

A WING SWINGABLE OUTWARDLY FROM A FLYING BODY

This invention relates to a spreadable wing which can be swung outwardly from a flying body. There is described herein such a wing which has a nose spar which is swivellable with its one end portion about a bearing axis provided on the flying body and a driving mechanism, provided with an energy (force) store, for swinging open or unfolding the nose spar about the associated bearing axis.

Such a flying body is e.g. a rocket which can be launched from a launching tube or a projectile to be fired from a weapon barrel, in which respect the flying body is provided with a number of spreadable wings which can be swung outwardly and which in their rest or storage position butt against the flying body, and which, only after leaving the launching tube (or weapon barrel) are swung away from the flying body and spread, in order to achieve stabilisation of the flight path of the flying body.

A flying body having wings which can be swung outwardly has been proposed in which the driving mechanism, provided with an energy store, for swinging open the/each wing has a pressure-gas container, which is fluidly connected by means of a pipeline to an inflatable body. Indeed, the inflatable body can, in the inactive rest position, be accommodated in a space-saving manner in the interior of the flying body, but the pressure-gas container cannot. The pressure-gas container needs a space requirement which cannot be disregarded, and this reduces the pay-load (useful-load) ratio of the flying body. Taking into account the fact that the inflatable body, in the activated state of the flying body, also has

a specific space requirement (which needs to be present initially) the result is a further reduction in the payload ratio of such a flying body.

5 A submunition flying body has also been proposed having deployable wings which are fastened thereto so as to be able to be swung out of grooves extending approximately parallel to the longitudinal axis of the flying body. The grooves are designed for the reception,
10 in each case, of a swung-in gliding wing (without engagement into the body) in extensions which jut out from the jacket surface of the flying body. Such a design is useful when several submunition flying bodies are accommodated in a submunition carrier, because it is
15 then possible to utilise the dead space, afforded between the submunition flying bodies and the submunition carrier, which space can be occupied by the extensions which jut out from the flying body and in which the wings are accommodated in the swung-in state. As a result of
20 the extensions in which the wings of the flying body are accommodated when swung in, such a flying body is not suitable for, or intended for, being launched separately from a launching tube in the manner of a rocket or being fired separately as a projectile from a weapon barrel.

25 An aim of the present invention is to provide a spreadable wing, which can be swung outwardly from a flying body, which has only a relatively small space requirement for the structural parts which are intended
30 for spreading the wing and which are connected to a driving mechanism having an energy store.

 According to the present invention there is provided on a flying-body, a wing which can be opened or spread
35 out, by means of a torque about a bearing axis of a front end portion of a nose spar, from a swung-in position approximately parallel to the flying body and in which

the flying body has a base spar which is arranged so as to be displaceable parallel to the flying body and which in the region of a front portion thereof, on introduction of a torque about the nose-spar bearing axis, is in operative communication with the nose spar, by way of an engagement extension on the front base-spar portion and an engagement recess on the front nose-spar portion, and in which the base spar by reason of its longitudinal displacement also tautens the wing surface. In contrast to spreadable wings which have a nose spar, a rear spar and a root or base spar which are designed with one another as a hinged triangle which can be variable in surface-area (and which are covered over with a covering-fabric skin), the root or base spar is operatively connected to the nose spar, and in accordance with the present invention the base spar is used for swinging open the nose spar. Since the base spar extends in the longitudinal direction of the flying body, only a relatively low space requirement is necessary for the base spar, so that a design of spreadable wing which can be swung outwardly from the flying body and which hardly impairs the pay-load ratio of the flying body is realisable.

In the case of a wing having a rear spar which is connected swingably by its one end portion to the second end portion of the nose spar, remote from the bearing axis of the nose spar, and having a wing covering which in the swung-open state spans the nose spar as far as the rear spar, it has proved to be advantageous if the base spar is connected swingably by its second end portion (remote from the bearing axis of the nose spar) to the second end portion of the rear spar, and if the rear spar has two spar elements which are connected hingedly to one another. The second end portion of the rear spar is, thus, not arranged so as to be displaceable along the base spar in order to form a hinged triangle which is

variable in its surface area, but the second end portions of the base spar and of the rear spar are connected hingedly to one another. By way of this hinged connection the result is, in contrast to a displaceable arrangement of these two spar portions, a reduction in the friction between these end portions, so that for the erection, i.e. spreading of the wing, a driving mechanism with a comparatively smaller energy store is sufficient in order to swing the wing outwardly from the flying body and to spread it. In this way the pay-load ratio of the flying body may be further improved.

The first end portion of the base spar and the first end portion of the nose spar are, in the case of a wing of the last described type (i.e. in the case of a wing having a nose spar, a rear spar, a base or root spar and a covering spanning these parts) preferably designed with engagement elements which, until achieving the swung-open end angular position of the nose spar, are in operative connection with one another for swinging open the nose spar; and in the swung-open end position of the nose spar the two spar elements of the rear spar form a rigid element and the operative connection between the nose spar and the base spar is cancelled (disabled). For stiffening or locking the two spar elements of the rear spar in the swung-open angular end position between the nose spar and the base spar or the flying body a stop can be provided on each of the two spar elements. Additionally or alternatively, the hinged connection between the two spar elements may be provided with a spring element assisting the stiffening/locking. In the position in which the two spar elements of the rear spar form a rigid element, the two spar elements are, preferably, held in alignment with one another.

In the case of the last described design of the wing, it has proved to be particularly advantageous if the base spar (for retautening the covering) is displaceable by means of the energy store from the position cancelling the operative connection between the nose spar and the base spar into an end position further spaced from the bearing axis of the nose spar. In this way, it is possible in a simple manner to retauten the covering provided between the nose spar and the rear

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spar, in order, thereby, to realise a further improved stabilisation behaviour of the flying body equipped with such wings.

5 Another design of the wing in accordance with the present invention has at least one lamella element which is parallel to the nose spar in any angular position, in which respect the/each lamella element can be swung open about an associated bearing axis (aligned parallel to the
10 bearing axis of the nose spar), simultaneously with the nose spar into an end position in which the nose spar and the at least one lamella element form the spread wing; and in the wing the bearing axis of the at least one lamella element is provided on the base spar, which is
15 linearly displaceable by means of the energy store between a swung-in basic closed position, a second position establishing the operative connection between the base spar and the nose spar and an end position (in which the nose spar and the at least one lamella element
20 assume (occupy) with respect to the flying body their swung-open angular end position). For stabilisation of the wing in the swung-open end position, swingable on the second end portion of the nose spar, remote from the bearing axis, is an elongate stabilisation element which
25 on a second end portion of the/each lamella element and remote from the associated bearing axis of the lamella element, extends between abutment elements fashioned on the associated lamella element. In the case of such a wing, the wing surface is, thus, not determined by a
30 covering spread between the nose spar and the rear spar of the wing, but is determined by the nose spar and the at least one lamella element aligned at any time at least approximately parallel to the nose spar. Also, in the case of such a spreadable wing which has at least one
35 lamella element and which can be swung outwardly from a flying body there emerges, as a result of the linearly displaceable base spar, a space-saving drive for the

spreadable wing. The erection procedure of the wing begins only in the second position establishing the operative connection between the base spar and the nose spar, in which respect the distance travelled between the basic closed position of the base spar and this second position of the base spar is relatively small and could be in the order of magnitude of a few millimetres. As a result of this relatively small distance travelled between the basic closed position and the second position of the base spar the result is, upon an activation of the force element of the driving mechanism for the base spar, a quasi sudden commencement of the opening-up procedure of the wing. The distance of travel of the base spar between its second position and its end position is greater than the distance travelled between the basic closed position and the second position of the base spar, in which respect the distance between the second position and the end position of the base spar is more especially dependent upon the angular end position between the nose spar and the at least one lamella element and the base spar or the longitudinal axis of the flying body. In the case of such a wing which has at least one lamella element, the base spar remains in operative connection with the nose spar in the angular end position. In this way the result is an exactly fixed angular position of the swung-open wing. The stability of the swung-open wing or of its wing profile is ensured in a simple manner by the elongate stabilisation element.

The base spar of a wing of the last-mentioned type can be designed on its first end portion adjacent to the bearing axis of the nose spar with its engagement element and the nose spar can be designed on its first end portion with a second engagement element, which in the second position of the base spar pass into operative connection with one another. As has already been mentioned, the engagement elements remain, from the

second position of the base spar as far as its end position, in operative connection with one another. These engagement elements may comprise an extension provided on the base spar and a recess formed on the nose spar, into which recess the extension jutting out from the base spar engages in order to establish the operative connection between the base spar and the nose spar.

It has proved to be advantageous if a locking mechanism which is effective both in the rest position or storage position (basic closed position) and in the end position of the base spar, in the case of which the wing is swung open, is provided between the flying body and the base spar. The locking mechanism may be biased by means of a spring element and be provided with a shear pin, which is engaged into a recess provided on the base spar when the elements of the wing which can be swung out (i.e. when the base spar, the nose spar and the at least one lamella element) are disposed in the swung-together basic closed position. Upon the initiation of the swinging-open movement of the wing, which is effected by the force element of the driving mechanism, the shear pin provided on the locking mechanism is sheared off, whilst the base spar moves from the basic position freely as far as the second position, in which the operative connection between the base spar and the nose spar is adopted. Since (until the second position is reached) the base spar can thus carry out a free movement which is not impaired by the erection of the wing, a problem-free shearing-off of the shear pin with relatively low expenditure of energy is possible.

The/each lamella has, preferably, on its reverse side remote from the nose spar two abutment elements which are spaced apart from one another and between which the elongate stabilisation element extends. In this way, a comparatively simple design of the lamella element

results and a simple arrangement of the elongate stabilisation element for the secure stabilisation of the entire wing in the swung-open angular end position may be provided.

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During erection of the wing there is accordingly effected the entrainment of the lamella elements by the elongate stabilisation element extending between the abutment elements of the lamella elements. The two most important components of a wing of the last mentioned type are, thus, the linearly movable base spar and the elongate stabilisation element, which in the erected wing state forms a rigid trailing edge of the wing.

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Further according to the present invention there is provided on a flying body, a spreadable wing which can be swung outwardly from the flying body and which has a nose spar which can be swivelled with one end portion about a bearing axis provided on the flying body, and a driving mechanism, provided with an energy store, for swinging open the nose spar about said bearing axis, and in which on the flying body a base spar of the wing is arranged with a first end portion in the neighbourhood of said bearing axis and is aligned at least approximately parallel to the longitudinal axis of the flying body, said base spar being arranged so as to be displaceable in its longitudinal direction and, for swinging open the nose spar, being operatively connectable or operatively connected to the energy store and to the nose spar by way of an engagement extension on one of the first end portion and said one end portion and an engagement recess on the other of said first end portion and said one end portion of the nose spar, said wing having a covering which is tautened by the movement of the base spar.

Further details, features and advantages will become apparent from the following description of two exemplified embodiments of a wing on a flying body in accordance with the present invention, which embodiments are shown, by way of example only, diagrammatically in the FIGURES of the accompanying drawings in which:-

FIGURE 1 shows a first embodiment of the wing in the swung-together basic closed position, and which can be swung open;

FIGURE 2 shows a wing in accordance with FIGURE 1 but in the swung open position, in which the nose spar occupies, with respect to the base spar, its angular end position and the rear spar having two spar elements forming a rigid element;

FIGURE 3 shows the wing in accordance with FIGURES 1 and 2 in the retautening position of the base spar and of the rear spar, in which the covering (not shown) which spans the nose spar and the rear spar is retautened;

FIGURES 4 to 7 and 7a show various angular positions of the nose spar and of the two spar elements of the rear spar with respect to the linearly moving base spar during the swinging-open of the wing from the basic position shown in FIGURE 1 to the angular end position, shown in FIGURE 2, of the nose spar;

FIGURE 8 shows an enlarged representation of the detail VIII in FIGURE 1;

FIGURE 9 shows an enlarged representation of the detail IX in FIGURE 2;

FIGURE 10 shows an enlarged representation of the detail X in FIGURE 1;

FIGURE 11 shows an enlarged representation of the detail XI in FIGURE 2;

FIGURE 12 shows the second embodiment of the wing in the swung-together basic closed position; and

FIGURE 13 shows the wing in accordance with FIGURE 12 in the swung-open angular end position.

FIGURES 1 to 12 show a first embodiment of a spreadable wing 10 which can be swung outwardly from a flying body (not shown) and which has a nose spar 12, a base spar 14 and a rear spar 16. The nose spar 12 has a first end portion 18 and a second end portion 20, the base spar 14 has a first end portion 22 and a second end portion 24, and the rear spar 16 has a first spar element 26 and a second spar element 28. Through the first end portion 18 of the nose spar 12 there extends a bearing axis 30, about which the nose spar 12 can be swivelled from the basic position shown in FIGURE 1 into the angular end position shown in FIGURE 2. In the angular

end position of the nose spar 12 the two spar elements 26 and 28, which are connected hingedly to one another by means of a hinge 32, are held in alignment with one another and form a rigid element for the stabilisation of the trailing edge of the wing. The first spar element 26 of the rear spar 16 is connected hingedly to the second end portion 20 of the nose spar 10, for which purpose a hinge axis 34 is provided between these component parts. The second spar element 28 is connected hingedly to the second end portion 24 of the base spar 14, for which purpose a hinge connection 36 is provided between the last-mentioned components.

The first end portion 18 of the nose spar 12 and the first end portion 22 of the base spar 14 are provided with engagement elements 38, 40, in which respect the engagement element 38 - as is clearly apparent from FIGURE 9 - is provided with a recess on the first end portion 18 of the nose spar 12, whilst the second engagement element 40 is designed as an extension projecting out from the base spar 14.

The two engagement elements 38 and 40 are held in operative connection with one another from the basic position of the wing 10, (shown in FIGURE 1) as far as the angular end position (shown in FIGURE 2) of the nose spar 12, and in this angular end position of the nose spar 12 the two spar elements 26 and 28 of the rear spar 16 result in a rigid element forming the trailing edge of the wing. The erection of the nose spar or of the wing 10 is effected by a linear movement of the base spar 14 from the basic position shown in FIGURE 8 along the arrow designated with number 42 in FIGURE 8 as far as the second position, made clear in FIGURE 9, of the base spar 14. In this second position of the base spar 14, the operative connection between the two engagement elements 38 and 40 is cancelled or disabled as is clearly apparent

from FIGURE 9, so that, immediately after movement to this second position of the base spar 14, it is possible to move the base spar by a small amount (as is shown in FIGURE 3) from the engagement element 38 in the direction of the arrow 42 (see FIGURE 8) further away from the bearing axis 30 and linearly into an end position shown in FIGURE 3. In this end position the rear spar 16 (which forms a rigid element) makes a small swivel movement about the hinge axis 34 in the anticlockwise direction, upon which the covering (not shown) provided between the nose spar 12 and the rear spar 16 is retautened.

FIGURE 11 shows, in a partially sectioned representation, a design of the hinge 32 between the first and the second spar element 26,28 which includes a spring element 44. The spring element 44 is mechanically biased at any time, i.e. both in the basic position shown in FIGURE 1 and in the spread position shown in FIGURES 2 or 3. The spring element 44 may be, for example, a (helical) compression spring.

In FIGURES 1 to 12 the same component parts are in each case designated with the same reference numbers, so that it is not necessary, in connection with all the individual FIGURES, to describe in each case all these component parts once again in detail.

A second embodiment of the wing which can be swung open is shown in FIGURES 12 and 13. This embodiment of the wing 10 has a nose spar 12, a base spar 14 and a number of lamella elements 46, in which respect the lamella elements 46 are aligned at least approximately parallel to the nose spar 12 in any angular position, i.e. the erection position of the wing 10 to the nose spar 12. The nose spar 12 is swivellable about a bearing axis 30 which is provided on the flying body 48 which is

indicated in sectors. The bearing axis 30 extends through the first end portion 18 of the nose spar 12. An elongate stabilisation element 50 is held hingedly on the second end portion 20 of the nose spar 12, for which purpose a bearing axis 52 is provided. Each lamella element 46 is arranged so as to be swingable by means of an associated bearing axis 54 on the base spar 14. The lamella elements 46 are, on their reverse side 56 remote from the nose spar 12, designed with two abutment elements 58 and 60, between which the elongate stabilisation element 50 extends.

Also, in the case of this design of the wing 10, the nose spar 12 is designed with an engagement element 38 and the base spar 14 is designed with an engagement element 40, which are operatively connectable to one another.

In FIGURE 12 the wing 10 is shown in its swung-together (swung-in) basic position, in which the engagement elements 38 and 40 have a small spacing d from one another. Within this spacing d the base spar 14 can move quasi-freely in the direction of the arrow 42, without leading to erection of the nose spar 12 and the lamella elements 46. During the movement along the small distance d shear pin 67 (see in particular FIGURE 12) is sheared off; pin 67 is provided on a locking mechanism 64, and in the basic position of the wing 10, shown in FIGURE 12, pin 67 is engaged into a detent recess 66 on an extension part 68 of the base spar 14. The locking mechanism 64 is mechanically biased by means of a spring element 70, so that the locking mechanism 64 butts with a conical abutment portion 72 against a frontal inclined plane 74 of the extension part 68 of the base spar 14 when (with the aid of the base spar 14 or respectively of the engagement elements 38 and 40) the nose spar 12 and, thus, simultaneously, the lamella elements 46 are swung

into their angular end position outwardly from the flying body 48, as is clearly apparent more especially in FIGURE 13. With the aid of the locking mechanism 64 there thus results a secure restraint of the wing 10 in the swung-out position. For this purpose, the first end portion 18 of the nose spar 12 is designed with an abutment portion which butts tightly against a counter-abutment of the flying body 48 in the angular end position.

10 For the avoidance of doubt the term "flying body" is not meant to refer to a body actually in motion.

Further according to the present invention there is provided on a flying body at least one wing or fin which can be swung from a closed position to an open position, in order to stabilise the body in flight, said wing or fin having a nose spar and a base spar and said base spar being displaceable along its axis relative to the flying body, to swing the nose spar outwardly from the body whilst being in operative connection with the nose spar and, preferably with a driving mechanism for swinging open the nose spar, said base spar being displaceable to a further position in which the operative connection with the nose spar is disabled, in order to tauten a covering of the wing or fin, said wing preferably comprising a rear spar consisting of two spar elements hinged to one another.

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CLAIMS

1. On a flying-body, a wing which can be opened or spread out, by means of a torque about a bearing axis of
5 a front end portion of a nose spar, from a swung-in position approximately parallel to the flying body and in which the flying body has a base spar which is arranged so as to be displaceable parallel to the flying body and which in the region of a front portion thereof, on
10 introduction of a torque about the nose-spar bearing axis, is in operative communication with the nose spar, by way of an engagement extension on the front base-spar portion and an engagement recess on the front nose-spar portion, and in which the base spar by reason of its
15 longitudinal displacement also tautens the wing surface.
2. A wing according to claim 1, which has a covering over said spars and in which, between a rear end portion of the nose spar and a rear end portion of the base spar,
20 a rear spar consisting of two hingedly connected spar elements is hinged.
3. A wing according to claim 1 which has, between the nose and base spars, lamella elements which are hinged to
25 the base spar and in each case have at an opposite end stop elements, between which there extends a stabilisation element which is hinged to the rearward portion of the nose spar.
- 30 4. A wing according to any one of the preceding claims, in which a locking mechanism which is effective both in the swung-in position and in the spread position of the nose spar is provided between the flying body and the
35 base spar.



5. A wing according to claim 1 having at least one lamella element which is in any angular position at least approximately parallel to the nose spar, and a first end portion of the/each lamella element is swingable about an associated bearing axis aligned parallel to the bearing axis of the nose spar during swinging of the nose spar into an angular end position, and in which the nose spar and the at least one lamella element form the spread wing, and in which the bearing axis of the at least one lamella element is provided on the base spar, which base spar is adjustable linearly by means of the energy store between a swung-in basic closed position, a second position establishing the operative connection between the base spar and the nose spar and an end position (in which the nose spar and the at least one lamella element assume, with respect to the flying body, their swung-open angular end position) and for stabilisation of the wing in the swung-open end position, held so as to be swingable on the second end portion of the nose spar, remote from the bearing axis, is an elongate stabilisation element which on a second end portion of the/each lamella element and, remote from the associated bearing axis of the lamella element, extends between abutment elements fashioned on the associated lamella element.

6. A wing according to claim 5, in which the base spar on its first end portion adjacent to the bearing axis of the nose spar and the nose spar on its first end portion facing the bearing axis are designed with engagement elements which, in the second position of the base spar, pass into operative connection with one another.

7. A wing according to Claim 6, in which the engagement elements remain in operative connection with one another from the second position of the base spar as far as its end position.



8. A wing according to any one of claims 5 to 7, characterised in that a locking mechanism, which is effective both in the swung-in basic closed position of the wing and in the end position of the base spar is provided between the flying body and the base spar.

9. A wing according to claim 8, in which the locking mechanism is biased by means of a spring element.

10. A wing according to any one of claims 5 to 9, in which the/each lamella element has on its reverse side remote from the nose spar the two abutment elements which are spaced apart from one another and between which the elongate stabilisation element extends.

11. A spreadable wing substantially as herein described and illustrated with reference to FIGURES 1 to 11 or 12 and 13 of the accompanying drawings.

12. On a flying body, at least one wing or fin which can be swung from a closed position to an open position, in order to stabilise the body in flight, said wing or fin having a nose spar and a base spar and said base spar being displaceable along its axis relative to the flying body, to swing the nose spar outwardly from the body whilst being in operative connection with the nose spar and said base spar being displaceable to a further position in which the operative connection with the nose spar is disabled, in order to tauten a covering of the wing or fin.

13. A wing according to Claim 12 having a driving mechanism for swinging open the nose spar.

14. A wing as claimed in Claim 12 or 13 comprising a rear spar consisting of two spar elements hinged to one another.



15. A wing according to Claim 14 in which a first end portion of the base spar and a first end portion of the nose spar are designed with engagement elements which, until achieving a swung-open end angular position of the nose spar, are in operative connection with one another for swinging open the nose spar, and in said swung-open end position of the nose spar the two spar elements of the rear spar form a rigid element and the operative connection between the nose spar and the base spar is disabled.

16. A wing according to Claim 15 when dependent from Claim 13, in which, for tautening the covering of the wing, the base spar is displaceable by means of the force store from said position disabling the operative connection into an end position further remote from the bearing axis of the nose spar.

17. On a flying body, a spreadable wing which can be swung outwardly from the flying body and which has a nose spar which can be swivelled with one end portion about a bearing axis provided on the flying body, and a driving mechanism, provided with an energy store, for swinging open the nose spar about said bearing axis, and in which on the flying body a base spar of the wing is arranged with a first end portion in the neighbourhood of said bearing axis and is aligned at least approximately parallel to the longitudinal axis of the flying body, said base spar being arranged so as to be displaceable in its longitudinal direction and, for swinging open the nose spar, being operatively connectable or operatively connected to the energy store and to the nose spar by way of an engagement extension on one of the first end portion and said one end portion and an engagement recess on the other of said first end portion and said one end portion of the nose spar, said wing having a covering which is tautened by the movement of the base spar.

