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(54) PROJECTILE OR WARHEAD

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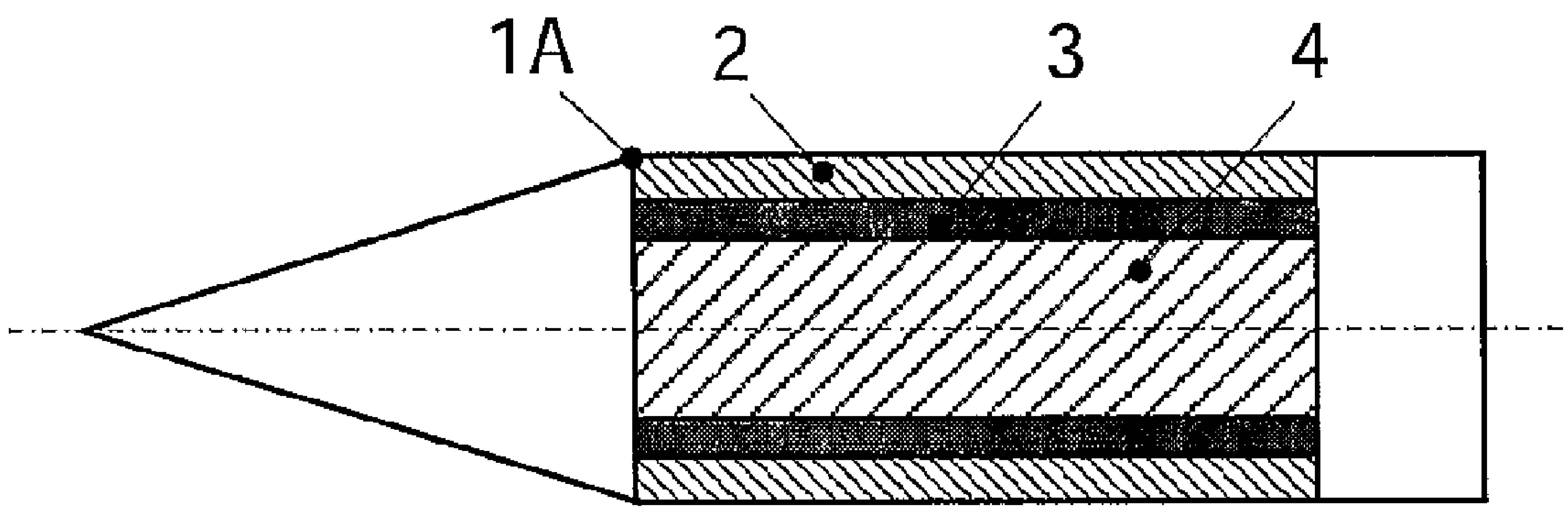
(57) **ABSTRACT**

The aim of the invention is to obtain great final ballistic effectiveness of fragmentation bullets and warheads regardless of the impact speed while using as little explosive material as possible. Said aim is achieved by combining explosive shell (**3**) with a damming inner member (**4**) in connection with an accelerated outer jacket (**2**). This arrangement results in the best possible conversion of the explosive energy while offering great creative flexibility regarding the design. A wide range of additional possible effects is created by blast-compacting the inner damming member (**4**). Furthermore, the shape of the inner damming member allows the fragments to obtain a directionally controlled effect. Depending on the caliber and technical design, the amount of explosive material used can be reduced by 50 to 80 percent compared to conventional explosive bullets at comparable fragment speeds or sub-bullet speeds. The explosive material economized is available as additional effective mass. The accelerated jacket (**2**) can also be entirely or partly composed of preformed fragments or sub-bullets.



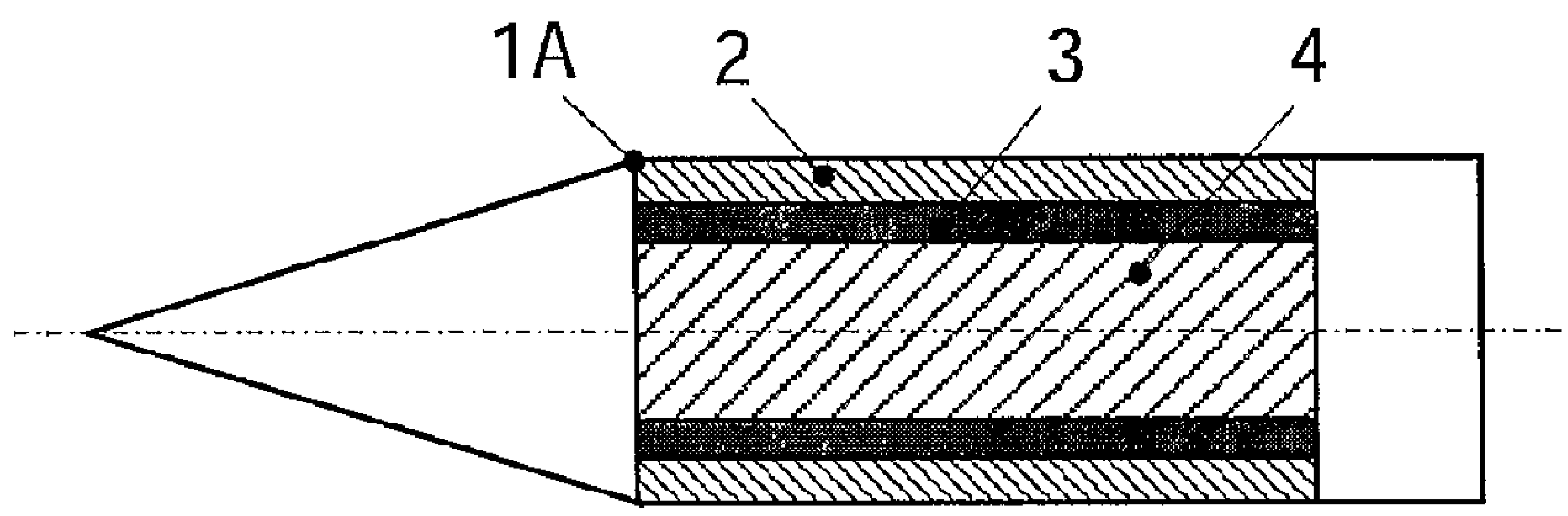


Fig. 1A

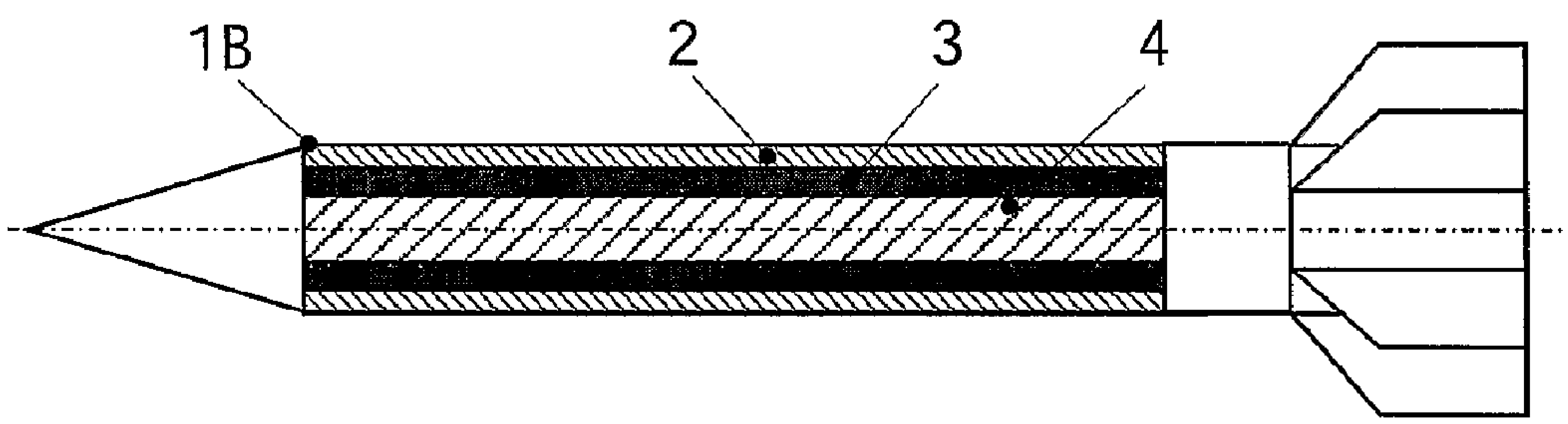


Fig. 1B

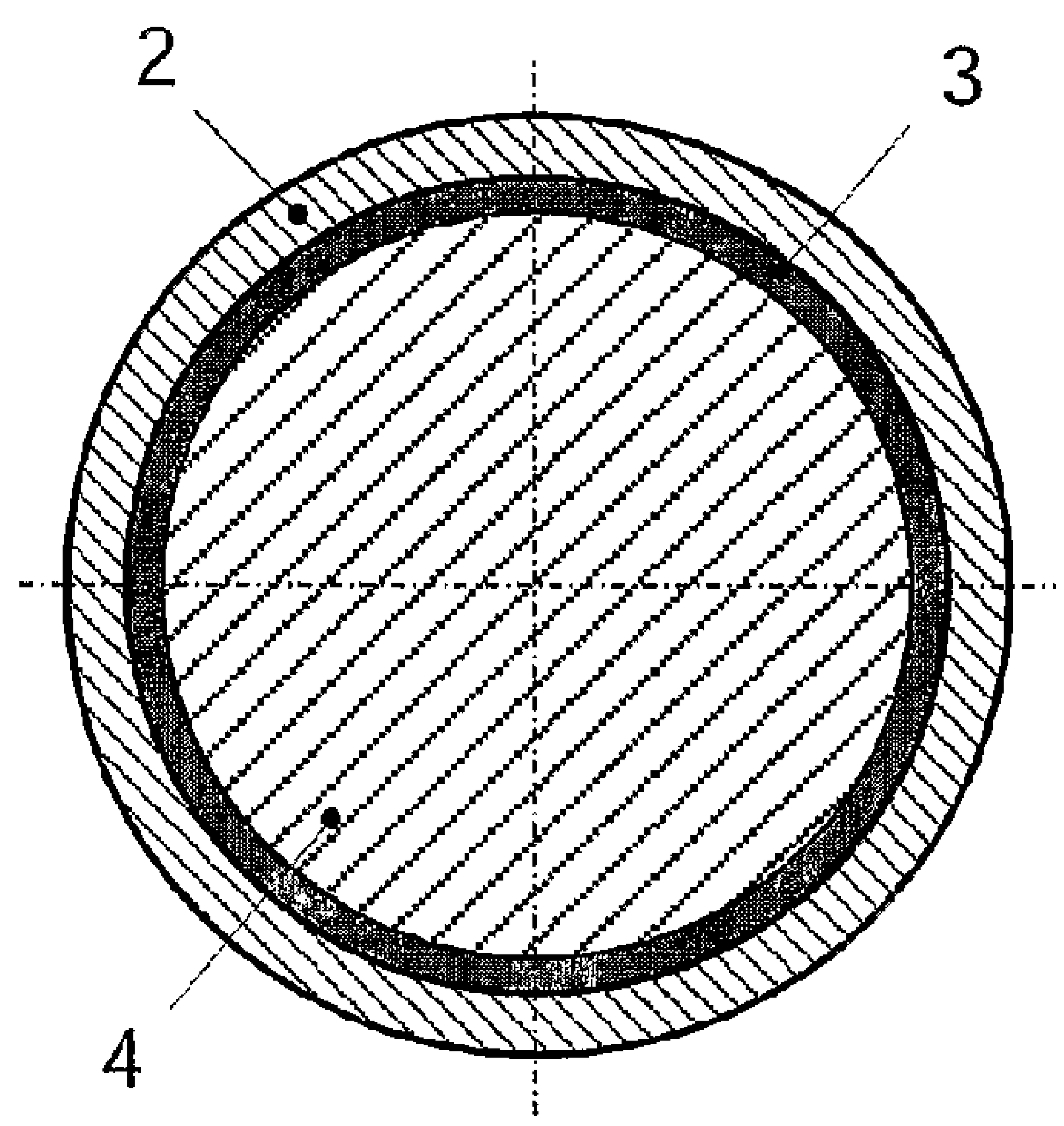
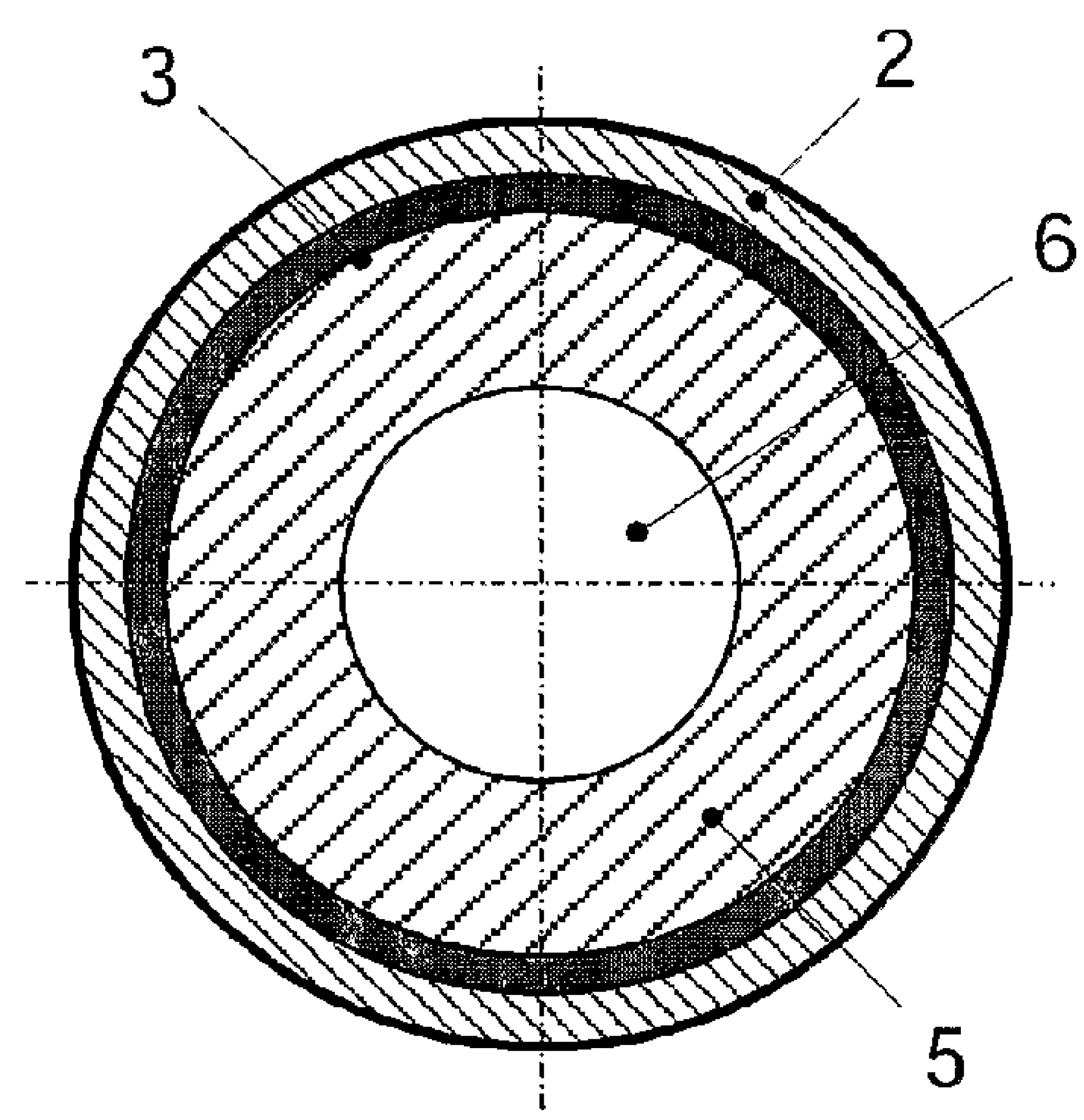


Fig. 2



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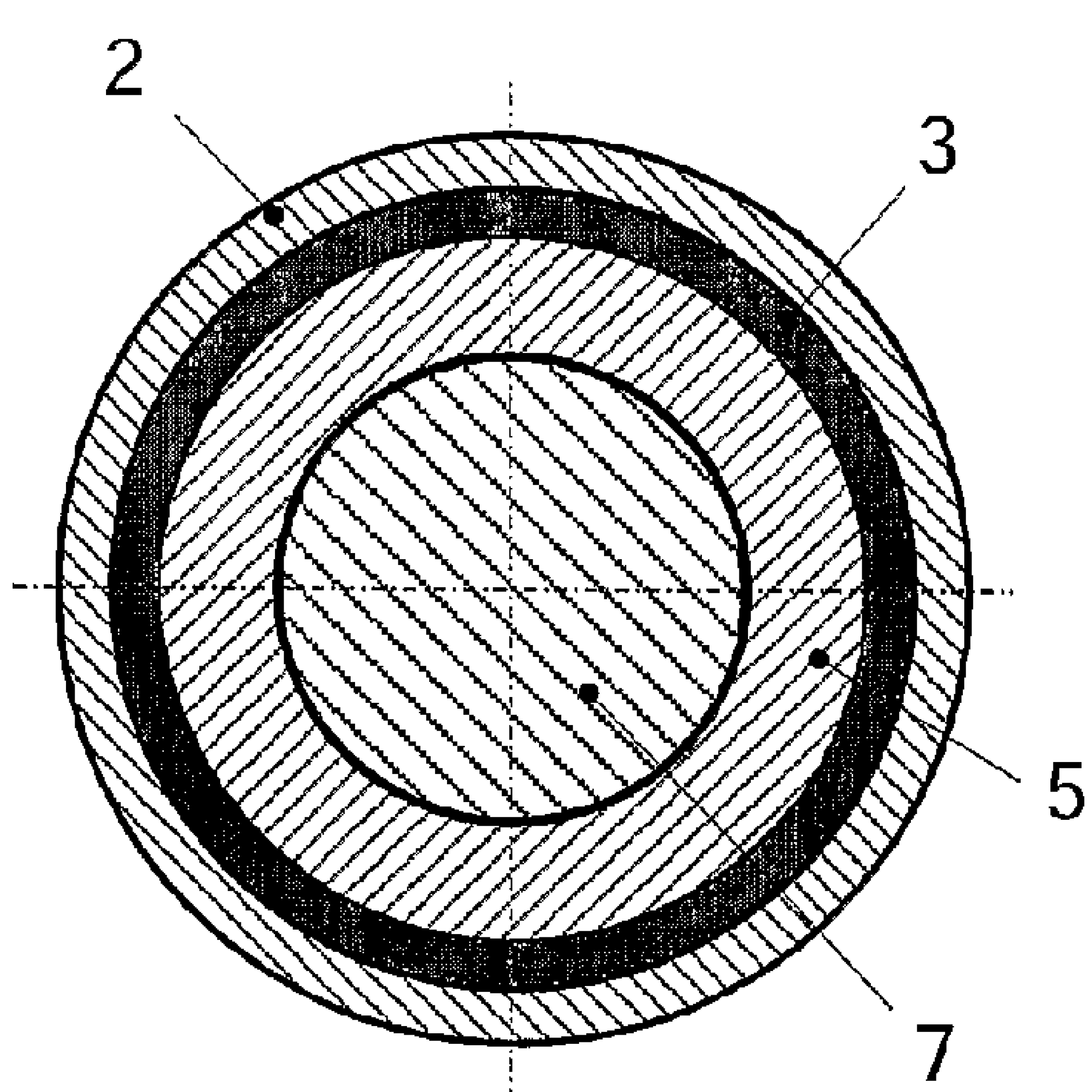

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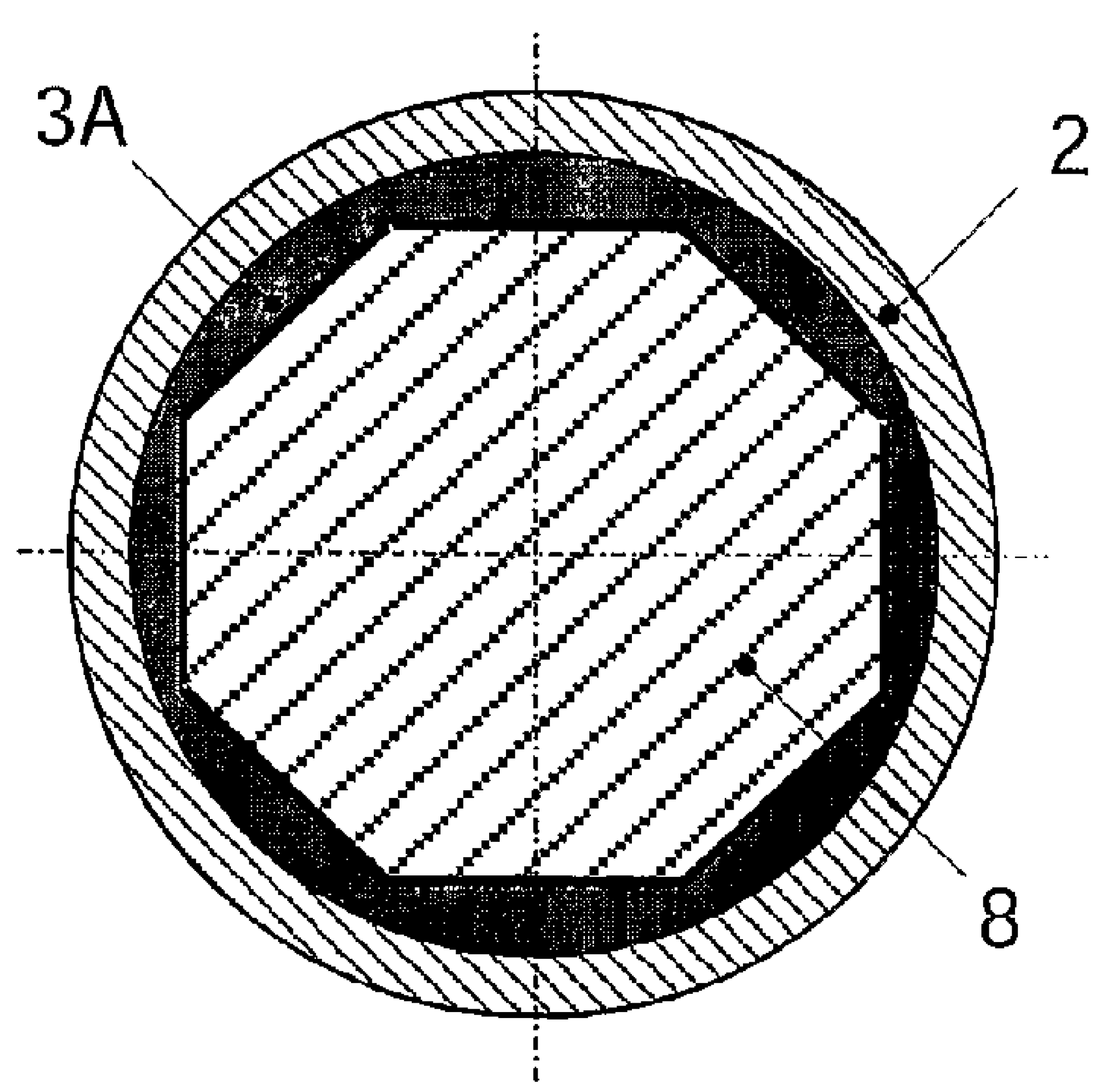

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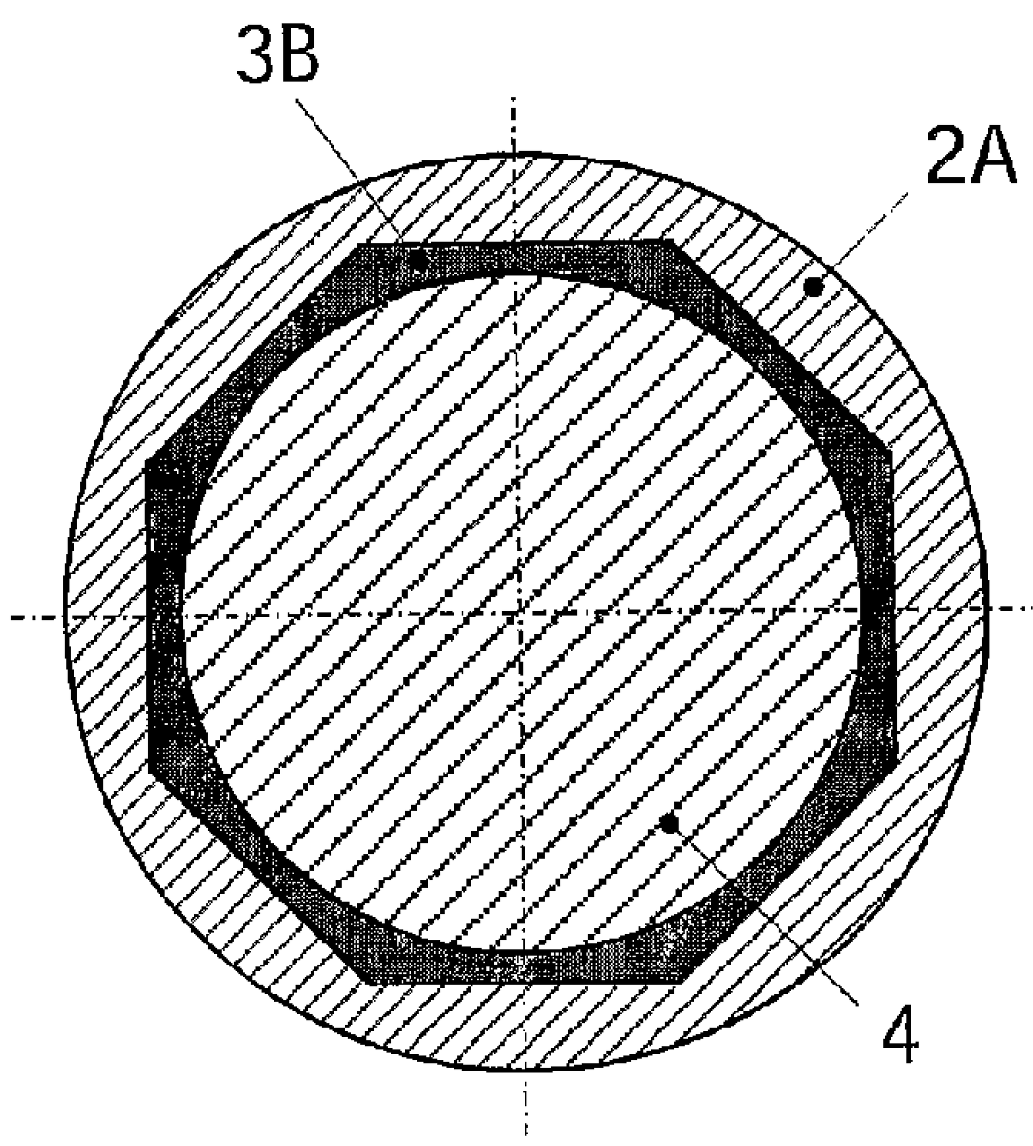

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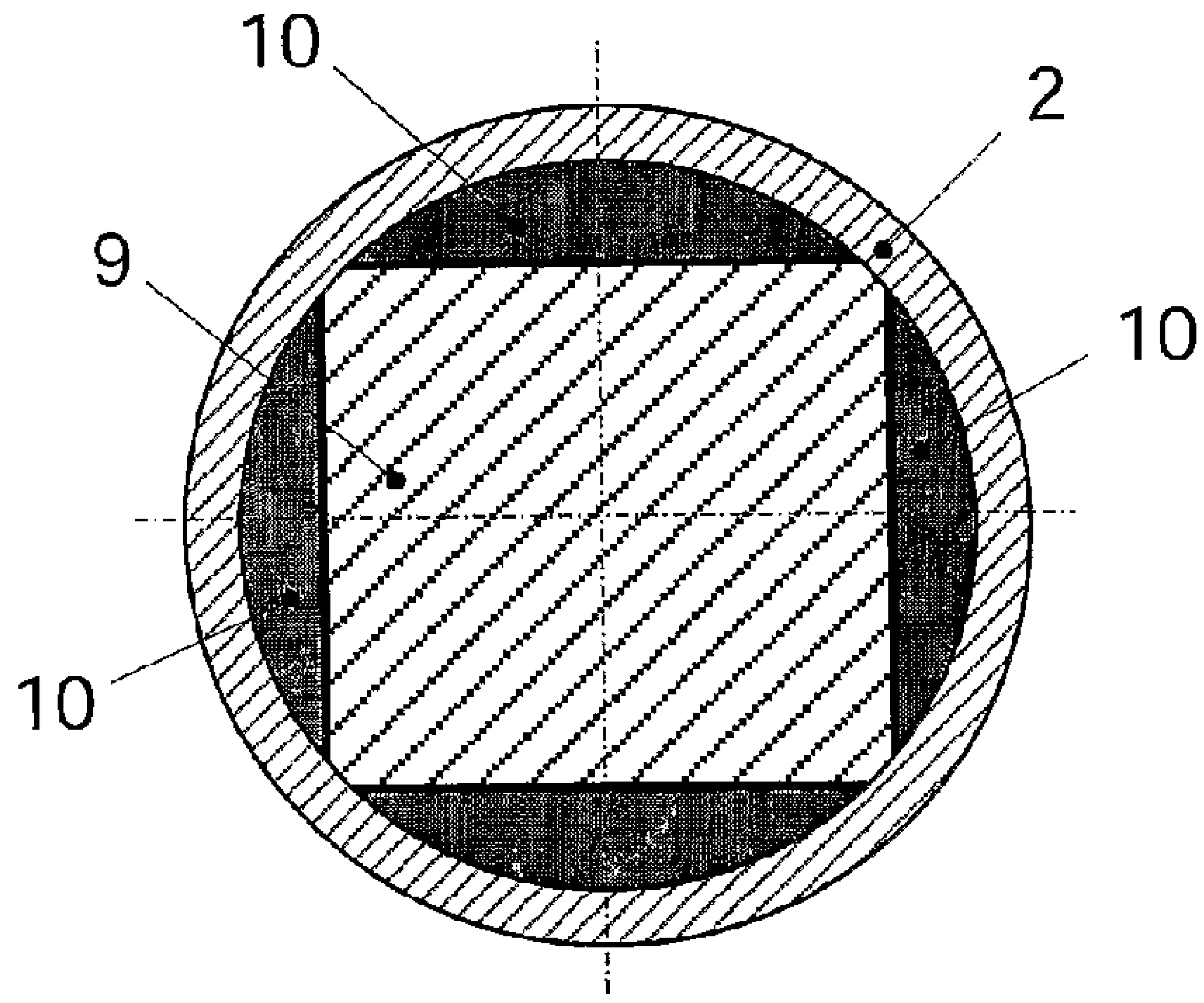

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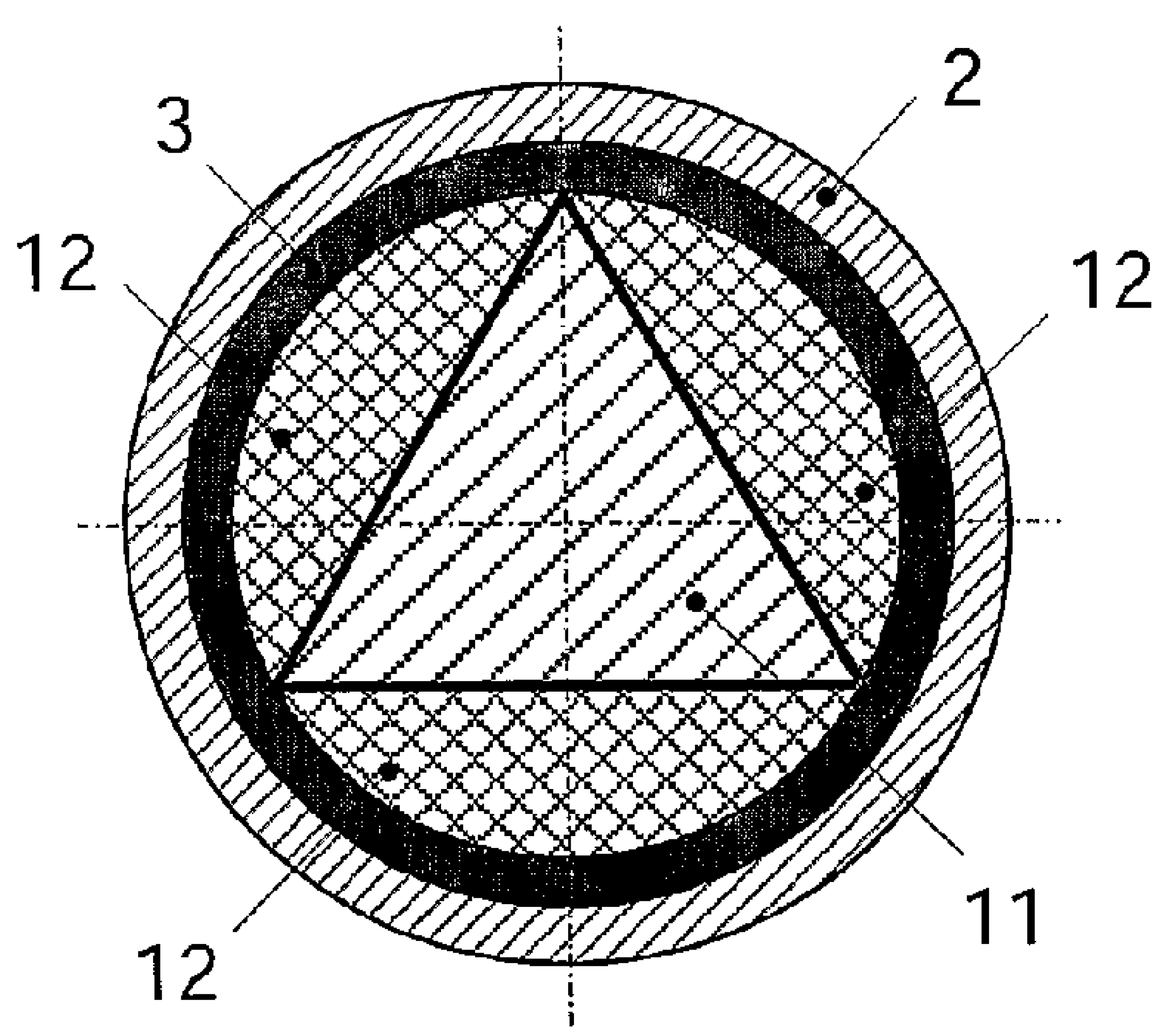

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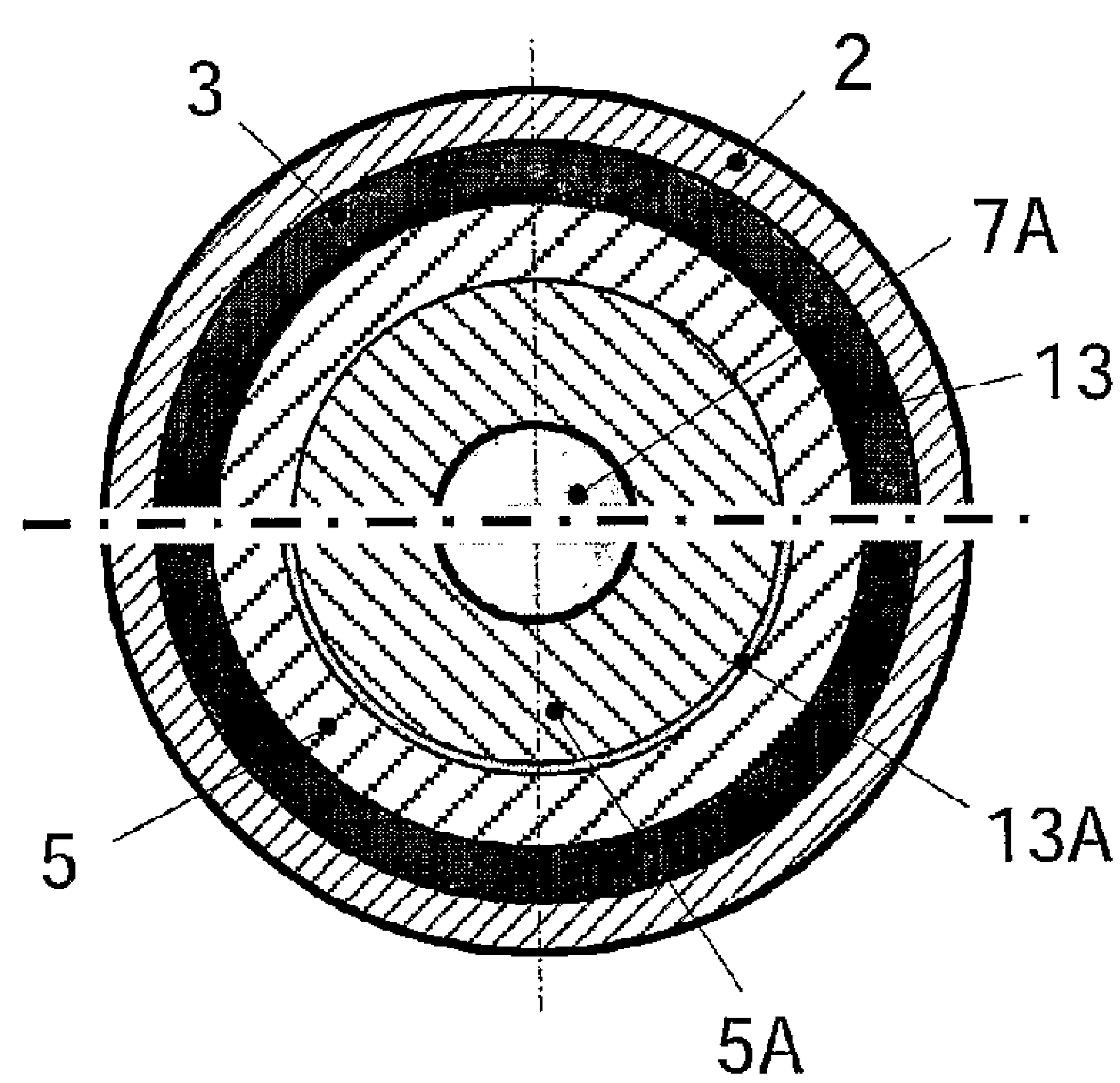

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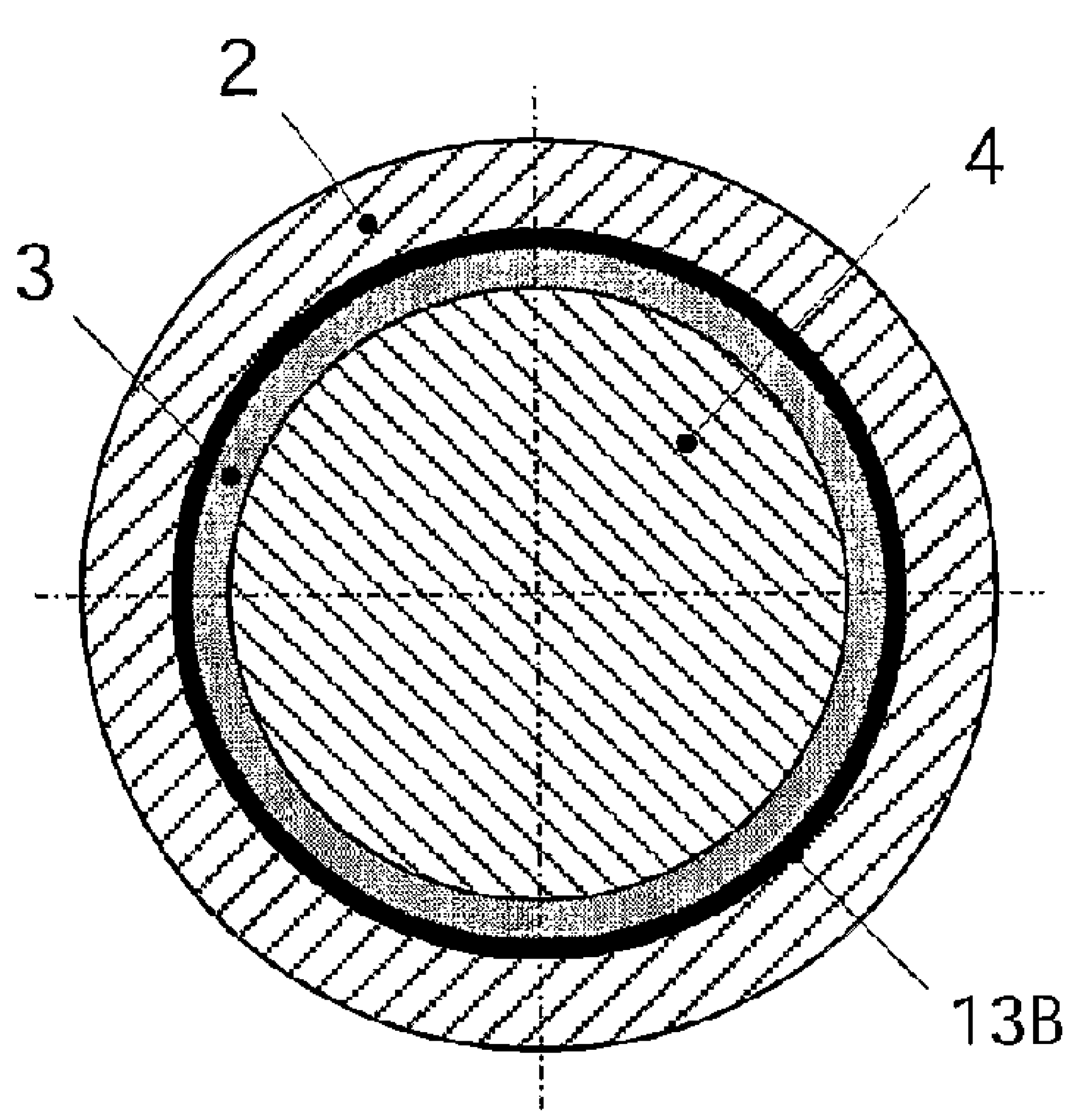

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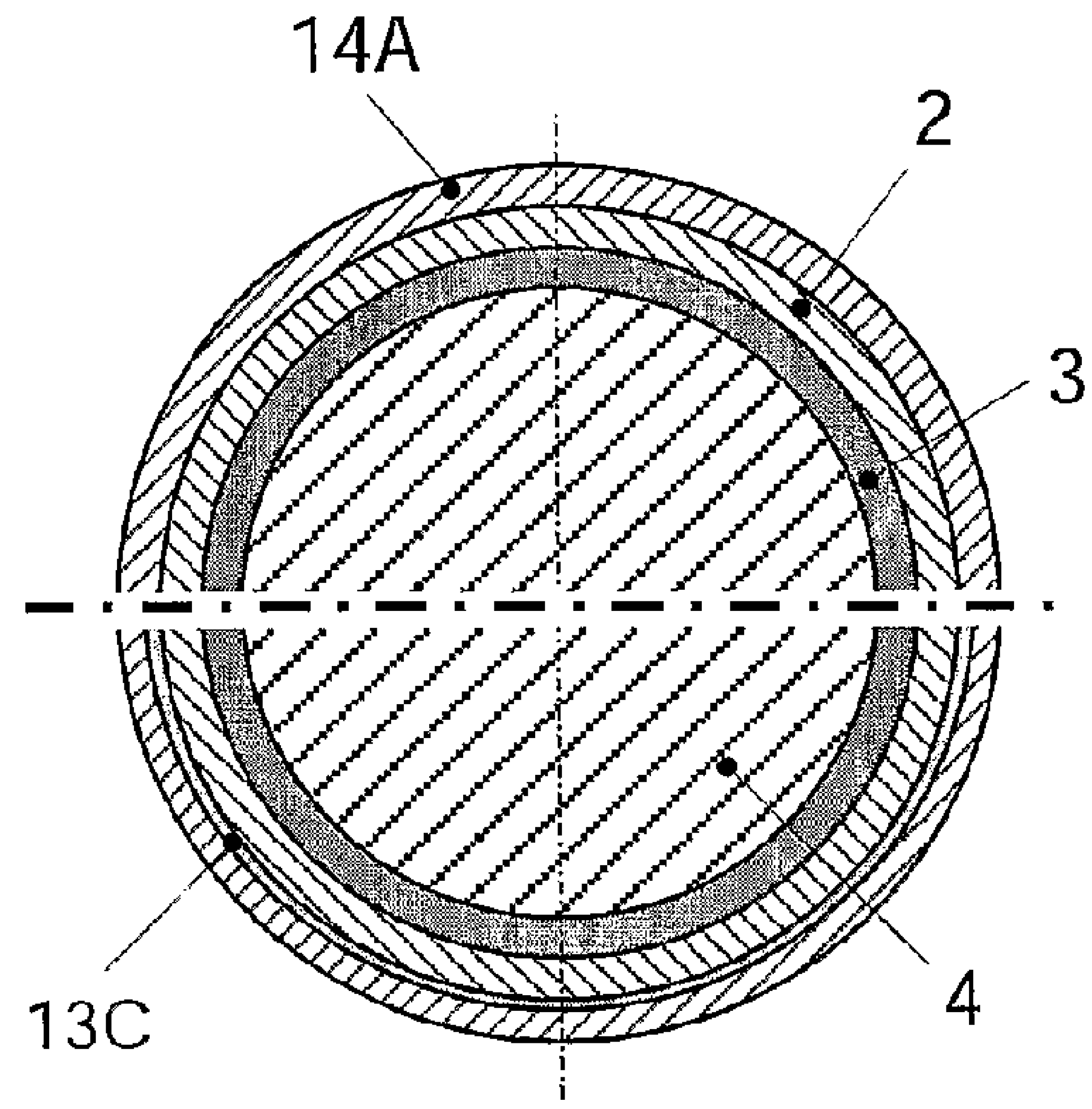

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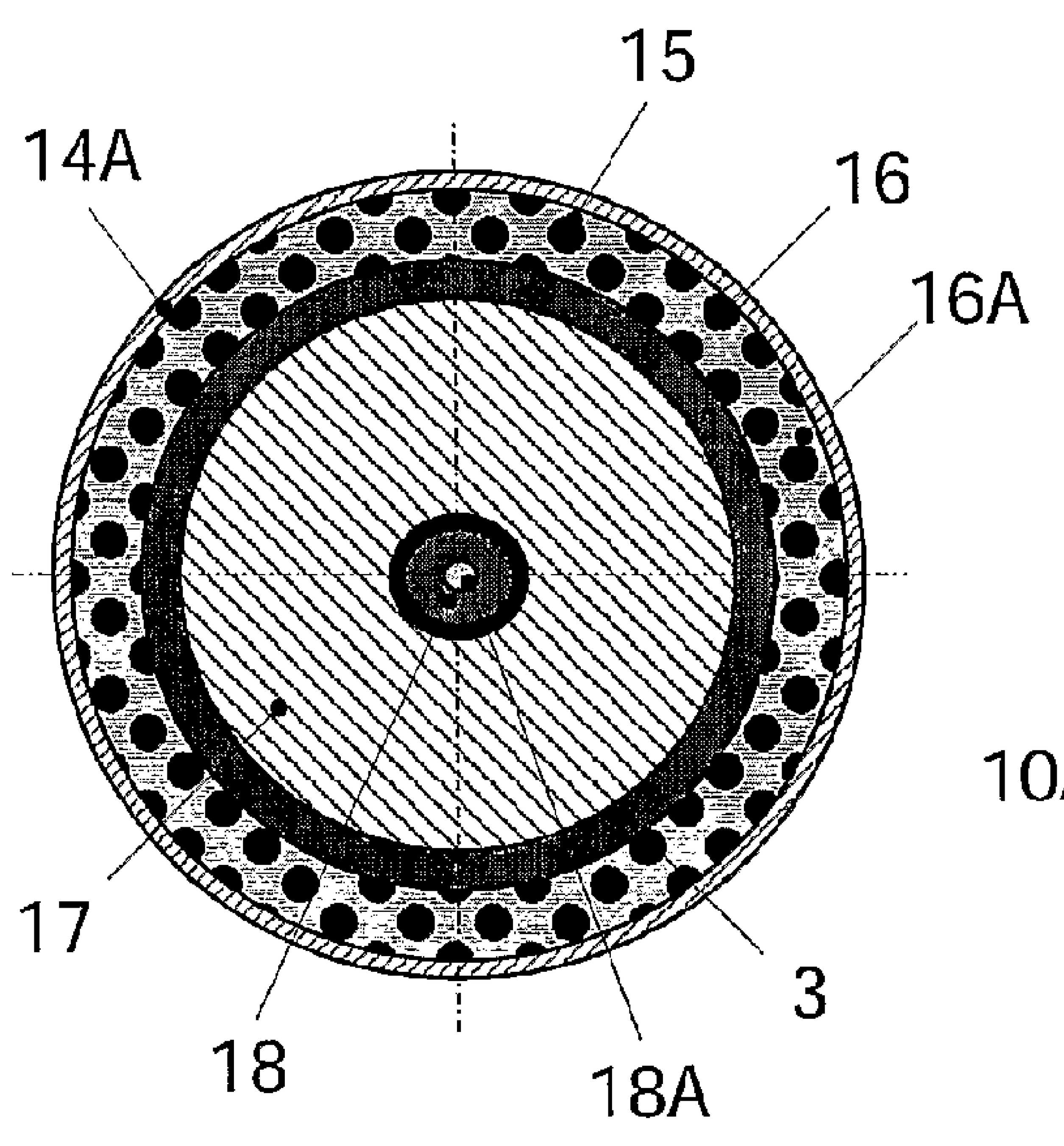

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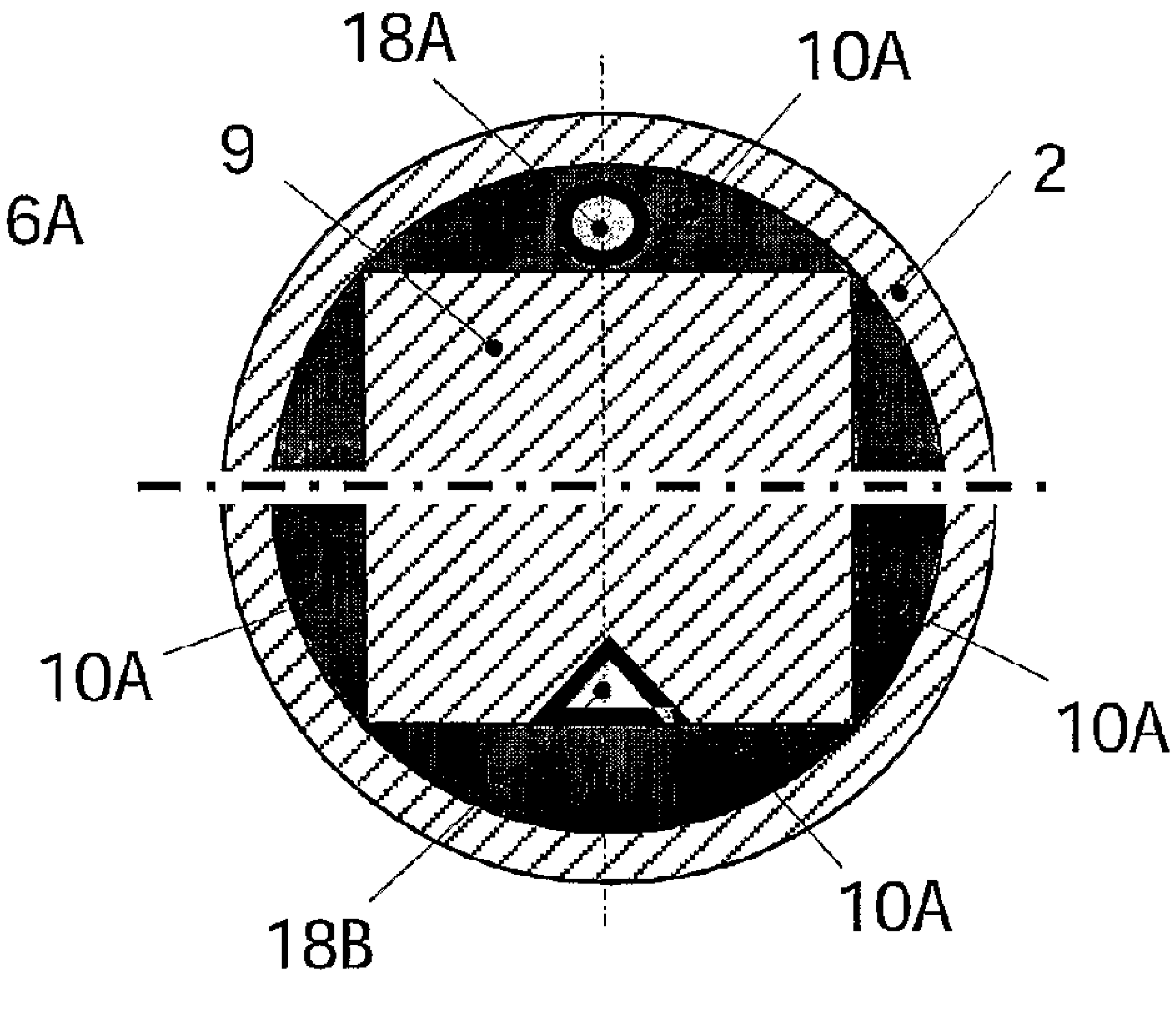

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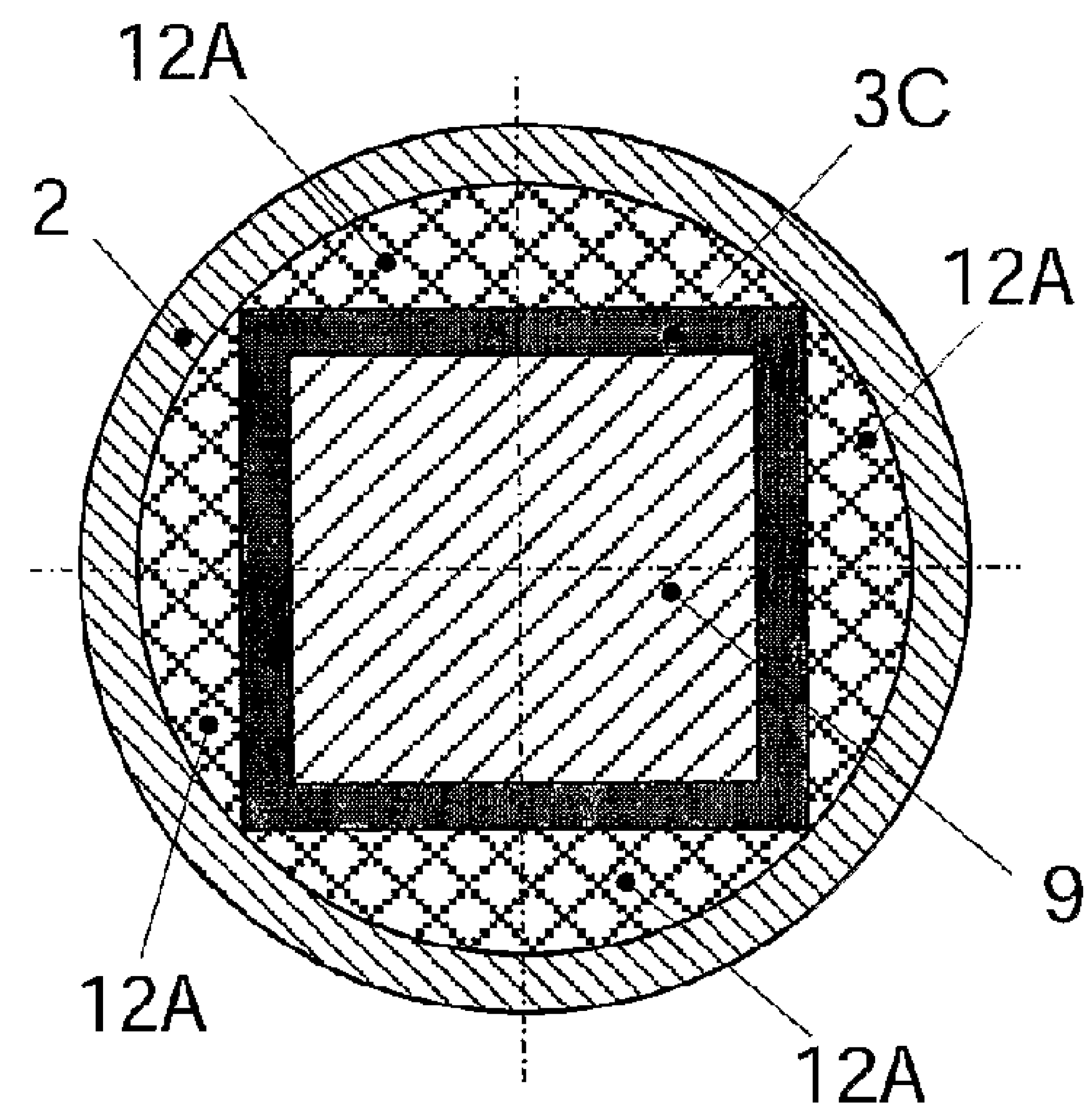

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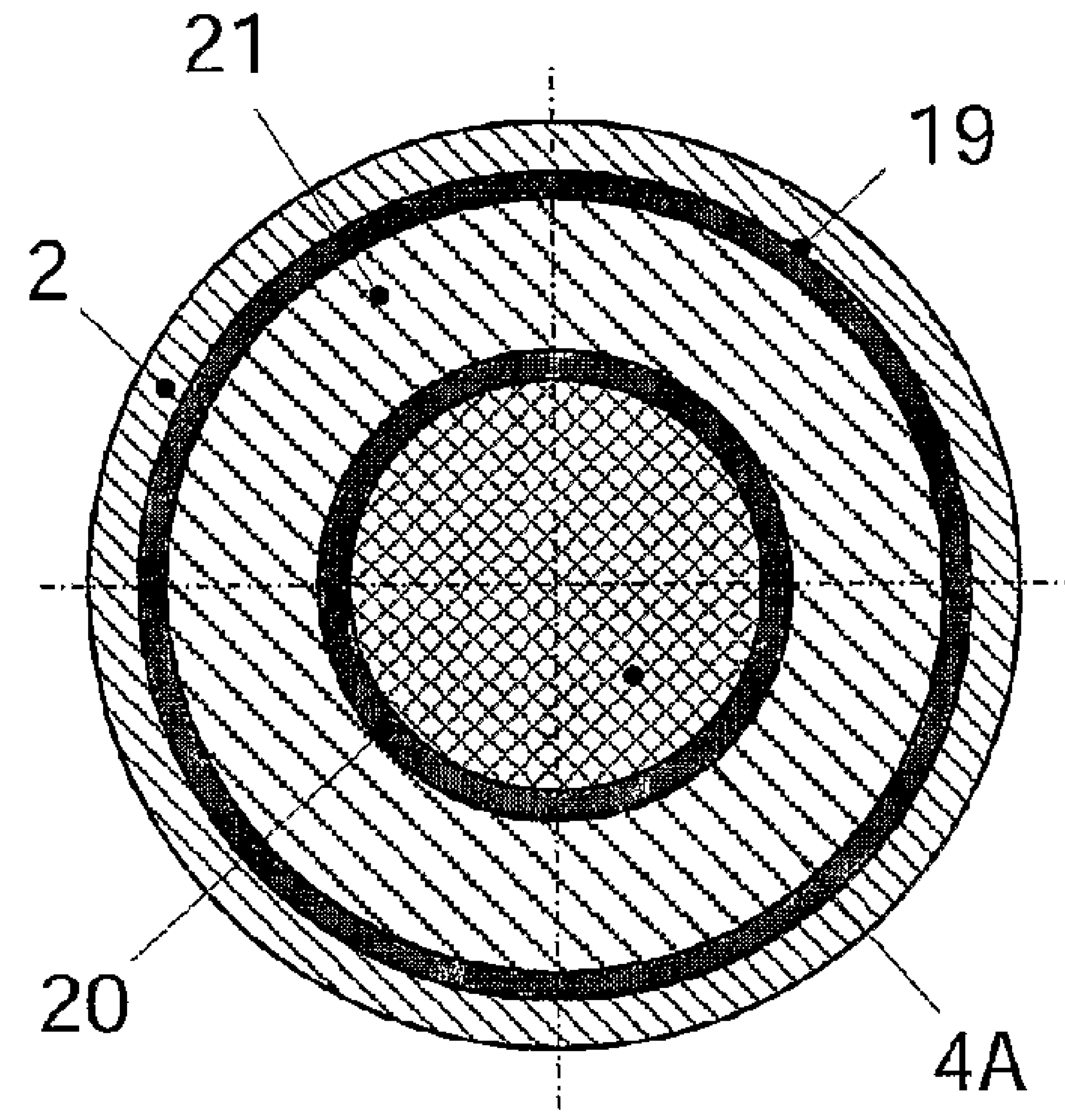

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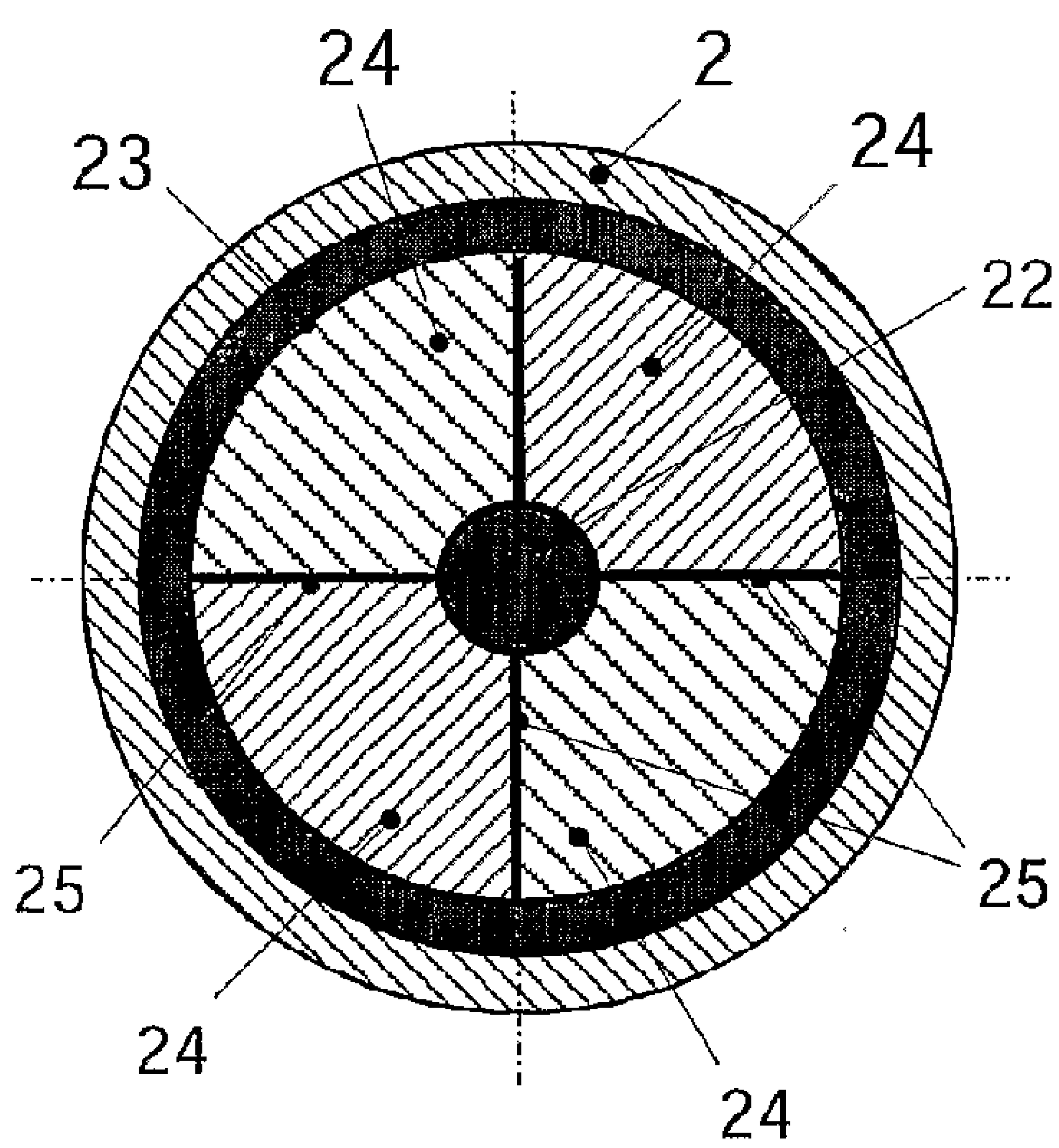

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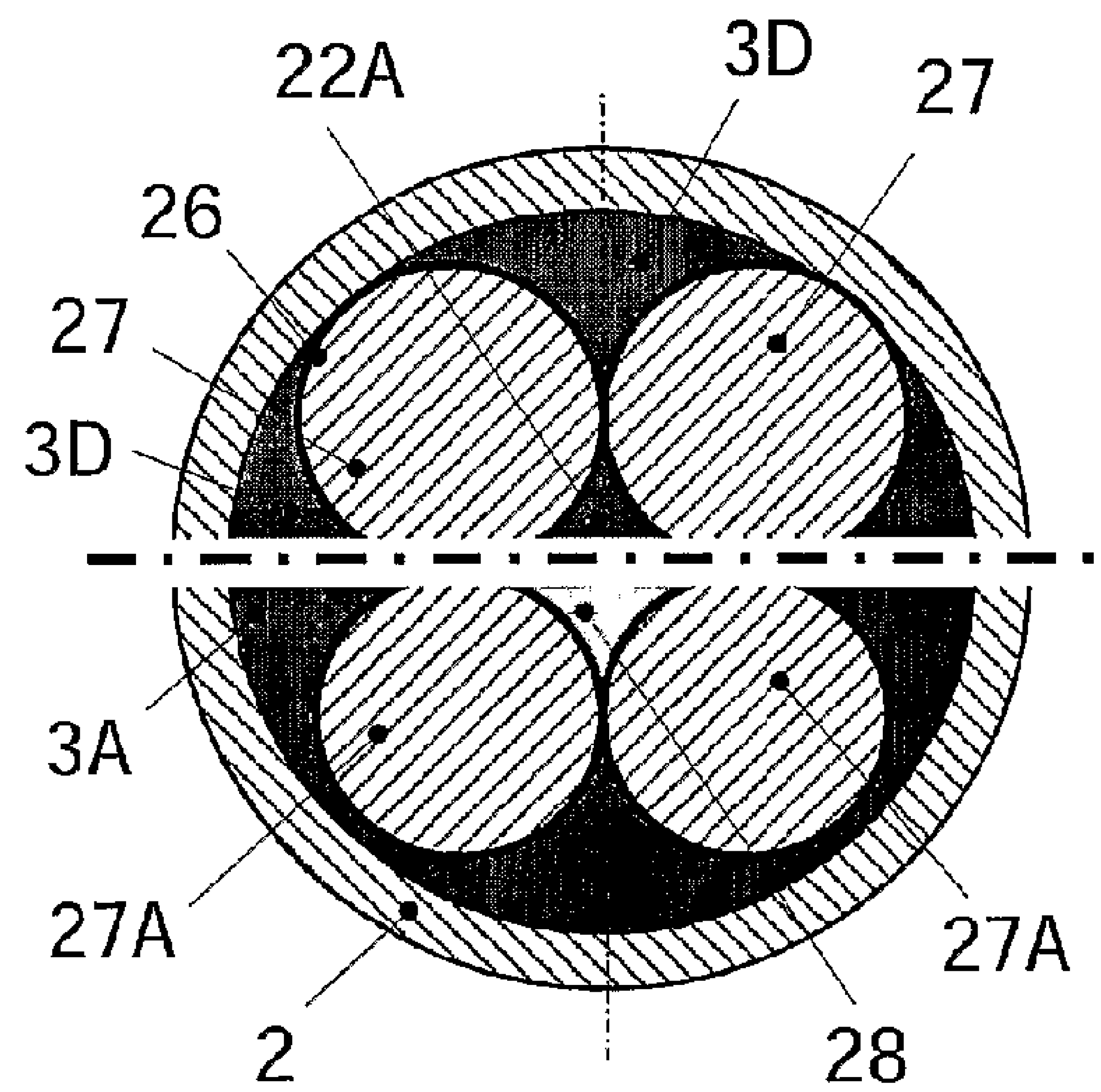

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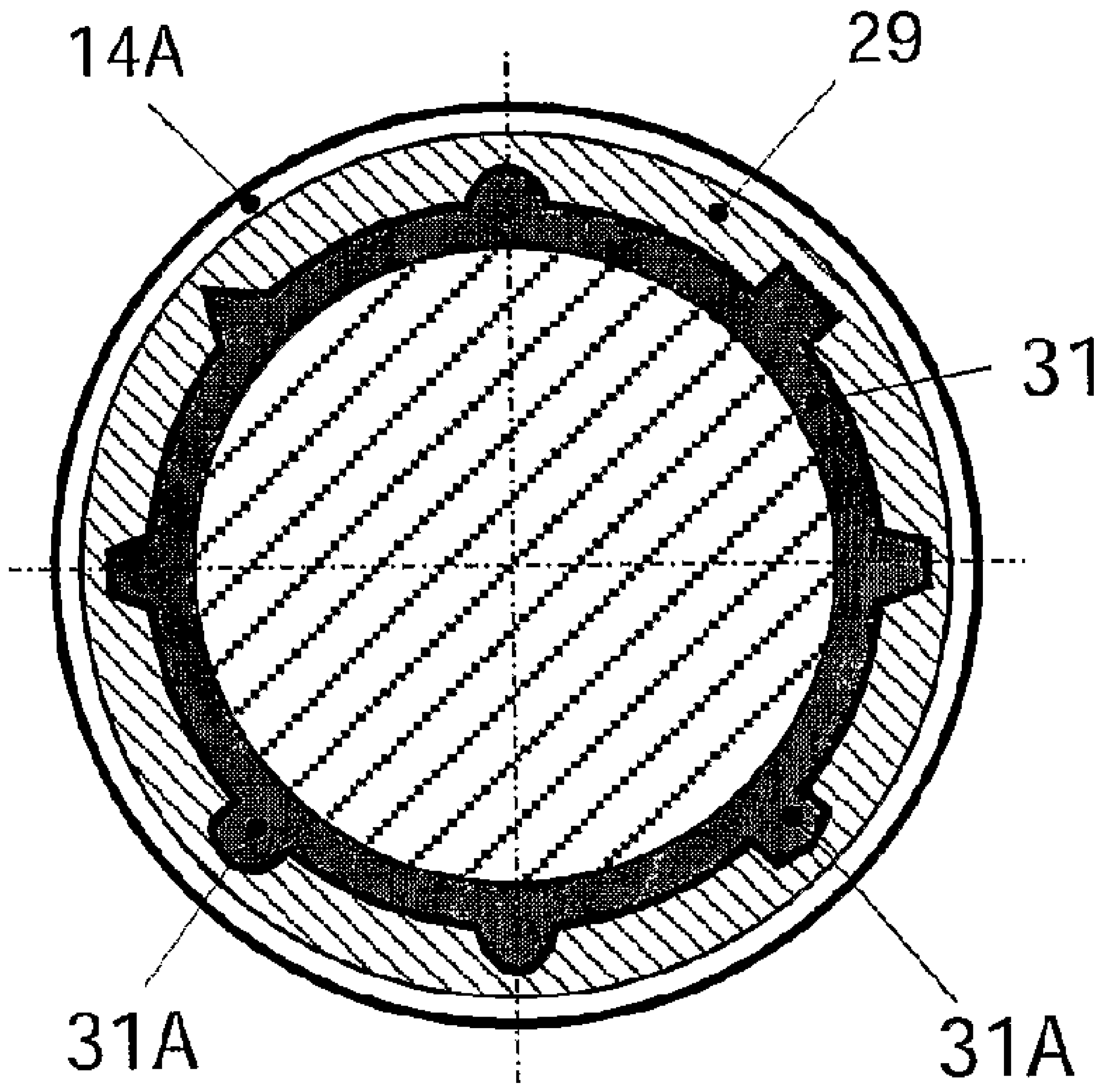

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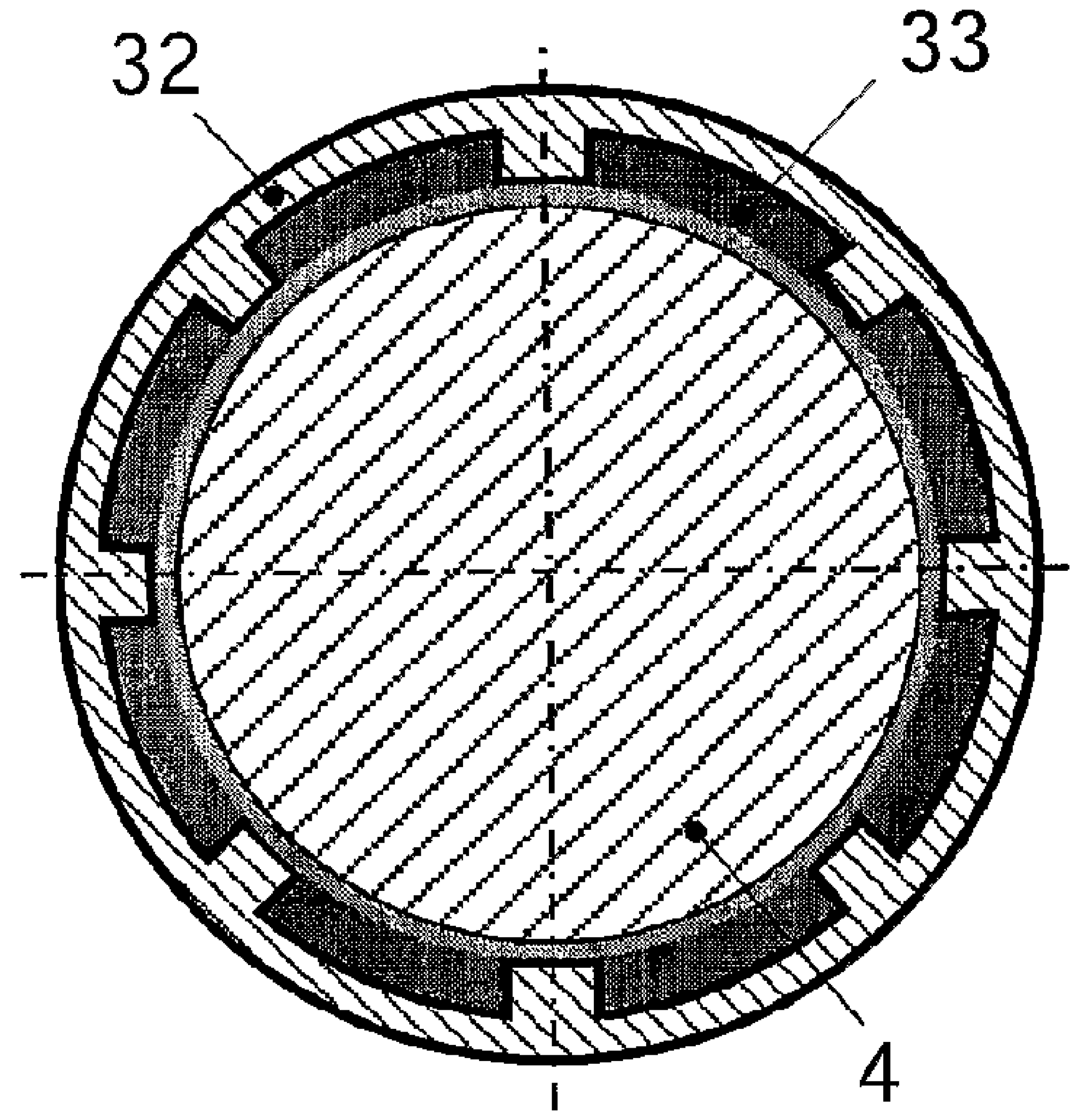

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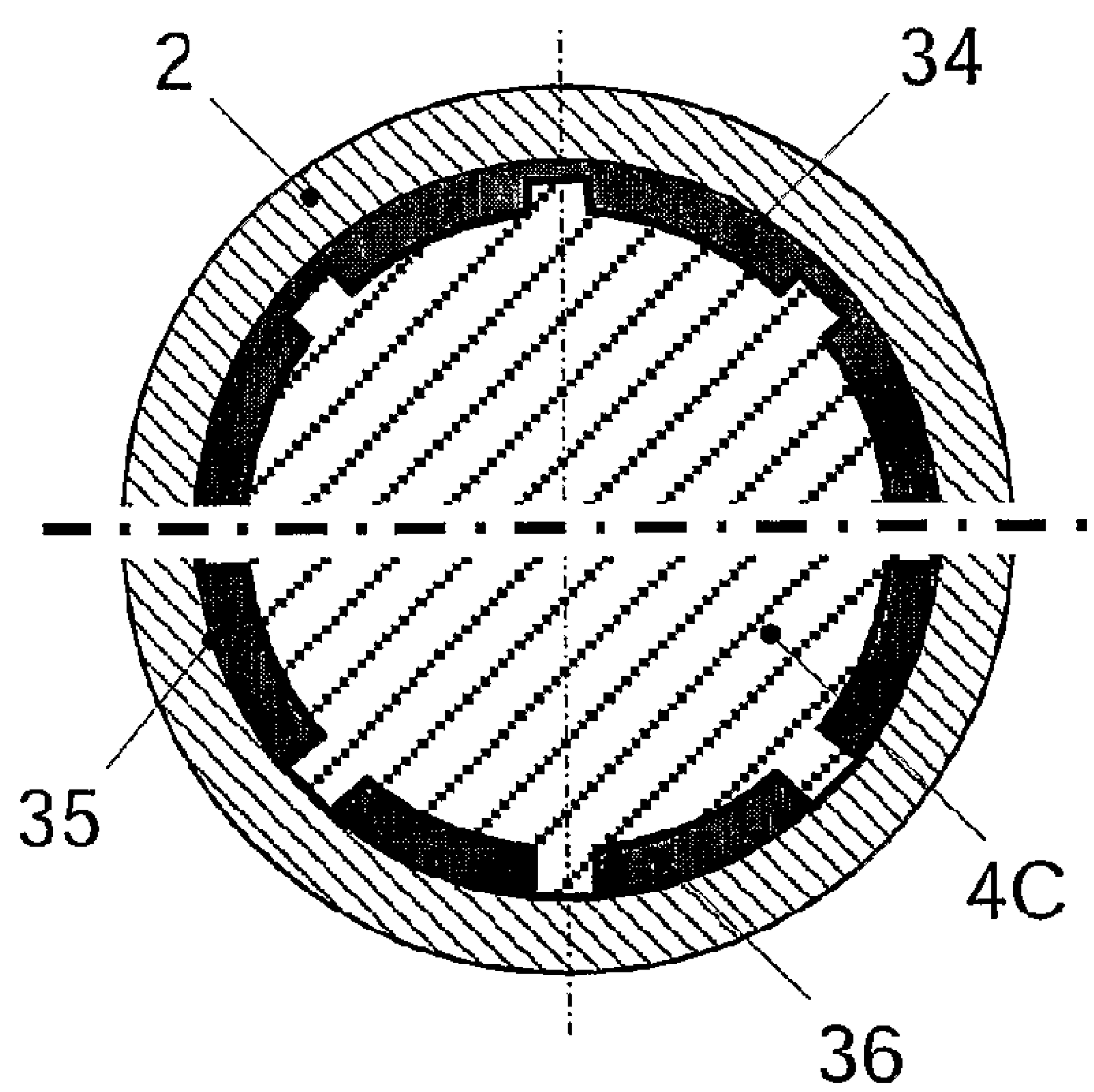

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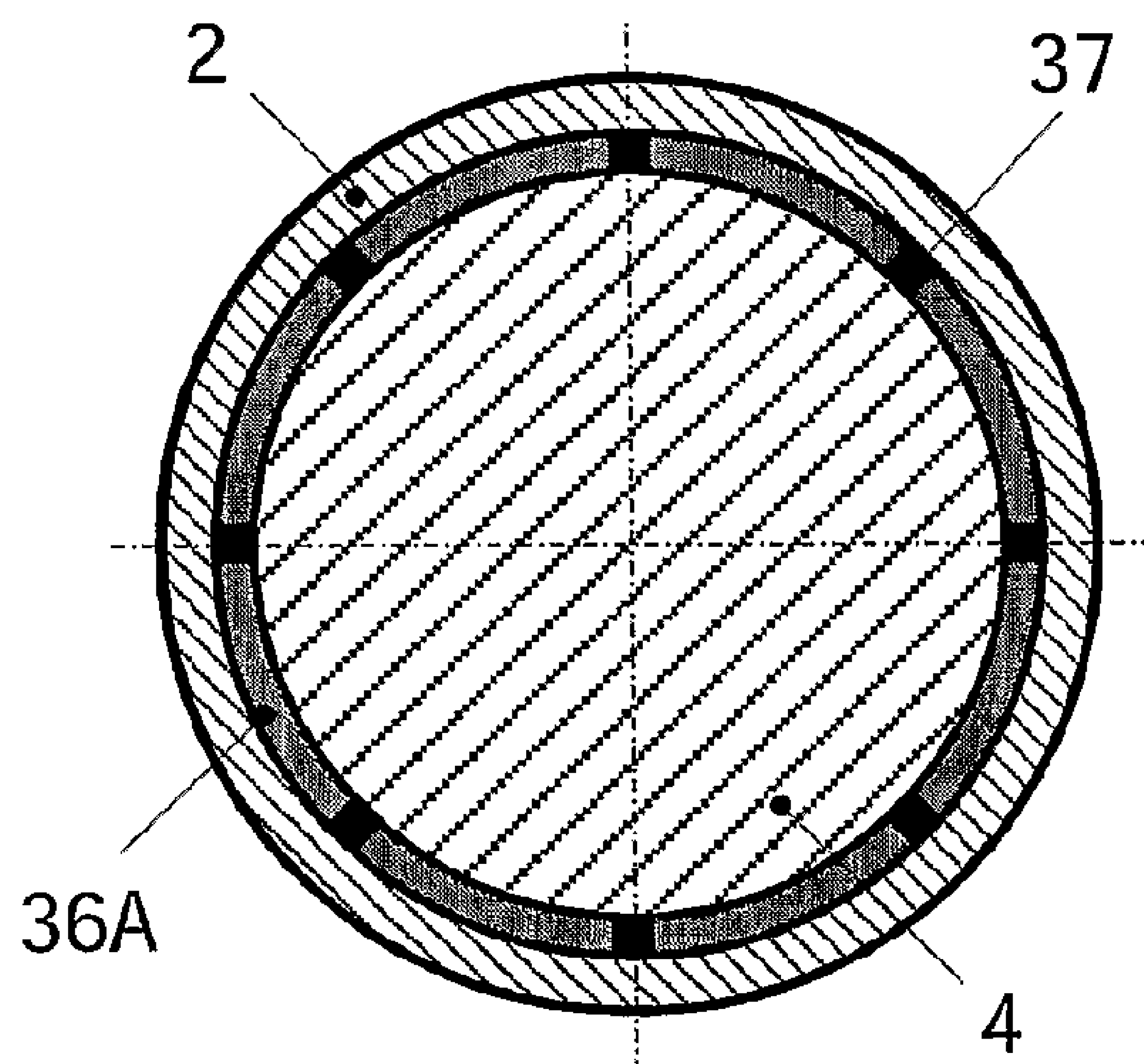

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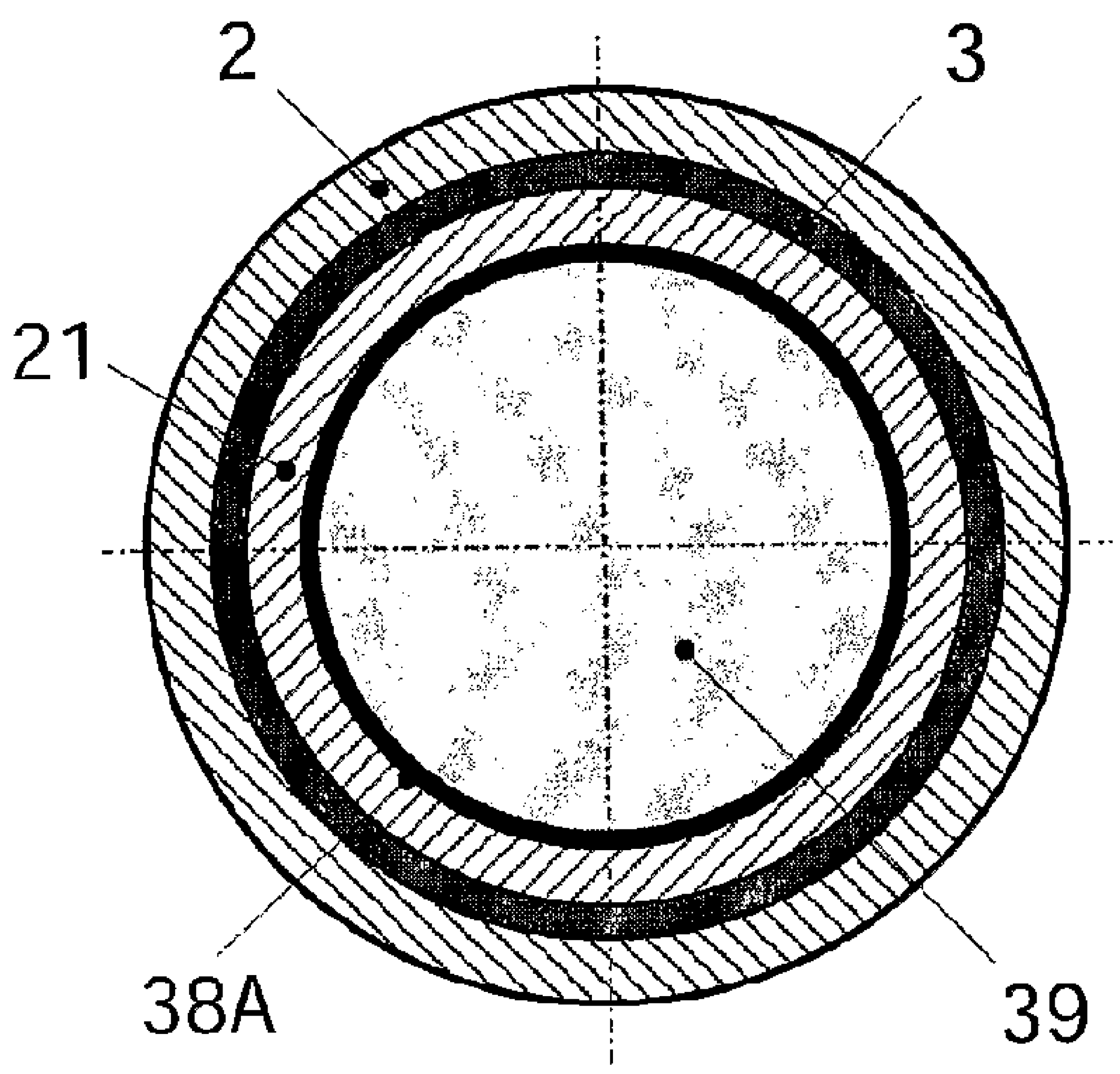

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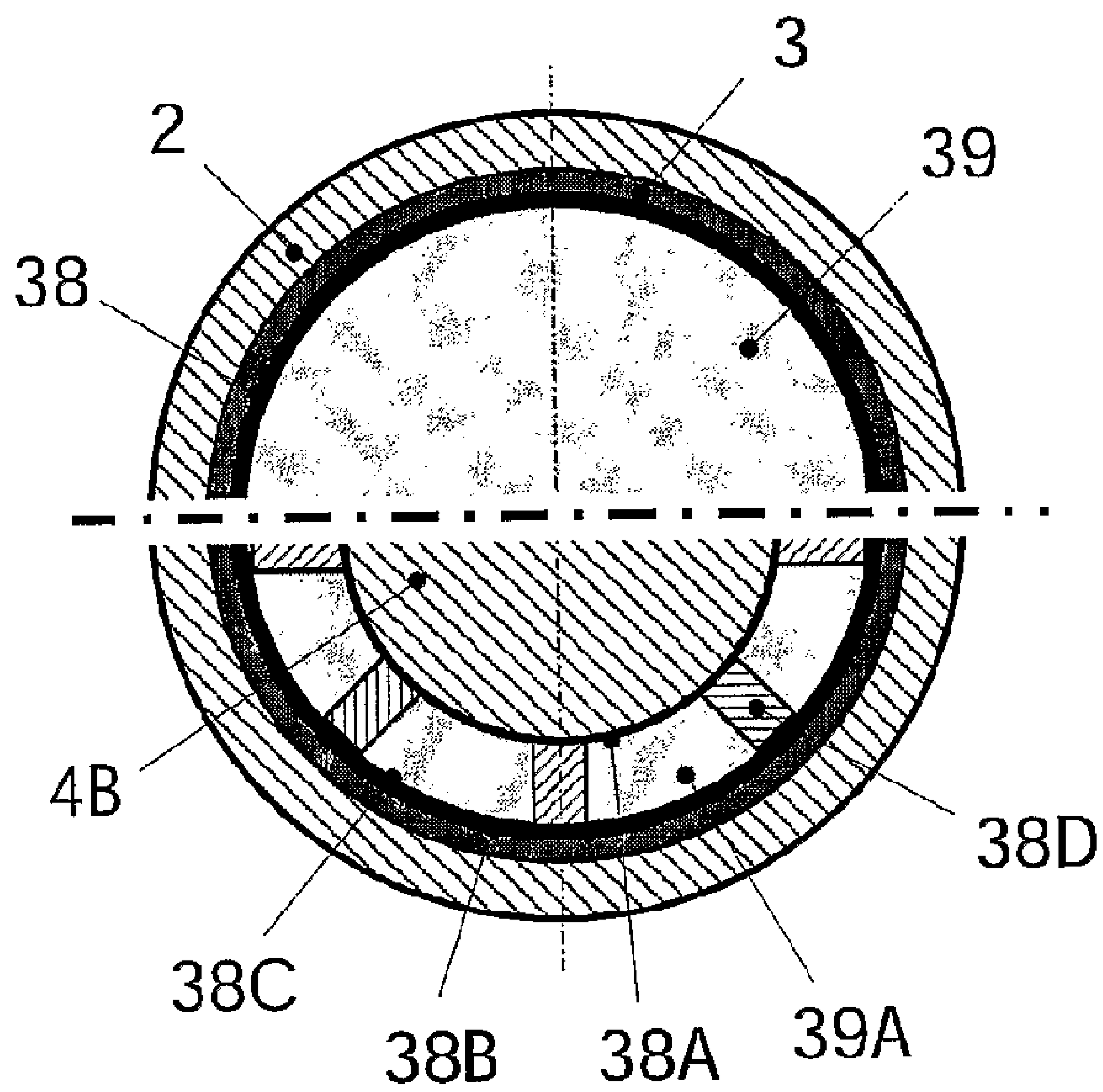

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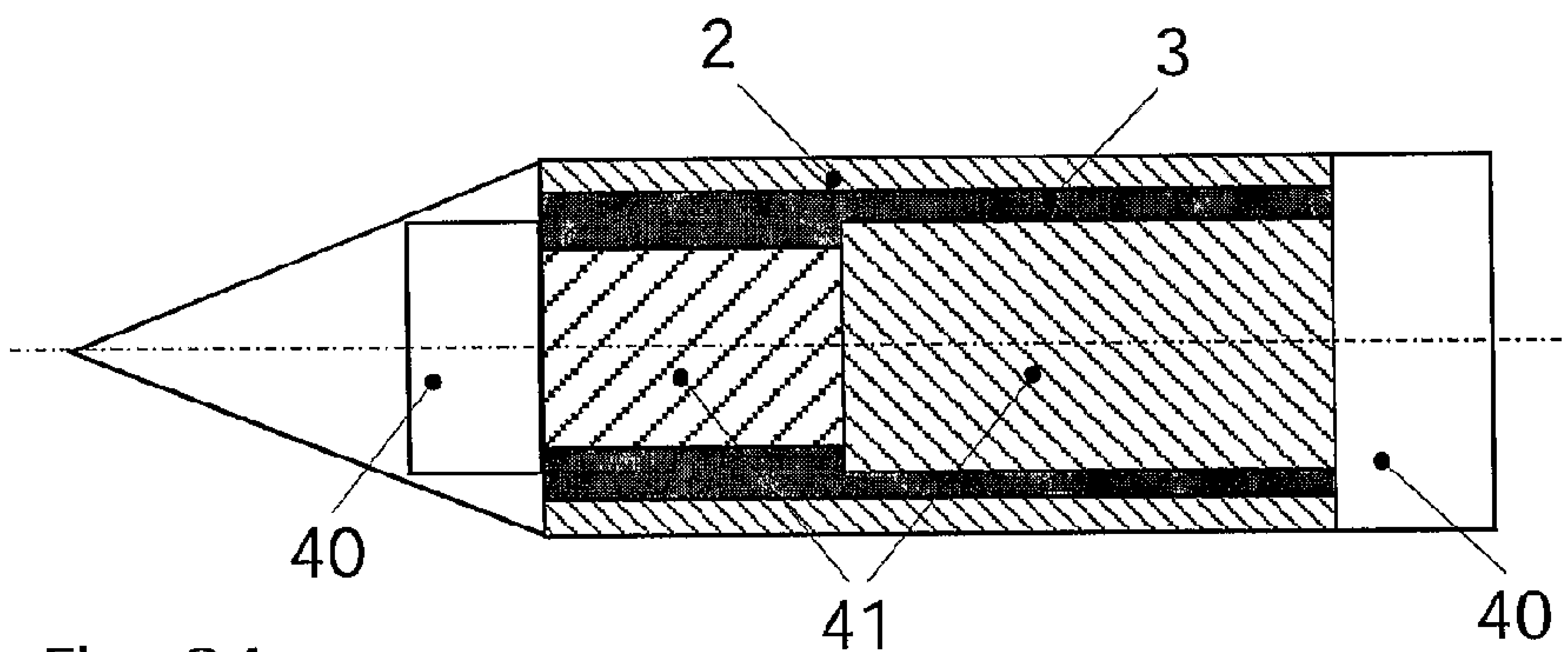

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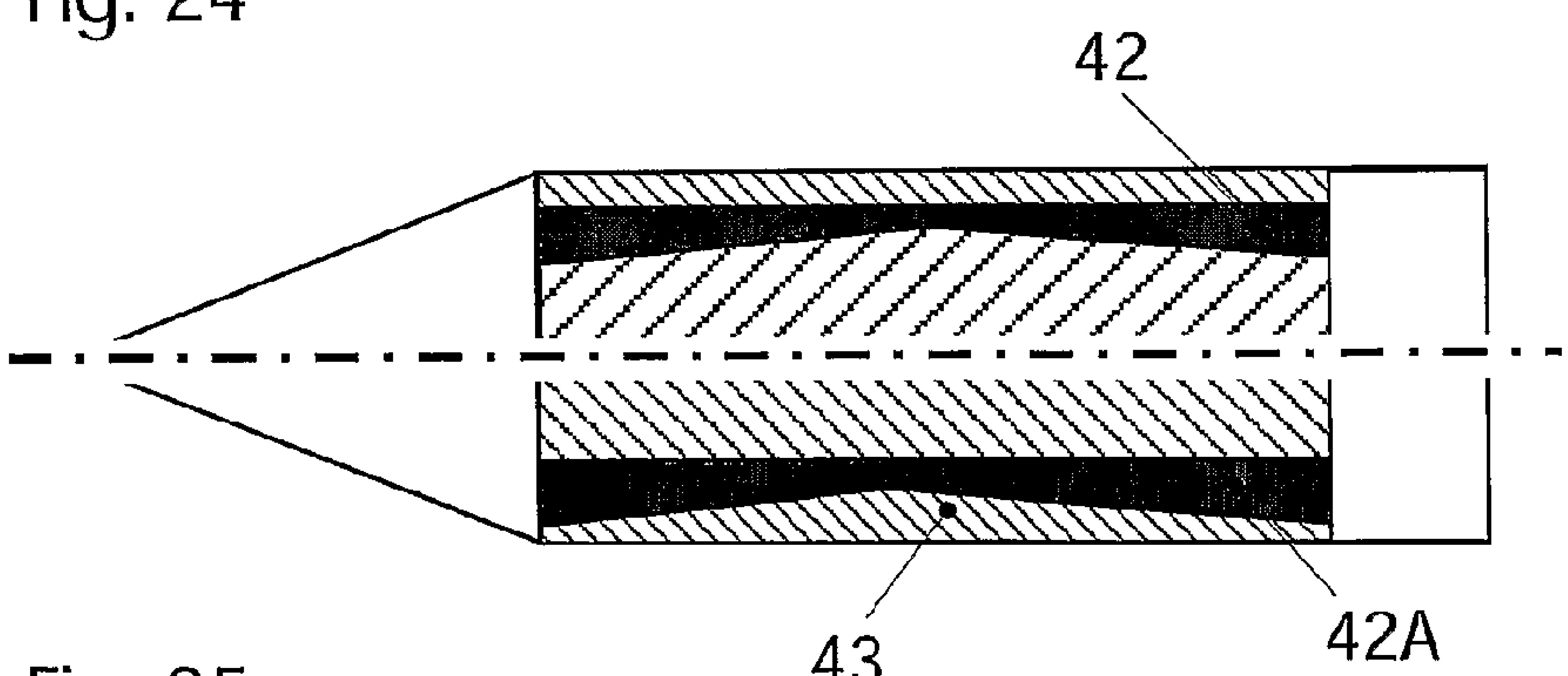

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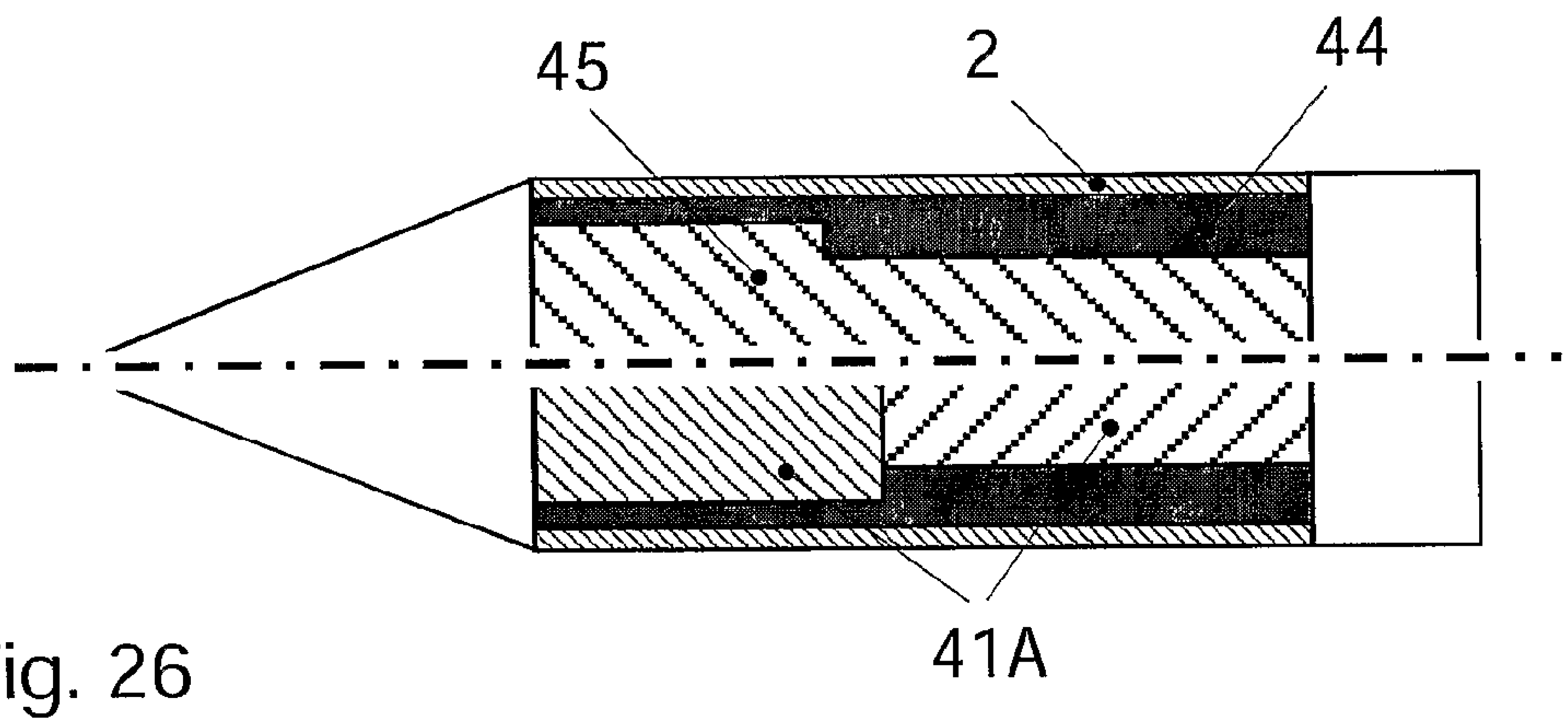

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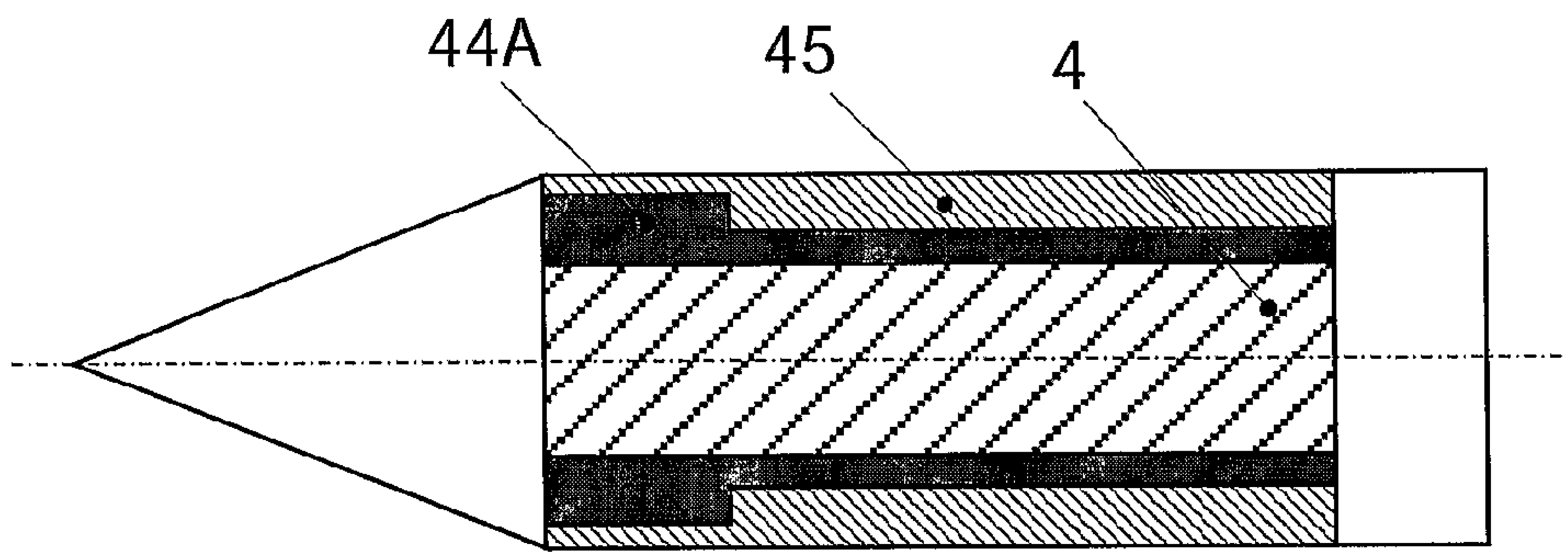

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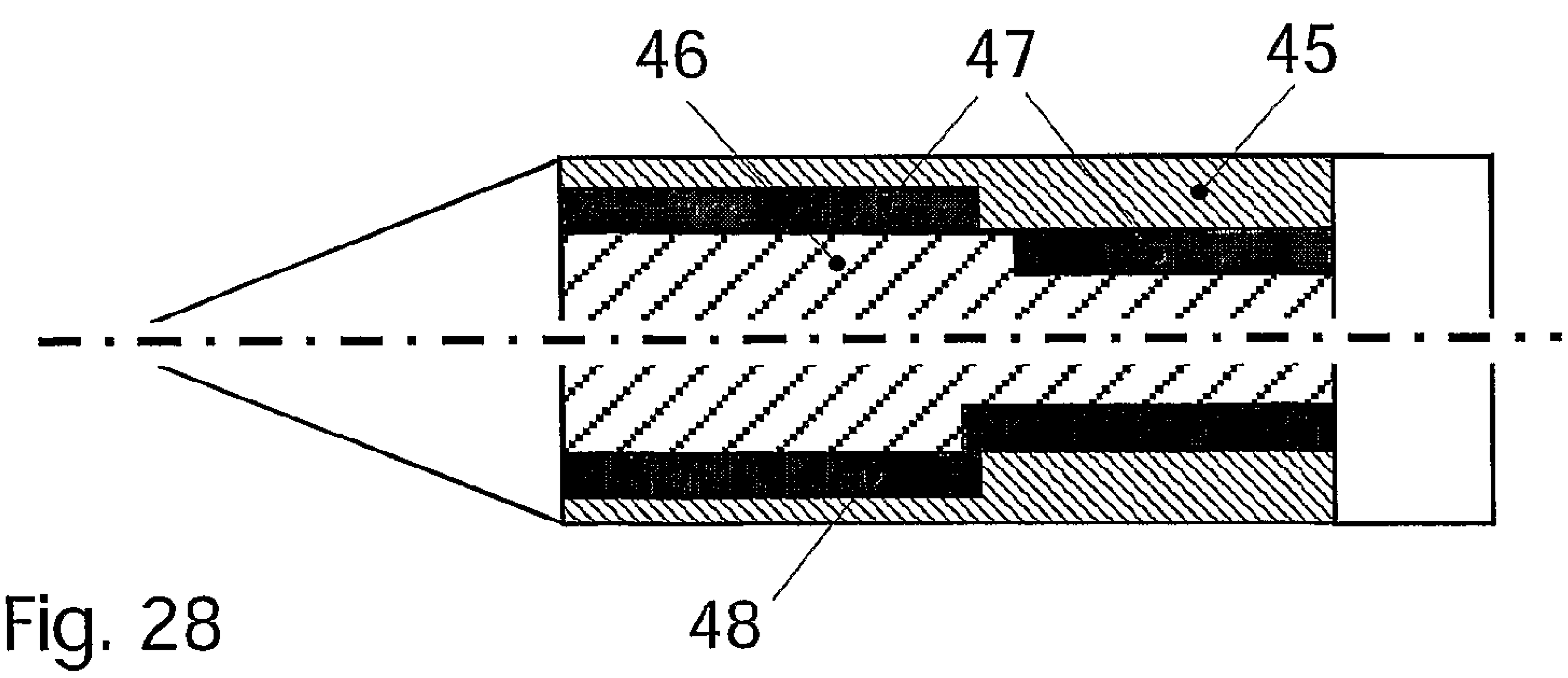

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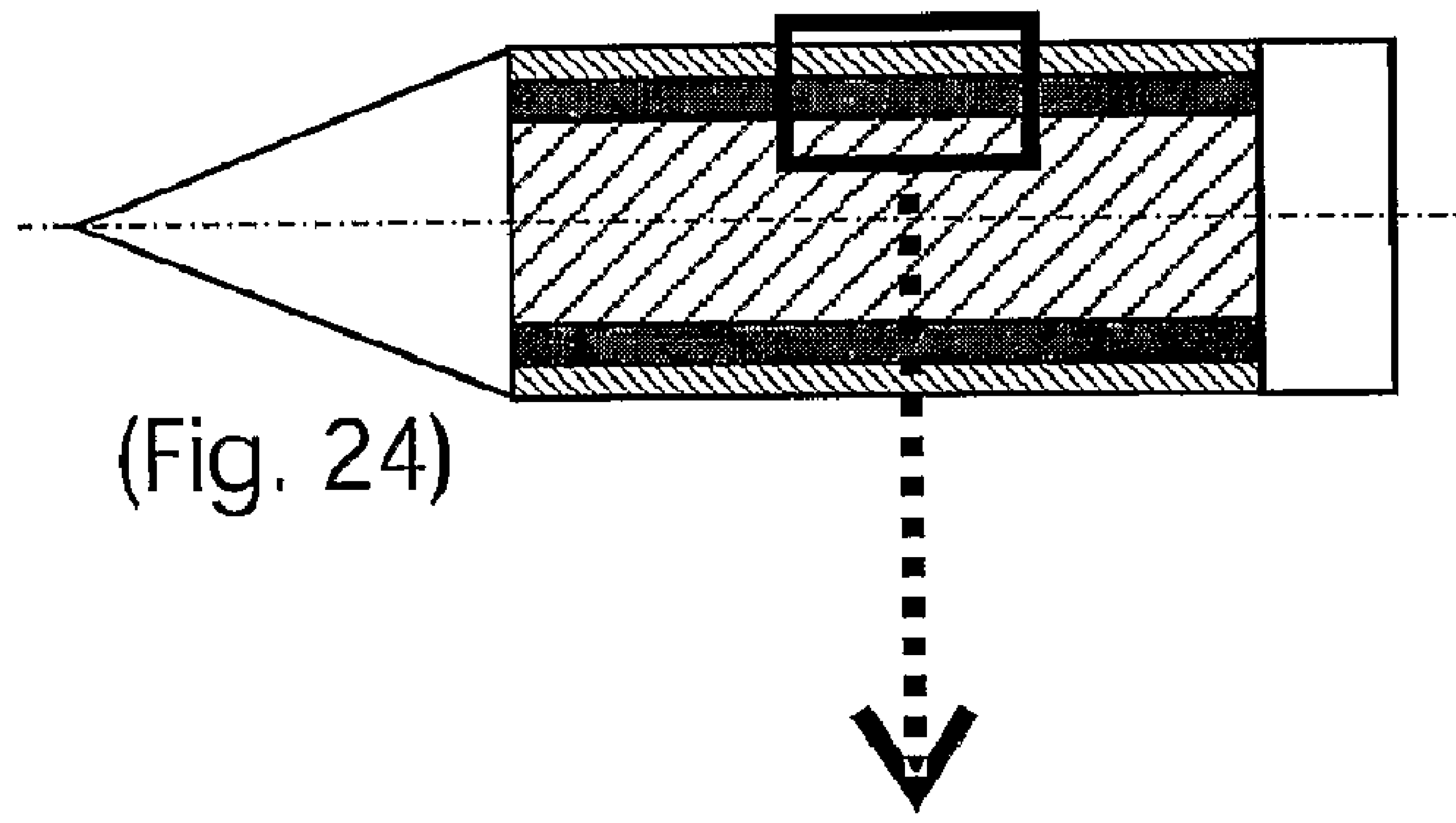

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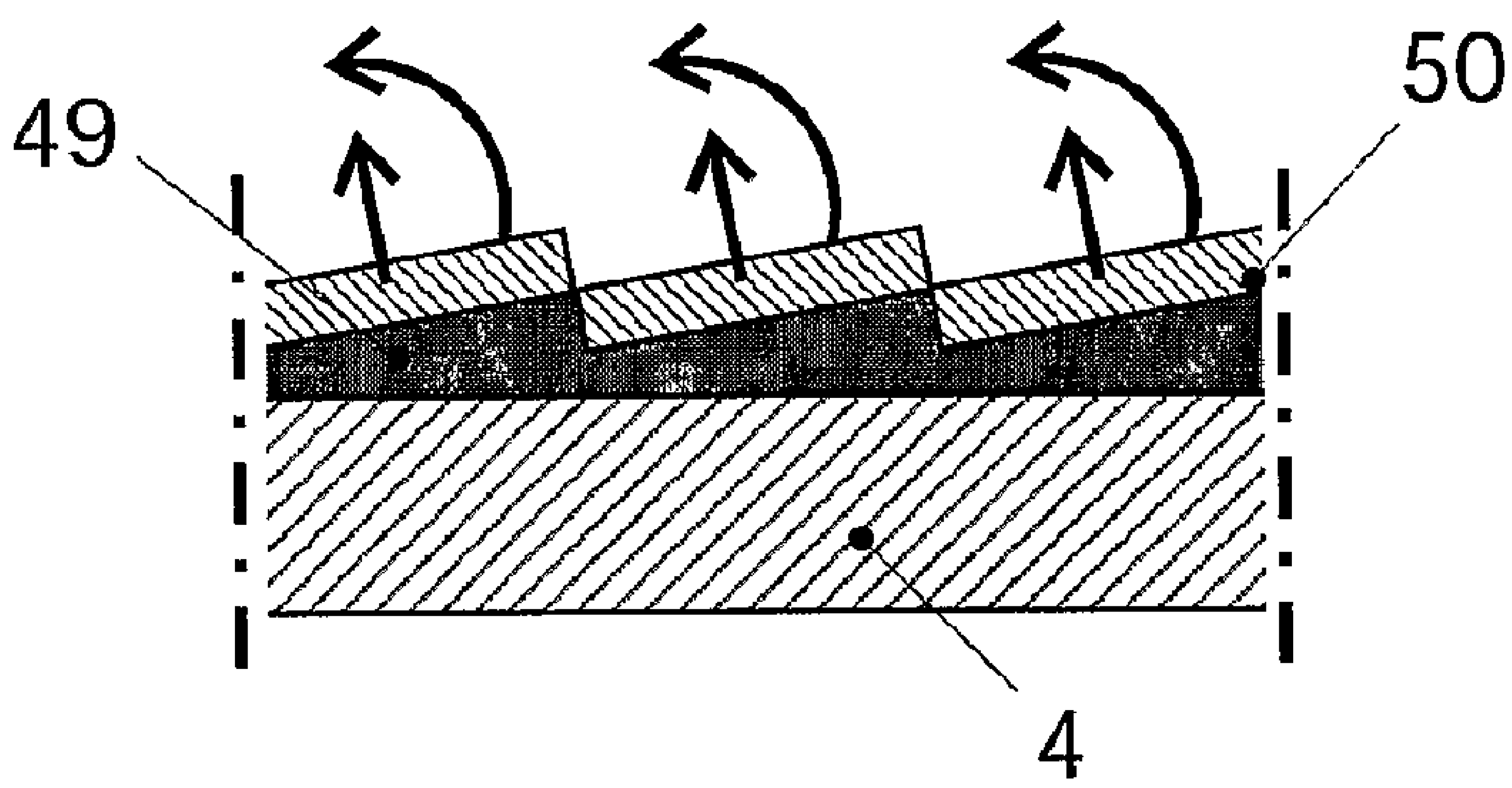

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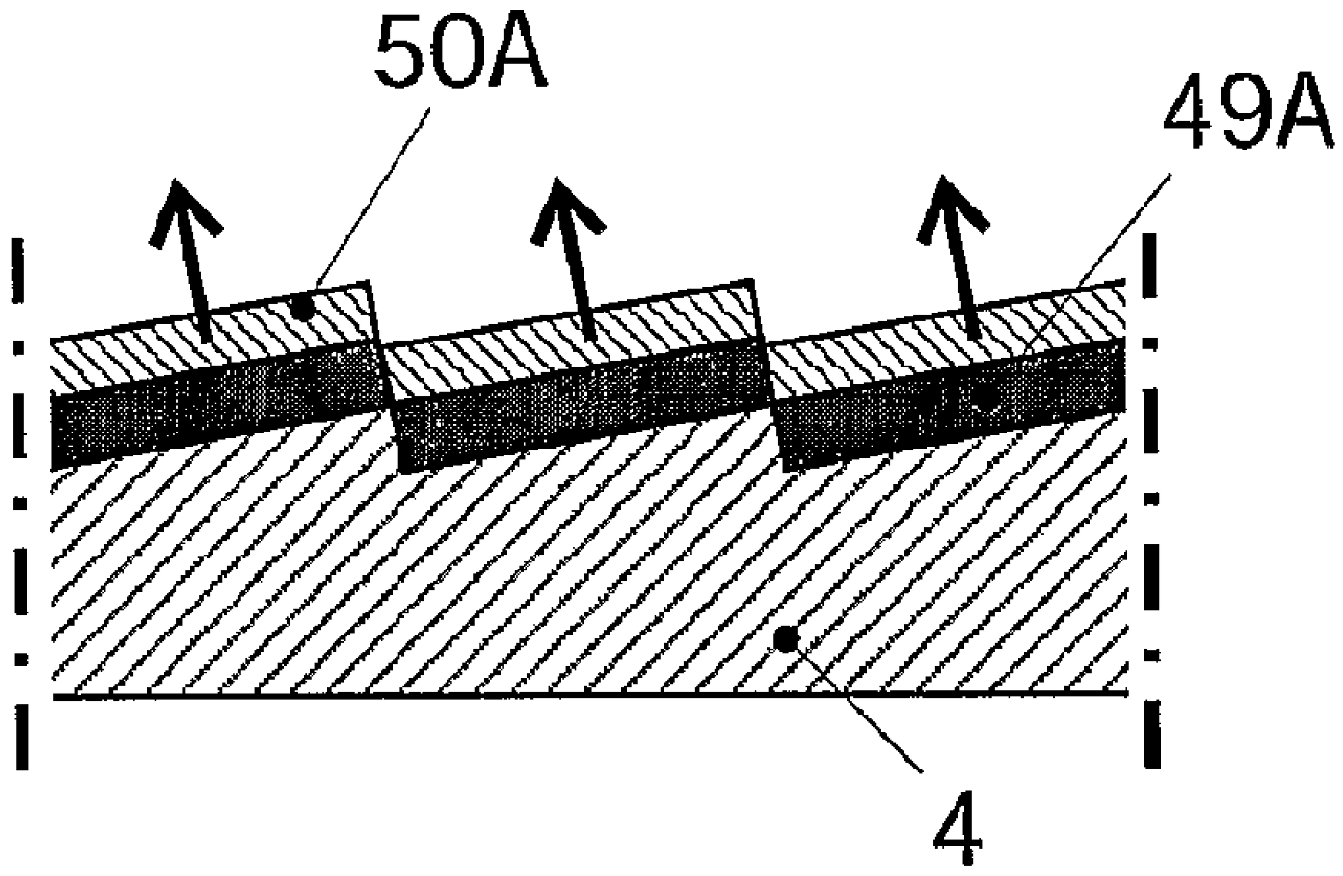

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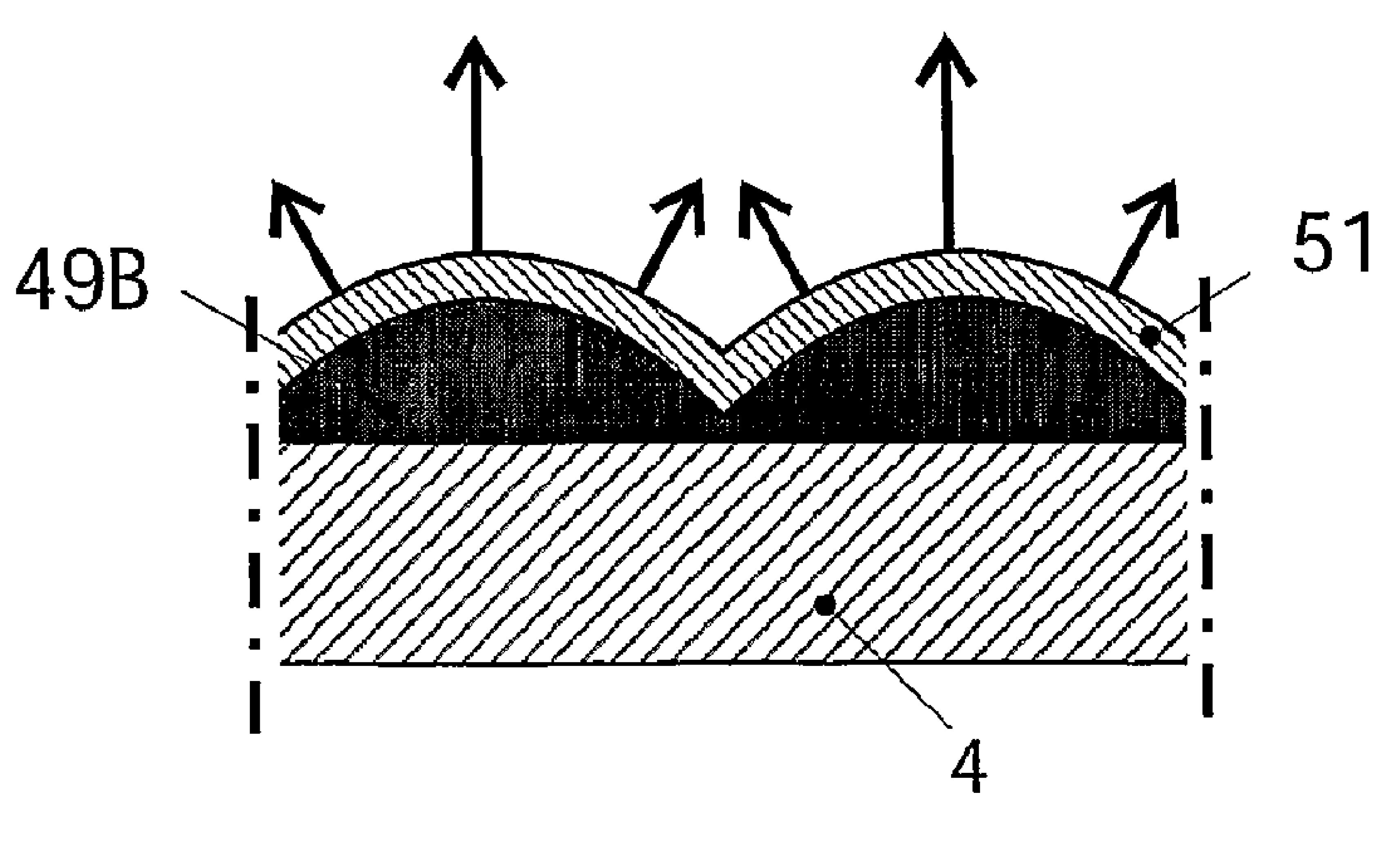

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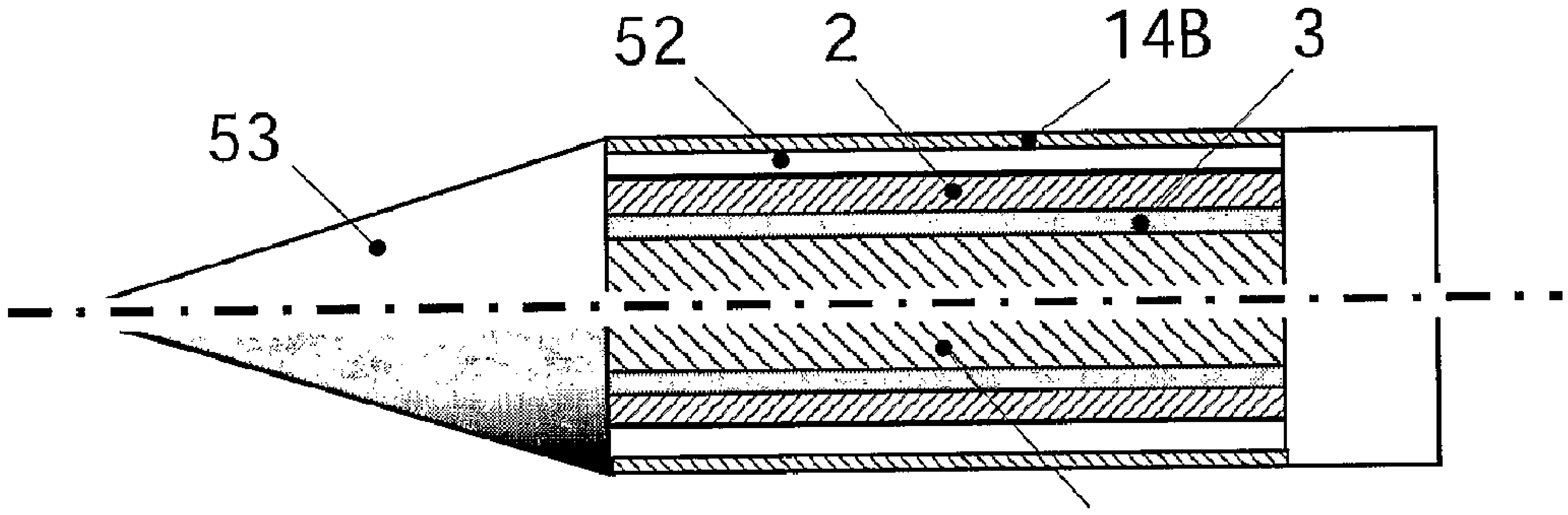

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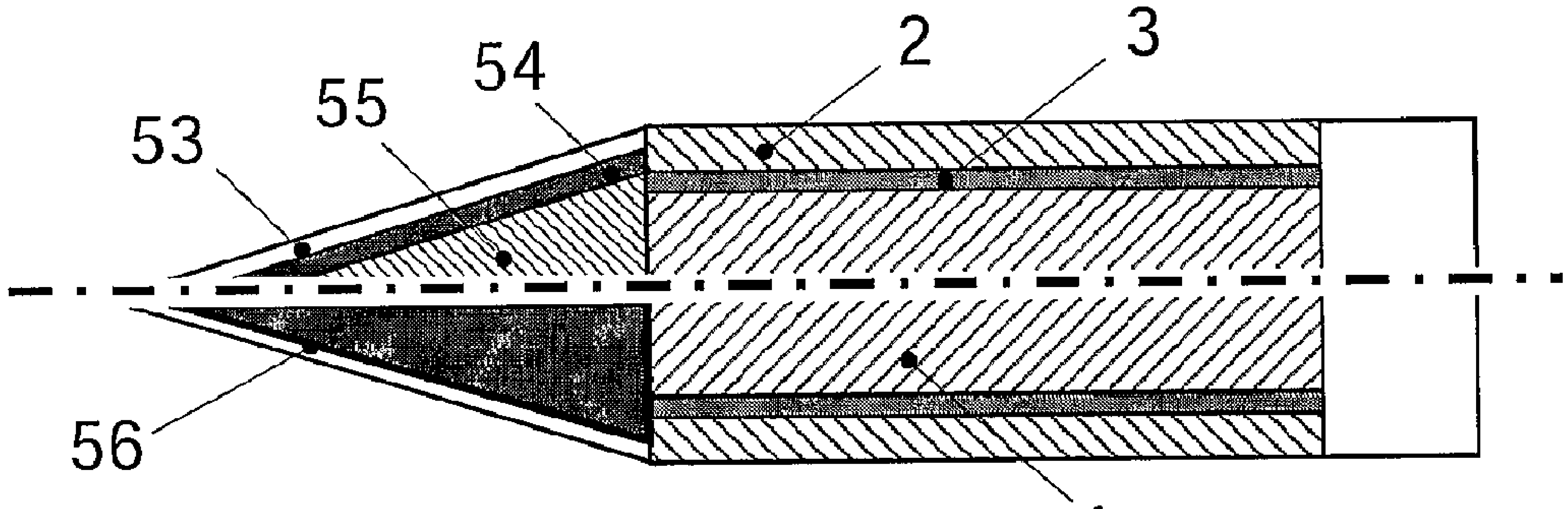

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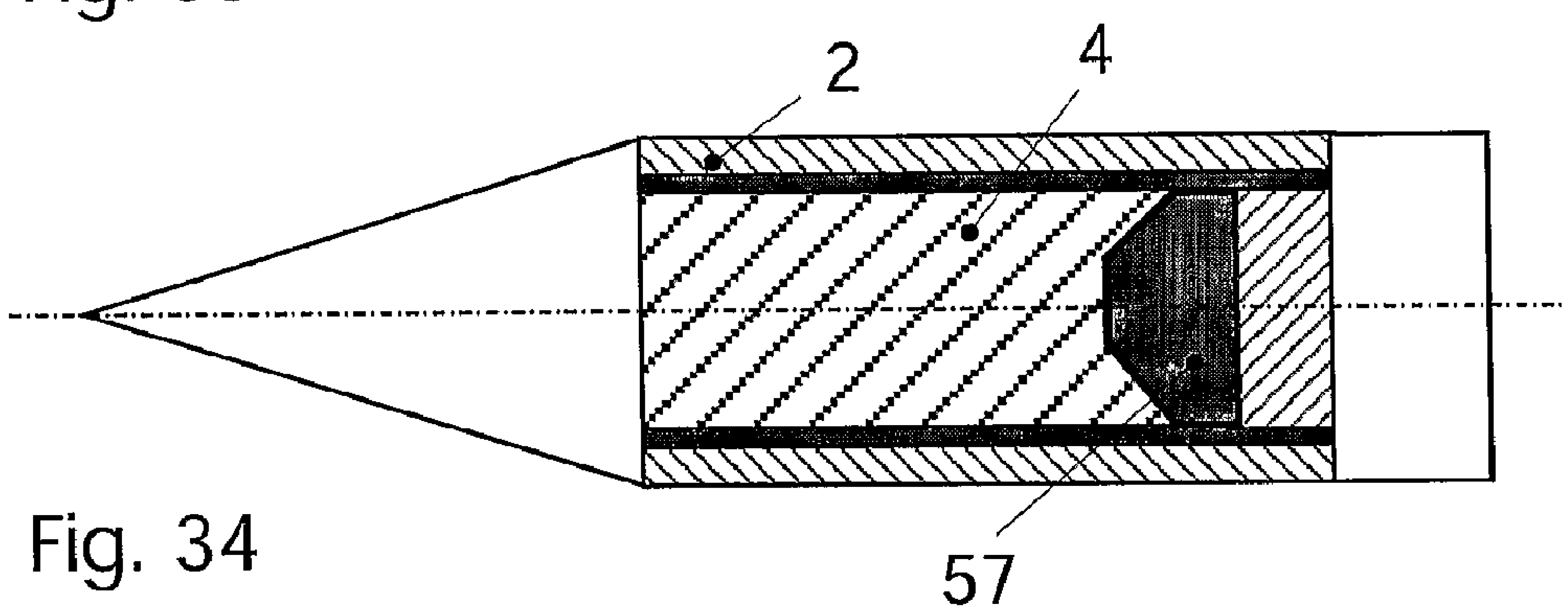

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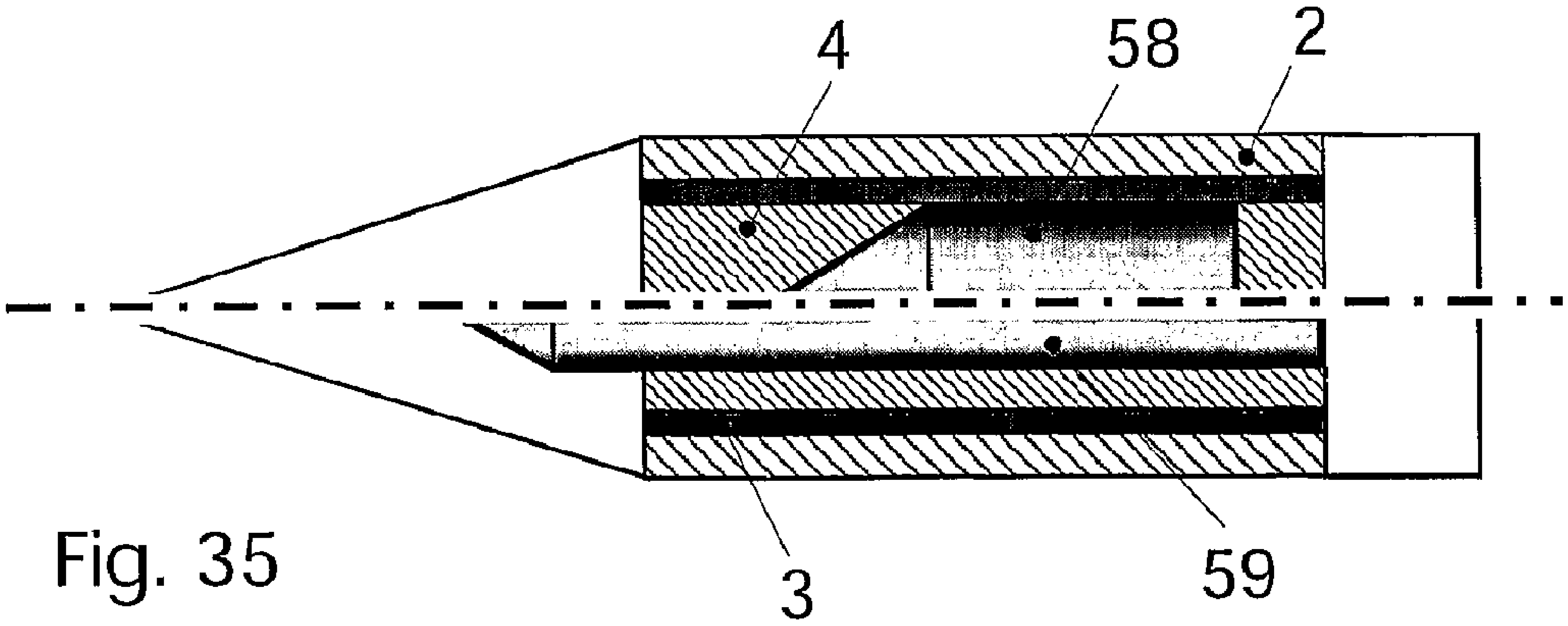

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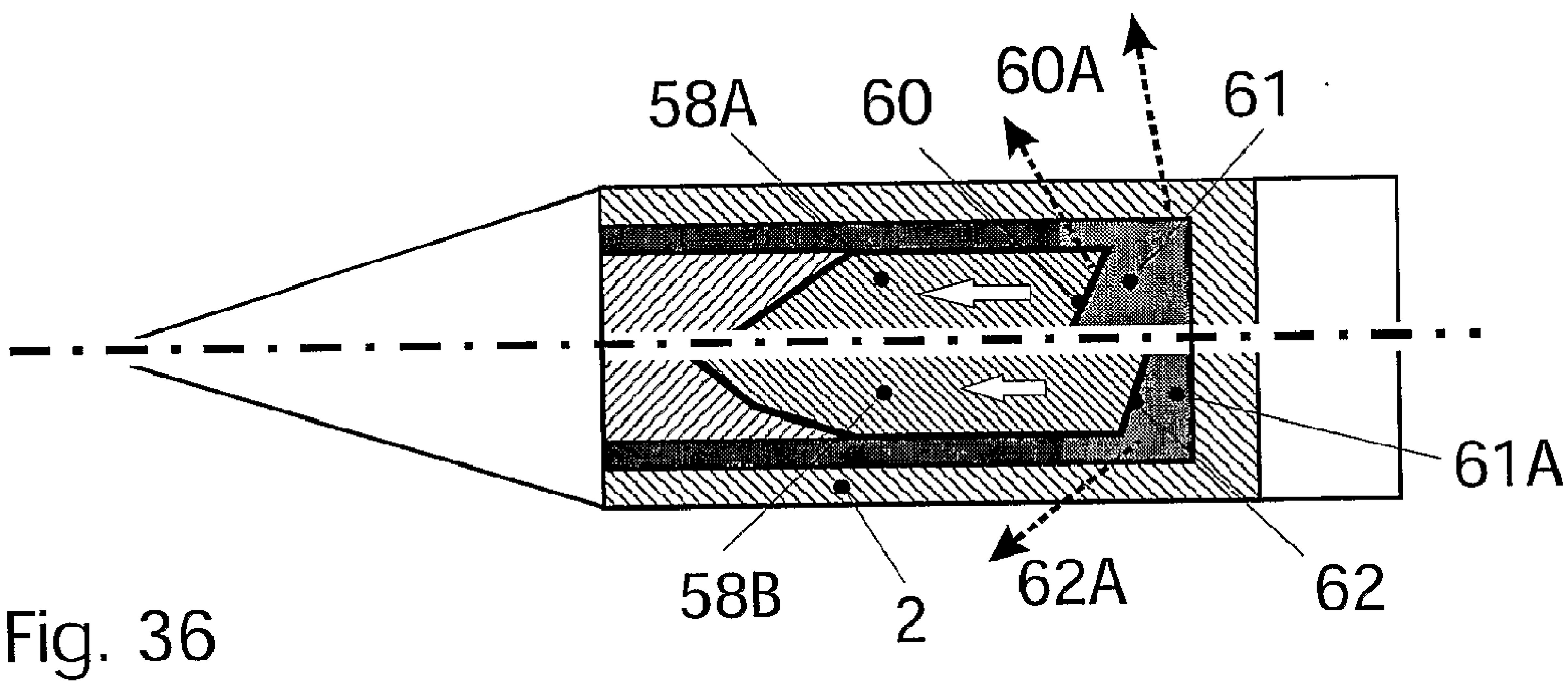

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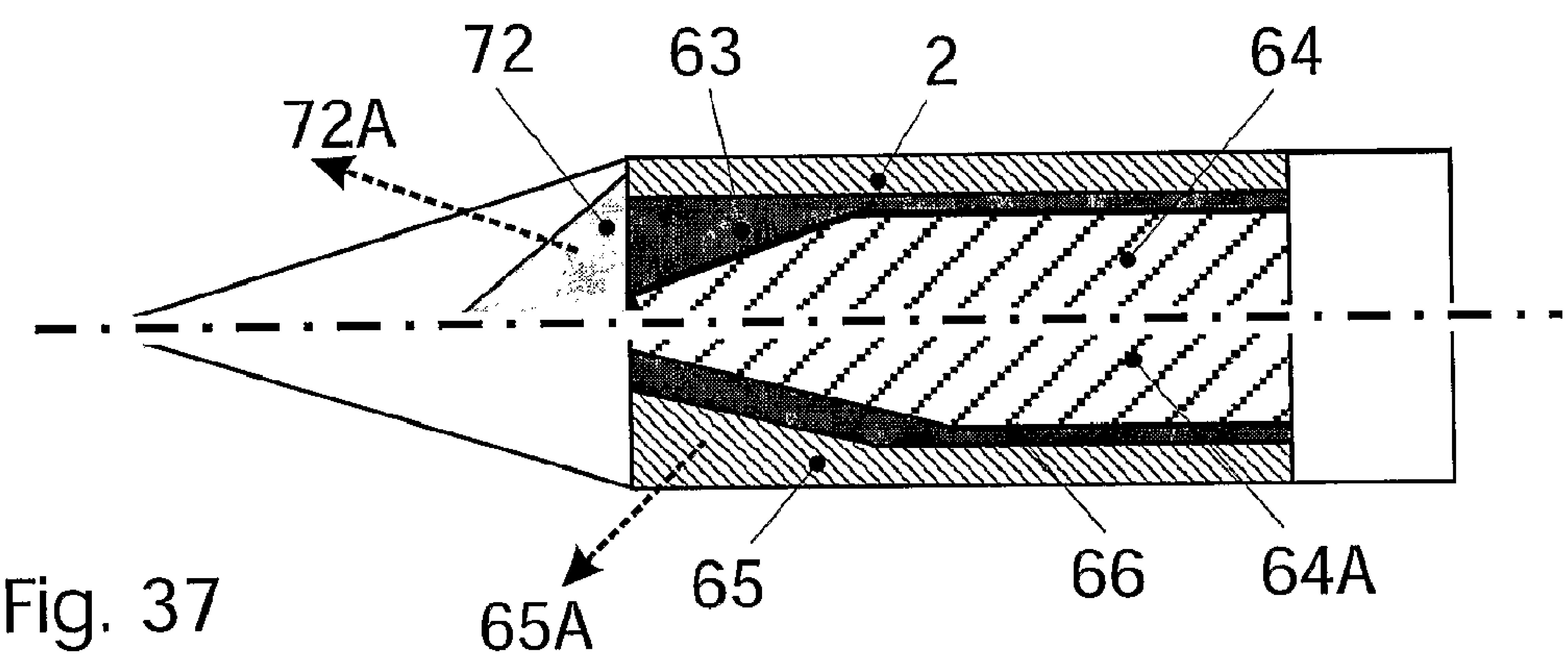

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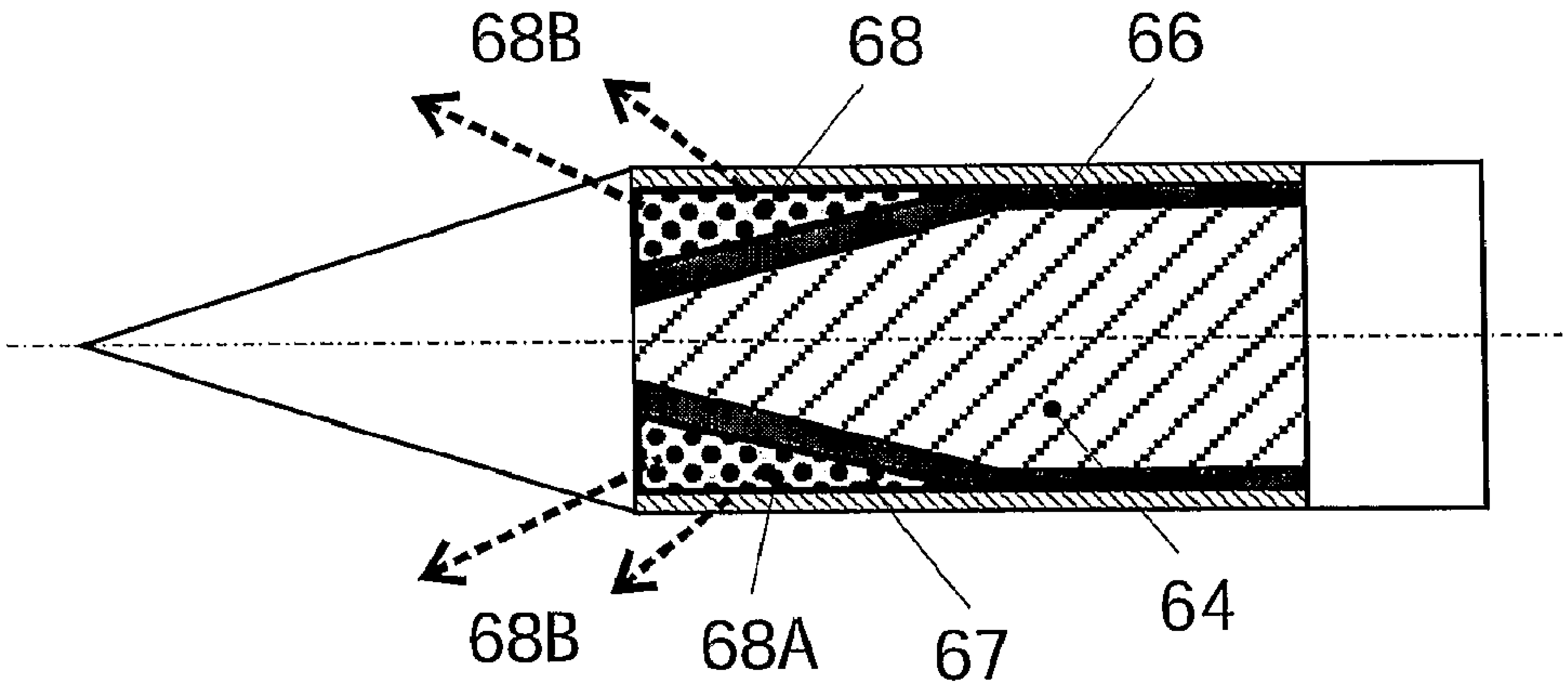

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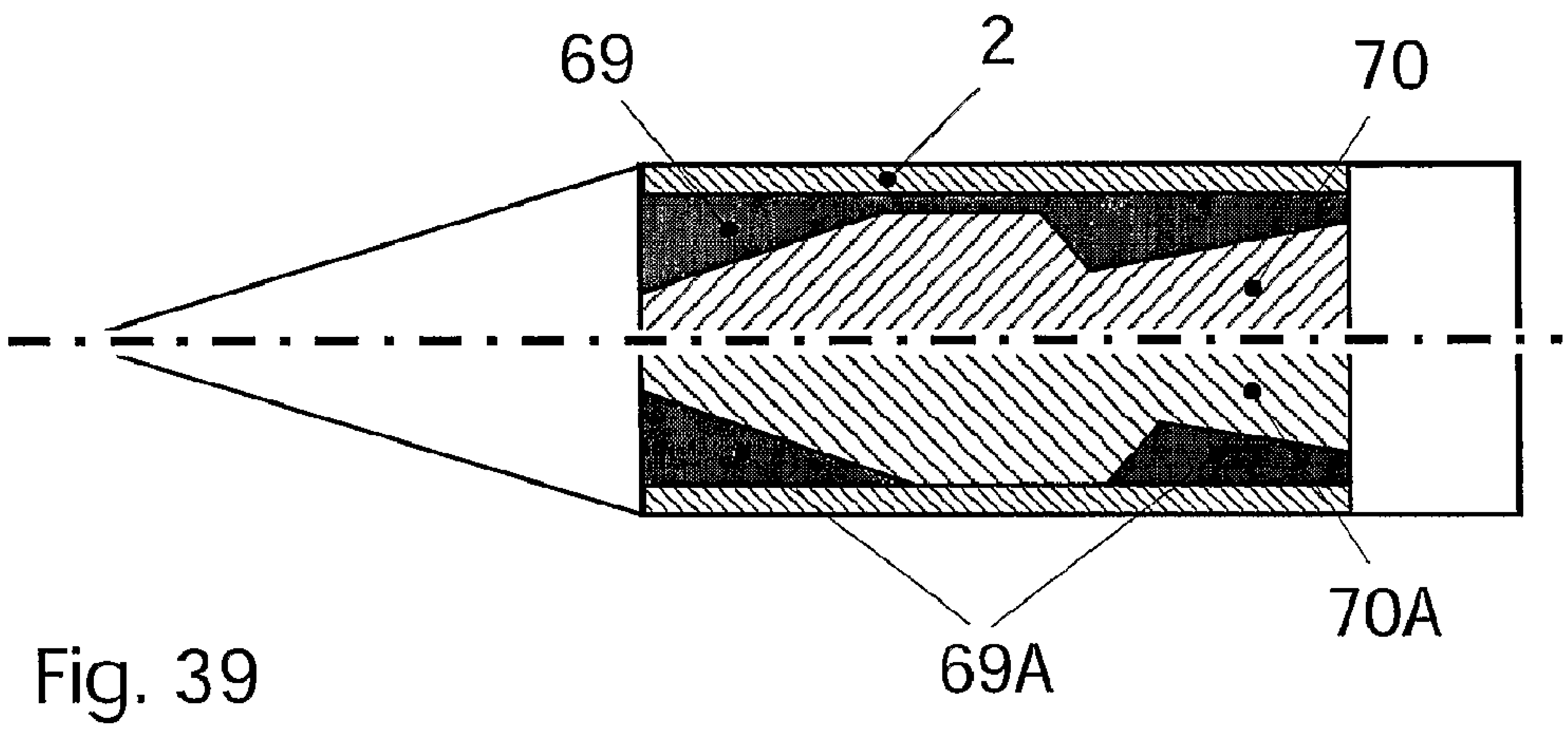

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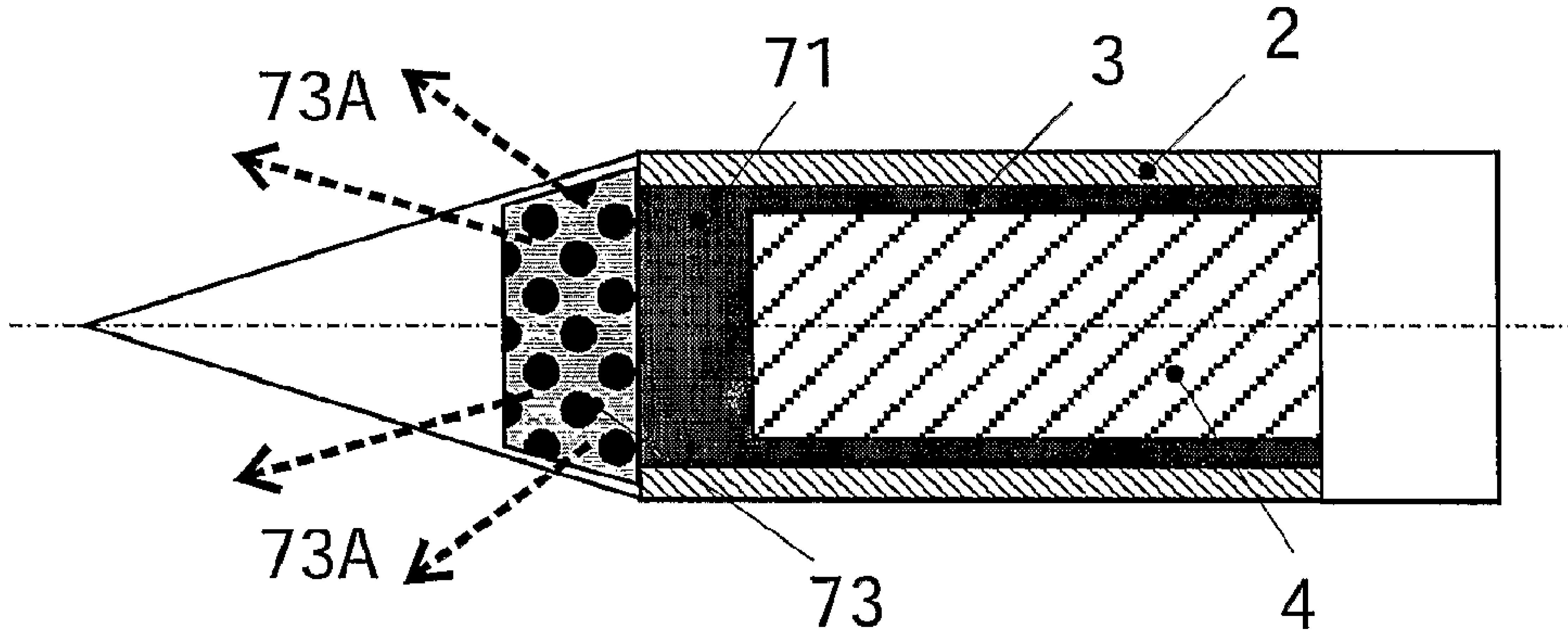

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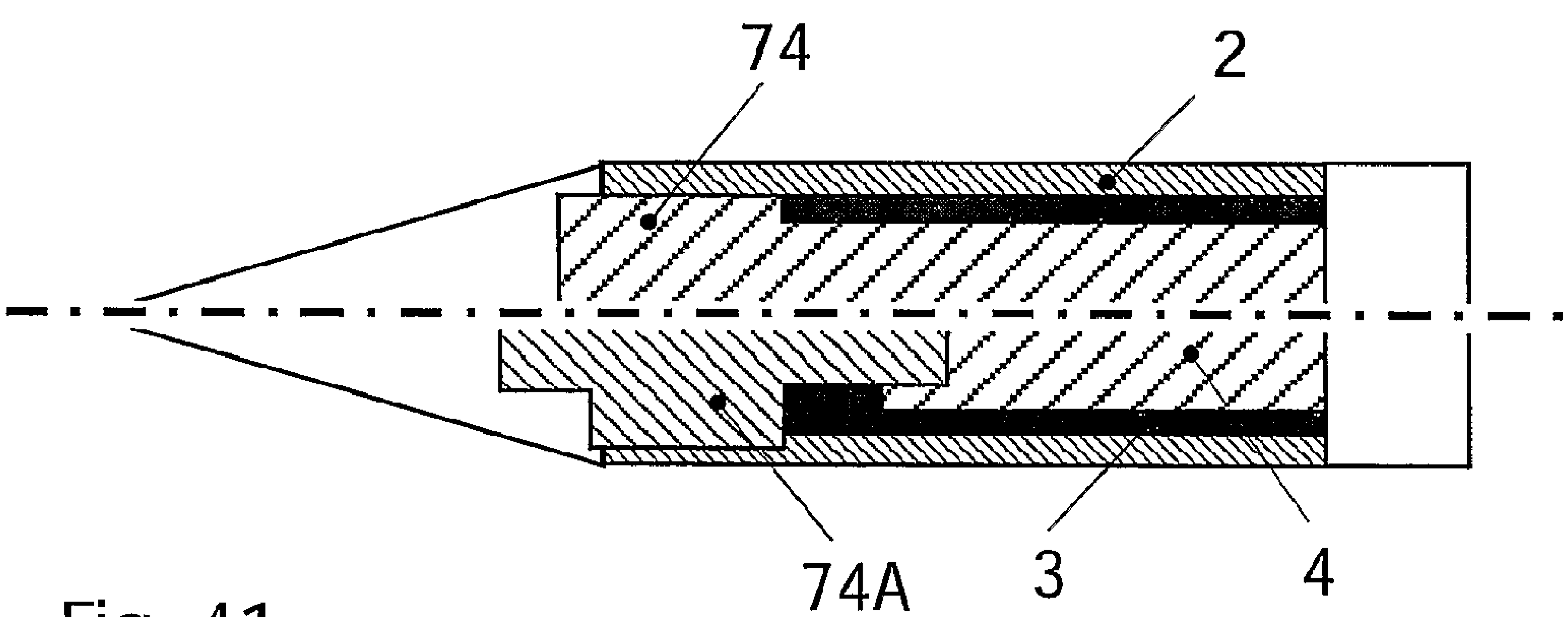

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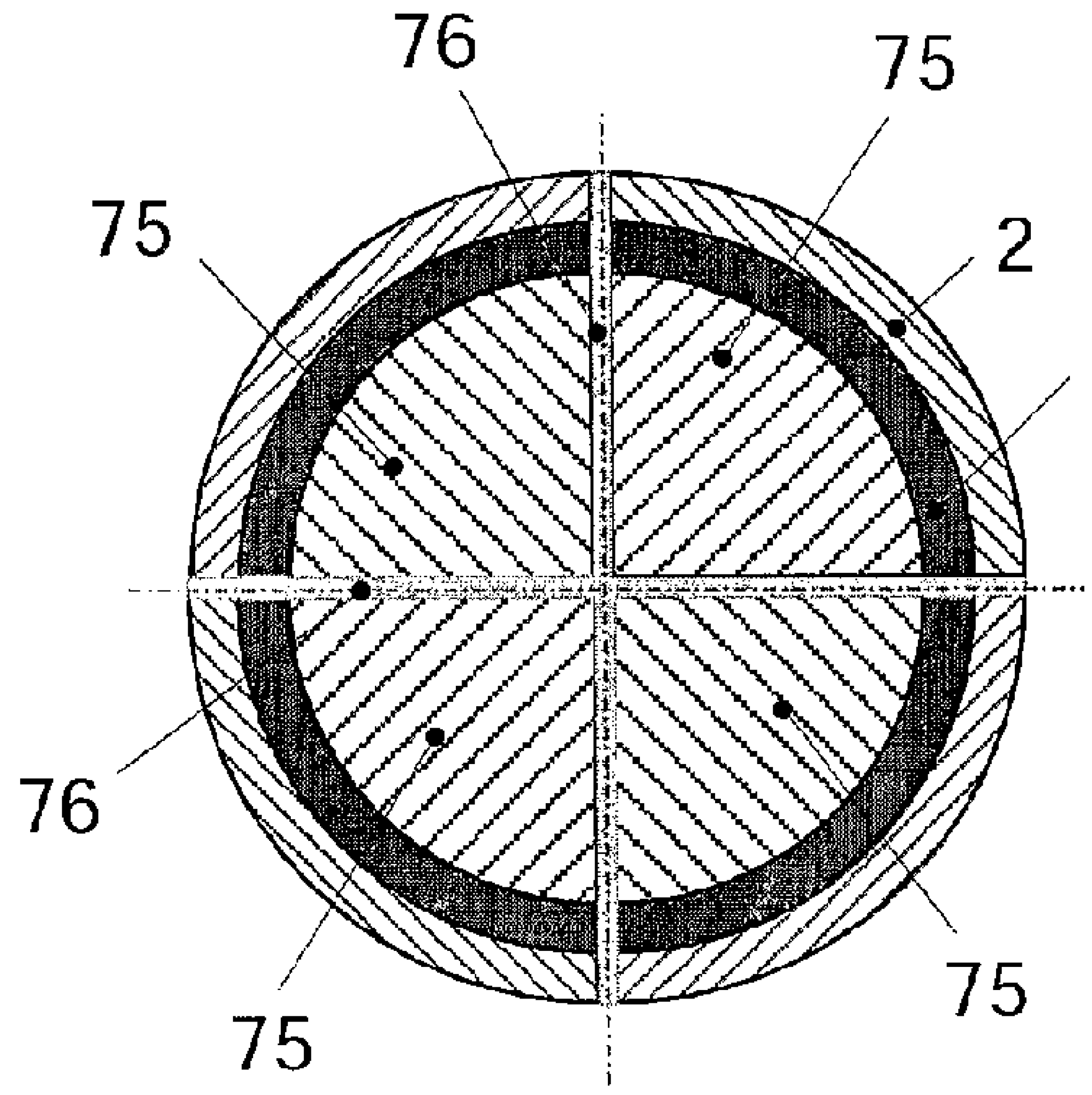

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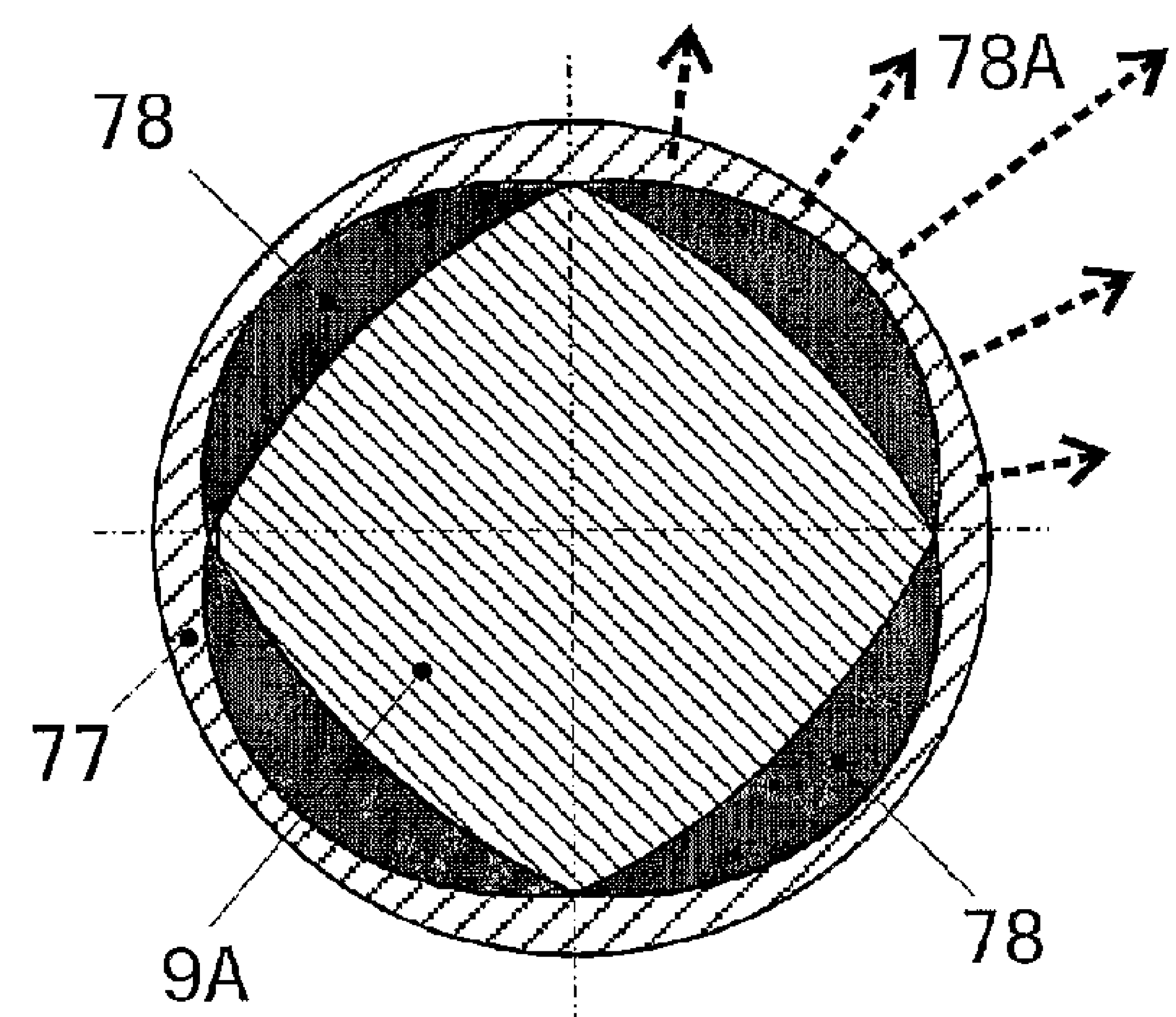

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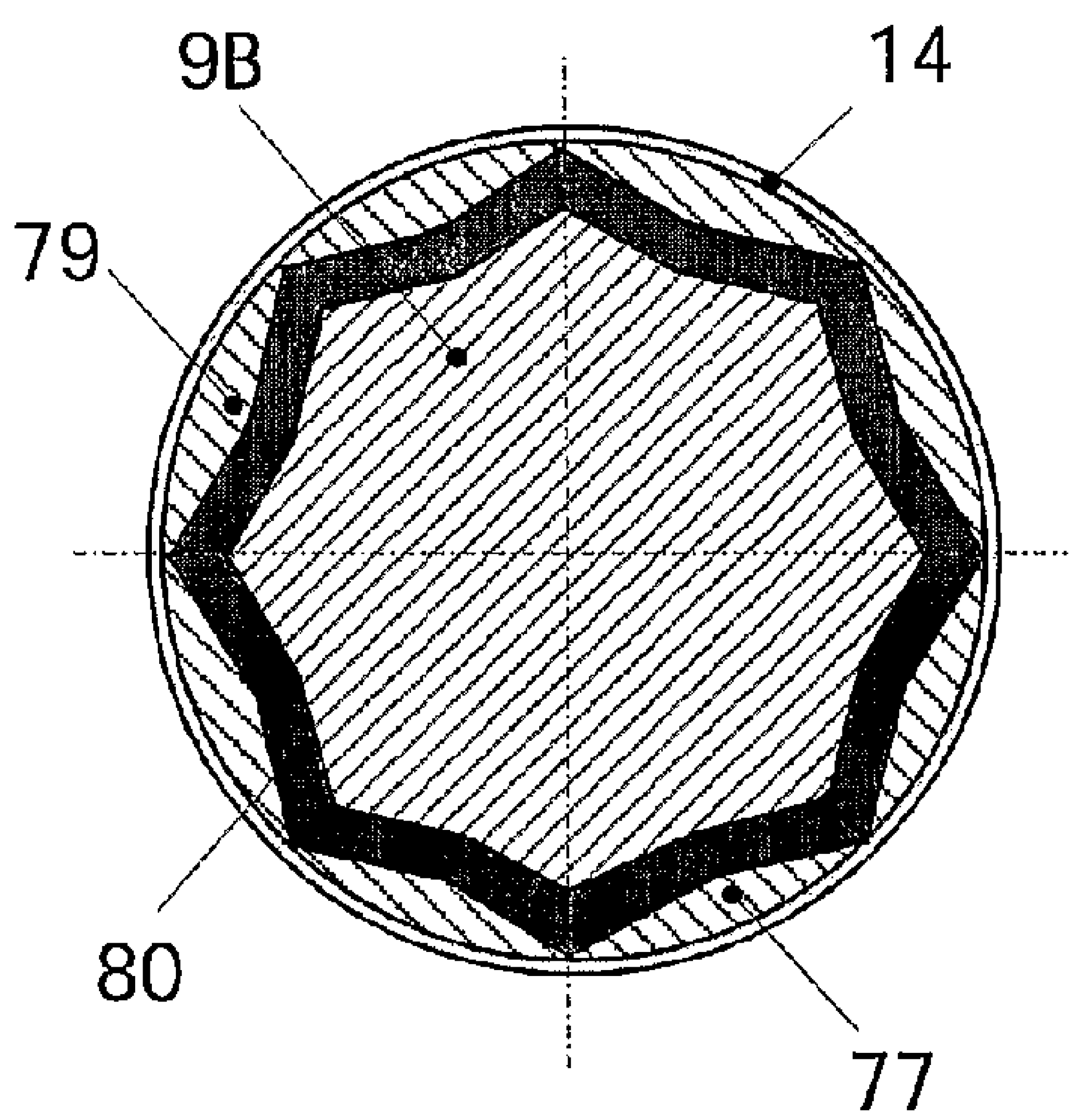

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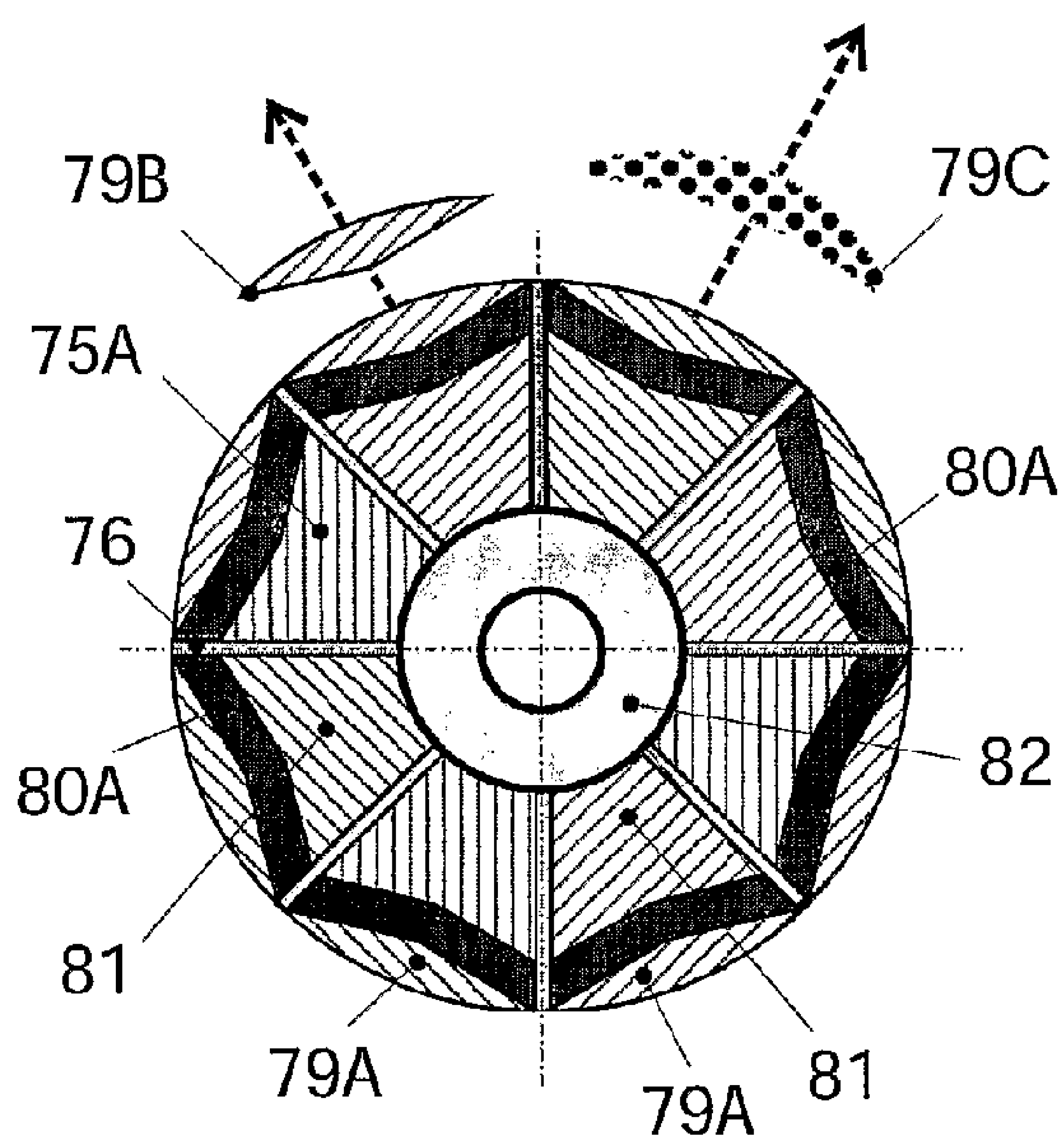

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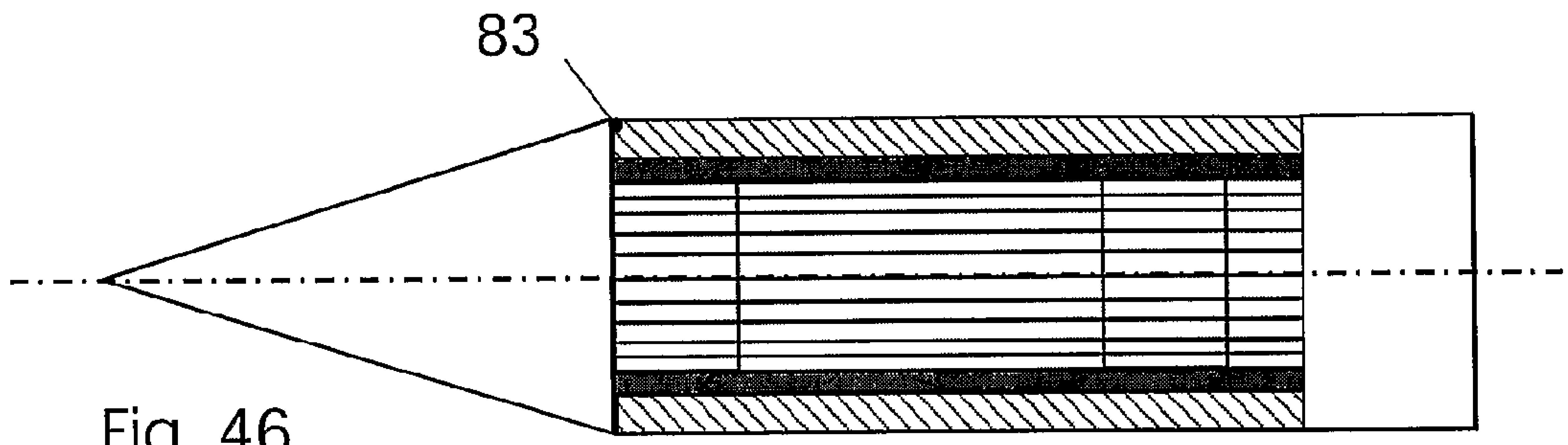

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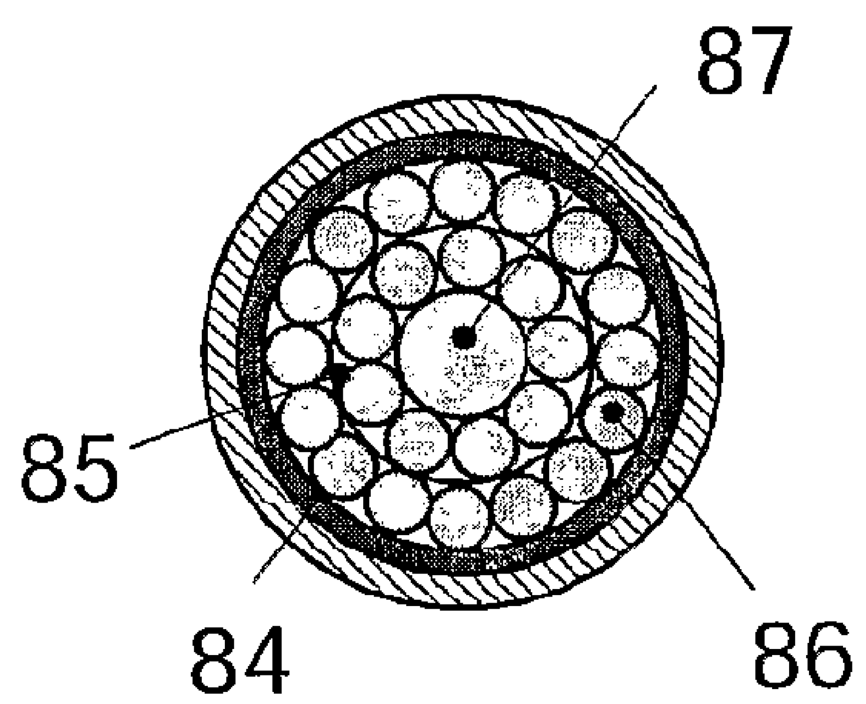

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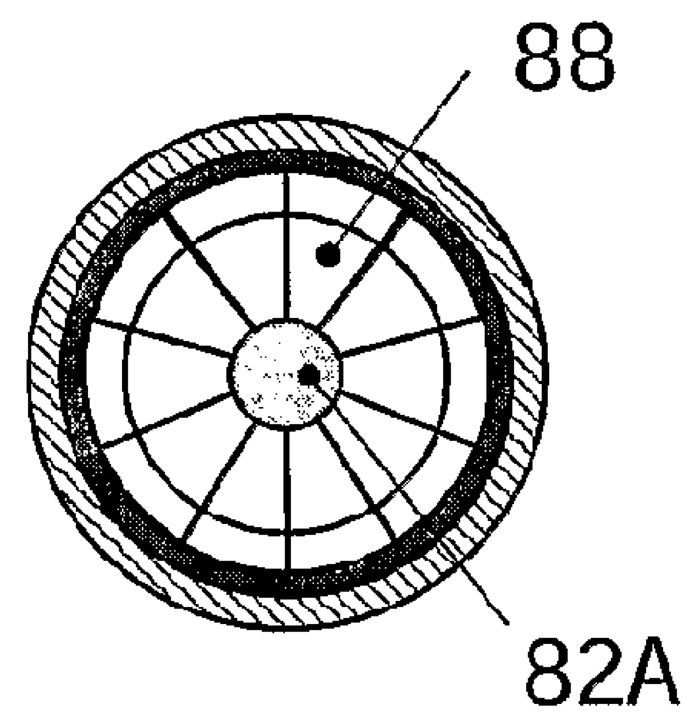

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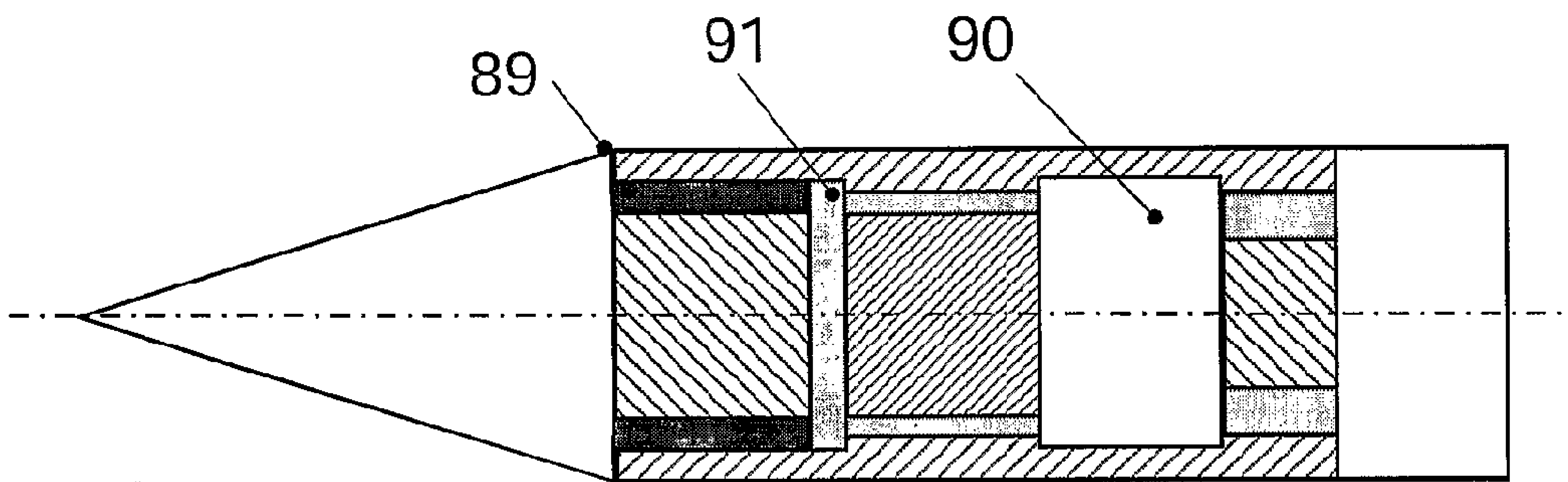

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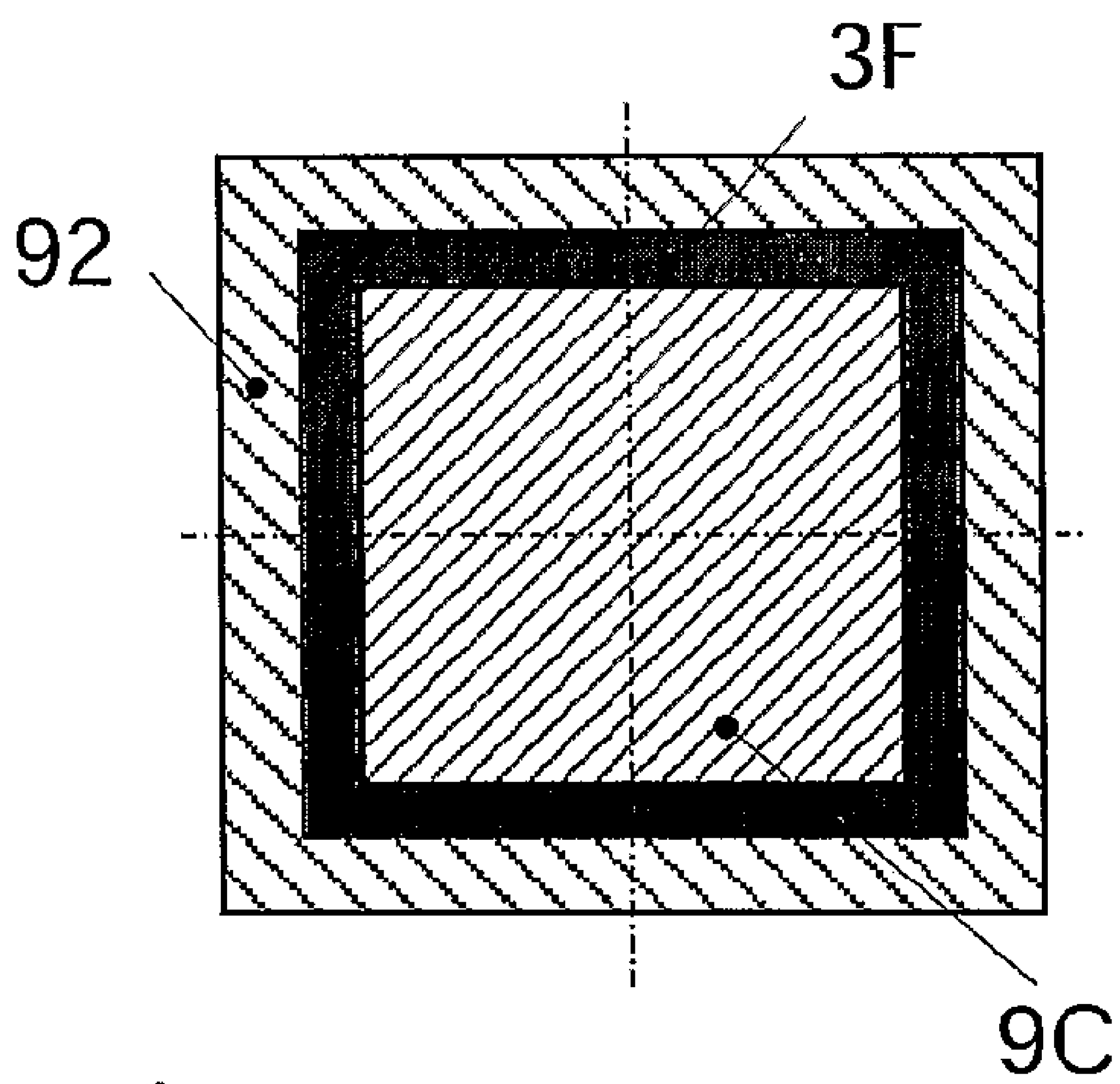

Fig. 50

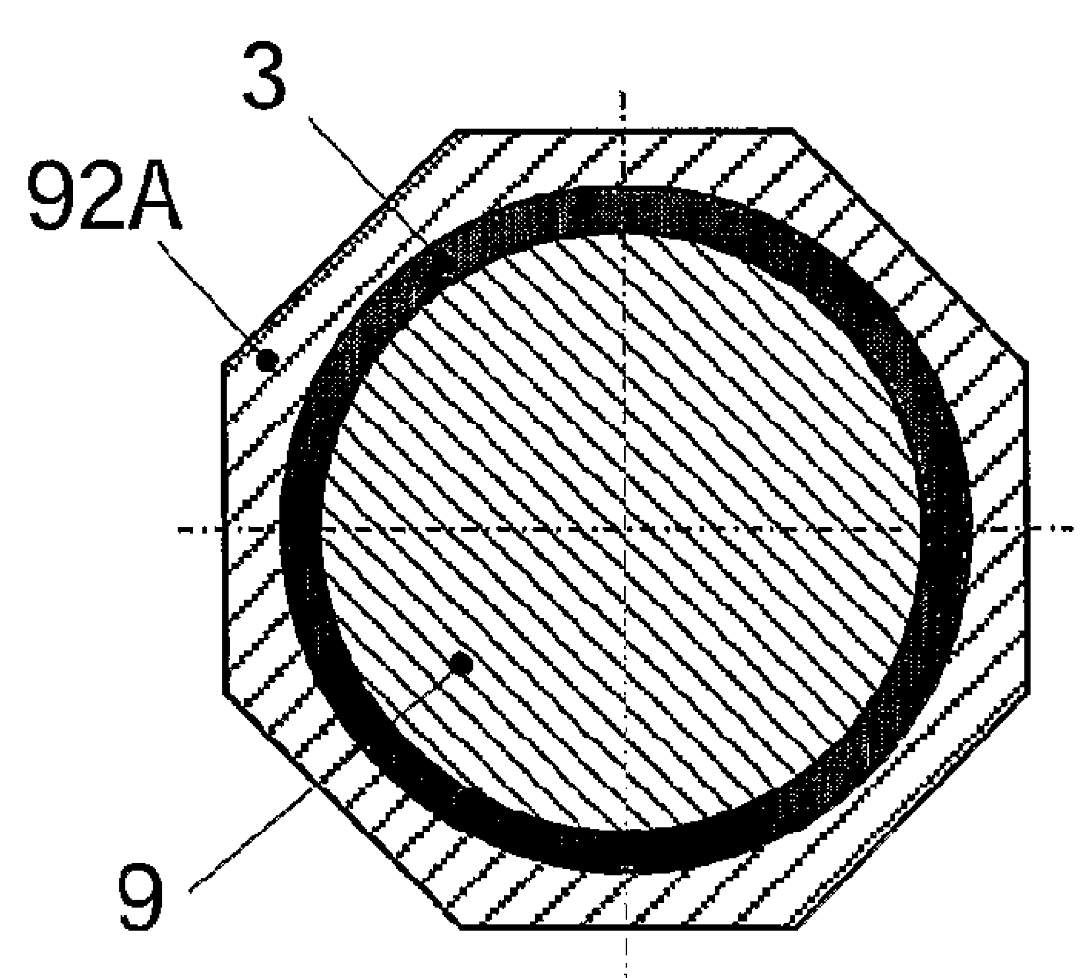

Fig. 51

PROJECTILE OR WARHEAD

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention concerns a fragments-forming or subprojectiles-forming projectile or warhead.

[0003] 2. Technical Background

[0004] Explosive projectiles are used in order to achieve final-ballistic effects in regard to extensive easy targets independently of the impact velocity of a projectile or warhead, by means of explosive-accelerated fragments, with a great initial velocity. Explosive projectiles of that kind are characterised in that the volume thereof is for the major part occupied by explosive. By virtue of their structure explosive projectiles or explosive-filled warheads contain a comparatively large mass of explosive which is not effective for a considerable part thereof or which cannot have any effect at all in part for physical reasons. Structural design freedom is thus severely limited in the case of the munitions known hitherto and is concentrated on the design configuration of the fragmentation casing and the pyrotechnic components.

[0005] In the case of fragmentation projectiles the distribution of fragments which are sufficiently rapidly accelerated on to a target area which is as large as possible or covering a space which is as great as possible (depth) is the decisive parameter. In the case of pure explosive projectiles however that aim can only be limitedly achieved as, upon detonation, the control options in regard to fragment formation and fragment distribution are limited. In conjunction with an adequate impact velocity for the projectile and the use of relatively small amounts of explosive, the above-indicated requirements have hitherto only been achieved with what are to referred to as ALP projectiles (active laterally effective penetrators). In the case of those laterally bursting, active projectiles based on the PELE principle (penetrators with enhanced lateral effect) the lateral velocities which can be achieved are however limited depending on the respective nature and mass of the pyrotechnic agent used and the structural configuration. That certainly corresponds to the objective of such penetrators or warheads as the actual final-ballistic result is afforded by the projectile velocity. The operating principle of a projectile based on the ALP principle is the active bursting of a penetrator before reaching the target into fragments or subprojectiles. The velocity of those components arises out of the small amount of explosive used, the energy of which is transmitted by way of an inert transmission medium to the outer active component in accordance with the shock wave theory and the materials used. The velocities of those active components are between a few m/s and about 200 m/s. The effectiveness or the penetration capacity of the active portions is thus primarily dependent on the impact velocity in the case of ALP projectiles, as in the case of conventional kinetic-energy projectiles.

[0006] Arrangements known hitherto in relation to explosive projectiles are limited to the charge structure and the configuration of the fragmentation casing. A representative example in respect of the charge structure is described in U.S. Pat. No. 5,243,916. The aim is primarily to achieve a lower munition vulnerability insofar as a bursting internal explosive component is surrounded by a more inert component. The aim of modifications is in particular to ensure detonation of the entire charge in order to achieve an adequate fragment velocity. Basically however this involves pure fragmentation projectiles of conventional kind. The interface between the explosive components is preferably of a star-shaped configuration. A large number of possible combinations are set forth, which essentially only differ by the proportion of explosive in the mixtures and different additives. In that arrangement the external layer can also comprise a chemically reactive substance, for example for producing gases.

[0007] In the case of warheads and missiles the declared aim is to achieve acceleration which is as careful as possible of subprojectiles or externally mounted containers by explosive backing arrangements, by virtue of particular structural configurations. As state of the art reference may be made to the two specifications DE 35 22 008 C2 and EP 0 718 590 A1. Thus DE 35 22 008 C2 provides for the fragmentation effect of the missile **10** from the casing **12** of the warhead **11** around the propulsion unit **16**. It is quite generally stated that a given casing thickness is sufficient to produce the desired penetration capability. This relates exclusively to targets which are to be attacked by missiles. Carrying this over to munition is not possible. Also, no physical laws whatsoever are addressed and also no general design rules are specified. Upon impact the entire body is for the major part or entirely hollow so that no damming or stemming effect whatsoever takes place. The assertion that there is no need to arrange a large mass of explosive over the entire cross-section of the missile in order to achieve a high penetration capability relates to the explosive covering of the internal hollow warhead casing. For, the interior of the missile is undoubtedly formed by the drive, the regulating devices and an active charge. No function, in connection with the fragmentation casing, is associated with the internal casing **12***c*. Rather it represents the housing of the propulsion unit with the control elements. That is also expressed by the fact that an insulating layer **19** of heat-insulating material is arranged between that casing **12***c* and the explosive covering. The crucial advantage of an internal damming means which in terms of its action on the fragment velocity which can be achieved is equivalent to the influence of the explosive thickness is not addressed and also cannot occur with the proposed arrangement.

[0008] EP 0 718 590 A1 describes the operative part of a rocket or a warhead which, to enhance lateral effectiveness, accelerates preformed elements by means of an explosive covering which is of annular shape in cross-section. The main aim of the described structure is to convert the high detonation velocity of the explosive layer into a relatively low propagation velocity of the accelerated elements or operative portions. The explosive ring **43** for accelerating the operative portions is initiated by way of a ring of pellets (firing elements **82**). The explosive casing **43** is basically identical in terms of its structure and function to the arrangement described in DE 35 22 008. In particular the propagation velocity, in conjunction with the dimensioning of the surrounding subprojectiles (**56**) is influenced by the property of the explosive or the explosive mixture.

[0009] Projectiles are also known which contain a pyrotechnic charge for enhancing the final-ballistic action. U.S. Pat. No. 3,302,570 serves as a representative example. It describes a type of projectile which primarily was designed for the purpose of piercing protective structures of armour steel while minimising the required projectile energy. That aim is achieved by a solid penetrator of relatively small diameter and relatively great length of heavy metal as a core portion of the projectile structure. In addition the effect is to be enhanced in or behind the target by virtue of the use of explosive or incendiary agent. In that case the action of two incendiary compositions and the projectile-specific bursting processes are referred to as factors besides actual target penetration.

[0010] A high-density combustible material encloses a penetrator with an enlarged head. The high-density material surrounding the penetrator imparts to the penetrator additional mass and thus projectile energy and also passes through the hole made by the penetrator head. The larger diameter of the head is intended to prevent the combustible material from being stripped off. Smashing of the penetrator when passing through harder targets provides that the combustible material is ignited and fragments are generated or incendiary agent is passed into the target. In the rear part of the projectile the central penetrator and the combustible material surrounding it are surrounded by the actual projectile body which is required to stabilise the projectile in the barrel and in flight. A cutting edge at the hardened front edge of the projectile body is intended to enlarge the hole of the target material which has already been pierced by the central main penetrator and greater damage can be caused in the interior by the entrainment of material of the target. In order to fill the space between the central penetrator (**13**) and the projectile body (**17**) a further layer of a combustible material (**16**) of low density is introduced. The additional layer is intended to hold the central penetrator in its position. Upon smashing of the projectile when it passes into harder targets the incendiary compositions are ignited. The approach of that invention is therefore different from in the case of the present invention. U.S. Pat. No. 3,302,570 provides for conveying combustible materials into the target, and they are ignited by virtue of the final-ballistic processes. There is no mention of a build-up of pressure in the interior of the projectile. That form of projectile is not an explosive projectile in the true sense. A function corresponding to the present invention is not provided and is also not indirectly addressed.

SUMMARY OF THE INVENTION

[0011] Regarding the present invention: it is based on the consideration that, in conventional explosive projectiles, a considerable part of the pyrotechnic components cannot make any contribution worth mentioning to fragment acceleration. Detonation of the explosive provides that it is dissociated and the fragmentation jacket is substantially accelerated by the reaction gases produced. Lateral acceleration of the fragmentation jacket causes a direct increase in volume and thus relief of stress so that the pressure components of the explosive internal body can only still supply a correspondingly reduced acceleration proportion.

[0012] The aim of the present invention is final-ballistically high effectiveness of fragmentation projectiles and warheads independently of the impact velocity when using a mass of explosive which is as slight as possible. That is achieved by the combination of an explosive casing with a damming or stemming internal body in conjunction with an external jacket which is accelerated to high velocity. That arrangement not only provides the best possible conversion of the explosive energy but it also affords a high degree of structural freedom in terms of the design of such munitions or warheads. The fragment or subprojectile velocities which can be achieved with relatively slight explosive coverings are between a few 100 m/s and close to 2000 m/s and are thus close to those of pure explosive projectiles. Blast compacting of the internal damming body affords a wide range of additional operative options. In particular there is the possibility of using the internal body for increasing the effectiveness of the entire system. Examples in that respect are the use of specific materials, multi-layer arrangements, the incorporation of subprojectiles and the integration of an additional central pyrotechnic component for breaking up and/or accelerating the internal body. Furthermore the design configuration of the internal damming makes it possible to achieve a directionally controlled action on the part of the fragments, which is not possible with conventional explosive projectiles in that form. Particular effects can also be achieved by the integration of reactive damming components in the penetrator or warhead interior. In conjunction with structural advantages and the possibility of using further operative components the overall effectiveness of the fragment-accelerating munition proposed here is far beyond that of known explosive projectiles or special munitions.

[0013] The present invention is essentially based on the action of an internal damming means in conjunction with a considerably smaller mass of explosive for achieving comparable fragment or subprojectile velocities in comparison with conventional explosive projectiles. An assessment of the fragment velocity which can be achieved is implemented hereinafter.

[0014] In principle the velocity of the jacket is determined by three substantially mutually independent effects: the mass distribution between the jacket to be accelerated and the internal support means, the energy of the explosive layer (energy per unit of volume and thickness) and the surface element size being considered (influenced by the fragment sizes which are formed). That fact is illustrated by the theoretical assessment of the fragment velocity, which can be effected for example by way of the Gurney equation which is known from the relevant literature. Two ways of considering the arrangement involved here present themselves: one is based on a cylindrical form and the other is based on a development of the cylindrical structure in order to achieve a planar surface element. That would then correspond in a first approximation to a reactive protective arrangement. There, it is not only the mass distribution of the two accelerated plates (that is to say the damming ratio) but also the sandwich size, that play a crucial part. With a 10 mm thick explosive layer and a 5 mm thick steel jacket as well as with a strong one-sided damming effect, for example in accordance with Gurney, with very large areas involved, velocities of 1500 m/s are involved. With a 10 mm thick rear plate 750 m/s is still calculated. With a narrow sandwich (strips), about 60% of those values is still achieved.

[0015] Further examples of calculation: without edge influences (therefore presupposing an element size which is sufficiently extensive) the theoretical velocity with a 5 mm steel covering and a great explosive thickness (>20 mm) and a high degree of internal damming is over 2000 m/s. With a jacket thickness of 5 mm and a 5 mm thick explosive layer as well as with internal damming by an aluminum hollow cylinder of a thickness of 20 mm the initial fragment velocity is of the order of magnitude of 1000 m/s and the velocity of the inwardly accelerated hollow cylinder, by virtue of the relatively slight damming effect, is still around 500 m/s. In the case of the combination of an 8 mm thick steel jacket with a 20 mm thick explosive layer and a different internal damming means the values fluctuate between 800 m/s (high damming) and 200 m/s (low damming). Those calculation examples also show that, with arrangements in accordance with the present invention, it is possible to cover a wide range of fragment or subprojectile velocities.

[0016] A Gurney equation which applies for explosive munition of conventional type presents itself for assessment of the fragment velocity of cylindrical structures, as follows:

$$v=D/3(M/C+0.5)^{-0.5}$$

with D as the detonation velocity, M as mass of the jacket (the container, the covering) and C as the explosive mass. In that respect D/3 can be assumed as a good approximation to the characteristic Gurney velocity. The fragment velocity is therefore proportional to the detonation velocity of the explosive used. For general considerations, it is possible to adopt values of between 2600 m/s and 3000 m/s (mean value 2800 m/s) for D/3. That formulation is helpful as for the most part the detonation velocity is known rather than the Gurney velocity.

[0017] The following calculation examples are intended to illustrate the circumstances with that way of considering the situation: with an outside diameter of 100 mm and a wall thickness for the jacket of 10 mm (inside diameter 80 mm) and a thickness for the explosive layer of 5 mm, that affords 25% of the Gurney velocity as the fragment/jacket velocity. With an inside diameter of 40 mm (that is to say with a 20 mm explosive layer thickness), that gives 45% of the Gurney velocity, that is to say about 1260 m/s. With an inside diameter of 60 mm and a 10 mm thick explosive layer 35% of the Gurney velocity (about 1000 m/s) is calculated. In the case of an explosive-filled jacket, that gives 50% of the Gurney velocity, that is to say about 1400 m/s. With ideal one-sided (internal) damming and a very thick explosive layer (>30 mm) the Gurney velocity is approximately attained with large areas (or diameters).

[0018] The internal damming which represents a central feature of the invention provides for optimum conversion of the explosive energy into fragment velocity so that correspondingly high velocities become possible, with relatively slight explosive thicknesses. The influence of the internal damming can be taken into consideration by way of a factor which is to be referred to as the damming factor (VF). It is dependent on the values M/C, $M_{internaldamming}/M_{jacket}$, rho_{core}, $sigma_{core}$ and the Hygoniot properties of the internal medium. Consideration can be based on the following estimated values: with thick jackets and a thick explosive layer as well as with thin jackets and a thick explosive layer there is a damming factor of between 1.1 and 1.2. That corresponds to a velocity increase of between 10% and 20%. In the case of a thick jacket combined with a thin explosive layer as well as a thin jacket with a thick explosive layer that gives a damming factor of between 1.2 and 1.3 (between 20% and 30% velocity increase). Accordingly it is not only possible to achieve very high fragment velocities up to about 2000 m/s and strong jacket fragmentation effects by way of high damming levels and corresponding explosives, but on the other hand it is possible to achieve relatively low fragment or subprojectile velocities, with correspondingly gentle acceleration, by way of less-damming internal bodies and more sluggish explosives.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1**A shows the basic structure of a spin-stabilised explosive layer-fragment projectile with fragment casing, explosive layer and damming internal body as well as control and firing elements,

[0020] FIG. **1**B shows the basic structure of an aerodynamically stabilised explosive layer-fragment projectile with fragment casing, explosive layer and damming internal body as well as control and firing elements,

[0021] FIG. **2** shows an example of the cross-sectional configuration of an explosive layer-fragment projectile with fragment jacket, explosive layer and damming internal body,

[0022] FIG. **3** shows a cross-section through an explosive layer-fragment projectile with damming internal ring or damming hollow internal body,

[0023] FIG. **4** shows a cross-section through an explosive layer-fragment projectile with a multi-layer damming internal structure,

[0024] FIG. **5** shows an example of the cross-sectional configuration with a circular external cross-section and any (here octagonal) internal cross-section of the explosive layer,

[0025] FIG. **6** shows an example of the cross-sectional configuration with a damming internal body and a circular internal cross-section and any (here octagonal) external cross-section of the explosive layer,

[0026] FIG. **7** shows an example of the cross-sectional configuration with any (here square) cross-section of the damming internal body and segmented detonation cross-section/explosive surface segments (here: separated by the internal body, with simultaneously or non-simultaneous firing),

[0027] FIG. **8** shows an example of the cross-sectional configuration with an internal body of any (here triangular) cross-section and inert, pressure-transmitting compensating segments between the internal body and the explosive layer,

[0028] FIG. **9** shows a cross-section with a plurality of (here two) damming hollow internal bodies and a dynamically acting layer between the explosive layer and the internal damming (top) and/or between the different internal dammings (bottom),

[0029] FIG. **10** shows a cross-section with a damming internal body and a dynamically acting layer between the explosive layer and the fragment jacket,

[0030] FIG. **11** shows an example of the cross-sectional configuration with an outer jacket/projectile casing and subjacent fragment casing (top) and an additional dynamically acting layer between the explosive layer and the fragment jacket (bottom),

[0031] FIG. **12** shows an example of the cross-sectional configuration with an outer jacket and a fragment body/preformed projectiles/intermediate layer containing thermal or mechanical fragmentation measures,

[0032] FIG. **13** shows an example of the cross-sectional configuration with (here square) damming internal body and explosive segments with areal/line-shaped/point-shaped firing device in the explosive layer (top) or with firing elements introduced into the internal body,

[0033] FIG. **14** shows an example of the cross-sectional configuration with an explosive area of any shape (here square) and pressure-transmitting segments between the explosive layer and the fragment casing or projectile jacket,

[0034] FIG. **15** shows an example of the cross-sectional configuration with a double-layer explosive covering and two damming layers,

[0035] FIG. **16** shows an example of a projectile or a warhead with a multi-part internal body (here comprising four circular segments of the same or different material) with a central pyrotechnic body,

[0036] FIG. **17** shows an example of a projectile or a warhead with a multi-part internal body (here four cylindrical penetrators) with a central pyrotechnic body (top) or an inert central body or empty internal volume,

[0037] FIG. **18** shows an example of the cross-sectional configuration with a projectile jacket/internal area, of a geometrical configuration, of the fragment casing/correspondingly shaped explosive layer and internal damming,

[0038] FIG. **19** shows an example of the cross-sectional configuration with an internal area, of a geometrical configuration, of the fragment casing and correspondingly shaped explosive layer,

[0039] FIG. **20** shows an example of the cross-sectional configuration with an internal area, of a geometrical form, of the explosive layer (top) or longitudinal explosive strips or explosive surface elements (bottom),

[0040] FIG. **21** shows an example of the cross-sectional configuration with internal damming and separating elements introduced into the explosive layer or geometrical structures (here longitudinal strips),

[0041] FIG. **22** shows an example of the cross-sectional configuration with a damming hollow internal ring and a central/damming internal body in the form of a container,

[0042] FIG. **23** shows an example of the cross-sectional configuration with a damming central container (top) or a central internal body and a space provided with legs between the explosive layer and the internal body,

[0043] FIG. **24** shows an example of a longitudinal section with a fragment casing, an explosive layer, a damming (here two-part) internal body and control or firing elements for the explosive layer,

[0044] FIG. **25** shows an example of a longitudinal section of variable explosive thickness and with a cylindrical fragment casing (top) and with variable fragment casing and explosive thickness (bottom),

[0045] FIG. **26** shows an example of a longitudinal section with an explosive layer/internal body diameter jump (top) or divided damming body/inserted penetrator body or penetrator ring (bottom),

[0046] FIG. **27** shows an example of a longitudinal section with a diameter change in respect of the fragment jacket and the explosive layer,

[0047] FIG. **28** shows an example of a longitudinal section with multi-part (here separate) explosive layers and (here) a different fragment jacket diameter (top) or a continuous explosive layer with a diameter jump (bottom),

[0048] FIG. **29** shows an example of the geometrical configuration of the fragment casing for achieving desired effects or preferred fragment directions. Here: directional control and rotation of the fragment bodies/fragment rings and continuous explosive layer with cylindrical damming internal body,

[0049] FIG. **30** shows an example of the geometrical configuration of the fragment casing for achieving desired effects or preferred fragment directions. Here: directional control of the fragment bodies and separate explosive layers and geometrically adapted damming internal bodies,

[0050] FIG. **31** shows an example of the geometrical configuration of the fragment casing for achieving desired effects or preferred fragment directions. Here: explosive covering for different fragment directions and fragment velocities,

[0051] FIG. **32** shows an example of a longitudinal section through an explosive layer-fragment projectile or warhead with an inwardly disposed explosive-covered fragment body and an intermediate space between the outer jacket and the fragment body as well as an empty or partially filled external-ballistic cover (top) or a solid/filled tip (bottom),

[0052] FIG. **33** shows an example of a longitudinal section with complete explosive covering (projectile body and tip region—top) and explosive-filled tip (bottom),

[0053] FIG. **34** shows an example of a longitudinal section with an explosive body inserted into the damming internal region,

[0054] FIG. **35** shows an example of a longitudinal section with a core embedded in the damming internal region (top) or slender cylinder with tip (bottom),

[0055] FIG. **36** shows an example of a longitudinal section with a pointed core embedded in the damming internal region, with focusing/core tail region-destroying explosive backing (top) or a core with a stepped tip and a centering (core-accelerating) explosive backing (bottom),

[0056] FIG. **37** shows an example of a longitudinal section with a geometrically configured internal body and corresponding explosive covering for directed fragment effect (top) or with a fragment directional effect by shaping of the damming internal body, the explosive surface and the fragment jacket (bottom),

[0057] FIG. **38** shows an example of a longitudinal section corresponding to FIG. **37** with additional fragment components,

[0058] FIG. **39** shows an example of a longitudinal section with (here) two-stage directed fragment effect and continuous explosive covering (top) and non-continuous explosive covering (bottom),

[0059] FIG. **40** shows an example of a longitudinal section with an additional, primarily axially accelerated fragment cone in the front region of the projectile, accelerated by an explosive surface,

[0060] FIG. **41** shows two examples of a longitudinal section with a front core/stepped core as the damming medium,

[0061] FIG. **42** shows an example of a cross-sectional configuration with explosive-accelerated individual segments,

[0062] FIG. **43** shows an example of the cross-sectional configuration with a variable thickness of the fragment casing and (here four) explosive segments of lens-shaped cross-section (in principle to be freely designed),

[0063] FIG. **44** shows an example of the cross-sectional configuration with a shaped explosive surface and adapted damming internal body,

[0064] FIG. **45** shows an example of the cross-sectional configuration with (here eight) segments and a freely designed explosive surface,

[0065] FIG. **46** shows examples of a longitudinal section with multi-part damming internal body (for example divided axially and radially),

[0066] FIG. **47** shows an example of the cross-sectional configuration of a projectile or warhead as shown in FIG. **42** with a damming internal body, here made up of cylinders in a pressure-transmitting matrix,

[0067] FIG. **48** shows an example of the cross-sectional configuration of a projectile or warhead as shown in FIG. **43** with segmented, single-layer or multi-layer damming internal body and a central penetrator,

[0068] FIG. **49** shows an example of a longitudinal section in the form of a multi-part active body (different stages with different functions) and a differing configuration or covering,

[0069] FIG. **50** shows an example of the cross-sectional configuration, which may be desired, of an explosive layer-fragment projectile or warhead, and

[0070] FIG. **51** shows a further example of the cross-sectional configuration which may be adopted.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0071] FIG. **1**A shows the basic structure of a spin-stabilised explosive layer-fragment projectile **1**A with a fragment casing/fragment jacket/fragmentation projectile jacket **2**, an explosive layer/explosive covering/explosive surface/pyrotechnic layer **3** disposed under the casing, and a damming or stemming internal body **4**. Integrated detonation firing elements with actuating means or electronic firing means for the explosive layer are indicated. Actuation and triggering of the explosive layer is to be adapted to the respective state of the art. The effectiveness of the arrangement remains substantially unaffected thereby.

[0072] The operating principle according to the invention equally allows application to aerodynamic stabilised projectiles as diagrammatically shown in FIG. **1**B. This Figure also shows the basic structure of the explosive layer-fragment projectile **1**B with fragment casing **2**, explosive layer **3** and damming internal body **4**, as well as firing elements or other projectile or warhead devices. The positioning of the firing elements is not relevant for the function of the fragmentation projectile; they can be disposed in the projectile base, in the damming internal body **4**, in the projectile tip or as modules at a plurality of locations (see for example FIGS. **24** and **45**).

[0073] FIGS. **2** through **23** and FIGS. **42** through **45** and FIGS. **47** through **51** show examples of the cross-sectional configuration of projectiles or warheads corresponding to the present invention.

[0074] Thus FIG. **2** shows a cross-section through an explosive layer-fragment projectile, according to the invention, with fragment jacket **2**, explosive layer **3** and damming internal body **4**. In the illustrated structure which shows the simplest variant of the possible configurations, the damming, dynamically correspondingly incompressible internal body **4** is in the form of a solid homogeneous cylindrical component. Basically all materials which provide a desired dynamic damming effect can be considered as the materials for the damming component. The dynamic properties thereof and in particular the degree of damming which results therefrom are determining factors in regard to the fragment velocity which can be achieved or the required thickness of explosive for achieving a desired acceleration of the jacket. For, as already mentioned, damming is equivalent in its effect on the fragment velocity which can be achieved, to the influence of the thickness of the explosive.

[0075] Further effect-relevant properties are the geometrical dimensions of the fragment jacket or the mass thereof and also the mechanical dynamic properties thereof. A particular advantage of the invention however is that no particular claims whatsoever are to be made on the individual components. Thus almost all properties are to be achieved by a suitable choice of material, without involving a high level of technical complication and expenditure.

[0076] FIG. **3** shows a cross-section through an explosive layer-fragment projectile with damming internal body **5**. In this case it is of an annular cross-section surrounding a hollow space **6**. The thickness and material of the ring **5** are to be so selected that sufficient damming of the explosive layer is effected. The explosive zone can be built up both from one layer and also from two or more similar or different layers. Incompressibility of the damming medium is not a necessary prerequisite for the basic function. Rather it is the degree of compressibility which influences the attainable speed of the fragments to be accelerated.

[0077] FIG. **4** shows a cross-section with a multi-layer damming internal structure, wherein disposed in the damming internal casing/internal body **5** which is in the form of a hollow cylinder is a second internal body/central body **7**. It will be appreciated that the components **5** and **7** can have different mechanical or physical properties. It is also conceivable that an internal body is firstly compacted and only thereby provides an adequate or enhanced damming action. Furthermore it is conceivable that a damming level which changes in the course of time, in accordance with the technical requirements, is implemented by way of the configuration or structure of the internal body. That property can be referred to as a damming jump. A whole series of materials with corresponding Hygoniot curve configurations is suitable for that purpose. In accordance with those considerations, particularly interesting effects are to be achieved with materials which have specific Hygoniot properties. They include for example glass or glass-like substances or fluid or pasty components.

[0078] FIG. **5** shows an example in which the explosive layer **3**A is of a circular configuration externally and of any shape (being octagonal in this example) internally. The damming internal body **8** is of a corresponding contour. The explosive layer (the explosive casing) **3**A can exert a differentiated effect on the fragmentation casing, by virtue of its configuration. Thus fragmentation processes can be assisted and it is possible to influence the fragment form and the fragment velocity.

[0079] Basically, in regard to the properties and the technical or material-specific nature of the fragment jacket or the projectile or warhead casing, all embodiments and technical options which are known in connection with conventional fragment projectiles fall to be considered.

[0080] FIG. **6** shows an example with damming internal body of the explosive layer **38** which here is of an octagonal external cross-section and a circular internal cross-section. It will be appreciated that other possible configurations/external shapes for the explosive layer **3**B are also possible. The fragment jacket **2**A is of an eight-sided internal contour corresponding to the shape of the explosive. In that way for example the fragmentation operation for the jacket can be influenced by means of different jacket thicknesses, densities and explosive layer thicknesses as well as by means of pyrotechnic properties.

[0081] FIG. **7** shows an example of basically any cross-section, which in this example is square, of the damming internal body **9**. In this view, the explosive body/explosive portion is separated under the fragment casing **2** by the internal body, by the contact surfaces/touching surfaces of the internal body **9** with the fragment casing **2**. That affords a segmented detonation cross-section or explosive surface segments are formed. In that respect, simultaneous or non-simultaneous firing of the explosive segments **10** is possible. The damming internal body **9** can obviously also be so dimensioned that the explosive casing is closed for ring firing. The internal body **9** can be held in position for example by means of legs.

[0082] In FIG. **8** an internal body **11** of (in this example) triangular cross-section is combined with inert, pressure-transmitting compensating segments **12** which fill the space between the outside surfaces of **11** and the annular (cylindrical) explosive casing **3**. Those inert segments **12** for which the same prerequisites apply in respect of the materials involved, as for the damming internal body, can be in the form of fragmentation bodies. In addition they can contain additional active portions. It will be appreciated that other functions can also be attributed to those segments. Thus for example they can be made from heavy metal, hard metal or hardened steel to achieve final-ballistic capabilities as subpenetrators.

[0083] A further structure for a projectile according to the invention is shown in FIG. **9**. Illustrated here are two variants of cross-sections with dynamically operative internal layers/ring surfaces. This dynamic effectiveness derives from the specific properties of the layer in relation to the passage of shock waves. In that respect the interfaces between the dynamic layer and the adjoining materials are decisive. The physical properties arise out of the acoustic impedance. That determines the degree of reflection of the shock waves at the interface between two media by the ratio $m-1/m+1$ with m as the quotient of the products density and longitudinal speed of sound of the two media.

[0084] The upper part of the view in FIG. **9** shows a cross-section through the projectile with two damming, hollow internal bodies **5**, **5**A and a dynamically acting layer **13** between the explosive layer **3** and the damming means **5**. Here an additional body **7**A, for example a central penetrator, is also disposed in the center. The lower part of the view shows a dynamically operative layer **13**A between the damming first body **5** and a second damming layer **5**A as an inner portion in **5**. That makes it possible to achieve the above-described dynamic effects such as for example buffering (shock-damping or shock wave passage-influencing or also shock-boosting) properties for temporal influence in respect of the shock or damming action and thus the fragment velocity, fragment formation and/or fragment distribution.

[0085] FIG. **10** shows a cross-section with a damming internal body **4** and a dynamically acting layer **13**B between the explosive layer **3** and the fragment jacket **3**. The properties and the structure of the dynamic layer **13**B make it possible to influence the acceleration effect of the explosive layer **3** on the fragment jacket **2**.

[0086] The lower part of the cross-sectional view in FIG. **11** shows a similar structure, in which case the dynamically operative layer **13**C is positioned in the outer fragmentation region of the fragment outer jacket **14** which comprises two parts. In that way the fragment development of the fragment casing **2** which is disposed thereover is to be influenced. The upper part of the cross-sectional view shows an example with an outer jacket/projectile casing **14**A and a fragment casing **2** disposed therebeneath. The design configuration of the outer projectile jacket **14**A can not only be derived from internal-ballistic requirements but it can also deploy a dynamic effectiveness in the described sense.

[0087] FIG. **12** shows an example with an outer jacket **14**A and a fragment body or a matrix **16**A. Here preformed projectiles **16** or other, ballistically effective elements such as fragmentation bodies **15** can be embedded. Acceleration/activation is again implemented by the explosive casing **3**. Here, embedded in the internal body **17** is a firing element **18** which can also support or effect additional breakup of the damming component. By embedding a firing element **18**A in **17**, a dynamic compacting effect can also be achieved by the formation of a pressure field. In that way for example destruction of **17** can be initiated after entering the target or only in the interior of the target.

[0088] FIG. **13** shows further examples with integrated firing elements. Here the cross-sectional configuration includes a damming internal body **9** (square in the illustration) and explosive segments **10**A. In the upper part of the view the explosive layer or the explosive segment **10**A includes a firing element **18**A which can be in the form of an areal, line-shaped or point-shaped device. In the lower part of the view a corresponding firing element **18** is disposed in the internal body **9**.

[0089] FIG. **14** shows an example of the cross-sectional configuration with an explosive surface **3**C which in principle is of any form and which is square in this example. Disposed between **3**C and the fragment layer **2** are pressure-transmitting segments **12**A. The damming internal body **9** is of a square cross-section, corresponding to the explosive layer **3**C. The segments **12**A once again, besides their pressure-transmitting function, can satisfy a series of further specific requirements such as for example can have a damping action or an action of influencing the fragment velocity of **2**. In this case, as in FIGS. **5** through **7**, different fragment velocities or fragment forms can be set for the fragmenting fragment jacket, here by virtue of the differing thickness of the operative segments **12**A.

[0090] FIG. **15** shows an example with a two-layer explosive covering **19**, and correspondingly two damming layers **4**A, **21**. Detonation firing of the explosive coverings can be effected simultaneously or in time-shifted relationship. A structure of that kind affords a particularly wide spectrum of action. Thus for example the outer layer can be detonated before a target, and the inner component can be detonated when passing through the target or only in the interior of the target. In this case the inner damming layer **4**A can be for example of such a nature that it has a final-ballistic capability, that is to say it can represent a penetrator. In that way it is possible to achieve a widely staggered effect deployment which is optimally adapted to the combat task.

[0091] FIG. **16** shows an example with a multi-part damming internal body **23** which here is composed of four circular segments **24** which can comprise similar or different materials. Layers **25** can be disposed between the segments **24**. They can be designed for example as dynamically operative layers in the sense of the foregoing description, that is to say they can consist of rubber/elastomer materials or materials involving plastic or damping properties. The individual components **23** can be fitted loosely or connected fixedly for example by means of adhesive, screwing or vulcanisation. In this example the projectile structure is provided with a central pyrotechnic body **22** which affords an additional breakup destruction effect/lateral component (in particular for the individual components **24**). The segments **24** can in turn be fragment-forming, include bodies or have their own final-ballistic capability in the sense of a central penetrator.

[0092] FIG. **17** shows two further examples with multi-part damming internal bodies/central penetrators **26**. They comprise for example four cylindrical penetrators **27**. In the upper part of the view disposed in the center of the cylindrical penetrators **27** is a central pyrotechnic body **22**A which imparts a lateral velocity component to the internal body **26** which is designed as a combination of penetrators. In the lower part of the view disposed at a location of **22**A is an inert central body **22** (or an internal space) between the components **27**A. By virtue of the form of **26** or **27** respectively the explosive layer **3**D surrounding the internal body **26** is of a differing thickness. That results in a different local acceleration of the jacket fragments. The explosive covering can be interrupted by the elements introduced (top) or it can be continuous (bottom).

[0093] FIG. **18** shows an example with a projectile jacket/casing **14**A, a fragment casing **29** disposed under **14**A, with an internal surface of a geometrical configuration, a correspondingly formed explosive layer **33** and the internal damping means **4**. A local weakening of the fragment jacket **29** is achieved by the shaped elements **31**A which extend into the fragment jacket **29**, and that permits fragmentation in a predeterminable fashion (for example strip-like, grid-like for forming given fragments). Different configurations of the elements **31**A are shown. A corresponding principle in FIG. **19** forms the basis for the cross-sectional configuration with a geometrically modified internal surface of the fragment casing **32** and the correspondingly formed explosive layer **31**.

[0094] In FIG. **20**, in the upper part of the view, the internal surface of the explosive layer **31** is of a geometrical configuration, with the explosive layer here forming a closed casing. In the lower part of the view the explosive component **35** is composed of longitudinal explosive strips or flat explosive elements **36**. In this case the correspondingly formed internal body **4**C acts as a separation between the individual explosive components.

[0095] The principle of the segmented explosive jacket is also implemented in FIG. **21**. The example shows the cross-sectional configuration with internal damming means **4** and, introduced into the explosive layer **36**A, separating elements or geometrical structures of basically any configuration. In the present example they represent longitudinally extending strips **37**.

[0096] FIG. **22** shows an example with a damming hollow internal ring **21** and a central internal body **38** (also possibly promoting the damming effect), which is in the form of a container having the wall **38**A. The filling **39** of the container can be for example a solid material, a pasty or fluid substance or a non-homogeneous conglomerate of elements.

[0097] FIG. **23** also shows cross-sectional configurations with a container. In the upper part of the view, the projectile is provided with a damming central container **38** filled with a liquid, a pasty or a compacted powder mass **39**. In the lower part of the view, an annular internal container **38**B with the wall **38**C and the filling **39**A is connected by means of legs **38**D to a central damming internal body **4**B. Depending on the respective requirements involved the legs **38**D can be in the form of independent operative portions (inert or pyrotechnically operative).

[0098] These examples of the cross-sectional configuration of arrangements corresponding to the present invention are followed in FIGS. **24** through **51** by a series of examples for the configuration of the longitudinal sections of corresponding projectiles or warheads.

[0099] Thus FIG. **24** shows a longitudinal section with a fragment casing **2**, a stepped/variable-thickness explosive layer **3** and a multi-part damming internal body **41**. The Figure also shows positions for the installation of control or detonation firing elements for the explosive layer. The damming internal body **41** is here of a two-part configuration. In that way it is also possible to achieve different fragment velocities and/or different fragment distributions, in the longitudinal direction. Control or firing elements **40** can be fitted in the head or base region of the projectile, which obviously also applies to the other presented projectile structures in accordance with the invention.

[0100] FIG. **25** shows a longitudinal section through a projectile of variable explosive thickness and with a cylindrical fragment casing in two different variants. The upper part of the Figure shows an arrangement with an explosive layer **42** which is variable in the long direction and a correspondingly shaped damming means while the lower part shows a variant with a fragment casing **43** which is variable in thickness and with a variable explosive layer **42**A.

[0101] In FIG. **26** the explosive layer/internal body have an abrupt change or jump in diameter. The projectile shown in the upper part of the Figure involves a variable thickness of the explosive layer **44** with a continuous damming internal body **45** with an abrupt change in diameter or a change in diameter of a different configuration. The lower part of the Figure shows a projectile with a divided damming body or a fitted penetrator or penetrator ring **41**A of differing diameters. Depending on their respective nature the internal bodies can perform different functions.

[0102] FIG. **27** shows an example with a variable thickness of the explosive casing **44**A and cylindrical internal body **4**. The fragment jacket **45** and the explosive layer **44**A have an abrupt change in diameter or a continuous change in diameter.

[0103] In the examples in FIG. **28** the upper variant is provided with multi-part, here separated explosive layers **47** and an adapted fragment jacket **45**. The damming stepped internal body **46** correspondingly involves a variable diameter. The projectile shown in the lower part of the Figure has a continuous explosive layer **48** with a variation in diameter.

[0104] Arrangements in accordance with the present invention makes it possible to achieve highly effective combinations or configurations of fragment jackets and explosive layers, in a technically particularly simple fashion. Taking a projectile as shown in FIG. **24** as the basic starting point, examples are shown in FIGS. **29** through **31**.

[0105] Thus FIG. **29** shows a geometrical configuration of the jacket casing for achieving desired effects or preferred fragment directions. A directional control and a rotation of the fragment bodies/fragment rings **50** are implemented here. Here, the explosive layer **49** which is of a sawtooth-shaped configuration in longitudinal section is provided throughout with a cylindrical damming internal body **4**. The example shown in FIG. **30**, with separate explosive layers **49**A, provides for directional control of the fragment bodies **50**A. The damming internal body **4** is geometrically adapted. FIG. **31** shows a fragment covering **51** for different fragment directions and fragment velocities with a suitably adapted explosive layer **49**B.

[0106] FIGS. **32** through **34** and FIGS. **37** through **41** show further configurations of the arrangement according to the invention by combination with well-known projectile components. FIGS. **35** and **36** show examples of integration/combination of arrangements with penetrators.

[0107] FIG. **32** shows two longitudinal sections with an inwardly disposed explosive-covered fragment body **2** and a space **52** between the outer jacket **24**B and the fragment body and an empty or partially filled external-ballistic cover **53** (upper part of the view) and a solid/filled tip (lower part). That illustration represents for example sub-caliber projectiles, projectiles with a launch base or full-caliber projectiles with an inwardly disposed operative portion of smaller diameter.

[0108] FIG. **33** shows two longitudinal sections with complete (continuous) explosive covering **3** and **54**. The upper part of the view shows the projectile body and the internally dammed tip region **55** while the lower part of the view shows an explosive-filled tip **56**.

[0109] FIG. **34** shows a longitudinal section with an explosive body **57** of basically any form, fitted into the damming internal region **4**. An explosive component of that kind can locally produce particularly high lateral fragment velocities or also in the body **4** itself desired effects such as compacting effects or mechanical loadings, going as far as breakup destruction or acceleration phenomena.

[0110] FIG. **35** shows two longitudinal sections with a hard or heavy metal core **58** embedded in the damming internal region **4** (upper part of the view) and a slender cylinder with a tip **59** (lower part). It will be appreciated that each variant of a body having a final-ballistic effect can be incorporated. The combination illustrated here of penetration capability and fragment effect covers a particularly wide spectrum of action.

[0111] FIG. **36** shows two examples with a core **58**A (here pointed) which is embedded in the damming internal region, with a focusing, inwardly conical tail region **60** on the core. Acceleration and/or destruction of the core **58**A can be implemented by means of the explosive backing **61** (upper part of the view). The lower part of the view shows a core with a stepped tip **58**B and a conical tail portion **62** with a centering, core-accelerating explosive backing **61**A. The operative directions of the configurations of the tail region with the core and the fragment jacket are symbolically indicated by the arrows **60**A and **62**A respectively.

[0112] FIG. **37** shows two longitudinal sections with an internal body **64** and a corresponding explosive covering **63** in conjunction with a tip module **72** for directed enhanced fragment effect in the axial direction (upper part of the view) and with a fragment directional effect by shaping of the damming internal body **64**, the explosive surface **66** and the fragment jacket **65** (lower part of the view). The corresponding arrows **72**A, **65**A symbolically representing the operative directions are also shown (see also FIG. **40**).

[0113] FIG. **38** shows a longitudinal section corresponding to the lower part of FIG. **37** with a fragment casing **67** and additional fragment components in a fragment pocket or a fragment ring **68** with the embedded operative portions **68**A (operative arrows **68**B). FIG. **39** shows two longitudinal sections with a (here) two-stage damming internal body **70**A with directed fragment effect by virtue of a particular configuration of the damming internal body **70** or **70**A respectively and a continuous explosive covering **69** (top) and a non-continuous explosive covering/separate explosive rings **69**A (bottom).

[0114] FIG. **40** shows an example with additional, primarily axially accelerated fragment body **73** (symbolically represented by the operative arrows **73**A) in the front region of the projectile, accelerated by an explosive surface **71** of the fragment casing **3**, the surface **71** also being dammed by the internal body **4**.

[0115] FIG. **41** shows two longitudinal sections with partial explosive covering in the form of a damming body with a front core/stepped core **74** (top). A front core **74**A of that kind can also be fitted separately (bottom). That front core **74**A can comprise for example a material which is highly effective in final ballistic terms such as hard or heavy metal or it may also comprise a brittle material which breaks up under dynamic loading due to impact, for example highly brittle tungsten carbide or pre-fragmented bodies. It serves primarily for piercing solid target plates. Attack against an inclined plate is improved or first made possible by virtue of the step-like configuration.

[0116] FIG. **42** shows a cross-sectional configuration with explosive-covered projectiles or warheads in accordance with the invention with individual (here four) segments **75**. The individual segments **75** correspond in their mode of operation to that of the examples already set forth hereinbefore of circular cross-section. The individual segments can be actuated separately by virtue of the segmentation and the separation **76** which can be both a structure/load-bearing internal wall and also a shock wave barrier. That example therefore stands for penetrators or warheads with a partial covering in the longitudinal direction/axial direction, which affords the possibility of partial field occupation in space by fragments.

[0117] FIG. **43** shows an example with a variable thickness of the fragment casing **77** and explosive segments **78** with (here four) lens-shaped cross-sectional form (which in principle however can be freely selected). The internal contour of the explosive segments **78** is formed by the corresponding damming internal body **9**A. It will be appreciated that the fragment and the explosive layer can extend separately or continuously, corresponding to FIG. **42**. Such arrangements make it possible to achieve highly differentiated fragment distribution effects which are symbolically represented in FIG. **43** for a segment by an array of arrows **78**A.

[0118] FIG. **44** shows an example of the cross-sectional configuration with an explosive surface **80** in the form of convex strips and an adapted damming internal body **9**B. FIG. **45** shows a corresponding example with (here eight) segments **81** with the explosive covering **80**A, which are separated by the surfaces **75**A. While in FIG. **44** the fragment-forming arrangement is disposed in a jacket **14**, in FIG. **45** the fragment-forming (or homogeneous) strips **79**A are free and exposed. In addition this example also has a central ring **82** which promotes the damming action in respect of the segments **81**. Furthermore the cylinder **82** can be hollow or contain a central penetrator.

[0119] FIG. **46** shows a longitudinal section through a projectile structure **83** in principle, with a multi-part damming internal body which can be made up of radial, axial or combined elements. In that way the damming action is to be combined with a mechanical pre-fragmentation effect or it is possible to assemble different bodies with various mechanical and physical properties.

[0120] FIG. **47** shows the cross-sectional configurations of a projectile as shown in FIG. **46** with a fragment casing and damming internal body **84**, here made up of cylinders **86** (continuous or stacked) of the same or different diameters or materials in a pressure-transmitting matrix **85**. The central region **87** can be formed by a penetrator or can also be filled with individual bodies. An additional pyrotechnic component corresponding to FIG. **12** can also be fitted. The cylinders **86** can involve a high degree of slenderness (length/diameter ratio) or can be formed from a stack of short cylinders. FIG. **48** shows a further example of the cross-sectional configuration of a projectile as shown in FIG. **46** with segmented, single-layer or multi-layer, damming internal body **88** and a central penetrator **82**A.

[0121] FIG. **49** shows a longitudinal section through an explosive layer-fragment projectile **89** which is constructed in the form of a multi-part/multi-stage operative body. It can be formed for example from different stages which are separated by means of a layer **91** or which are connected together, involving different functions or with structural spaces **90** provided therein.

[0122] In the examples shown hitherto, cylindrical fragment jackets were illustrated. It will be appreciated that that is not a necessary prerequisite for arrangements in accordance with the invention. Layer-like accelerating components mean rather that it is possible to implement any forms that may be desired, even with external components, without any limitation on effectiveness. No limits are set in terms of design options thereby. It will equally be appreciated that arrangements in accordance with the invention are also not limited to individual bodies. It is precisely by virtue of the design freedom that corresponding fragment-forming devices can be arranged in groups.

[0123] Some examples in this respect are shown in FIGS. **50** and **51**. Thus in FIG. **50** the fragment body **92** is of a square cross-section which is accelerated by the explosive layer **3**F corresponding to FIG. **14**. In FIG. **51** the fragment jacket is of an octagonal cross-section **92**A as an example of the shape that may be adopted if desired. Acceleration is effected here by way of an explosive layer **3** in ring form.

[0124] It will be appreciated that the arrangements set forth as examples can also be combined both in a projectile and also in a warhead if that is appropriate.

[0125] The essential features and advantages of the invention are summarised hereinafter:

[0126] The fragment-forming operative components or jackets containing fragments or subprojectiles are accelerated by way of an explosive layer which is thin in relation to the projectile or warhead diameter.

[0127] The mass of explosive necessary for acceleration of fragments is minimised. With comparable fragment or subprojectile velocities, the mass of explosive can be reduced by from 50% to 80% in comparison with conventional explosive projectiles, depending on the respective caliber and technical configuration.

[0128] The mass of explosive saved is available as an additional operative mass. That means that the freedom involved in terms of designing warheads or projectiles accelerating fragments or subprojectiles is considerably enlarged.

[0129] The smallest thickness of the explosive layer is determined by the need to ensure detonation firing or total detonation. Very thin areal explosive layers can be fired by the introduction of detonation firing aids such as fuse cords. The choice of explosive is also a free one, so that it is possible to embody very small thicknesses to an order of magnitude of 2 mm.

[0130] By way of greater explosive layer thicknesses, depending on the respective internal damming means, correspondingly thick jackets can be broken up or accelerated to high velocities. The theoretical maximum velocity of the fragments is approximately achieved with explosive layers of the order of magnitude of 20 mm, with a high level of internal damming.

[0131] The explosive layer can be in the form of a hollow cylinder and can be of a cross-sectional shape and/or wall thickness which remains the same or which is variable.

[0132] The explosive layer can be prefabricated in the form of a film or a body of some other form and can be introduced, cast in position or introduced in any fashion such as for example being pressed in place or being sucked into position by way of a reduced pressure. It can also comprise one or more mutually superposed layers.

[0133] A projectile or warhead can include a continuous explosive layer or can be made up of a plurality of explosive layers, both in an axial and also in a radial direction.

[0134] The explosive layer can be homogeneous or can include additives or embedded bodies.

[0135] Firing of the explosive layer or the explosive zones or the explosive fragments can be effected in any conceivable manner in accordance with the state of the art in relation to explosive projectiles or warheads.

[0136] The velocities and the direction of projectiles or subprojectiles can be varied in very wide limits by way of the detonation method and the configuration of the explosive layer and the internal bodies.

[0137] The damming internal body can be in one or more parts. It can comprise metallic or non-metallic materials or a combination thereof. Thus an almost unlimited range of materials of different mechanical, physical or chemical properties is available for adoption. Thus a homogeneous metallic internal body on the one hand can comprise for example a metal of low density such as for example magnesium while on the other hand it can comprise a heavy or hard metal body (homogeneous or segmented) of great density with correspondingly high final-ballistic capability.

[0138] By way of the properties of the internal body or the internal bodies, under a high-pressure loading (Hygoniot properties), the behaviour thereof can be determined or, in conjunction with the pyrotechnic components used and the technical configuration of the projectile or warhead, it is possible specifically to select materials involving given dynamic properties.

[0139] Homogeneous damming inert internal bodies can comprise a metallic or non-metallic substance which is capable of reacting under high pressure at locally occurring high temperature or can contain such substances.

[0140] The possible combinations in respect of damming internal bodies provides that (for example by the use of different materials such as for example by embedding subprojectiles in a matrix material) practically no limits are imposed on the design bandwidth.

[0141] The damming internal body can be of brittle material or material which becomes brittle under a dynamic loading. It can equally be pre-fragmented or subjected to a preliminary mechanical or thermal treatment.

[0142] The damming internal body can also be in the form of a hollow cylinder or, while being of any cross-sectional area, can contain a hollow space. That internal hollow space can in turn be empty or filled with an also more or less damming substance. That affords a further possible option in terms of influencing the damming effect and thus the velocity or acceleration of the jacket of fragment-forming or subprojectile-ejecting projectiles or warheads.

[0143] In a particular configuration the damming internal body can represent or include a container. The internal hollow space or the container which is introduced can be filled for example with a solid, powder, pasty or fluid substance. It can also include a reactive substance such as for example a combustible fluid.

[0144] In the simplest case the jacket of the projectile or warhead is homogeneous. In regard to pre-treatment thereof to promote fragment formation, it is possible to use all processes and techniques which correspond to the technical state in relation to conventional fragment projectiles.

[0145] The accelerated jacket can also entirely or partially comprise preformed fragments or subprojectiles. A layer of that kind can itself represent the projectile jacket or can be fitted as a layer between the explosive and the outer jacket. By way of that structure, a layer which is pre-fabricated or which is very brittle or which becomes brittle under a dynamic loading can also be disposed between the explosive layer and the outer jacket.

[0146] In the case of a large-caliber munition or in the case of warheads it is also conceivable for an intermediate layer filled with a pasty or liquid substance which can also contain solid substances or individual bodies to be disposed between the explosive layer and the outer skin.

[0147] A layer which dynamically promotes the damming effect can be disposed between the explosive layer and the damming internal body. The mode of operation thereof is determined by the acoustic impedance of the materials involved.

[0148] Likewise a medium which has a dynamically damping action can be disposed between the explosive layer and the fragment jacket, as a layer for reducing the acceleration shock.

[0149] The explosive layer can be made up of interconnected surfaces or it can be made from surfaces which are separated in the radial or axial direction.

[0150] The explosive layer can have a surface (contour) which is of any shape so that locally different fragment formation phenomena and also fragment velocities can be achieved.

[0151] The explosive layer can form an angle with respect to the axis of the projectile, by way of the form of the internal damming means. In that way fragments or subprojectiles can be accelerated in directionally controlled manner. Arrangements of that kind can be provided both at given positions of the projectile (for example in the tip region) or can extend over the entire surface.

[0152] The explosive layer will generally be in the form of a hollow cylinder. It can be open at the ends or it can be closed at one or both sides by means of an explosive layer at the front end or the tail end.

[0153] Explosive disks (explosive bridges) can be introduced over the entire penetrator length. That means that for example internal bodies can be accelerated in the axial direction.

[0154] Parts of the tip can be accelerated by way of an end explosive covering. In addition the tip of the projectile or warhead can be partially or entirely filled with explosive.

[0155] The tip or the tip region can also comprise an inert body which has a final-ballistic effect or may include such a body in order by way of that component to implement final-ballistic effects.

[0156] Further configurations of arrangements in accordance with the present invention are afforded by the introduction of an additional pyrotechnic component within the damming internal body. That can either be fired by the detonation of the explosive layer or can be actuated directly. In arrangements of that kind for example supplemental to fragments or subprojectiles, from the jacket region, radially accelerated elements are produced from the internal region.

[0157] The function and efficiency of arrangements in accordance with the invention are independent of the kind of stabilisation. Thus the active bodies can be gun-fired projectiles, warfare portions of a missile or a rocket, parts of a bomb or the operative portion of a torpedo.

LIST OF REFERENCES

[0158] **1**A spin-stabilised explosive layer-fragment projectile with fragment casing **2**, explosive layer **3** and internal body **4**

[0159] **1**B fin-stabilised explosive layer-fragment projectile with fragment casing **2**, explosive layer **3** and internal body **4**

[0160] **2** fragment jacket/fragment casing/fragment-forming projectile jacket

[0161] **2**A fragment jacket of basically any internal cross-section (here octagonal)

[0162] **3** explosive casing/explosive covering/explosive layer/explosive surface/pyrotechnic layer

[0163] **3**A explosive casing of basically any internal cross-section (here polygonal)

[0164] **3**B explosive casing of basically any external cross-section (here octagonal)

[0165] **3**C explosive casing of basically any cross-section (here rectangular)

[0166] **3**D explosive-filled intermediate space between **27** and **2**

[0167] **4** damming internal body/internal damming means

[0168] **4**A damming means for **20**

[0169] **4**B central internal body

[0170] **4**C internal body with surface structure

[0171] **5** hollow damming internal body/damming internal casing/internal ring/support ring

[0172] **5**A second (internal) damming layer

[0173] **6** central hollow space (of any cross-section)

[0174] **7** second (here central) damming internal body

[0175] **7**A internal body/central penetrator

[0176] **8** damming internal body of basically any cross-section (here octagonal)

[0177] **9** damming internal body of basically any cross-section (here square)

[0178] **9**A damming internal body

[0179] **9**B damming internal body

[0180] **9**C damming internal body

[0181] **10** explosive segment between **9** and **2**

[0182] **10**A explosive segment between **9** and **2**

[0183] **11** central body of basically any cross-section (here triangular)

[0184] **12** inert/pressure-transmitting segment (homogeneous or containing bodies)/fragment-forming segment between **11** and **3**

[0185] **12**A inert/pressure-transmitting segment (homogeneous or containing bodies)/fragment-forming segment between **3**C and **2**

[0186] **13** dynamically acting layer between **9** and **3**

[0187] **13**A dynamically acting layer between **5** and **7**

[0188] **13**B dynamically acting layer between **3** and **2**

[0189] **13**C dynamically acting layer between **2** and **14**

[0190] **14** external fragment ring

[0191] **14**A projectile jacket/projectile casing/outer skin

[0192] **14**B projectile jacket/warhead wall

[0193] **15** annular surface containing fragments/preformed elements between **14** and **3**

[0194] **16** embedded in **16**A, bodies/preformed fragments/preformed projectiles

[0195] **16**A matrix of **15**

[0196] **17** internal body (centrally or decentrally) with embedded firing element **18**

[0197] **18** firing element embedded in **17** (explosive fuse cord)

[0198] **18**A firing element in **10**A, **18**

[0199] **18**B inserted in **10**A, firing element/firing line of any form and of any cross-section

[0200] **19** outer explosive layer

[0201] **20** inner explosive layer

[0202] **21** internal operative casing/internal fragment ring (damming means for **19** and fragment jacket for **20**)

[0203] **22** central charge (explosive fuse cord)/pyrotechnic body

[0204] **22**A central explosive body for radial acceleration or breakup of **26**

[0205] **23** multi-part internal body (here subdivided into four circular segment cross-sections **24**)

[0206] **24** individual element of **23**

[0207] **25** separation/separation layer between the elements **24**

[0208] **26** multi-part internal body of basically any form (here formed from four cylinders **27** and **27**A respectively)

[0209] **27** cylinders/bodies of basically any cross-section (here circular)

[0210] **27**A body of basically any cross-section (here circular)

[0211] **28** inert central body in **26**/internal space/hollow space

[0212] **29** fragment jacket of variable wall thickness/with incisions/with internal structure **30**

[0213] **30** incision/internal structure

[0214] **31** explosive layer with structured external contour

[0215] **31**A explosive element/explosive leg

[0216] **32** fragment jacket with structured inside/inside equipped with shaped portions

[0217] **33** explosive jacket with incisions

[0218] **34** explosive layer with change in diameter/jump in diameter/notches/incisions on the inside

[0219] **35** segmented/interrupted/leg-like explosive layer (consisting of surface elements)

[0220] **36** explosive strip/flat surface element

[0221] **36**A explosive strip/explosive segment

[0222] **37** separation layer/separation element/separation strip/separation grid between **36**A

[0223] **38** central container/internal body

[0224] **38**A wall of **38**

[0225] **38**B container in the form of an intermediate layer

[0226] **38**C wall of **38**B

[0227] **38**D leg/holder/connecting structure

[0228] **39** filling/content of **38**

[0229] **39**A filling/content of **38**B/liquid ring

[0230] **40** control/firing element

[0231] **41** multi-part/multi-stage damming body

[0232] **41**A multi-part damming body (of the same or different diameters)

[0233] **42** explosive layer of variable thickness (here inside diameter variable)

[0234] **42**A like **42**, outside diameter variable

[0235] **43** fragment jacket of variable thickness

[0236] **44** explosive casing with (here internal) diameter jump/change in diameter

[0237] **44**A diameter jump/diameter change

[0238] **45** stepped fragment jacket/fragment jacket of variable thickness

[0239] **46** stepped internal body

[0240] **47** divided/multi-part explosive casing

[0241] **48** explosive casing with diameter jump/diameter change

[0242] **49** explosive casing (herein continuous) for a directed fragment effect

[0243] **49**A explosive casing consisting of individual portions/fitted separate annular surfaces

[0244] **49**B structured explosive casing (here consisting of annular surfaces of circular element cross-section)

[0245] **50** fragment covering to achieve a directed effect

[0246] **50**A segmented fragment covering of **49**A

[0247] **51** fragment jacket comprising convex rings

[0248] **52** hollow space between **2** and **14**B (empty or with internal structure)

[0249] **53** tip with explosive casing **54**/external-ballistic cover

[0250] **54** explosive layer in **53**

[0251] **55** damming internal body in **53**

[0252] **56** tip filled with explosive/a pyrotechnic medium

[0253] **57** explosive body embedded in **4**

[0254] **58** penetrator embedded in **4** (here hard, heavy metal or steel core **58**)

[0255] **58**A core with tail internal cone **60**

[0256] **58**B core with conical tail **62**

[0257] **59** central penetrator/cylinder embedded in **4**

[0258] **60** tail internal cone in **58**A

[0259] **60**A arrows, symbolically indicating the operative direction of the explosive zone **61**

[0260] **61** explosive zone at the tail of **58**A for accelerating/breaking up **58**A

[0261] **61**A explosive zone at the tail of **58**B for accelerating **58**B

[0262] **62** conical tail of **58**B

[0263] **62**A arrows, symbolically indicating the operative direction of the explosive zone **61**A

[0264] **63** explosive covering for partially boosted axial fragment effect

[0265] **64** internal body in **63**

[0266] **64**A internal body in **65**

[0267] **65** fragment jacket with axial fragment effect

[0268] **65**A arrow, symbolically indicating the operative direction

[0269] **66** explosive casing

[0270] **67** fragment casing corresponding to **65** with fragment pocket **68**

[0271] **68** fragment pocket/fragment ring

[0272] **68**A bodies embedded in **68**

[0273] **68**B arrows symbolically indicating the operative direction of the fragment pockets **67**

[0274] **69** explosive jacket of variable inside diameter for directed fragment acceleration

[0275] **69**A explosive jacket elements for directed fragment acceleration (here with section-wise/multi-stage explosive layer)

[0276] **70** damming internal body with external contour for directed fragment effect

[0277] **70**A damming internal body with external contour for directed fragment effect

[0278] **71** axially acting explosive zone

[0279] **72** tip module with directed fragment effect

[0280] **73** arrow, symbolically indicating the operative direction

[0281] **73**A arrow, symbolically indicating the operative direction of the fragment covering of **73**

[0282] **74** damming internal body with partial explosive covering

[0283] **74**A multi-part internal body with stepped tip

[0284] **75** segment of a damming internal body of cylindrical contour

[0285] **75**A segment of a damming internal body of cylindrical contour

[0286] **76** separation surface

[0287] **77** fragment casing

[0288] **78** lens-shaped explosive segment/segment of any cross-section

[0289] **78**A arrows, symbolically indicating the operative direction

[0290] **79** fragment segment

[0291] **79**A fragment segment

[0292] **79**B accelerated fragment segment **79**A

[0293] **79**C broken-up and accelerated fragment segment **79**A

[0294] **80** explosive ring of segments of any configuration

[0295] **80**A explosive segment of any configuration

[0296] **81** segment of a damming internal body of any contour

[0297] **82** internal body, central penetrator

[0298] **82**A internal body, central penetrator

[0299] **83** damming internal body which is composed/built up in section-wise fashion

[0300] **84** ring comprising rods/cylinders/bodies of any cross-section

[0301] **85** separation layer between **80**

[0302] **86** rods/cylinders/bodies of any cross-section

[0303] **87** central body

[0304] **88** rings of section-wise configuration

[0305] **89** projectile with differing damming internal bodies

[0306] **90** inert portion

[0307] **91** spacing/buffering inert element/separation layer

[0308] **92** fragment ring/fragment casing of any form (here square)

[0309] **92**A fragment ring/fragment casing of any form (here octagonal)

1. A projectile or warhead forming fragments or subprojectiles (fragmentation munition) with partial explosive covering,

characterised in that

a fragmentation projectile jacket (**2**) is arranged over an explosive layer (**3**) which is thin in relation to the projectile diameter and which in turn surrounds an internal body (**4**) damming the explosive layer (**3**).

2. A projectile or warhead as set forth in claim **1** characterised in that the thickness of the explosive layer (**3**) is between 2 mm and 20 mm.

3. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) is introduced by a casting technology process or in the form of a preformed body or pressed into position or introduced under a reduced pressure.

4. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) is in the form of a hollow cylinder of a cross-sectional shape and/or wall thickness which remains the same or is variable.

5. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) is homogeneous or contains additives or embedded bodies.

6. A projectile or warhead as set forth in claim **1** characterised in that firing of the individual explosive segments (**8**) or a plurality of explosive layers is effected in point form, in line form or in ring form at one or more locations.

7. A projectile or warhead as set forth in claim **1** or claim **6** characterised in that firing is effected by way of a time, distance or impact fuse, by way of a program-controlled signal or by means of radio.

8. A projectile or warhead as set forth in claim **1** and claim **7** characterised in that firing of a plurality of explosive elements (**8**) is effected by pre-firing, simultaneous firing or serial firing (in time-displaced relationship).

9. A projectile or warhead as set forth in claim **1** characterised in that the internal body (**4**) is of a one-part structure (metallic or non-metallic) or a multi-part structure.

10. A projectile or warhead as set forth in claim **1** characterised in that the internal body (**4**) comprises a brittle material or a material which becomes brittle under dynamic loading.

11. A projectile or warhead as set forth in claim **9** characterised in that the internal body (**4**) contains subprojectiles (steel, hard metal, heavy metal).

12. A projectile or warhead as set forth in claim **9** characterised in that the internal body (**4**) is prefragmented or is subjected to mechanical or thermal preliminary treatment.

13. A projectile or warhead as set forth in claim **1** characterised in that the internal body (**4**) is in the form of a homogeneous or segmented penetrator or includes such a penetrator.

14. A projectile or warhead as set forth in claim **9** characterised in that the internal body (**4**) comprises a plurality of (identical or different) subprojectiles/internal bodies.

15. A projectile or warhead as set forth in claim **14** characterised in that the subprojectiles enclose an inert volume.

16. A projectile or warhead as set forth in claim **1** or claim **14** characterised in that the internal body/the internal bodies (**4**) is/are of any cross-sectional area/any cross-sectional areas.

17. A projectile or warhead as set forth in claim **1** characterised in that the internal body (**4**) represents or includes a container.

18. A projectile or warhead as set forth in claim **17** characterised in that the internal body/container is filled with an inert or reactive medium.

19. A projectile or warhead as set forth in claim **1** and claim **16** characterised in that the internal body (**4**) comprises a medium which is reactive under pressure loading or under a temperature influence.

20. A projectile or warhead as set forth in claim **1** characterised in that the projectile has two or more explosive layers in a radial direction.

21. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) is made up of interconnected surfaces or of surfaces which are separated (in the radial and/or axial direction).

22. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) forms an angle with respect to the projectile axis.

23. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) is formed from separate or connected segments of any surface configuration.

24. A projectile or warhead as set forth in one of the preceding claims characterised in that the accelerated jacket (**2**) entirely or partially comprises preformed fragments or subprojectiles.

25. A projectile or warhead as set forth in claim **24** characterised in that the fragments/subprojectiles are accelerated in directionally controlled fashion.

26. A projectile or warhead as set forth in claim **1** characterised in that fragment bodies are introduced between the explosive layer (**3**) and the projectile jacket (**2**).

27. A projectile or warhead as set forth in claim **26** characterised in that the fragment bodies are embedded into a matrix.

28. A projectile or warhead as set forth in claim **1** characterised in that a layer of a brittle material is disposed between the explosive layer (**3**) and the projectile jacket (**2**).

29. A projectile or warhead as set forth in claim **1** characterised in that the layer backed with explosive is positioned within a projectile outer jacket.

30. A projectile or warhead as set forth in claim **29** characterised in that there is a hollow space between the explosive layer (**3**) and the projectile jacket (**2**).

31. A projectile or warhead as set forth in claim **1** characterised in that a liquid enclosure is inserted between the explosive layer (**3**) and the projectile jacket (**2**).

32. A projectile or warhead as set forth in claim **1** characterised in that a dynamically damping medium is disposed between the explosive layer (**3**) and the projectile jacket (**2**).

33. A projectile or warhead as set forth in claim **1** characterised in that a layer dynamically supporting the damming action is disposed between the explosive layer (**3**) and the internal body (**4**).

34. A projectile or warhead as set forth in claim **1** characterised in that the longitudinal section of the explosive layer (**3**) is of any form (contour).

35. A projectile or warhead as set forth in claim **34** characterised in that the explosive layer (**3**) is of equal thickness over its entire length or has contours which are different at one side.

36. A projectile or warhead as set forth in claim **1** characterised in that the explosive layer (**3**) represents a hollow layer with ends closed at one or both sides or intermediate layers (explosive bridges).

37. A projectile or warhead as set forth in claim **1** or claim **36** characterised in that introduced internal bodies are accelerated by way of explosive elements in the axial direction.

38. A projectile or warhead as set forth in claim **1** characterised in that the damming internal body (**4**) contains a pyrotechnic element.

39. A projectile or warhead as set forth in claim **1** characterised in that the projectile is of a one-stage or multi-stage structure in the axial direction.

40. A projectile or warhead as set forth in claim **1** characterised in that the projectile has a tip (**1**C) which is partially or completely filled with explosive.

41. A projectile or warhead as set forth in claim **1** characterised in that a tip or a tip region of the projectile comprises an inert portion which is operative in final-ballistic relationship.

42. A projectile or warhead as set forth in claim **1** characterised in that the operative body comprises a combination of individual arrangements.

43. A projectile or warhead as set forth in claim **1** characterised in that the operative body is spin-stabilised or aerodynamically stabilised.

44. A projectile or warhead as set forth in claim **1** characterised in that the operative body represents a canon-launched projectile, the warfare portion of a missile, a bomb or the warfare portion of a torpedo.

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