

TITLE: "TAIL ASSEMBLY FOR A GUIDED AND FIN-STABILIZED PROJECTILE"

DESCRIPTION

5 Technical field

The present invention relates to a tail assembly for a guided projectile.

Technical background

10 In the projectile industry, different types of tail assemblies are known.

In guided projectiles, e.g. using canard fins, tail assemblies are typically employed to provide aerodynamic stabilization, and comprise a fixed part and a movable part having a plurality of stabilizing fins. The movable part is
15 generally mounted at the rear and is freely rotatable relative to the fixed part about a longitudinal axis defined by the latter.

In projectiles equipped with tail assemblies made in accordance with the prior art, it is typically necessary to
20 reduce as much as possible the friction between the fixed part and the movable part. During the flight along the trajectory towards the target, in fact, the movable part generally rotates at high speed. For this reason, a perimetral gap is normally left in the axial direction
25 between the fixed part and the movable part of the tail assembly, so that, when the projectile is flying towards the target, the movable part can turn freely with considerably less friction and thus effectively stabilize the trajectory being followed.

30 However, such tail assemblies suffer from a number of drawbacks.

One drawback is that, when a projectile equipped with

a tail assembly according to the prior art is fired through the barrel of an artillery installation, gases at high temperature (e.g. approx. 2,700 °K) and high pressure (e.g. 4,000 bar) are produced. The presence of a perimetral gap
5 between the fixed part and the movable part allows such gases to enter the tail assembly, with the risk of damaging its components and jeopardizing the projectile's flight stability.

Summary of the invention

10 It is one object of the present invention to provide a tail assembly which can overcome this and other drawbacks of the prior art.

According to the present invention, this and other objects are achieved through a tail assembly having the
15 features set out in the appended independent claim. A tail assembly thus conceived makes it indeed possible to keep the movable part decoupled from the fixed part during the flight of the projectile, while at the same time preventing the high-temperature, high-pressure gases generated in the
20 barrel as the projectile is fired from entering the tail assembly. In more detail, the "normal" condition of the tail assembly is the spaced-apart condition, since the elastic group tends to keep the movable part axially away from the fixed part. Conversely, when the projectile is fired through
25 the barrel of an artillery system, the movable part is subjected to a considerable axial thrust in the direction opposite to that of the elastic force of the elastic group, thus switching from the spaced-apart condition to the abutment condition. The fixed part and the movable part are
30 thus "coupled", and the perimetral gap is eliminated, thereby substantially reducing the potentially adverse effects of undesired admission of firing-generated gases. Afterwards,

when the projectile is flying along its trajectory towards the target to be hit, the axial thrust generated in the barrel on the movable part will have ended its effect; therefore, the elastic group will be free to bring the
5 movable part and the fixed part back into the spaced-apart condition, thus allowing for mutual rotation with low friction.

It is understood that the appended claims are an integral part of the technical teachings provided in the
10 following detailed description of the present invention. In particular, the appended dependent claims define some preferred embodiments of the present invention that include some optional technical features.

Further features and advantages of the present
15 invention will become apparent in light of the following detailed description, provided herein merely as a non-limiting example and referring, in particular, to the annexed drawings as summarized below.

Brief description of the drawings

20 Figure 1 is a perspective view of a projectile including a tail assembly obtained in accordance with an illustrative embodiment of the present invention.

Figure 2 is a partially sectioned perspective view of the tail assembly shown in Figure 1.

25 Figure 3 is an axial or longitudinal sectional view of the tail assembly shown in Figure 2. In this figure, one can see a fixed part and a movable part of the tail assembly, shown in a condition of mutual abutment.

Figure 4 is a magnified view of a detail delimited by
30 line IV in Figure 3.

Figure 5 is an axial or longitudinal sectional view of the tail assembly shown in Figure 2. Unlike Figure 3, the

fixed part and the movable part of the tail assembly are shown in a spaced-apart condition.

Figure 6 is a magnified view of a detail delimited by line VI in Figure 5.

5 Figure 7 is a magnified axial or longitudinal view of the tail assembly shown in the preceding figures, showing an elastic group and a connection group interposed between the fixed part and the movable part.

10 Figure 8 is a magnified axial or longitudinal view of the tail assembly shown in the preceding figures, showing further details of the connection group interposed between the fixed part and the movable part.

For completeness' sake, the following is a list of alphanumerical references and names used herein to identify parts, elements and components illustrated in the above-

15 summarized drawings.

1. Projectile
2. Main body
- 2a. Forward section
- 20 2b. Midsection
3. Canard fins
10. Tail assembly
12. Fixed part
14. Movable part
- 25 16. Stabilizing fins
18. Elastic group
19. Disc springs
20. Flange
22. Shoulder end
- 30 24. Connection group
26. Sleeve
28. Bearings

- 28a-b. Annular structures
- 30. Rolling members
- 32. Main portion
- 34. Stem
- 5 35. Annular groove
- 36. Jacket
- 38. Annular body
- 40. Tubular body
- 42. Stop ring
- 10 44. Spacer disc
- 46. Guide elastic member
- 48. Further bearing
- 52. Fixing ring nut
- X-X. Longitudinal axis
- 15 G. Perimetral gap

Detailed description of the invention

With reference to Figure 1, reference numeral 1 designates as a whole a guided projectile, e.g. a projectile using canard fins 3. Projectile 1 is also aerodynamically stabilized by a tail assembly 10 obtained in accordance with an illustrative embodiment of the present invention.

Projectile 1 comprises a main body 2 of a per se known type. In the embodiment illustrated herein, main body 2 has a substantially elongate shape and comprises a forward section 2a and a midsection 2b coupled to the forward section 2a. The forward section 2a is tapered, whereas midsection 2b is substantially cylindrical with a circular cross-section.

In the illustrated embodiment, projectile 1 preferably comprises canard fins 3 mounted on main body 2, which fins can be oriented in a controlled manner relative to the latter. Canard fins 3 are shown to be mounted in midsection 2b, near the forward section 2a. It will however be clear to

a person skilled in the art that canard fins 3 may be mounted in any position on main body 2, whether on the forward section 2a or on midsection 2b.

In the illustrated embodiment, projectile 1 is also, advantageously, of the undercalibrated type, e.g. of the discarding-sabot type. In other words, projectile 1 further comprises a casing (not shown in the drawings), also referred to in the industry as "sabot", which is used in order to increase the outside diameter of main body 2 to match the inside diameter of the barrel of the artillery installation in which projectile 1 will be housed before being fired. Typically, the sabot is mounted around at least a portion of midsection 2b.

In the illustrated embodiment, canard fins 3 are of the non-retractable type, in that they protrude radially outwards from main body 2 both when projectile 1 is inserted in the barrel of the artillery installation and when projectile 1 has been fired and is flying along its trajectory towards the target.

Tail assembly 10 is mounted to the back of main body 2 of projectile 1, in particular to the back of midsection 2b thereof.

With reference to Figures 2 to 7, there are shown in more detail the structure and the components of tail assembly 10.

Tail assembly 10 comprises a fixed part 12 to be connected to the back of main body 2 (in particular, to midsection 2b) of projectile 1, defining a longitudinal axis X-X. In the following detailed description, terms or expressions such as "axial" and "axially", "radial" and "radially", "inwards" and "outwards" will refer to longitudinal axis X-X.

Tail assembly 10 further comprises a movable part 14 equipped with a plurality of stabilizing fins 16 and mounted to the back of fixed part 12, freely rotatable relative to the latter about longitudinal axis X-X. In particular, longitudinal axis X-X of tail assembly 10 coincides, advantageously, with the longitudinal axis of projectile 1.

As is particularly visible in Figures 3 to 6, movable part 14 is axially movable relative to fixed part 12 between an abutment condition (shown in Figures 3 and 4) and a spaced-apart condition (shown in Figures 5 and 6).

In the abutment condition, fixed part 12 and movable part 14 are in axial abutment with each other. In the spaced-apart condition, on the contrary, fixed part 12 and movable part 14 are axially spaced apart, thus defining a perimetral gap G in between.

Tail assembly 10 further comprises an elastic group 18 tending to retain movable part 14 in the spaced-apart condition. For example, elastic group 18 comprises a plurality of disc springs 19 axially stacked or packed in the direction of longitudinal axis X-X. Nevertheless, as will be apparent to a person skilled in the art, in further variant embodiments not shown herein the elastic group may even include just one disc spring. It is also conceivable to replace the disc spring(s) with one or more different springs, e.g. compression springs.

In light of the above, the spaced-apart condition corresponds to the substantially "normal" condition assumed by tail assembly 10, in which perimetral gap G allows fixed part 12 to turn, supported by movable part 14, about longitudinal axis X-X, reducing the friction between them. Conversely, the abutment condition corresponds to a condition in which tail assembly 10 is subjected to an

external stress, which causes movable part 14 to be brought into axial abutment with fixed part 12 against the action of elastic group 18.

From an operational viewpoint, in particular, the
5 abutment condition occurs when projectile 1 (to which tail assembly 10 is mounted) is fired through the barrel of an artillery installation. When firing occurs, in fact, projectile 1 undergoes a strong acceleration, which pushes movable part 14 towards fixed part 12, overcoming the
10 opposing action of elastic group 18. In this situation, the absence of perimetral gap G substantially prevents the gas generated when firing occurs from getting into tail assembly 10 and potentially damaging its components.

When firing has occurred and projectile 1 has come out
15 of the barrel, elastic group 18 moves movable part 14 axially away from fixed part 12, thus re-establishing the spaced-apart condition. In this manner, as the projectile is flying along its trajectory towards the target, perimetral gap G allows movable part 14 to rotate relative to fixed part 12
20 with reduced friction, without jeopardizing the stabilization of the projectile.

Preferably, fixed part 12 comprises a flange 20 which is radially external to longitudinal axis X-X. Movable part 14 comprises a shoulder end 22 co-operating with flange 20
25 to define perimetral gap G. Shoulder end 22 (which defines a movable annular surface) is configured to abut axially on flange 20 (which defines a corresponding fixed annular surface) in the abutment condition, and to move axially away from flange 20 in the spaced-apart condition to form
30 perimetral gap G.

With reference to Figure 7, tail assembly 10, which is shown therein in the spaced-apart condition, preferably

comprises a connection group 24 that connects fixed part 12 to movable part 14. Connection group 24 allows movable part 14 to rotate freely relative to fixed part 12 about longitudinal axis X-X. At the same time, connection group 24
5 also allows movable part 14 to slide freely relative to fixed part 12 along longitudinal axis X-X.

In the illustrated embodiment, connection group 24 can translate integrally with movable part 14 relative to fixed part 12 in the direction of longitudinal axis X-X.

10 In the illustrated embodiment, with reference to Figure 7, elastic group 18 is axially interposed between connection group 24 and fixed part 12. In particular, elastic group 18 presses, with one axial end thereof, onto connection group 24 and, with the opposite axial end thereof, onto fixed part
15 12. As an alternative to or in combination with the above, in some variant embodiments (not shown) the elastic group may be interposed between the fixed part and the movable part.

In the illustrated embodiment, connection group 24
20 comprises a sleeve 26 mounted slidable over fixed part 12 along longitudinal axis X-X and locked in rotation about longitudinal axis X-X relative to fixed part 12.

In the illustrated embodiment, connection group 24 comprises a plurality of bearings 28 that couple movable
25 part 14 and sleeve 26 in rotation about longitudinal axis X-X. In particular, there are a pair of bearings 28 axially stacked or packed in the direction of longitudinal axis X-X. Each one of bearings 28 is, preferably, a rolling bearing, in particular having a radially internal annular structure
30 28a fixed to sleeve 26 and a radially external annular structure 28b fixed to movable part 14. Between annular structures 28a, 28b a plurality of rolling members 30, e.g.

balls, are radially interposed.

In this way, when projectile 1 is fired through the barrel, movable part 14 and connection group 24, including sleeve 26 and bearings 28, will translate integrally relative to fixed part 12 along longitudinal axis X-X, overcoming the opposing action of disc springs 19. Therefore, shoulder end 22 of movable part 14 will abut on flange 20 of fixed part 12.

Subsequently, when projectile 1 has come out of the barrel and is flying towards the target, disc springs 19 will push movable part 14, sleeve 26 and bearings 28 of connection group 24 as one piece, causing them to translate relative to fixed part 12. This translational movement will also occur along longitudinal axis X-X, but this time in the opposite direction, thus moving away shoulder end 22 of movable part 14 and defining perimetral gap G relative to flange 20 of fixed part 12. Thus, thanks to bearings 28, movable part 14 will be free to rotate about longitudinal axis X-X over sleeve 26 locked in rotation relative to fixed part 12. As aforementioned, the presence of perimetral gap G ensures reduced friction during the rotation of movable part 14 relative to fixed part 12.

The following will describe further preferred and optional structural features of tail assembly 10 made in accordance with the embodiment of the present invention described above by way of non-limiting illustrative example.

In the illustrated embodiment, fixed part 12 comprises a main portion 32 configured to be fixed to main body 2 of projectile 1, and a stem 34 extending rearwards from the back of main portion 32. In particular, main portion 32 and stem 34 are made as one piece.

In the illustrated embodiment, main portion 32 is

substantially hollow, defining a cup-like shape. In particular, main portion 32 carries flange 20, which protrudes radially outwards from it. Main portion 32 and stem 34 develop around longitudinal axis X-X.

5 In the illustrated embodiment, sleeve 26 of connection group 24 is slidably mounted on stem 34 of fixed part 12. In addition, sleeve 26 is locked in rotation on stem 34.

 In the illustrated embodiment, disc springs 19 are mounted around stem 34 and abut on the back of main portion
10 32 on one side and on the widened top of sleeve 26 on the other side. In particular, disc springs 19 are housed in an annular groove 35 formed on the back of main portion 32 around stem 34.

 In the illustrated embodiment, movable part 14
15 comprises a substantially hollow jacket 36 carrying, on the outside, radial stabilizing fins 16. Movable part 14 further comprises an annular body 38 and a tubular body 40 stacked along longitudinal axis X-X and radially fixed inside jacket 36. Therefore, annular body 38 and tubular body 40 translate
20 and rotate integrally with jacket 36, being constrained thereto.

 In the illustrated embodiment, stem 34 of fixed part 12 is coupled to annular body 38 through connection group 24. In particular, bearings 28 and sleeve 26 are radially
25 interposed between annular body 38 and stem 34.

 In the illustrated embodiment, sleeve 26 of connection group 18 can slide over stem 34 of fixed part 12 integrally with bearings 28 and annular body 38 of movable part 14 in the direction of longitudinal axis X-X, against the action
30 of disc springs 19.

 With reference to Figure 7, fixed part 12 further comprises a stop element, e.g. a stop ring 42, which

connection group 24 and/or movable part 14 are configured to approach when pushed by elastic group 18 towards the spaced-apart condition.

In particular, stop ring 42 is fitted around stem 34,
5 and is intended to be approached by at least one of sleeve 26 of connection group 24, bearing 28 of connection group 24, and annular body 38 of movable part 14 when pushed by disc springs 19 into the spaced-apart condition.

In the illustrated embodiment, fixed part 12 further
10 comprises a spacer disc 44 in axial abutment with bearings 28 (e.g. with internal annular structure 28a) and/or with sleeve 26 of connection group 24; in particular, spacer disc 44 is in axial abutment with that part of connection group 24 which is locked in rotation with fixed part 12. Moreover,
15 fixed part 12 comprises also a guide elastic member 46 abutting on stop ring 42 on one side and on spacer ring 44 on the other side to push it in the direction of longitudinal axis X-X. In this way, in the spaced-apart condition spacer disc 44 will maintain an axial distance between stop ring 42
20 and both connection group 24 (in particular, external annular structure 28b) and movable part 12 (in particular, annular body 38). This permits the rotation of movable part 14 over fixed part 12 while avoiding any undesired friction, in particular between annular body 38 and stop ring 42.

25 In the illustrated embodiment, sleeve 26 and annular body 38 keep bearings 28 axially stacked or packed along longitudinal axis X-X, due to end shoulders (not numbered) that keep all components pressed together.

With reference to Figure 8, there is shown a distal end
30 of fixed part 12 and the coupling thereof with movable part 14. In the illustrated embodiment, the connection group 24 comprises a further bearing 48. In particular, this further

bearing 48 is fixed to fixed part 12 on one side and to movable part 14 on the other side by means of a fixing ring nut 52, which is, for example, screwed inside tubular body 40 of movable part 14. Fixing ring nut 52 supports further
5 bearing 48, so as to support the end of stem 34 of fixed part 12 and allow it to rotate and/or slide relative to tubular body 40 of movable part 14.

CLAIMS

1. Tail assembly (10) for a guided projectile (1), said tail assembly comprising:

- a fixed part (12) to be connected to the back of a main body (2) of a projectile (1), and defining a longitudinal axis (X-X); and
- a movable part (14) equipped with a plurality of stabilizing fins (16) and mounted to the back of the fixed part (12), being freely rotatable about said longitudinal axis (X-X);

characterized in that said movable part (14) is axially movable relative to said fixed part (12) between

- an abutment condition, wherein said fixed part (12) and said movable part (14) are in axial abutment with each other, and
- a spaced-apart condition, wherein said fixed part (12) and said movable part (14) are axially spaced apart, thus defining a perimetral gap (G) in between; and

in that it further comprises an elastic group (18) tending to retain said movable part (12) in said spaced-apart condition.

2. Tail assembly according to claim 1, wherein said fixed part (12) comprises a flange (20) which is radially external to said longitudinal axis (X-X), and said movable part (14) comprises a shoulder end (22) configured to abut axially on said flange (20) in said abutment condition and to move axially away from said flange (20) in said spaced-apart condition.

3. Tail assembly according to claim 1 or 2, comprising a connection group (24) which connects said fixed part (12) and said movable part (14), and which allows said movable part (14) to rotate freely relative to the fixed part (12)

about said longitudinal axis (X-X) and to slide freely relative to said fixed part (12) in the direction of said longitudinal axis (X-X).

4. Tail assembly according to claim 3, wherein said
5 connection group (24) translates integrally with said movable part (14) over said fixed part (12) in the direction of said longitudinal axis (X-X).

5. Tail assembly according to claim 4, wherein said elastic
10 group (18) is axially interposed between said fixed part (12) and at least one of said connection group (24) and said movable part (14).

6. Tail assembly according to any one of claims 3 to 5,
wherein said connection group (24) comprises a sleeve (26)
mounted slidable over said fixed part (12) along said
15 longitudinal axis (X-X) and locked in rotation about said longitudinal axis (X-X) relative to said fixed part (12).

7. Tail assembly according to claim 6, wherein said fixed
part (12) comprises a main portion (32) and a stem (34) that
extends rearwards from the back of said main portion (32),
20 whereon said sleeve (26) is slidably mounted and locked in rotation about the longitudinal axis (X-X).

8. Tail assembly according to claim 6 or 7, wherein said
connection group (24) comprises at least one bearing (28)
that rotatably couples said movable part (14) with said
25 sleeve (26) around said longitudinal axis (X-X).

9. Tail assembly according to any one of claims 3 to 8,
wherein said fixed part (12) comprises a stop member (42)
towards which at least one of said connection group (24) and
said movable part (14) are configured to move when they are
30 pressed by said elastic group (18) towards said spaced-apart condition.

10. Tail assembly according to any one of the preceding

claims, wherein said elastic group (18) comprises at least one disc spring (19).

11. Guided projectile comprising a tail assembly according to any one of the preceding claims.