SPOOR & FISHER

FORM P.8
(To be lodged in duplicate)

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

PUBLICATION PARTICULARS AND ABSTRACT

(Section 32(3)(a) – Regulation 22(1)(g) and 31)

OFFICIAL APPLICATION NO.	LODGING DATE	ACCEPTANCE DATE
21 01. 2003/9157	22 ~~11 MAR 2002~~	43 25·11·04

INTERNATIONAL CLASSIFICATION	NOT FOR PUBLICATION
51 F41A; F42B	CLASSIFIED BY: WIPO

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EARLIEST PRIORITY CLAIMED

COUNTRY	NUMBER	DATE
33 AU	31 PR 5280	32 25 MAY 2001

TITLE OF INVENTION

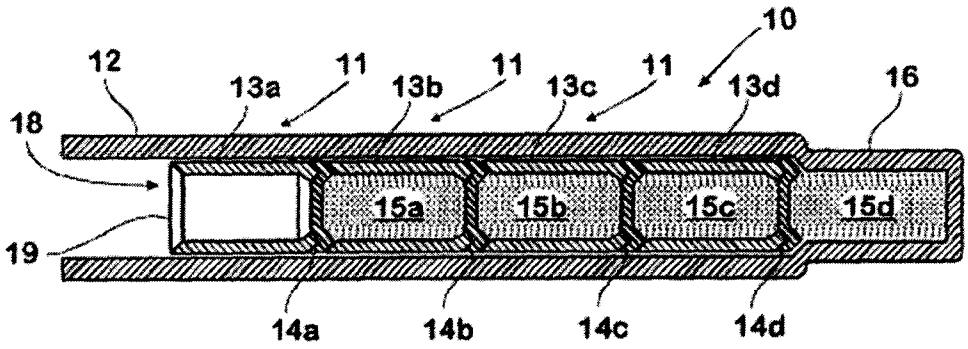
54	BARREL ASSEMBLY WITH TUBULAR PROJECTILES FOR FIREARMS

57	ABSTRACT (NOT MORE THAT 150 WORDS)	NUMBER OF SHEETS	27

If no classification is finished, Form P.9 should accompany this form.
The figure of the drawing to which the abstract refers is attached.

Abstract

A barrel assembly (10) for munitions and firearms, said barrel assembly including a barrel (12) having a muzzle with a plurality of tubular rounds (11) stacked axially within the barrel together with discrete selectively ignitable propellant charges (15). The rounds (11) suitably include tubular bodies (13a, 13b, 13c, 13d) and closure means (14a, 14b, 14c, 14d) interposed between the tubular rounds for effecting both an operative barrel closure between the tubular rounds (11) and operative sealing engagement with the barrel (12). The propellant charges (15) are contained within each round (11) and selectively ignitable (15a) for propelling an adjacent leading round (13a) and associated closure means (14a) through the muzzle of the barrel.



BARREL ASSEMBLY WITH TUBULAR PROJECTILES FOR FIREARMS

TECHNICAL FIELD

The invention relates to munitions and firearms. This invention has particular, but not exclusive, application to a barrel assembly having a plurality of rounds stacked axially within a barrel together with discrete selectively ignitable propellant charges for propelling the rounds sequentially through the muzzle of the barrel. Such barrel assemblies will be referred to hereinafter as "of the type described".

BACKGROUND ART

This invention concerns barrel assemblies for munitions and firearms, particularly of the type described, such as illustrated in earlier International Patent Applications Nos. PCT/AU94/00124 and PCT/AU96/00459 filed by the present inventor.

Whilst tubular rounds are known in certain limited applications such as supersonic projectiles, the applicant is unaware of any tubular rounds suitable for stacking within a barrel with selectively ignitable propellant charges, and particularly no tubular rounds suited to barrel assemblies of the type described.

DISCLOSURE OF INVENTION

It is desirable to provide barrel assemblies for electronically controlled munitions and firearms, particularly of the type described, that are adapted to firing tubular type rounds, and to provide tubular rounds for that purpose.

According to one aspect this invention provides a barrel assembly of the type described including:

a barrel having a muzzle;

a plurality of tubular rounds stacked axially within the barrel and arranged for operative sealing engagement with the barrel;

closure means interposed between the tubular rounds for effecting both an operative barrel closure between the tubular rounds; and

a selectively ignitable propellant charge within each round and ignitable for propelling an adjacent leading round and associated closure means through the muzzle of the barrel.

Preferably the tubular rounds are stacked in abutting relationship, although they could be spaced apart by the propellant. It is also preferred that each round includes a tubular body having a closure means associated with at least its trailing end.

The closure means may also act to close the leading end of the trailing round. Alternatively, separate closure means could be used for the leading and trailing ends of each round provide that the closure for the leading end is made inoperative upon ignition of the charge therein to enable the combustion effects to propel the leading round from the barrel.

The closure means may be arranged to discard from the tubular body or it may be fixed to the leading tubular body. The tubular rounds may be configured to have desired flight characteristics by their aerodynamic form. The form of the inner face of the tubular body, when used with a discarding closure means, may act to maintain axial alignment of the round with the flight path. Alternatively the tubular body may be weighted whereby one end is heavier than the other end.

The closure means is suitably a closure wall member sandwiched between adjacent tubular body portions. Each closure wall member may extend to and engages sealably with the barrel. Alternatively the tubular rounds may have complementary outer end wall portions which abut or lie closely adjacent one another, with the closure wall member being sandwiched between inner end wall portions.

In the former arrangement, the closure wall member may be sandwiched between end faces of adjacent tubular rounds. The closure wall member may be of a form which does not deform under operational conditions. Alternatively, the peripheral portion of the closure wall member may be formed so as to spread outwardly between the adjacent tubular rounds into operative sealing engagement with the barrel by axial compression applied by the end faces. For low pressure applications, such deformation for effecting a tight sealing engagement with the barrel should not be necessary.

The end faces of adjacent tubular rounds may extend radially of the barrel or the end faces of adjacent tubular rounds may be formed to engage with respective complementary wedging surfaces on the peripheral portion of the sandwiched closure wall member.

The tubular bodies of adjacent rounds may overlap one another to provide a telescoped engagement between adjacent rounds. For this purpose the rounds may include outer end wall portions which overlap inner end wall portions of the adjacent round and the closure wall members may be sandwiched between inner complementary end wall faces of the telescoped rounds.

If desired the telescoped portions of adjacent rounds may include a thin walled portion which may expand outwardly into sealing engagement with either the adjacent telescoped round portion so as to prevent escape of propellant into the barrel or blow by into the adjacent propellant charge. Alternatively the outward expansion may be of the outer telescoped portion so as to enhance the sealing engagement of the round being fired and the barrel.

Each sandwiched closure wall member may also be arranged to react to propellant charge pressure against its leading face to seal against the end face of the trailing round to prevent blow-by ignition of the charge contained in the adjacent trailing round. Such reactive sealing may also occur between abutting end face portions of the rounds and/or between the leading round and the closure wall member.

The ignition of the propellant charges may be such as is described in my earlier International applications. For this purpose each selectively ignitable propellant charge may include an electrically actuated primer connected to a pair of spaced annular contacts extending about the round and contacting respective electrical contacts protruding through the barrel and suitably associated with electronic control means.

The closure means may be integral with the rounds and may include wall segments which may move, or a wall which may expand, forwardly from a closed attitude to an open attitude and substantially barrel conforming attitude. When in the closed attitude the wall segments may react to ignition of a leading propellant charge to maintain or enhance the closing effect of the closure means.

Suitably each round with its propellant charge is prepared prior to loading into the barrel but if desired the barrel may be loaded by sequentially loading a round tubular body having on open leading end, propellant charge followed by closure of the open end, either as a separate operation or as a result of placing the next round tubular body into its located position.

In another aspect, the invention resides in a round for firing from the barrel assembly of a munition or firearm, said round including:

an open ended tubular body adapted for loading into a barrel of the barrel assembly and for operative sealing engagement with the barrel;

a closure wall member adapted to be interposed between said tubular body and the tubular body of an adjacent round for effecting an operative barrel closure between rounds; and

a selectively ignitable propellant charge within the tubular body of the adjacent round, which propellant charge is ignitable for propelling the tubular body of said round through the muzzle of the barrel.

BRIEF DETAILS OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate typical embodiments of this invention and wherein:

FIGS. 1A to 1D diagrammatically illustrate, in section, one form of the invention and its mode of operation;

FIGS. 2A to 2D diagrammatically illustrate, in section, a further embodiment of the invention and its mode of operation;

FIG. 3 is a perspective view illustrating one round of the embodiment illustrated in FIGS. 2A to 2D;

FIG. 4 diagrammatically illustrates, in section, another form of the invention; and

FIG. 5 diagrammatically illustrates, in section, yet another form of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the embodiment illustrated in FIGS. 1A to 1D, the barrel assembly 10 has a plurality of rounds 11 stacked in axial abutting relationship within the barrel 12 and which are adapted to be fired electrically or otherwise in sequence, such as is illustrated in the inventor's earlier International applications or as is otherwise known in the art.

Each round 11 comprises a tubular body 13 associated with a barrel closure member 14 disposed between and separating adjacent tubular bodies 13a, 13b, 13c and 13d from one another, and with a propellant charge 15 arranged behind a closure member 14. The propellant charge 15a is, for example, supported within a trailing tubular body 13b between respective barrel closure members 14a and 14b. In the embodiment a further propellant charge 15d is contained in a rear extension 16 of the barrel assembly 10 for propelling the rearmost tubular body 13d.

It will be seen in FIG. 1A that the leading annular end 18 of each body 13 extends inwardly and rearwardly to form a part conical end face 19. The part conical end face co-operates with a complementary part conical face 22 formed about the outer trailing peripheral portion of the barrel closure member 14, as shown in FIG. 1B. A further complementary part conical leading face 23 is formed about the outer edge of the closure member 14, as shown in FIG. 1C. The further complementary part conical leading face 23 is associated with a return face 24 so as to provide a recess 25 which receives the complementary shaped trailing end wall 26 of each tubular body 13.

It will be seen that the end walls 26 return inwardly whereas the remainder of the tubular body 13 is of constant tubular section, although it could be formed to provide a venturi shape through the body 13 if desired.

The return wall portion 26 is captured by the closure member 24 during firing of the leading body 13 from the barrel as illustrated in FIG. 1B. As depicted in FIG. 1C the closure member 14 may be discarded from the tubular body 13 during flight, such as the result of rotation of the body 13 due to rifling provided in the barrel 12 or it may stay with the body 13 during flight as depicted in FIG. 1D. For this purpose, the closure member 14 could be secured to the body 13 by screwing, pinning, gluing, swaging or otherwise as required.

In use, the barrel assembly 10 is stacked with rounds 11 wherein an empty tubular body 13a is the leading projectile. When the leading propellant charge 15a is ignited in the next adjacent body 13b, the resultant gas pressure will act upon both the leading and trailing end closure members 14a, 14b enclosing the ignited propellant charge. The action of the gas pressure causes the leading closure member 14a to be propelled from the barrel 12 together with the leading body 13a. At the same time the gas pressures will force the trailing closure member 14b into

axial compression with the trailing body 13b, resulting in radial expansion of the part conical end face 19 of the trailing body.

This arrangement will wedge the leading annular end 18 of the trailing body 13b into sealing engagement with the barrel 12 and wedge the closure member 14b into sealing engagement with the part conical end face 19, ensuring there is no leaking of combustion gasses into the propellant of the next trailing charge 15b. Thereafter, the empty body 13b as shown in FIG. 1B may be propelled from the barrel assembly 10 by ignition of the propellant 15b in the next trailing body 13c.

In the embodiment of the barrel assembly illustrated in FIGS. 2A to 2D, each round 30 has a tubular body portion 31 provided with outwardly converging wall segments 33 which abut or overlap to form respective closures for the tubular body 31. These segments 33 provide a central land portion 35 which mutually abut when the rounds 30 are disposed along the length of a barrel 36.

The preferred form of wall segments 33 is an opposing pair of segments as illustrated in FIG. 3, disposed between body extensions 38 having end walls 39 which abut when disposed in the barrel 36.

The leading segments 33 open to lie alongside the barrel 36 upon ignition of the propellant 37 contained within the round 30. Propellant ignition also propels the leading round 30, shown partially in FIG. 2A. This action provides the next leading round 30 with a substantially tubular body 31 in the barrel, which body is closed only at its rear end by the trailing closure segments 33 which diverge rearwardly to provide a land portion 35, as shown in FIG. 2B. The land portion 35 abuts the land portion 35 formed at the front of the forwardly diverging segments 33 of the next adjacent trailing round 30.

When the propellant 37 in that next adjacent trailing round 30 is ignited, its leading segments 33 will open to place the pressure of the combustion gasses into contact with the trailing faces of the segments 33 at the trailing end of the leading body 31 and thus propel that body from the barrel 36. In this action, the next body is made ready for firing.

The segments could alternatively be a plurality of substantially triangular segments having their bases disposed about the periphery of the body 31 and extending inwardly to form a pyramid shaped closure.

If desired, the trailing closure segments 33 may be coupled to the tubular body 31 by hinge means 32, which segments open upon exiting the barrel due to air pressure passing through the tubular body 31, as illustrated in FIG. 2D. If desired, these segments 33 may be provided with flights or other projections to stabilise the flight of the body 31 or make it spin as required.

It will be seen from the above that the high pressure resulting from propellant burn which propels the leading body 31 acts on the rear section of the trailing round, pressing it against the leading edge of the following round, and sealing against undesired blow-by ignition of the propellant in that following round, thus ensuring consistent operation of the firearm at a desired firing rate.

In operation barrel closure members 14 may be the free floating and behave as a discarding section, separated by the rotation of the tubular round if fired from a rifled barrel, or separated by air pressure during flight. With the section discarded the round would have improved aerodynamic performance for relatively long range engagements, such as need when fired from an aircraft or when used to engage incoming missiles in such areas as ship self defence.

However, in certain applications there may be advantage in fixing the closure members 14 to the tubular body 31. For example, the closed rounds may be fired from multiple barrels against a buried land mine. Such a round would then act to scoop earth into the body 31 and carry it away from the mine location. That effect would be into addition to the usual disturbance of earth due to the kinetic impact of the round on the ground. Firing multiple rounds from multiple barrels thus has the potential to provide improved means of exposing and/or neutralizing buried land mines.

The rounds make contact with each other while stacked in a barrel, and are positively located in their intended position. In effect, the rounds utilize a cartridge case which also doubles as the projectile itself.

In the barrel assembly 40 illustrated in FIG. 4, the barrel 41 is shown cutaway at its leading end or muzzle so that only the two rearmost rounds 42 and 43 are illustrated, a leading round (not shown) having been recently fired from the barrel. It will be seen that in this embodiment the rounds 42 and 43 are telescoped, with the outer leading end portion 44 of the trailing round 43 extending about the inner trailing end portion 45 of the intermediate round 42.

All end face portions are part conical with the respective complementary outer end face portions 46 and 47 terminating adjacent one another, and the inner end face portions 48 and 49 terminating in spaced apart relation with one another and in abutting relationship with the closure wall member 50. The closure wall member includes a peripheral portion 52 also having a part conical end face 54. In this embodiment the telescoped wall portions 44 and 45 are relatively long and are formed as a close fit, one within the other.

In use during discharge of the leading round (not shown), propellant pressure acts against the closure wall member 50 of the intermediate round 42 which contains the ignited propellant. This urges the end face 54 of the wall member 50 against the complementary inner end face portion 49 of the trailing round 43. During exit of the leading round, pressure thus acts on the leading ends 47, 49 of the trailing round 43 and forces the intermediate projectile 42 outward and rearward to wedge the trailing face 46 into the leading outer face 47 effecting a seal therebetween. The outward pressure also expands the leading end 51 of the leading outer end portion 44 of the trailing round 43 into engagement with the barrel 41.

The inner faces 48, 49 also wedge into sealing engagement with the peripheral portion 52 of the closure wall member 50, preventing blow by ignition of the propellant for the trailing round 43. Furthermore, the propellant pressure will tend to expand the inner trailing end portion 45 of the intermediate round 42 into tight engagement with the outer leading end portion 44 of the trailing round 43 so as minimise leakage to the barrel 41.

As illustrated a primer 55 is located within each selectively ignitable propellant charge 56 and connected to positive and negative slip ring type contacts 57, 58 spaced along the outer periphery of the rounds 42, 43. The barrel 41 is provided with correspondingly located spring contacts 53, 59 protruding into the barrel for effecting a contact with the respective contact rings 57, 58.

Suitable electronic controls are provided for actuating the primer and igniting the propellant charges 56. These peripheral contacts 57, 58 are suitably utilised on all the illustrated rounds such as is shown in FIG. 3.

The barrel assembly 60 illustrated in FIG. 5 is similar to the embodiment illustrated in FIG. 4, the difference being reversal of the rounds 61 and the annular skirt portion 63 provided in the barrel 64. That is in the FIG. 4 embodiment, the

rounds 42, 43 have an inner wall which reduces rearwardly whereas the inner wall 62 of the rounds 61 is of constant diameter throughout the majority of its length and then expands outwardly. It is believed that this arrangement will provide a more aerodynamic configuration but less effective sealing than the embodiment of FIG. 4.

INDUSTRIAL APPLICATION

The barrel assembly and tubular rounds of this invention could be utilised in small arms but it is envisaged that they would be more suited to rounds of 20mm diameter and above. It will be seen that each barrel closure may cooperate with the leading annular end of the adjacent tubular round, either by forcing the annular end outwardly into contact with the bore of the barrel and wedge a barrel closure into sealing engagement with the barrel or the leading annular end, or by causing the closure member to wedge into close sealing contact with the part-conical inner end of the tubular round and without significant expansion of that leading end into engagement with the barrel.

This wedging may be achieved by maintaining the wedging angles relatively steep, by providing a stop on the leading end which stops rearward movement of the closure at a point at which sealing between the closure and tubular round is effected but prior to radial expansion of the leading end of the tubular round occurring. Alternatively the leading end may be formed sufficiently robust to resist outward splaying under the influence of the wedging action created by the propulsion force from a leading round. Such a sealing action is more suited to low pressure, low muzzle velocity applications.

While illustrated as being stacked rounds supplied in situ in a barrel, the rounds may also be supplied individually to a weapon from an external magazine by conventional means. For this purpose each round may include the closure wall suitably fixed to the trailing end of the round and a wad closure or the like for securing the propellant in the round.

The barrel assemblies of this invention which utilise open tubular rounds may also be useful for firing from underwater locations such as from ships, submarines or as concealed land based surface piercing defence installations. For example submarines may utilise such barrel assemblies for self-defence, for underwater mine destruction or anti-torpedo or missile activity.

It will of course be realised that the above has been given only by way of illustrative example of the invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is set forth in the following claims.

In this specification, applications corresponding to the following patent application numbers have been published under the following corresponding published patent application numbers:

Application Numbers	Corresponding Published Application Numbers
PCT/AU94/00124	WO 94/20809
PCT/AU96/00459	WO 97/04281

CLAIMS

1. A barrel assembly for firearms, including:

a barrel having a muzzle;

a plurality of tubular rounds stacked axially within the barrel;

closure means interposed between the tubular rounds and responsive to pressure for effecting closures between the tubular rounds; and

a selectively ignitable propellant charge within each round and ignitable for propelling an adjacent leading tubular round and associated closure means through the muzzle of the barrel.

2. The barrel assembly as claimed in claim 1, wherein each tubular round has an open ended tubular body portion and each closure means is a closure wall member sandwiched between adjacent tubular body portions.

3. The barrel assembly as claimed in claim 2, wherein each closure wall member extends into contact with the bore of the barrel for effecting operative sealing engagement with the barrel.

4. The barrel assembly as claimed in claim 2, wherein the closure wall member is sandwiched between end faces of adjacent tubular rounds and a peripheral portion of the closure wall member is spread outwardly between the adjacent tubular rounds into operative sealing engagement with the barrel by axial compression applied by the end faces.

5. The barrel assembly as claimed in claim 2, wherein the closure wall member forms a sealing engagement with end faces of adjacent tubular rounds.

6. The barrel assembly as claimed in claim 4, wherein the end faces of adjacent tubular rounds are formed to engage with respective complementary wedging surfaces on the peripheral portion of the sandwiched closure wall member.

7. The barrel assembly as claimed in claim 2, wherein the tubular rounds have complementary outer end wall portions which abut or lie closely adjacent one another and wherein the closure wall member is sandwiched between inner end wall portions.

8. The barrel assembly as claimed in claim 7, wherein the end faces of adjacent tubular rounds extend radially and/or obliquely of the barrel axis.

9. The barrel assembly as claimed in claim 7, wherein said outer end wall portions and said inner end wall portions are axially spaced from one another so as to provide a telescoped engagement between adjacent rounds.

10. The barrel assembly as claimed in claim 9, wherein the telescoped portions of adjacent rounds include a thin walled portion that may expand outwardly into sealing engagement with either an adjacent telescoped portion or the barrel.

11. The barrel assembly as claimed in claim 2, wherein each sandwiched closure wall member reacts to propellant charge pressure against its leading face to seal against blow-by ignition of the charge contained in the adjacent trailing round.

12. The barrel assembly as claimed in claim 1, wherein each selectively ignitable propellant charge includes an electrically actuated primer connected to a pair of spaced annular contacts extending about the round and contacting respective electrical contacts protruding through the barrel.

13. The barrel assembly as claimed in claim 1, wherein the tubular round has a tubular body portion provided with outwardly converging wall segments which converge to form respective closures for the tubular body.

14. The barrel assembly as claimed in claim 1, wherein each round other than the leading round in the barrel contains a propellant charge and the leading round is propelled from the barrel upon ignition of the propellant charge in the following round.

15. The barrel assembly as claimed in claim 14 wherein pressure resulting from ignition of the propellant charge opens wall segments at the leading end of the trailing round.

16. A round for firing from the barrel assembly of a munition or firearm, said round including:

an open ended tubular body adapted for loading into a barrel of the barrel assembly;

a closure wall member adapted to be interposed between said tubular body and an adjacent round and responsive to pressure for effecting a closure between the rounds; and

a selectively ignitable propellant charge within the tubular body for propelling an adjacent leading round through the muzzle of the barrel.

17. The round as claimed in claim 16 wherein the closure wall member is sandwiched between end faces of adjacent rounds and in use a peripheral portion of the closure wall member is spread outwardly between the adjacent rounds into operative sealing engagement with the barrel by axial compression applied by the end faces.

18. The round as claimed in claim 17 wherein the end faces of adjacent tubular rounds are formed to engage with respective complementary wedging surfaces on the peripheral portion of the sandwiched closure wall member.

19. The round as claimed in claim 16 wherein the tubular body has end faces adapted for telescopic engagement with adjacent rounds.

20. The round as claimed in claim 16 wherein the closure wall member is adapted to abut a closure wall member provided on an adjacent round when loaded into the barrel.

21. A round for a firearm, including:

a tubular body that in use forms part of a stack of rounds within a barrel of the firearm;

a closure at the trailing end of the body that responds to pressure to form a seal with an adjacent trailing round in the stack and/or with the barrel; and

a propellant charge within the body that is ignitable to propel an adjacent leading round and a respective closure from the barrel.

22. A round according to claim 21 wherein the closure is responsive in use to pressure caused by ignition of the respective propellant charge.

23. A round according to claim 21 wherein the closure is responsive to form a seal across the tubular body of the trailing round.

24. A round according to claim 21 wherein the closure is responsive to form a seal across the barrel.

25. A barrel assembly for a weapon, including:

a barrel containing an axial stack of tubular rounds;

substantially all of the rounds having a tubular body, a closure at the trailing end of the body, and a propellant charge within the body,

wherein each closure forms a seal across the tubular body in response to ignition of the respective propellant charge.

26. A barrel assembly according to claim 25 wherein the leading round in the stack does not contain a propellant charge.

27. A barrel assembly according to claim 25 wherein the tubular body engages the closure on one or more complementary surfaces.

28. A barrel assembly according to claim 25 wherein each closure also forms a seal across the barrel in response to ignition of the respective propellant charge.

29. A barrel assembly according to claim 25 wherein each tubular round has an open ended tubular body portion and the closures are shaped walls between the open ends of adjacent rounds.

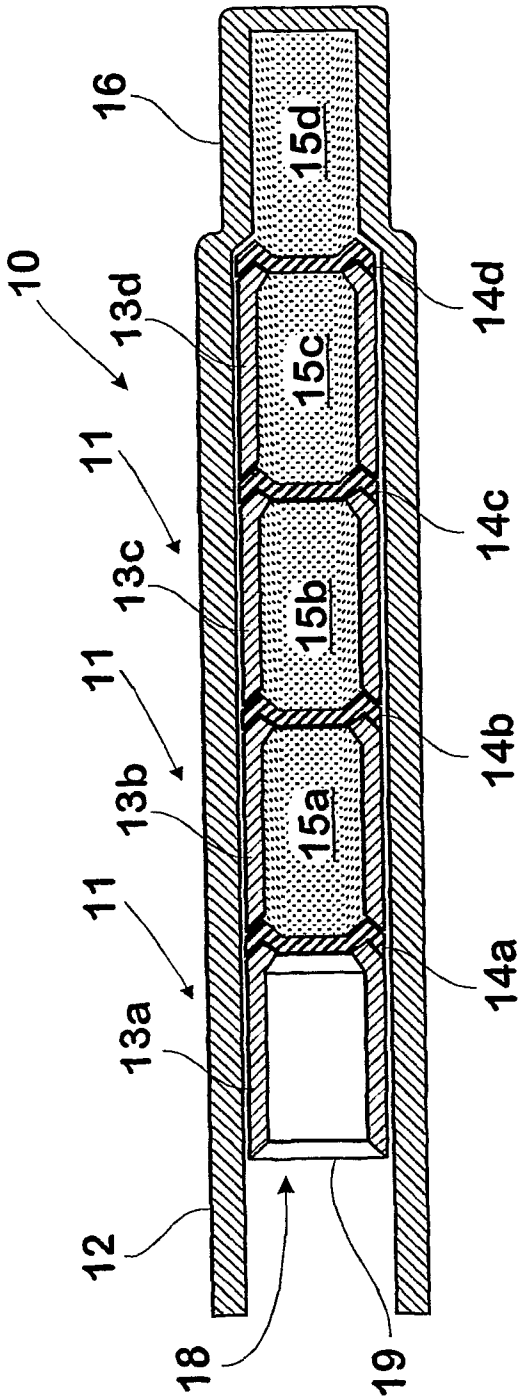

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Fig. 1A

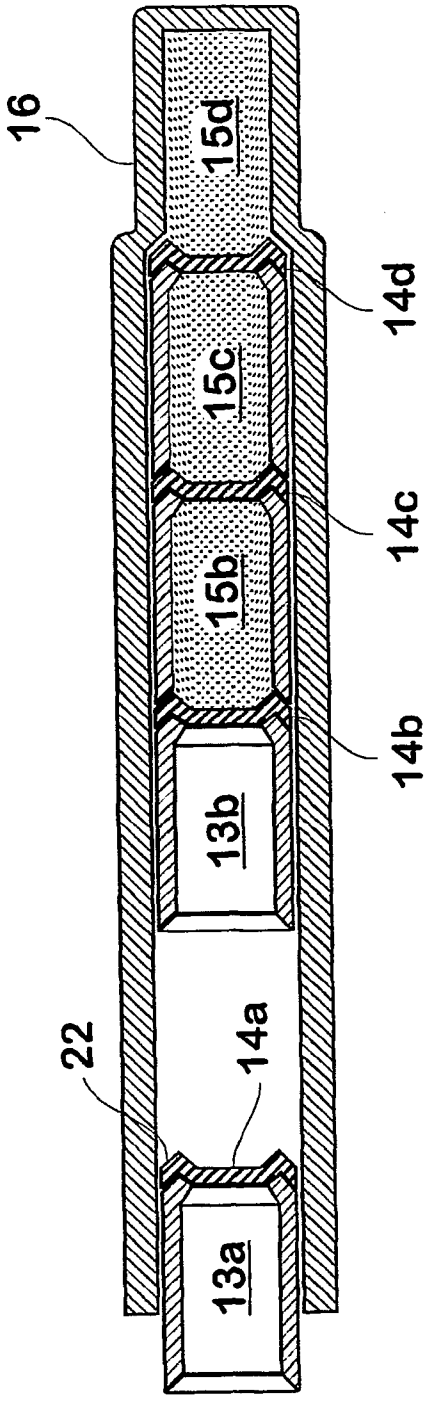
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Fig. 1B

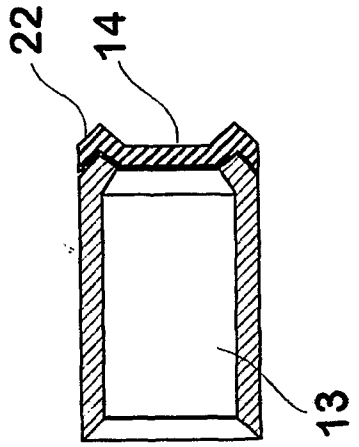

Fig. 1D

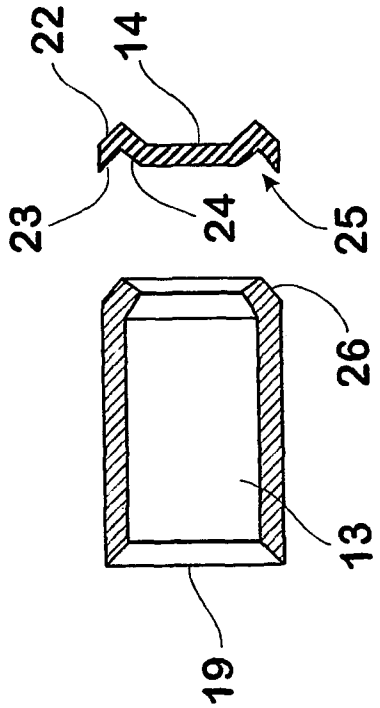

Fig. 1C

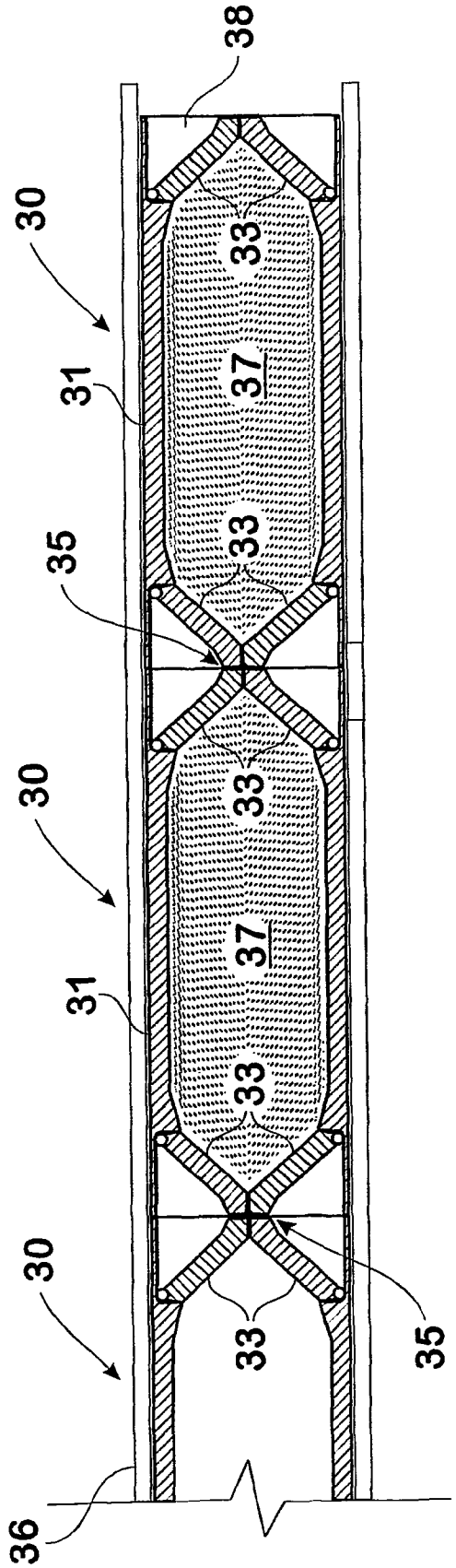

Fig. 2A

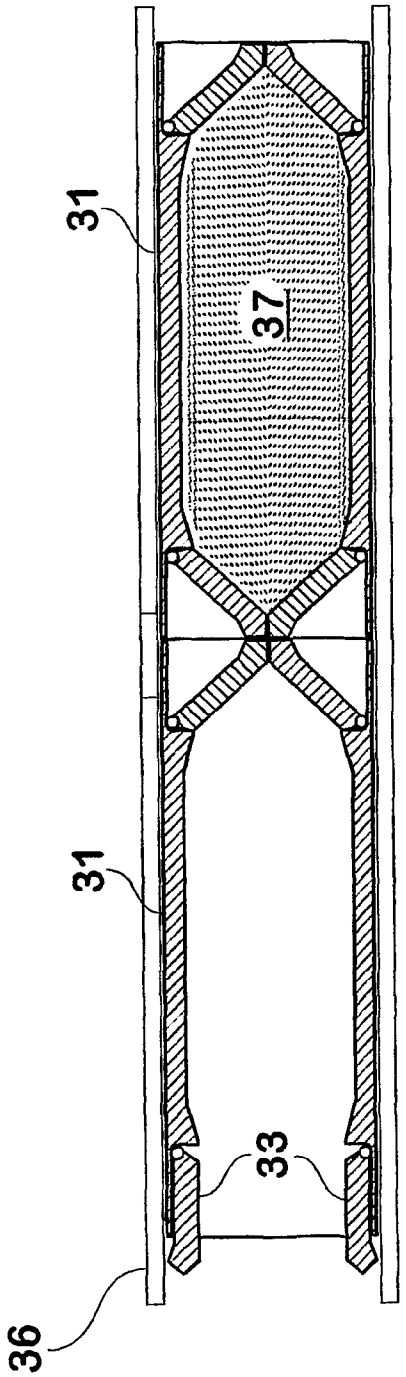

Fig. 2B

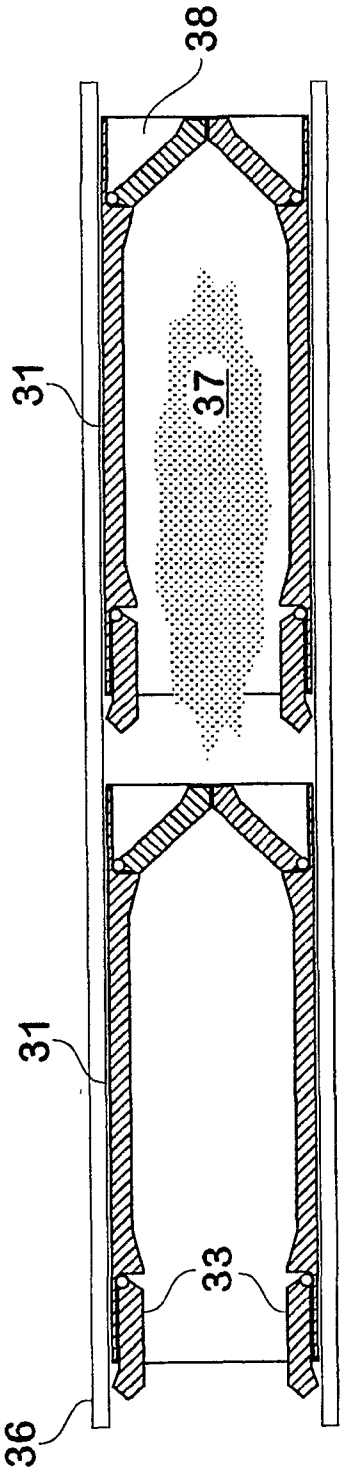

Fig. 2C

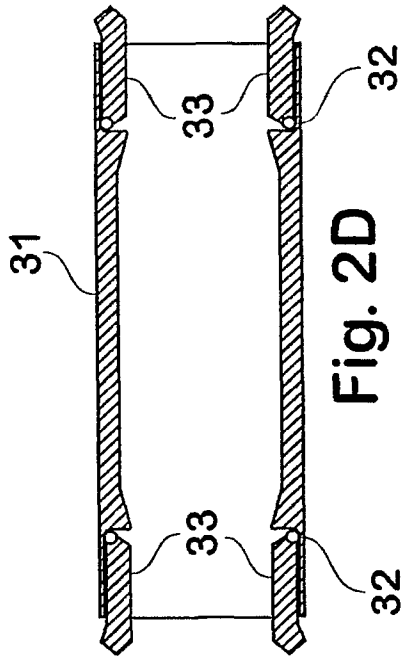

Fig. 2D

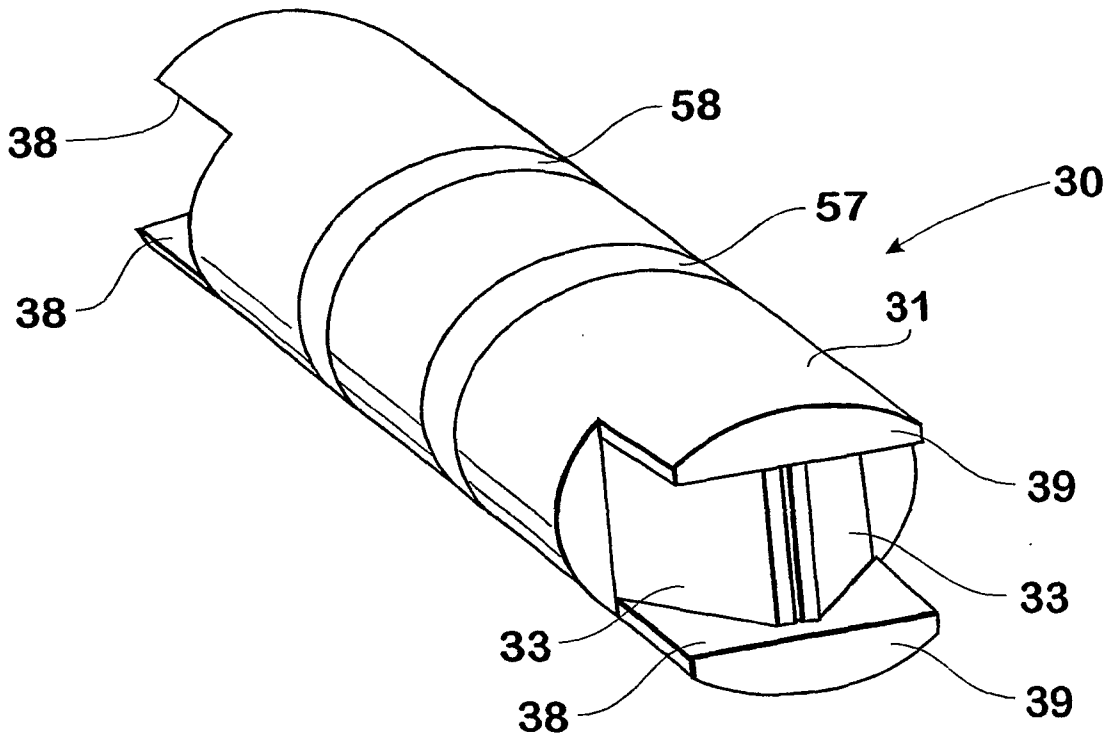

Fig. 3

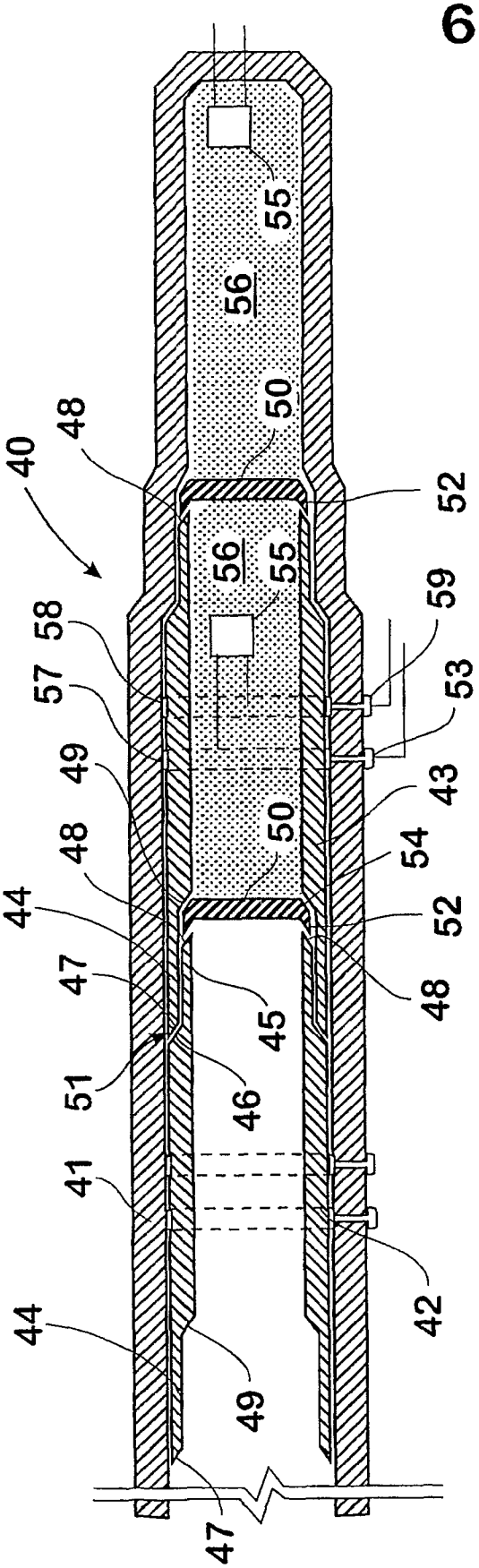
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Fig. 4

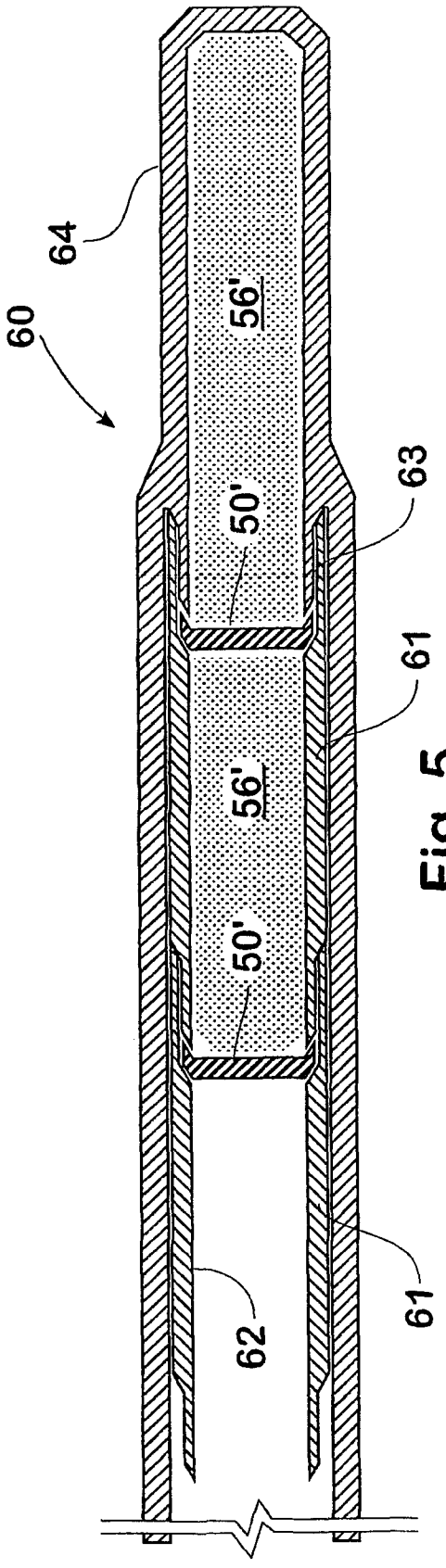
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Fig. 5