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Thomanek

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[45] **May 15, 1973**

[54] **HOLLOW-EXPLOSIVE CHARGE CONSTRUCTION**

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[30] **Foreign Application Priority Data**

Sept. 7, 1964 Germany ..... B 78 449

[52] **U.S. Cl.** ..... **102/24 HC,** 102/56, 175/4.6

[51] **Int. Cl.** **F42b 1/02**

[58] **Field of Search** ..... 102/24 HC, 56; 175/4.6

[56] **References Cited**

UNITED STATES PATENTS

2,837,995	6/1958	Castel	102/24 HC
2,900,905	8/1959	MacDougall	102/24 HC
3,108,540	10/1963	Fletcher	102/24 HC
3,217,650	11/1965	Paul et al.	102/24 HC
3,218,975	11/1965	Massey	102/24 HC
3,251,300	5/1966	Reyne	102/24 HC
3,267,853	8/1966	Merendino et al.	102/24 HC
3,280,743	10/1966	Reuther	102/24

FOREIGN PATENTS OR APPLICATIONS

1,112,254	11/1955	France	102/24 HC
1,161,445	3/1958	France	102/24 HC
1,354,270	1/1964	France	102/24 HC

Primary Examiner—Verlin R. Pendergrass
Attorney—McGlew & Toren

[57] **ABSTRACT**

The construction of an explosive charge includes means for causing deviations from the rotational symmetry of the charge. Such means may comprise the eccentric location of the liner for the charge body or the manner in which the charge may be burned or any combination of these.

3 Claims, 26 Drawing Figures

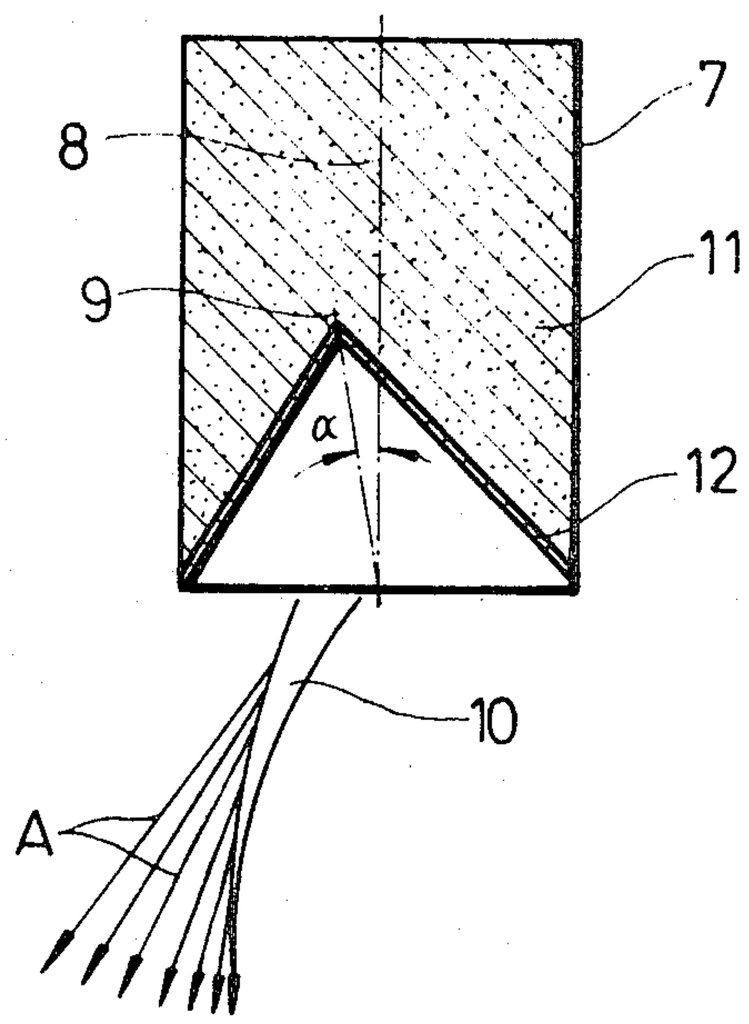

Fig. 1

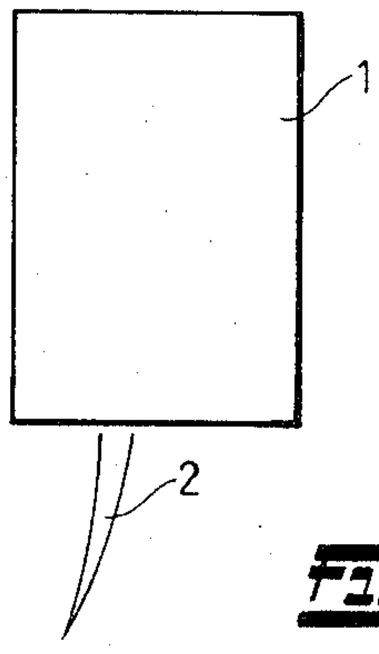

Fig. 2

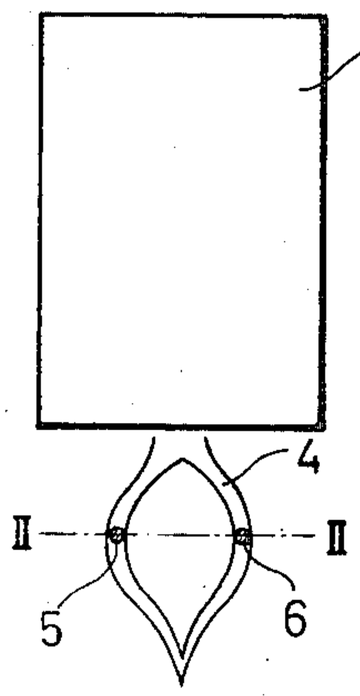

Fig. 3

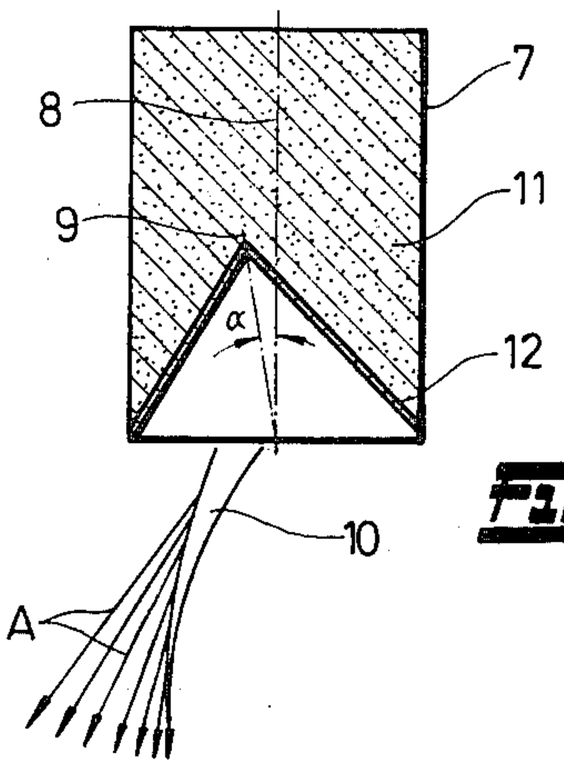

Fig. 4

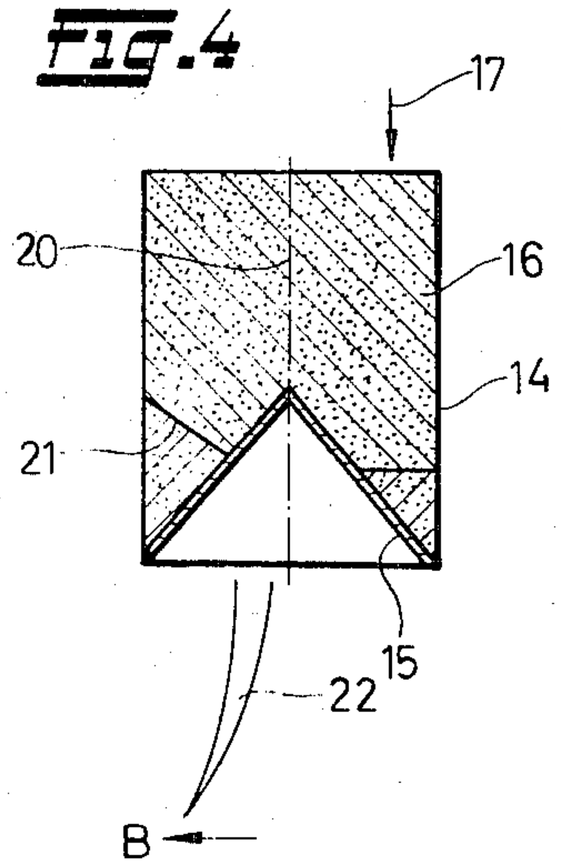

Fig. 5

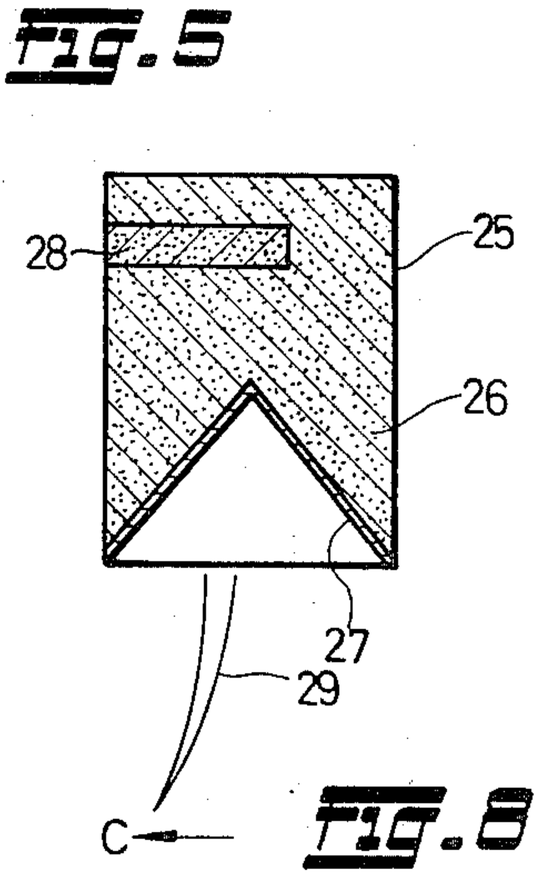

Fig. 6

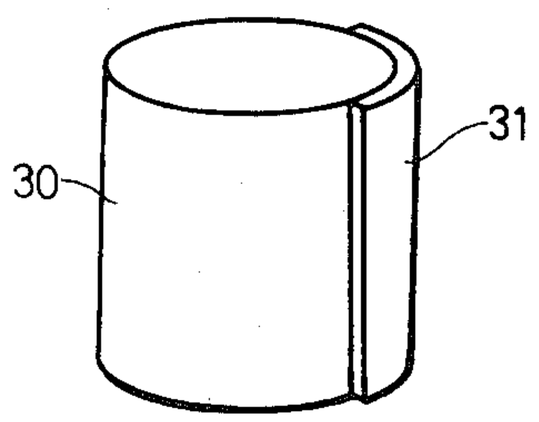

Fig. 7

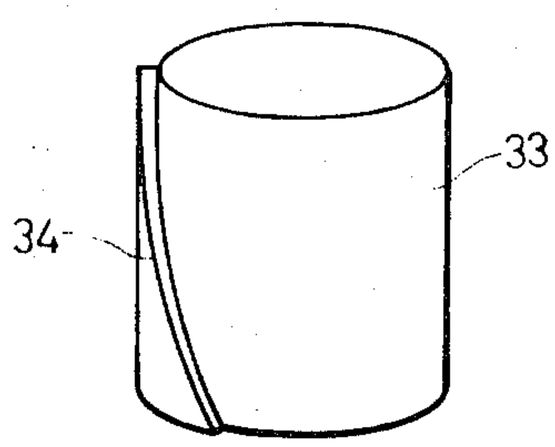

Fig. 8

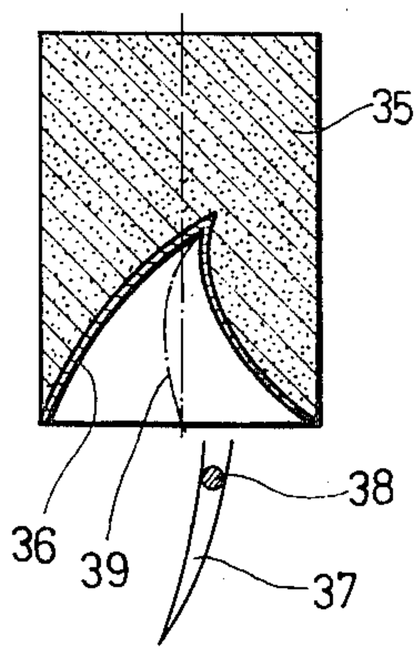

Fig. 9

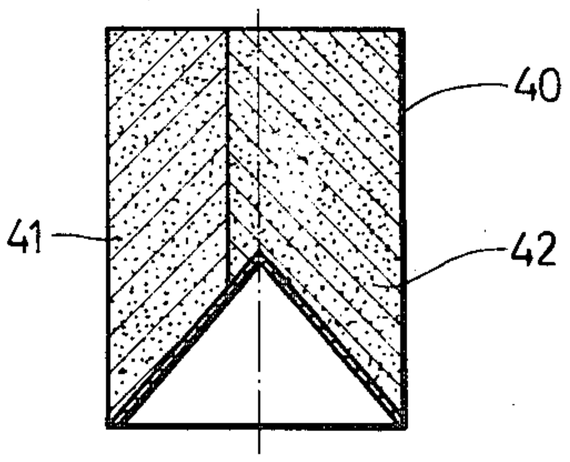

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Fig. 10

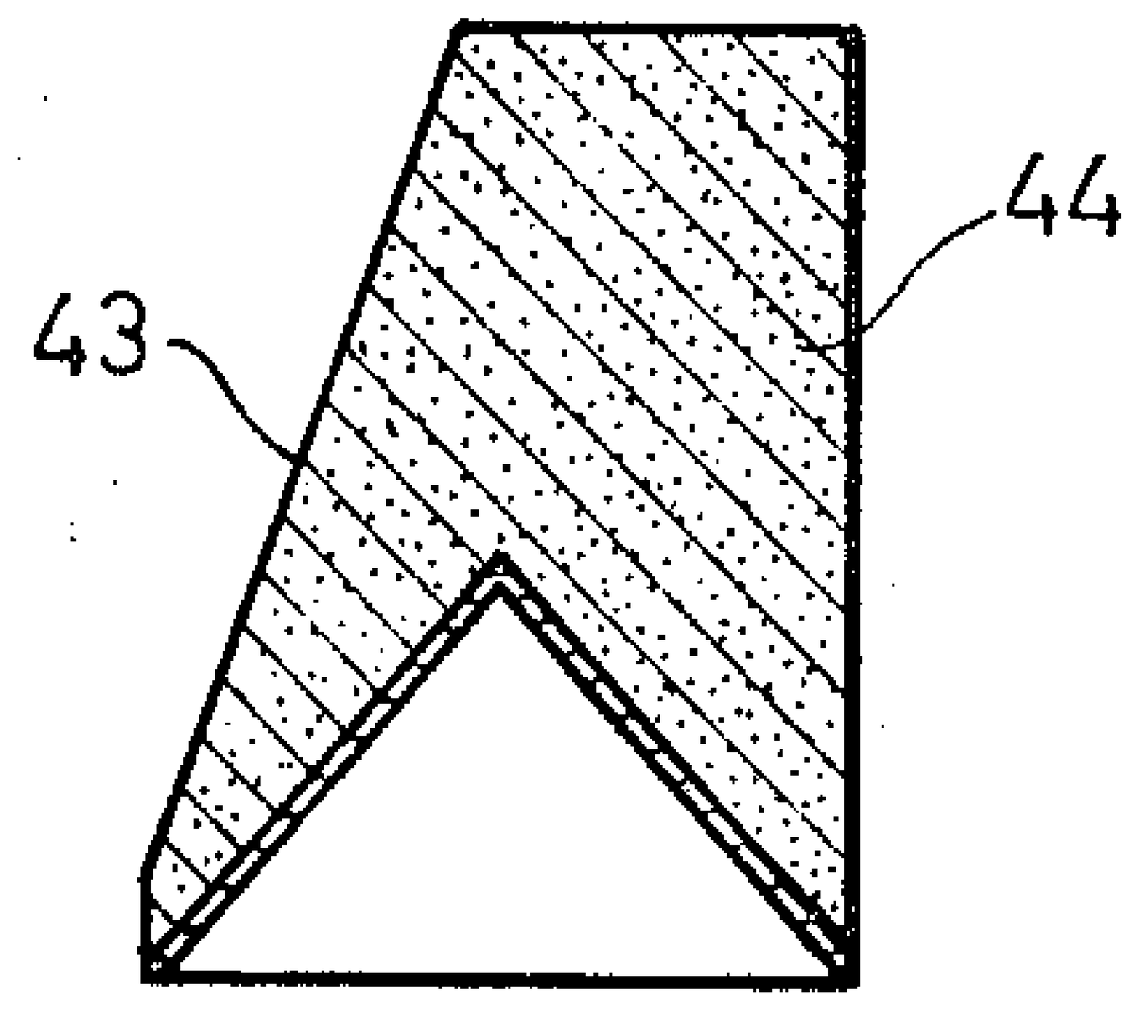

Fig. 11

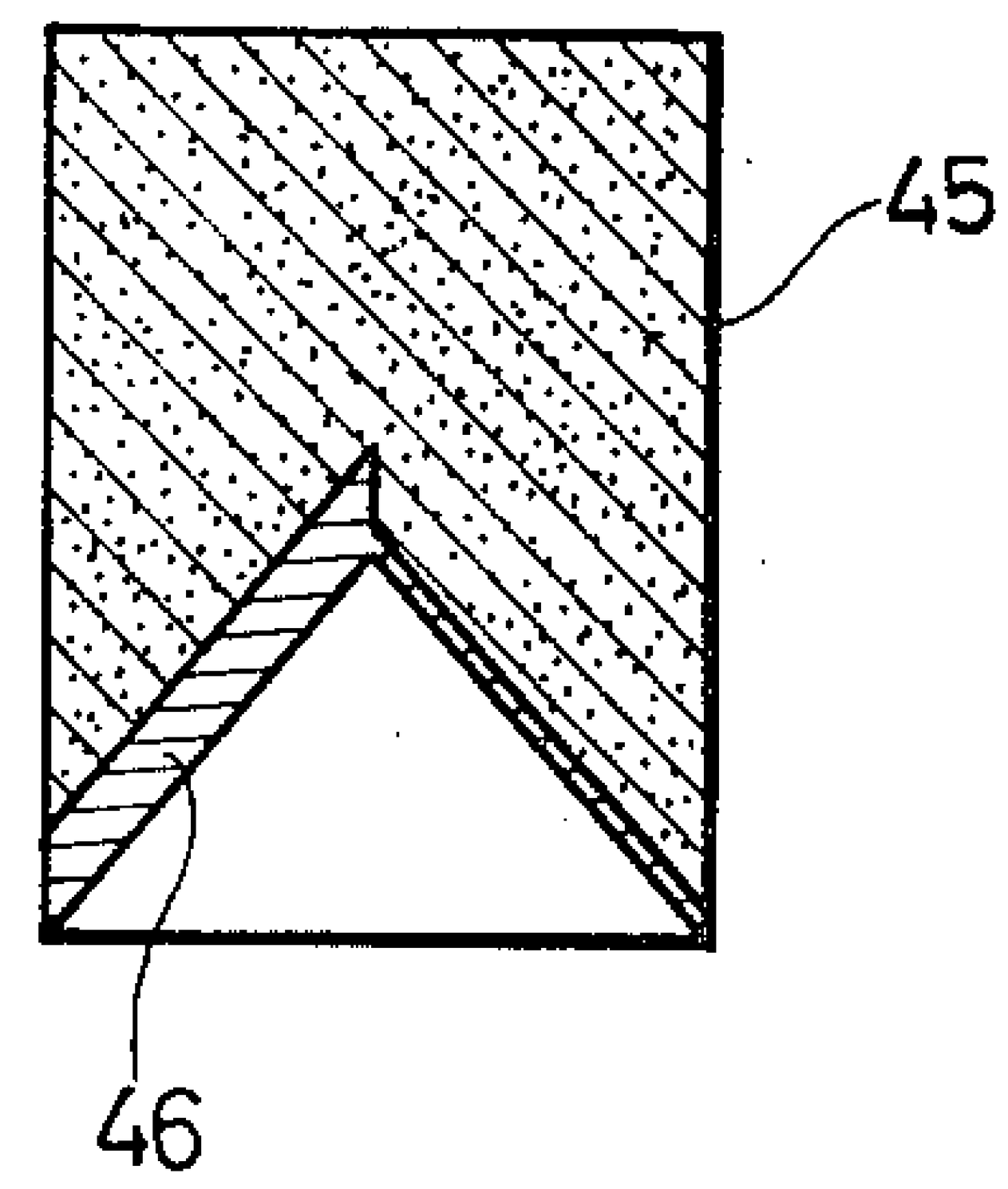

Fig. 12

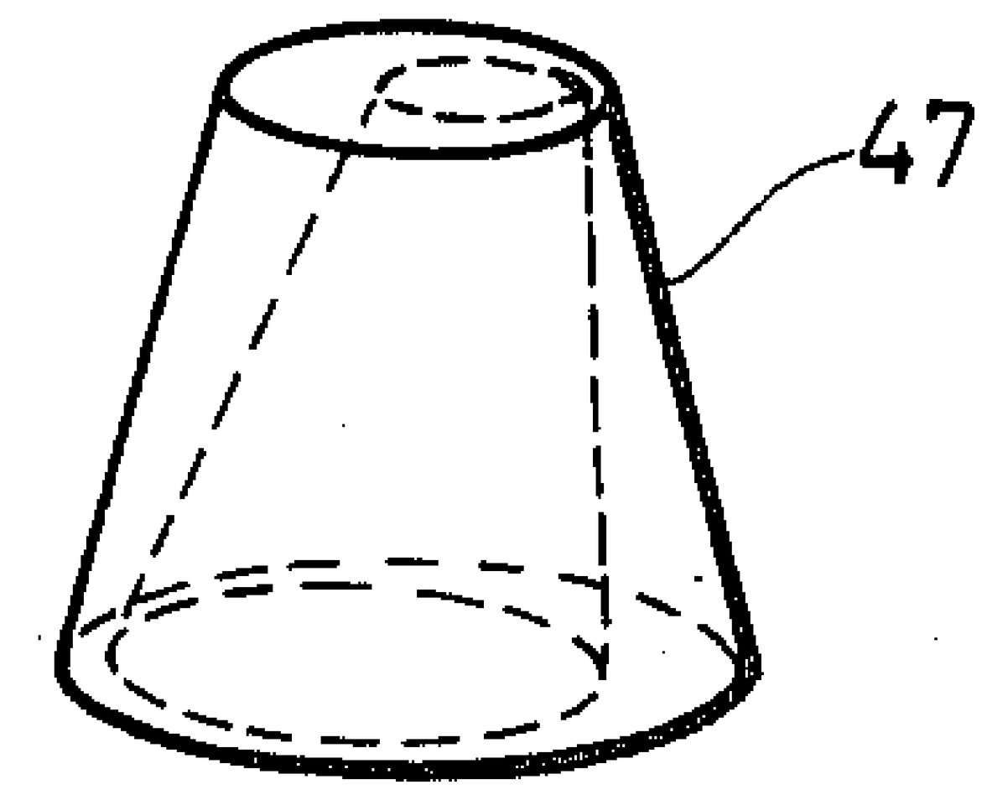

Fig. 13

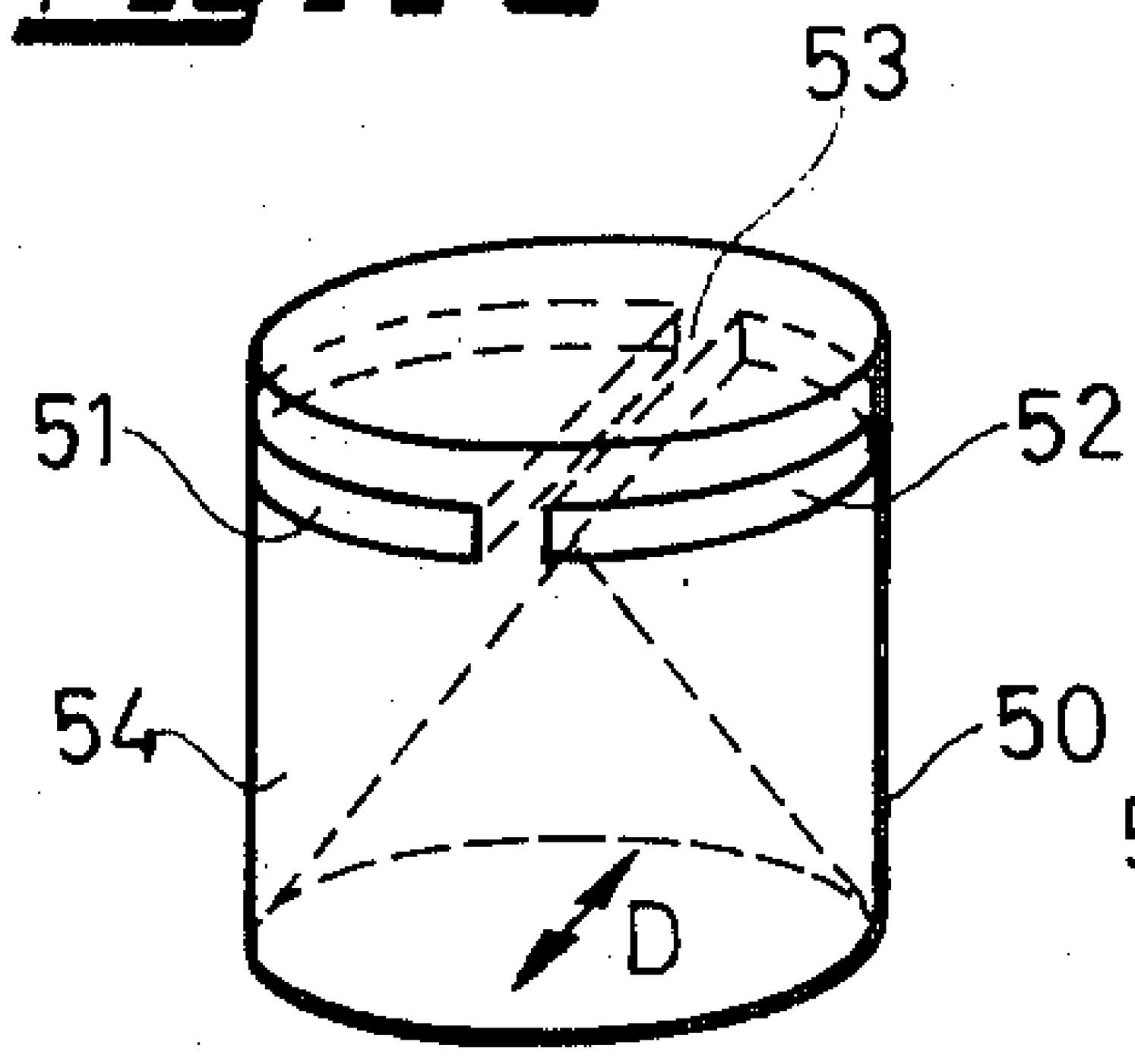

Fig. 14

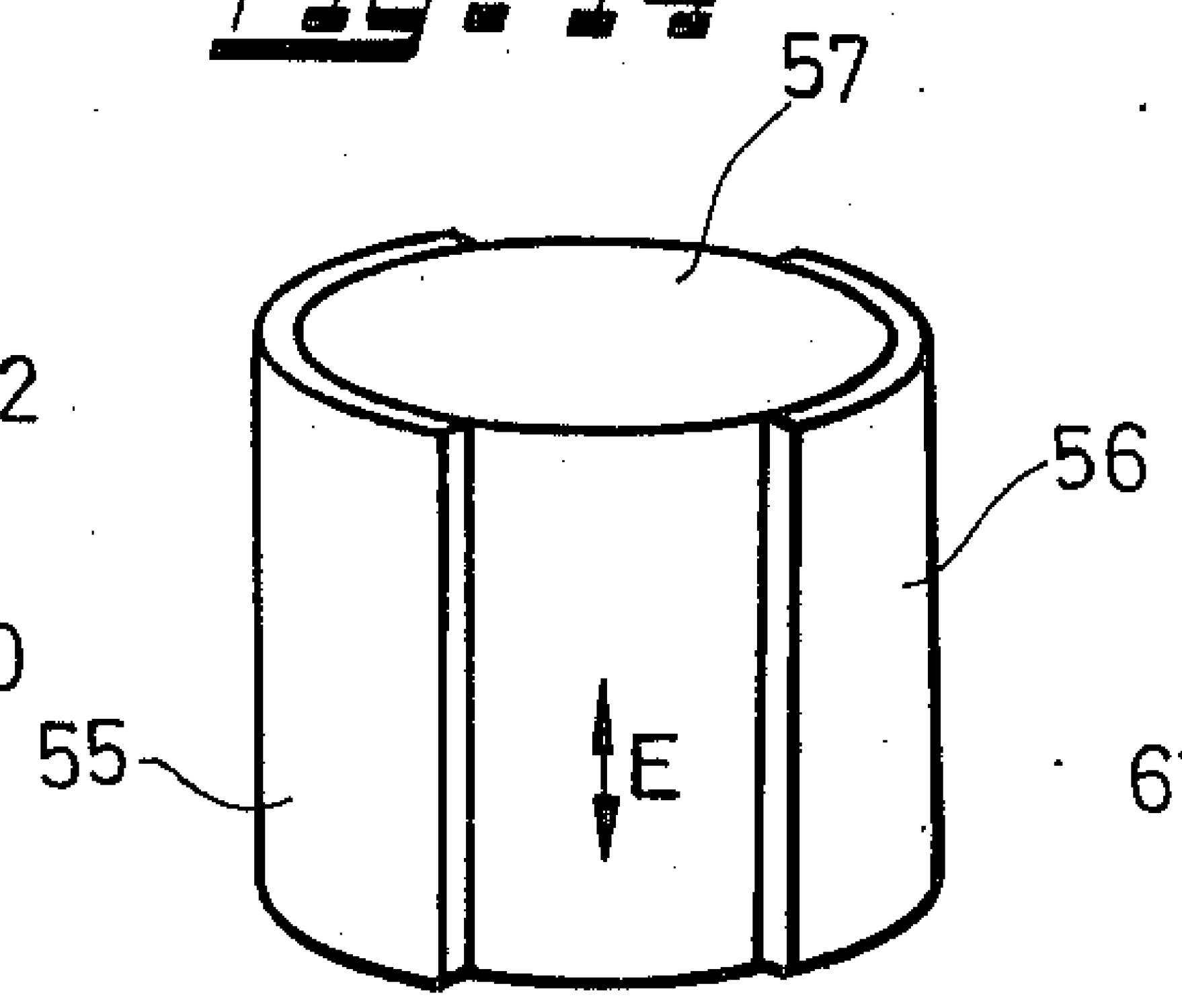

Fig. 15

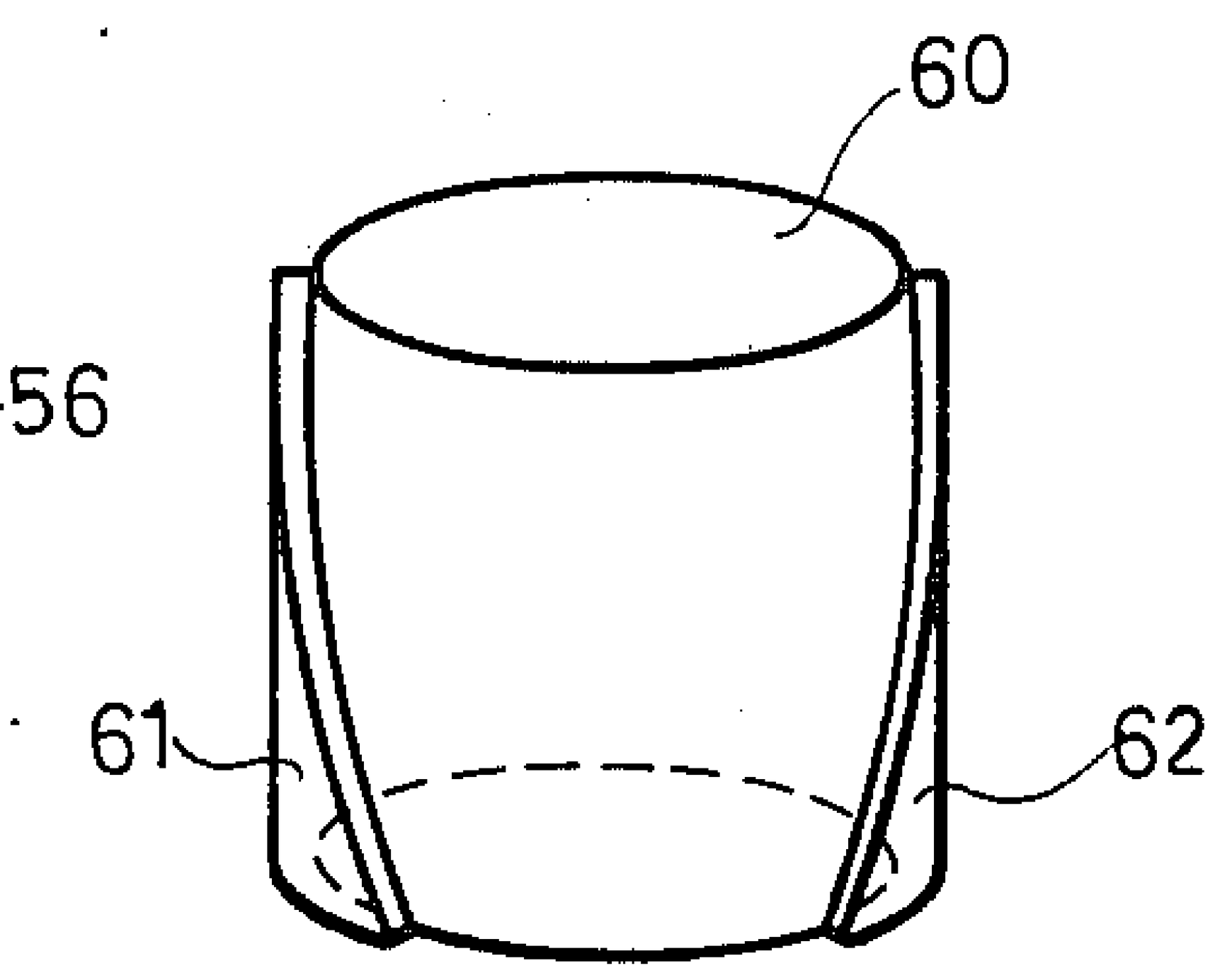

Fig. 16

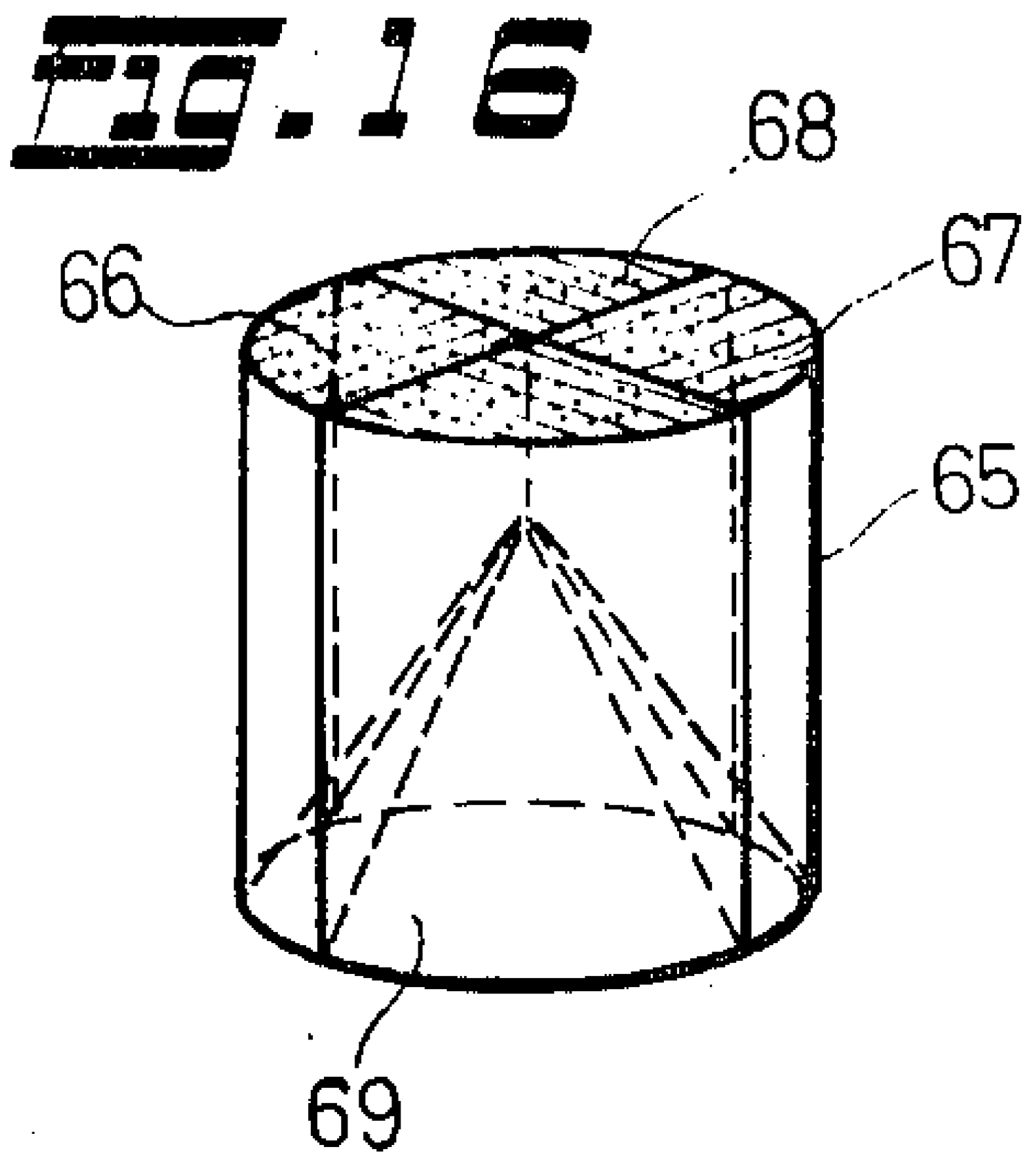

Fig. 17

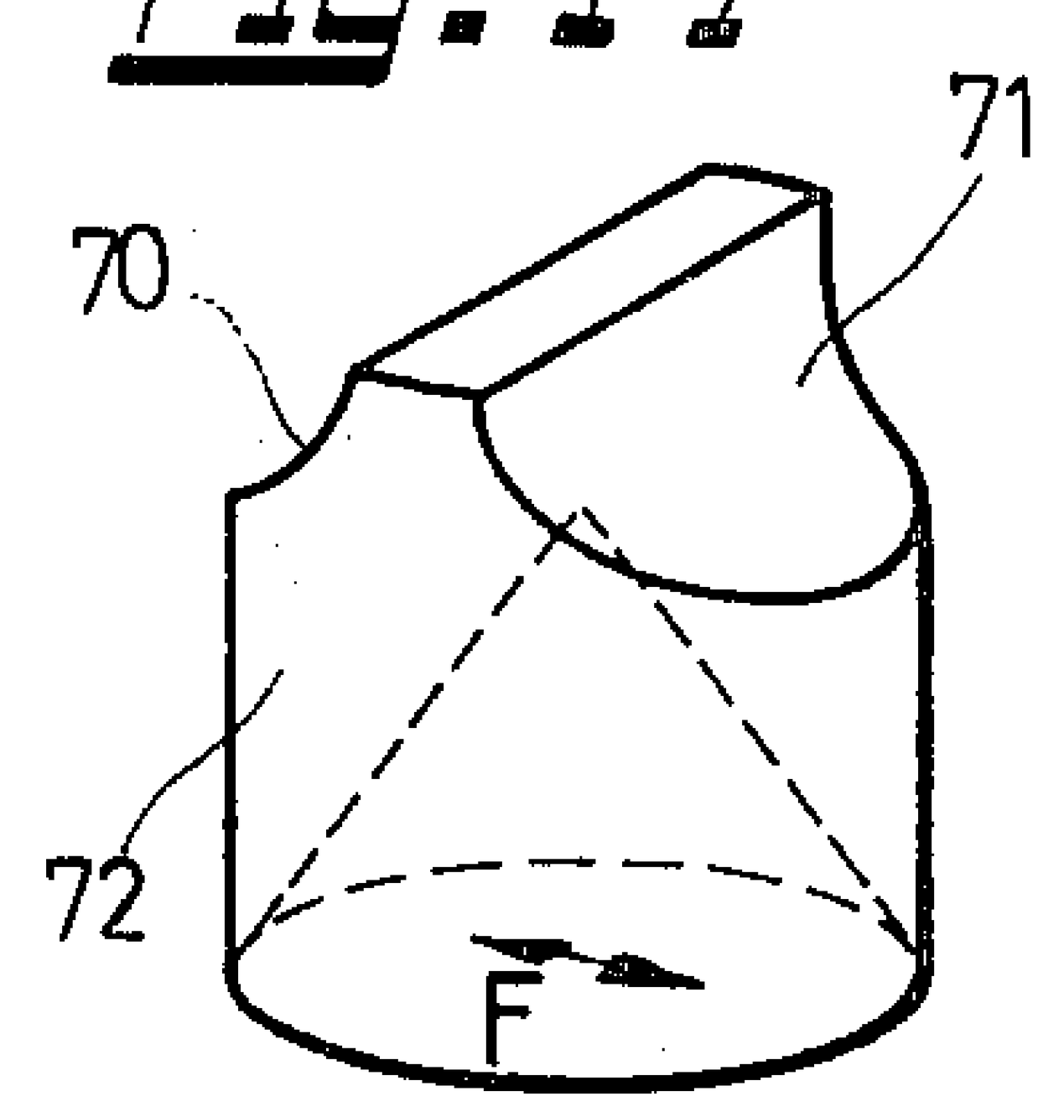

Fig. 18

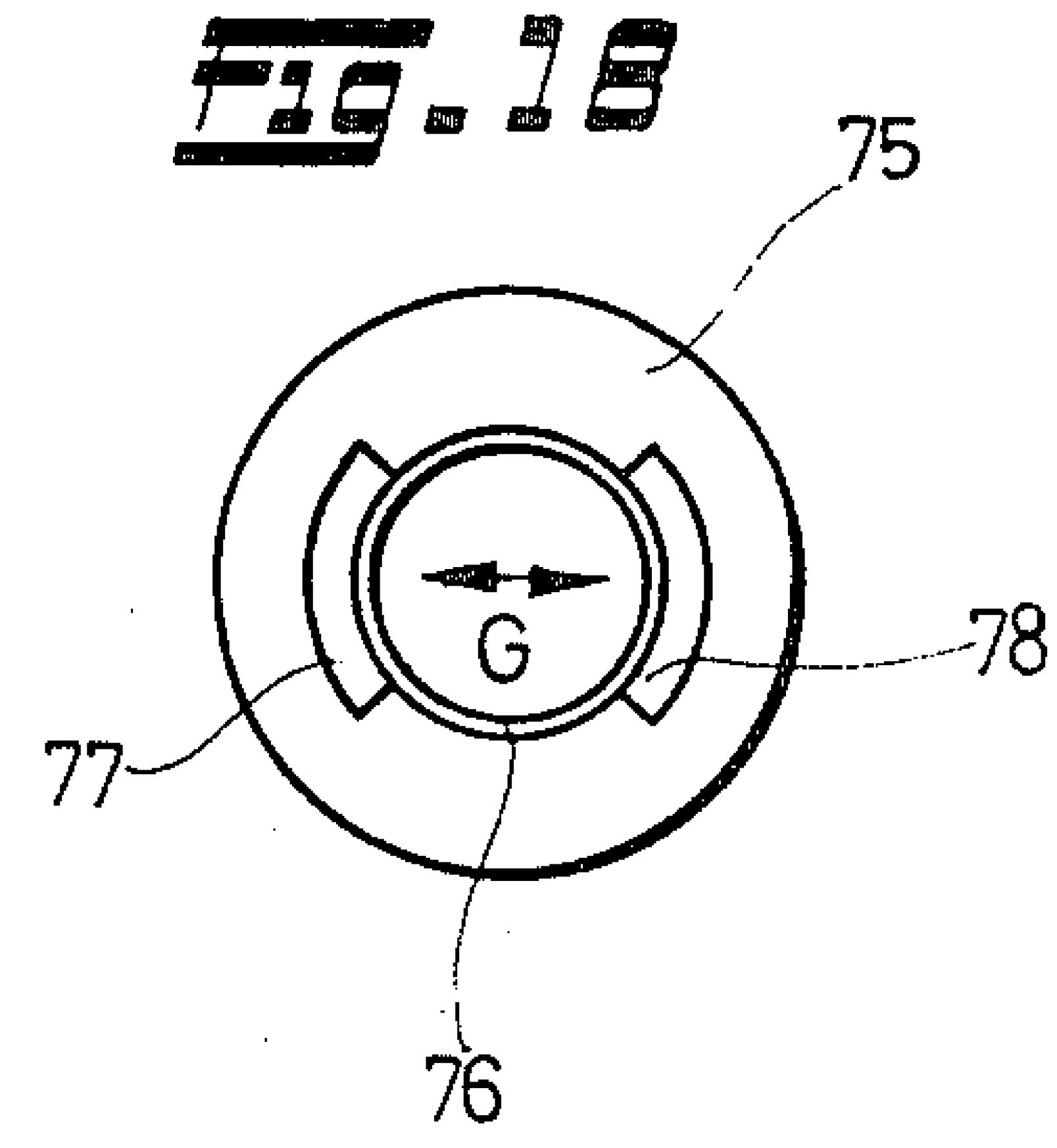

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Fig. 19

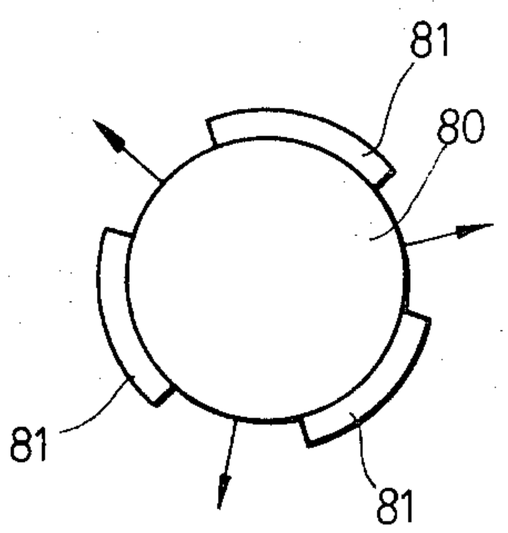
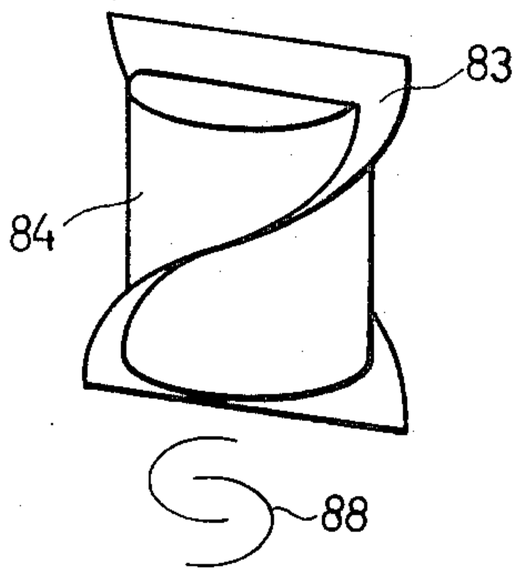


Fig. 20



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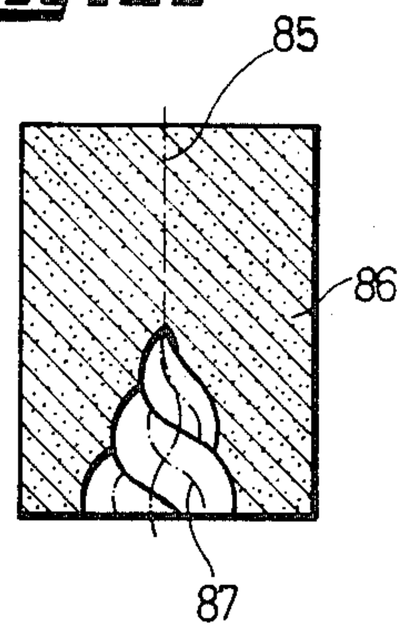
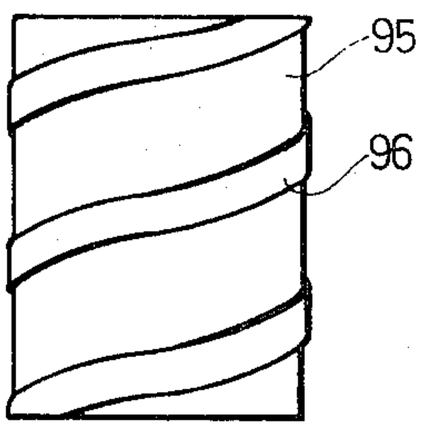


Fig. 22



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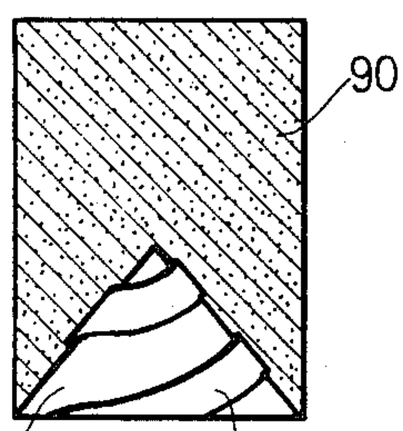

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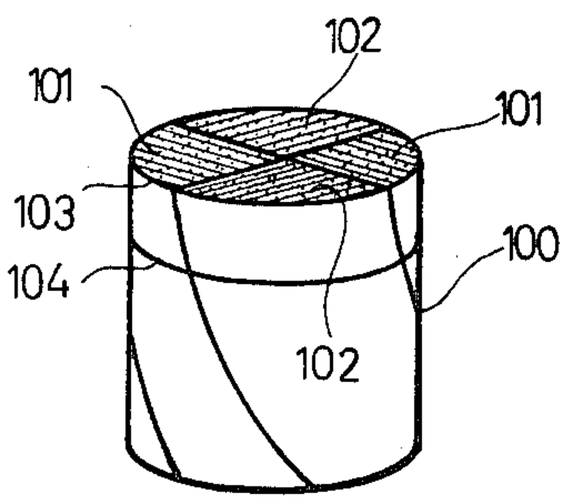


Fig. 25

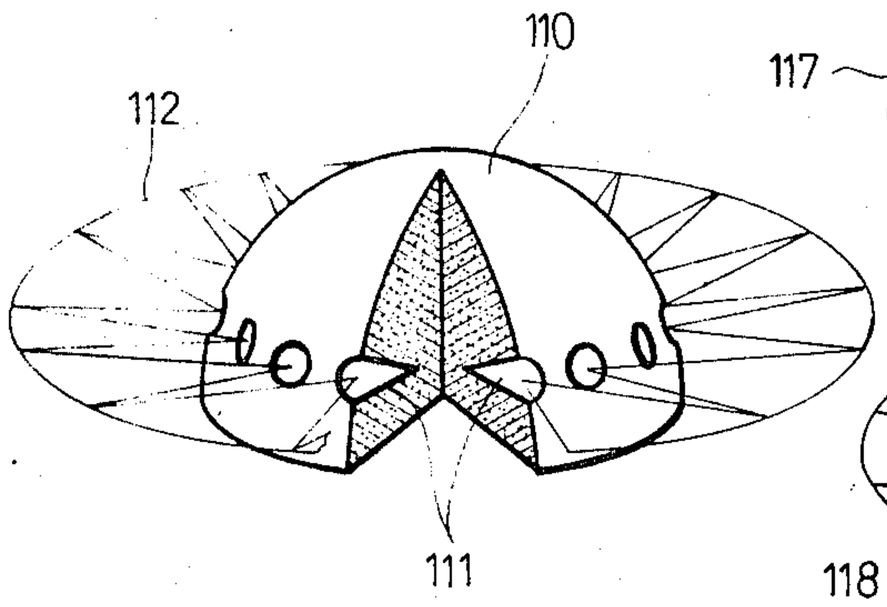
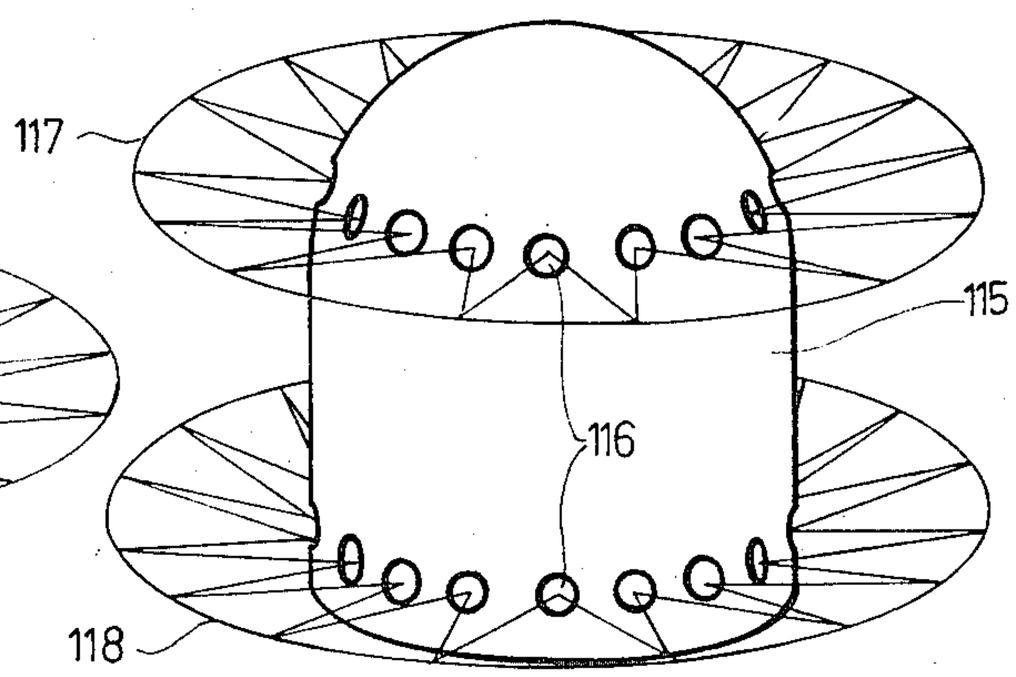


Fig. 26



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HOLLOW-EXPLOSIVE CHARGE CONSTRUCTION

SUMMARY OF THE INVENTION

This invention relates in general to the construction of explosive charges and in particular to a hollow explosive charge for producing or generating explosive effects along a line, particularly for producing cuts or perforations which extend along a straight or curved line.

Prior to the present invention hollow charges were constructed to obtain an explosive effect which is concentrated to a point-like area, as much as possible, because, in accordance with experience, explosions which are concentrated in a point are particularly effective in respect to armored targets. Such charges, however, are not suitable for use for combatting extended targets or targets which consist of thin walls.

In accordance with the invention, hollow charges are proposed which yield an increased effect in regard to width or area, while having a lesser penetration depth. In particular, it is an object of the invention to provide hollow charges which cause a cut-like effect in which the length of the cut and the depth of the cut of the individual holes or breakthroughs are changeable within predetermined limits by varying several features of the charge construction.

Experiments have shown that the intended purpose can be obtained in different ways. However all these ways have one thing in common, to wit, that means must be provided to vary the prior art rotationally symmetrical hollow charge construction or firing effect. This applies both for small distances of the hollow charge to the target and also for distances up to 50 and more calibers.

The inventive measures to be effected with hollow charges for producing effects along at least one line are characterized by a charge construction wherein particularly the lining, and/or the explosive charge have at least one deviation from the rotation symmetry or that means are provided in order to influence the direction of the detonation wave. The various measures which cause deviation from the rotation symmetry can also be used in combination. In order to obtain one-sided effects, eccentric initiation is suitable and also the one-sided arrangement of a barrier in the charge between the initiation point and the lining. Also one-sided damming or cutouts provided in the explosive materials or composite explosive bodies may cause such effects. Further, two-sided plane symmetrical embodiments may be used by an arrangement on one side only.

For the production of curved cuts, the symmetry axis in cross section has to be arranged, with one-sided arrangement, in a helical manner in the subsequent cross sections. A curved cut can also be obtained by providing a helical lining axis.

All the methods to obtain cut-like effects upon detonation of the charge may be divided into two groups dependent on whether the hollow charges cause the formation of

a. a bent thorn, or

b. a thorn having a plane-symmetrical cross section.

Accordingly, it is an object of the invention to provide an explosive charge which generates explosive effects along a line.

A further object of the invention is to provide an explosive charge construction in which the lining or the explosive charge or the means for influencing the direction of the detonation wave are such as to cause a deviation from the rotational symmetry of the charge.

A further object of the invention is to provide an explosive charge which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIGS. **1** and **2** are somewhat schematic side elevational views of an explosive charge and associated thorn which would be formed thereby upon explosion;

FIGS. **3, 4** and **5** are transverse sectional views of an explosive charge construction with the thorn produced thereby indicated somewhat schematically subjacent the various embodiments of the invention;

FIGS. **6** and **7** are top perspective views of explosive charges of other embodiments of the invention;

FIGS. **8** to **11** are transverse sectional views of other embodiments of explosive charge, with FIG. **8** indicating the thorn formation;

FIGS. **12** to **17** are top perspective views of still further embodiments of the invention;

FIGS. **18** and **19** are horizontal cross sectional views of further embodiments of explosive charges;

FIG. **20** is a front perspective view of another embodiment of explosive charge;

FIG. **21** is a transverse section of still another embodiment of explosive charge;

FIG. **22** is a front elevational view of another embodiment of explosive charge;

FIG. **23** is a sectional view of another embodiment of explosive charge; and

FIGS. **24, 25** and **26** are schematic perspective views, partly in section, of still further embodiments of explosive charge.

Referring to the drawings in particular, in FIG. **1** there is shown a hollow charge **1** in diagrammatic simplified manner which causes the formation of a bent thorn **2.** Embodiments of hollow charges of this nature are also shown in FIGS. **3** through **12.**

All these hollow charges have the common feature that they have a symmetry plane in which the lining or the explosive charge deviates from the symmetry or that in this symmetry plane there are arranged means which influence the direction of the detonation wave.

FIG. **2** shows a hollow charge **3** which yields a plane symmetrical thorn **4.** This thorn in a predetermined instance of its development has the cross sections **5** and **6** taken along lines II—II and superimposed on the thorn. Such charges have, preferably at diametrically opposite sides, deviations of their symmetry and will be described in connection with the embodiments of FIGS. **13** through **18.**

The first group of charges (group a) includes hollow charge bodies which cause bent or curved thorns, for example as shown in FIG. **1.**

A hollow charge **7** which is shown in longitudinal section in FIG. **3** has a charge body **11** whose longitudinal axis **8** defines an angle α relative to the longitudinal axis **9** of a conical lining **12.** The thorn **10** which is formed

by the detonated charge is bent. Its mass particles move in direction of the diverging arrows A and cause a cut.

Similar conditions prevail in a hollow charge built in accordance with FIG. 4. This charge 14 has a rotation symmetrical lining 15 and a charge body 16 which is rotation symmetrical relative to the longitudinal axis 20. In this hollow charge the detonation wave is influenced by means producing an eccentric initiation 17 of the charge 16. The intersecting curve of the detonation wave 21 with the lining 15 has a base closest point on the right hand generatrix of the lining cone 15. The thorn 22 is situated on the left relative to the longitudinal axis 20 and its action line extends in the section plane in direction of the arrow B.

In FIG. 5 a hollow charge 25 is seen in longitudinal section which has a charge body 26 and a rotational symmetrical lining 27. In this embodiment the detonation wave is influenced by means of an inert barrier 28 which is built-in on one side in the charge body 26. In this embodiment a thorn 29 develops whose action line extends in a cross sectional plane in the direction of the arrow C. The thorn forms on that side of the hollow charge on which the propagation velocity of the detonation wave is obstructed by the barrier 28.

An action line which extends toward one direction is also formed if the hollow charge 30, as seen in FIG. 6, is provided with a one-sided damming means 31. In the FIG. 6 embodiment the parallel action line extends from the longitudinal axis of the charge toward the left-hand side.

FIG. 7 shows a hollow charge 33 with a one-sided damming means 34 which, in relation to its enveloping associated mass, varies in subsequent or successive cross sections.

FIG. 8 shows in longitudinal section and in a simplified manner a hollow charge 35 wherein the longitudinal axis 39 of the lining 36 is bent in the section plane. Such a hollow charge develops a bent thorn 37 of almost circular cross section 38.

FIG. 9 shows a longitudinal section of a hollow charge 40 wherein the charge is composed of two bodies of different explosives 41 and 42. A hollow charge 44 with a one-sided cutout 43 is shown in FIG. 10. The action line extends in both hollow charges (FIGS. 9 and 10) from the longitudinal axis of the charge to the left if, in the hollow charge of FIG. 9, the explosive 41 is the one which detonates in a slower manner. The hollow charge 45 of FIG. 11 has also an action line which is directed toward the left. The longitudinal section shows that the lining 46 in this hollow charge is reinforced on one side.

A similar measure is shown in FIG. 12. This figure shows a hollow charge 47 with dissimilar wall thickness from top to bottom formed by a lining disposed obliquely in respect to the charge body.

The following hollow charges show thorns of the kind illustrated in FIG. 2 and these hollow charges have the same symmetry deviations predominantly at two diametrically opposed sides.

FIG. 13 shows a construction of charge 50 to create a straight flat thorn. In the hollow charge 50 there are arranged two inert barriers 51 and 52 with gap 53 situated therebetween which gap 53 is filled with the explosive 54. A saddle-shaped detonation wave which is created behind this gap straightens the flat thorn in the gap plane in the direction of the arrow D.

The damming means 55 and 56 of the hollow charge 57 along two sectors of the charge cylinder, corresponding to FIG. 14, causes the formation of a straight flat thorn in the longitudinal plane by the undammed sectors in the direction of the arrow E. In accordance with FIG. 15 a hollow charge 60 is provided wherein the damming means 61 and 62 varies in cross section.

FIG. 16 shows a hollow charge 65 wherein two opposing quadrants 66 and 67 of the charge cross section consist of a slower acting explosive for example TNT, in comparison to a more rapidly detonating hexogen-TNT mixture in the two other quadrants 68 and 69. The result in a straight, flat thorn in the plane of the more rapid acting explosive quadrants.

In FIG. 17 the charge 72 has two horseshoe cuts or sections 70 and 71 which weaken the explosive wall in a plane-symmetrical manner. Such a hollow charge body 72 causes the formation of a flat thorn in the weakened section plane and whose action line extends in the arrow direction F.

In FIG. 18 a hollow charge 75 is shown in cross section. Its lining 76 has diametrically opposing reinforcements 77 and 78. These cause the formation of a flat thorn with an action line indicated by arrow G.

If a hollow charge is built such that it has several symmetry planes which, for example, include angles of 120°, then action lines are obtained which extend in a star-shaped manner.

Such an embodiment is shown in FIG. 19 illustrating the hollow charge 80 showing dammings 81 in cross section which are offset relative to each other by 120°. Correspondingly, other measures of the kind previously described may be used. If such charges are used against relatively weak sheet metal, the sheet metal flaps which are formed in this manner will bend through whereby relatively large holes or breakthroughs are obtained.

According to FIG. 20 the symmetry surface 83 of a hollow charge 84 may also be in a spiral or helical form or it may, corresponding to FIG. 21, have a symmetry axis 87 which is helical about a longitudinal axis 85 of the charge 86. Such hollow charges have bent action lines, for example, a double spiral 88.

In FIG. 22 a hollow charge 95 is shown about which the helical damming 96 is arranged. This charge causes a curved cut which widens spirally.

FIGS. 23 shows a hollow charge 90 in longitudinal section whose lining 91 is provided with a spirally applied reinforcement 92. If this reinforcement has one turn, then the action line of the charge extends approximately to a semicircle, while, if there are two turns, a closed or endless curve is formed.

In FIG. 24 a hollow charge 100 is shown which is built of two different explosives 101 and 102. Subsequent cross sections 103 and 104 are turned relative to each other. By combination of the measures described in connection with the individual embodiments, additional hollow charges can be produced within the scope of this invention.

FIG. 25 shows an explosive body 110 with linings 111 which are circumferentially and radially arranged wherein, in conformity with the previous embodiments, measures are taken in such a manner that the individual effects of the charges complement each other to an annularly extending action line 112. The individual charges may furthermore be arranged so that several annular inwardly extending parallel cuts are formed as the sum of the individual partial cuts. In doing so, such

charges whose section or cut embraces a large annular range, are arranged in a plane, however, with equal inclinations of their longitudinal axis relative to the longitudinal axis of the explosive body.

In FIG. **26** there is shown another explosive body **115** for creating annular cuts in approximately parallel superimposed extending planes. The explosive body **115** has two sets of vertically spaced hollow charge linings or incuts **116.** The action lines **117** and **118** of the hollow charge **115** extend in the manner of closed rings about their longitudinal axes. Analogous to the embodiment shown, hollow charge linings may be arranged in the explosive body **115** in more than two planes.

In the two embodiments of FIGS. **25** and **26,** it is advantageous to arrange the initiation means for the explosive in the intersection point of the lining axes of the

respective groups of hollow charges.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A hollow charge construction of a substantially cylindrical charge body having a single hollow charge liner extending inwardly from one end, said liner being inclined in respect to the axis of said charge body.

2. A hollow charge construction according to claim **1,** wherein said liner includes straight sides.

3. A hollow charge construction according to claim **1,** wherein said liner includes curved sides.

* * * * *