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(54) ADJUSTABLE ADAPTABLE VERTICAL LAUNCHING SYSTEM

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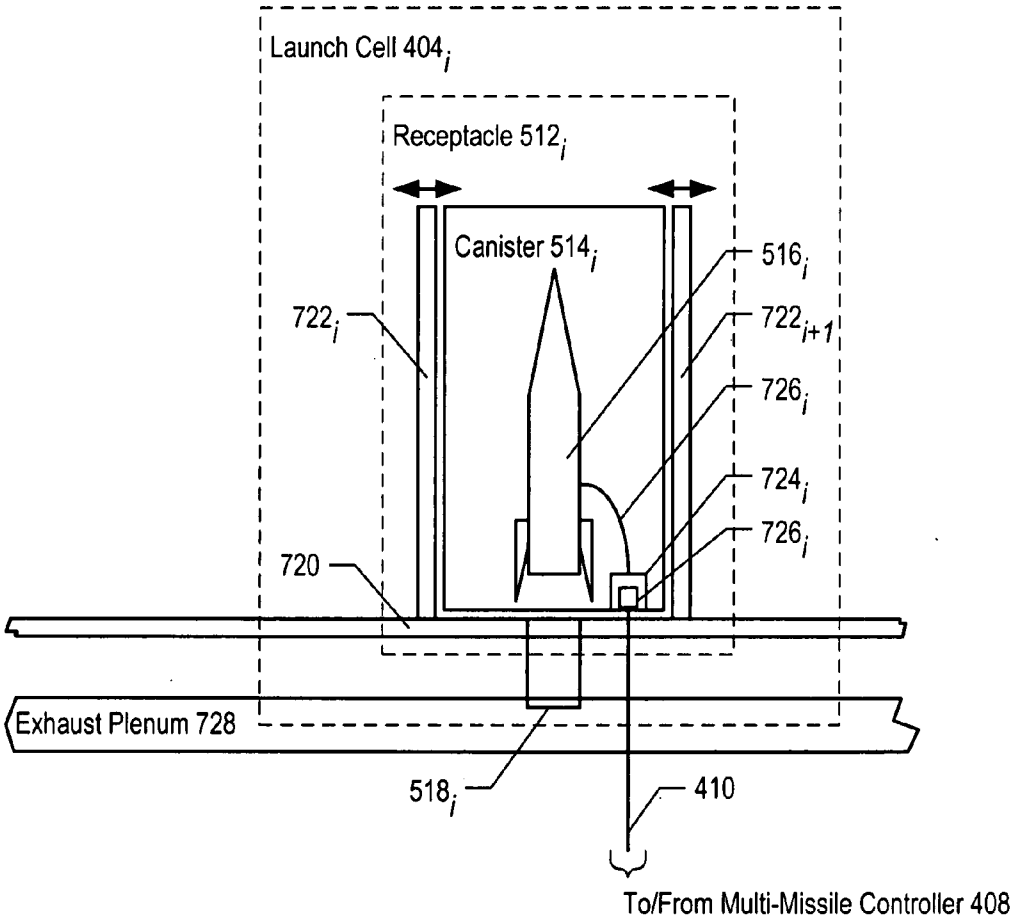
(57) **ABSTRACT**

A reconfigurable missile launcher that avoids some of the costs and disadvantages associated with missile launchers in the prior art. In particular, the illustrative embodiment of the present invention uses a variable-size receptacle for locating and holding a missile canister chosen from a set of missile canister types. The illustrative embodiment also includes a controller that includes data sets that are specific to each of a plurality of missile types.



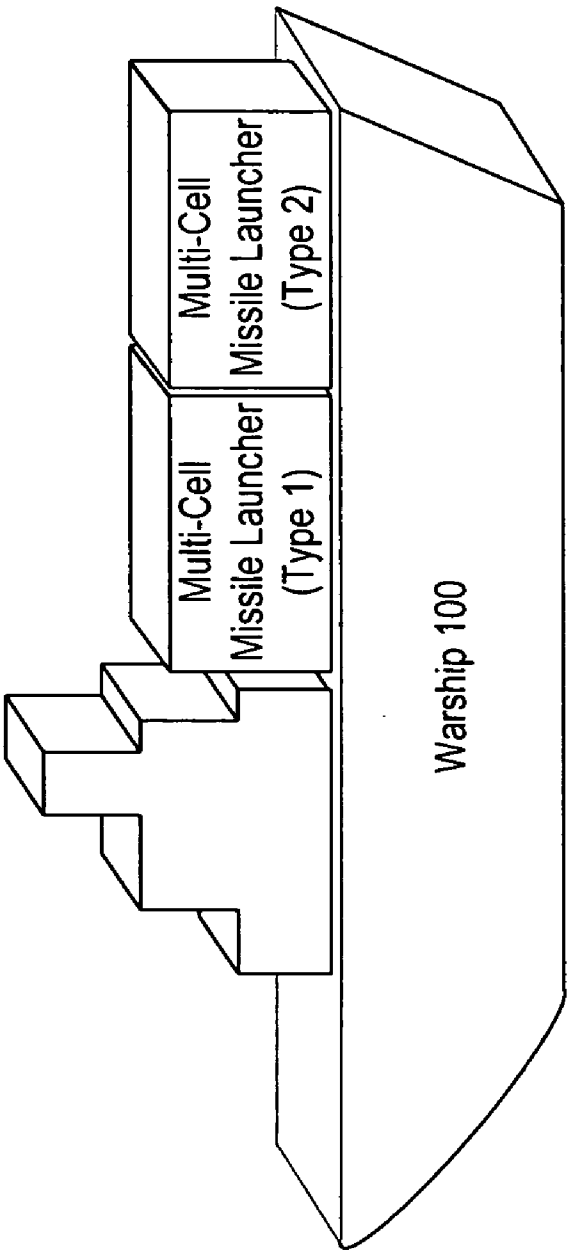


Figure 1 (Prior Art)

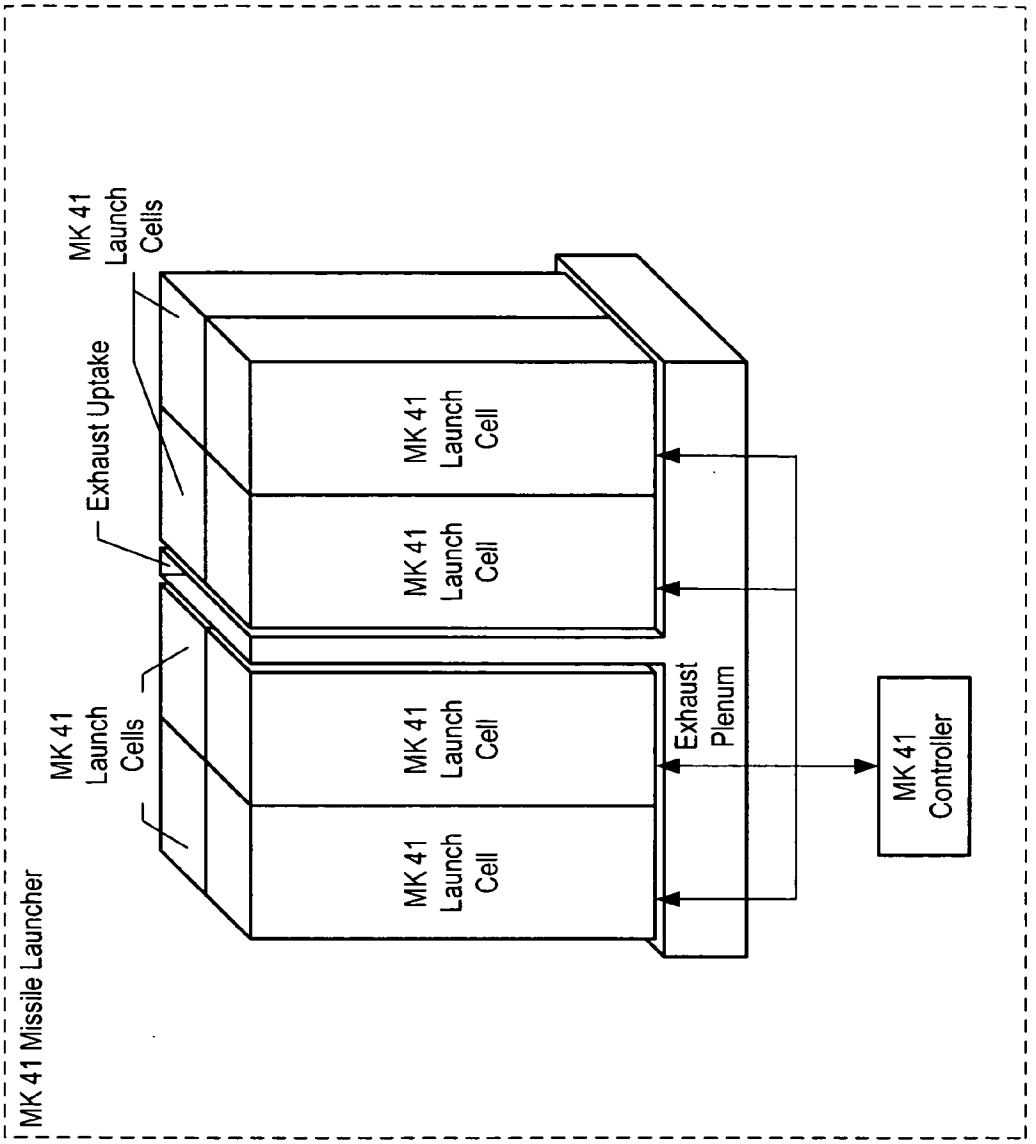


Figure 2 (Prior Art)

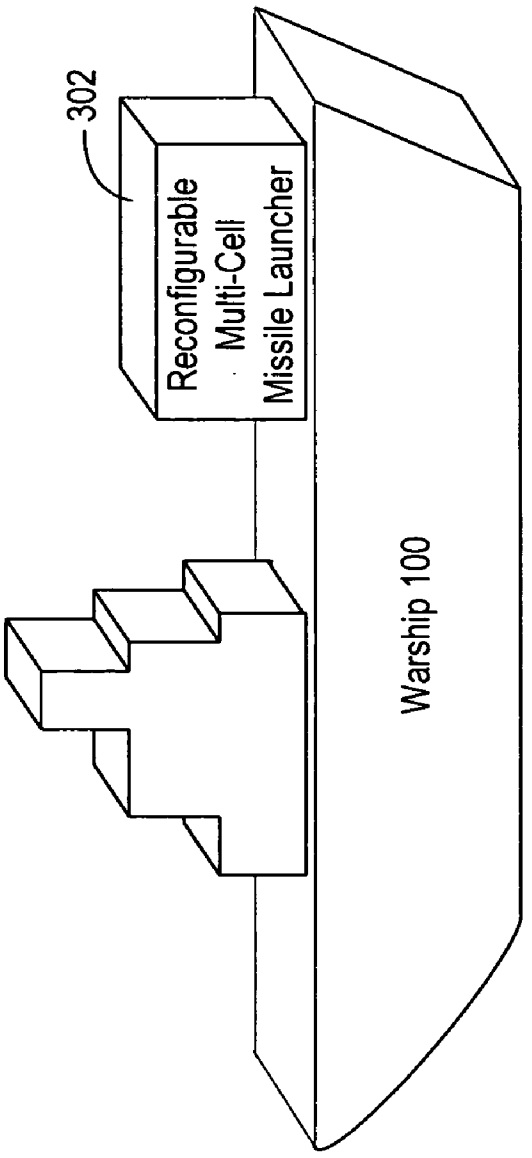

302
Reconfigurable
Multi-Cell
Missile Launcher
Warship 100

Figure 3

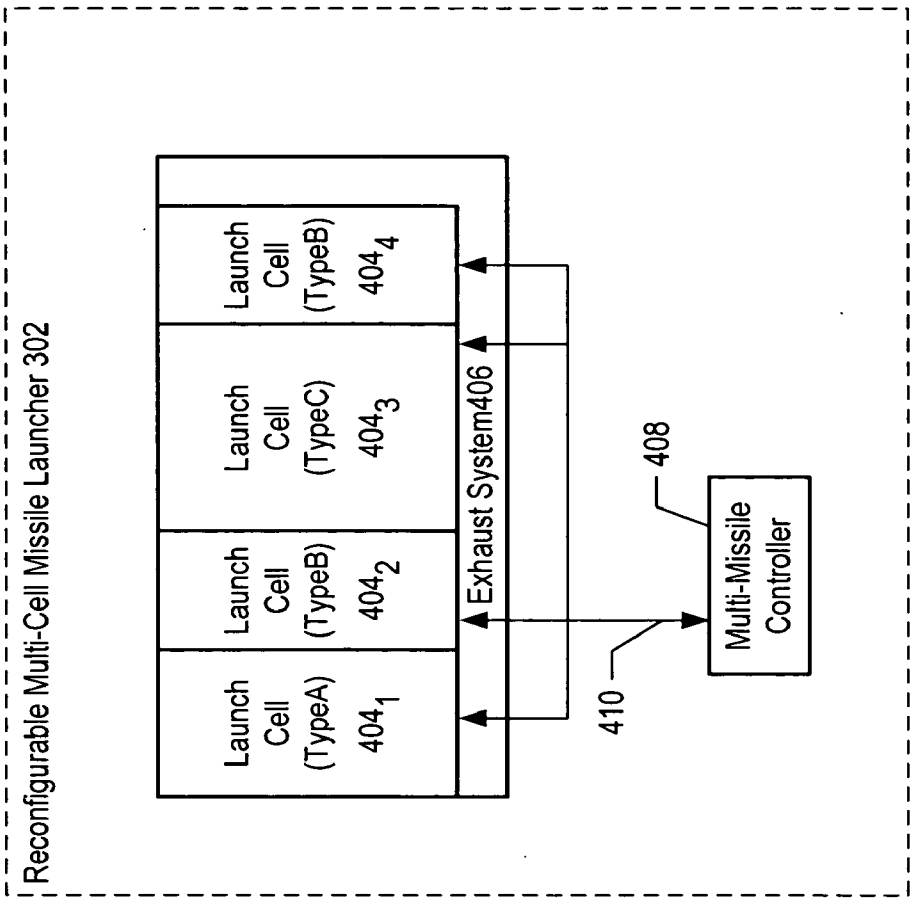

Reconfigurable Multi-Cell Missile Launcher 302
Launch Cell (TypeA) 404 1
Launch Cell (TypeB) 404 2
Launch Cell (TypeC) 404 3
Launch Cell (TypeB) 404 4
Exhaust System406
410
408
Multi-Missile Controller

Figure 4

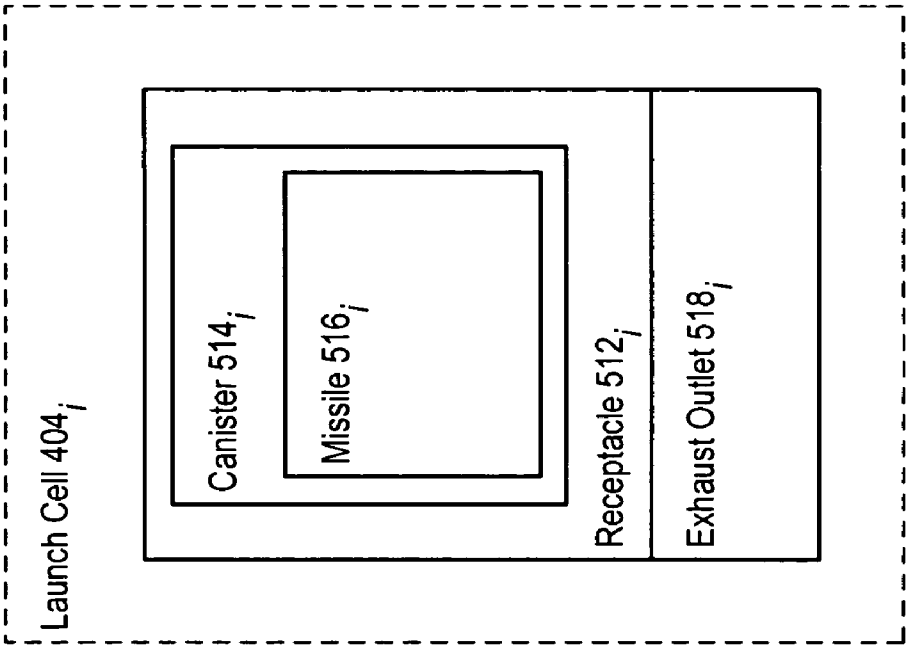

Launch Cell 404$_i$
Canister 514$_i$
Missile 516$_i$
Receptacle 512$_i$
Exhaust Outlet 518$_i$

Figure 5

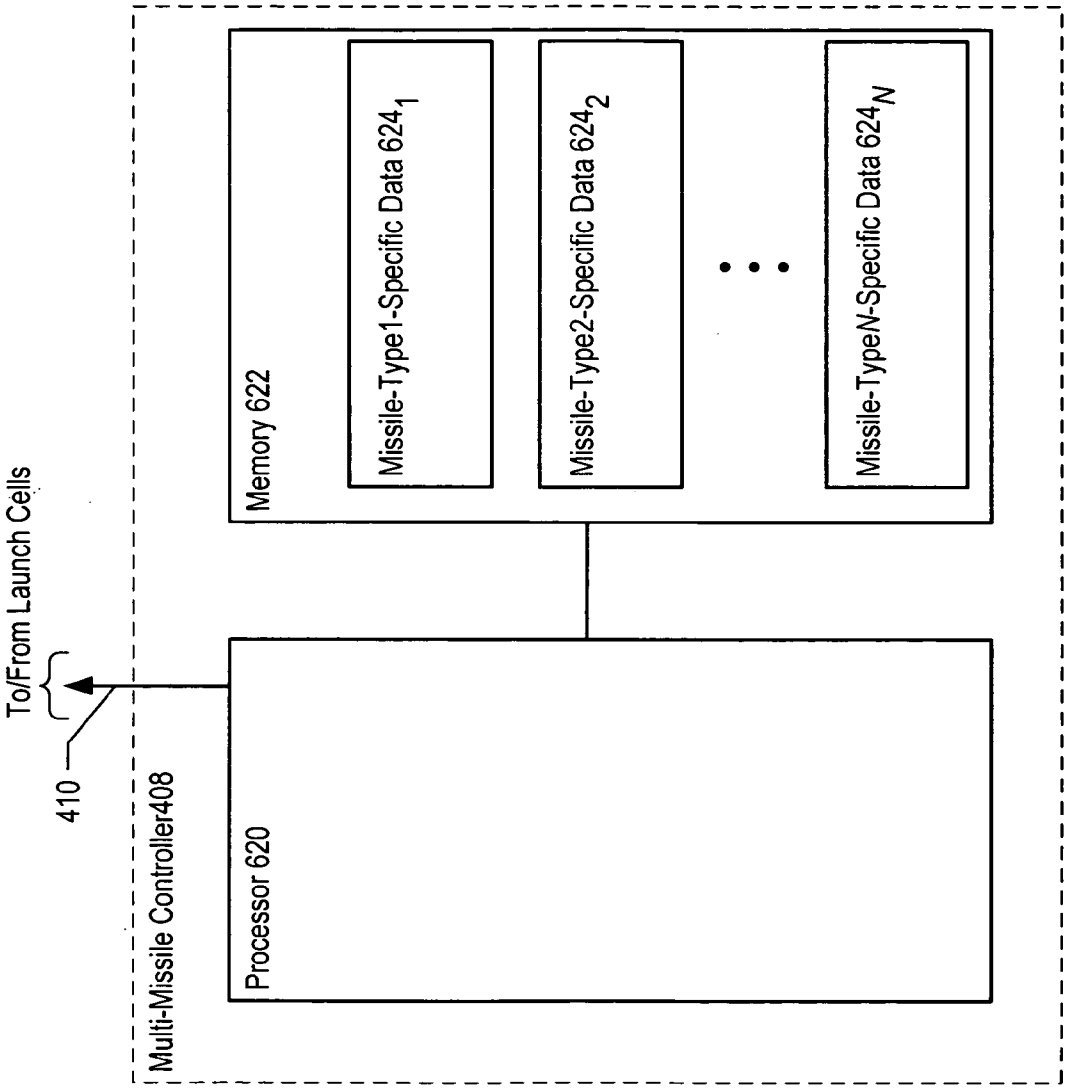

Multi-Missile Controller408
Processor 620
Memory 622
Missile-Type1-Specific Data 624$_1$
Missile-Type2-Specific Data 624$_2$
Missile-TypeN-Specific Data 624$_N$
410
To/From Launch Cells

Figure 6

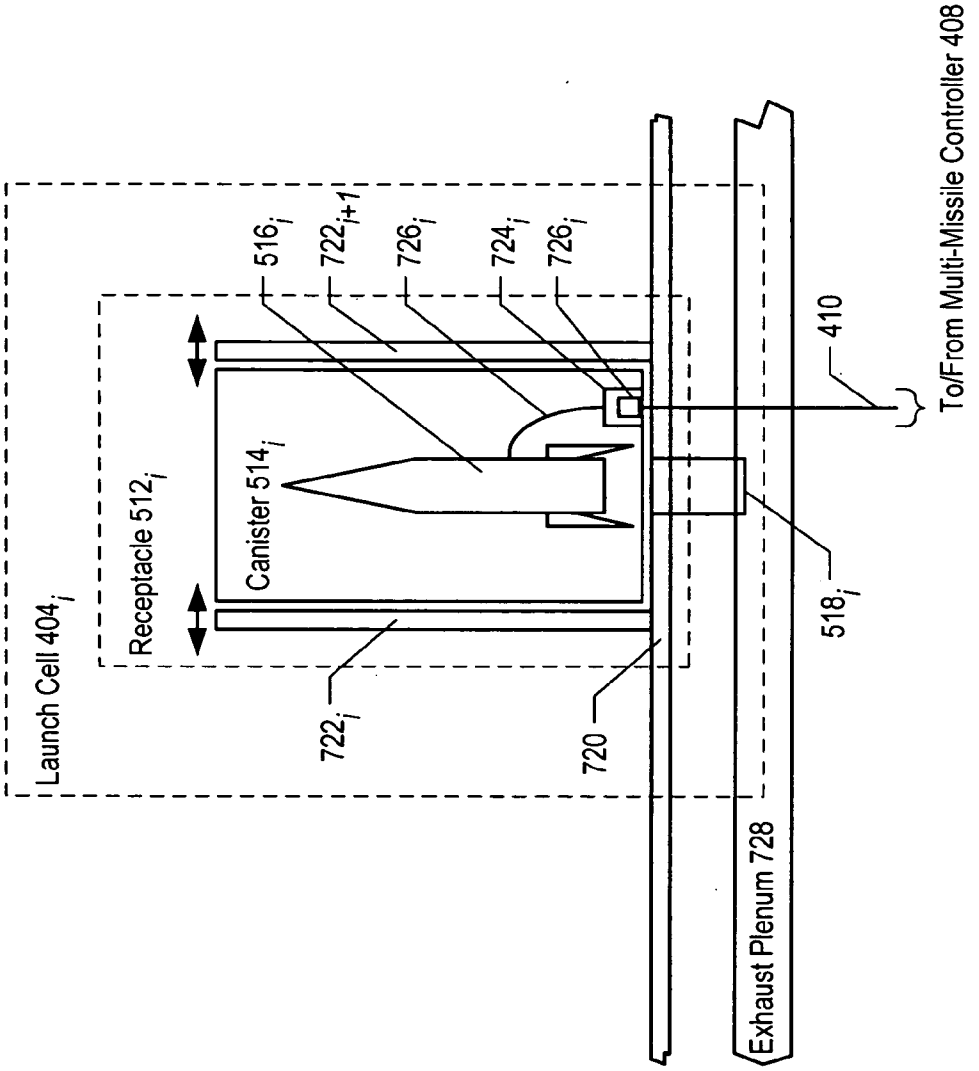

Launch Cell 404$_i$
Receptacle 512$_i$
Canister 514$_i$
516$_i$
722$_{i+1}$
726$_i$
724$_i$
726$_i$
410
To/From Multi-Missile Controller 408
518$_i$
722$_i$
720
Exhaust Plenum 728

Figure 7

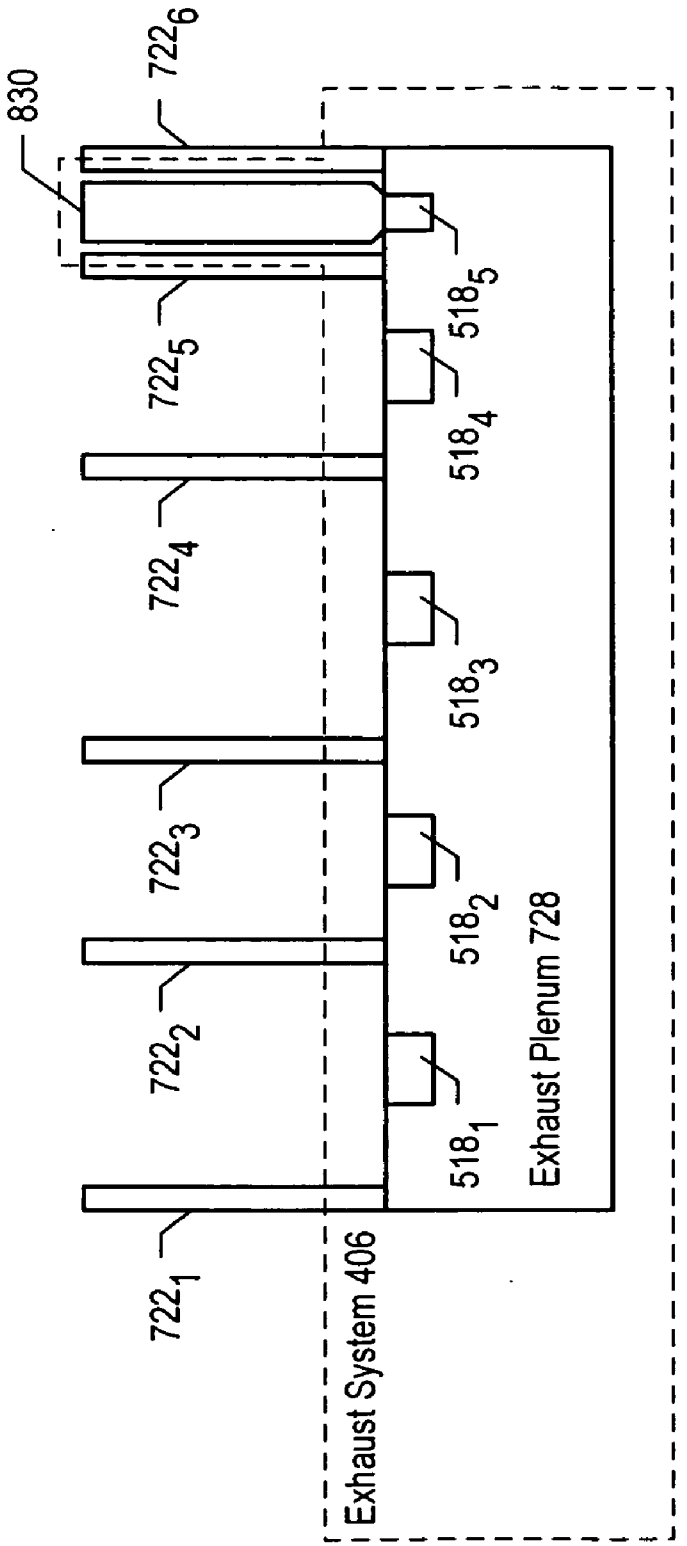

830
722_6
722_5
722_4
722_3
722_2
722_1
518_5
518_4
518_3
518_2
518_1
Exhaust Plenum 728
Exhaust System 406

Figure 8

ADJUSTABLE ADAPTABLE VERTICAL LAUNCHING SYSTEM

FIELD OF THE INVENTION

[0001] The present invention relates to missilery in general, and, more particularly, to missile launchers.

BACKGROUND OF THE INVENTION

[0002] A missile is propelled by fuel and a chemical-propulsion engine. A chemical-propulsion engine propels a missile by the reaction that results from the rearward discharge of gases that are liberated when the fuel is burned. For the purposes of this specification, a "missile" is defined as a projectile whose trajectory is not necessarily ballistic and can be altered during flight (as by a target-seeking radar device and control elements).

[0003] Multi-cell missile launchers have been developed for several types of missiles. **FIG. 1** depicts two such multi-cell missile launchers mounted to the deck of warship **100** as is known in the prior art. In some prior art arrangements, the multi-cell missile launchers are mounted below the deck. Each launcher is capable of locating, holding, and launching a plurality of a single type of missile canister. The type(s) of launcher is chosen based on the desired capability of the weapons platform, such as warship **100**.

[0004] **FIG. 2** depicts a perspective-view of a Lockheed-Martin MK 41 multi-cell missile launcher, which is an example of a multi-cell missile launcher known in the prior art. Each cell of the multi-cell missile launcher is the same (i.e., only one type of missile is launched from the launcher). A characteristic of modern warfare is the need to derive multi-functional capability from weapons platforms used in battle. A warship, for example, might need to launch surface-to-surface missiles during one phase of a battle, and surface-to-air missiles during a different phase of the same battle. Currently, multi-functionality is derived at the level of the systems platform, such as warship **100**, by providing multiple missile launching systems wherein each missile launching system has different functionality. In order to attain multi-functional capability for the weapons platform, multiple launchers are required, which leads to added infrastructure, space requirement, and expense for the weapons platform.

[0005] The multi-cell missile launcher depicted in **FIG. 2** comprises a 2×4 array of MK-41 launch cells, each of which contains a missile of the same type. Each cell is controlled by a MK-41 controller, which contains data and information that is specific to the type of guided missile contained in the launch cells.

[0006] In the prior art, missile canisters have been adapted to hold missiles that are smaller than the missiles for which these missile canisters have been designed. However, this leads to wasted space and reduced firepower for the launch system. In addition, the size of the missile canister limits the size of the missile that can be used, which limits the flexibility of existing missile launchers.

[0007] Therefore, the need exists for a missile launcher that avoids or mitigates some or all of these problems.

SUMMARY OF THE INVENTION

[0008] The present invention provides a missile launch system that can be reconfigured to launch missiles of various types and sizes. In particular, the illustrative embodiment of the present invention uses variable-sized receptacles for locating and holding different types of missile canisters. In addition, the illustrative embodiment uses a controller that contains a data set of information for each type of missile for which the reconfigurable launcher can be configured. This mitigates some of the problems associated with launching multiple missile types in the prior art.

[0009] The illustrative embodiment comprises: a missile canister, a missile contained in the missile canister, a reconfigurable receptacle for locating and holding any one of a plurality of missile canister types, an reconfigurable exhaust system for venting fumes from missile canisters in any allowed launcher configuration, and a controller for controlling a plurality of missile types.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** depicts a representational diagram of a naval launch system according to the prior art.

[0011] **FIG. 2** depicts a perspective view of a multi-cell missile launcher according to the prior art.

[0012] **FIG. 3** depicts a representational diagram of a naval launch system in accordance with the illustrative embodiment.

[0013] **FIG. 4** depicts a block diagram of reconfigurable launcher **302** in accordance with the illustrative embodiment.

[0014] **FIG. 5** depicts a block diagram of a launch cell in accordance with the illustrative embodiment.

[0015] **FIG. 6** depicts a block diagram of a multi-missile controller in accordance with the illustrative embodiment.

[0016] **FIG. 7** depicts a cross-sectional view of a launch cell in accordance with the illustrative embodiment.

[0017] **FIG. 8** depicts a cross-sectional view of an exhaust system in accordance with the illustrative embodiment.

DETAILED DESCRIPTION

[0018] **FIG. 3** depicts a representational diagram of a naval launch system in accordance with the illustrative embodiment. Although reconfigurable multi-cell missile launcher **302** (hereinafter referred to as "reconfigurable launcher"**302**) is mounted on the deck of warship **100**, it will be clear to those skilled in the art, after reading this disclosure, how to make and use alternative embodiments of the present invention in which reconfigurable launcher **302** is mounted below the deck of warship **100**, is terrestrially-based, or is mounted on another type of vehicle (e.g., a truck, a railroad car, a submarine, a space vehicle, a satellite, etc.)

[0019] **FIG. 4** depicts a block diagram of reconfigurable launcher **302** in accordance with the illustrative embodiment. Although only a one-dimensional array of four launch cells is shown in **FIG. 4**, it will be clear to those skilled in the art, after reading this disclosure, how to make and use alternative embodiments of the present invention in which launch system **302** comprises a single reconfigurable launch cell, a one-dimensional array of any number of reconfigurable launch cells, or a two-dimensional array of any number of reconfigurable launch cells.

[0020] Reconfigurable launcher **302** comprises Type-A launch cell $\mathbf{404}_1$, two Type-B launch cells $\mathbf{404}_2$ and $\mathbf{404}_4$, Type-C launch cell $\mathbf{404}_3$, exhaust system **406**, cable **410**, and multi-missile controller **408**. The missile types, A, B, and C represent three different nonspecific missile types, each having a different canister size.

[0021] Exhaust system **406** is connected to all launch cells $\mathbf{404}_1$ through $\mathbf{404}_4$ via exhaust outlets such that exhaust system **406** vents exhaust fumes generated during the launch of a missile in one or all of launch cells $\mathbf{404}_1$ through $\mathbf{404}_4$. Exhaust system **406** is described in detail below and with respect to **FIGS. 7 and 8**.

[0022] Multi-missile controller **408** contains multiple data sets, wherein each data set contains the data and information specific to the control and launch of each missile type for which reconfigurable launcher **302** is configured. Multi-missile controller **408** is connected to each launch cell $\mathbf{404}_1$ through $\mathbf{404}_4$ via cable **410**, so as to provide bi-directional communications between multi-missile controller **408** and each launch cell. Multi-missile controller **408** is described in detail below and with respect to **FIG. 6**.

[0023] **FIG. 5** depicts a block diagram of launch cell $\mathbf{404}_i$, wherein i is a positive integer in the set {1, . . . , 4}, in accordance with the illustrative embodiment. Launch cell $\mathbf{404}_i$ comprises receptacle $\mathbf{512}_i$, missile canister $\mathbf{514}_i$, missile $\mathbf{516}_i$, and exhaust outlet $\mathbf{518}_i$.

[0024] Receptacle $\mathbf{512}_i$ locates and secures missile canister $\mathbf{514}_i$, which includes missile $\mathbf{516}_i$. Exhaust outlet $\mathbf{518}_i$ provides a path through which the exhaust fumes generated by missile $\mathbf{516}_i$ during launch can escape from launch cell $\mathbf{404}_i$. The size of receptacle $\mathbf{512}_i$ determines the type of missile canister $\mathbf{514}_i$. Different types of missiles are contained in missile canisters of different sizes. Therefore, in order to enable reconfigurable launcher **302** to accommodate different missile types, the size of receptacle $\mathbf{512}_i$ is reconfigurable, as well as the position of exhaust outlet $\mathbf{518}_i$. The reconfigurability of receptacle $\mathbf{512}_i$ and exhaust outlet $\mathbf{518}_i$ is described in detail below and with respect to **FIG. 7**.

[0025] **FIG. 6** depicts a block diagram of multi-missile controller **408** in accordance with the illustrative embodiment. Multi-missile controller **408** comprises processor **620** and memory **622**. Memory **622** comprises N data sets $\mathbf{624}_i$, wherein i is a positive integer in the set {1, . . . , N}. Each data set $\mathbf{624}_i$ includes data and information specific to the control and launch of one of the N missile types for which reconfigurable launcher **302** can be configured.

[0026] **FIG. 7** depicts a cross-sectional view of launch cell $\mathbf{404}_i$ in accordance with the illustrative embodiment. Launch cell $\mathbf{404}_i$ comprises missile canister $\mathbf{514}_i$, exhaust outlet $\mathbf{518}_i$, platform **720**, movable supports $\mathbf{722}_i$ and $\mathbf{722}_{i+1}$, missile $\mathbf{516}_i$, missile canister connector $\mathbf{724}_i$, and missile canister-to-missile umbilical $\mathbf{726}_i$.

[0027] Platform **720** and movable supports $\mathbf{722}_i$ and $\mathbf{722}_{i+1}$ locate and support missile canister **514**. The position of movable supports $\mathbf{722}_i$ and $\mathbf{722}_{i+1}$ can be changed such that the spacing between them accepts a missile canister different than missile canister $\mathbf{514}_i$, and therefore a missile different than missile $\mathbf{516}_i$. Movement of movable supports $\mathbf{722}_i$ and $\mathbf{722}_{i+1}$ can be accomplished using hydraulics, electric motors, or manual means. It will be clear to those skilled in the art how to position movable supports $\mathbf{722}_i$ and $\mathbf{722}_{i+1}$.

[0028] The total size of reconfigurable launcher **302** is fixed and each of movable supports **722** may be shared between two adjacent launch cells $\mathbf{404}_i$ and $\mathbf{404}_{i\pm1}$. Therefore, as the size of launch cell $\mathbf{404}_i$ is changed, the size of adjacent launch cell $\mathbf{404}_{i-1}$ or $\mathbf{404}_{i+1}$ is changed as well. For example, as movable support $\mathbf{722}_i$ is moved toward the left to enable location of a larger missile canister in receptacle $\mathbf{512}_i$, the opening between movable support $\mathbf{722}_i$ and $\mathbf{722}_{i-1}$ (not shown) is made smaller. Thus, the type of missile canister that can be located by receptacle $\mathbf{512}_{i-1}$ is changed. In some configurations, reconfigurable launcher **302** will have less than four launch cells, while in other configurations reconfigurable launcher **302** will have more than four launch cells.

[0029] Missile canister $\mathbf{514}_i$ includes a fly-through cover on one end, and a missile canister back plate on the other end. The missile canister back plate either opens or bursts upon ignition of missile $\mathbf{516}_i$ to provide access to exhaust outlet $\mathbf{518}_i$ for exhaust fumes from missile $\mathbf{516}_i$. Exhaust outlet $\mathbf{518}_i$ vents exhaust fumes into exhaust plenum **728**, where they combine with the exhaust fumes from other launch cells. It will be clear to those skilled in the art how to make and use a missile canister back plate that provides access to exhaust outlet $\mathbf{518}_i$ upon ignition of missile $\mathbf{516}_i$. The position of exhaust outlet $\mathbf{518}_i$ is reconfigurable to accommodate any of the missile types for which reconfigurable launcher **302** is configured.

[0030] Missile $\mathbf{514}_i$ communicates with multi-missile controller **408** via cable **410**. Cable **410** is connected to missile $\mathbf{514}_i$ through cable connector $\mathbf{726}_i$, missile canister connector $\mathbf{724}_i$, and missile canister-to-missile umbilical $\mathbf{726}_i$. In the illustrative embodiment, cable connector **726** is a universal connector that can mate to any of the missile canister connectors associated with each missile canister type for which reconfigurable launcher **302** is suitable. In some embodiments, cable **410** includes a plurality of cable connectors, one for each type of missile canister type for which reconfigurable launcher **302** is suitable.

[0031] **FIG. 8** depicts a cross-sectional view of exhaust system **406** in accordance with the illustrative embodiment. Exhaust system **406** comprises exhaust plenum **728**, exhaust outlets $\mathbf{518}_i$, wherein i is a positive integer in the set {1, . . . , 5}, and exhaust uptake **830**. Each launch cell $\mathbf{404}_1$ through $\mathbf{404}_4$ includes an exhaust outlet $\mathbf{518}_1$ through $\mathbf{518}_4$, such that the exhaust fumes generated during a missile launch in that cell are directed into exhaust plenum **728**. An additional exhaust outlet $\mathbf{518}_5$ provides access to exhaust uptake **830** for the exhaust fumes in exhaust plenum **728**. Exhaust uptake **830** provides egress for the exhaust fumes into the atmosphere that surrounds reconfigurable launcher **302**.

[0032] In some embodiments of the present invention, exhaust system **406** includes a plurality of exhaust uptakes **830**. In some embodiments of the present invention, exhaust uptake **830** is located in the interior of reconfigurable launcher **830**, i.e. between two launch cells such as launch cells $\mathbf{404}_2$ and $\mathbf{404}_3$. In some embodiments of the present invention, platform **720** comprises through-holes that allow exhaust fumes to vent directly through platform **720** and into and out of exhaust plenum **728**, obviating discrete exhaust outlets $\mathbf{518}_1$ through $\mathbf{518}_5$.

[0033] It is to be understood that the above-described embodiments are merely illustrative of the present invention

and that many variations of the above-described embodiments can be devised by those skilled in the art without departing from the scope of the invention. For example, in this Specification, numerous specific details are provided in order to provide a thorough description and understanding of the illustrative embodiments of the present invention. Those skilled in the art will recognize, however, that the invention can be practiced without one or more of those details, or with other methods, materials, components, etc.

[0034] Furthermore, in some instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the illustrative embodiments. It is understood that the various embodiments shown in the Figures are illustrative, and are not necessarily drawn to scale. Reference throughout the specification to "one embodiment" or "an embodiment" or "some embodiments" means that a particular feature, structure, material, or characteristic described in connection with the embodiment(s) is included in at least one embodiment of the present invention, but not necessarily all embodiments. Consequently, the appearances of the phrase "in one embodiment,""in an embodiment," or "in some embodiments" in various places throughout the Specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, materials, or characteristics can be combined in any suitable manner in one or more embodiments. It is therefore intended that such variations be included within the scope of the following claims and their equivalents.

The following claims are presented for examination:

1. An apparatus comprising:

(1) a first receptacle for positioning a missile canister, wherein said first receptacle has a physical adaptation that enables said first receptacle to accept missile canisters of different sizes; and

(2) an exhaust system for venting fumes from said missile canister.

2. The apparatus of claim 1 further comprising a controller capable of controlling a plurality of different types of missiles.

3. The apparatus of claim 2, wherein said controller comprises a data set for each of said plurality of different types of missiles.

4. The apparatus of claim 1 further comprising:

a first missile canister; and

a first missile, wherein said first missile is contained in said first missile canister and said first missile is selected from said plurality of different types of missiles.

5. The apparatus of claim 1 further comprising a second receptacle for positioning a missile canister, wherein said second receptacle has a physical adaptation that enables said second receptacle to accept missile canisters of different sizes.

6. The apparatus of claim 5 further comprising:

a second missile canister; and

a second missile, wherein said second missile is contained in said second missile canister and wherein said second missile is selected from said plurality of different types of missiles.

7. The apparatus of claim 5 further comprising a second missile canister, wherein said second guides locate said missile canister and wherein said exhaust missile canister vents fumes from said first missile canister.

8. The apparatus of claim 1 wherein said exhaust system comprises an exhaust outlet and wherein said exhaust outlet has a physical adaptation that enables the position of said exhaust outlet to be changed.

9. The apparatus of claim 1 wherein said exhaust system comprises a plurality of exhaust outlets.

10. The apparatus of claim 1 wherein said physical adaptation of said first receptacle comprises a plurality of supports, wherein said supports locate and secure said missile canister and wherein the position of at least one said support can be changed.

11. An apparatus comprising:

a platform;

a plurality of first guides for locating a missile canister, wherein said first guides project from a surface of said platform and wherein said first guides are substantially parallel to one another and further wherein a spacing between said first guides is variable such that said first guides locate any one of a plurality of missile canister types; and

an exhaust system for venting fumes from said missile canister.

12. The apparatus of claim 11 further comprising a controller capable of controlling a plurality of different types of missiles.

13. The apparatus of claim 12, wherein said controller comprises a data set for each of said plurality of different types of missiles.

14. The apparatus of claim 13 further comprising:

a first missile canister, wherein said first missile canister is selected from said plurality of missile canister types; and

a first missile, wherein said first missile is contained in said first missile canister and wherein said first missile is selected from said plurality of different types of missiles.

15. The apparatus of claim 14 wherein said controller further comprises a communications cable and a cable connector and further wherein said cable connector can mate to any of said plurality of missile canister types.

16. The apparatus of claim 14 further comprising a first missile, wherein said first missile is contained in said first missile canister and wherein said first missile is one of said different types of missiles.

17. The apparatus of claim 11 wherein said exhaust system comprises an exhaust outlet and wherein the position of said exhaust outlet is fixed.

18. The apparatus of claim 11 wherein said exhaust system comprises an exhaust outlet and wherein the position of said exhaust outlet is variable.

19. The apparatus of claim 11 wherein said exhaust system comprises a plurality of exhaust outlets.

20. The apparatus of claim 11 further comprising a plurality of second guides for locating a second missile canister, wherein said second guides project from a surface of said platform and wherein said second guides are substantially parallel to one another and further wherein a

spacing between said second guides is variable such that said second guides locate any one of said plurality of missile canister types.

21. The apparatus of claim 20 further comprising:

a second missile canister, wherein said second missile canister is selected from said plurality of missile canister types; and

a second missile, wherein said second missile is contained in said second missile canister and wherein said second missile is selected from said plurality of different types of missiles.

22. The apparatus of claim 20 wherein said exhaust system comprises an exhaust missile canister, wherein said second guides locate said exhaust missile canister and further wherein said exhaust missile canister vents fumes from said first missile canister.

23. An apparatus comprising:

a controller, wherein said controller is capable of controlling a plurality of different types of missiles; and

a first receptacle for positioning a missile canister, wherein said first receptacle has a physical adaptation that enables said first receptacle to accept a missile canister selected from a plurality of different types of missile canisters.

24. The apparatus of claim 23 further comprising:

a first missile canister, wherein said first missile canister is selected from said plurality of different types of missile canisters; and

a first missile, wherein said missile is selected from said plurality of different types of missiles.

25. The apparatus of claim 23 further comprising a second receptacle for positioning a missile canister, wherein said second receptacle has a physical adaptation that enables said second receptacle to accept a missile canister selected from a plurality of different types of missile canisters.

26. The apparatus of claim 25 further comprising:

a second missile canister, wherein said second missile canister is selected from said plurality of different types of missile canisters; and

a second missile, wherein said second missile is selected from said plurality of different types of missiles.

* * * * *