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(54) Projectile with directed fragmentation effect

(57) The present invention relates to a method and an arrangement for bringing about, from a carrier projectile (1, 9, 14, 29, 36a, 36b) in the form of a shell, missile or equivalent, a concentrated fragment sheaf (35, 40, 44) in the direction of a target detected by a homing sensor (7, 10, 15-18) forming part of the carrier projectile. The invention is particularly characterized in that it uses a limited fragment spread within previously determined limits in the direction directly towards the target instead of, as is otherwise normal, scattering the fragments radially around the entire circumference of the carrier projectile.

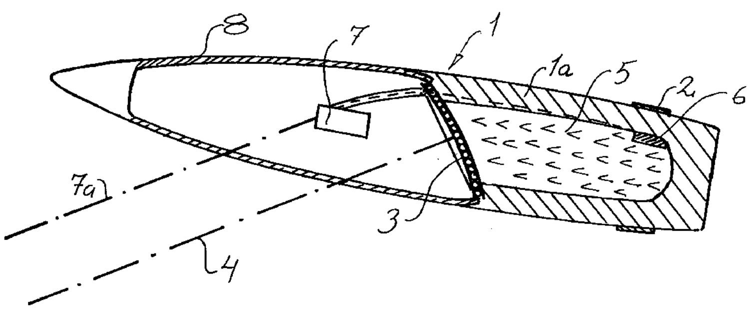

Fig. 1

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Description

The present invention relates to a method and an arrangement for bringing about, in the direction of a detected target, a directed fragmentation effect on detonation of explosive-filled rotationally stabilized active parts or projectiles such as artillery shells and missiles. These consist of, in addition to an explosive-filled active charge, an outwardly delimited fragment-forming casing which preferably consists of at least partly preformed heavy metal fragments and a priming charge intended for said active charge. The fragments are formed on detonation of the active charge. The priming charge is connected to a homing sensor or target sensor which is intended to scan a predetermined direction relative to the flying direction of the projectile during the flight of the projectile towards the target. The target sensor is designed to ignite the priming charge on detection of targets worth combating, which in turn primes the active charge. On detonation, the active charge throws out fragments at great speed in directions which are predetermined relative to the flying direction of the projectile.

The development of microelectronics has resulted in the access to small and efficient target sensors of IR, radar or laser type being increased considerably. This has meant that, within artillery technology, possibilities have been seen for broadening the application of such target-sensor-primed ammunition to new areas of application and weapon calibres. Access to efficient target sensors means that the capacity has been afforded for priming the active charge of the ammunition at absolutely the right time. On the other hand, the problem of concentrating the whole effect of the existing active charge in the direction of the target detected by the target sensor has until now not had a satisfactory solution. As far as fragment-forming projectiles are concerned, the usual method until now has been to design the outer casing of these so that, on detonation of the active charge, this forms fragments and scatters these uniformly around its own central axis. In the case, for example, of a near miss of the target, then there is also, in addition to the fragments which are scattered in the direction of the target, a great quantity of fragments which as a rule are of little use because they are scattered in a direction away from the target. There would therefore be much to gain if it were instead possible to direct the fragments in a concentrated "sheaf" towards the target detected by the target sensor.

The aim of the present invention is then to offer a functional solution to this problem.

The prerequisite for the invention is therefore that there is access to a rotating active part or projectile, such as a rotationally stabilized artillery shell or a missile. The latter can have been imparted adequate speed of rotation by means of for example inclined fins. The active part in question is also to be equipped with a target sensor which, if it detects a target worth combating at a combatable distance during the flight of the projectile, will prime a priming charge included in the projectile. This will in turn prime the active charge of the projectile. The active charge is closed off in its main direction of action by a fragment-forming casing which, on detonation of the charge, is broken up into free metal fragments which are accelerated at high speed in the direction of the target. By means of the design of the active part, which is characteristic of the invention, that is to say the active charge and the fragment-forming casing, a concentration is obtained, on detonation of the active charge, of the fragments, which are with this released and accelerated at high speed, into one or more coherent sheaves in one or more directions, at least one of which coincides with the direction of the target identified by the target seeker.

A basic principle which is characteristic of the invention is thus that both the scanning direction of the target sensor and the dynamic fragmentation direction of the active part, that is to say the common fragmentation direction of the explosive charge and the fragment-forming casing, which is determined by the vector sum of the speed of the fragments formed on detonation of the explosive charge and the path speed of the carrier projectile and at least in certain cases the speed of rotation thereof, are to form an angle of 30° to 90° with the flying direction of the projectile. The scanning direction of the target sensor and the dynamic fragmentation direction are therefore to be aligned relative to one another in such a manner that the fragment sheaf covers the detected target well when it arrives there. This can therefore mean that a smaller inclination is required between the scanning direction of the target sensor and the main direction of action of the fragment-forming casing. Within the invention, two different alternatives can be distinguished, the first of which involves the scanning area of the target sensor and the main direction of action of the active charge both being inclined but directed forwards relative to the flying direction of the projectile. This variant is equally suitable for combating ground targets and flying targets. In combating ground targets, the scanning direction of the target sensor and the main direction of action of the active charge, that is to say its dynamic fragmentation direction, will follow, during the downward path of the projectile, a gradually contracting funnel or cone which in the ground plane forms a spiral creeping in towards the centre. A corresponding spiral path will in the same manner also take in a shelled air target and it will therefore accept a relatively large miss distance in the case of an air target also and yet produce the effect in the target at the same time as covering very near misses also because the scanning beam of the target seeker passes this area immediately before the projectile.

It is well known that it has been possible to ascertain by experience that multiple hits by fragments produce a high elimination probability although the effect of each individual fragment is limited. In this variant, the fragment-forming casing of the active charge preferably consists of a plate which is inclined relative to the flying direction of the projectile and which advantageously can consist of a large number of preformed heavy metal balls which are joined together with one another. Several different ways of producing such ball plates are previously known and their effect in various types of target is well documented. The type of ball sheaves which the ball plates in question give rise to is in turn determined by their shape. If the ball plates are made convex in the firing direction for example, a successively scattered ball sheaf is obtained, while a reasonably concave ball plate produces a concentrated ball sheaf. In a preferred embodiment of this variant, the plate is inclined by more than 40° relative to the flying direction of the projectile at the same time as the priming of the explosive in the active charge arranged behind the ball plate takes place eccentrically so that the detonation front strikes the plate as close to perpendicularly as possible. In this embodiment, the balls from the ball plate are thrown out at a greater speed than that which is obtained in the case of a corresponding cylindrical casing. By selecting a suitable shape for the ball plate, it is possible for example to bring about a ball sheaf in the form of a cone with a half apex angle of for example 6 to 20° so the ball density can be kept high even at a long target distance such as up towards 50 metres from the detonation point.

The invention therefore affords a way of achieving a good result with unguided projectiles in spite of the use of relatively simple and imprecise fire-control systems. Possible iring arrangements in which it could be of interest to make use of the invention could therefore be older automatic anti-aircraft cannon of 30-40 mm calibre and upwards, of which there is still a vary large number in service. Moreover, anti-tank weapons of the back-blow or counter-mass type provided with projectiles designed according to the invention could be used against helicopters and other targets which are well defined against the background.

According to a second variant, the projectile is designed with one, two or more target sensors which are expediently arranged in its front end and the scanning directions of which are angled out at 90°relative to the flying direction of the projectile and which are uniformly distributed around the circumference of the projectile. These target sensors are then combined with a corresponding number of fragment-forming casings, the respective main directions of action of which, that is to say their dynamic fragmentation direction, are in turn aligned with the different target sensors while the space between the fragment-forming casings or alternatively between the sole fragment-forming casing and the outer wall of the projectile is used for the explosive charge and the priming charges necessary for detonation of this in the desired direction. In active charges comprising a number of fragment-forming casings arranged in different directions, the main direction of action of which in each case corresponds to the optical input to a target seeker, a central priming of the main charge may also be possible. What is essential in this connection is that one of the casings is centred on the target so that its concentrated fragment sheaf can be expected to produce the maximum effect in the target.

This variant can be used for example for combating air targets from pieces which have a fire-control system which is actually intended for other less fast target types or is an antiquated model. The variant with four target sensors and the same number of fragment-forming casings can thus be used by tanks for example for combating helicopters which, apart from other tanks, are their most dangerous enemies, while the variant with one target sensor and one fragment-forming casing could find use in for example 57 mm shells for use in older ship and AA cannon.

The invention has been defined in the following patent claims and it is now to be described in greater detail in conjunction with the attached figures, in which

Fig. 1 shows a longitudinal section through a shell provided with a target sensor angled obliquely forwards and a fragment-forming casing,

Fig. 2 shows an X-ray picture of a projectile for a back-blow weapon with a laterally directed target sensor with associated fragment-forming casing,

Fig. 2a shows a cross-section of the figure according to Fig. 2,

Fig. 3 shows an X-ray picture of a shell with four laterally facing target sensors and associated fragment-forming casings.

Fig. 4 shows combating of a ground target with a shell of the type shown in Fig. 1.

Fig. 5 shows a basic diagram of a variant in combating an air target with a shell of the type shown in Fig. 1.

The shell 1 shown in Fig. 1 comprises a rear shell body 1a with a conventional girdle 2 and an internal explosive charge 5 which, forward in the flying direction of the shell, is closed off by a fragment-forming casing in the form of a heavy metal ball plate 3 of a type known per se which is inclined relative to said flying direction. As can be seen from the figure, the heavy metal hall plate 3 is angled obliquely with its main direction of action 4 at more than 40° relative to the flying direction of the shell 1 which coincides with its main axis. There is a priming charge 6 for priming the explosive charge 5. Situated in front of the fragment-forming casing is also a target sensor 7, the scanning direction 7a of which is angled down parallel to the dynamic fragmentation direction, that is to say the vector sum of the fragment speed plus the shell speed, that is to say the main direction of action 4 of the fragmentation casing. The front part of the shell is furthermore covered by an aerodynamically designed casing 8 which could be removed after firing in order to give the target sensor a completely free field of vision.

The shell shown in Fig. 2 consists of an outer casing 9, a straight laterally directed target sensor 10 - that is to say angled out at 90° - arranged in the front part thereof, a fragment-forming casing 11 which is arranged immediately inside the outer casing of the shell and directed in the same direction as the target sensor and which consists of heavy metal balls of a type known per se which are moulded into a suitable matrix. Located behind the heavy metal ball plate are the explosive charge 12 and its priming charge 13. The latter is therefore coupled together with the target sensor in such a manner that when the shell passes sufficiently close to a detectable target, the target sensor will ignite the priming charge which in turn primes the explosive charge which, when it detonates, throws out the heavy metal balls at high speed in the direction of the target. Fig. 2a shows the same components as in Fig. 2 with the exception of the target sensor 10. The heavy metal ball plate 11 is concave forward in the main direction of action of the charge in order to produce as concentrated a fragment spray as possible. Since the shell rotates, the target sensor and fragment charge will cover the revolution round and along its path.

The shell shown in Fig. 3 is of the type which has four target sensors 15, 16, 17 and (18) distributed uniformly around its own front part. Target sensor 18 is concealed in the figure. The rear part of the shell contains four outwardly concave fragment-forming casings 19, 20, 21 and 22 in the form of the previously mentioned ball plates and an explosive charge 23 arranged between these. This construction therefore provides four different possible detonation directions and, for each detonation direction, there is a priming charge 24, 25, 26 and 27 arranged towards the inside of fragment-forming casings directed in the opposite direction. In this variant, the target sensor which first detects a combatable target therefore primes the detonation of the charge 23 in the direction in which it has detected a target.

Figure 4 is intended to illustrate the use of a shell 29 of the type shown in Fig. 1 for combating ground targets. The scanning beam 30 of the target sensor can be seen as a straight line while the fragmentation casing, if the main charge is detonated, produces a fragment spread which will cover a certain area in the ground plane. For the sake of simplicity, however, the fragment spread can to start with be seen as a straight line 31 which represents its main direction of action, that is to say its dunamic fragmentation direction, and which coincides in the figure with the scanning beam of the target sensor. The scanning beam and the main axis of the fragment sheaf which could therefore be formed at any moment if the main charge was detonated will, as a result of the rotation of the shell, follow a path 33 which runs inwards in a spiral towards the theoretical point of impact 32 of the shell 29 during the downward path into the ground plane of the latter. The area of action of the shell therefore covers the entire area inside the spiral path 33. If then, as indicated in the figure, there is a target at point 34, to which the target seeker of the shell responds and therefore primes the main charge of the shell, the target and the surrounding area, here designated 35, will thus be covered by the fragments of the ball sheaf formed on detonation of the shell.

Lastly, Fig. 5 shows a variant in the case of combating an air target with a shell of the type shown in Fig. 1. The shell is shown in a first position 36a and a second position 36b in its own path 37. Furthermore, it is assumed that the target seeker of the shell has a scanning angle α. In the figure, there have then been drawn for both shell positions 36a and 36b one and a half revolutions of the spiral curve 38a and 38b respectively which the target seeker and the main direction of action of the active charge, that is to say its dynamic fragmentation direction, follow at an arbitrary distance, which is the same in both cases, in front of the shells 36a and 36b respectively. If it is then assumed that a target which is worth combating and can be detected by the target sensor is situated at point 39, this will, when the shell has reached the position 36b shown in the figure where the main charge of the shell is detonated, be covered by the ball sheaf indicated by 40, which has the coverage 41 around the target. The line 42 which is also drawn in the figure and illustrates the scanning beam of the target seeker when the shell is situated in the position 36a has been included only in order to show that, when the shell is situated in this position, the scanning beam can never hit the target at point 39 but a target situated at a greater distance from the projectile path 37, for example at point 43, which in that case will be covered by the ball sheaf 44 with its coverage 45 around the target, in which connection, however, the fragment density and thus the effect in the target will be correspondingly reduced.

Claims

1. Method of bringing about a directed fragmentation effect on the priming of such rotationally stabilized carrier projectiles as artillery shells and missiles which comprise an active charge, a fragment-forming casing delimiting said charge in its main direction of action, that is to say its dynamic fragmentation direction, a priming charge intended for priming the active charge, and their own target sensor adapted to search, during the flight of the projectile towards the target, a predetermined direction relative to the flying direction of the projectile, in order, when a target worth combating has been detected, to ignite the priming charge for priming the main charge, characterized in that the searching direction of the target sensor and the main direction of action of the active charge are aligned in a direction which forms an angle of 30-90° to the flying direction of the projectile.

2. Method according to Claim 1, characterized in that the searching direction of the target sensor of the carrier projectile and the main direction of action of the active charge are inclined relative to the flying direction of the projectile to such a great extent that they form an angle which is greater than 40° to it.

3. Method according to Claim 1, characterized in that the carrier projectile is equipped with one or more target sensors each arranged with its main searching direction essentially perpendicular to the flying direction of the projectile, each sensor being aligned with a fragment-forming casing with a corresponding main direction of action.

4. Rotationally stabilized projectile such as an artillery shell or a missile (1, 9 and 29) of the type which comprises an active charge (5, 12 and 23), a fragment-forming casing (3, 11, 19-22) delimiting said charge in its main direction of action (4), a priming charge intended for priming the active charge, and its own target sensor (7, 10, 15-18) intended to search, during the flight of the projectile (1, 29, 36a, 36b) towards the target, a predetermined direction relative to the flying direction of the projectile, in order, when a target (34, 39, 43) worth combating has been detected, to ignite the priming charge (6, 13, 21-24), the projectile (1, 29, 36a, 36b) being designed to produce, on its detonation, a directed fragmentation effect in accordance with the method according to one of claims 1, 2 or 3, characterized in that the searching direction (7a, 30, 42, 46) of the target sensor and the main direction of action (31) of the active charge are aligned and inclined relative to the flying direction (32, 37) of the projectile in such a manner that they form an angle of 30-90° with it.

5. Rotationally stabilized projectile (1, 29) according to Claim 4, characterized in that the target sensor (7, 10, 15-18) is arranged in its front part and in that the fragment-forming casing (3, 11, 19-22) arranged at an angle relative to the flying direction of the projectile (1, 29) is arranged behind the sensor with the active charge (5, 12, 33) immediately behind it and with the priming charge (6) arranged eccentrically in the projectile but centred in relation to the intended main direction of action (4) of the charge.

6. Rotationally stabilized projectile according to Claim 5, characterized in that the scanning direction of the target sensor (10, 15-18) and the main direction of action of the active charge and of the fragment-forming casing form a 90° angle with the flying direction of the projectile, the fragment-forming casing (11, 19-22) extending along a large part of one inner side of the latter while the priming charge is arranged towards its opposite inner side.

7. Rotationally stabilized projectile according to Claim 6, characterized in that it comprises two or more, preferably four, target sensors (15-18) arranged uniformly distributed around its circumference with their searching directions at a 90° angle relative to the flying direction, and a corresponding number of fragment-forming casings (19-22) aligned with the searching directions of the target sensors, and associated priming charges (24-27), and also an active charge arranged between the casings, the target sensor which first detects a target (33) worth combating being arranged to prime the active charge in its own scanning direction.

8. Rotationally stabilized projectile according to Claim 7, characterized in that the target sensors (10, 15-18) are arranged in its front part while the fragment-forming casings (11, 19-22) extend along the inside of the remaining part of the projectile.

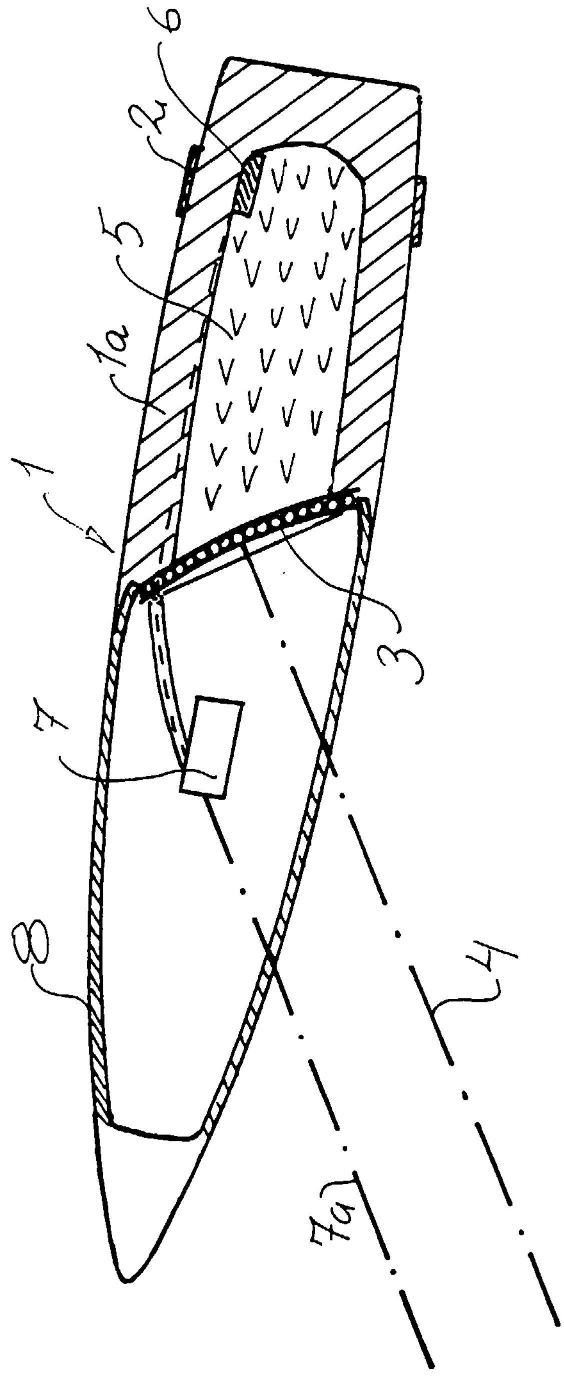

Fig. 1

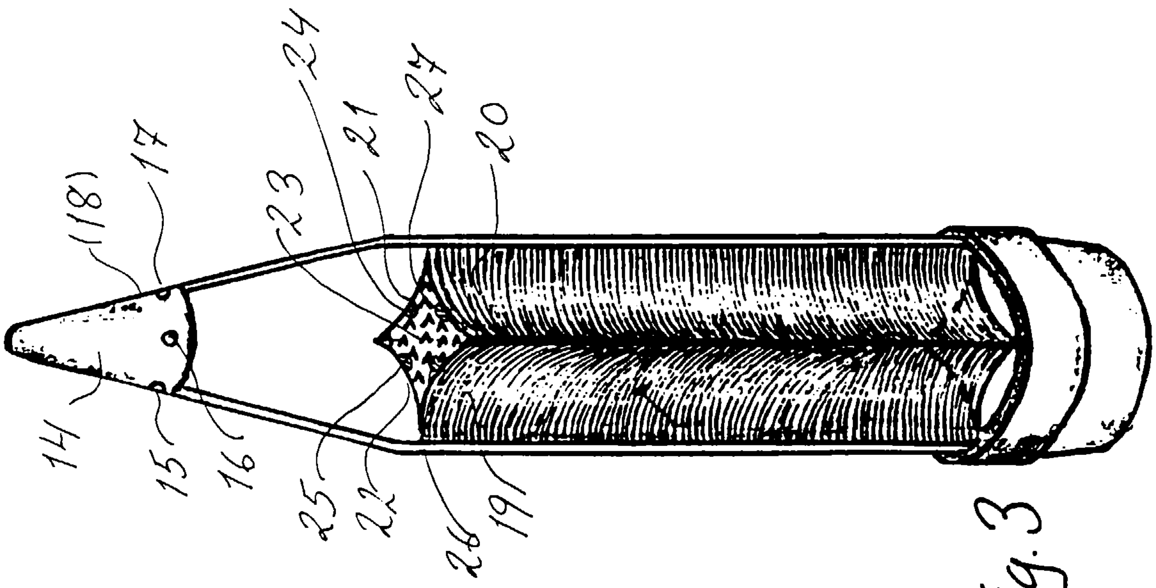

Fig.3

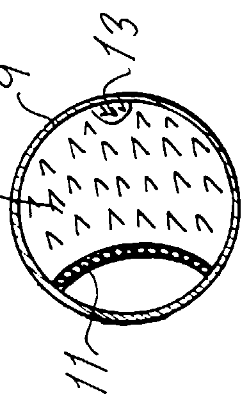

Fig.2a

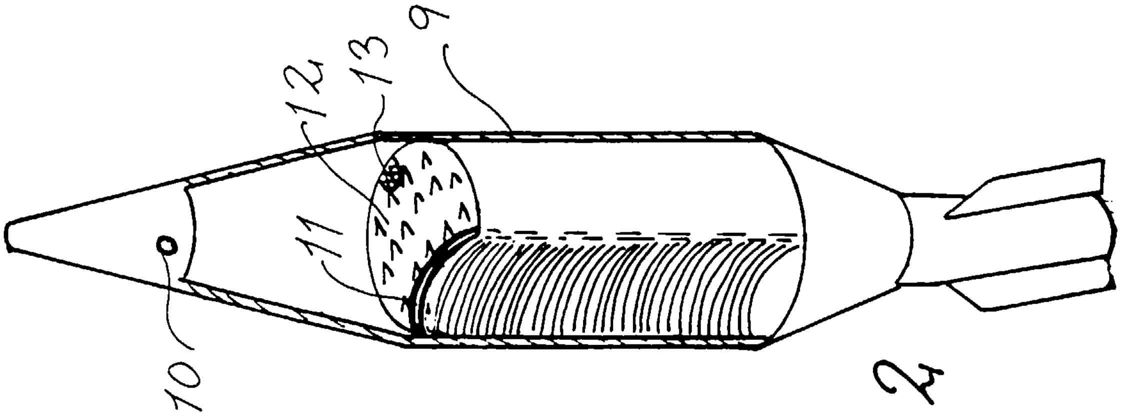

Fig.2

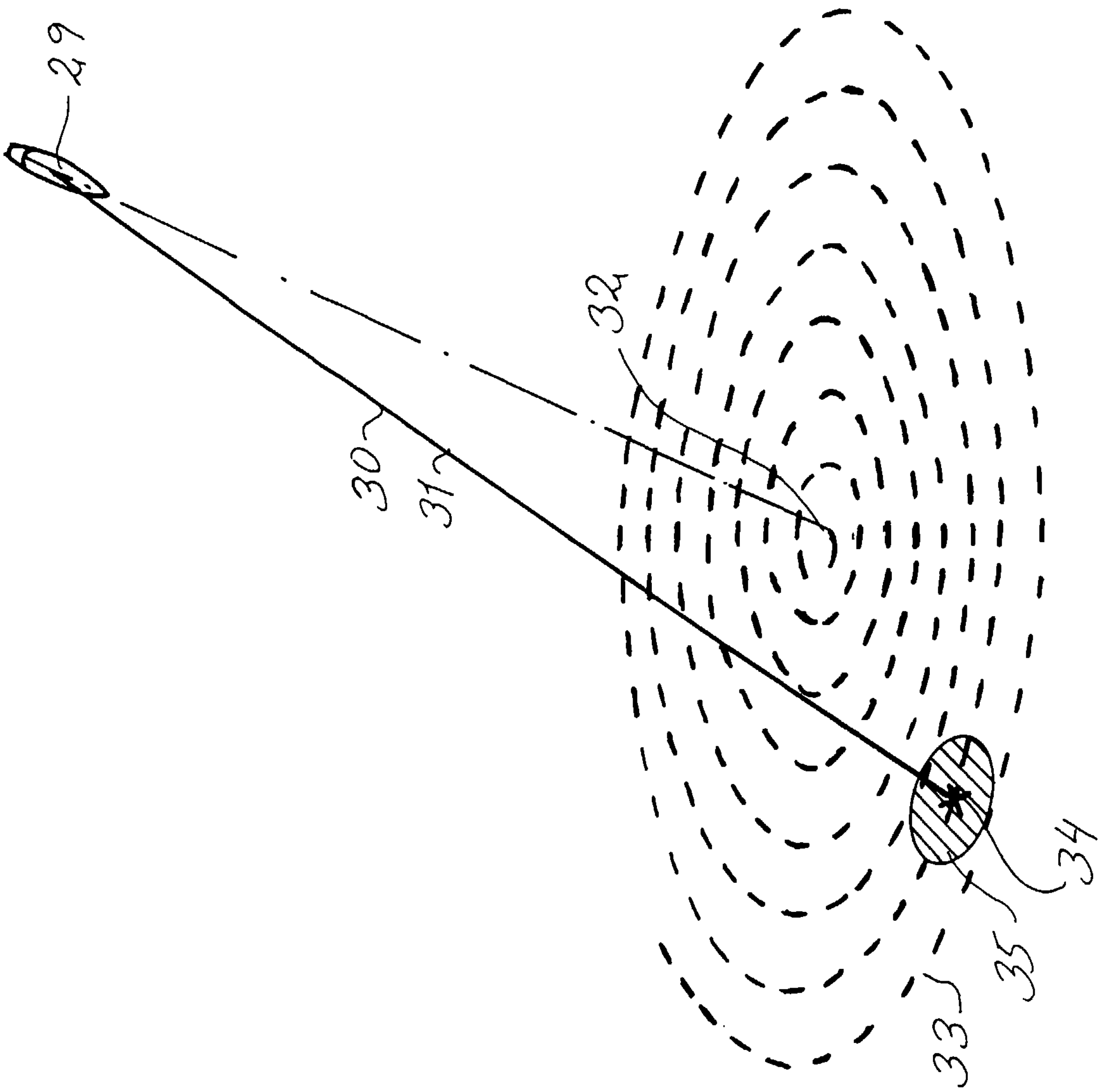

Fig. 4

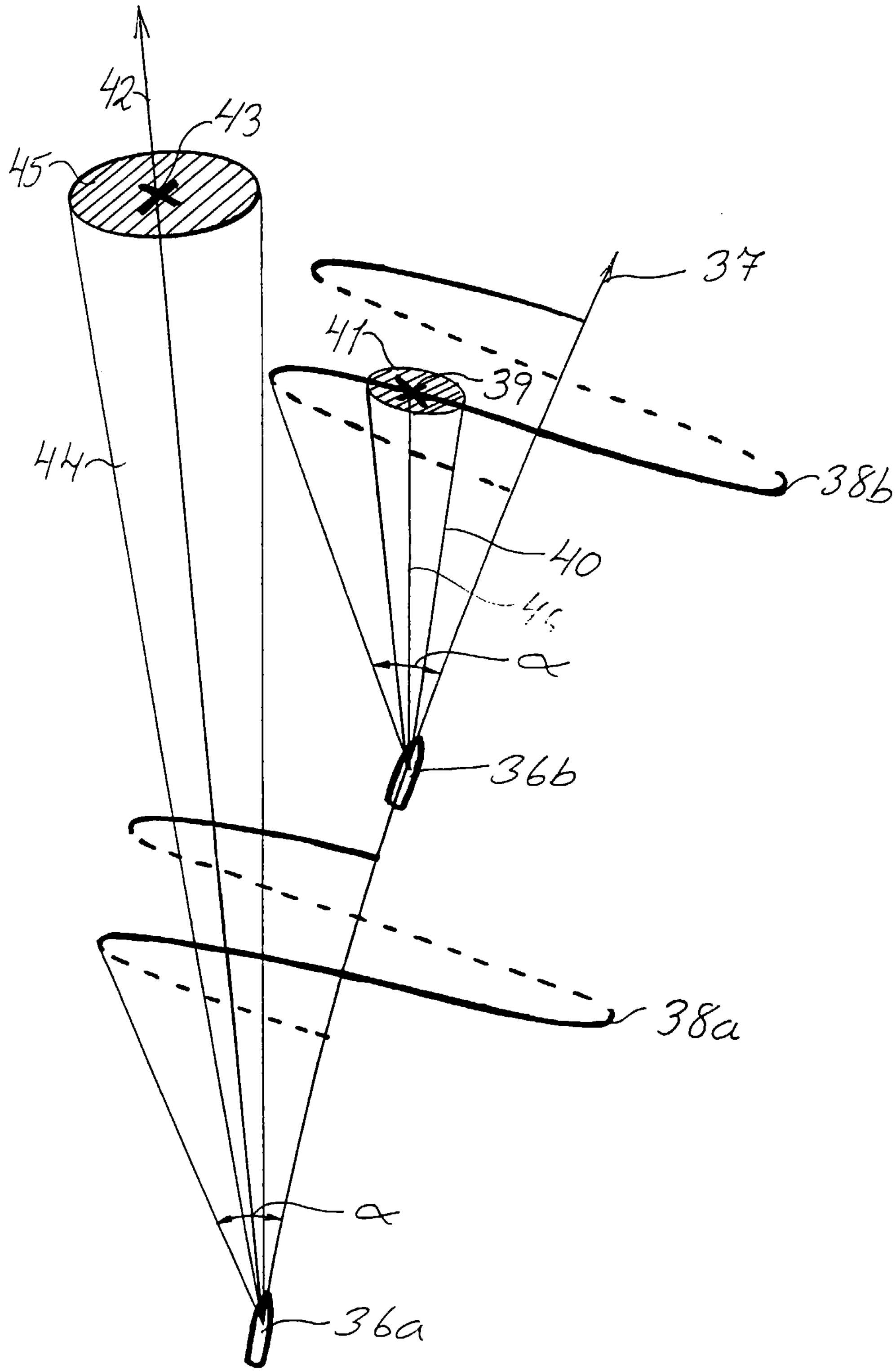

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 96 85 0096

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE 40 11 243 C (DIEHL GMBH & CO) 9 May 1996 * column 3, line 24-55 * * column 4, line 60 - column 5, line 14; figures 1,4 * ---	1,4	F42B1/00 F42B12/22 F42C19/095
A	US 3 731 633 A (DAVIS D) 8 May 1973 * column 4, line 41 - column 5, line 7; figures 6-6E * * column 5, line 41-44 * ---	1,4	
A	FR 2 641 070 A (DIEHL GMBH & CO) 29 June 1990 * page 3, line 7-32; figures 1,2 * ---	1,4	
A	DE 14 53 815 A (MESSERSCHMITT-BÖLKOW-BLOHM GMBH) 6 February 1969 * page 9, paragraph 1-2; figures 3,3A * ---	1,4	
A	DE 25 19 507 A (MESSERSCHMITT BOELKOW BLOHM) 18 November 1976 -----		TECHNICAL FIELDS SEARCHED (Int.Cl.6) F42B F42C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 October 1996	VAN DER PLAS J.

CATEGORY OF CITED DOCUMENTS

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