United States Patent [11] 3,598,345

[72] Inventor Xaver Suter
Ruschlikon, Switzerland
[21] Appl. No. 758,067
[22] Filed Sept. 6, 1968
[45] Patented Aug. 10, 1971
[73] Assignee Werkzeugmaschinenfabrik Oerlikon-Buhrle AG
Zurich, Switzerland
[32] Priority Sept. 6, 1967
[33] Switzerland
[31] 12471

[54] ROCKET WITH FOLDING FINS AND BRAKING DEVICE
6 Claims, 8 Drawing Figs.

[52] U.S. Cl. 244/3.27, 244/3.28, 244/3.29
[51] Int. Cl. F42b 13/32
[50] Field of Search 244/3.27, 3.28, 3.29

[56] References Cited
UNITED STATES PATENTS

2,793,591	5/1957	Jasse	244/3.29
2,941,764	6/1960	Lee, Jr. et al.	244/3.28 X
2,942,545	6/1960	Fogel et al.	244/3.28 X
3,174,430	3/1965	Apotheloz	244/3.28
3,343,767	9/1967	Cafissi	244/3.27

Primary Examiner—Verlin R. Pendegrass
Attorney—Wenderoth, Lind and Ponack

ABSTRACT: Rocket having a nozzle body with a unit of folding fins arranged around the body. Means are provided for swinging the fins out of a normal position into an operating position. A braking device varies the flight path of said rocket and has swiveling flaps which in the normal position of the fins are located between the fins and the nozzle body in an inactive position. When the rocket is launched the forces that come into action swing the flaps into a braking position. Latch members cooperate with the flaps and are displaced by the fins to release the flaps.

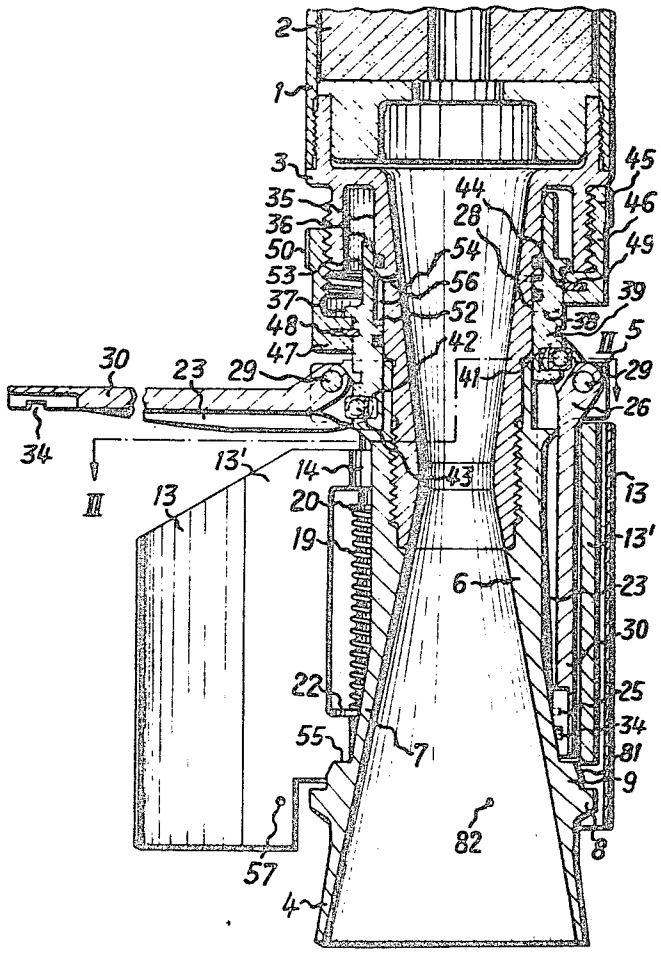
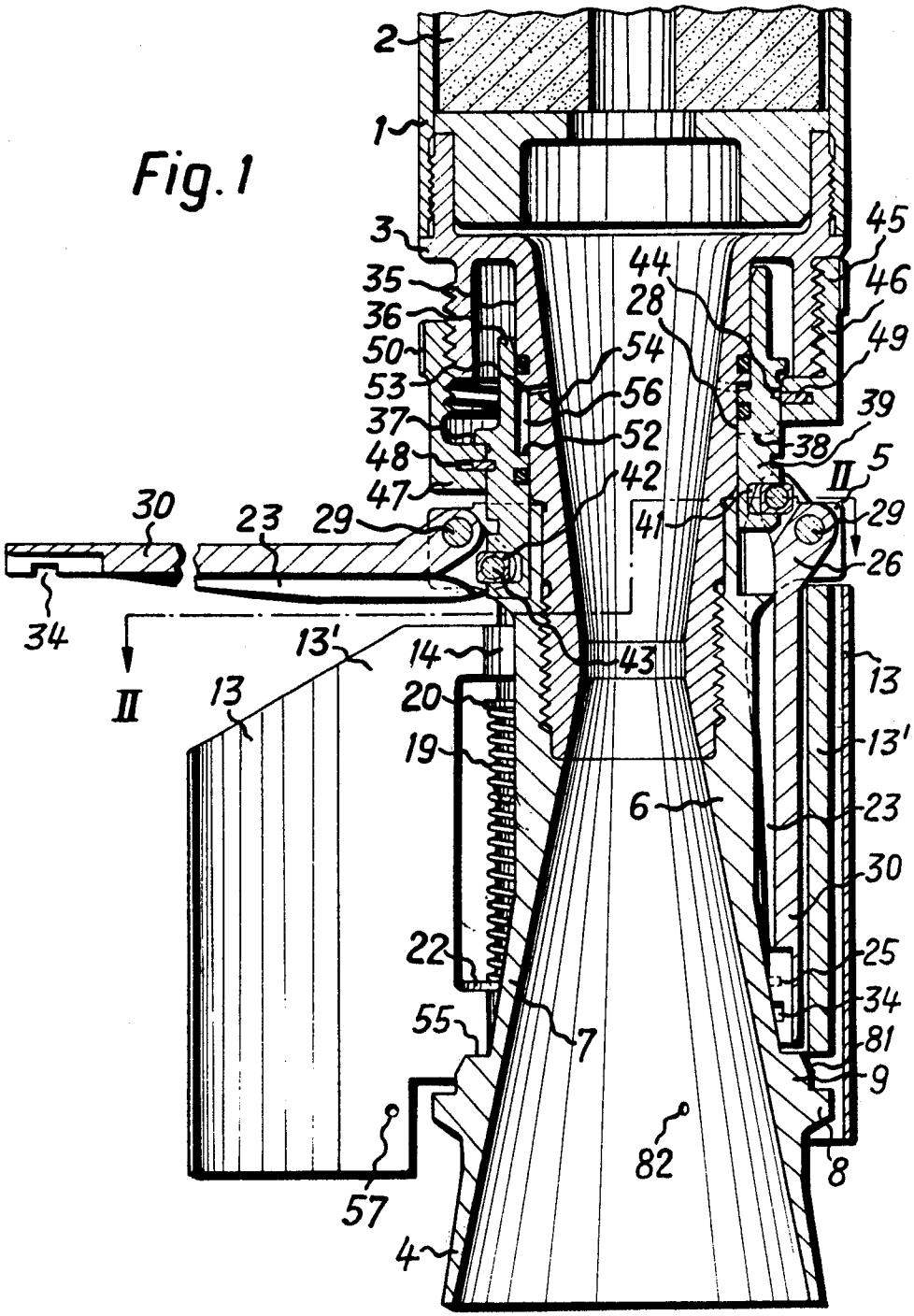


Fig. 1



INVENTOR

XAVER SUTER

By Wenderoth, Lind & Ponack

ATTORNEYS

Fig. 2

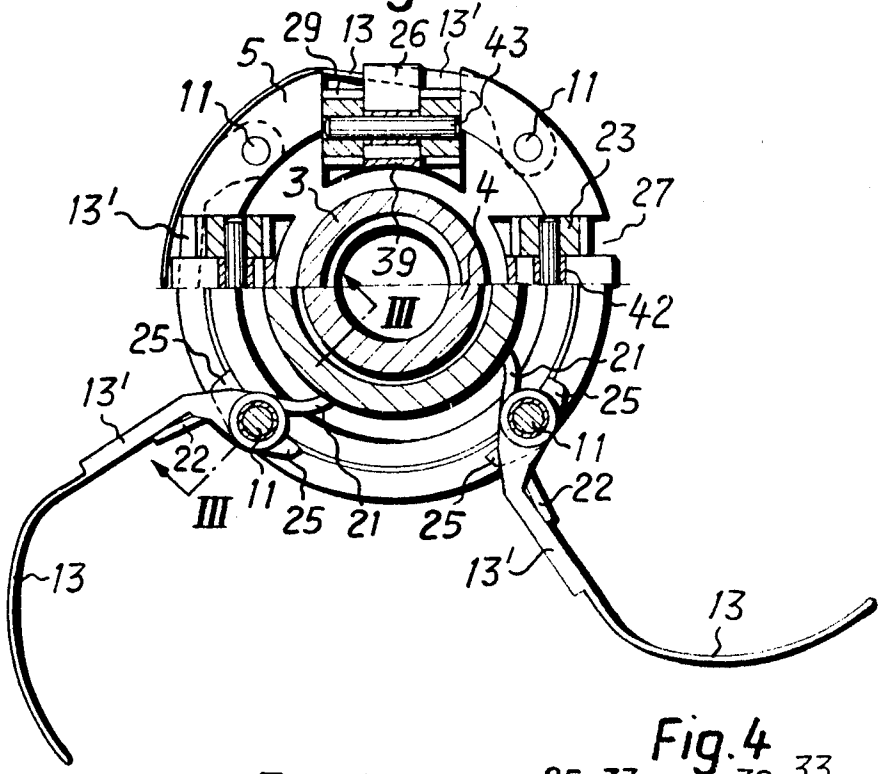


Fig. 3

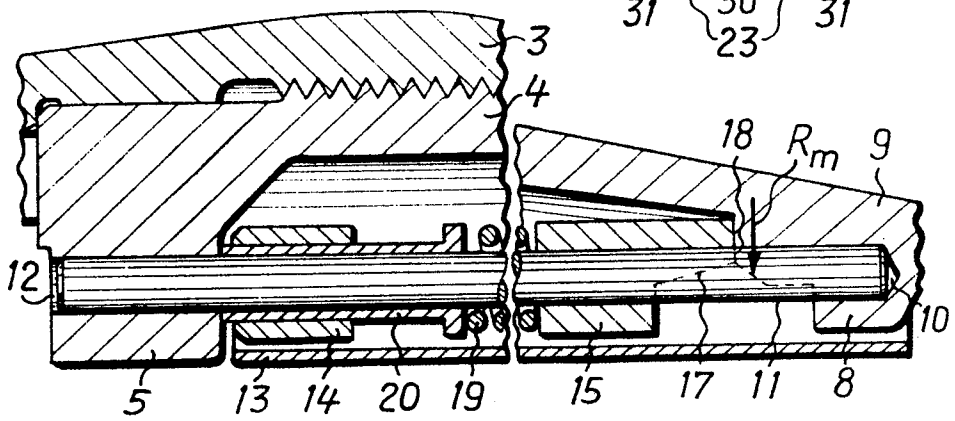
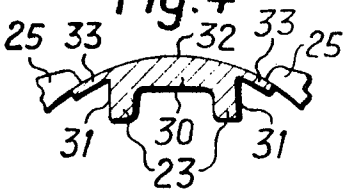


Fig. 4



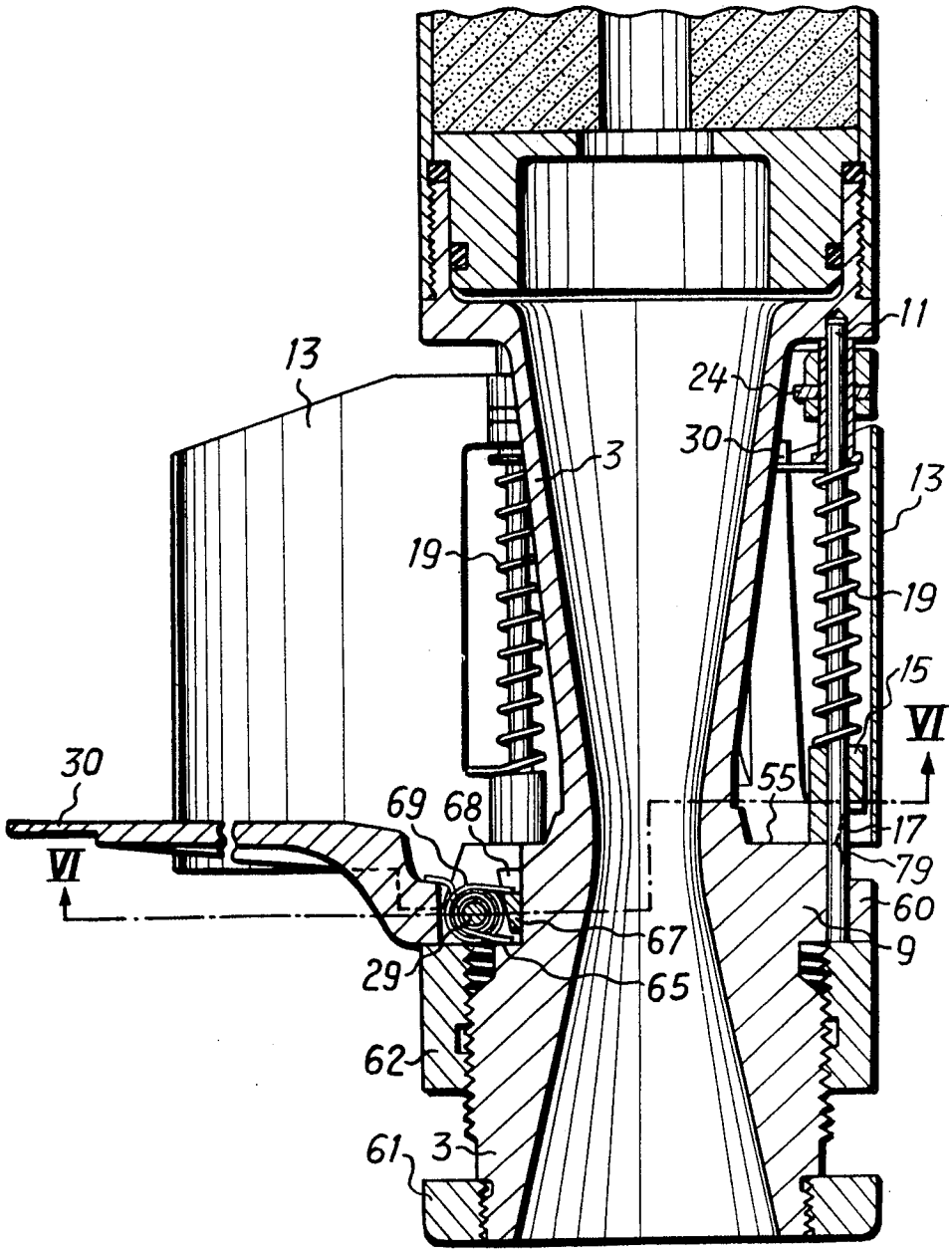
INVENTOR

XAVER SUTER

By Wenderoth, Lind & Ponack

ATTORNEYS

Fig. 5

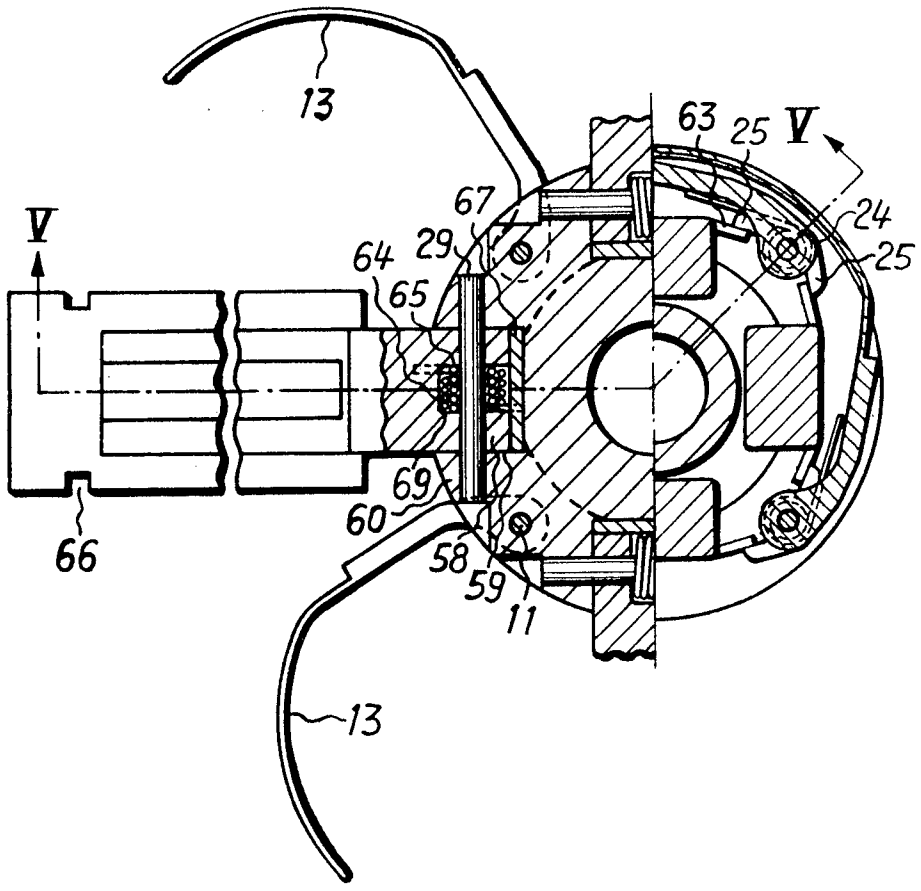


INVENTOR

XAVER SUTER

By Wenderoth, Lind & Ponack
ATTORNEYS

Fig. 6



INVENTOR
XAVER SUTER
By Wenderoth, Lind & Ponack
ATTORNEYS

Fig. 7

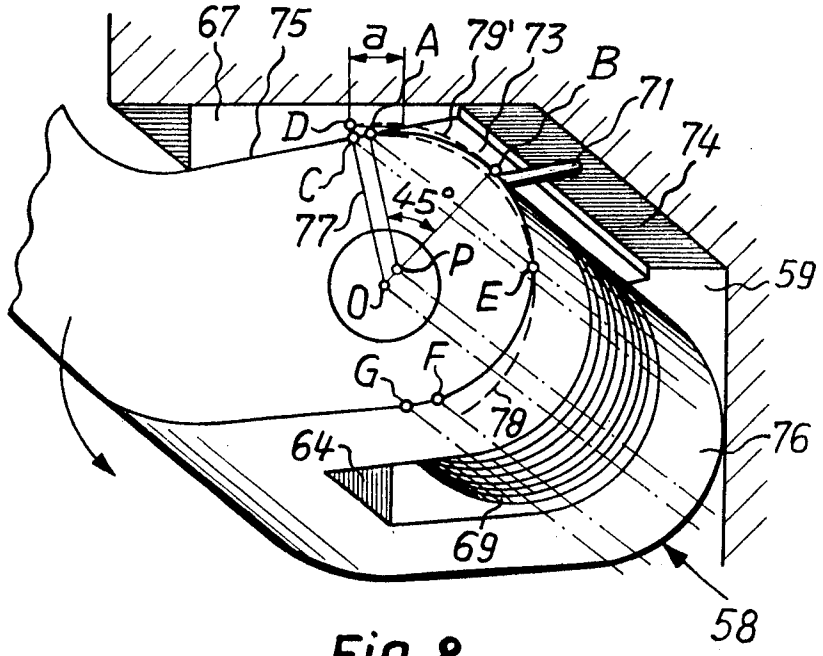
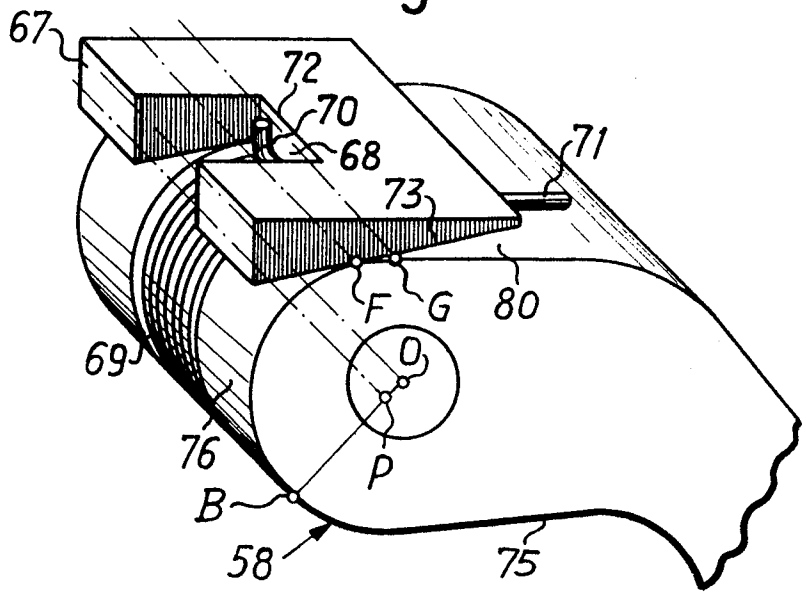


Fig. 8



INVENTOR
XAVER SUTER
By Wenderoth, Lind & Ponack
ATTORNEYS

ROCKET WITH FOLDING FINS AND BRAKING DEVICE

The invention relates to a rocket with a nozzle body around which a unit of folding fins is arranged, of which the fins can be swiveled from a normal position into an operating position having a braking device for changing the flight path of the rocket. A rocket of this type is known in which the brake device for changing the flight path of the rocket consists of a conical brake plate which must be put on to the launcher tube before the rocket is launched. This device has the disadvantage that it cannot be used with automatic rocket launchers in which several rockets are launched in succession, since it is impossible to put the brake plate on the launcher tube at the same rate at which the rockets are launched.

The object of the present invention is to overcome this drawback. The rocket according to the invention is characterized in this that the brake device has swiveling flaps which in the normal position of the folding fins are between the latter and the nozzle body in an inactive position and that forces acting when the rocket is launched swivel the flaps into a braking position. In the case of missiles stabilized by spin it is well known to arrange flaps on swivel axles transversal to the longitudinal axis of the projectile in order to change the flight path of the latter.

Two examples of embodiments of the rocket will now be described with reference to the appended drawings in which:

FIG. 1 shows a longitudinal cross section taken through the center of two flaps according to the first example, wherein the right-hand half shows a folding fin in the normal position and a flap in the inactive position and the left-hand half shows fins and flaps in the swung-up position;

FIG. 2 shows a cross section along line II–II in FIG. 1 which is turned 90° with respect to the latter;

FIG. 3 shows a section along line III–III of FIG. 2 with the fins in the normal position;

FIG. 4 shows a cross section through a flap and the associated holding cams;

FIG. 5 shows an axial longitudinal section according to the second example, wherein in the right-hand half the section is made through the axle of a closed fin and a flap in the inactive position, while in the left half the section is made through the center of a flap and the fin and flap are in the swung-up position;

FIG. 6 shows a section along line VI–VI of FIG. 5, in which fin and flap are shown on the right in the swung-up position and on the left in the inactive position;

FIG. 7 is a diagram of the hub portion of FIG. 5 in its inactive position and

FIG. 8 is a diagram of the hub of FIG. 5 in its active position.

In accordance with FIG. 1 there is a propellent 2 in a housing 1 of a rocket. At the rear end of housing 1 a nozzle body 3 is fixed on which is screwed a conical extension 4 extending backwards. At the front end of the extension 4 is a flange 5 arranged in front of the narrowest cross section of the nozzle body 3 and in one piece with the extension 4. The external diameter of flange 5 is substantially equal to the external diameter of the rocket housing 1. The part 6 of extension 4 attached to said flange 5 at the back has an external cylindrical surface area. The rear portion 7 of extension 4 has a backward-extending, conical external surface area. The extension 4 is extended in front of its rear end to form a flange 8, the front part 9 of which is offset with respect to the rear part and provided with a projection 81 extending conically backwards, the said projection ending in a front surface 55. In the rear flange 8 there are arranged at regular angular distances four boreholes 10 parallel to the axis of the rocket, (one of said holes being shown in FIG. 3) and their axes are at a radial distance from the axis of the rocket which substantially agrees with the middle radius Rm of the conical projection 81 (FIG. 3). Boreholes 12 are arranged in the front flange 5, and these are coaxial with the boreholes 10. Four axles 11 are fixed with one end in each borehole 10 and the other end in each borehole 12.

Each fin 13 carries two hubs 14 and 15. The outer part of the fin is cylindrically bent, while the thicker inside part 13' is straight. As may be seen from the right-hand half of FIG. 1, and from FIG. 2, assuming the left-hand fin 13 to be folded, in the normal position of fin 13 the bent part of such a fin will always overlap the straight part 13' of an adjacent fin. The overlapping fin 13 in the normal position does not then project over the profile of the rocket. In accordance with FIG. 3 the front hub 14 is adapted to slide on a sleeve 20 and is pivoted. Said sleeve 20 and the rear hub 15 are slidably supported on the axle 11. Close to the rear end of each fin 13 said fin has a borehole 57 to take one end of a holding wire. The extension 4 is provided with four equal boreholes 82, each of which takes the other end of a holding wire. The holding wires have thickened portions at their ends and those thickened portions which are inside the extension 4 are adapted to melt under the action of the hot propellent gases.

According to FIG. 3, the hub 15 has at its rear end an abutting surface 17 which is bounded at the back by a stop-face 18 at right angles to the axis of the hub. The surface 17 forms the same angle with the axis of the hub as the generating line of the conical projection 81 forms with the rocket axis; consequently in the swung-out position of fin 13, shown on the left in FIG. 1, the abutting surface 17 can come to rest upon the conical surface 81 as will be described in detail hereinafter.

A spiral spring 19 surrounding the axle 11 on the one hand presses the sleeve 20 against the rear end surface of the flange 5 of extension 4 and on the other hand presses the stop face 18 of hub 15 in the folded position of the fin 13 against the front surface 55 of the conical projection 81. One end 21 of the spring 19 is supported, according to FIG. 2, on the extension 4 and the other end 22 rests on the inside of fin 13. The spring 19 strives to turn the fin 13 anticlockwise around the axle 11, looking in the forward direction.

The hub 15 has two cams 25, which extend in the peripheral direction of the extension 4 and in the normal position of the fin 13 each of these engages on one of two adjacent flaps 30, as shown on the right in FIG. 1.

In accordance with FIG. 2, four grooves 27 are arranged at equal distances on the periphery of the front flange 5. The planes of symmetry of said grooves 27 are in the middle between every two adjacent axles 11 of the fin 13. The bottom of the groove is a part of a cylindrical surface of which the axis coincides with the rocket axis and its diameter with the diameter of the generated surface 28 of the nozzle body 3. Axles 29 are arranged in flange 5 and these axles pass transversely through the grooves 27 and the flaps 30 are pivoted thereon by means of a hub portion 26. The flaps 30 in their inactive position extend backwards between extension 4 and the fins 13.

These flaps 30, according to FIG. 4, have a U-shaped cross section, the legs 23 being provided with plane sidewalls 31, having their edges parallel to the rocket axis. The flaps 30 are supported by these edges on the extension 4. The back 32 of the flaps 30, facing the fin 13 the front edge of which back passes into the hub portion 26, is cylindrically curved and has extensions 33, which are offset from the two legs in the peripheral direction, and have slots 34 near the rear ends.

As shown on the right of FIG. 1, in the inactive position of the flaps 30, the cams 25 of the hubs 15 resting on the axles 11 of fins 13 are in front of the slots 34. As shown in FIG. 4, a cam 25 engages over each extension 33 of each flap 30 and holds the flap in the inactive position.

The nozzle body 3 has two cylindrical generated surfaces 28 and 35 of different diameters. A sleeve 36 is slidably supported on these two surfaces. The sleeve 36 has a flange 37 and four tongues 39 projecting downwards from its rear end surface 38. Each of the tongues 39 projects between the front ends of two legs 23 of a flap 30, which are guided on the lateral surfaces of the grooves 27 of flange 5. The tongues 39 have on their outer side grooves 41 crosswise to the axis of the rocket. In each of said grooves 41 there is a radially displaceable prismatic member 42 which is supported on a bolt 43 fixed

in the ends of the two legs 23 of flap 30. A groove 44 is arranged in the sleeve 36 (and extends over its entire periphery) between the flange 37 and the end surface 38.

The nozzle body 3 has an annular extension 45 concentrically surrounding its front end and threaded on the outside. Screwed on to this thread is an adjusting sleeve 46 having an inwardly projecting flange 47 which forms a stop for flange 37 of sleeve 36. A slotted spring-ring 49, which is pressed by its own tension on the sleeve 36, is arranged in an annular groove 48 cut into flange 47 from the inside. A part 50 of the adjusting sleeve 46 is milled or knurled in order to increase its gripping capacity; but it can also have a gear-tooth system. In the inactive position of the flaps 30 a shoulder 52 connecting the two boreholes of sleeve 36 is at a slight distance from and facing a shoulder 53 of nozzle body 3. Two boreholes 54 passing through the wall of nozzle body 3 open out into the annular space 56 bounded by these two shoulders 52 and 53.

Instead of boreholes 54 axially directed springs can be arranged, which are supported on the one hand on nozzle body 3 and on the other hand on sleeve 36 and exert to slide the sleeve 36 backwards.

The rocket we have described operates in the following manner: Before the rocket is inserted in the launcher tube, according to the desired amount of drag to be generated by the flaps 30, the adjusting sleeve 46 is screwed more or less far backwards from the zero position shown on the right in FIG. 1, for example to the position indicated on the left in FIG. 1. The sleeve 46 is turned by hand on the part 50 in order to do this. It can also be shifted by the cogwheel of an automatic control (not shown in the drawing) provided that the adjusting sleeve, as stated, has a gear-tooth system, in which the cogwheel engages. The rocket is then pushed into the launcher tube, from which it can be launched.

After the ignition of the propellent 2, while the rocket is passing through the launcher tube (not shown) under the thermal effect of the combustion gases of the propellent, the said holding wires which have hitherto held the fins 13 in the normal position, will melt. However, the fins 13 are still held in the folded position by the launcher tube until they come into the operating position, under the action of the springs 19 engaging them, after the rocket has left the tube. During this opening movement the surfaces 18 of the rear fin hubs 15 slide on the front surface 55 of the flange of the extension 4. Just before the operating position is reached, the hub surfaces 18 slide off this front surface 55, so that now the fins 13 are moved back by the axially directed compressive forces of the springs 19 attacking their hubs 15, until the abutting surfaces 17 rest on the conical surface 38 of flange portion 9, thus preventing further swinging of fin 13 beyond the open position.

In this axial movement of the fins 13 the cams 25 are shifted into the range of the slots 34, cut in the extensions 33 of the flaps 30, so that these flaps 30 can now swing up around their axles 29. This swinging up takes place under the action of a force exerted by gases, branching off from the nozzle and passing through the boreholes 54 into the annular space 56, on the shoulder surface 52 of the sleeve 36 (now acting as piston) and thus on the bolts 43 passed into the grooves 41 of their tongues 39. The sleeve 36 can thereupon be moved back until its flange 37 strikes on the flange 47 (of adjusting sleeve 46) acting as a stop. In this final position the sleeve 36 and also the flap 30 coupled therewith, which have now swung into the braking position shown on the left in FIG. 1, are prevented from moving back by the spring-rings 49 jumping into the groove 44 of sleeve 36.

Sleeve 36 can, instead of this, also be moved by the force of said spring loading said sleeve.

In FIGS. 5 to 8 similar parts, or parts exercising the same function as in the first embodiment are designated by the reference numerals used there. The flaps 30 are pivoted around axles 29 which, contrary to the first example, are arranged in the region of the rear part of fin 13. The forked hub-parts 58 (of flap 30) supported on the axles 29 engage in grooves 59 arranged in a flange 60 of nozzle body 3 situated behind the nozzle throat. The front part *a* of flange 60 is offset with respect to the rear portion and provided with a projection 79 extending conically backwards, and ending in a front surface 55 which supports hubs 15 of the fin 13. Between flange 60 and a ring 61 screwed on the rear end of nozzle body 3 there is a thread on which adjusting ring 62 is screwed and can be shifted by turning in the axial direction. The brake action is at the maximum if the flap 30 lie with the surfaces 80 (FIG. 8) of their hub portions in a plane perpendicular to the longitudinal axis of the rocket (FIG. 5) in which the rear surface of flange 60 rests which also forms the stop for adjusting ring 62.

In the normal position of a flap 30 (FIG. 5) the flap extends substantially along the nozzle body 3, which widens in diameter towards the front. The flaps 30 in the normal position are masked by the fins 13, since they are arranged between the axles 11 of said fins. Similarly to the first example, the contiguous edges 63 (FIG. 6) of two adjacent flaps 30 are overlapped by the cams 25 of a bolt 24 arranged in the front hub-portion of a fin 13. The ends of a spiral spring 65, arranged in a slot 64 of the hub-part 58 of a flap 30 and surrounding the axle 29 are supported on the flap and on the nozzle body 3. The spring 65 is exercising its efforts to turn the flap 30 (FIG. 5) anticlockwise, but the flap is held in the inactive position by the locking cams 25. The latter are in front of the slots 66 (FIG. 6) cut in the edges 63 of the flap 30.

A wedge-shaped latch member 67 indicated in FIG. 5 is represented on an enlarged scale together with the hub-portion 58 of a flap 30 in FIGS. 7 and 8. A notch 68 is cut out from the front in said wedge-shaped latch member 67 which tapers from front to back. The end 70 of another spiral spring 69 wound around spring 65 is supported on the surface 72 (bordering on the notch 68) of the latch member 67. The other end 71 of spring 69 rests on the surface 73 (on the outside in relation to the rocket) of latch member 67 and presses same against the bottom 74 of groove 59 in the nozzle body 3. The latch member 67 is pressed backwards through the end 70 of the pretensioned spring 69 so that it is supported with its surface 73 on the surface 75 of the hub portion 58.

In accordance with FIGS. 7 and 8 the rotary axis 0 of a flap 30 does not coincide with the axis P of the cylindrical surface 76, which forms the rounded end of the hub portion 58. The surface 73 of the latch member 67 touches said cylinder 76 along a line A. The two parallel axes O and P, which are at a distance from each other, lie in a plane which, in the inactive position of flap 30 (FIG. 7) intersects the cylinder 76 along the line B and forms an angle of 45° with a plane perpendicular to the axis of the rocket. A plane 77 containing the axis of rotation O intersects the surface 73 of latch member 67 to which it is perpendicular, along a line C.

A cylinder 78 (dotted lines in the drawing) whose axis coincides with the axis O and whose radius is equal to the distance AO, of the axis O from the contact line A, intersects the cylinder 76 along a line E. Another cylinder 79 of radius OB, placed around O, intersects the plane 77 along a line D. As also shown in FIG. 7, the distance of that part of cylinder 76 between A and E from the axis O is greater than the distance of cylinder 78 from the same axis, and the greatest distance between these two cylindrical surfaces 76 and 78 occurs in the plane which contains the axis O and the line B. The cylinder 76 enters the plane area 80 of the hub-portion 58 along a line designated as G. The distance of cylinder 76 from the axis of rotation O decreases steadily from B towards G.

In the position of the hub 58 shown in FIG. 8, where the flap is swung into the active position at 180° to the inactive position, the latch member 67 touches the cylindrical surface 76 of the hub 58 along a line F.

This second embodiment operates in the following manner: The fins 13 are opened by the springs 19. The hub surfaces 17 are supported on the frontal flange portion 9 of the nozzle body 3, whereby the fin 13 is locked. Since the fins 13 are axially displaced when opening, the cams 25 of the locking bolts 24 geared thereto slide over the slots 66 of the flaps 30. The

flaps **30** are thereby released and swung by the springs **65** around the axles **29** into the operating position in which, as shown in FIG. **5**, they are supported on the adjusting ring **62**.

The entire radius of action of the flaps **30** determined by the limiting positions of the adjusting ring **62**, is limited by their position, shown on the left in FIG. **5**, and also by a position (not shown) fully hinged back at 180° with respect to the inactive position. Contrary to the first example, in this case the radius of action of the flaps **30** is shifted to the rear region of fins **13**, which is an advantage insofar as the stabilizing effect of the fins cannot be undesirably affected by the stream around the flaps. Another advantage is the fact that the aerodynamic braking forces, which also have a stabilizing effect on the rocket, in this case act upon a greater lever arm with respect to the center of gravity of the rocket.

When a flap **30** is swung out of the inactive position into the operating position shown in FIG. **5**, then, according to FIG. **7**, the section of cylinder **76** between lines A and B comes first of all in contact with latch member **67**. Since the line B is at a distance from the axis of rotation O which is greater by the distance between line D and line C than the distance of line C from said axis O, the latch member **67** will be thrust forward, against the pressure exerted by the end **70** of spring **69**, along the surface **74** of the nozzle body **3**. If the line B of cylinder **76** has reached the plane **77**, the latch member **67** has travelled a path *a* and reached its foremost position. When the flap **30** is swung on beyond the line B towards line G, the latch member **67** is thrust back, since the distance of the part of cylinder **76**, how passing in front of it, from the axis of rotation O is continuously decreasing, so that it remains in contact with the hub portion **58**.

Under the action of spring **65** and under the action of an aerodynamic force increasing as the angle of traverse increases and finally under the action of an inertia force which attacks the flap **30** during the phase of acceleration, the flap **30** strikes the adjusting ring **62** at relatively high speed and is rejected by said ring. This rebound movement is powerfully damped by a high frictional force which appears because the latch member **67** is now clamped between the surface **74** and the region of the hub **58** situated between line B and line G. The path travelled by the flap **30** when rebounding from the adjusting ring **62** is therefore short, so that after a return movement under the action of spring **65** and the aerodynamic force, it rebounds from adjusting ring **62**, but now with so little energy that it is immediately stopped and held in the operating position under the action of said frictional force.

By reason of the development of the hub part **58** of a flap **30**, the latch member **67** of course also acts in the same way in any other predetermined operating position of the flap.

In the case of rockets which perform a twisting movement, centrifugal forces act upon the flaps **30**. These forces are exerted to turn the flaps, which are in the operating position, in the opposite direction to the aerodynamic forces, i.e. clockwise (see FIG. **8**). The latch members **67** now prevent the flaps **30** from being turned away from the adjusting ring by the centrifugal forces when the speed of the rocket decreases and therefore the aerodynamic forces become less.

I claim:

1. Rocket comprising a nozzle body, folding find arranged around said body, axles for said fins on said nozzle body parallel to the rocket axis, means for swinging said fins from a folded position alongside said nozzle body into an operating position extended from said body, a braking device on said body to vary the flight path of said rocket comprising swiveling flaps which in said folded position of said fins are located between said fins and said nozzle body in an inactive position and means operative when the rocket is launched swinging said flaps into a braking position extended from said body.

2. Rocket according to claim **1** wherein latch members are provided for said flaps supported on said axles for said fins and said latch members are displaced by said fins to release said flaps.

3. Rocket according to claim **2** wherein said fins are brought by a swiveling movement and a displacement in the axial direction out of said folded position into said operating position and said flaps have slots into which said latch members engage upon axial displacement of said fins to release said flaps.

4. Rocket according to claim **1** wherein axles for said flaps are provided on said nozzle body arranged adjacent the rear ends of said fins in a plane perpendicular to the rocket axis and said flaps in inactive position rest on said nozzle body in front of said axles of said flaps.

5. Rocket according to claim **4** wherein said flap axles are arranged on said nozzle body adjacent the front ends of said fins in a plane perpendicular to the rocket axis and said flaps in the inactive position lie behind said flap axles on said nozzle body.

6. Rocket according to claim **1** wherein the braking position of said flaps is in a region bounded by the position in which said flaps are in a plane perpendicular to the rocket axis and by the position in which said flaps are pointing backwards approximately parallel to the rocket axis.