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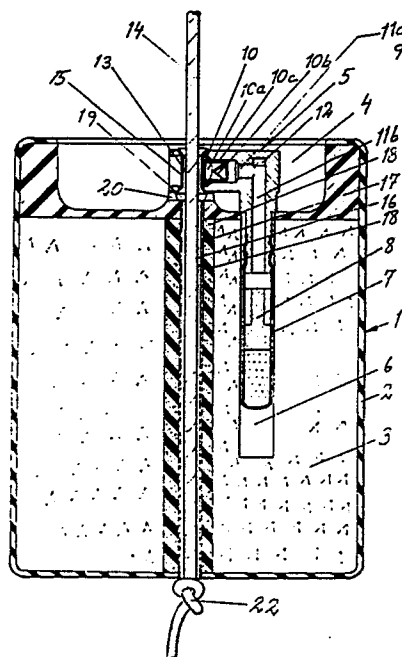
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Detonator for a non-electric detonation system for blasting charges.

The present invention relates to a detonator for nonelectric detonation systems for blasting charges intended to be initiated by a detonating fuze (14) which passes through a passage (13) provided for this purpose in the body (9) of the detonator (5). A major characterising feature of the detonator (5) according to the present invention is that a conventional percussion cap (10) which is immediately initiated by the detonating fuze (10) is utilised for initiating the detonator.

The invention also relates to a booster charge (1) intended for the detonator and provided with a reinforced central channel (16) for the detonating fuze (14).



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TITLE OF INVENTION:

A DETONATOR AND A CHARGE
ADAPTED THERETO

TITLE MODIFIED

see front page

TECHNICAL FIELD

The present invention relates to a detonator for a non-electric detonation system for blasting charges, primarily intended for interval delay blasting, but also usable in the
5 initiation of individual charges. The present invention also relates to a specially designed booster charge adapted to the detonator.

BACKGROUND ART

In delay interval blasting above ground, non-electric
10 detonation systems are generally preferred, since otherwise extreme vigilance must be maintained vis-à-vis the risk of electric storms and the use of radio transmitters in the immediate vicinity. This latter means of communication may constitute a particular problem, since today's contracting and mining
15 industries are making increasing use of communication by radio for work supervision. The use of electric drills and loading machines has also increased considerably, particularly in tunnelling work.

PETN fuzes or other detonator fuzes may advantageously be
20 used for a more or less instantaneous initiation of a plurality of blasting charges. It is also possible to initiate the different charges in a delay interval blasting operation by means of a detonating fuze, but in such cases special individually delayed detonators are required which transmit the detonation impulse from

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the detonating fuze to each respective major charge or booster. A number of different but closely related time delay fuzes of this type and booster charges adapted thereto are disclosed in US Patent Specifications 4 060 033 and 4 165 619, and also in
5 laid-open EPO Application No. 0 164 941. According to the two US patent specifications, the booster charges are constructed in mutually reminiscent manners, with an insulated tunnel along their one longitudinal edge in which a PETN fuze may pass. Furthermore, the charges are provided with a bore or a groove close to their
10 second longitudinal edge in which the detonation cap of the fuze with its associated delay assembly may be placed. Furthermore, the fuzes described in each respective patent specification are designed with communication means angled from each respective detonation cap and extending across the charges and up to the
15 tunnel for the PETN fuze where they are provided with a pyro assembly. Thus, the intention is that the pyro assembly be initiated when the PETN fuze detonates. The fire from the pyro assembly is then led, through the intermediary of the communication means (which, according to US PS 4 060 033, is to
20 consist of a low-strength detonating fuze, and, according to US PS 4 165 691, of an empty, angled plastic tube) further to the delay assembly of the blasting cap in order, after the pre-determined time delay, to initiate the blasting cap and, in its turn, each respective booster charge.

25 Albeit the basic principles of these two charges with their associated detonators may in and of themselves be satisfactory, their detailed designs are nevertheless afflicted with a number of serious drawbacks. Thus, the detonators are designed as elongate, angled members which are sensitive to disruption and may be tricky
30 to mount in place if the blasting operation is to be carried out during the winter and the charge layer is obliged to work with gloves. Moreover, the insulated tunnels for the PETN fuze are disposed along the one longitudinal edge of the booster charges, with the result that the PETN fuze cannot be used for lowering the
35 charges down into narrow bores, which would otherwise have been the most practical solution. The reason for this is that with the lowering cable, i.e. in this case the PETN fuze, disposed along

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the one edge of the charge, the "jammed drawer" effect is almost unavoidable between the relatively heavy charges and the drill riflings on the side walls of a narrow bore hole.

The booster charge and detonator according to EPO Patent Application No. 0 164 941 are more practicable construction, but neither can these be considered as fully satisfactory from all aspects. Thus, the booster charge consists of an explosive charge encapsulated in a cylindrical casing and provided with a first centered axial through-passage and a second passage disposed parallel with at some distance from the first passage, the second passage being, however, not necessarily a through-passage. According to the EPO application, a low-strength detonating fuze is led through the first passage and a blasting cap with built-in delay assembly is disposed in the second passage. As communication link between the detonating fuze and the blasting cap there is further provided, in a specially adapted space in one end of the booster charge, a device which in the body of the specification is designated a coupling charge. This consists of an impact or shock-sensitive detonating explosive encapsulated in its own protective capsule. To hold together the blasting cap, which at its one end turned to face the coupling charge is provided with a percussion cap, and the coupling charge, a separate detail designated a coupling block is employed. The coupling block is further provided with a slit tubular anchorage member which is intended to be passed down into the above-mentioned first passage for fixedly retaining the interconnected unit consisting of the blasting cap and the coupling charge. In its turn, the anchorage device is provided with a central channel with room for accomodating the detonating fuze.

Thus, the apparatus disclosed in the EPO application offers a booster charge which is initiated by means of a centrally and axially placed detonating fuze through the intermediary of a specially designed and adapted detonator consisting of a separate coupling charge and a blasting cap united by means of a separate coupling block. The disadvantages inherent in this prior art apparatus are that it contains a plurality of different details

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which must be interconnected and, as a result will be most
circumstantial to handle. At the same time, the separate provision
of a coupling charge which is initiated by the detonating fuze and
in its turn initiates the blasting cap entails the introduction of
5 an extra detonation signal transfer stage which in itself involves
increased risk of malfunction. In this context, it cannot be
over-emphasized that booster charges of this type are normally
employed for the initiation of such low energy explosives as are
used in interval or deck blasting in open cast mining and
10 quarrying and in contracting work in which every salvo contains
immense amounts of explosives, for which reason any malfunction of
the detonation system is wholly unacceptable. The major advantage
offered by the detonation system according to the EPO application
is probably that the component parts and details are - as is also
15 pointed out in the specification itself - extremely well suited
for mass production in modern automatic machines. In all
probability, the coupling charge also requires extremely careful
handling.

OBJECT OF THE PRESENT INVENTION

20 The primary object of the present invention is to realize a
detonator produced in a single unit and intended for booster
charges of the main type described in the above-mentioned EPO
patent application.

ADVANTAGES

25 The detonator according to the present invention enjoys the
advantage that it is supplied ready-for-use as a unit which need
not be assembled in conjunction with the charge. As a result, the
detonator may easily be handled, even wearing gloves. The sole
measure required on final disposition and arrangement of the
30 charge is to insert the detonator into the space intended
therefore in the booster charge and to insert a detonating fuze
through a passage provided in the detonator body and further
through the central channel or tunnel of the coincident booster
charge.

35 A major characterising feature of the detonator according to
the present invention is that the detonating fuze passing through
a special passage through the body of the detonator will, on

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its detonation, directly initiate a percussion cap which is disposed in the immediate vicinity of the passage and is provided with a conventional receptive base, the direction of detonation and effect of the percussion cap being at right angles to the longitudinal direction of the detonating fuze. In its turn, this percussion cap initiates a detonation tablet or capsule which, either directly or through the intermediary of a conventional delay assembly, initiates the blasting cap which detonates the booster charge.

10 It has become possible to construct a compact, operationally reliable detonator integrated in a single functional unit by the steps of disposing the percussion cap in direct association with the detonating fuze, possibly separated from the fuze by a thin metal seal, and with the effective direction of the percussion cap
15 aimed along a first passage disposed at right angles to the fuze, this passage being angled, at a suitable distance, down into a second passage which is parallel with the fuze and there terminates with a conventional blasting cap which may be provided with a built-in delay assembly, and finally by disposing the
20 detonating tablet or capsule now under consideration in the angle between the first and the second passages.

The body of the detonator may be manufactured of metal or plastic, but is suitably of metal.

Percussion caps provided with a receptive base have been used
25 for many years and are extremely reliable in their function. The ignition capsule is highly sensitive to initiation and is suitably mounted in the angle between the first and the second detonation passage immediately above the change of direction proper where the second ignition passage is angled down in parallel with the
30 longitudinal axis of the booster charge. This entails that the effective direction of the detonation capsule will be aimed straight at the blasting cap. At the same time, this disposition entails that the initiation capsule lies close to the percussion cap, but well protected so as not to be fractured on initiation of
35 the blasting cap. This arrangement ensures an extremely high degree of blasting safety and reliability, at the same time as the percussion cap is disposed in a well protected position within the

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wall of the passage of the detonating fuze where it may, moreover, be further protected by a thin metal seal. Hence, all high-shatter or "brisant" details are well encapsulated within the detonator body.

5 As far as the booster charge proper is concerned, the present invention calls for the provision of the booster charge with a defining lining about the central passage which protects the secondary explosives in the booster charge from the detonation of the detonation fuze. This provision according to the present
10 invention is intended to enable the employment of standard quality PETN fuzes, thereby obviating the requirement of selecting low-power fuzes of special qualities. Suitably, this lining consists of a thin-walled metal sheath and, preferably, a steel tube which, moreover, may be provided with extra insulation
15 between itself and the explosive, this extra insulation consisting of an elastically or plastically deformable plastic layer. This latter reinforced lining of the central passage may be motivated in, for example, underwater blasting, in which the presence of water in the central passage would markedly increase the pressure
20 rises in the central passage when the detonation fuze is fired.

It is further proposed according to the present invention that one or more ventilation apertures be disposed between the detonator body and the adjacent end of the central passage, such that the gases generated from the detonation of the fuze may be
25 led off from the central passage without the risk that these dislodge the detonator body from its normal position. Such ventilation is most simply provided in that the detonator body be allowed to rest against the edge about the central passage through the intermediary of two or more creases with interjacent openings
30 disposed in the detonator body or the booster.

The present invention may also be considered as including a method of anchoring the fuze in the booster, according to which the coring-out or end recess adapted for the detonator body is designed with an edge or ridge projecting at least partly over the
35 assembly mounting position of the detonator body and preventing the detonator from being inserted in place with the blasting cap

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in its intended passage as long as the passage of the detonator body and the central passage of the booster charge for the detonator fuze are centered in register with one another. Nevertheless, this edge or ridge is of such dimensions as to
5 permit insertion of the fuze down with the blasting cap in the passage intended therefor as soon as the detonator body has been twisted aside such that the above-mentioned aperture and passage do not cover one another, and the detonator body may be twisted into place beneath the ridge as soon as the blasting cap is wholly
10 inserted in the passage intended therefor. In this latter position, the detonator is held in place by the ridge. It is also possible to design the recess in the end of the booster with two opposing beads between which the detonator body is urged into place and snapped in position.

15 The booster charge is most simply fixed in position on the detonator fuze by an edge beneath the booster and, if required, the end of the booster provided with the detonator may be turned to face downwardly. The detonator will then be reliably fixed in place by the weight of the booster until such time as the
20 detonator fuze is fired.

If extremely high detonation reliability is required, the detonator according to the present invention may be provided with two or more separate, identical detonating units joined together in a single detonator.

25 BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The nature of the present invention and its aspects, as defined in the appended Claims, will be more readily understood from the following brief description of the accompanying Drawings, and discussion relating thereto.

30 In the accompanying Drawings:

Figs. 1 and 3 are longitudinal sections through the booster charge of the present invention provided with mounted single- and double-sided detonators, respectively;

Fig. 2 is an oblique projection of the detonator according to
35 Fig. 1; and

Fig. 4 is an end elevation of the projection in Fig. 3.

Corresponding details on the different Drawing figures have been given the same reference numerals.

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DESCRIPTION OF PREFERRED EMBODIMENT

Referring to the Drawings, Fig. 1 shows a booster charge 1 consisting of an outer shell 2, a charge 3 of a secondary explosive, for example hexoto1 or compressed PTB/TMT. At one end of the booster charge, there is a depression or recess 4 for a detonator 5, a coring-out or bore 6 being included in the charge 3 for insertion of the blasting cap 6 of the detonator with its associated pyrotechnical delay assembly 8. The blasting cap 7 and its delay assembly are encased, in a conventional manner, in a thin metal sheath.

The detonator 5 consists moreover of a body 9 of metal or plastic in which the blasting cap 7 is fixedly retained at a right angle to the plane of the body. The body 9 is inserted into the recess 4 and there extends past the central passage 16 of the booster charge 1. The detonator body 9 further includes a through-passage 13 for the detonator fuze. When the detonator 5 is mounted in place, the passage 13 and the central channel 16 coincide, such that a detonator fuze 14 may be passed there-through. From the passage 13, there departs, at right angles to the major direction of the detonator body 9, a first detonator channel 11a. At a slight distance from the passage 13, this channel forms a right angle with a second detonator channel 11b whose other end terminates at the detonation end of the blasting cap 7. At the first end of the channel 11a, in immediate association with the passage 13, a percussion cap 10 is pressed in place. This comprises an ignition charge 10a and a base 10b, encased in a metal sheath 10c. The passage 13 is lined with a thin tubular rivet 15 which, hence, runs in immediate association with the end of the percussion cap 10 and, on detonation of the fuze 14, is buckled such that the percussion cap is initiated. However, the body 9 proper and the tubular rivet 15 are dimensioned to be of such strength as not to be pulverised on detonation of the detonation fuze. At the elbow or angle between the first channel 11a and the second channel 11b, a detonation capsule 12 in the form of a pyrotechnic assembly is disposed so as to ensure that the flame from the percussion cap 10 is transmitted to the delay assembly 8 of the blasting cap 7, which in its turn initiates the blasting cap proper.

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The capsule 12 is suitably mounted in the illustrated position in the wall of the first channel 11a immediately above the discharge orifice of the second channel 11b; where the capsule is protected from being shattered by the detonation flame from the percussion cap 10, but is sufficiently close to be ignited and positioned where its own ignition direction is aimed directly at the delay assembly 8. Furthermore, the capsule 12 is suitably in the form of a compressed cylindrical washer or truncated tube with a centre hole which coincides with the opening of the second channel.

With the fuze in the assembled state, the passage 13 constitutes a direct continuation of a channel 16 which passes centrally through the booster 1. The channel 16 is lined with a thin steel tube 17 and may be provided with a lining 18 facing the charge 3 and consisting of, for instance, a deformable plastic material. This is provided to absorb elevated pressure on detonation of the fuze 14 in such cases as, for example, underwater blasting.

In order that the pressure or shock wave deriving from the detonation of the fuze 14 does not force the detonator out of its normal position, a pressure relief gap 19 has been provided between the end of the tube 17 and the detonator body 9. This gap has been realised by means of two beads 20 and 21, disposed in the booster wall about the upper end of the channel 16. These beads could just as well have been incorporated in the detonator body.

Arming of the detonator 5 in the booster 1 is a simple operation, since its blasting cap 7 need merely be moved down into the coring-out or recess 6, the detonator body 9 be snapped in place in the recess 4 and the detonating fuze 14 be passed through the channel 16 and further through the passage 13 and also be provided with at least one retaining nut on the under face of the booster to prevent it from sliding out of position. In the condition illustrated in Fig. 1, the complete charge is ready to be lowered down, with the fuze 14 as lowering line, into a bore hole where the charge may, for example, be used for initiating a low-energy explosive of the slurry type which otherwise fills out the remainder of the bore hole.

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In cases of delay interval, or deck, blasting, use is made of detonators with different pyrotechnical delay assemblies 8 in the detonators in each respective bore hole.

In the apparatus according to the present invention
5 illustrated in Figs. 3 and 4, there is disclosed a detonator 23 whose detonator body 24 has been rendered double-sided, with room for two identical detonation systems. Since all other details are identical - with the exception that the booster 1a has been provided with a second coring-out 6a for the second blasting cap
10 7a, all of the remaining details have been given the same reference numerals as previously.

The detonation system permits delayed interval, or deck, blasting in that detonators with different delay assemblies are employed. Naturally, several detonators may be interconnected,
15 either in parallel with the detonating fuze as detonation signal transfer member, or alternatively in series with the charges placed one after the other. Irrespective of the mode selected, initiation of the different detonators will be substantially instantaneous.

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WHAT WE CLAIM AND DESIRE TO SECURE BY LETTERS PATENT IS:

1. A detonator (5) for explosive charges (1) intended to be initiated by a detonating fuze (14) which passes through a passage (13) intended therefor and provided in the body (9) of the detonator (5), comprising a detonating function (10) encapsulated in the body (9) of the detonator in immediate association with said passage (13), and a blasting cap (7) in communication with said detonating function (10) and parallel to but spaced apart from the passage (13) for the detonating fuze (14), and anchored in the body (9) of the detonator, possibly preceded by an integral delay assembly (9) designed in a conventional manner, characterised in that said detonating function (10) consists of a percussion cap (10) which is disposed in immediate association with the detonating fuze (14), and whose impact sensitive detonating charge (10a) is turned to face said passage (13) for the fuze (14), while its detonation direction coincides with a first detonation channel (11a) disposed at right angles to the longitudinal direction of the fuze (14), said channel merging, through the intermediary of a right-angled elbow, into a second detonation channel (11b) which leads to said blasting cap (7), and a detonation capsule (12) in the form of a pyrotechnical assembly, being disposed in the angle between the first and second detonation channels.

2. The detonator as claimed in claim 1, characterised in that the percussion cap (10) is of the type which is provided with a receptive base (10b) which rests against its impact-sensitive detonating charge (10a).

3. The detonator as claimed in claim 2, characterised in that the passage (13) intended for the detonating fuze (14) is lined with a thin metal insert (15) for example in the form of a tubular rivet which separates the percussion cap (10) from the detonating fuze (14).

4. The detonator as claimed in any one of claims 1-3, characterised in that a detonation tablet or capsule (12) is recessed into the wall of the first channel (11a) in the angle between the first channel and the discharge opening of the second channel.

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5. The detonator as claimed in claim 4, characterised in that the detonation tablet or capsule (12) is in the form of a flat cylindrical washer with a centre hole; and that the axis of said centre hole coincides with the centre axis of said second channel
5 (11b).

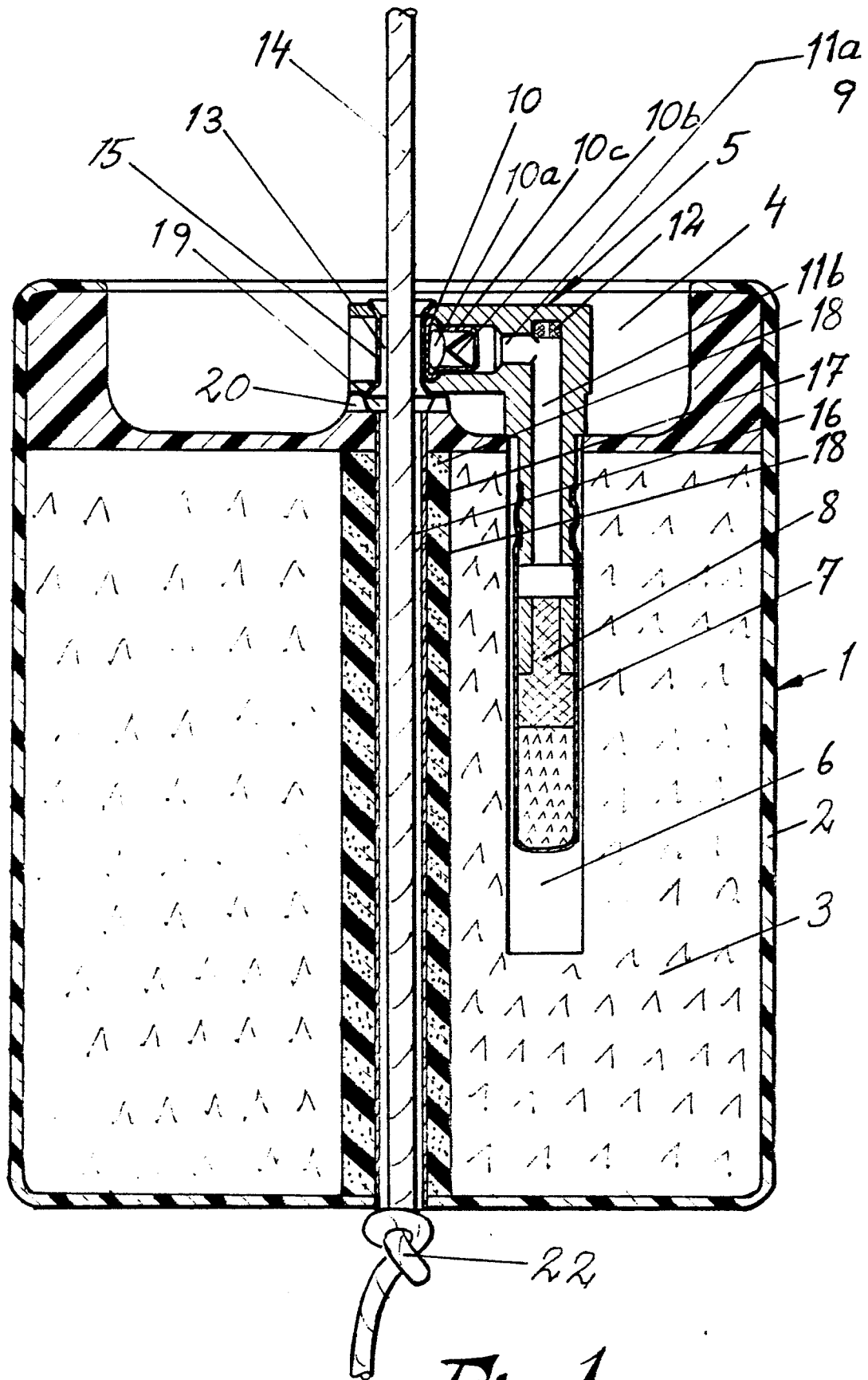


Fig. 1

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