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(54) Title: MULTIPLE MISSILE CARRIAGE AND LAUNCH GUIDANCE MODULE

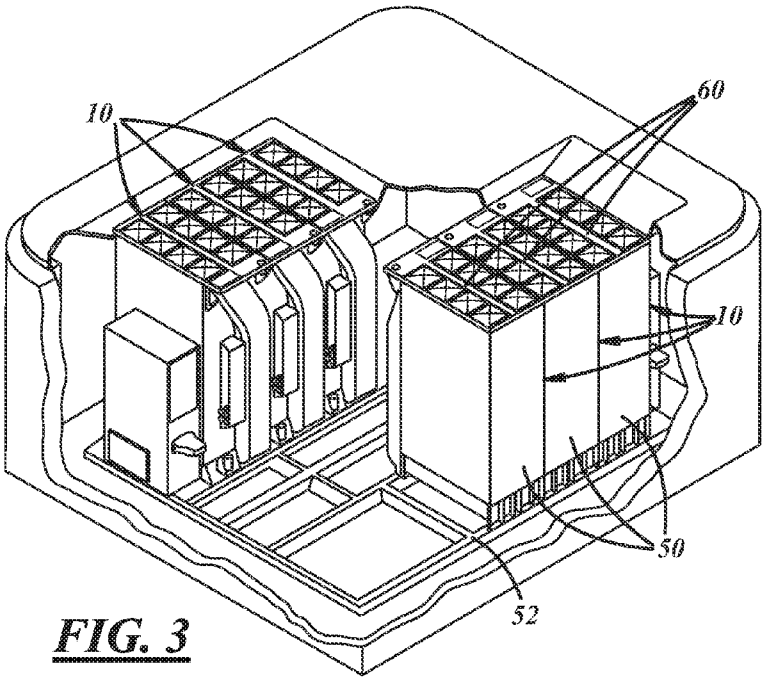

FIG. 3

(57) Abstract: A multiple missile carriage and launch guidance module comprising a plurality of missile launch rails that are each configured to carry and guide the launch of a missile and are carried on a common missile carriage wall in respective positions and orientations allowing for missile carriage and launch from the rails.

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

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MULTIPLE MISSILE CARRIAGE AND LAUNCH GUIDANCE MODULE

CROSS-REFERENCES TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND

FIELD

This application relates generally to a multi-missile carriage and launch guidance module for supporting the carriage and guiding the launch of a plurality of missiles.

DESCRIPTION OF RELATED ART INCLUDING INFORMATION DISCLOSED UNDER 37 CFR 1.97 AND 1.98

Surface-to-surface missile launch systems are known to include canisterized missiles. Figure 2 shows such a system installed in a surface vessel with deck launch bay doors open to show canister-housed (canisterized) missiles carried by missile carriage and launch modules received in launch bays of the surface vessel. Because each missile canister includes its own systems for supporting, communicating with, and controlling the environment of its housed missile, the canisters comprise a significant portion of the launch system's mass. This becomes a liability in that it reduces the total number of missiles that may be carried by a combat system or that may be loaded into a ground, air, or sea transport for resupply.

SUMMARY

A multiple missile carriage and launch guidance module is provided, which comprises a plurality of missile launch rails, each one of which is configured to carry and guide the launch of a missile. A common missile carriage wall may carry the missile launch rails in respective positions and orientations that allow for missile carriage and launch from the rails.

DRAWING DESCRIPTIONS

These and other features and advantages will become apparent to those skilled in the art in connection with the following detailed description and drawings of one or more embodiments of the invention, in which:

Figure 1 is a perspective view of a ship carrying a Surface-to-Surface Mission Module including two Surface-to-Surface Missile Systems;

Figure 2 is a perspective view of a prior art Surface-to-Surface Mission Module including three prior art carriage and launch guidance modules;

Figure 3 is an orthogonal view of the Surface-to-Surface Mission Module of Figure 1 cut away to show two Surface-to-Surface Missile Systems;

Figure 4 is an orthogonal view of one of the Surface-to-Surface Missile Systems of Figure 3;

Figure 5 is an orthogonal partial-cutaway view of one of three carriage and launch guidance modules of the Surface-to-Surface Missile System of Figure 3;

Figure 6 is a partially-exploded orthogonal view of the carriage and launch guidance module of Figure 5 with a shell cover and module lid removed to reveal missiles carried internally by the module;

Figure 7 is an orthogonal view of the carriage and launch guidance module of Figure 5 with missiles, shell covers, and module lid removed;

Figure 8 is a partially-exploded orthogonal view of the carriage and launch guidance module of Figure 7 with front and back structural skin portions of a missile carriage wall of the module separated to reveal an interior of the carriage wall;

Figure 9 is a fragmentary partial-cutaway top view of the carriage and launch guidance module with separated shell cover;

Figure 10 is a magnified view of circled region 10 of Figure 9 showing a linear wedge seal interface between the shell cover and the missile carriage wall of the launch guidance module;

Figure 11 is an isometric view of the linear wedge seal of Figure 10;

Figure 12 is a side view of the linear wedge seal of Figure 10 with the seal shown in a disengaged position;

Figure 13 is a cross-sectional view of the linear wedge seal of Figure 10 taken along line 13-13 of Figure 12 and showing a linear hook of the linear wedge seal as it is positioned with the linear wedge seal in its disengaged position; and

Figure 14 is a cross-sectional view of the linear wedge seal of Figure 10 showing the linear hook as it is positioned with the linear wedge seal in its engaged position.

DETAILED DESCRIPTION

A multiple missile carriage and launch guidance module is generally shown at 10 in Figures 1, and 3-8. The module 10 may include eight generally parallel missile launch rails 12 as best shown in Figure 7, although, in other embodiments, any number of rails 12 may be included. The rails 12 may, for example, be of the type used in an M299 Missile Launch System. As shown in Figures 5 and 6, each rail 12 may be configured to carry and guide the launch of a missile 14, such as, for example, an AGM-114L Longbow HELLFIRE missile.

As best shown in Figures 7 and 8, the module 10 may also include a common missile carriage wall 16 carrying the missile launch rails 12 in respective positions and orientations allowing for missile carriage and launch from the rails 12. The common missile carriage wall 16 obviates the need to accommodate individually canisterized missiles, reducing module weight and footprint by increasing missile 14 packing density in, for example, an Littoral Combat Ship Vertical Launch System LCSVLS application.

As shown in Figure 8 and 9, the carriage wall 16 may comprise a carriage wall core 17 defined by generally parallel spaced-apart front and back structural skins 18, 20 of the carriage wall 16. The skins 18, 20 may be joined together around respective peripheral edges by fasteners 22, and may include a rubber O-ring gasket 24 received in a channel 26 formed around the peripheral edge of one or both of the structural skins. The gasket 24 may be sandwiched between the peripheral edges of the skins 18, 20 to close and seal the carriage wall core 17. The carriage wall skins 18, 20 may be configured to cooperate in the carriage and distribution of missile carriage loads. The carriage wall structural skins 18, 20 may be machined from aluminum slabs or may, in other embodiments, be formed by any suitable means from any suitable material.

As shown in Figures 7 and 8, the rails 12 may be distributed between and carried by the front and back structural skins 18, 20 of the carriage wall 16. Four of the eight

rails 12 may be carried by the front skin 18 of the carriage wall 16 and the remaining four rails 12 carried by the back skin 20 of the carriage wall 16. The launch rails 12 of the plurality of launch rails 12 may be spaced laterally and oriented generally parallel to one another on the front and back skins 18, 20 of the carriage wall 16.

To provide structural stiffness in the carriage wall 16, the front and back structural skins 18, 20 may be machined to leave hard points 28 that project integrally inward from inner surfaces of the skins 18, 20 as shown in Figure 8. The hard points 28 may be configured to engage one another when the skins 18, 20 are closed together. Alternatively, or in addition to the hard points 28, the carriage wall 16 may comprise a filler 29 disposed between the front and back structural skins 18, 20 to add stiffness. The filler 29 may comprise, for example, aluminum honeycomb or a heat-resistant materials comprising, for example, Nomex®.

As shown in Figure 8, the module 10 may include sprinkler nozzles 30 carried by and distributed between the front and back structural skins 18, 20 of the carriage wall 16. Sixteen such nozzles 30 are distributed between the front and back structural skins 18, 20 in the present embodiment, but in other embodiments any suitable number of sprinkler nozzles 30 may be used. Each sprinkler nozzle 30 may be connected to sprinkler piping 32 that may be connected to a fluid source 33. The sprinkler piping 32 may be configured to provide a fluid pathway through the carriage wall core 17 and carriage wall structural skins 18, 20 for a fluid, such as a fire suppressant fluid, to be delivered to and dispensed through the sprinkler nozzles 30. The sprinkler nozzles 30 may be configured to dispense fluid in a direction and manner that suppresses missile exhaust flame. The sprinkler nozzles 30 may be selected, configured, and/or positioned to perform in a manner that meets safety requirements for whatever type of missiles 14 are to be carried by and launched from the module 10. For example, the nozzles 30 may be configured to spray fluid in a pattern that will wet-down and cool critical components such as warheads and/or pressure vessel sections of missiles 14 carried by the rails 12. The nozzles 30 may also or alternatively be located relatively high on the carriage

wall 16 to allow gravity to help direct the spray pattern to cover a vast majority of desired areas and components.

As shown in Figure 8 the sprinkler piping 32 may include an external portion 34 extending from the fluid source 33 to the carriage wall 16, and an internal portion 36 extending through the carriage wall core 17. The internal portion 36 may comprise machined-in piping walls that integrally extend from at least one of the inner surfaces of the structural skins 18, 20 and compress rubber seal strips 38 against an opposing inner surface or piping wall to define a fluid channel between the structural skins 18, 20.

The sprinkler piping 32 may further comprise a penetration interface (not shown) disposed between peripheral edges of the carriage wall structural skins 18, 20. The penetration interface may be configured to provide fluid communication between the external and internal sprinkler piping portions 34, 36 while maintaining a seal between the peripheral edges of the carriage wall structural skins 18, 20. The penetration interface may comprise any suitable interface known in the art such as, for example, a fluid tube cable that extends between the carriage wall structural skins 18, 20 and that is sealed by a gland nut. Alternatively, the penetration interface may comprise a bulkhead interface comprising a permanent or quick disconnect connector mounted and sealed to one or both carriage wall structural skins 18, 20.

The module 10 may include desiccant holder structures 42 configured to carry long-term storage desiccant within the carriage wall core 17 to maintain a dry environment within the carriage wall core 17. As shown in Figure 8, the desiccant holder structures 42 may be machined into the inner surfaces of the carriage wall skins 18, 20 to support the desiccant material in advantageous locations within the core 17.

The module 10 may include environmental sensors 44 disposed in the carriage wall core 17 as shown in Figure 8. The environmental sensors 44 may be configured to monitor conditions within the core 17 such as temperature, humidity, shock, vibration and the like, to monitor maintenance and safety requirements.

Figure 8 shows that the carriage wall 16 may include an integral cableway 46 comprising cableway walls 48 that integrally extend from the inner surfaces of at least one of the structural skins 18, 20 and compress rubber seal strips 38 against an opposing inner surface or cableway wall to define a cable channel between the structural skins 18, 20. The cableway walls 48 may run through the carriage wall core 17 and cooperate to form a channel configured to receive cabling (not shown), such as missile umbilical cabling, connecting the missiles 14 mounted on the rails 12 to a launcher electronics assembly such as an M299 Launcher Electronics Assembly (LEA) from an M299 missile launch system. The missile umbilical cabling may carry signals related to munitions control and monitoring. The integral cableway 46 may also or alternatively receive rail cabling connecting the rails 12 to the launcher electronics assembly for controlling and/or powering the environmental sensors 44, and/or other systems such as access/intrusion sensors, and/or rail-related electromechanical devices.

As shown in Figures 3-9, the module 10 may include a pair of spaced-apart generally parallel end walls 50 carrying the common carriage wall 16 between them. As shown in Figure 3, the end walls 50 may be configured to be carried by mounting interfaces of a module supporting structure 52, e.g., a ship-board structure configured to carry a missile carriage and launch module 10. Such a ship-board structure 52 may include a set of C channels or I beams that may carry attachment point hardware, e.g., a Base Ship Structure (BSS) or slightly modified version thereof.

As shown in Figures 5-8, the module 10 may include a plenum 54 carried by and between the end walls 50. The plenum 54 may be configured and positioned to receive and re-direct exhaust gases from missiles 14 being launched from the module 10. The plenum 54 may direct the exhaust gases to a discharge chute 56 configured to direct gases up through an uptake hatch 58 level with a deck of a ship in which the module 10 is mounted as best shown in Figure 6. The plenum 54 may include siliconized ablatives on interior surface areas of the plenum 54 where missile exhaust impinges, and may include other types of ablatives on other interior surface areas.

As shown in Figures 3-6, the module 10 may include a module lid 60 (or deck interface) carried by, and connected to and sealed by any suitable means to a top edge of the carriage wall 16. The module lid 60 may be connected and sealed by any suitable means to top edges of the end walls 50. The module lid 60 may be mounted flush with the deck as shown in Figure 3, and may include a rigid rectangular opening grid which may support flexible membranes configured to tear open when missiles 14 are launched through them. The carriage wall 16, module lid 60, plenum 54, and end walls 50 may be interconnected in such a way as to provide structural stiffness between these elements and to transfer loads from the carriage wall 16 and plenum to mounting interfaces of a structure, e.g., a ship-board structure, which is to carry the module 10.

As best shown in Figures 7 and 8, the end walls 50 may be connected by any suitable means at or adjacent respective top ends to the module lid 60. At or adjacent respective lower ends of the end walls 50, the end walls 50 may be connected to the plenum 54. The end walls 50 may be connected along inner vertical median regions to respective side edges of the carriage wall 16. The end walls 50 may thus support the plenum 54 in a position to receive and re-direct exhaust gases from missiles 14 being launched from the module 10, and to provide structural rigidity between the carriage wall 16, module lid, and the mounting interfaces of a structure carrying the module 10.

The module 10 may include front and back generally rectangular shell covers 62 removably disposed across and closing respective front and back module openings. The front module opening may be defined by front edges of the module lid 60, end walls 50, and plenum 54. The back opening may be defined by back edges of the module lid 60, end walls 50, and plenum 54. The shell covers 62 may be removable to provide access to the rails 12 and/or missiles 14 carried by the rails 12.

As best shown in Figures 5 and 6, each shell cover 62 may comprise a main cover panel 64 shaped to be removably disposed across and close a module opening 65, and 3 missile separator panels 66 integrally extending from the main cover panel 64.

The missile separator panels 66 may be spaced apart and configured to engage the carriage wall 16 and divide the spaces between the carriage wall 16 and the shell covers 62 into cells for individually housing missiles 14 carried by the rails 12 to protect such missiles 14 from each others' exhaust during launch. While the Figures show three missile separator panels 66 being used to separate four missiles 14 per shell cover 62, other embodiments may employ shell covers 62 configured with either more or fewer separator panels 66 corresponding to the various numbers of rails 12, missiles 14, etc. included in that embodiment.

The separator panels 66 may be sealed against outer surfaces of the carriage wall structural skins by, for example, linear wedge seals 68 configured to receive and engage mating linear hooks 76, as shown in Figures 9-14. The linear wedge seals 68 may comprise a sliding clamp 72, a brace 70, and mounting bolts 74 configured to attach the sliding clamp 72 to the brace 70. The sliding clamp 72 may include diagonal slots configured to receive the mounting bolts 74, such that the sliding clamp 72 may slide around the mounting bolts 74 along a path that allows it to approach and withdraw from the brace 70 as shown in Figure 11 and 12. The linear wedge seal 68 may be configured to receive the mating linear hook 76 between the brace 70 and the sliding clamp 72, and may be configured to seal the linear hook 76 between the brace 70 and the sliding clamp 72 by sliding the sliding clamp 70 along the path allowed by the diagonal slots 76 until it establishes a compression seal with the brace 70 and the linear hook 76 as shown in Figure 14. As shown in Figure 9, one of the linear hook 76 or linear wedge seal 68 may be carried by the carriage wall 16, the end walls 50, and/or by any of the main cover or separator panels 64, 66, such that each linear hook 76 may engage a linear wedge seal 68 when the cover panel 64 is installed. In the drawings the wedge seals 68 and linear hooks 76 are configured such that each cover panel 64 may be installed by sliding the cover panel's linear hooks 76 endwise into wedge seals 68 installed on the carriage wall 16 and end walls 60. In other words, the cover panels 64 may be installed vertically through the top of the module 10. However, in other embodiments, the wedge seals 68 may be oriented to allow the shell covers 62 to be installed from the sides of the module 10, into each module opening 65, or from any other unobstructed direction.

A typical configuration of an LCSVLS may, for example, include a Surface-to-Surface Mission Module (SSMM) comprising two Surface-to-Surface Missile Systems (SSMS). Each SSMS may include three missile launch modules 10, and a Launcher Management Assembly (LMA), e.g., an M299 LMA. Each LMA may be configured to control the three launch modules 10 in its SSMS. Each module 10 may be individually removable from its SSMS, allowing a module 10 with expended missiles 14 to be removed and reloaded with missiles 14 or replaced with a pre-loaded module 10.

A multiple missile carriage and launch guidance module as described above provides a space and weight-efficient platform capable of safely storing, monitoring, and launching missiles. This description, rather than describing limitations of an invention, only illustrates an embodiment of the invention recited in the claims. The language of this description is therefore exclusively descriptive and is non-limiting. Obviously, it's possible to modify this invention from what the description teaches. Within the scope of the claims, one may practice the invention other than as described above.

What is claimed is:

1. A multiple missile carriage and launch guidance module comprising:

a plurality of missile launch rails, each rail being configured to carry and guide the launch of a missile; and

a common missile carriage wall carrying the plurality of missile launch rails in respective positions and orientations allowing for missile carriage and launch from the rails.

2. A multiple missile carriage and launch guidance module as defined in claim 1 in which the rails are distributed between and carried by opposite-facing front and back sides of the carriage wall.

3. A multiple missile carriage and launch guidance module as defined in claim 2 in which the carriage wall comprises a carriage wall core defined by generally parallel spaced-apart front and back structural skins of the carriage wall configured to cooperate in the carriage and distribution of missile carriage loads.

4. A multiple missile carriage and launch guidance module as defined in claim 3 in which the carriage wall comprises filler disposed between the front and back structural skins.

5. A multiple missile carriage and launch guidance module as defined in claim 1 in which the module includes:

at least one sprinkler nozzle carried by the carriage wall and configured to emit fluid in a direction and manner that suppresses missile exhaust flame; and

sprinkler piping connected at an outlet end to the sprinkler nozzle and connectable at an inlet end to a fluid source, the sprinkler piping being configured to provide a fluid pathway from a fluid source through the carriage wall core and carriage wall structural skin for a fluid to the sprinkler nozzles.

6. A multiple missile carriage and launch guidance module as defined in claim 5 in which the sprinkler piping includes piping walls that integrally extend from an inner surface of at least one of the carriage wall structural skins and seal against an opposing structural skin inner surface to define a fluid channel between the carriage wall structural skins.

7. A multiple missile carriage and launch guidance module as defined in claim 3 and further comprising desiccant carried by the carriage wall within the carriage wall core.

8. A multiple missile carriage and launch guidance module as defined in claim 3 and further comprising at least one environmental sensor carried by the carriage wall, disposed within the carriage wall core, and configured to monitor one or more conditions within the core selected from the group of conditions consisting of temperature, humidity, shock or vibration.

9. A multiple missile carriage and launch guidance module as defined in claim 3 in which the carriage wall includes an integral cableway running through the carriage wall core and configured to receive cabling.

10. A multiple missile carriage and launch guidance module as defined in claim 1 and further comprising a pair of spaced-apart end walls carrying the common wall between them and configured to be carried by mounting interfaces of a module supporting structure.

11. A multiple missile carriage and launch guidance module as defined in claim 10 and further comprising a plenum carried by the end walls and configured and positioned to receive and re-direct exhaust gases from missiles being launched from the module.

12. A multiple missile carriage and launch guidance module as defined in claim 11 in which:

the module includes a module lid carried by the carriage wall and the end walls; and

the carriage wall, cover, plenum, and end walls are interconnected in such a way as to provide structural stiffness between these elements and to transfer loads from the carriage wall and plenum to mounting interfaces of a structure that is to carry the module.

13. A multiple missile carriage and launch guidance module as defined in claim 12 in which the end walls are connected to the module lid, to the plenum, and side edges of the carriage wall.

14. A multiple missile carriage and launch guidance module as defined in claim 10 and further comprising front and back shell covers removably disposed across and closing respective front and back module openings, the front opening being defined by front edges of the module lid, end walls, and plenum; and the back opening being defined by back edges of the module lid, end walls, and plenum.

15. A multiple missile carriage and launch guidance module as defined in claim 14 in which the shell covers each comprise:

a main cover panel shaped to be removably disposed across and to close a module opening; and

a plurality of missile separator panels integrally extending from the main cover panel and spaced apart and configured to engage the carriage wall and divide the spaces between the carriage wall and the shell covers into cells for housing missiles carried by the rails.

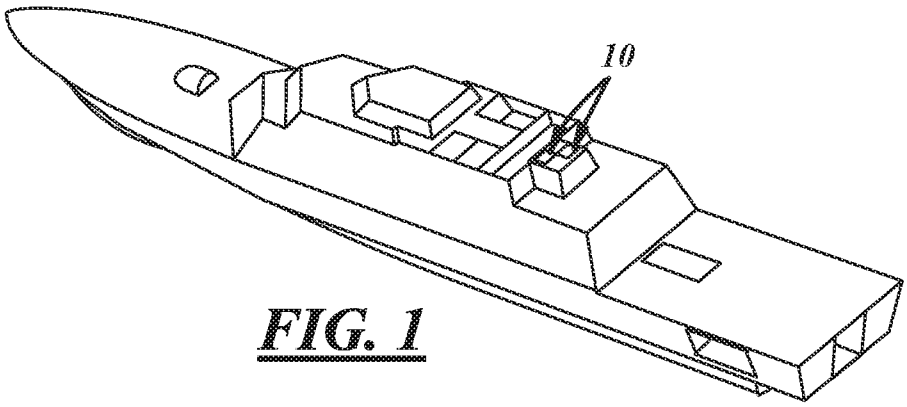
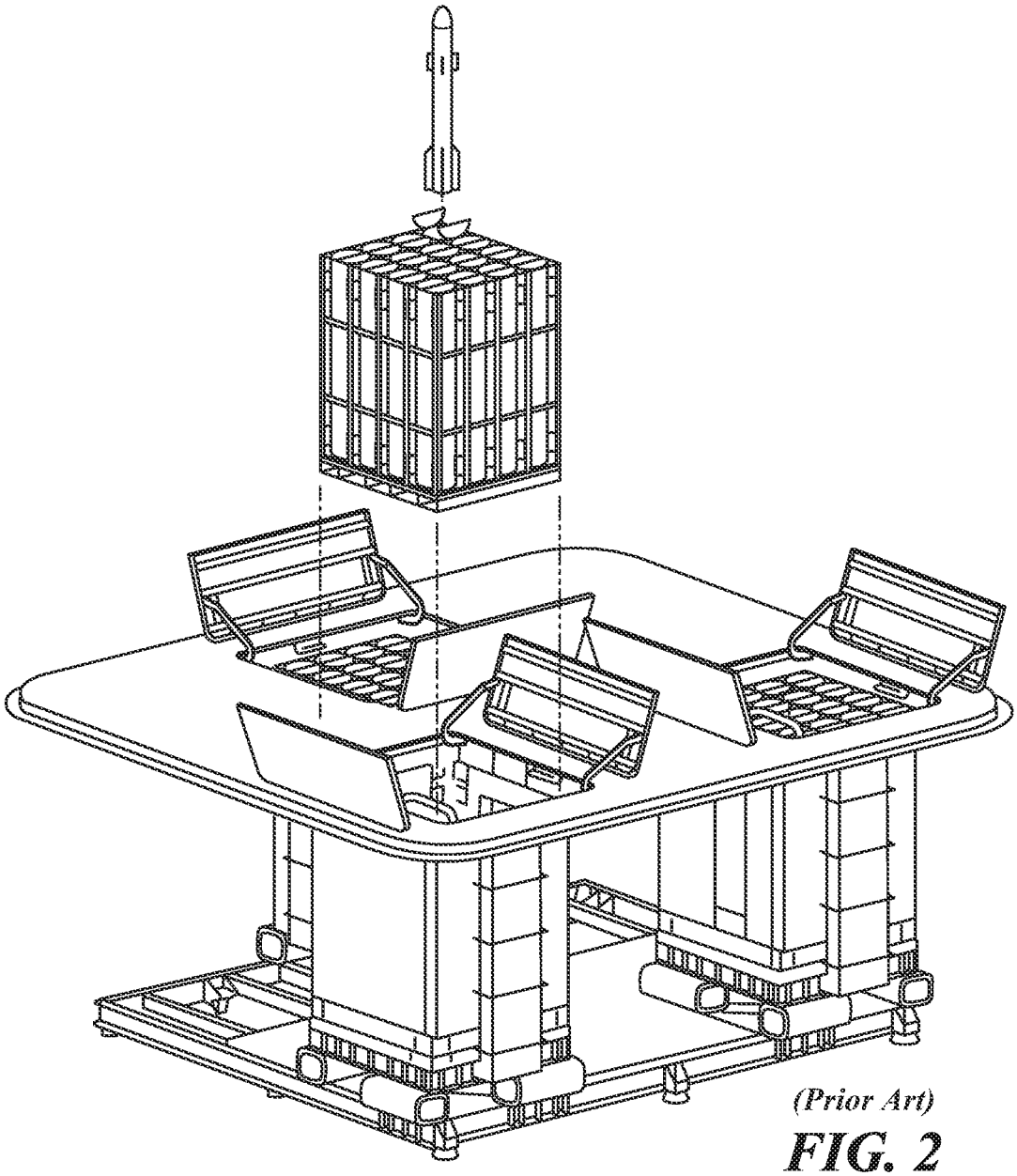


FIG. 1



(Prior Art)

FIG. 2

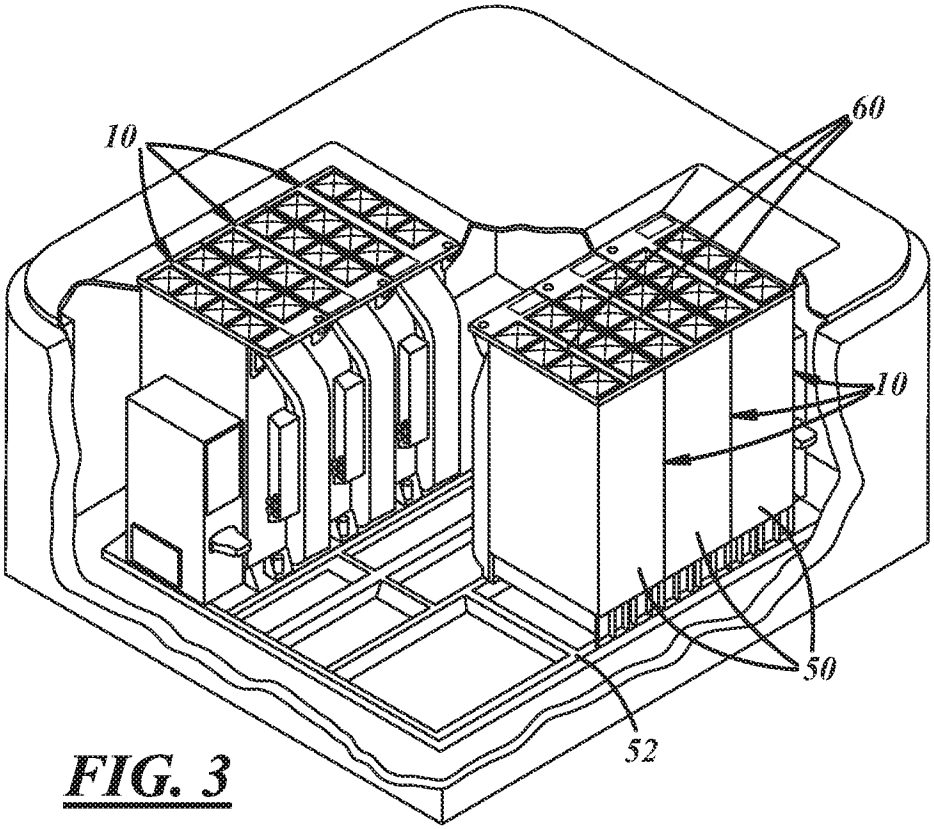


FIG. 3

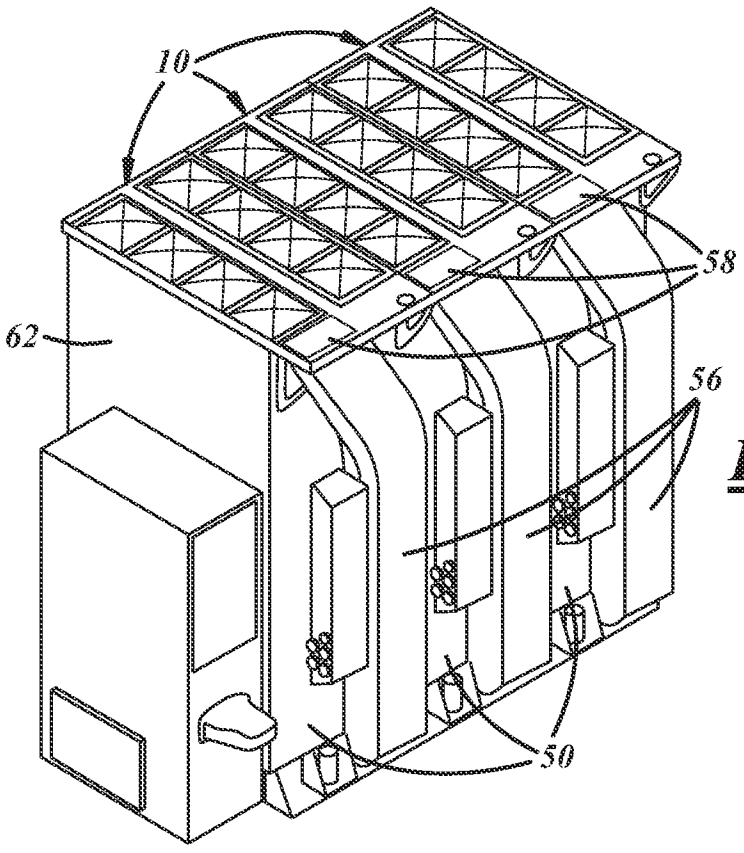


FIG. 4

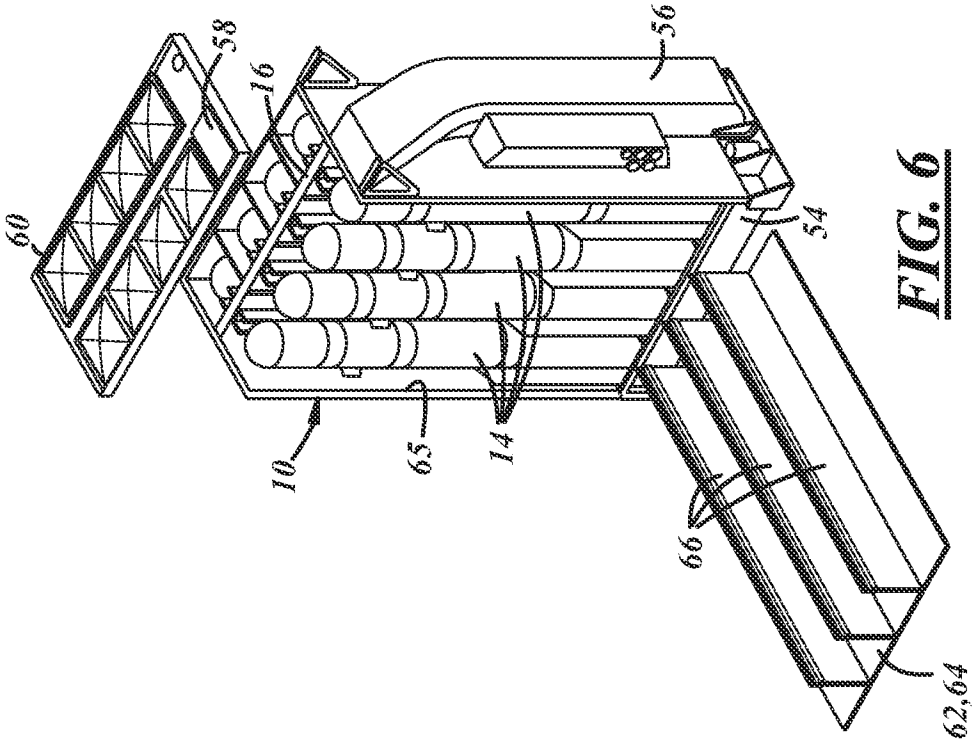


FIG. 6

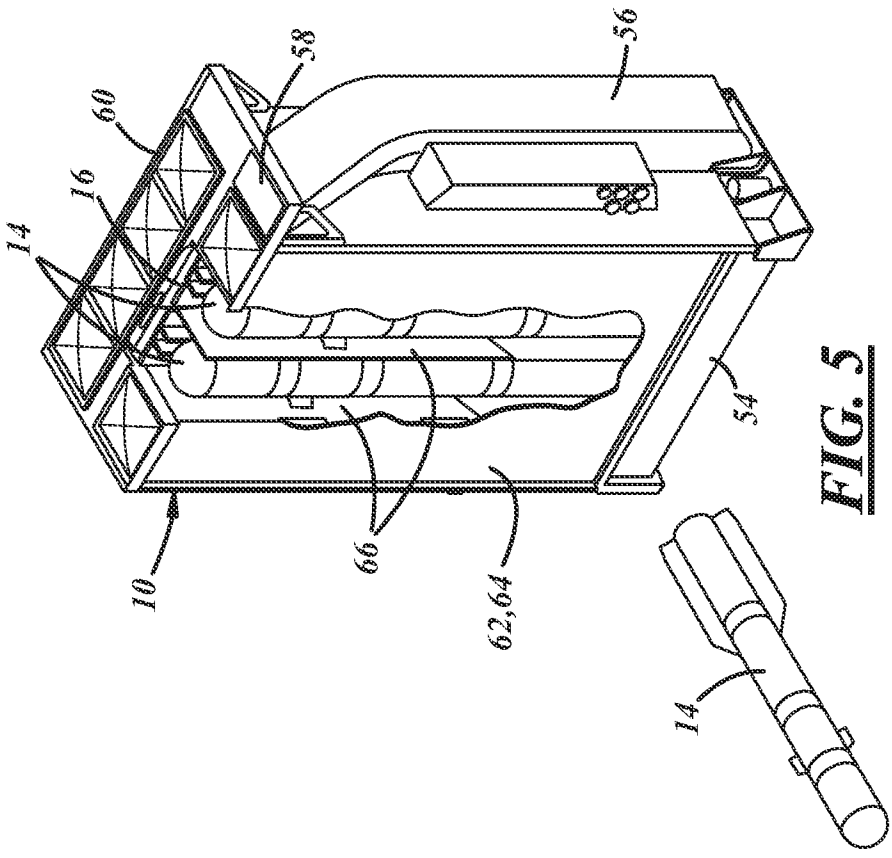


FIG. 5

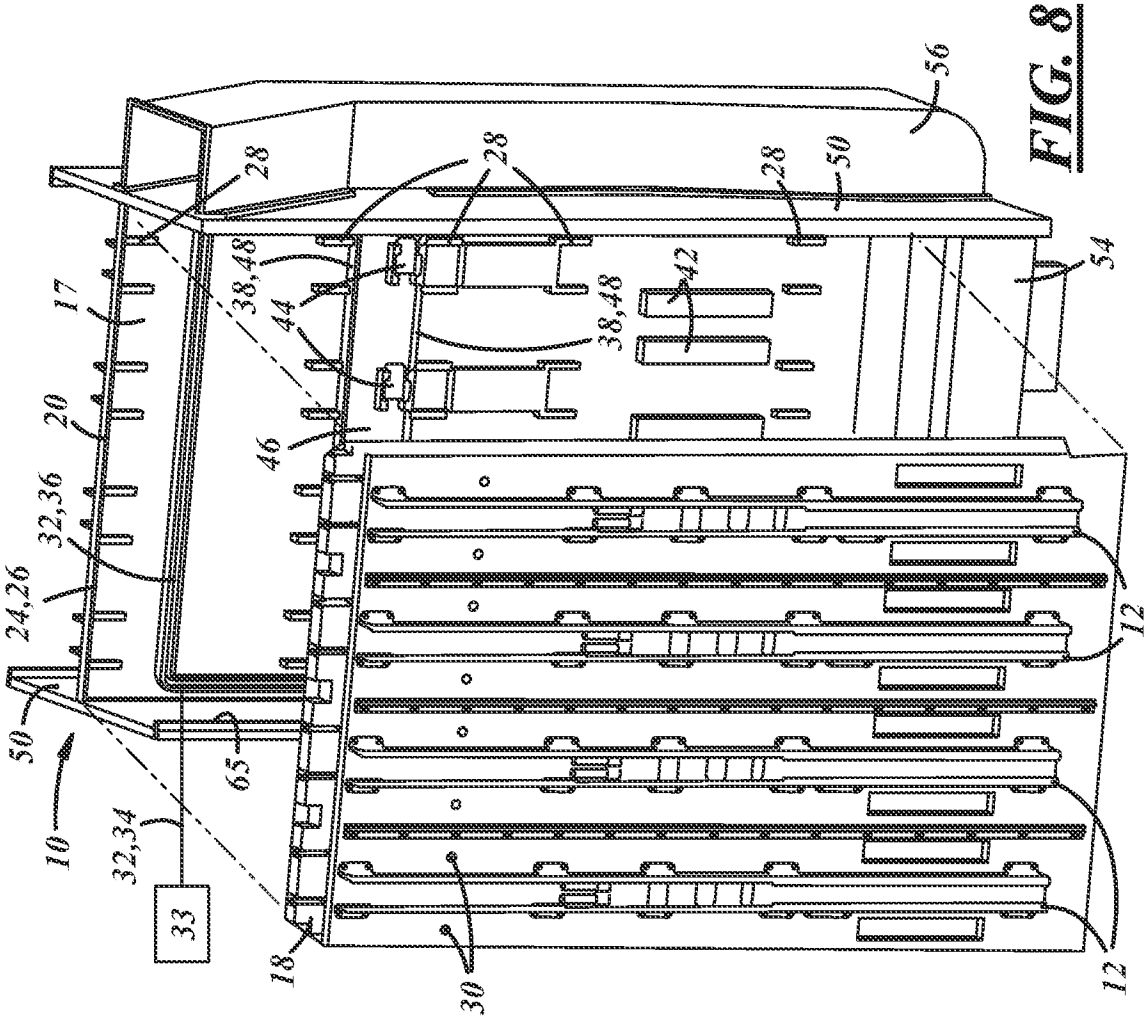

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FIG. 8

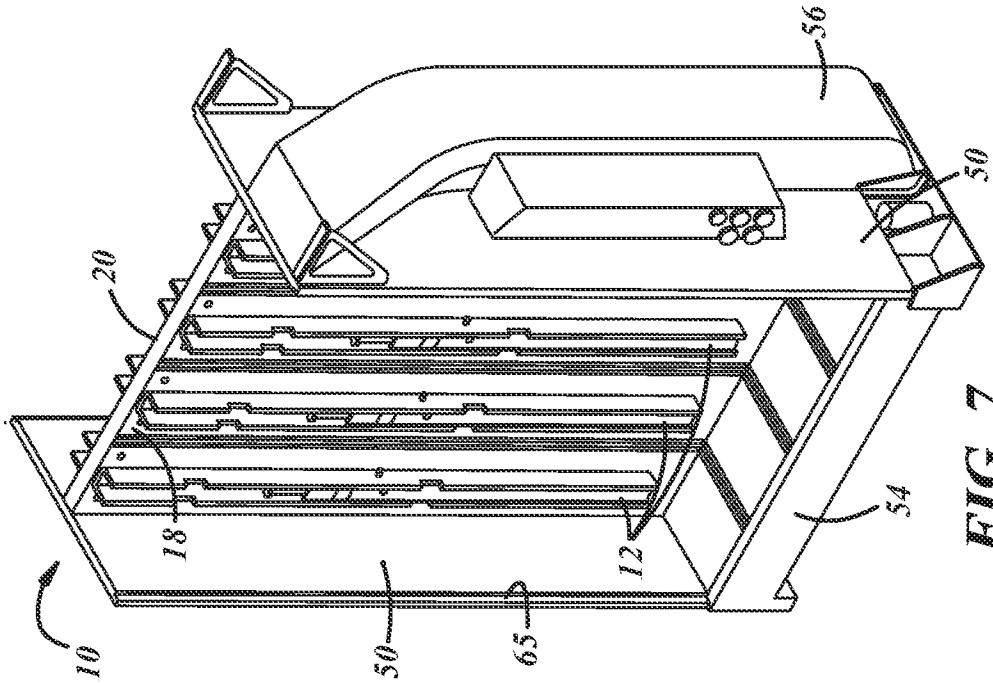
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FIG. 7

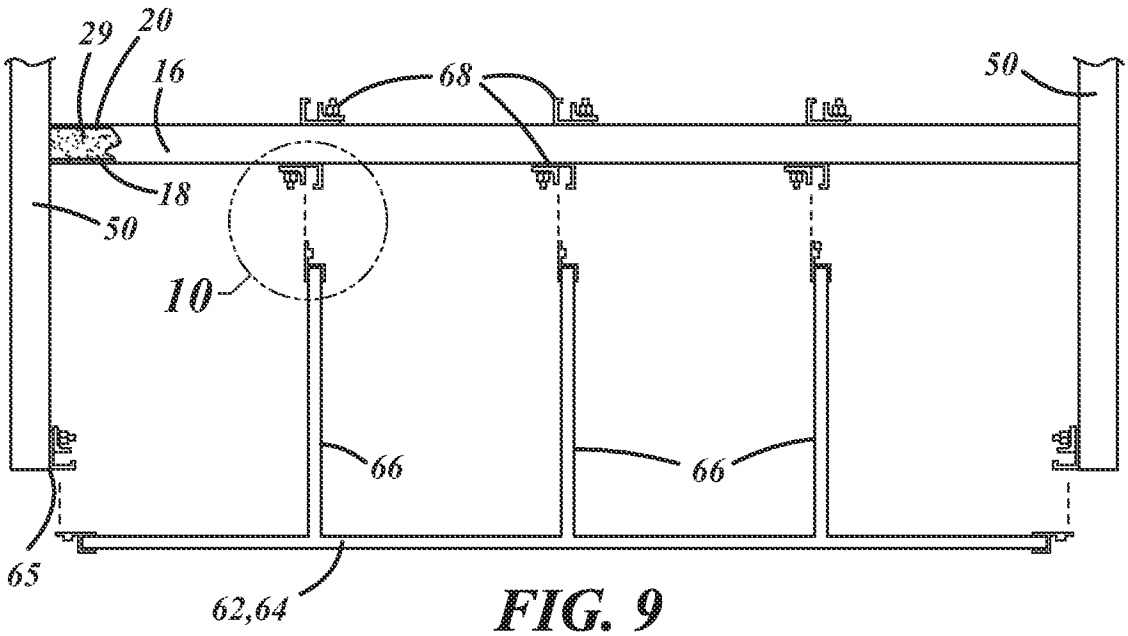

FIG. 9

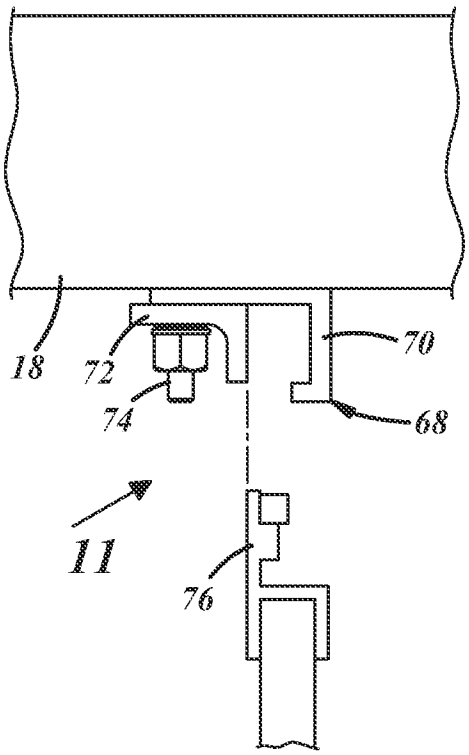

FIG. 10

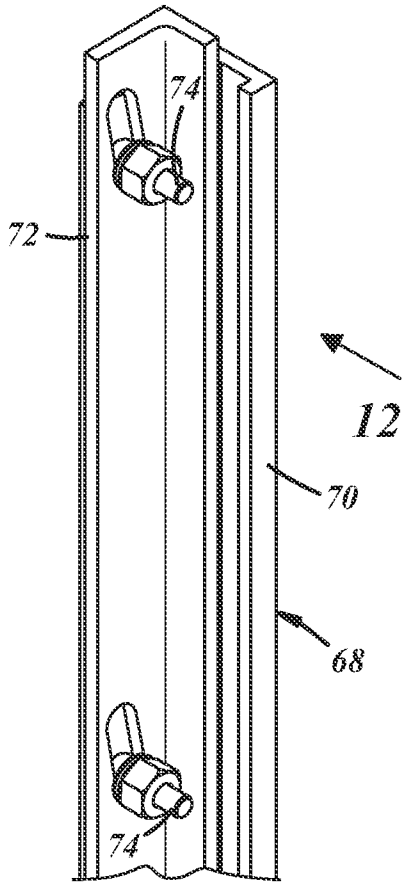

FIG.11

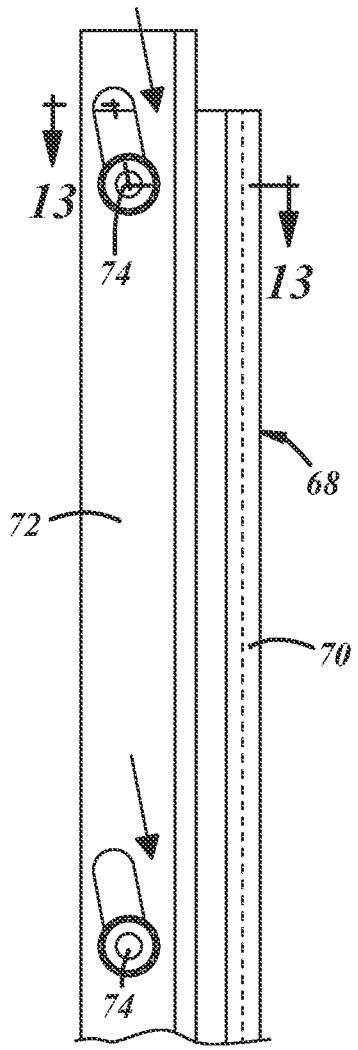

FIG.12

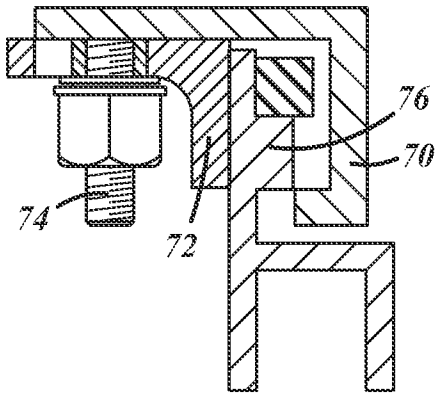

FIG.13

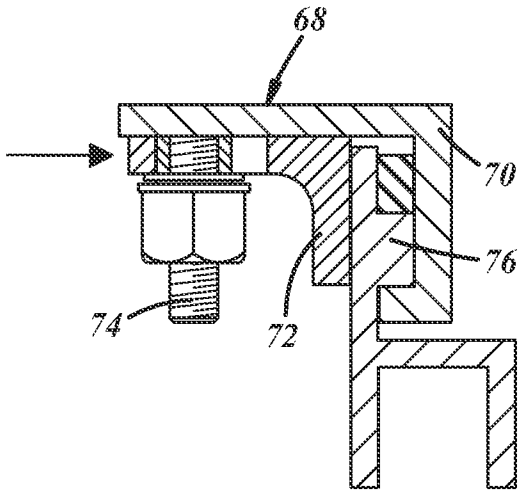

FIG.14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/51439

A. CLASSIFICATION OF SUBJECT MATTER
IPC: **F41F 3/04**(2006.01),**7/00**(2006.01)

USPC: 89/1.819
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 89/1.819,1.8,1.816,1.81,1.817,1.803,1.802,1.807,1.819

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,230,604 B1 (LARSON ET AL) 15 May 2001 (15.05.2001)	1 and 10-15 ---------- 5 and 6
X	US 2,809,559 (LAURITSEN ET AL) 15 October 1957 (15.10.1957)	1
X	US 3,138,989 (LEWIS ET AL) 30 June 1964 (30.06.1964)	1
X	US 4,362,459 (KLAUSBRUCKNER ET AL) 07 December 1982 (07.12.1982)	1-3
X --- Y	US 2,961,927 (DUFOUR) 29 November 1960 (29.11.1960)	1 and 2 ---------- 1-4 and 7-9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
11 March 2015 (11.03.2015)

Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT	International application No. PCT/US14/51439

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,079,310 A (YAGLA ET AL) 27 June 2000 (27.06.2000)	1 and 5-6
Y	US 5,115,711 A (BUSHAGOUR ET AL) 26 May 1992 (26.05.1992)	3,4 and 7-9
Y	US H000213 (PANLAQUI) 03 February 1987 (03.02.1987)	7
Y,P	US 8,534,177 (KALMS ET AL) 17 September 2013 (17.09.2013)	1-3

INTERNATIONAL SEARCH REPORT	International application No. PCT/US14/51439

Continuation of B. FIELDS SEARCHED Item 3:
Search Text: US-PGPUB;USPAT;FPRS;EPO;JPO;DERWENT
Search Terms: desiccant, extinguisher, sprinkler