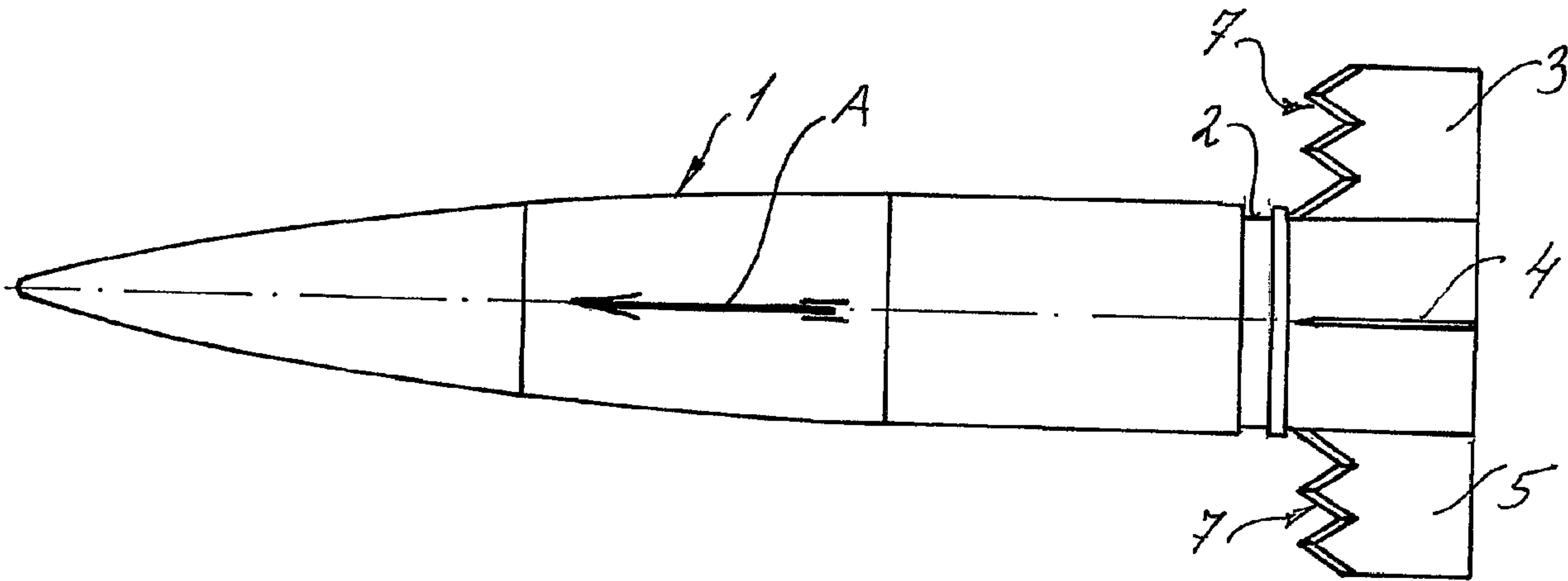




(86) Date de dépôt PCT/PCT Filing Date: 2001/08/24  
 (87) Date publication PCT/PCT Publication Date: 2002/03/14  
 (45) Date de délivrance/Issue Date: 2009/02/10  
 (85) Entrée phase nationale/National Entry: 2003/03/04  
 (86) N° demande PCT/PCT Application No.: SE 2001/001800  
 (87) N° publication PCT/PCT Publication No.: 2002/021069  
 (30) Priorité/Priority: 2000/09/05 (SE0003115-3)

(51) Cl.Int./Int.Cl. *F42B 10/04* (2006.01),  
*F42B 10/14* (2006.01)  
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(54) Titre : PROCÉDE ET SYSTÈME D'EXTENSION DU PARCOURS DE TIR D'UN MISSILE D'ARTILLERIE STABILISÉ PAR AILETTES  
 (54) Title: METHOD AND ARRANGEMENT FOR EXTENDING THE RANGE OF FIRE OF A FIN-STABILIZED ARTILLERY MISSILE



(57) Abrégé/Abstract:

Method and arrangement for extending the range of fire of a fin-stabilized artillery missile. The fin-stabilized artillery missile (1), which is fired in a ballistic trajectory, has fins (3-6), which have been given a sawtooth-shaped leading wing edge (7) that has been found to give the missile (1) an extended range of fire and improved manoeuvrability.

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



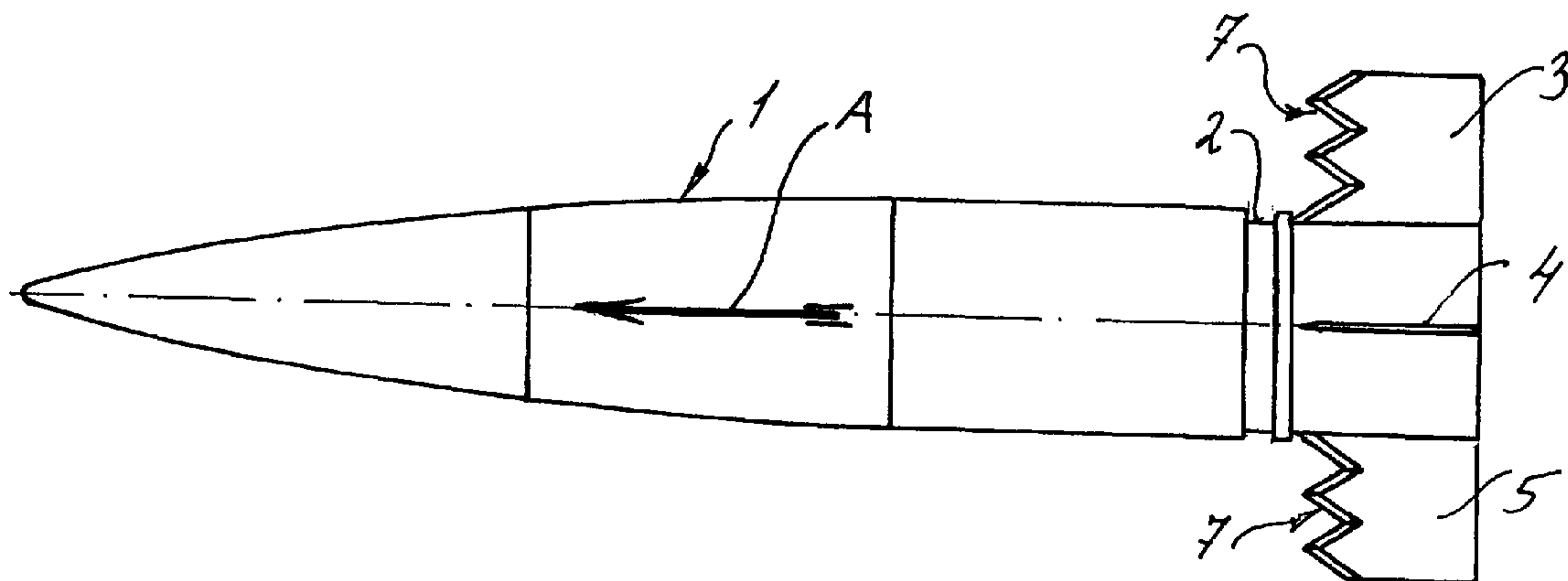
(43) International Publication Date  
14 March 2002 (14.03.2002)

PCT

(10) International Publication Number  
**WO 02/21069 A1**

- (51) International Patent Classification<sup>7</sup>: **F42B 10/04**, 10/14
- (21) International Application Number: PCT/SE01/01800
- (22) International Filing Date: 24 August 2001 (24.08.2001)
- (25) Filing Language: Swedish
- (26) Publication Language: English
- (30) Priority Data:  
0003115-3 5 September 2000 (05.09.2000) SE
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: METHOD AND ARRANGEMENT FOR EXTENDING THE RANGE OF FIRE OF A FIN-STABILIZED ARTILLERY MISSILE



(57) Abstract: Method and arrangement for extending the range of fire of a fin-stabilized artillery missile. The fin-stabilized artillery missile (1), which is fired in a ballistic trajectory, has fins (3-6), which have been given a sawtooth-shaped leading wing edge (7) that has been found to give the missile (1) an extended range of fire and improved manoeuvrability.



WO 02/21069 A1

Method and arrangement for extending the range of fire of a fin-stabilized artillery missile.

5 The present invention relates to a fin-stabilized  
artillery missile which is fired in a ballistic  
trajectory and whose stabilizing fins have been given a  
specific configuration that has been found to give the  
missile an extended range of fire and improved  
10 manoeuvrability.

Artillery missiles fired in ballistic trajectories are  
normally stabilized in their trajectory either by  
rotation stabilization, where the required rotation is  
15 preferably obtained in a rifled barrel, or with the aid  
of suitably adapted fins, where the fins, if the firing  
takes place from the barrel of a gun or howitzer or the  
like, have to be kept retracted during the actual  
firing phase and are deployed only after the missile  
20 has completely exited the barrel. Moreover, if a  
missile intended for fin stabilization of its  
trajectory is to be fired from a rifled barrel, this  
must be done either by the missile being provided with  
a drive band which completely eliminates or to a great  
25 extent limits the rotation which the missile  
experiences on its travel through the barrel, or the  
rotation of the missile has to be decelerated before  
the fins can be deployed unless the fins are also used  
for decelerating the rotation, but extra strong fins  
30 are then needed. In many cases it may also be  
necessary, before deployment of the fins, to decelerate  
the rotation of missiles fired using drive bands.

When correctly configured, fin-stabilized missiles  
35 fired in ballistic trajectories, such as artillery  
shells, can be given good ranges of fire by means of  
the fins contributing with an aerodynamic lifting  
force, which in turn increases the range of fire of the  
missile.

- 2 -

In addition, it is much easier to correct the trajectory of a fin-stabilized shell than that of a rotation-stabilized shell. This reason for choosing to  
5 fin-stabilize artillery shells has become all the more important since great advances in recent years in the field of microelectronics have made it easier to provide artillery shells even of medium calibre with their own homing devices or remote controls which,  
10 coupled with active trajectory correction systems, result in extremely efficient independently guided or remote-control-guided missiles.

The problem which the present invention is intended to  
15 solve is that of making available a novel type of stabilizing fin for fin-stabilized shells, which contributes with the greatest possible lifting force.

The fins of shells fired from barrels must be able to  
20 be retracted during the firing phase and, in their retracted position or for their retracting function, they must not take up too much of the space inside the shell, since this space must be available for the payload. The requirement to the effect that the fins  
25 are to be retractable and take up the least possible space must additionally be combined with the fact that the fins in their retracted positions must be able to withstand the high acceleration stresses to which they and the shell are subjected during firing. Increasing  
30 the lifting force of the fins with, for example, movable leading edge flaps which require many fragile components, is therefore not a solution to the problem.

According to the laws of aerodynamics, the lifting  
35 force of a wing in principle increases in proportion to the wing surface and at a certain limit to the attitude angle (the angle between the wing surface and the velocity vector). This limit is called the stalling angle.

23260-461

- 3 -

In the present case it is not possible, for reasons of space, to increase the surface area. A maximum surface area for a given space is obtained using a rectangular wing shape. However, this wing shape gives a low stalling angle and thus a low maximum lifting force, especially if the wing cannot be made thin, for reasons relating to strength.

A known method for increasing the stalling angle is to have the leading edge of the wing sweep back strongly. In this application, this solution would lead to a considerably reduced wing surface and thus a poorer lifting force. Another known method is to apply so-called strakes in front of the wing. This too is not possible here for reasons of space.

According to a first aspect of the present invention, there is provided a method applied to artillery missiles which are fired in ballistic trajectories from barrels and which are stabilized in their trajectory, after firing, by means of deployable fins, said method being intended to increase the range of the missiles and, in relation to their combined fin area, to improve their manoeuvrability, wherein the leading edges of the fins as viewed in the direction of flight of the missile are given a configuration which deviates from a straight line in their plane and which gives the fins extended leading edges comprising, within each fin, a plurality of subsidiary areas extending forwards in the direction of flight of the missile and separated from each other by empty spaces or recesses.

According to a second aspect of the present invention, there is provided a fin-stabilized missile, such as an artillery shell or the like, which can be fired in a

23260-461

- 3a -

ballistic trajectory from a barrel and whose trajectory is stabilized by said fins, designed in accordance with the method according to the first aspect, in order thereby to obtain an increased range of fire in relation to the launch velocity and an improved manoeuvrability in relation to the combined fin surface area, wherein each of its fins has a leading edge as viewed in the direction of flight of the missile, the length of which leading edge exceeds the straight line between the end points of the fin edge because it has a plurality of parts which extend forwards and are separated by cutouts extending rearwards in the direction of flight.

According to embodiments of the present invention, the leading edges of the fins viewed in the direction of flight of the missile are given a configuration which deviates from the straight line in their plane and which gives the fins extended leading edges, while at the same time the fin area is given subsidiary areas which extend forwards in the direction of flight and are separated by empty spaces or recesses arranged between them and extending rearwards in the direction of flight. The fin thus has a roughly sawtooth-shaped leading edge, and a sawtooth-shaped leading wing edge according to embodiments of the invention gives a very high stalling angle with a minimum reduction in the wing surface area.

We have found that the optimum design of such fins with a sawtooth-shaped leading edge is one in which each tooth or subsidiary area and the empty spaces arranged between them have the same triangular shape. This triangular shape can advantageously be equilateral and the tothing must not be too fine since the advantages are then lost. Although it may be difficult to set

23260-461

- 4 -

absolute limits, we have nevertheless observed that the length of the triangular forwardly extending subsidiary areas ought to lie somewhere between  $1/3$  and  $1/6$  of the full width of the fin. This means that each fin  
5 designed according to the invention will have a plurality of teeth, if the word plurality is, as here, taken to mean at least two teeth.

Also, the fins according to the invention can be  
10 produced from whole metal sheets in which the leading edges of the triangular subsidiary areas have been honed until they are knife-sharp in order to offer the least possible air resistance. In their deployed position during the firing phase, the fin plates can  
15 then be rolled around the missile body and can be covered in a known manner by a removable protective hood.

By taking the fins of older fin-stabilized artillery  
20 shells with straight leading edges and replacing them with the fins described in general terms above with sawtooth-shaped leading edges, we have been able, while keeping the fin surface area unchanged, to extend the range of fire of the shells by 5-8%, and, since we have  
25 at the same time found that it is easier to correct the course of fins with sawtooth-shaped leading edges, we believe that it will therefore be possible to increase their range of fire still further.

30 Examples of embodiments of the invention will now be described in slightly more detail in connection with the attached figures, where

Figure 1 shows a side view of a fin-stabilized  
35 artillery shell, and

Figure 2 shows, on a larger scale, the broad side of an associated fin, while

- 5 -

Figure 3 shows an end view of the fin according to Figure 2.

The shell 1 shown in Figure 1, with direction of flight A, is provided with a band track 2 for a drive band which has been used for firing the shell from the gun or howitzer for which it is intended. Since the figure shows the shell after firing, the band, which by then has fulfilled its task, has left its band track, and the same applies to the hood which during firing is assumed to have covered the retracted fins 3-6 (the fin 6 is concealed in Figure 1). During firing, the fins 3-6 are assumed to have been curved down towards and arranged closely along the periphery of the shell body and to have been covered by the aforementioned hood. The fins 3-6 are also assumed to have been made of a resilient material with such a good storage stability that even after many years in storage they are able to quickly resume their intended shape after firing and as soon as the protective hood has been removed. As will be seen in particular from Figure 2, the various fins have sawtooth-shaped leading edges 7 comprising a number of triangular subsidiary areas 8 which extend forwards in the direction of flight A and which, in the example shown in the figure, have the shape of equilateral triangles separated by similarly equilateral triangular recesses 9. In addition, the leading edges 7 are sharp-edged in order to offer the least possible air resistance.

23260-461

- 6 -

CLAIMS:

1. Method applied to artillery missiles which are fired in ballistic trajectories from barrels and which are stabilized in their trajectory, after firing, by means of  
5 deployable fins, said method being intended to increase the range of the missiles and, in relation to their combined fin area, to improve their manoeuvrability, wherein the leading edges of the fins as viewed in the direction of flight of the missile are given a configuration which deviates from a  
10 straight line in their plane and which gives the fins extended leading edges comprising, within each fin, a plurality of subsidiary areas extending forwards in the direction of flight of the missile and separated from each other by empty spaces or recesses.
- 15 2. Method according to Claim 1, wherein the leading edges of the fins have been given a sawtooth-shaped configuration with a plurality of triangular subsidiary surfaces which extend forwards in the direction of flight and which are separated by cutouts extending rearwards in  
20 the direction of flight of the missile.
3. Fin-stabilized missile, such as an artillery shell or the like, which can be fired in a ballistic trajectory from a barrel and whose trajectory is stabilized by said fins, designed in accordance with the method according to  
25 either of Claim 1 or 2, in order thereby to obtain an increased range of fire in relation to the launch velocity and an improved manoeuvrability in relation to the combined fin surface area, wherein each of its fins has a leading edge as viewed in the direction of flight of the missile,  
30 the length of which leading edge exceeds the straight line between the end points of the fin edge because it has a

23260-461

- 7 -

plurality of parts which extend forwards and are separated by cutouts extending rearwards in the direction of flight.

4. Fin-stabilized missile according to Claim 3, wherein the leading edges of its fins have a sawtooth-shaped configuration comprising a plurality of triangular parts which extend forwards in the intended direction of flight of the missile and are separated by triangular recesses extending rearwards in the direction of flight.

5. Fin-stabilized shell according to Claim 4, wherein each fin is produced from a flat metal sheet in which the sawtooth-shaped triangular parts or leading edges extending forwards in the intended direction of flight of the missile have been honed to give knife-sharp edges in order to offer the least possible air resistance.

6. Fin-stabilized shell according to any one of Claims 3 to 5, wherein each fin, along its edge directed towards the shell body, has a triangular portion extending forwards in the direction of flight of the shell.

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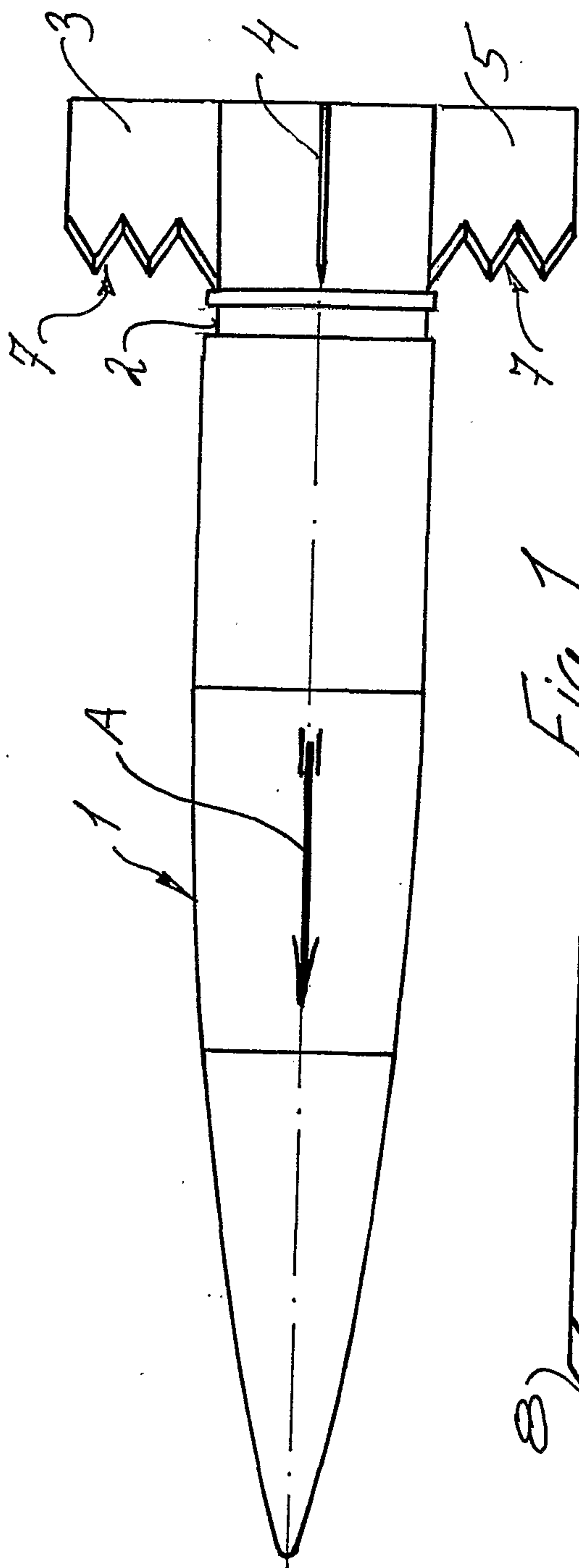


Fig. 1

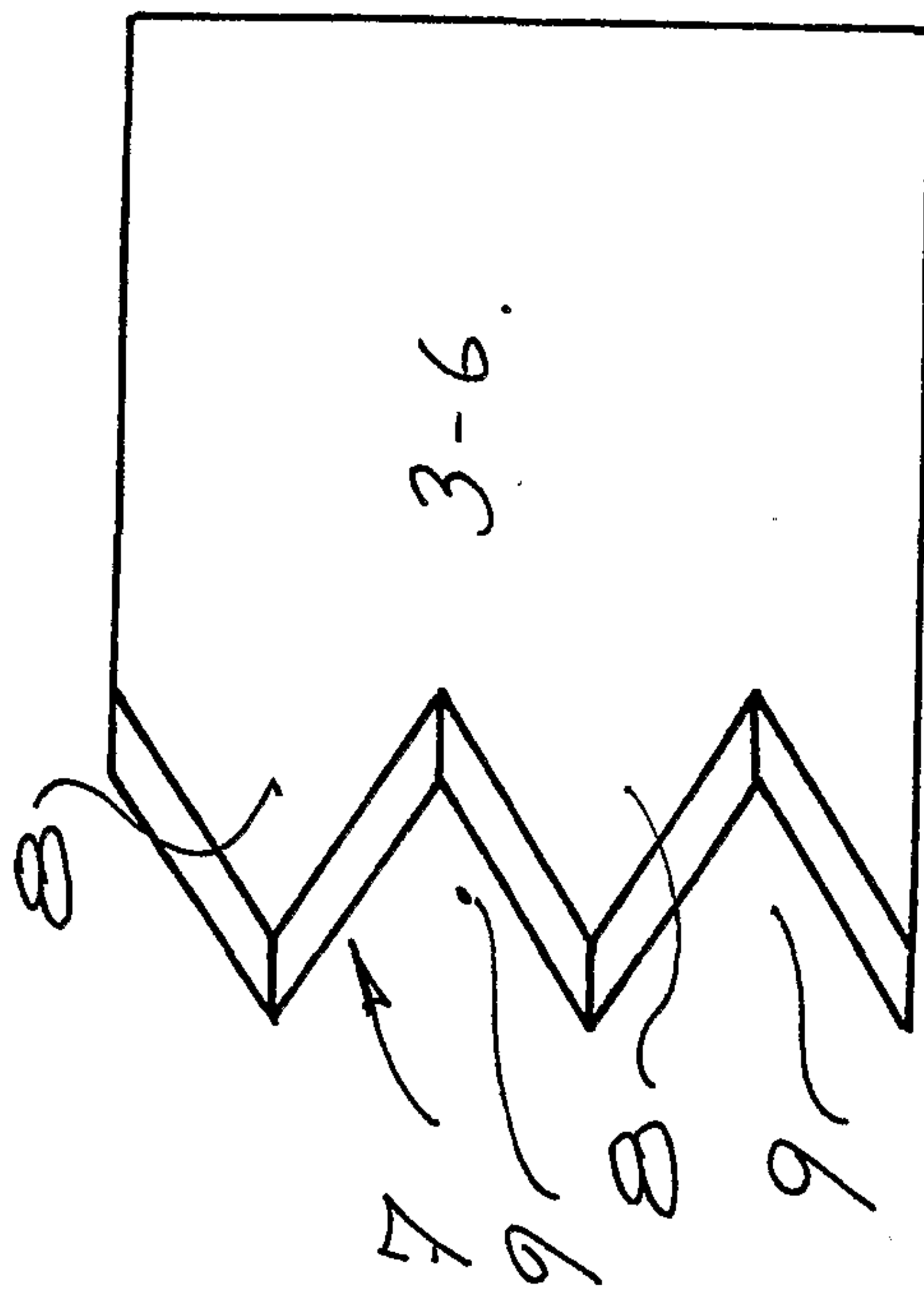


Fig. 2

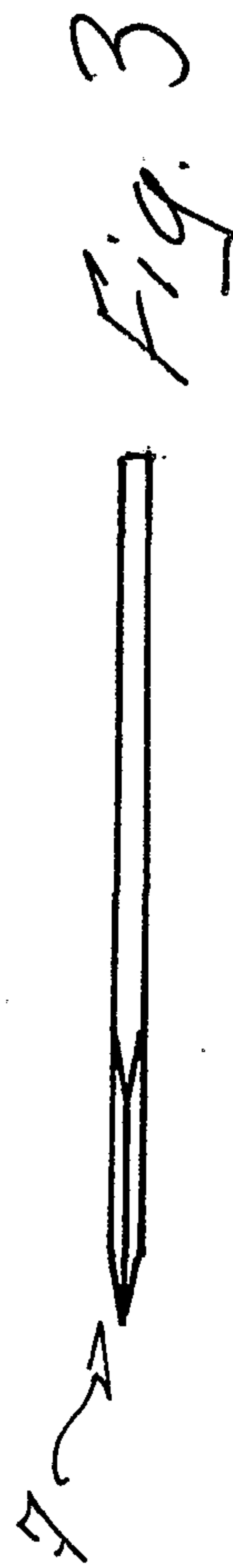


Fig. 3

