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(54) **A DUMMY SHELL FOR PRACTICE AMMUNITION, PRACTICE AMMUNITION AND RELATED FABRICATION METHOD**

(57) A dummy shell for practice ammunition has external dimensions substantially equal to dimensions of a corresponding shell for live ammunition of a same caliber provided with explosive charge and detonating fuse, the dummy shell for practice ammunition comprising a single-piece metal ogival body (1) having a bottom (2) and a side wall (3) defining an inner cavity (4) having an apical opening (5). The side wall (3) and the bottom (2) of the ogival body (1) are thicker than in the corresponding shell

for live ammunition, the actual weight (AW) of the shell for practice ammunition is smaller than the nominal weight (NW) of the corresponding shell for live ammunition and a plug (7) is soldered on the apical opening (5) for sealing the inner cavity (4) that is void, the plug (7) having a weight (PW) substantially equal to the difference between the nominal weight (NW) and the actual weight (AW).

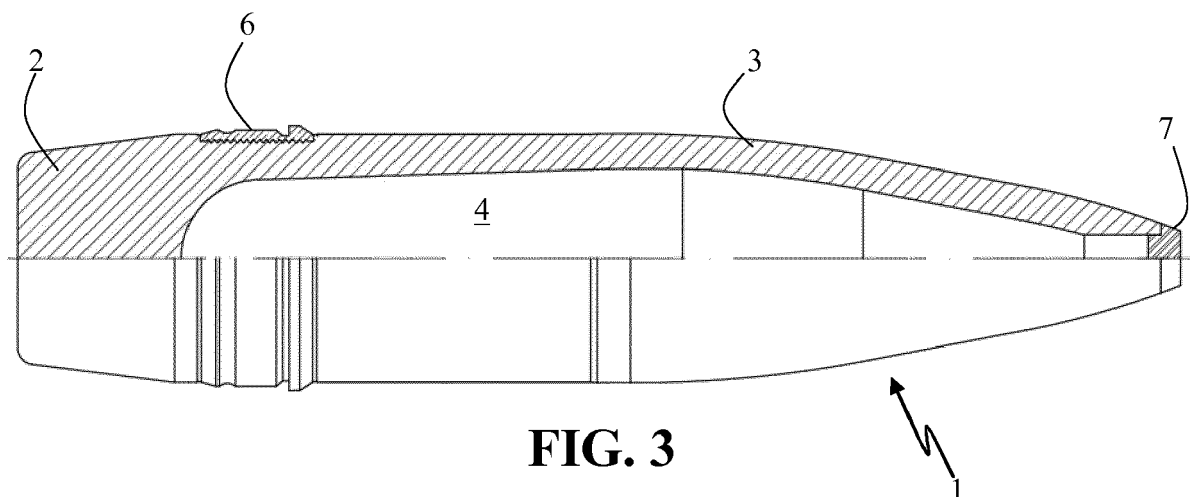


FIG. 3

Description

TECHNICAL FIELD

[0001] The present invention relates to ammunitions for artillery and more in particular to a dummy shell for target practice ammunition, a target practice ammunition and a related method of fabrication of such a dummy shell for practice ammunition.

BACKGROUND OF THE INVENTION

[0002] The so called Target Practice ammunition, or more briefly TP, are ammunitions for practicing purposes, i.e. deployed of explosive, that look like corresponding live ammunitions of the same caliber. A live complete ammunition is an ammunition having a shell containing a bursting charge and a fuze.

[0003] In order to ensure inner and outer ballistic characteristics matching those of corresponding live ammunitions, i.e. exactly compliant with the standard shooting tables, practice ammunitions are realized so as to match in the most accurate fashion size, profile, weight and position of the center of gravity of corresponding live ammunitions. To this end, according to a known technique, the dummy shell, that is identical with the corresponding live ammunition ("High Explosive" or, shortly, HE), is charged with inert material (i.e. not explosive), is equipped with a dummy fuze, that on its turn has a shape, weight and center of gravity as a corresponding live fuze, and the same protection plate used for corresponding live ammunitions is soldered on the base of the shell.

[0004] The operation of charging with inert material, for example plaster or gypsum, the density of which must be as close as possible to that of the explosive of live ammunitions (about 1,67 g/cm³), takes place throughout repeated steps for inserting and compressing it. These operations are quite critical because they must be accurately executed in order to make the inert material be distributed uniformly inside the dummy shell, so as to allow a correct determination of the position of the center of gravity. Moreover, the material must be accurately compressed both for preventing formation of air bubbles inside it, that would unbalance the shell, as well as for preventing displacements of the center of gravity of the shell when shooting or flying. Indeed, when shooting, the dummy shell, and thus the inert material contained therein, is subjected to a relevant longitudinal acceleration that may bulk the inert material, if it had not been adequately compressed. Moreover, the high axial rotation speed of the shell, due to gases developed in the rifle and that flow around the driving band of the shell, causes a relevant centrifugal force acting on the inert material that, if the material is not adequately compressed, could displace or deform it unbalancing the shell.

[0005] According to another known technique, alternative to the charging with compressed inert material, the dummy shell is filled with a thermosetting resin having a

known density.

[0006] In both cases, the charging with an inert material or with a thermosetting resin remains a critical operation both for the above mentioned compression problems of the material as well as for making the weight and the relative position of the center of gravity of the dummy shell coincide with those of a corresponding live shell, so as to match accurately the shooting characteristics.

10 SUMMARY

[0007] Studies carried out by the applicant lead to infer that it is possible to realize in a simple fashion shells for practice ammunitions that matches in a very accurate fashion shape, weight and position of the center of gravity of a shell of corresponding live ammunitions, because they are made of a smaller number of components and do not require charging with inert material.

[0008] Differently from known shells for practice ammunitions, the shell realized according to the present disclosure comprises a single-piece metal ogival body whose external dimensions are substantially identical with those of a corresponding shell of live ammunition with bursting charge and from fuze. This shell has inside an inner cavity with an apical opening equipped also with a driving band identical with those of shells for live ammunition. The wall and the bottom of the ogival body are thicker than in the corresponding shell for live ammunition and are determined so as:

- the actual weight of the single-piece metal ogival body surrounded by the driving band is smaller than the nominal weight of the corresponding shell for live ammunition equipped with bursting charge and fuze, and
- the position of the center of gravity of the single-piece metal ogival body surrounded by the driving band is substantially the same as for the shell for live ammunition equipped with bursting charge and fuze.

[0009] The nominal weight of the shell for practice ammunition is fixed by soldering a plug on the apical opening in order to seal the void inner cavity, wherein the plug has a weight determined so as to correspond to the difference between the nominal weight of the corresponding shell for live ammunition and the actual weight of the single-piece metal ogival body surrounded by the driving band.

[0010] Further, a practice ammunition comprising such a shell as well as a method of fabricating a shell for practice ammunition are also disclosed.

[0011] The claims as filed are integral part of this specification and are herein incorporated by reference.

55 BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Figure 1 is a partial sectional view that shows a partly machined piece composed of a single-piece ogival body surrounded by a driving band.

Figure 2 is a partial sectional view showing the piece of figure 1 after having shaped the driving band.

Figure 3 is a partial sectional view that shows a shell for practice ammunition according to this disclosure, with a plug sealing the empty inner cavity.

DETAILED DESCRIPTION

[0013] In this specification a method of fabrication of a shell for practice ammunition will be illustrated referring to the caliber 76/62 that corresponds to weight equal to 6.3 ± 0.01 kg, though what will be said may be repeated *mutatis mutandis* for ammunitions of different caliber.

[0014] The shell for practice ammunition according to the present disclosure has shape, dimensions, weight and position of the center of gravity accurately matching the characteristics of a corresponding live ammunition of a same caliber, i.e. containing a bursting charge and a fuze. As it will appear clearer hereinafter, the shell according to this disclosure is particularly simple to realize because it is substantially made of a single piece and need not to be charged with inert material, need not to be threaded internally because it needs not mounting a dummy fuze and further it needs not a disk soldered onto the base plate, as by contrast it is required in known shells for practice ammunitions.

[0015] The shell of this disclosure can be realized from a steel bar (billet), for example of the type C50, that is loaded on a transportation belt. The steel bar is conveyed to heating coils and is heated at a temperature adapted to cut a block by means of shears. The block is transferred by means of a manipulator to the next station for the die stamping step. The block is placed in a press so as to impart to it a shape with a base, a substantially cylindrical side wall that delimits an inner cavity opened from the opposite side of the base.

[0016] The die stamped piece is transferred to a drawing press for the next wire drawing step that substantially elongates it, making thinner the side walls and the base in a controlled fashion. An outer machining is carried out, in order to make thinner the side walls in proximity of the opening of the cavity in order to impart more easily the desired ogival shape to the worked piece.

[0017] After having mounted the piece on a mandrel, a seat destined to house a driving band of the shell, that will be identical with the driving band present on corresponding shells for live ammunition of the same caliber, is defined in a substantially central zone of the half-worked piece. In order to allow a more secure locking of the driving band, a knurling step is carried out in the housing seat.

[0018] The worked piece is thus transferred to a press for shaping the ogive that, for example, cold bends the ends of the side walls for conferring the typical ogival shape, leaving an apical opening through which the inner

cavity communicates with the outside. At the end of this operation, the single-piece half-worked piece has an ogival shape the base of which and the side walls of which delimit an inner cavity having an apical opening.

[0019] Differently from shells for known practice ammunition, this cavity will remain empty and will not be filled with inert material nor with thermosetting resins because the outer shape, the size, the weight as well as the relative position of the center of gravity of the finished piece will substantially match those of the corresponding shells for live ammunition without adding these materials inside or soldering a disk onto the base.

[0020] In order to ensure the desired mechanical features of the shell, a tempering step is carried out according to typical procedures in the art, for example by advancing automatically the half-worked piece inside an oven for an overall time of about one hour and 20 minutes, passing throughout zones at different temperature, for example a zone at 800 °C and another zone at 840 °C, thus immersing in oil at 50-60 °C the piece that exits from the oven and leaving it immersed for about 4 minutes and 15 seconds.

[0021] Successively, according to typical procedures in the art, a drawing temper step is carried out during which the piece is inserted in an oven at a temperature of about 460 °C and is left cooling for an overall time of about 10 hours. At the end of the drawing temper, a control of the hardness of the walls and a control of the technological characteristics of the so obtained piece are carried out before executing a classic sandblast step.

[0022] Once the sandblast step is finished, the piece is mounted on tongs so as to refine accurately by a lathe the ogival portion for imparting the desired shape, as that of shells for live ammunition of same caliber, then the base plate is refined with a lathe, for making it match that of the corresponding shells for live ammunitions.

[0023] After having carried out a magnetoscopic control of the characteristics of the piece, a driving band is applied, obtained by cutting a tube, for example made of ormolu, and by applying it in the knurled housing seat using a press.

[0024] At the end of these operations, a piece as shown in figure 1 is obtained, composed of a single-piece metal ogival body 1 having external dimensions substantially identical to those of a corresponding shell for live ammunition equipped with bursting charge and with a fuze, the ogival body 1 having a bottom (base plate) 2 and a side wall 3 that define an empty inner cavity 4 with an apical opening 5. A driving band 6, installed so as to wrap the metal ogival body 1, has a diameter D and may be identical with that of the corresponding shell for live ammunition. The side wall 3 and the base plate 2 of the ogival body 1 are thicker than in the corresponding shell for live ammunition and are determined so as the actual weight AW of the single-piece metal ogival body 1 surrounded by the driving band 6 is smaller than a nominal weight NW of the corresponding shell for live ammunition provided with bursting charge and with front fuze, by not

more than a weight difference, with the position of the center of gravity of the single-piece metal ogival body 1 surrounded by the driving band 6 being substantially the same as in the shell for live ammunition. Given that the base plate 2 and the side wall 3 are thicker, it is not necessary to solder a disk below the base plate 2 for making the weight, the outer dimension as well as the position of the center of gravity match those of the shells for live ammunition of a same caliber.

[0025] According to an embodiment of the present invention, a shell of a caliber 76/62 has a base plate having a minimum thickness comprised between 49.9 mm and 50.1 mm and the thickness of the side wall at various levels are properly increased for keeping substantially unchanged both the position of the center of gravity as well as the outer shape of the shell.

[0026] Once checked the characteristics of the driving band 6, the piece of figure 2, almost finished, is mounted on tongs for shaping its driving band 6 so as the propellant gases produced in the rifle of the gun do not escape along the sides of the shell but impart thereto the maximum possible momentum and eventually even a gyroscopic stabilizing spinning motion. At the end of this operation, a single-piece ogival body 1 is obtained on which the driving band 6 is mounted.

[0027] The piece shown in figure 2 is not yet completed because the apical opening 5 of the ogival body 1 is not occluded, though the outer shape of the piece, as well as the position of the center of gravity, substantially match those of a corresponding shell for live ammunition of a same caliber with bursting charge and detonation fuze.

[0028] The actual weight AW of the piece shown in figure 2 is smaller than the nominal weight NW of a shell for live ammunition equipped with bursting charge and detonation fuze. Since the bottom 2 and the side wall 3 of the single-piece ogival body 1 shown in figure 2 are thicker than in the corresponding shell for live ammunition, the single-piece ogival body 1 weights more than the corresponding ogival body of a shell for live ammunition before being charged with explosive and before assembling the detonation fuze.

[0029] Nevertheless, the nominal weight of the piece shown in figure 2 is determined so as to be close to the nominal weight NW of a shell for live ammunition, even if smaller than it. Therefore, the machining operations illustrated hereinbefore for transforming a steel block into an ogival body are less critical because it is not necessary that the final piece has an actual weight AW identical with the nominal weight NW of a shell for live ammunition, complying with the strict tolerances imposed by specifications.

[0030] The final correction of the weight is carried out, according to an aspect of this disclosure illustrated in figure 3, by shutting the apical opening 5 with a plug 7 having a weight PW, a head with a section and transversal dimensions adapted to shut the apical opening 5 and a stem with longitudinal dimensions accurately determined so as the actual weight AW of the single-piece

ogival body 1 with the driving band 6, plus the weight PW of the plug 7, substantially matches the nominal weight NW of the corresponding shell for live ammunition equipped with bursting charge and with fuze, complying with the strict weight tolerances of live ammunitions.

[0031] Before soldering the plug 12 on the single-piece ogival body, the piece shown in figure 2 is weighted together with a plug chosen in a set of plugs of different weight and it is checked whether the overall weight satisfies the desired weight specification, that for shells having a caliber 76/62 is 6.3 ± 0.01 kg. If the weight specification is not complied with, another plug is chosen from the set of plugs until an appropriate plug 7 for complying with specifications is found. Finally, the plug 7 is soldered, preferably electrically, and the eventually exceeding material is removed.

[0032] Since the weight of the single-piece ogival piece surrounded with the driving band is much greater than the weight of the plug 7, choosing a plug of a certain weight instead another plug lighter or heavier than the former does not modify in a noticeable manner the position of the center of gravity of the finished shell. For example, for a shell having a caliber 76/62 that has a nominal weight of 6.3 kg, the plug 7 will conveniently have a weight not greater than 18 g, so as to comply with the tolerance of ± 2 mm, imposed by specifications currently in force, for the position of the center of gravity in respect to the nominal position.

[0033] More generally, this weight difference does not overcome 1%, preferably 0.5%, more preferably 0.3% of the nominal weight NW of the finished shell independently from its caliber, so as to ensure that the choice of the weight 7 does not alter in a relevant manner the position of the center of gravity.

[0034] Conveniently, the plugs of different weight of the set from which the respective closing plug is selected for each single-piece metal ogival body, are made of a same material, for example steel, and have a transversal size and/or section substantially equal to and complementary with those of the apical opening, but different longitudinal size. This aspect does not pose problems when mounting because the stem of the plug 7 is housed in the inner cavity 4. Moreover, it is very easy to realize plugs of different and accurately determined weight, because the head of the various plugs of different weight is the same and the longitudinal size of the stem that penetrates inside the cavity 4 can be very accurately determined in function of the weight PW that the plug 7 must have.

[0035] It is to be noticed that the shell shown in figure 3 is not filled with inert material or with thermosetting resin, such as the shells for known ammunitions, but the inner cavity 4 remains empty and is sealed by the plug 7. Moreover, no dummy fuze is installed, as by contrast it is required in known dummy shells, thus the well known problems of determination of the weight and of the position of the center of gravity of the ammunition, that this operation implies, are avoided.

[0036] The method of fabrication proceeds with usual final test during which, throughout a visual control and a dimensional control, the construction parameters of the almost finished shell are verified, then a stamping step in correspondence of a portion of the side wall of the single-piece ogival body is carried out. The final operations of phosphatization, outer painting and final test after painting are customary in the art and for this reason they will not be illustrated further.

[0037] Characterizing features of the dummy shell for target practice of this disclosure are thus:

- an accurately determined weight so as to match the nominal weight NW of a corresponding shell for live ammunition with bursting charge and front fuze,
- reduced environmental impact;
- simple realization;
- reduced fabrication costs.

[0038] Compliance with stringent weight specifications is ensured by choosing the plug 7 with the most appropriate weight for sealing the inner cavity 4 of the shell, that remains empty. This allows to obtain accurately repeatable outer ballistic and impact results, while respecting the shooting tables determined for shells for live ammunitions.

[0039] The dummy shell for target practice of the present disclosure can be used during a practice activity or for controlling shooting configuration as well as by certain navy ships on targets of small and medium size, wherein stopping the target ship and not destroying the target is envisaged. In particular, for this last operation the success is determined by the precision of the shoot and thus by the possibility of having dummy shells of accurately determined weight.

[0040] Ease of fabrication of the desired product is mainly due to the fact that it is composed of a forged single-piece body, mechanically spot-faced and joined to the plug 7 that seals the empty inner cavity 4. The fact that the sealed inner cavity 4 is empty avoids problems due to charging and compacting inert material and to its displacement while shooting or when the shell is flying.

[0041] Moreover, when shot for practice purposes, the shell according to this disclosure can be also recovered and the material of which it is made may be fully recycled. This is advantageous from an environmental point of view because the known shells for target practice contain thermosetting resins that are dispersed in the environment and degrade only in very long times, thus they are pollutants.

[0042] The shell according to the present disclosure can be realized in a low cost fashion because it does not require other components such as the dummy fuze, the soldered disk below the base plate (bottom) and the inert material. The fact that it is not necessary to insert a dummy fuze avoids the step of threading the front end of the ogival body.

[0043] Moreover it is not necessary to solder a steel

disk to the base plate, which is a step that is notoriously critical because, if it is not accurately realized or if it is carried out using a steel disk with some defects, may lead to unacceptable penetrations of propellant gas in the plane of the base plate.

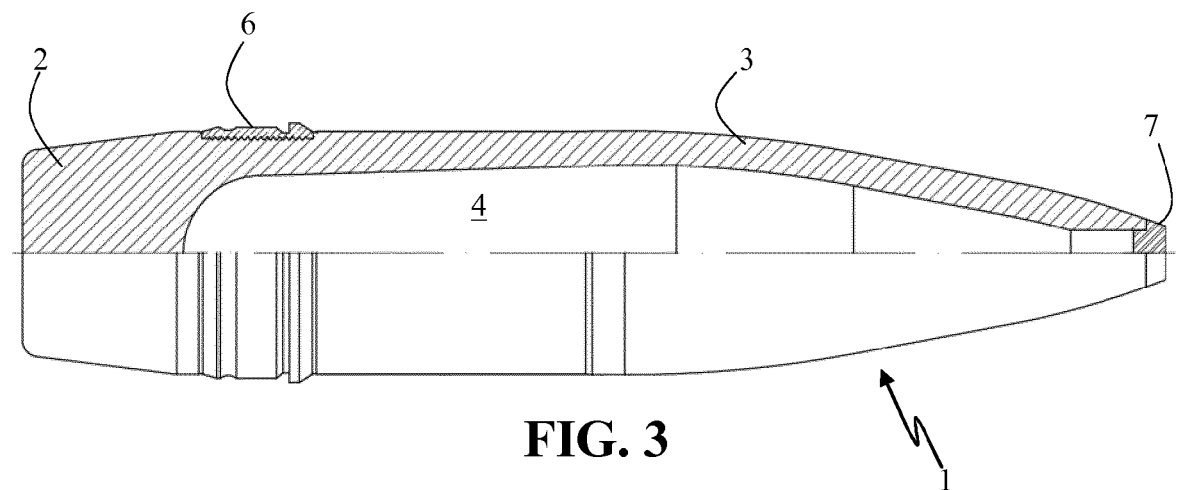
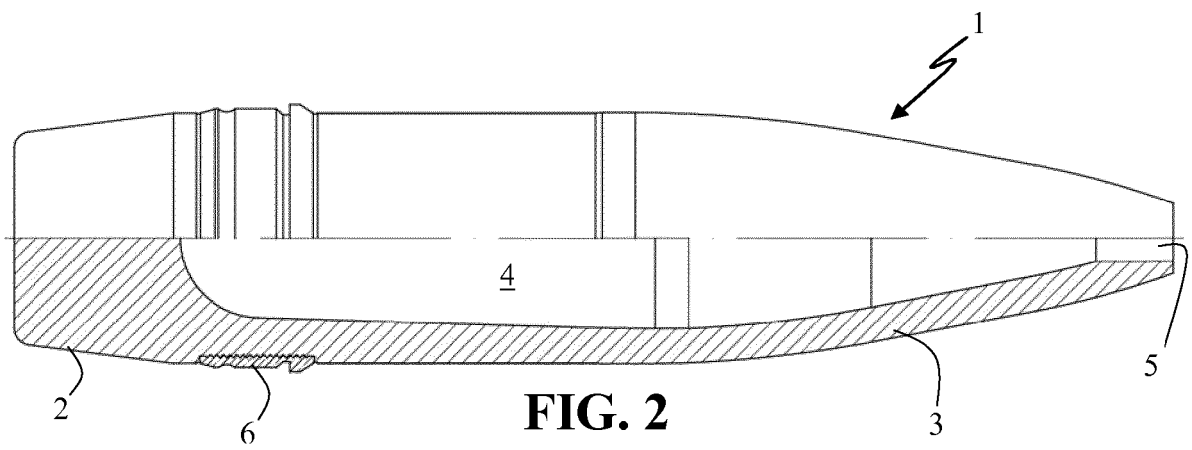
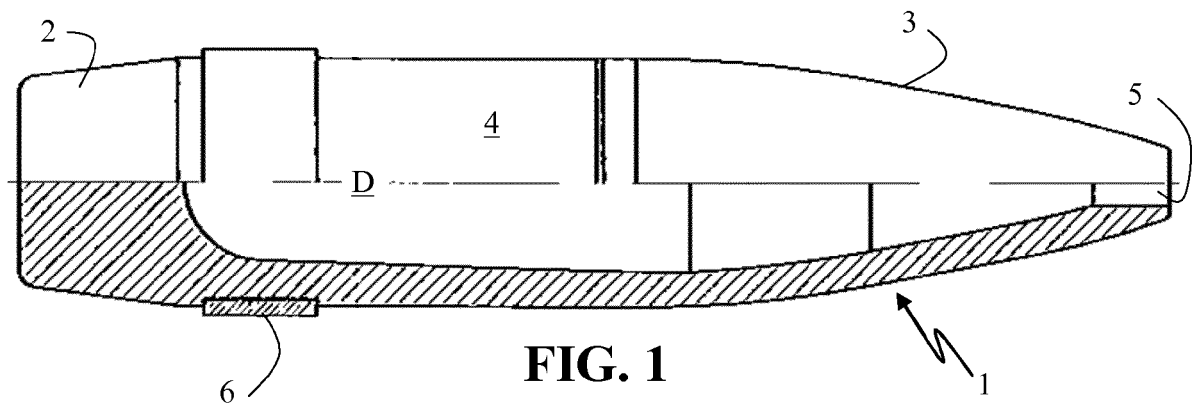
[0044] The illustrated method of fabrication can be used for shells for target practice of anti-aircraft or artillery, for shells for practice ammunitions of great caliber, for example from the caliber 40/70 up to the caliber 127/54, or even greater.

[0045] Eventual variations and/or additions can be executed by skilled persons on the embodiment disclosed and illustrated herein while remaining within the scope of the following claims. In particular, further embodiments may comprise the technical features of one of the following claims with the addition of one or more technical features, considered singularly or in any reciprocal combination described in this text and/or illustrated in the drawings.

Claims

1. A dummy shell for practice ammunition having external dimensions substantially equal to dimensions of a corresponding shell for live ammunition of a same caliber provided with explosive charge and detonating fuse, said dummy shell for practice ammunition comprising a single-piece metal ogival body (1) having a bottom (2) and a side wall (3) defining an inner cavity (4) having an apical opening (5), **characterized in that** the side wall (3) and the bottom (2) of said ogival body (1) are thicker than in the corresponding shell for live ammunition, the actual weight (AW) of said shell for practice ammunition is smaller than the nominal weight (NW) of the corresponding shell for live ammunition and a plug (7) is soldered on said apical opening (5) for sealing said inner cavity (4) that is void, said plug (7) having a weight (PW) substantially equal to the difference between said nominal weight (NW) and said actual weight (AW).
2. The dummy shell according to the previous claim, wherein said plug (7) has a stem inserted into said apical opening (5) and a head that shuts said apical opening (5).
3. The dummy shell according to one of previous claims, wherein a driving band (6) encircles said metal ogival body (1).
4. The dummy shell according to the previous claim, wherein the center of gravity of said single-piece metal ogival body (1) encircled by said driving band (6) and shut by said plug (7) is substantially in the same position of the center of gravity of said corresponding shell for live ammunition.

5. The dummy shell according to one of previous claims, wherein the weight (PW) of the plug (7) is equal to or smaller than 1% of said nominal weight (NW).
6. The dummy shell according to the previous claim, wherein the weight (PW) of the plug (7) is equal to or smaller than 0.5% of said nominal weight (NW).
7. The dummy shell according to the previous claim, wherein the weight (PW) of the plug (7) is equal to or smaller than 0.3% of said nominal weight (NW).
8. The dummy shell according to one of previous claims, wherein the dummy shell has a caliber 76/62 and the minimum thickness of the bottom (2) ranges between twice and three times the minimum thickness of the bottom of a shell for live ammunition of the same caliber.
9. The dummy shell according to one of previous claims, having a caliber 76/62, wherein the nominal weight (NW) of the corresponding shell for live ammunition is 6.3 kg and the weight (PW) of the plug (7) corresponds to said nominal weight (NW) minus said actual weight (AW) with a tolerance smaller than 10g.
10. A practice ammunition, comprising a dummy shell for practice ammunition according to one of the previous claims.
11. A method of fabricating a dummy shell for practice ammunition, comprising the following steps:
 - a. realizing a single-piece metal ogival body (1) having external dimensions substantially equal to dimensions of a corresponding shell for live ammunition of a same caliber provided with explosive charge and detonating fuse, said dummy shell for practice ammunition comprising a single-piece metal ogival body (1) having a bottom (2) and a side wall (3) defining an inner cavity (4) having an apical opening (5), wherein the side wall (3) and the bottom (2) of said ogival body (1) are thicker than in the corresponding shell for live ammunition;
 - b. determining the actual weight (AW) of the dummy shell for practice ammunition;
 - c. determining the weight difference between the nominal weight (NW) of the corresponding shell for live ammunition, provided with explosive charge and detonating fuse, and the actual weight (AW) of the dummy shell for practice ammunition;
 - d. selecting, from a set of plugs of different weight, a plug (7) having a weight substantially equal to said weight difference;
 - e. soldering said selected plug (7) on said apical opening (5) for sealing said inner cavity (4) that is void.
12. The method according to the previous claim, wherein said set of plugs is made of plugs of a same material having a head of a same dimension and transverse sections and a stem with different longitudinal length, said stem being adapted to be inserted into said apical opening (5).
13. The method according to claim 12 or 13, wherein a driving band (6) is placed around said metal ogival body (1) before determining the actual weight (AW) of the dummy shell for practice ammunition.
14. The method according to the previous claim, wherein the center of gravity of the single-piece metal ogival body (1) encircled by said driving band (6) and shut by said plug (7) is substantially in the same position of the center of gravity of said corresponding shell for live ammunition.





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 EP 16 17 9375

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		1 December 2016	Schwingel, Dirk
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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