to be observed that the invention claims specifically the employment of moulding by injection for the manufacture of moulded parts of organic materials, the material in powder or grains being liquified by the action of heat, then subjected to the action of a piston which injects it into the mould.

Experience has shown that there are thus obtained moulded pieces in a single piece, as also in two pieces, which can be utilized immediately.

The invention is applied so that the case is formed entirely of these materials or only a portion thereof is thus formed. Tests made by the applicants have shown that sporting cartridge cases behave particularly well when they are constituted entirely of the above mentioned materials.

The same is also the case for some shell cases. In the case where the case is formed of two pieces for example, in the case of cartridges for weapons of small calibre, the base is advantageously of metal. It has already been proposed to make cases in two pieces but there are certain difficulties in securing the metal part to the body of the case. In particular a process proposed, which consists in surrounding the base by the case, is not satisfactory as the explosion separates the case from the base. There are leakages of gas towards the rear and difficulties also arise in extracting the case. The applicants claim the arrangement which consists in having a metal base of a certain height which surrounds the body of the case of organic material at its base. This constitutes a binding of the case at its base which strengthens it, on the other hand the explosion wedges the body of the case into its base and thus fluidtightness is ensured as also the cohesion of the whole for extraction.

For reducing the cost of production, when the case is made of two pieces, there may be substituted for the expensive plastic material of the part forming the base, an embedded core of cheap products: cardboard, felt, compressed fabrics or cotton, moulded materials of low cost of the type of invoirine or the like.

Finally the core may with advantage be moulded previously to a shape near the final shape.

The applicants have found that in the case where the case is of plastic material the base may easily be constructed of an alloy of light metals such as aluminium, which ensures great lightness to the munition. There is claimed as a new process the case formed of plastic materials with a metal base of an alloy of light metals such as those with a base of aluminium, magnesium and so forth.

The securing of the various parts of the case may be effected by screwing, the metal portion forming the base being screwed on a screw-threaded base of the body.

This metal portion may also be secured by adhesion with or without mortising. In the case of mortising, the base of the case of suitable hard material, preferably fitting into the metal part, may be conical or be provided with a groove for ensuring a better hold of the whole.

There is also provided in the case where the upper collar mortised on the ball or on the shell may be liable to slip slightly and to remedy this the edge is fitted with a metal ring which may be held simply by adhesion or by screwing or by mortising on the body of the case, so as to avoid any fracture of the base, the finished cartridge should engage between the upper collar and the skirt of the base.

The securing of the ball when dealing with a projectile forming part of the case, is relatively easy when there is provided a metal ring on the upper collar. It is then possible to operate in the manner usual with brass cases.

However there is advantageously provided for profiled balls, which have a smaller diameter at the rear, an additional annular thickness on the base of the shell of organic materials so as to form a collar against which the more constricted portion of the ball bears, which gives a rigid securing. This same excess thickness may be provided in the case where there is not used a metal ring on the collar of the case.

For convenience in manufacture it is easier to shape separately the mass of the base and the tube forming the body of the case. Tests have shown that when a base of metal or even of a more resistant plastic material, is to envelope the outside of the body of plastic material, it is advisable to shape the body of the case by starting from a tube of plastic material, obtained for example by drawing, the said body then receiving its final shape, at certain points, either by hammering whilst hot or under mechanical pressure or by moulding whilst hot, such as moulding under steam pressure, or by modelling whilst hot, or by any other mechanical treatment for shaping whilst hot and the said body is completed in its parts which are the thickest with additional pieces of analogous material which may be obtained in the same manner or by simple moulding or in any other manner.

Thus the body of the case receives a base which is of metal or of organic material (preferably harder than the material forming the body) and eventually inserted parts of organic material of suitable hardness for reinforcing the body at certain points, as for example, the lower part in sporting cartridges, the lower part and the upper collar in the case of a case for a ball cartridge for war purposes or otherwise.

Advantageously, for facilitating the manufacture, it has already been stated that it is preferable to start with materials sufficiently thermoplastic so as to be capable of receiving under heat and pressure the exact form desired. For making the body of the case the operation is

started with a tube of thermoplastic material of the nature of those defined.

It may also be formed in a press. It may also be formed by modelling on a rotating mould, the thicknesses being regulated by a calibre. The modelling may also be effected, the part on the mould being stationary and the rotary modelling tool being guided by a rotary calibre. The modelling is preferably effected under heat. However the simple heat of friction of the tool may be sufficient for modelling.

The materials proposed can be worked mechanically almost in the same way as metal, the processes of manufacture by turning being capable of being applied satisfactorily to the whole or a portion of the article.

In the case where the case is formed by a number of parts the various elements may be gripped mainly by adhesion, either alone or in combination with screwing, mortising in the cold or under heat or joining by force in the cold or under heat. The adhesive to be employed is different and adapted to each case special glues for uniting pieces of plastic material amongst themselves or pieces of plastic material with metal pieces.

Finally the manufacture may be effected by starting with materials which are still malleable by reason of the fact that they contain volatile solvents. The shaping is effected in this case in moulds under pressure, preferably during the drying of the material after its manufacture. The drying of the piece should then be terminated on a mould so that there is no further deformation, the volatile solvent may be recovered.

The accompanying drawings show examples of constructing cases according to the invention.

In Fig. 1 there is shown a case of organic materials according to the invention which presents at the bottom a screw-threaded portion **2** and on the collar a screw-threaded portion **3**. On the part **2** there may be secured, by screwing, a metal base **4** which naturally has a larger base **5** with a suitable hole for the introduction of the cap at **6**. On the screw-threaded part **3** of the collar there may be secured, by screwing, a kind of ring **7** which protects the edges of the collar **3** and prevents them from expanding.

A case thus formed is particularly applicable for the preparation of munitions of war with the securing of the ball in the collar **3**.

Fig. 2 shows in section a profiled ball **8**, that is to say having a portion of smaller diameter at the rear at **9**. The body of the case **1** is provided with a base **4**, as indicated above, but which at the top, on a level with a collar and inside, is provided with an additional annular thickness of organic materials at **10** against which the base of the ball **6** bears in such a manner that the tightening of the ball and its securing may be effected in a suitable manner. This tightening is naturally facilitated by the presence of the ring **7** as indicated above.

It is possible to use for the metal part any suitable metal; advantageously for example the lower base may be made of aluminium whilst the upper ring may be of brass for facilitating the securing of the ball. For sporting cartridges the parts of the metal base may be constructed according to known technology in this type of manufacture with a suitable adaptation to the nature itself of the body of the cartridge of organic materials.

Figs. 3 to 9 show modifications in mounting.

Fig. 3 shows a body **10** of material according to the invention with a reduced screw-threaded lower portion **12** and an upper screw-threaded portion **11**.

On **11** there is secured the collar of the shape **13** and on **12** there screws the base **14**.

Fig. 4 shows a body **5** with a collar formed integral therewith and constricted at **16** for receiving the ball as is well known. On **12** there is also screwed the metal base **14**.

Fig. 5 shows the body **17** with a smooth constricted lower portion **18** which enters the smooth base **19**, the securing being effected by adhesion.

Fig. 6 shows a smooth base with a groove **21** near the body in such a manner that the base **22** which has a thicker rim **23** may be secured by tightening, the excess thickness **23** serving to engage the groove **21** and to give the whole the shape at **24** in Fig. 7 without the excess thickness reducing the section.

Fig. 8 shows a truncated end which enters by **25** into the smooth base **26**, the tightening pressing the base inwardly against the truncated portion at **27** (Fig. 9) in such a manner as to obtain a unit of the same section throughout its length and towards the base. A clearance **27'** enables the tightening of the base.

Fig. 10 to 13 show methods of construction of sporting cartridges or projectile cases separately.

Moreover for cases for separated projectiles and in all the technology of sporting cartridges, the construction indicated in Fig. 17 is also applicable. For shell cases all the technology of cases with an attached base is also applicable.

Fig. 10 shows that the body **25** of the cartridge has a groove **29** at the rear which enables the base of low height **30** to be secured thereto by tightening and pushing the metal material of the base into the said groove as shown at **31** (Fig. 11).

Fig. 12 shows a device of the same type but in which the bottom of the cartridge has a truncated shape **32** which enters the metal base **34** of such shape that when tightening as indicated at **34** the material forced in fills completely the portion left free by the truncated portion **32**.

Figs. 13 and 14 show sections of cases formed of three pieces. The third piece (the base) is not shown in Fig. 15.

As will be seen in Fig. 14 the body **35** of the cartridge is a drawn tube of cellulose diacetate or triacetate, of satisfactory resistance so that when the body is subjected to expansion at the moment of firing, this body is sufficiently rigid so as not to stick completely in the interior of the chamber.

In the bottom of this body **35** there is secured by adhesion or otherwise, a member **36** which is of any suitable material and shape (moulded material which if desired may be of less resistance than the body or may simply be of cardboard moulded or not or the like). This assembly **35—36**, is completed by the metal cap **37** which is tightened in position as shown at **38**.

There is thus obtained a cartridge formed of three parts. However without departing from this feature if there is employed a base of iron, for example, this iron may be covered with a thin film of brass for example, not shown, but this film does not form a fourth piece as it forms a portion so to speak of the base.

In Fig. 15 there is shown the body of a case **38** obtained by drawing cellulose diacetate or triacetate. At the end **38** (shown in chain-dotted lines) there has been formed a constriction with thinning in such a manner as to obtain finally the neck **40**. At the lower end in the interior of the body **38** there is secured, for example by adhesion,

another tube 41 which forms a lining or excess thickness in such a manner that there may be machined thereon the screw-thread 42 in the thickness of the end 38 whilst retaining a sufficient thickness at the said end. It is known that on this screw 42 there is screwed the metal base.

As will be seen, according to the invention, the end of the case enters the interior of the base. The same would be the case if the securing were effected by crimping according to one of the constructions described above, the lining tube 41 serving to give greater rigidity to the end and there is thus obtained a case which, according to the invention, is constituted by three parts (the base is not shown in Fig. 15).

According to the invention there may be imparted to the cases for sporting cartridges a shape of equal resistance in the vicinity of the base in such a manner that the explosion which occurs is not liable to simply detach the base from the tube as is liable to occur.

Fig. 16 shows a section of a case of this character in which there is shown a case formed of a single piece but which may obviously be formed of a number of pieces. The bottom of the case 43 is in the form of a hollow body of revolution of which the curvature 44 is substantially of the same order as that of a solid of equal resistance to the mechanical forces which increase whilst starting from one end of the piece. There will also be seen at 45 a shoulder between the tube and the part 43, this shoulder being adapted to form a kind of seating for the wad which is placed above the enclosed powder, in principle in the space 46 whilst the shot is assembled in the space 47.

As stated Fig. 16 shows a cartridge in one piece but it will be obvious that it may be formed of two parts, the tubular part 48 being manufactured from a drawn tube, as above described, whilst the part of the cap 43 is manufactured in a mould by means known in the technology of moulding plastic materials in the form of a solid material or from powders which are moulded or injected.

It is also possible according to the invention to give a particular shape to the tubular portion at the point of attachment to the portion forming the base in such a manner as to completely solidarize the two parts once the manufacture has been completed and to avoid any detachment at the moment of firing the shot and facilitating the extraction by causing the extractor to act on a collar of the tube itself.

Fig. 17 shows a case constructed in this way from two parts: the tubular part 49 and the part forming the base 50. As will be seen in the drawing the part forming the base 50 is provided at the rear with an annular chamfered portion 51 in such a manner that when the tube 49 and the part 50 are assembled under pressure and heat in a mould the end of the tube 49 is offset under the chamfer 51 and naturally is extended at 52 so as to form a collar. In this manner there is obtained an excellent hold of the tube and of the base at the moment of firing the shot and on extraction. It is also possible to make the tube 49 solid with the part 50 by providing a certain number of perforations (this arrangement however, is not indispensable), such as 53, on the tube adjacent the part 50 in such a manner that when moulding under heat and pressure the material of the portion 50 enters these orifices 53 and thus forms holding pins which contribute in rendering the part solid. It is possible to assume various other methods for securely connecting the two parts together.

The idea of holes is applicable to metal bases, not only for ensuring a better connection, but also for forming vents for the escape of air during moulding.

The invention also proposes to reinforce the base of the case in such a manner that when the cap is struck it cannot damage the organic material which is thus subjected to intense heat and which is liable to melt or even to volatilize. For this purpose and also for preventing detachment of the base at the moment of extraction there is provided a metal lining in this part.

The first means which come to mind consist in providing on the base and if necessary in the seating of the capsule a more or less thick film of metal according to known technology. It is possible advantageously to proceed in another way as shown in Fig. 17 in which the device is applied to a war cartridge.

It will be seen that the base is secured to a metal part itself forming a collar at 44 which forms a sleeve at 45 for the reception of the capsule and which is expanded at 46 so as to render this reinforcement and the body of the case perfectly solid.

In this manner there has been solved the problem of protecting the organic material 47 from the ignition flame and also the solidity of the collar 44 for the purpose of extraction.

Finally the invention also consists in imparting to all the types of cases for munitions of war shapes avoiding, during moulding under pressure of plastic materials especially by the use of a drawn tube which is then softened by heat and pressed against the wall of the mould for example by the pressure of a gas, any sectioning of the material and any too thin thickness which is liable to occur when the portions of attachment of the various sections do not possess a progressive form and form more or less acute angles.

A case for a munition of war constructed in accordance with the invention is shown in Figs. 19 and 20.

In Fig. 19 it will be seen that the tube 68 which forms the body of the case, has been obtained by means of a drawn tube placed into a shaping mould, heated in a suitable manner and then applied under pressure, preferably of a gas or liquid against the wall of the mould and along a uniform thickness as the profile has been selected without a sudden change of direction. It will be understood, as will be seen in Fig. 20, that the cap 61 which is connected to the part 58 has the same chamfer 62 but in the opposite direction in such a manner as to be applied effectively against the annular part 60.

The moulding of the tube may be effected on the base itself which then forms one of the ends of the tube. In this case the screw-thread 59 may be replaced by a shape forming a dovetailed section (as at 27 in Fig. 9) or any other arrangement such as the annular openings such as 63 (Fig. 21) which ensure a satisfactory connection of the two parts.

Openings should preferably be provided. These are small holes which are very weak or more important than those only serving for securing.

It is necessary in this method of manufacture to apply, in a fluidtight manner, the plastic portion of the case in its metal base before blowing.

The applicants have found that this result is obtained for example by taking the tube of drawn plastic material of the same external diameter as

the internal diameter of the metal base and gluing the two pieces together. The gluing may be effected by coating the ends of the plastic tube with a special glue and introducing it with slight force into the base. The glue should be a solution of high concentration and with relatively low viscosity (of the plastic material suitably plastified by dissolution in a solvent of which the dissolving action should be modified by a certain quantity of diluting product).

In the case where the plastic material has a base of cellulose acetate for example, the glue may have the following composition:

Plastic material used	kgs	10 to 20
Acetone or methylenechloride	litres	70 to 90
Absolute alcohol	litres	10 to 30

These proportions only constitute an example, the concentration of the plastic material may vary from 0 to 30%.

For the mounting it is mainly necessary to provide for the securing of the cap in the base and of the ball or of the closing wad in a sporting cartridge.

Experience has shown the applicants that the cap can be secured easily by means of an adhesive when the base is of plastic material. This method of securing, which is easier than a force fit generally employed, also has the advantage of ensuring satisfactory fluidtightness. It may be employed in combination with a force fit or tightening.

The securing of the balls must satisfy certain conditions of rigidity and resistance to detachment which can be obtained by a tightening under heat under conditions similar to those for tightening metal cases.

Tightening is not obtained either under heat or with the assistance of a solvent except on conditions that the crude initial tube from drawing is itself of smaller diameter.

In fact the plastic material has the property when it is heated or when it is placed into a plastifying solvent to return to its initial size. There will therefore take place a tightening if the initial tube has an internal diameter less than that of the ball. Automatic tightening will thus take place either under heat or by reason of the presence of the solvent or of a glue containing a solvent.

The applicants have also found that this result is obtained more simply and at the same time, without there being any danger of breaking the collar of the case for ball and shell cases, by the use of an adhesive which must in the first instance permit by drying a contraction of the collar of the case producing a tightening of the projectile, in the second case a filling of all the pores of the metal surface in contact without however ensuring complete adhesion. It is characterized in that:

1. A solvent of the organic material employed which may be rendered more consistent by the preliminary dissolving of a binder, more especially of a product constituting the case.

This solvent more or less penetrating the organic material, which is subsequently eliminated by drying, is for the purpose of adapting the collar by modifying in a suitable direction its elasticity which comes into play from the commencement of firing for the purpose of avoiding fractures or cracks of the said collar.

2. A product attacking the slight corosion of the metal constituting the parts to be fixed to the plastic mass and compatible with the first constituent and the plastic mass itself.

3. A material serving the part of a dry lubricant on the surfaces of the metal part in contact with the plastic mass and compatible with the preceding constituents.

It is by combining these conditions that the applicants have been able to secure easily the projectiles to the cases whilst ensuring for their securing the necessary resistance.

An example of the composition of the adhesive of the character tested by the applicants and suitable for cases formed of a base of cellulose acetate is the following:

	Parts
Acetate solution at 5% in acetone	8
Crystallisable acetic acid	1
Solution of gum lac of 4 to 8% in alcohol	1

For closing sporting cartridges the applicants have found that when using the usual tightening machines, by causing them to rotate sufficiently fast for heating the upper edge of the cartridge, there is obtained a tightening similar to that of cardboard cartridges. This process has the disadvantage that the collar breaks at the commencement of firing and the cartridge cannot be re-used.

The applicants have found that by placing on the lead a washer of plastic material and soldering it to the walls by a gum simply adhesive as that described above for securing the balls to the case, there is thus ensured a sufficient securing for holding the charge and it is detached when firing without destroying the cartridge. Further there is thus ensured the fluid-tightness of the cartridge and its satisfactory preservation even in a humid locality.

The applicant also proposes to obtain for the upper portion of the cartridge a softer material by a bath of a heavy solvent which will plastify sufficiently the edge of the cartridge so as to enable it to be tightened in the same way as a cartridge of cardboard and for avoiding breakage of the collar when firing.

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