



Case 95-C115/CH

Switzerland

Process for Filling Missile Bodies with Sub-
Projectiles and Device for Carrying out the Process

The invention relates to a process for filling missile bodies with sub-projectiles and a device for carrying out the process.

As is known, for example, from a publication OC 2052 d 94 of the company Oerlikon-Contraves AG, Zurich, an attacking target can be destroyed by multiple hits with missiles containing sub-projectiles if, after the sub-projectiles have been ejected, the expected area of the target is covered by a cloud formed by the sub-projectile. In this case, the sub-projectiles are ejected by an explosive charge housed in the missile, during the ignition of which the section of the missile carrying the sub-projectiles is separated and torn open at predetermined breaking points. Such missiles are subject to high requirements, and therefore it is important, for example, that the sub-projectiles are held firmly and secured against rotation in the missile. In this way, the rotation is transmitted to the sub-projectiles so that the missile follows a stable flight path. Moreover, on complete transmission of the rotation, the spin of the sub-projectiles is stabilised after they are ejected.

In order to continue to achieve a better probability of hit, the sub-projectiles should be distributed as evenly as possible to lie on circular areas, the even distribution

being principally determined by the geometric arrangement of the sub-projectiles inside the missile.

Every missile of the type described above contains a relatively large number of sub-projectiles which must be carefully inserted in the required geometric arrangement in order to achieve uniform characteristics. This can only be achieved with a high time expenditure with the conventional filling processes.

The object of the invention is to propose a process and a device of the aforementioned type which do not have the above-mentioned disadvantages.

This object is achieved by the invention specified in patent claims 1 and 7. In this case, prior to filling the sub-projectiles are assembled into layers which are as thick as the length of the sub-projectiles and extend in planes transverse to the longitudinal axis of the missile body. The sub-projectiles assume a position in the layer which corresponds to their geometric arrangement in a cavity of the missile body. The circumference of the layers is formed during assembly in such a way that, after a layer is inserted into the cavity, the sub-projectiles are secured against rotation therein while adhering to the previously formed geometric arrangement.

According to a preferred arrangement, the circumference of the layer has the form of a regular hexagon, in which case the sub-projectiles composed of cylinders run with their axes parallel to the longitudinal axis of the missile body.

According to a further development of the invention, several layers are generated simultaneously and inserted one behind

the other simultaneously into the cavity of the missile body.

The advantages achieved with the invention are that the filling time is substantially reduced and costs can be spared. Moreover, faults which could occur, for example, by rearrangement of the sub-projectiles are virtually prevented, thus allowing wastage to be reduced to a minimum.

The filling time may be reduced further with the proposed further development of the invention using several reservoirs to form several layers of sub-projectiles simultaneously. The special configuration of the device according to the invention to assemble the sub-projectiles into layers in the form of a regular hexagon and place them in the missile in this form results in optimum even distribution of the sub-projectiles located on circular areas after their ejection and thus results in an improved probability of hit.

The invention is explained in more detail below on the basis of several examples in association with the drawing.

Figure 1 shows a longitudinal section of the device according to the invention along I-I in Figure 2;

Figure 2 is a partial sectional view of the device in the direction of arrow A in Figure 1;

Figures 3a,

3b, 3c show geometric arrangements of sub-projectiles in planes running transversely to the longitudinal axis of a missile body;

Figures 4a,
4b, 4c show further embodiments of geometric arrangements of sub-projectiles in planes running transversely to the longitudinal axis of the missile body;

Figures 5a,
5b, 5c show cross-sectional forms of a slide of the device for use in arrangements shown in Figures 3a to 3c;

Figures 6a,
6b, 6c show cross-sectional forms of the slide of the device for use in arrangements shown in Figures 4a to 4c;

Figure 7 shows a longitudinal section through reservoirs of a second embodiment of the device along line VII-VII in Figure 8;

Figure 8 is a partial sectional view of the first reservoir in the direction of arrow B in Figure 7;

Figure 9 shows a cross-section through two reservoirs of the second embodiment along line IX-IX in Figure 8;

Figure 10 shows a cross-section through a slide of the second embodiment of the device;

Figures
11a, 11b show the device according to Figures 1 and 2 during a first process step;

Figures

12a, 12b show the device according to Figures 1 and 2 during a second process step;

Figures

13a, 13b show the device according to Figures 1 and 2 during a third process step, and

Figure 14 shows the device according to Figures 1 and 2 during a fourth process step.

A vertically arranged assembly centring means with a U-shaped cross-section which is screwed to a cover 2 is given the reference 1 in Figures 1 and 2. The assembly centring means 1 and the cover 2 form a reservoir 3 with a cross-section in the form of a slot-like rectangle, the width of which corresponds to the length of cylindrical sub-projectiles (20, Figures 3, 4) and the length of which results from the diameter and number of the sub-projectiles as well as their geometric arrangement (Figures 3, 4). A cover plate 4 with a slot 5, which is approximately congruent with the cross-section of the reservoir 3, is fastened to the upper end of the assembly centring means 1. A slide 7 connected to a handle 8 for operation is guided horizontally in a flange 6 screwed to the assembly centring means 1 in the lower region of the reservoir 3. The width of the slide 7 corresponds in cross-section to the length of the rectangular cross-section of the reservoir 3. On its upper side, the slide 7 has a V-shaped notch extending in its longitudinal direction, the sloping surfaces (7.1, Figure 5) of which form an angle of 120° in a preferred embodiment and correspond to the sides of a regular hexagon.

The underside of the slide 7 has a roof-like shape, its

sloping surfaces (7.2, Figure 5) forming an angle of 120° and, like the sloping surface of the V-shaped notch, correspond to the sides of a regular hexagon. The assembly centring means 1 has a passage 9 running coaxially to the slide 7 and connected on the inlet side to the reservoir 3, its contour in a first portion of the assembly centring means 1 being approximately the same as the above-described contour of the slide 7. A projection 10 is provided at the outlet of the passage 9 for guidance of the sub-projectiles to be inserted into a missile body part (41, Figure 14). During the filling process, the missile body part is centred in a retaining ring 11 running coaxially to the projection 10 and fastened to the assembly centring means 1.

Recesses 12 communicating with the passage 9 via openings 13 are provided on the sides of the assembly centring means 1. The recesses 12 have sliding surfaces 14 which are inclined downwards by an angle of 30° , for example, from the horizontal and have their beginning approximately at the upper corner points 15 of the vertical sides of the regular hexagon formed by the passage 9.

The assembly centring means 1 is screwed to a receptacle 16 and a base plate 17. The receptacle 16 has two inclined feed surfaces 18 arranged on both sides of the assembly centring means 1 in the region of the openings 13 for surplus sub-projectiles.

According to Figures 3a to 3c, cylindrical sub-projectiles 20 with a diameter d are assembled into layers (40, Figure 14) in the form of regular hexagons which are allocated to missile bodies with different diameters. The layers are arranged in planes running transversely to the longitudinal axis (43, Figure 14) of a missile body part (41, Figure 14),

the axes of the sub-projectiles 20 being aligned parallel to the longitudinal axis. The circumference of the regular hexagons is given the reference U, their diameter D resulting from a whole multiple of the sub-projectile diameter d. As already mentioned above, the distance b between two parallel sides of the regular hexagons results from the diameter d and the number of sub-projectiles 20 as well as their geometric arrangement.

As shown in Figures 4a to 4c, the cylindrical sub-projectiles 20 with diameter d are assembled into layers in the form of irregular hexagons, which are allocated to missile bodies with different diameters. In this case, distance b as well as diameter D must be determined from the number and diameter d of the sub-projectiles 20 as well as their geometric arrangement.

The surplus sub-projectiles thrown out during filling are given the reference 20.1 in Figures 5a to 5c and 6a to 6c.

Further U-shaped assembly centring means screwed to assembly centring means 1 are given the reference 30 in Figures 7 to 10, and an equal number of reservoirs 3 is formed in keeping with the number of assembly centring means 1, 30. Passages 31 are provided in the further assembly centring means 30, said passages 31 having the same cross-sectional form in a first part of the assembly centring means 30 as passage 9 of assembly centring means 1 (Figure 1) and running concentrically thereto. Recesses 32 communicating with the passage 31 via openings 33 are provided on the sides of the further assembly centring means 30. The recesses 32 have sliding surfaces 34 which are inclined downwards by an angle of 30° , for example, from the horizontal and have their beginning approximately at the upper corner points of the

vertical sides of a regular hexagon formed by passage 31. Ejector noses 35 are arranged in the passage 31 which project into grooves 37 of a further slide 36 which may slide through passages 9, 31. The cross-section of the further slide 36, except for grooves 37, is the same as the cross-section of slide 7 of Figure 1, but has a length which extends at least over all the assembly centring means 1, 30. The above-described device, like the device according to Figures 1 and 2 and not shown in further detail, is connected to a receptacle and a base plate, and is provided with a retaining ring 11 for the missile body part 41, a flange for guidance of the slide 36 and a cover 2.

The device described on the basis of Figures 1 and 2 operates as follows.

In a first step (Figures 11a, 11b), the sub-projectiles 20 are fed by means of a vibrating spiral conveyor (not shown) into the reservoir 3 in which they fall vertically down onto a first restriction formed by the upper side of the slide 7. In so doing, the desired geometric arrangement is formed in accordance with the shape of the slide 7 and the cross-sectional length of the reservoir 3, and the circumference of a layer 40 composed of sub-projectiles 20, which may be a regular hexagon in a preferred embodiment, is partly formed. In a second step (Figures 12a, 12b), the slide 7 is retracted so that the sub-projectiles 20 drop by a certain magnitude, which corresponds to the diameter D of the circumference of the selected regular rectangle, onto a second lower restriction. Since the second restriction is formed by the shape of the lower portion of passage 9 or reservoir 3, the geometric arrangement and the partly formed circumference of the layer 40 is retained in this case. In a third step (Figures 13a, 13b), the sub-projectiles 20

located between the first and second restrictions are pushed with the slide 7 in the direction of filling from the reservoir 3 into passage 9, whereby the final shaping of the circumference of the layer 40 is achieved by the surplus sub-projectiles 20.1 (Figure 5) being passed through the openings 13 and rolling down onto the sliding surfaces 14. They drop onto the feed surfaces 18 and from there pass into the receptacle 16. They may be removed from there and fed onto the vibrating spiral conveyor again for further processing. At the same time as the third step, a following pre-formed layer 40 of sub-projectiles is held on the upper side of the slide 7. In a fourth step (Figure 14), the finally shaped layers are inserted into a cavity 42 of the missile body part 41, and the previous layers 40 are displaced by the respective last layer 40 on repeated reciprocal movement of the slide 7 until the cavity is filled. In this case, according to the embodiment using the arrangement shown in Figure 3c, eight layers 40 each composed of nineteen sub-projectiles 20 can be placed in the missile body part 41.

The second embodiment of the device described on the basis of Figures 7 to 10 operates in the same manner in the first and second steps as described above, both in the assembly centring means 1 and in the further assembly centring means 30, however in this case the retraction movement of the further slide 36 extends over all the assembly centring means 1, 30. In the case of the third step, the final shaping of the circumference of the layer also occurs in the assembly centring means 1 in the way described above.

In the further assembly centring means 30 the lowest of the surplus sub-projectiles 20.1 strike against the ejector noses 35 during the lifting movement of the slide 36, thus

enabling all the surplus sub-projectiles 20.1 to be passed through the openings 33 and drop down onto the sliding surfaces 34. The fourth step is the same as described above, except that the number of lifting movements is reduced in keeping with the number of reservoirs 3. An optimum result can be attained if the number of reservoirs 3 is equal to the number of layers required, as then only a single lifting movement of the slide is necessary to fill a missile body.

List of Reference Numbers

1	Assembly centring means	40	Layer
2	Cover	41	Missile body part
3	Reservoir	42	Cavity
4	Cover plate	43	Longitudinal axis
5	Slot		
6	Flange		
7	Slide		
7.1	Sloping surfaces		
7.2	Sloping surfaces	d	Diameter (sub-projectiles)
8	Handle	U	Circumference
9	Passage	D	Diameter (circumference)
10	Projection	b	Distance (length of the rectangular cross- section of the reservoir)
11	Retaining ring		
12	Recesses		
13	Openings		
14	Sliding surfaces		
15	Upper corner points		
16	Receptacle		
17	Base plate		
18	Feed surfaces		
20	Sub-projectiles		
20.1	Sub-projectiles		
30	Further assembly centring means		
31	Passages		
32	Recesses		
33	Openings		
34	Sliding surfaces		
35	Ejector noses		
36	Further slide		
37	Grooves		



Patent Claims:

1. Process for filling a missile body with sub-projectiles, characterised in that prior to filling the sub-projectiles (20) are assembled into layers (40), which are as thick as the length of the sub-projectiles (20) and which lie in planes transverse to the longitudinal axis (43) of the missile body, said sub-projectiles (20) assuming a position in the layer (40) which corresponds to their geometric arrangement in a cavity (42) of a missile body part (41), and the circumference of said layers (40) is formed in such a way that, after insertion of a layer (40) in the cavity (42), the sub-projectiles (20) are held therein while adhering to the previously formed geometric arrangement.
2. Process according to Claim 1, characterised in that
 - in a first step the sub-projectiles (20) are fed into a reservoir (3) in which they fall vertically down onto a first restriction, whereby the desired geometric arrangement is formed and the circumference of a layer (40) is partly formed;
 - in a second step the sub-projectiles (20) drop by a certain magnitude onto a second-lower restriction, whereby the geometric arrangement and the partly formed circumference of the layer (40) are retained;
 - in a third step, the sub-projectiles (20) located between the first and second restrictions are pushed out of the reservoir (3), whereby the final shaping of the circumference of the layer (40) is achieved;
 - at the same time the sub-projectiles (20) of a following layer in the reservoir (3) are held on the



first restriction, and

- in a fourth step, the finally shaped layers (40) are inserted into the cavity (42) of the missile body part (41), and the previous layers (40) are displaced by the respective following layer (40) until the cavity (42) is filled.

3. Process according to Claim 2, wherein the sub-projectiles (20) consist of bodies with cylindrical surface shells, the axes of which run parallel to the longitudinal axis (43) of the missile body part (41), characterised in that the circumference of the layer (40) containing the sub-projectiles (20) is shaped to a regular hexagon.
4. Process according to Claim 2, wherein the sub-projectiles (20) consist of bodies with cylindrical surface shells, the axes of which run parallel to the longitudinal axis (43) of the missile body part (41), characterised in that the circumference of the layer (40) containing the sub-projectiles (20) is shaped to an irregular hexagon.
5. Process according to Claim 3, characterised in that the specific magnitude corresponds to the diameter of the circumference of the hexagon.
6. Process according to Claim 2, characterised in that several layers (40) are generated simultaneously and inserted one behind the other simultaneously into the cavity (42) of the missile body part (41).
7. Device for carrying out the process according to Claim 2, characterised in that



- a vertically arranged, U-shaped assembly centring means (1) is connected to a cover (2), and a reservoir (3) is formed which has a cross-section in the shape of a slot-like rectangle;
 - a flange (6) is fastened to the assembly centring means (1) in the lower region of the reservoir (3), and a slide (7) is guided horizontally in said flange, the width of said slide corresponding to the length of the slot-like rectangle;
 - on its upper side, the slide (7) has a V-shaped notch extending in its longitudinal direction;
 - on its underside, the slide (7) has a roof-like structure extending in its longitudinal direction;
 - in the assembly centring means (1) a passage (9) is provided which runs coaxially to the slide (7) and in a first part is approximately the same as the contour of the slide (7) and in a second part is approximately the same as the contour of the layer (40);
 - at the outlet of the passage (9), a projection (10) is provided for guidance of the sub-projectiles (20) to be inserted into the missile body part (41); and
 - a retaining ring (11) running coaxially to the projection (10) is fastened to the assembly centring means (1).
8. Device according to Claim 7, characterised in that the upper side of the slide (7) forms a first restriction for the sub-projectiles (20) located in the reservoir (3); and that the lower part of the passage (9) or the reservoir (3) forms a second restriction for the sub-projectiles (20).



9. Device according to Claim 7, characterised in that the upper side of the slide (7) and the lower part of the passage (9) are formed so that the arrangement of the sub-projectiles (20) in the layer (40) is the same on the slide (7) and in the passage (9).
10. Device according to Claim 7, characterised in that the sloping surfaces (7.1) of the V-shaped notch and the sloping surfaces (7.2) of the roof-like structure each enclose an angle of 120° and correspond to the sides of a regular hexagon.
11. Device according to Claim 7, characterised in that the sloping surfaces (7.1) of the V-shaped notch and the sloping surfaces (7.2) of the roof-like structure each enclose an angle of 120° and correspond to the sides of an irregular hexagon.
12. Device according to Claim 11, characterised in that the distance between the tip of the V-shaped notch and the tip of the roof-like structure of the slide (7) approximately corresponds to the diameter (D) of the circumference (U) of the hexagon.
13. Device according to Claim 11, characterised in that recesses (12) communicating with the passage (9) via openings (13) are provided on the sides of the assembly centring means (1); and that the recesses (12) have sliding surfaces (14), which are inclined downwards by a specific angle from the horizontal and have their beginning approximately at the upper corner points (15) of the vertical sides of the hexagon formed by the passage (9).



14. Device according to Claim 11, characterised in that the width of the slot-like rectangle of the reservoir (3) corresponds to the length of cylindrical sub-projectiles (20) and the length of the slot-like rectangle corresponds to the distance (b) between two parallel sides of the hexagon.
15. Device according to Claim 7, characterised in that one or more further assembly centring means (30) are provided between the one assembly centring means (1) and the cover (2), in which case an equal number of reservoirs (3) is formed in keeping with the number of assembly centring means (1, 30); and that passages (31) are provided in the further assembly centring means (30), said passages (31) having the same cross-sectional form in a first part of the assembly centring means (30) as the first part of passage (9) of assembly centring means (1) and running concentrically thereto.
16. Device according to Claim 15, characterised in that recesses (32) communicating with the passage (31) via openings (33) are provided on the sides of the further assembly centring means (30); and that the recesses (32) have sliding surfaces (34) which are inclined downwards by a specific angle from the horizontal and have their beginning approximately at the upper corner points of the vertical sides of a hexagon formed by passage (31).
17. Device according to Claim 16, characterised in that ejector noses (35) are arranged in the second part of passage (31) which project into grooves (37) of a further slide (36) which may slide through the passages (31, 9).