Jan. 3, 1967 V. J. CUSHING ETAL 3,295,444

DISPERSAL TYPE CLUSTER WARHEAD

Filed Aug. 2, 1956 3 Sheets-Sheet 1

FIG.1.

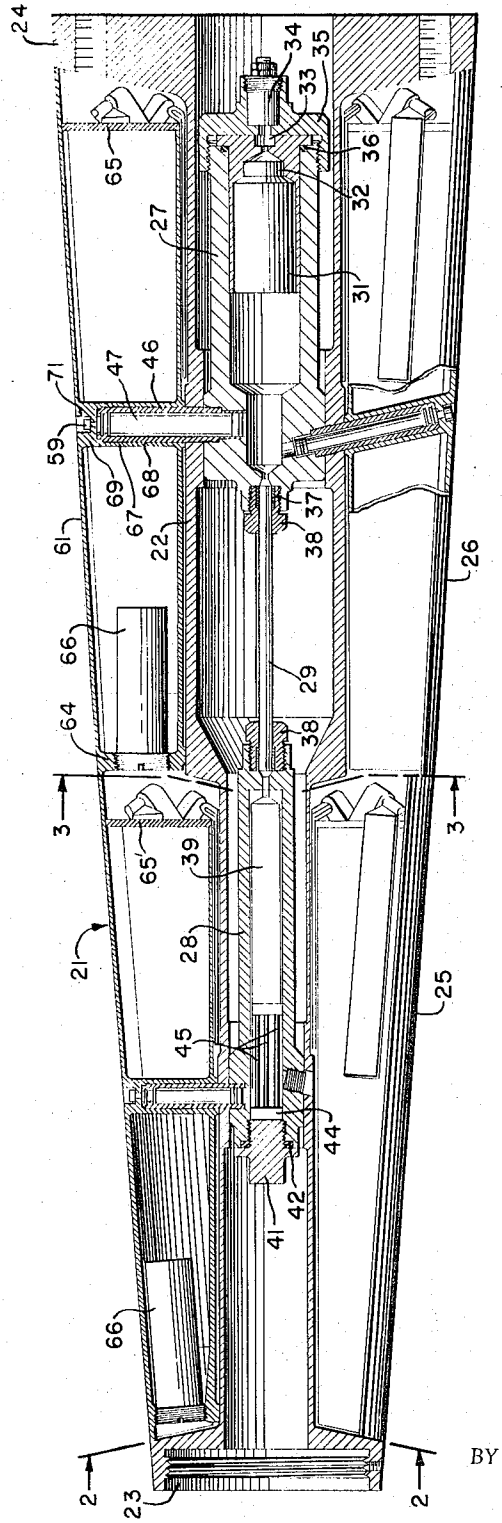
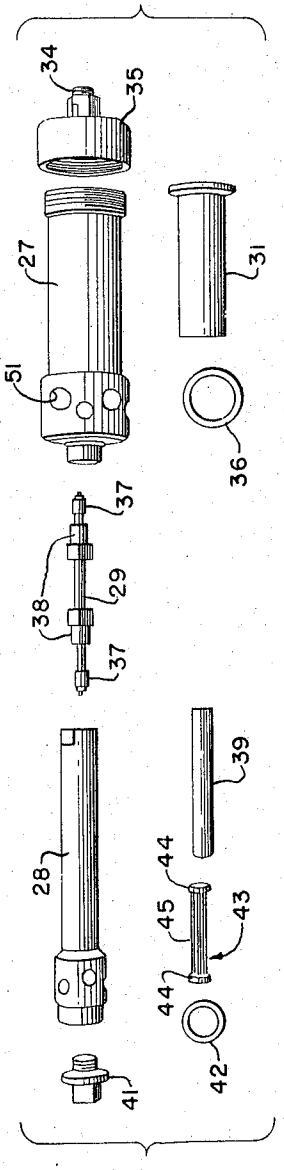



FIG.5.

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DISPERSAL TYPE CLUSTER WARHEAD

Filed Aug. 2, 1956 3 Sheets-Sheet 2

FIG.4.

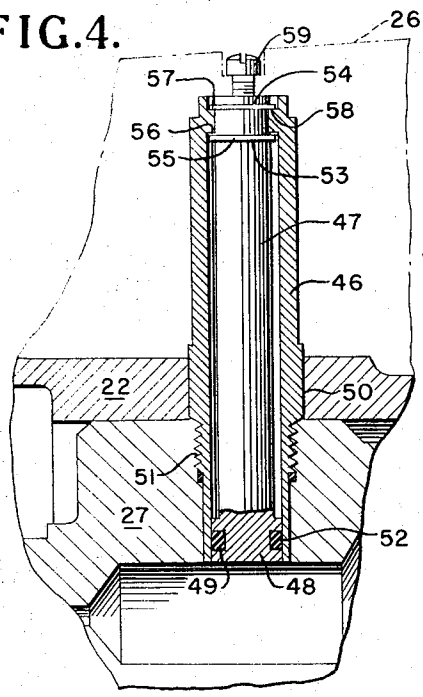



FIG.3.

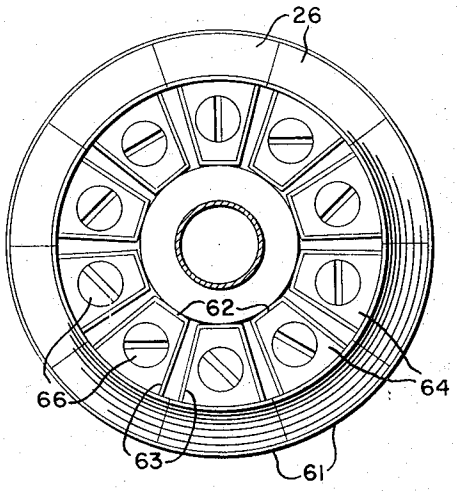



FIG.2.

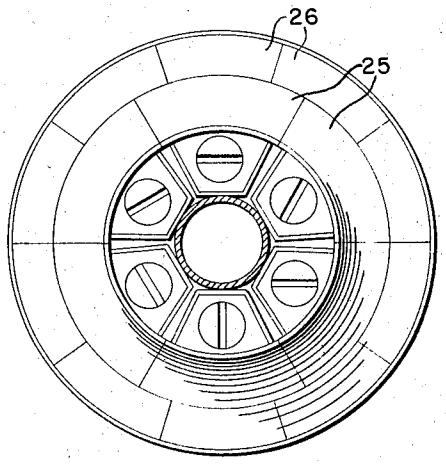



FIG.11.

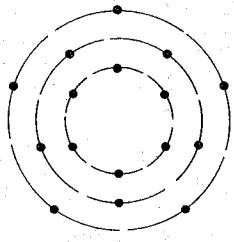
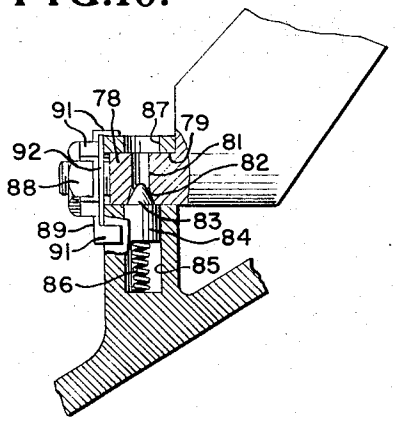


FIG.10.

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DISPERSAL TYPE CLUSTER WARHEAD

Filed Aug. 2, 1956 3 Sheets-Sheet 3

FIG.6.

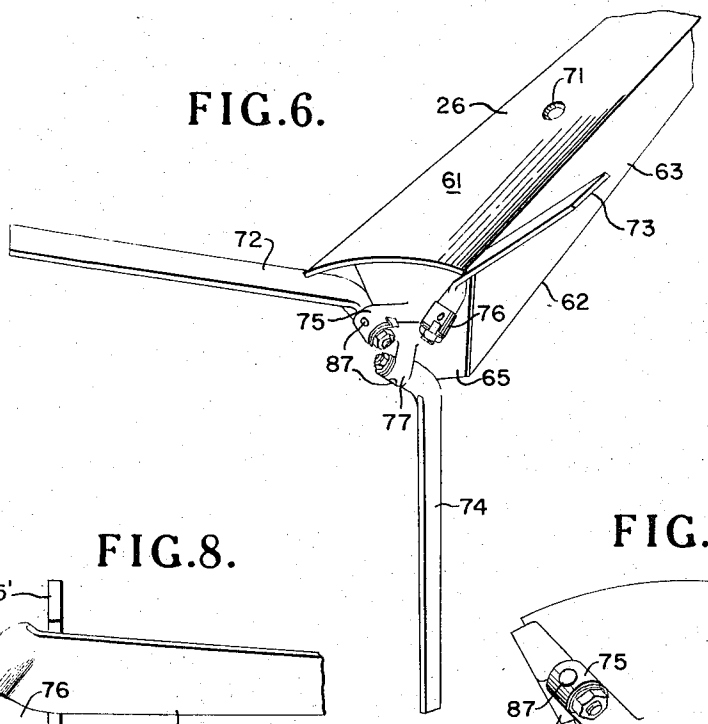



FIG.8.

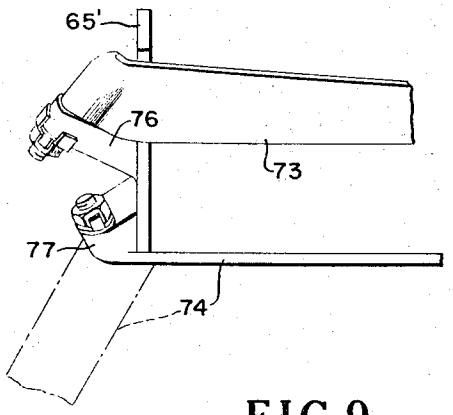



FIG.7.

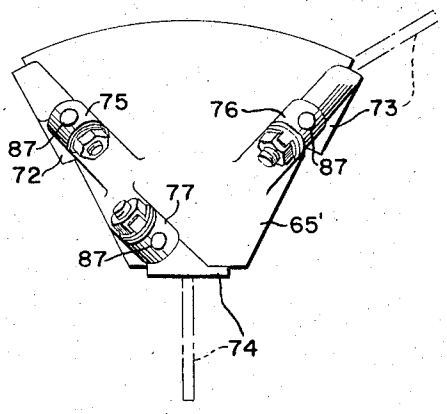
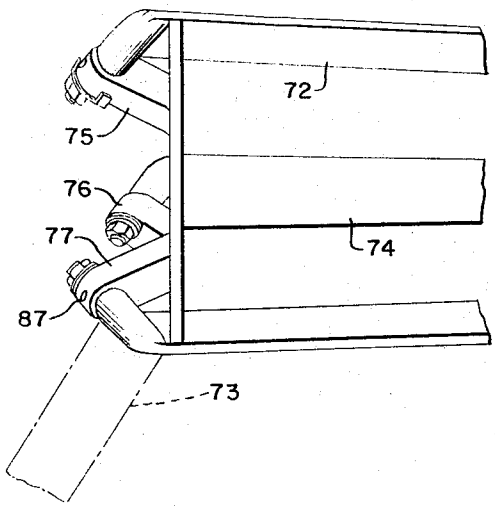



FIG.9.

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United States Patent Office

3,295,444

Patented Jan. 3, 1967



3,295,444

# DISPERSAL TYPE CLUSTER WARHEAD

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Filed Aug. 2, 1956, Ser. No. 601,848

3 Claims. (Cl. 102—7.2)

The present invention relates to a dispersal type cluster warhead and more particularly to a dispersal type cluster warhead comprising a plurality of submissiles, each submissile containing an explosive charge and designed to penetrate a target even at acute angles of approach. The warhead of this invention may be incorporated in a guided missile, rocket, bomb, torpedo or other suitable ordnance items.

Various types of cluster warheads have been proposed including a type in which a carrier or parent missile has attached thereto or incorporated therein a small number of submissiles which are ejected from or dispersed relative to the parent missile upon approach of the missile within a predetermined distance of the target, in order that the target be struck by a number of missiles, thereby increasing the probability of destruction or "kill" of the target. Heretofore, most missiles have been circularly symmetrical and have had a conically shaped fuze attached at the front end thereof. When such a missile struck a target at other than normal incidence, the fuze was quite likely to be detached or "washed off" at impact, thus rendering the missile explosively ineffective and making it a dud. Also, folding fin designs on such missiles have required that the fins extend rearward in folded position, thereby occupying a great deal of valuable space.

The cluster warhead of the present invention comprises, in essence, a carrier missile and a considerable number of submissiles, each submissile containing its own explosive charge, which is in sufficient quantity to produce fatal damage to a target, the submissiles being dispersed when the missile comes within a predetermined distance of the target. More specifically, the submissiles are arranged in a plurality of banks and are of designs to form clusters whose external shape is that of the carrier missile ogive. These submissiles are stabilized by folding fins and have a novel shape to give the highest packaging density in the cluster while allowing for a sufficient quantity of explosive. Because of its unusual shape, it has been possible to provide each submissile with a fuze well, so that the fuze can be contained within the submissile and the fuze thus protected from "wash off" or detachment prior to detonation of the explosive in the submissile. The type of folding fin evolved for the cluster warhead of this invention is such that the fins fold forward and lie flush with the sides of the submissile when packaged in the warhead, thus greatly increasing the packaging density, yet when in open position, the three fins on each submissile form a perfectly symmetrical and conventional aerodynamic configuration whereby the plane of the fin surfaces of the three fins intersect in a common line for aerodynamic guidance of the submissile to the target.

One object of the present invention is the provision of a cluster warhead comprising banks of submissiles of novel design and having external surfaces that define the warhead ogive.

Another object is the provision of submissiles of such shape and design to give optimum packaging density in the cluster warhead and at the same time allow for a sufficient quantity of explosive in the submissile.

Still another object is to provide a fin assembly for each of the submissiles wherein the fins fold forwardly



and lie flush with the sides of the submissile when the same is packaged in the cluster warhead.

A still further object is the provision of means for pivotally mounting three fins on each of the submissiles, which fins in the folded positions thereof lie flush with the sides of the submissile, yet when in open position, the three fins form a symmetrical conventional aerodynamic configuration.

An additional object is to provide detent means for locking each of the fins in the open position thereof.

Another object of the invention is the provision of rotation axes for the fins such that the setback forces acting on the fins at the time of submissile ejection serve to unfold the fins and rotate them to the open positions thereof.

A further object is to provide means for slowing or retarding the speed of such rotation, as the fins are rotated to their open or unfolded positions.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 is a sectional plan view of the cluster warhead of this invention, with parts broken away;

FIG. 2 is a cross sectional view of the cluster warhead, taken generally along line 2—2 of FIG. 1 and looking in the direction of the arrows;

FIG. 3 is a cross sectional view of the cluster warhead, taken generally along line 3—3 of FIG. 1 and looking in the direction of the arrows;

FIG. 4 is a detail view of one of the piston assemblies of the dispersal gun;

FIG. 5 is an exploded view of the dispersal gun, with the piston assemblies thereof omitted;

FIG. 6 is a perspective view of one of the submissiles of the cluster warhead of this invention, with the three fins of the submissile being shown in the open or unfolded position thereof;

FIG. 7 is a rear elevational view of one of the fin assemblies with the fins thereof in the forward or folded position, the dotted lines serving to illustrate the open positions of two of the fins;

FIG. 8 is a side elevational view of the fin assembly, the fins being fragmentarily shown and the dotted lines illustrating the unfolded position of one of the fins;

FIG. 9 is a plan view of the fin assembly, the fins being in fragmentary form and the dotted lines illustrating the unfolded position of one of the fins;

FIG. 10 is a detail sectional view of the means mounting one of the fins for rotation, showing the means for slowing or retarding such rotation as the fin approaches its open position and the detent means for locking the fin in the open position; and

FIG. 11 schematically illustrates the theoretical dispersion pattern of the submissiles.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1, which illustrates a preferred embodiment, a cluster warhead generally designated by reference numeral 21. More specifically, the cluster warhead comprises a central tubular support 22, which extends the length of the warhead, the support being provided at one end with a threaded portion 23, into which a suitable nose may be threaded, and has a base portion 24 adapted to be attached to appropriate propulsion means. Clustered about the tubular support 22 are a forward bank of submissiles or sprites 25 and a rear bank of submissiles or sprites 26,

the submissiles or sprites being secured to the support by means hereinafter described in greater detail.

Disposed within the support 22 is a dispersal gun comprising a rear or aft gas chamber 27 and a forward or fore gas chamber 28, the chambers being interconnected by a high pressure channel or igniter tube 29. The aft gas chamber 27 is energized through to the medium of a propellant cartridge 31 which is ignited by a powder charge 32, the powder charge in turn being set off by an electric primer 33, in response to an impulse transmitted through a suitable safety and arming mechanism 34. Mechanism 34 is housed in a cap 35 which is threadedly connected to one end of the gas chamber 27, a ring seal or gasket 36 being provided to make the connection gas tight. Igniter tube 29 is connected in gas tight relation to the other end of gas chamber 27 by suitable means, for example, a high pressure connector comprising a sleeve 37 threaded on the end portion of tube 29 and a cup-shaped member 38 surrounding the sleeve 37 and tube 29, said member being threadedly connected to gas chamber 27.

The other end of igniter tube 29 is similarly connected to the rear end of the forward or fore gas chamber 28, this end of the igniter tube terminating at the base of a propellant cartridge 39 contained in the gas chamber 28. The forward end of gas chamber 28 is closed off and sealed by a plug 41 threadedly connected thereto and a ring seal or gasket 42. To insure that the base of cartridge 39 is related in proper proximity to the associated end of igniter tube 29, there is provided a spacer member, generally designated 43, disposed between the cartridge and plug 41. Spacer member 43 comprises a pair of spaced apart rings 44, interconnected by a plurality of elongated members, such as rods 45, or the like, see FIG. 5. One of the rings 44 is adapted to be placed in abutting relation to the forward end of cartridge 39 and the other ring 44 in abutting relation to plug 41, rods 45 being of such length that, when plug 41 is completely screwed in, the base of cartridge 39 is properly related to the associated end of igniter tube 29.

It will be noted the high pressure gas channel or igniter tube 29 is of relatively small cross sectional area, the size of the opening necessary in the tube being such as to permit the high pressure gases generated in the gas chamber 27, by burning of the propellant therein, to spurt through the igniter tube and ignite the propellant in the forward gas chamber 28. However, the igniter tube so constricts the gas flow that there is no appreciable transfer of energy between the gas chambers through the tube; if the transfer of energy were appreciable, violent and destructive pressure oscillations could result. With the system described ignition of the propellant charge 31 in the aft gas chamber 27 is sufficient to initiate firing the dispersal gun, and it is therefore necessary to have only one safety and arming mechanism 34.

Turning now to FIGS. 1 and 4, it will be noted that each gas chamber has associated therewith piston assemblies, a typical piston assembly being shown in FIG. 4 and comprising a cylinder 46 and a piston 47, the piston having an enlarged portion 48 which is provided with a circumferential groove 49 therein. The cylinder 46 is threaded, as at 51 to the housing of the gas chamber and communicates with the interior thereof; the cylinder passing through a suitable opening 50 in tubular support 22. In the circumferential groove 49 there is disposed an O-ring seal 52 for the purpose of preventing the leakage of gas pressure past the enlarged portion 48 of the piston.

The free end of the reduced portion of piston 47 is provided with a pair of spaced apart circumferential grooves 53 and 54. In the innermost of said last mentioned grooves, that designated by numeral 53, is a shear ring 55, said ring being adapted to engage a shoulder 56 inside the cylinder 46, and in the other of said grooves, designated by numeral 54, is a retaining ring 57 which engages an external shoulder 58 on the cylinder. Threaded into the end portion of piston 47 is a frangible attachment screw 59, such screw serving to attach and hold in place a submissile, in a manner which will later be apparent.



From an inspection of FIG. 1, it should be noted that some of the piston assemblies are arranged with the longitudinal axis thereof radially disposed with respect to the longitudinal axis of the warhead and perpendicular or normal thereto, while other piston assemblies are radially disposed and at an angle to the longitudinal axis of the warhead. This is true of the piston assemblies associated with both the rear and the fore gun gas chambers of the dispersal gun. Half of the piston assemblies associated with each gas chamber are canted as indicated and are arranged in alternation with the other piston assemblies that are perpendicularly disposed, the reason for the canting being to avoid mutual interference between adjacent piston assemblies at the inner ends thereof and in order to maximize the strokes of the pistons within the limitations of the overall size of the warhead. It is also to be noted that the enlarged portions of the several piston assemblies have different dimensions and the dimensions are such that when related to the gas pressures generated in the gas chambers, the piston assemblies are moved outwardly by gas pressure to impart to the submissiles desired ejection velocities.

In operation, an electrical impuse is received from a suitable influence device carried by the ordnance item incorporating the warhead of this invention and actuates the electric primer 33 at a predetermined interval of time away from the target, say for example, one quarter of a second. The primer, through the powder train 32, ignites cartridge 31 which burns and causes a rapid rise in gas pressure, thus energizing the aft gas chamber 27, an accompanying energizing of the forward gas chamber 28 resulting from hot gases the spurting through tube 29 and igniting cartridge 39. The rapid rise in gas pressure ruptures shear ring 55 of each of the piston assemblies and allows the piston to travel through its ejection stroke. During this stroke, the submissile is accelerated relative to the tubular support 22 until the enlarged portion 48 of the piston strikes the internal shoulder 56 with such force that the frangible attachment screw 59 ruptures, freeing the submissible and allowing it to continue with its acquired ejection velocity. The ejection force passes through the center of gravity of the submissile so that no undersirable overturning moments are imparted to the submissile; also, the force which ruptures the screw passes substantially through the center of gravity of the submissile so that no undesirable overturning moments are imparted to the submissile during this detachment process.

It has been previously stated that the submissiles are so designed and shaped that the external surfaces thereof, when clustered in the warhead, define the ogive of the warhead and, from viewing FIGS. 1, 2 and 3, it will be appreciated that the submissiles or sprites are generally segmental in cross-section. In addition, of course, each of the submissiles or sprites is elongated and comprises an external or skin member 61, bottom wall 62 and side walls 63, the member 61 conforming in shape to the particular segment of the warhead that the submissile forms.

For a better understanding of the configuration of the submissile, reference may be had to FIG. 6, wherein is illustrated, in perspective, one of the submissiles or sprites 26 of the aft bank or cluster of submissiles. While the configuration of the submissile or sprite 25 will be generally similar to that of sprite 26, there will, of course, be differences in dimensions due to the dimensional characteristics of that portion of the warhead of which the sprite 25 forms a part; better understood by reference to FIGS. 2 and 3.

Sprite 26 is closed off at its ends by a front plate 64 and a rear plate 65, front plate 64 being suitably bored to receive and support a suitable fuze 66 within the sub-

missile. Interconnecting skin member **61** and bottom wall **62** is a tubular portion **67** formed with a large bore portion **68** and a reduced bore portion **69**, the reduced bore portion receiving attachment screw **59** and being countersunk, as at **71**, to locate the head of the screw inwardly of the skin member **61**.

While the description has referred only to the structural features of submissile or sprite **26**, it is to be understood, of course, each submissile or sprite **25** is provided with features that are substantially the same, differing only in dimensional characteristics.

The space in each of the submissiles, not occupied by the fuze and the tubular portion, is utilized to house the explosive charge of the submissile, approximately 1.4 pounds of high explosive; the tubular portion of each submissile being so located that the longitudinal axis of the tubular portion passes through the center of gravity of the submissile so that the hereinbefore mentioned ejection and attachment screw rupturing forces pass, or substantially pass through said center of gravity. The center of gravity is that when the submissile has been charged with explosive and fuzed, and has been provided with fins folded forwardly, which fins will now be described.

For the purpose of aerodynamically directing each of the submissiles toward the target, there is provided on the trailing end thereof a fin assembly, comprising three fins **72**, **73** and **74**, mounted on the rear plate of the submissile by means of projections or mounting standards **75**, **76** and **77**, respectively secured to the plate or formed integrally therewith. Each of the fins is mounted for rotation in its respective standard, the standards being so disposed and the axes of rotation so chosen, that in the open positions of the fins, as illustrated in FIG. 6, the fins form a symmetrical and conventional aerodynamic configuration, whereby the planes of the fin surfaces intersect in a common line; yet the fins are adapted to fold forward and lie flush with the bottom and side walls of the submissile.

The dispositions of the standards, and the axes of rotation of the fins, may be better understood by reference to FIGS. 7, 8 and 9, in which the fins are shown associated with a rear plate **65'** of a submissile **25**; the folded forward positions of the fins being shown in full lines and the dotted lines showing the open positions of some of the fins. Viewing FIG. 7, it should be apparent that in the unfolded or open positions of the fins, the planes of the fins surfaces are disposed in planes angularly related and approximately 120 degrees from each other, the planes meeting generally in a line of intersection.

Further, it will be appreciated if possible to select rotation axes such that the setback forces acting upon the fins at the time of submissile ejection are adequate to move the fins to the unfolded or open positions thereof, thus obviating the need for additional means, such as springs, or the like, for unfolding the fins.

For locking the fins in the unfolded or open position, each fin is provided with a detent mechanism. On each fin, at one end thereof, is a shaft **78**, the shaft being journalled for rotation in a bore **79** in one of the projections or standards **75**, **76** or **77**, as the case may be. The shaft **78** is provided with a bore **81**, the bore having a flared opening **82**. The flared opening is adapted to receive the tapered portion **83** of a detent element **84**, the detent element being mounted for movement in a bore or well **85** formed in the associated standard and urged or biased to locking position by a spring **86** reacting against the detent element and the bottom of the well. A port or opening **87** is provided in the standard, in alignment with well **85**, in order that a thin rod may be passed through said opening and bore **81** for forcing the detent element out of locking position.

It has been found that during rotation of the fins to open position, the speed of rotation attained was often so great that the detent mechanism was adversely affected and the fins would not lock properly. Various ways of slowing or retarding the speed of rotation were attempted and the preferred manner of doing so will now be described. The outer or free end portion of the shaft **78** is threaded so as to receive a nut **88** thereon, the nut being held against movement relative to the standard or projection by means of a retainer member **89**, the retainer member being provided with tangs **91** some of which are bent to engage the sides of the standard and the others being bent in the other direction to engage the nut. Disposed between the nut and the standard, on one side of the retainer member or the other, as desired, is a washer **92** of suitable material; for example, aluminum, or the like. With the nut retained against movement relative to the standard, rotation of the shaft, due to movement of the fins to open position, will have the effect of drawing the nut tighter to the standard, thereby exerting a pressure upon the washer, which pressure deforms the washer and may be sufficient to cause extrusion of the material of which the washer is made. This deformation of the washer absorbs some of the energy of rotation and the speed of rotation is accordingly slowed or retarded as the fin moves to open position, the detent mechanism then functioning to lock the fin in the open position. It will be understood, of course, for the desired effect just described to obtain, the threads on the shaft of certain ones of the fins will be right hand due to the direction of rotation of such fins, whereas the threads on the shaft of other fins will be left hand because the direction of such fins will be opposite to the direction of rotation of the first named fins.

The desired pattern at the target consists of five, five, and six submissiles, equally spaced around the peripheries of three substantially concentric, generally circular boundaries of radii of approximately 40 feet, approximately 29 feet, and approximately 18 feet, respectively. Since the dispersal time has been set at a quarter of a second away from the target, the required dispersal or ejection velocities are approximately 160, 116, and 72 feet per second, respectively. It is to be understood, of course, that the remainder of the warhead and the nose attached to it, as well as the propulsion means, constitute the center submissile in the desired pattern. The ejection velocity of approximately 72 feet per second for the 6 missiles in the forward bank or cluster is determined by the piston size of the piston assemblies of the forward gas chamber and the gas pressure generated therein. The aft gas chamber has 10 submissiles and 10 piston assemblies associated therewith and every other piston has a diameter such as to give a suitable accelerating impulse to five submissiles to achieve 160 feet per second ejection velocity; the piston assemblies of the remaining five submissiles have a piston diameter such as to cause an ejection of velocity of 116 feet per second. These various ejection velocities substantially produce the theoretical desired pattern schematically shown in FIG. 11.

The operation of the warhead of this invention should be apparent from the foregoing description and only a brief summary thereof will be recited. After incorporation of the warhead in a suitable ordnance item having appropriate propulsion means and influence devices, the warhead is propelled toward the target and at a predetermined time from the target, an impulse is delivered through the electric primer **33**, burning of the propellant in gas chamber **27** is initiated and gases are generated which develop high pressures and high temperatures. The gases generated in gas chamber **27** spurt through igniter tube **29** and ignite the propellant in gas chamber **28**, thereby generating gases therein. The gases generated in the gas chambers **27** and **28** exert pressure upon the pistons of the piston assemblies associated therewith, and when the pressure exerted on the pistons becomes sufficiently great, the shear rings holding the pistons are ruptured and the pistons move outwardly, each carrying with it the associated submissile. At the end of the stroke of each piston, the enlarged portion thereof strikes

the internal shoulder of its respective cylinder and the ejection forces are sufficient to rupture the frangible attachment screw securing the submissile to its piston, thereby releasing the submissile with an acquired ejection velocity dependent upon the dimensions of the piston and the pressure of the gases exerting pressure on the piston. The particular ejection velocity acquired by the submissile causes the submissile to assume its place in the submissile pattern. During movement of the submissile to its place in the submissile pattern, the fins unfold and rotate to open position, the metal washer associated with each of the fins serving to absorb some of the energy the speed of rotation of the fin, thereby slowing or retarding the rotation of the fin so the detent mechanism thereof functions to lock the fin in open position for aerodynamically guiding the submissile so it may maintain its proper place in the submissile pattern.

From the foregoing description, it is evident there has been provided a cluster warhead comprised of a considerable number of submissiles, the external surfaces of the submissiles defining the external shape of the warhead, and means have been provided for ejecting the submissiles and for aerodynamically guiding the same so that the submissiles will strike a target in a desired submissile pattern.

Obviously many modifications and variations of the present invention are possible in light of the above teaching. It is therefore to be understood that the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a warhead of the type including circumferentially arranged submissiles which are adapted to be radially outwardly dispersed, a means for dispersing the submissiles comprising a gas chamber, a plurality of piston assemblies operatively associated with said gas chamber, each of the piston assemblies including a radially disposed cylinder formed with an internal shoulder and communicating with the interior of the gas chamber, an elongated piston in said cylinder, said piston being connected to a submissile, a shear ring carried by the piston and normally engaging said shoulder, said gas chamber containing means for generating high pressure, hot gases therein, said gases exerting pressure on said piston sufficient to rupture said shear ring and move the piston the length of its stroke, movement of the piston serving to impart a velocity to the submissile, said piston having an enlarged portion adapted to engage said shoulder at the end of the piston stroke, engagement of the shoulder by the piston suddenly stopping movement of the piston and serving to break the connection of the submissile to the piston; whereby the submissile is released for dispersal with a velocity imparted thereto.

2. A claim according to claim 1, wherein said means for dispersing the submissiles further comprises a second gas chamber connected to the first-named gas chamber by a high pressure channel, said second gas chamber containing a propellant charge therein, said channel being adapted to transmit hot gases from the first-named gas chamber to the second chamber for igniting said propellant charge, and piston assemblies operatively associated with said second gas chamber.

3. A claim according to claim 2, wherein predetermined ones of the cylinders of the piston assemblies associated with the respective gas chambers, have axes disposed in a plane, the cylinders of the remaining piston assemblies having axes canted with respect to said plane.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,003,082 | 9/1911 | Ziegenfuss | 102—7.2 |
| 1,278,578 | 9/1918 | Blackmore | 102—7.2 |
| 1,300,708 | 4/1919 | Edison | 102—50 |
| 2,376,227 | 5/1945 | Brown | 102—7.2 |
| 2,430,896 | 11/1947 | Uhl et al. | 102—50 |
| 2,447,941 | 8/1948 | Imber et al. | 102—7.2 |
| 2,690,122 | 9/1954 | Darnall et al. | 102—7.2 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 20,503 | 8/1945 | Finland. |

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