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[54] **SUBMISSIBLE AIR-TO-SURFACE WARHEAD WITH PROPELLANT-DIAPHRAGM DEPLOYMENT MECHANISM**

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[52] **U.S. Cl.** **102/7.2,** 102/37.6, 102/68

[51] **Int. Cl.** **F42b 25/16**

[58] **Field of Search** 102/7.2, 4, 7.4, 8, 37.6, 102/67, 68; 89/1.5

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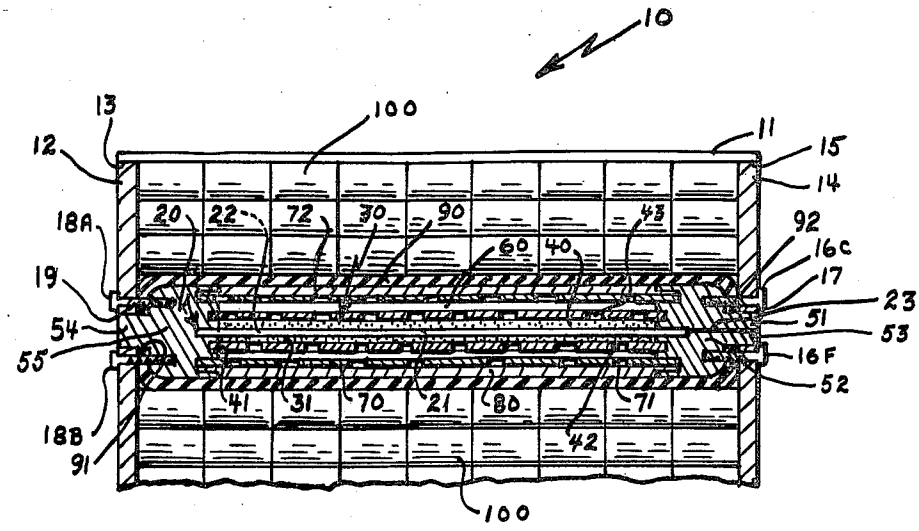
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[57] **ABSTRACT**

A submissile warhead, which is part of a parent air-to-surface missile, incorporates a novel propellant-diaphragm deployment mechanism which causes the simultaneous ejection of a plurality of submissiles, each of which contains an explosive charge, from within the warhead at different velocities and, thereby, results in a large, controlled and uniform ground impact distribution pattern of the submissiles upon the designated enemy ground target, such as a surface-to-air missile site.

3 Claims, 5 Drawing Figures



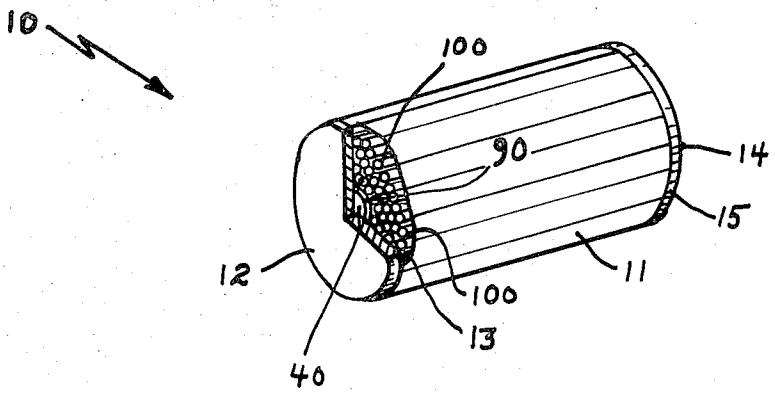


FIG. 1

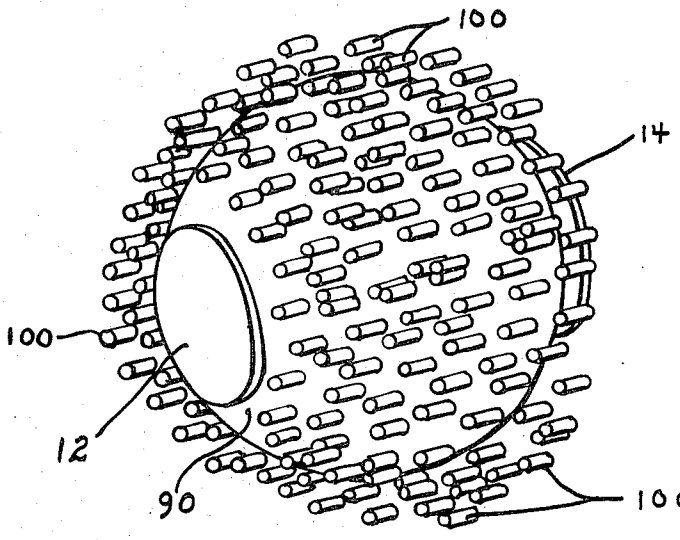


FIG. 5

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FIG. 3

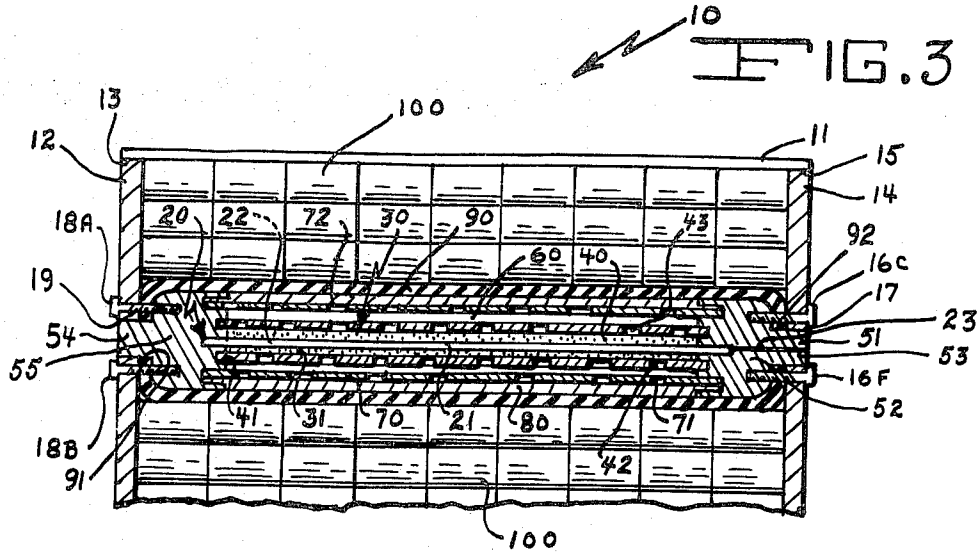


FIG. 2

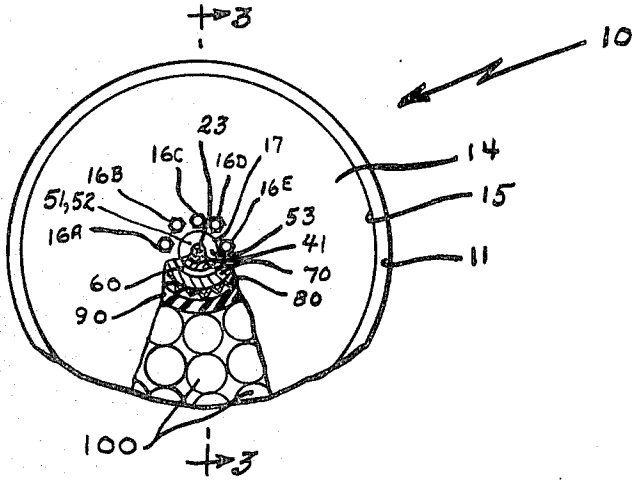
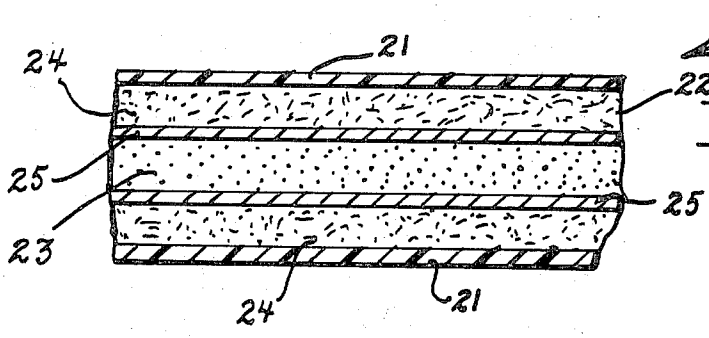


FIG. 4



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SUBMISSIBLE AIR-TO-SURFACE WARHEAD WITH PROPELLANT-DIAPHRAGM DEPLOYMENT MECHANISM

BACKGROUND OF THE INVENTION

This invention relates generally to a busmissile warhead which is part of a parent (i.e., carrier) air-to-surface missile structures, and more particularly to a propellant-diaphragm deployment mechanism in the warhead for ejecting (i.e., deploying, dispersing, or projecting) a plurality of submissiles (i.e., mini-bombs, bomblets and the like) from within the warhead on to a designated enemy ground target.

It is obviously in the interest of national security that the U.S. Government have available for self-defense a submissile air-to-surface warhead from which a plurality of submissiles, each of which contain an explosive charge, are ejected in such a manner as to result in a large, controlled, uniform submissile ground impact distribution pattern upon an enemy target, especially where the target is or includes a surface-to-air missile site.

Prior art techniques of submissile dispersal may be divided into three broad categories: dispersion by aerodynamic characteristics, dispersion by centrifugal means, and dispersion by chemical energy. Dispersion by aerodynamic characteristics includes spinning bodies, lifting bodies, winged bodies, parachutes and webbing catapult systems. These systems provide small, random, uncontrolled grouped impact patterns usually with an area near the center containing no submissiles. The second category in the dispersion of submissiles by spinning a container at high speed prior to release. This system in general requires complex, precision subsystems of high parasitic weight and volume resulting in high unit cost. The third category, dispersal by chemical energy, includes ejection of submissiles from containers by means of a propelling system within the container or by a self-contained propulsion system within the munition. Since the submissile should be made as small as possible, to achieve high packing density, a self-contained propulsion system is impractical. Therefore, a propelling system within the container that would provide a large, controlled, uniform submissile ground impact pattern is desired and is needed.

Several propelling system techniques have previously been used. These include the mortar technique, spigot technique, clamshell technique, rubber sleeve, and blast technique. The first two systems, mortar and spigot techniques, are both highly efficient in converting a high percentage of the available chemical energy to submissile kinetic energy. They provide controllable submissle ejection velocities in any range desired. However, both systems are complex, heavy, costly, and require large parasitic volumes. The clamshell technique requires both high parasitic weight and volume and results in relatively low velocity ranges (less than 100 feet per second). The rubber sleeve technique and blast technique are both low efficiency systems and provide high impact loading to the submissiles. Therefore, considerable buffering material is required to reduce the impact loads and large parasitic volumes result. Also, high, uncontrolled ejection velocities are obtained.

Therefore, there exists a genuine and critical need for a submissile air-to-surface warhead which includes a simple, moderate cost, minimal weight submissile deployment mechanism of the propelling system type to

provide a positive and controlled deployment of the charge-containing submissiles, such that the plurality of submissiles housed within the warhead will be ejected from the warhead simultaneously and with different velocities and will result in the desired large and uniform ground impact distribution pattern of the submissiles on the target. The submissile warhead and the deployment mechanism also should provide low impact loading to the submissiles; should have a low parasitic volume; and should permit the use of submissiles of almost any configuration.

We have invented a submissile warhead which incorporates such a submissile deployment mechanism and thereby have fulfilled the need and significantly advanced the state-of-the art. In addition, our invention converts approximately 70 percent of the available chemical energy of the propellant used into kinetic energy, instead of the 16 percent which is usually converted by prior art devices, and we have thereby further advanced the state-of-the art.

SUMMARY OF THE INVENTION

This invention relates to a submissile air-to-surface warhead which incorporates a simple, moderate cost, minimal weight propellant-diaphragm deployment mechanism for simultaneously ejecting at different velocities a plurality of submissiles, each of which contain an explosive charge, onto an enemy ground target, especially a surface-to-air missile site, in a large, controlled and uniform ground impact distribution pattern. The invention also permits low impact loading to the submissiles, low parasitic volume and the use of submissiles of almost any configuration.

Therefore, the principal object of this invention is to provice such a submissile warhead with such a propellant-diaphragm deployment mechanism.

This principal object, and still other and related ones of this invention, will become readily apparent after a consideration of the description of the invention and reference to the drawings.

DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view, in schematic form and partially fragmented, of a preferred embodiment of the submissile warhead;

FIG. **2** is an end elevation view, in schematic form and partially fragmented, of the preferred embodiment shown in FIG. **1**;

FIG. **3** is a side elevation view, in cross-section and in schematic form, of the preferred embodiment shown in FIGS. **1** and **2**, taken along line **3—3** of FIG. **2**;

FIG. **4** is a side elevation view, enlarged and in detail in cross-section, in schematic form, and partially fragmented, of a preferred embodiment of the igniter-initiator explosive charge of the propellant charge explosive train used in the submissile warhead; and

FIG. **5** is a perspective view, in schematic form, of the ejection of the submissiles from the warhead.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. **1**, there is shown a perspective view, in schematic form and partially fragmented, of a preferred embodiment **10** of the submissile warhead. The preferred embodiment **10** includes, as shown in FIG. **1**: a hollow open-ended cylindrical casing or sheath **11** of frangible material, preferably of Plexiglas;

first circular end plate **12**, preferably of heat treated aluminum, connected to and closing the open end **13** of cylindrical casing **11**; second circular end plate **14**, preferably of heat treated aluminum, connected to and closing the other open end **15** of cylindrical casing **11**; centrally located propellant chamber **40**; rubber diaphragm **90**, preferably 0.25 inch thick and made of what is known in the art as "RTV-630" silicon rubber; and a plurality of submissiles **100** circumferentially arranged in multiple radial layers, around rubber diaphragm **90**, in the space between the outer surface of rubber diaphragm **90** and the inner surface of casing **11**. It is to be noted, in connection with the submissiles **100**, that although they are depicted in FIG. **1** as being cylindrical in form, this is merely by way of illustration and not by way of limitation. The submissiles, such as **100**, may be of almost any configuration.

In FIG. **2** is shown an end elevation view, in schematic form and partially fragmented, of the preferred embodiment **10** depicted in FIG. **1**. Shown in FIG. **2** are: cylindrical casing or sheath **11**; second circular end plate **14** connected to, abutting the inner periphery of, and closing open end **15** of casing **11**; a plurality of retainers or fasteners, such as **16A**, **16B**, **16C**, **16D** and **16E**, passing into and through suitable openings in second circular end plate **14**; aperture **17** in second circular end plate **14**, with protuberance **51** of second end cap **52**, which said end cap is preferably of steel, fitting therein; aperture or longitudinal passage **53** in second end cap **52**, with igniter explosive charge **23**, preferably of the cord-type, such as is known in the art as "820 Pyrocore" and is manufactured by the duPont deNemours Co., therein; propellant chamber tube **41**, preferably of steel; annular expansion chamber **60**, concentric to and surrounding propellant chamber tube **41**; structural or support tube **70**, preferably of steel, of a larger diameter than, and concentric to and surrounding, propellant tube **41** and defining the outer surface of annular expansion chamber **60**; metal diaphragm or shell **80**, preferably of corrugated soft aluminum alloy and in the form of a hollow open-ended cylinder, of a larger diameter than, and concentric to and surrounding, structural tube **70**; rubber diaphragm **90**, which is circular in cross-section in its unexpanded state, of a diameter larger than, and concentric to and surrounding, metal diaphragm **80**; and a plurality of submissiles **100**, circumferentially arranged, in multiple radial layers, around diaphragm **90**, in the annular space between diaphragm **90** and casing **11**. It is again here emphasized that, although the submissiles **100** are shown in FIG. **2**. as having a circular end view, this is only by way of illustration. Submissiles of any end view configuration may be used.

FIG. **3** is a side elevation view, in cross-section and in schematic form, of the preferred embodiment **10** shown in FIGS. **1** and **2**, taken along line **3—3** of FIG. **2**. As shown in FIG. **3**, and in conjunction with FIGS. **1** and **2**, in all of which FIGS. the same component has the same reference numeral, submissile warhead **10** is, externally, essentially a close-ended right circular cylinder housing which is defined and formed by open-ended cylindrical casing **11**, and first **12** and second **14** circular end plates which close, respectively, open end **13** of casing **11** and other open end **15** of casing **11**. Circular end plates **12** and **14** fit into, abut the inner periphery of, and are connected to casing **11** at the respective open ends **13** and **15**. First circular end plate **12** has, at its geometric center, an aperture **19**. Similarly, second circular end plate **14** has at its geometric center, an aperture **17**. Protuberance **54** of first end cap **55**, which is preferably of steel, fits into and mates with aperture **19** of first circular end plate **12**. Similarly, protuberance **51** of second end cap **52** fits into and mates with aperture **17** of second circular end plate **14**. Second end cap **52** has an aperture or longitudinal passage **53** therein which is aligned with aperture **17** of second circular end plate **14**, and which contains in said passage **53** a portion of the length of the cord-type igniter **23** that is, thereby accessible external of second end cap **52**. Rubber diaphragm **90** is, in its unexpanded state, in the shape of a hollow close-ended cylinder having an aperture **91** at one end and an aperture **92** at the other end. Rubber diaphragm **90** is constrained and retained in longitudinal position at one end by and between, first end cap **55** and first circular end plate **12** which, in turn, are connected to each other by suitable means, such as fasteners or retainers **18A** and **18B**. Rubber diaphragm **90** is similarly constrained and retained in a longitudinal position at the other end by and between, second end cap **53** and second circular end plate **14** which, in turn, are connected to each other by suitable means, such as fasteners or retainers **16C** and **16F** (and **16A**, **16B**, **16D** and **16E** of FIG. **2**). As can be seen, protuberance **54** of first end cap **55** passes through aperture **91** of rubber diaphragm **90**, and protuberance **51** of second end cap **52** passes through aperture **92** of rubber diaphragm **90**. First end cap **55** and second end cap **52** are internal of rubber diaphragm **90**, and first circular end plate **12** and second circular end plate **14** are external to rubber diaphragm **90**.

Still with reference to FIG. **3**, soft aluminum alloy diaphragm or shell **80** is in the form of a corrugated hollow open-ended cylinder; is located internal of rubber diaphragm **90** in a longitudinal position; is concentric with and abuts rubber diaphragm **90**; and is disposed between and secured and closed at each end respectively by, first end cap **55** and second end cap **52**. Structural or support tube **70** is longitudinally positioned concentric with, adjacent to, and internal of diaphragm **80**; has a plurality of ports, such as **71** and **72**, preferably 16, in its wall; and is disposed between, secured and closed at each end respectively by, first end cap **55** and second end cap **52**. Propellant chamber tube **41** is longitudinally positioned concentric with, and internal of, structural tube **70**; has a plurality of ports, such as **42** and **43**, preferably 36, in its wall; and is disposed between, secured and closed at each end respectively by, first end cap **55** and second cap **52**, except for aperture or longitudinal passage **53**. Annular expansion chamber **60** is formed by the inner surface of structural tube **70**, the outer surface of propellant chamber tube **41**, and the inner surface of first and second end caps **55** and **52**. Disposed in the annular space formed by the outer surface of rubber diaphragm **90**, the inner surface of casing **11** and the inner surface of first and second circular end plates **12** and **14**, are a plurality of submissiles **100** circumferentially arranged, in multiple radial layers, around rubber diaphragm **90**.

Again with reference to FIG. **3**, propellant chamber **40** is formed by the inner surface off propellant chamber tube **41** and the inner surface of first and second end caps **55** and **52**. Disposed within propellant chamber **40**, and of course propellant chamber tube **41**, is propellant charge explosive train assembly **30**. The ex-

plosive train assembly includes a suitable propellant **31**, (i.e., propellant charge) the purpose or function of which is to produce (i.e., generate) gas. It is here to be noted that the term "propellant" is intented to mean and to include, but not be limited to, not only a single constituent propellant, but also a mixture or a compound of a plurality of propellant constituents. In fact, a propellant mixture or charge consisting of equal parts by weight of what is known and designated in the art as SR4990 propellant manufactured by duPont deNemours & Co. and of M–10 propellant is preferred. Alternatively, a propellant mixture or charge consisting of equal parts by weight of what is known and designated in the art as "Red Dot" propellant, which is manufactured by Hercules, Inc. and of M–10 propellant is preferred. Centrally positioned within propellant **31** and part of assembly **30** is igniter-initiator charge subassembly **20** which includes tube **21**, preferably of thin wall plastic, containing igniter-initiator explosive charge **22**.

With reference to FIG. **4**, there is shown in side elevation view enlarged and in detail, in cross-section, in schematic form and partially fragmented, a preferred embodiment of the propellant charge explosive train igniter-initiator charge subassembly **20** used in propellant chamber **40**, FIG. **3**, with propellant **31**, FIG. **3**. Within igniter-initiator tube **21** is igniter-initiator explosive charge **22** which includes centrally located igniter explosive charge **23**, preferably of the cord-type, such as is known and is designated in the arts as 820 Pyrocore, surrounded by an initiator explosive charge **24**, preferably a mixture of boron potassium nitrate. Igniter **23** has a covering or wrapping **25** within which igniter **23** is contained and confined prior to activation. It is here again noted that a portion of the length of igniter **23** with covering **25** is positioned in passage **53** of second end cap **52**, FIGS. **2** and **3**; is not surrounded by initiator **24**; and is accessible external of second end cap **52**.

With reference to FIG. **5**, therein is shown a perspective view, in schematic form, of the ejection, i.e., deployment of the plurality of submissiles **100** from the warhead. Also shown are first circular end plate **12**, second circular end plate **14**, and rubber diaphragm **90** which is constrained and retained at each end, and which has expanded radially and differentially, i.e., has expanded the greatest or most at the center thereof.

Again with reference to FIG. **5**, it is emphasized that although the submissiles **100** are shown therein as cylindrical in form, this is by way of illustration only. Submissiles of any configuration may be used.

Therefore, in summary and with reference to FIGS. **1–5**, the preferred embodiment **10** of our submissile warhead may be said to comprise: a housing formed by frangible open-ended cylindrical casing **11** and by first circular end plate **12** and second circular end plate **14**; a plurality of submissiles, such as **100**, each containing an explosive charge, with the submissiles circumferentially arranged within the housing in multiple radial layers; and a propellant-diaphragm deployment mechanism, centrally located within the housing and radially surrounded by submissiles, for ejecting the submissiles from the housing simultaneously and at different velocities, so that a controlled, large and uniform ground impact distribution pattern of the submissiles is obtained on the target. The propellant-diaphragm deployment mechanism may, in the interest of simplicity and brevity, be said to include but not be limited to: rubber diaphragm **90**, constrained and retained at each end; corrugated soft aluminum alloy diaphragm **80** concentric with, within, and abutting rubber diaphragm **90**; structural tube **70**, with ports, concentric with, within, and abutting diaphragm **80**; propellant chamber tube **41**, with ports, and with propellant chamber **40** therein, with tube **41** concentric with and within structural tube **70**, annular expansion chamber **60** formed by the inner surface of structural tube **70** and the outer surface of propellant chamber tube **41**; suitable means, such as end caps **55** and **52** for closing each end of, and securing in concentric relationship, rubber diaphragm **90**, metal diaphragm **80**, structural tube **70**, and propellant chamber tube **41**; and a suitable propellant charge explosive train assembly **30** disposed within propellant chamber **40** of tube **41**.

MODE OF OPERATION OF THE PREFERRED EMBODIMENT

When the parent (i.e., carrier) air-to-surface missile is released from its source, such as an aircraft over or near the designated target, the submissile warhead **10** is, in turn, subsequently launched, dropped, or the like, from the parent missile and the propellant charge explosive train, FIGS. **3** and **4**, is activated. Since neither the parent missile nor the means for activating the propellant charge explosive train **30** form any part of this invention and since an understanding of either is not necessary for an understanding of this invention, neither will be described or explained herein.

More specifically, cord-type igniter **23** with covering **25**, FIGS. **3–5**, is activated by suitable conventional means not part of this invention. As a result igniter **23** fragments, burns, and the like, covering **25** and ignites the initiator charge **24**, FIG. **4**. Then, the initiator charge **24** fragments, burns, and the like, igniter-initiator tube **21**, FIGS. **3** and **4**, and ignites propellant **31** FIG. **3**. In turn, propellant **31** burns and generates a gas which is exhausted through ports, such as **42** and **43**, FIG. **3**, of propellant chamber tube **41**, FIGS. **2** and **3**. The gas generated by the burning of propellant **31** is exhausted through the propellant chamber tube ports and flows into annular expansion chamber **60**, FIGS. **2** and **3**, at a rate determined by choked flow. The gas is expanded and cooled in chamber **60**. The gas then flows through the ports, such as **71** and **72**, FIG. **3**, of structural or support tube **70**, FIGS. **2** and **3**, and into the volume behind corrugated metal diaphragm **80**, FIGS. **2** and **3**. It is here to be noted that metal diaphragm **80** prevents the propellant gases from coming into direct contact with rubber diaphragm **90**, FIGS. **1**, **2**, **3** and **5**, since the gases would be detrimental to the rubber diaphragm **90** in that they might cause damage and premature rupture to rubber diaphragm **90**. As gas pressure increases metal diaphragm **80** and rubber diaphragm **90** expand radially and provide the energy to accelerate submissiles **100**, FIGS. **1**, **2**, **3** and **5**, without high impact loading of the submissiles **100**. The energy imparted through submissiles **100** shatters casing **11**, FIGS. **1–3**, thereby permitting ejection of the submissiles **100**. Since rubber diaphragm **90** is constrained and retained at each end, differential expansion of diaphragm **90** occurs over its entire length, thereby varying the ejection velocity of each of the submissiles **100**.

As a result, a large, controlled, uniform ground impact distribution pattern of the submissiles **100** is obtained on the target.

As a related matter, it is to be noted that two full scale models of the preferred embodiment **10** of the submissile warhead were fabricated and tested. Each of these warheads was 12.12 inches in diameter, 21.5 inches long, and weighed approximately 150 pounds. Five hundred sixty-seven 95-gram simulated submissiles of cylindrical configuration were packaged, i.e., circumferentially arranged in multiple radial layers, in the annular space formed by the outer surface of rubber diaphragm **90,** FIGS. **1, 2, 3** and **5,** the inner surface of casing **11,** FIGS. **1–3,** which in these models was of Plexiglass, the inner surface of first circular end plate **12,** FIGS. **1, 3** and **5,** and the inner surface of second circular end plate **14,** FIGS. **1, 2, 3** and **5.** In one test model a propellant mixture of 50 grams of M–10 propellant and 50 grams of SR 4990 propellant was used. Each model tested resulted in the desired controlled, large, uniform submissible impact pattern.

While there have been shown and described the fundamental features of our invention, as applied to a preferred embodiment and as adapted for a particular use, it is to be understood that various substitutions, omissions and adaptations may be made by those of ordinary skill in the art without departing from the spirit of the invention. For example, our invention may be used, or can be adapted to be used, with or in a suitable ordnance item, other than an air-to-surface missile structure.

What we claim is :

1. A submissile warhead, adapted for use with a parent air-to-surface missile structure from which said warhead is launched onto a designated ground target, comprising:

a. a housing which includes:
   1. a hollow open-ended cylindrical casing of frangible material;
   2. a first circular end plate connected to and closing one open end of said casing;
   3. a second circular end plate connected to and closing the other open end of said casing;

b. a plurality of submissiles positioned within said housing, with each of said plurality of submissiles containing an explosive charge, and with the said plurality of submissiles circumferentially arranged, within said housing, in multiple radial layers;

c. and, means, disposed within said housing, for ejecting said plurality of submissiles, simultaneously and at different velocities, from within said housing, with said means centrally located within said housing and radially surrounded by said plurality of submissiles, and wherein said means includes:
   1. a rubber diaphragm in the unexpanded shape of a hollow close-ended cylinder having an aperture at each end, with said rubber diaphragm disposed within and concentric with said casing of said housing, and with said rubber diaphragm constrained and retained at each end by suitable means which also closes the apertures of said rubber diaphragm;
   2. a soft aluminum alloy diaphragm in the unexpanded shape of a corrugated hollow open-ended cylinder, with said soft aluminum alloy diaphragm positioned internal of, concentric with, and abutting said rubber diaphragm, and with said soft aluminum alloy diaphragm disposed between and secured and closed at each end by suitable means;
   3. a steel structural tube with a plurality of ports in its wall, with said structural tube positioned internal of, concentric with, and abutting said soft aluminum alloy diaphragm, and with said structural tube disposed between and secured and closed at each end by suitable means;
   4. a steel propellant chamber tube with a plurality of ports in its wall, with said propellant chamber tube positioned internal of and concentric with said steel structural tube, and with said propellant fchamber tube disposed between and secured and closed at each end by suitable means;
   5. and, a propellant charge explosive train, for generating gas, disposed essentially within said propellant chamber tube, wherein said propellant charge explosive train includes:
      aa. an igniter explosive charge;
      bb. an initiator explosive charge radially surrounding said igniter explosive charge;
      cc. and, a propellant explosive charge radially surrounding said initiator explosive charge;

whereby when said submissiles are ejected from said housing, they form a controlled, large, uniform ground impact distribution pattern on the target.

2. Means for ejecting said plurality of submissiles from within said housing, as set forth in claim **1,** wherein said igniter explosive charge of said propellant charge explosive train is of the cord-type.

3. Means for ejecting said plurality of submissiles from within said housing, as set forth in claim **1,** wherein said initiator explosive charge is a mixture of boron potassium nitrate.

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