July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 1

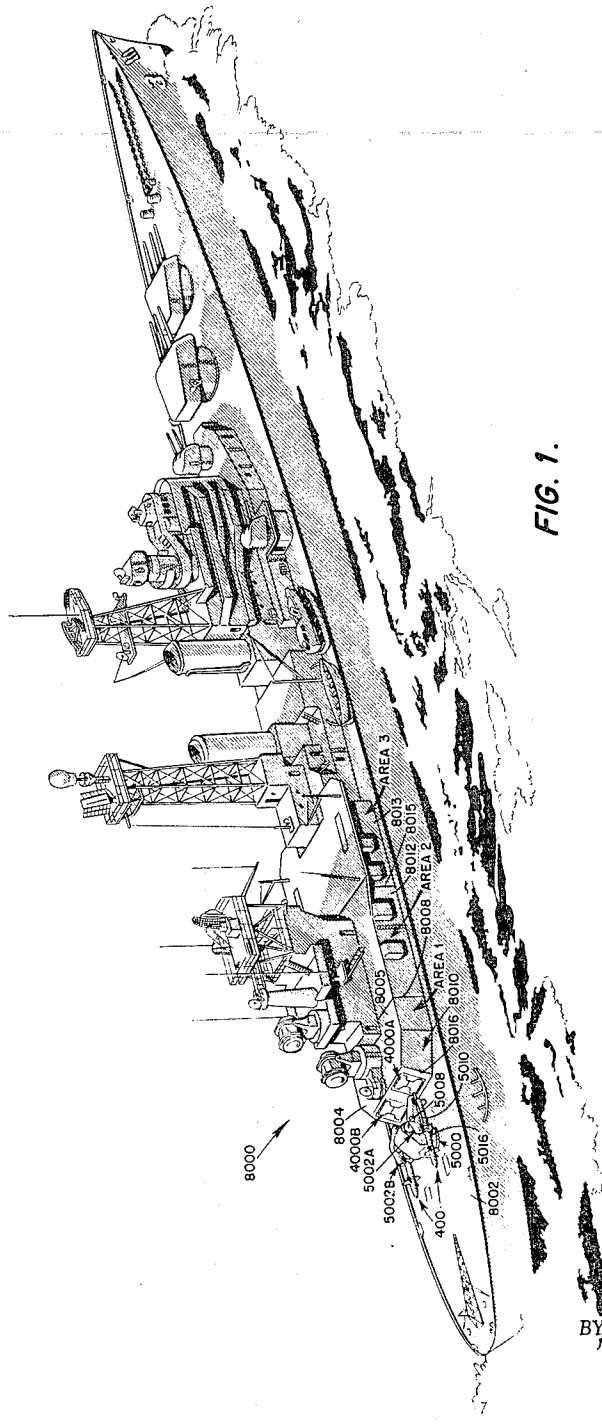


FIG. 1.

MYRON J. BAUER
RICHARD C. WILSON
INVENTORS

BY Walter J. Finch
O. Boyd Warner
ATTORNEYS

July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 2

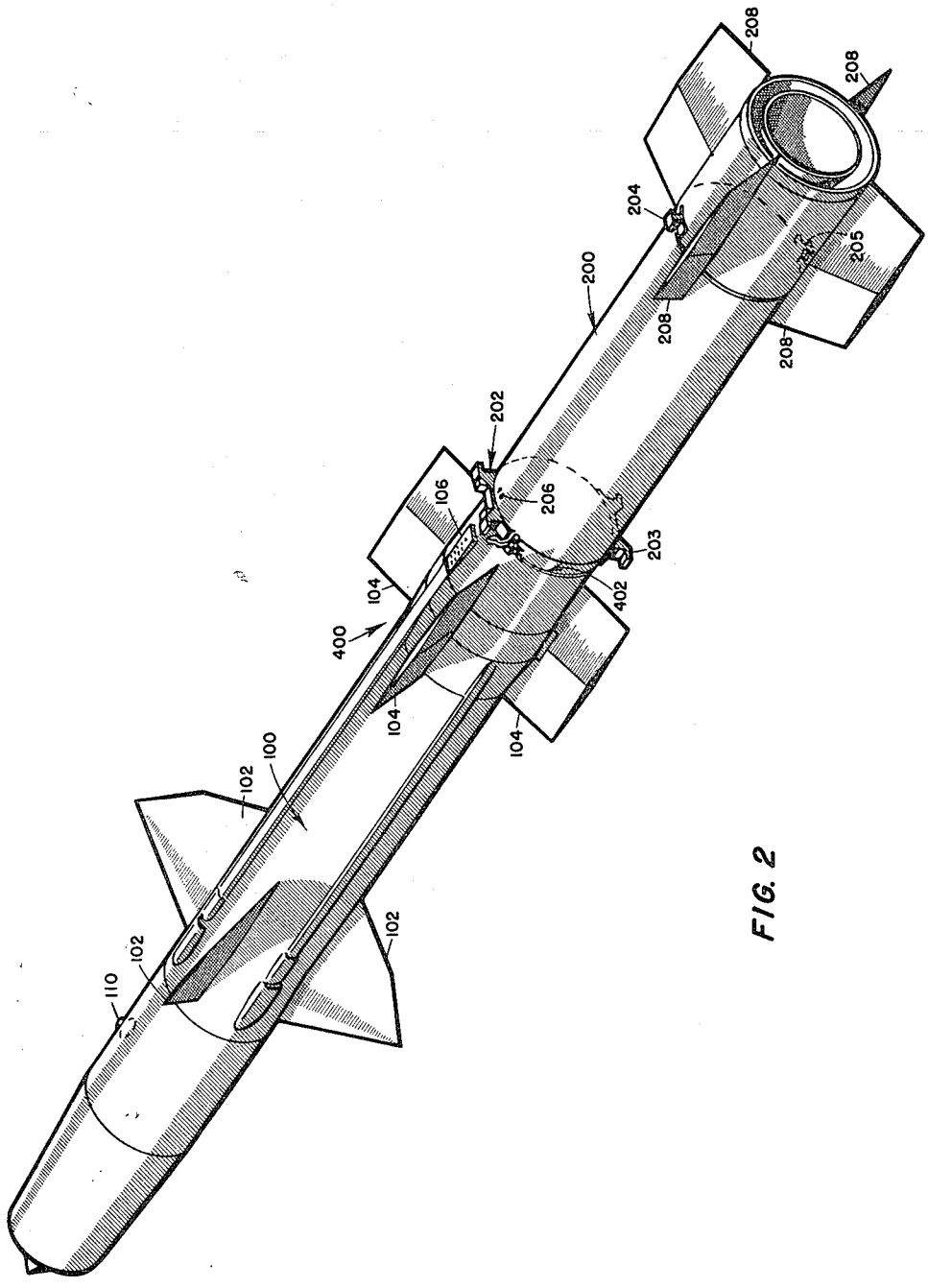


FIG. 2

July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT
FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 3

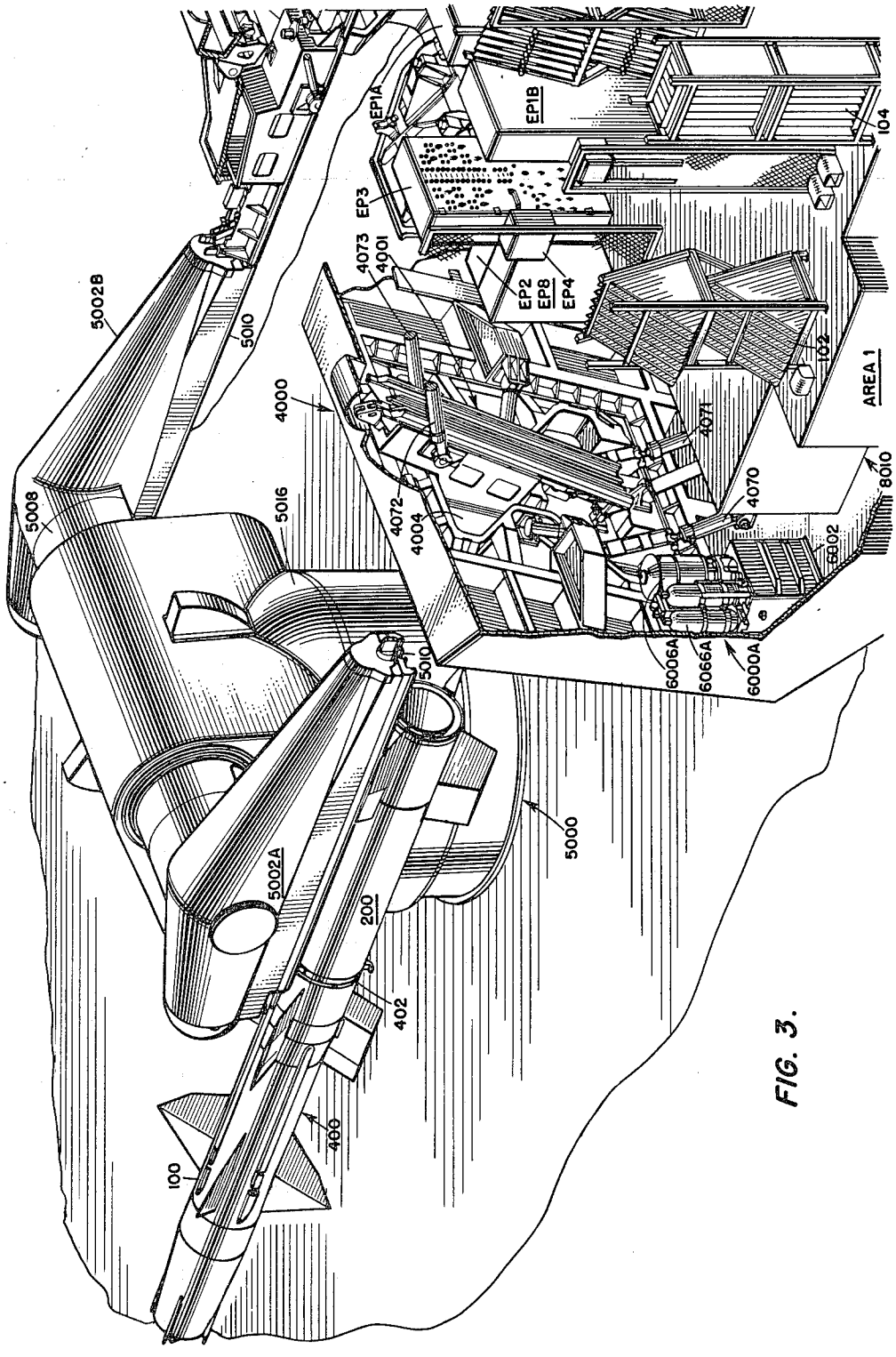


FIG. 3.

July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT
FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 4

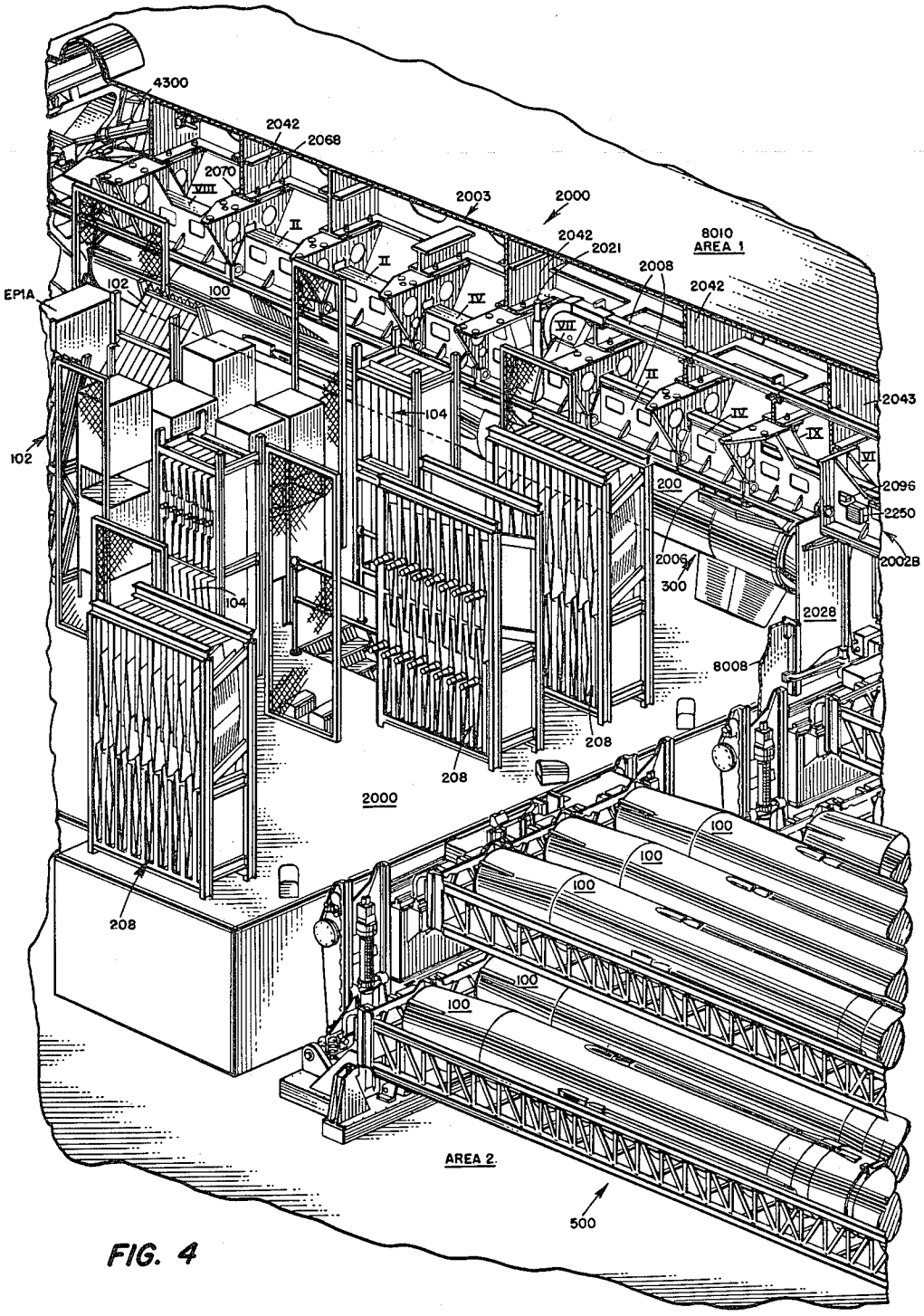


FIG. 4

July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 5

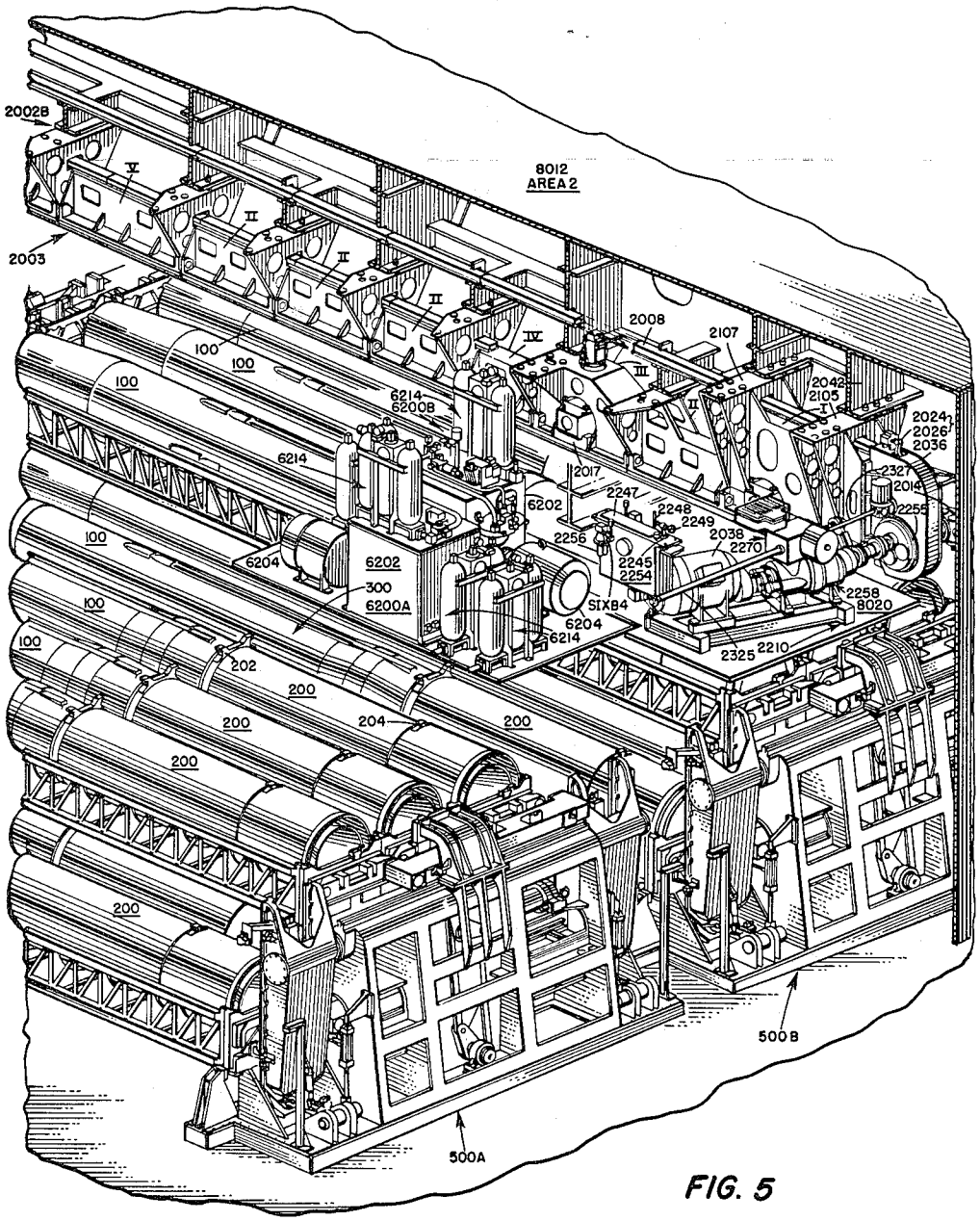


FIG. 5

FIG. 6

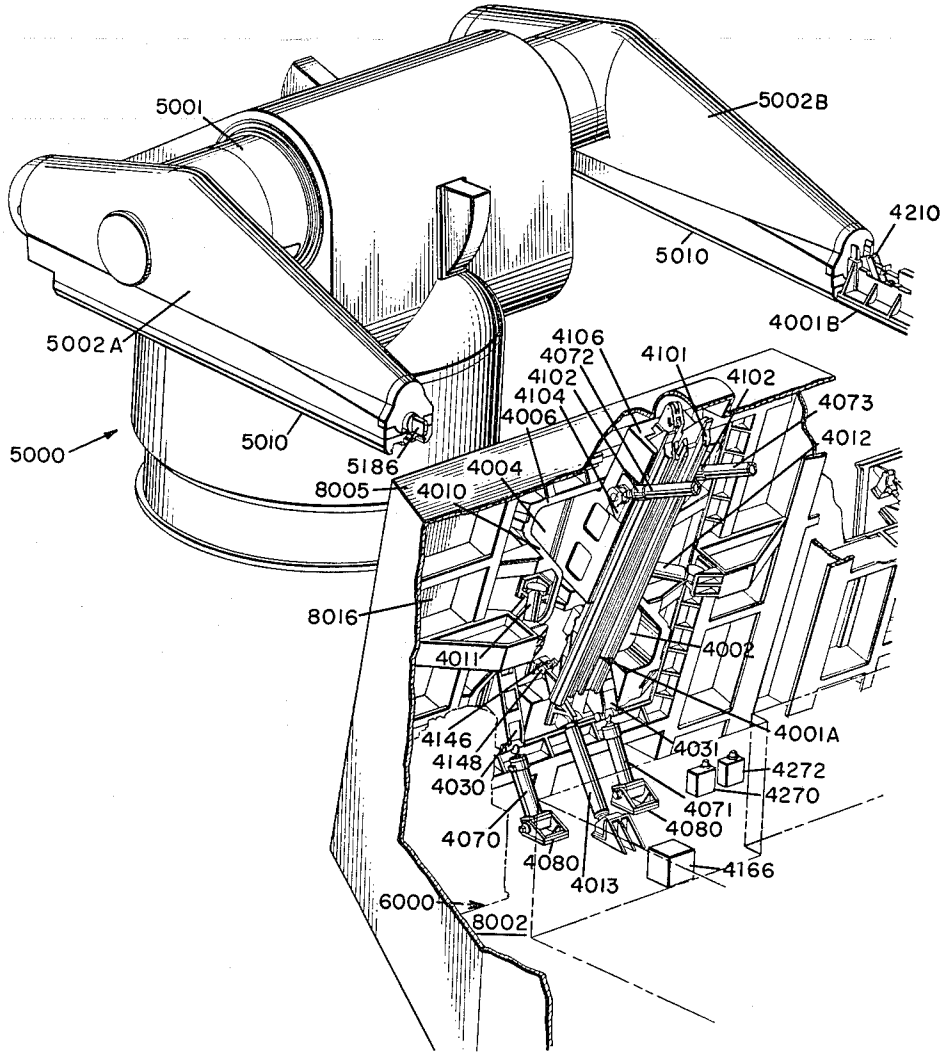
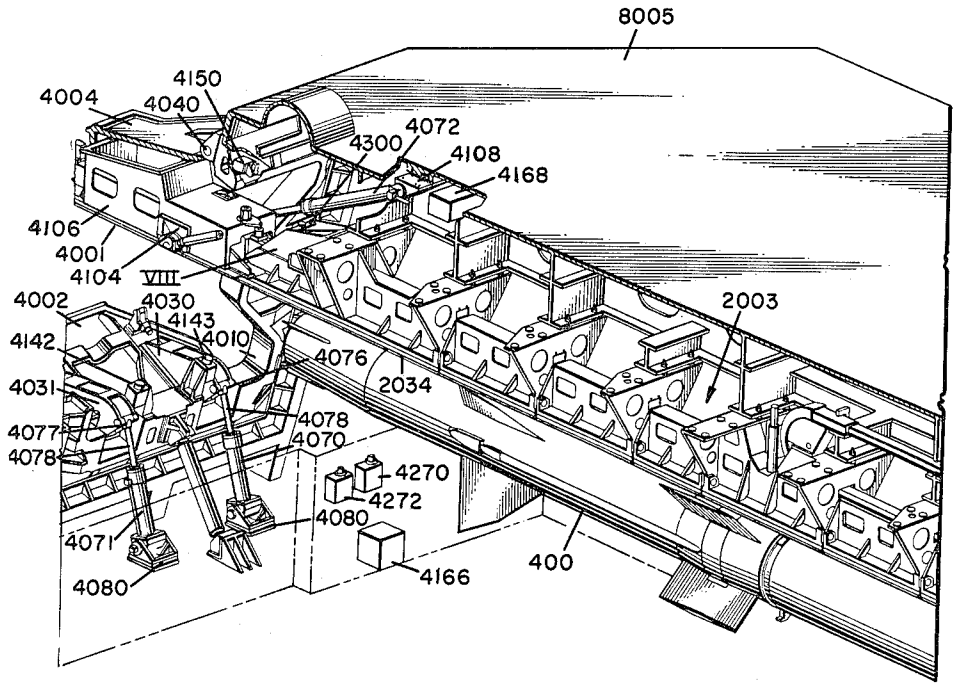

5001
5002B
4210
5010
4001B
5002A
4106
4072
4101
4102
4102
4104
4073
4006
4012
5000
5010
5186
4004
8005
4010
8016
4011
4002
4146
4001A
4148
4031
4272
4030
4270
4071
4080
4070
4080
4166
4013
6000
8002

FIG. 6A


8005
4150
4004
4040
4072
4300
4108
4168
4106
4001
4104
VIII
4002
4030
4143
4010
4142
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2003
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4270
4272
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4071
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4166
400

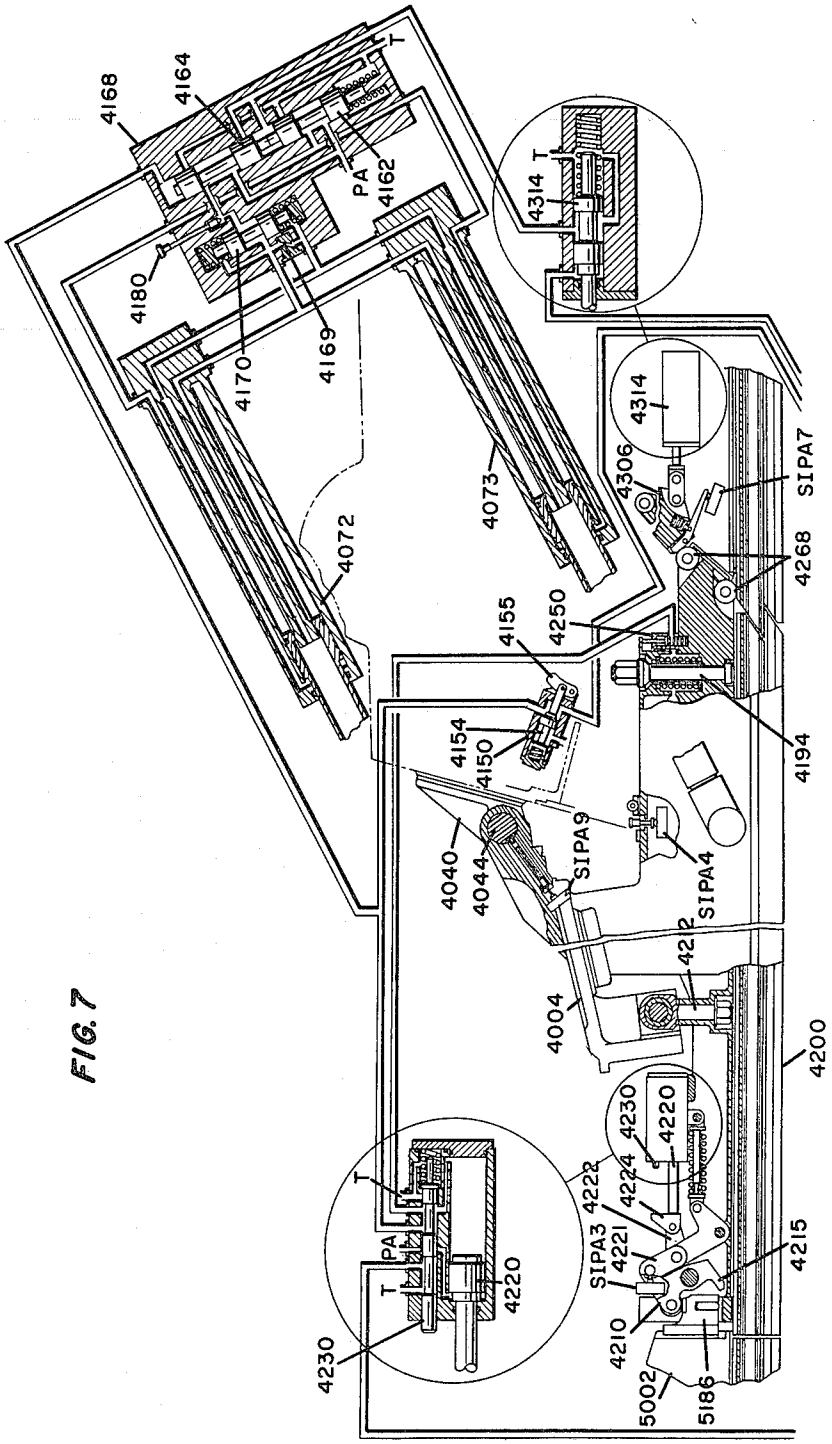

4168
4164
T
PA
4162
4180
4170
4169
4314 T
4314
4306
SIPA7
4268
4073
4072
4155
4250
4154
4150
4194
4040
4044
SIPA9
SIPA4
42
4004
4200
4230
4220
4222
4224
SIPA3
4221
4215
4210
5002
5186
T
PA
4220
4230

FIG. 7

July 2, 1963 M. J. BAUER ET AL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 9

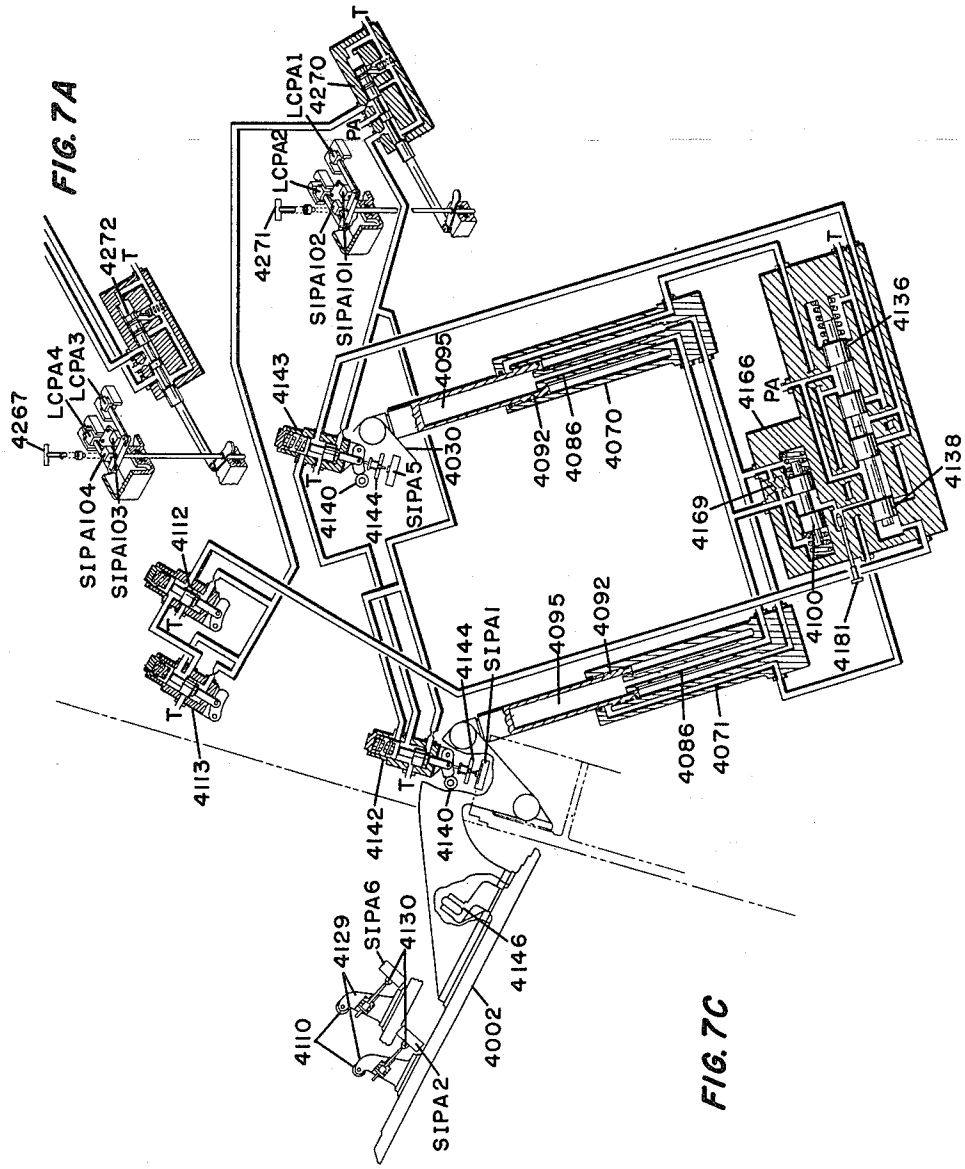


FIG. 7A

FIG. 7C

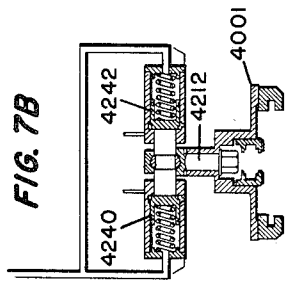


FIG. 7B

July 2, 1963 M. J. BAUER ETAL 3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 10

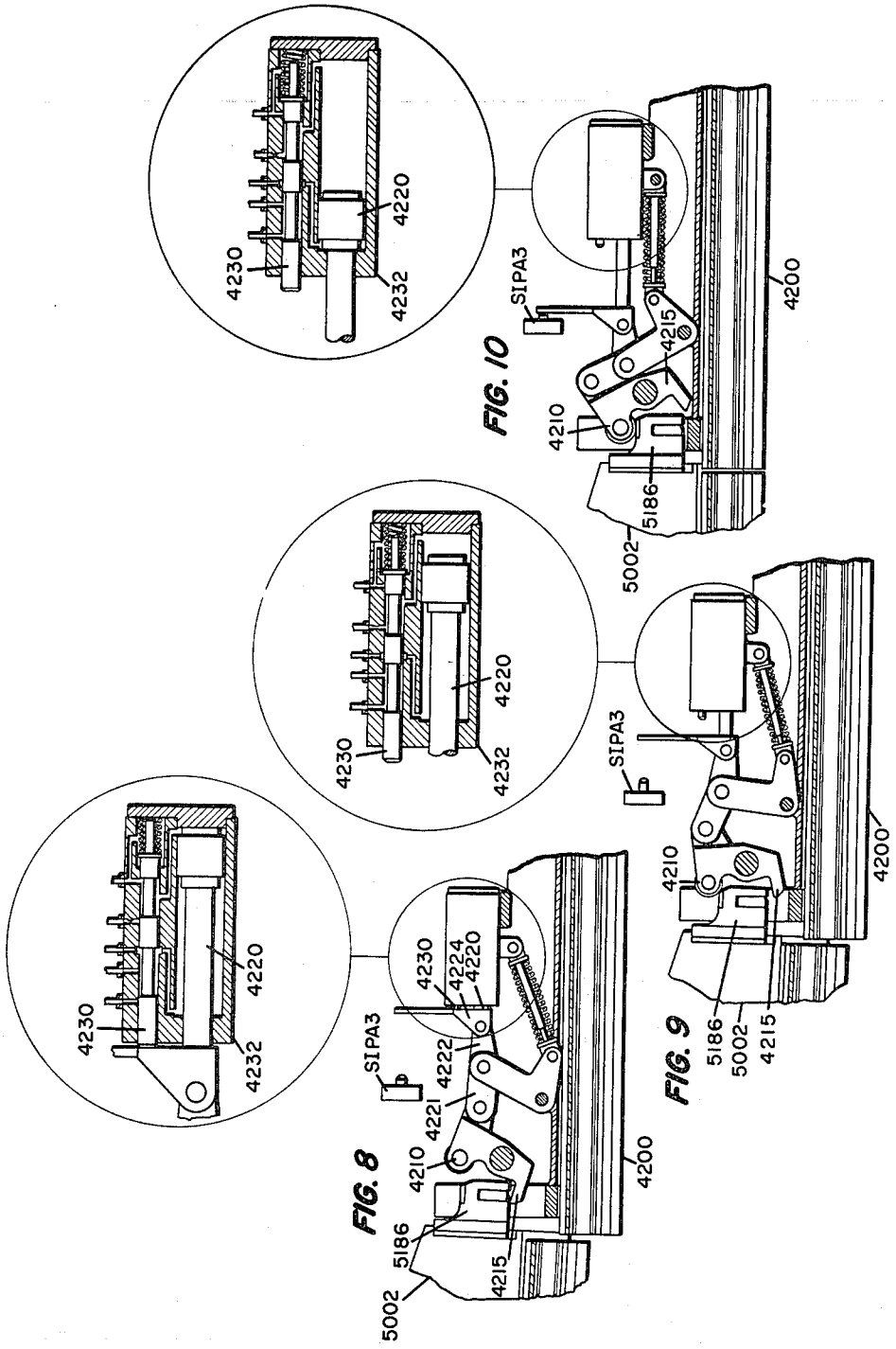


FIG. 10

FIG. 9

FIG. 8

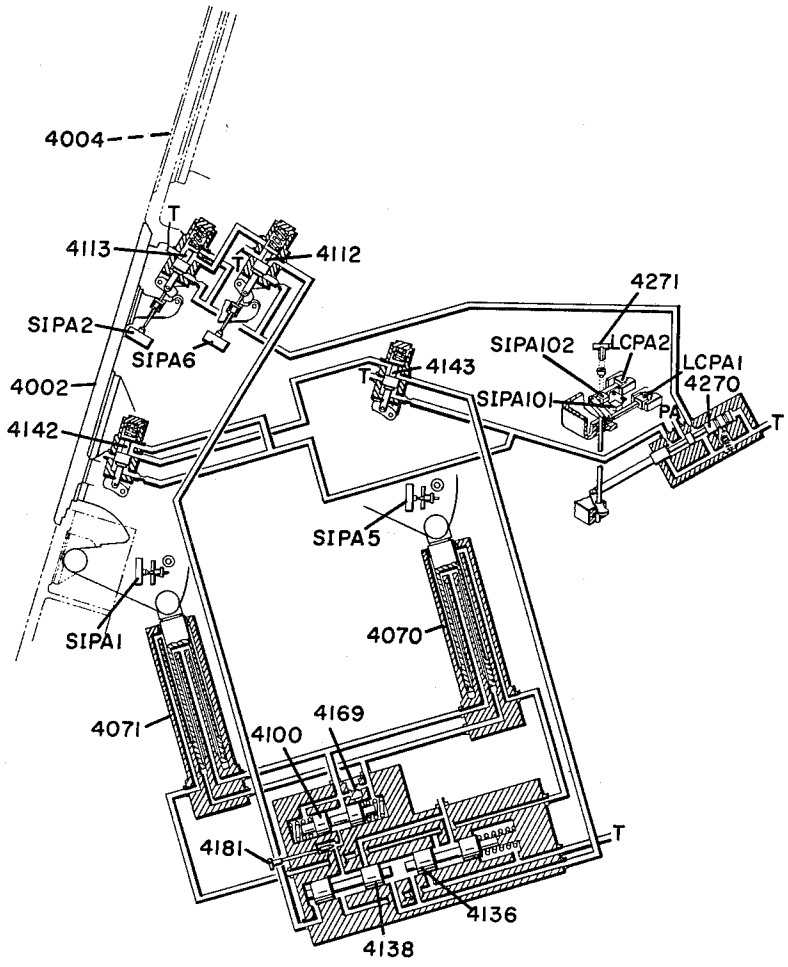

4004
T
4113
4112
4271
SIPA2
SIPA6
SIPA102
LCPA2
LCPA1
4143
4270
4002
SIPA101
4142
T
SIPA5
SIPA1
4070
4071
4169
4100
T
4181
4136
4138

FIG. 11

FIG. 12

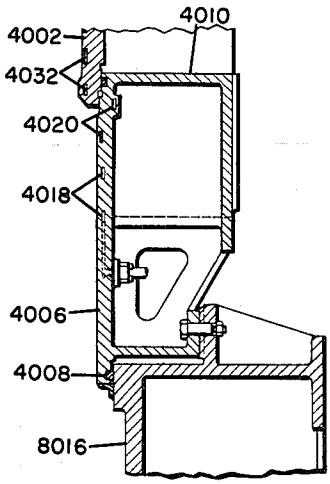

4010
4002
4032
4020
4018
4006
4008
8016

FIG. 13

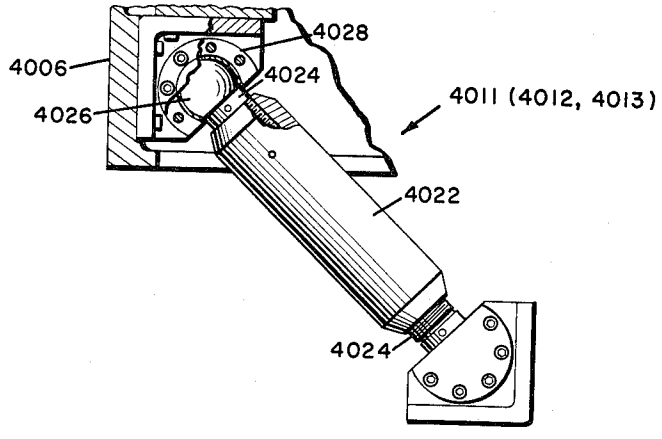

4028
4006
4024
4026
4011 (4012, 4013)
4022
4024

FIG. 14

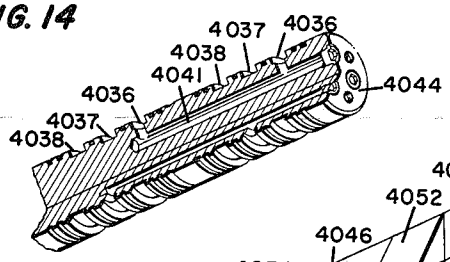


FIG. 15

FIG. 16

FIG. 17

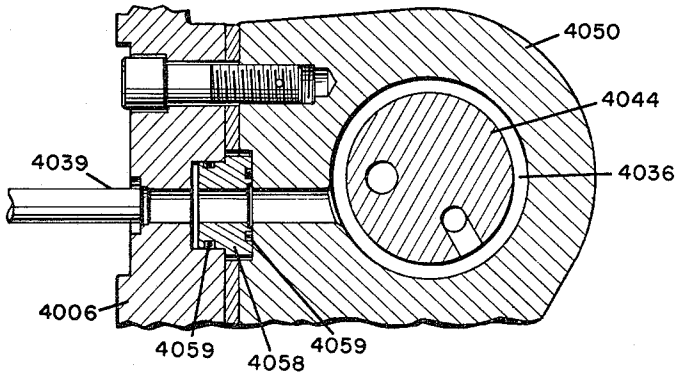


FIG. 18

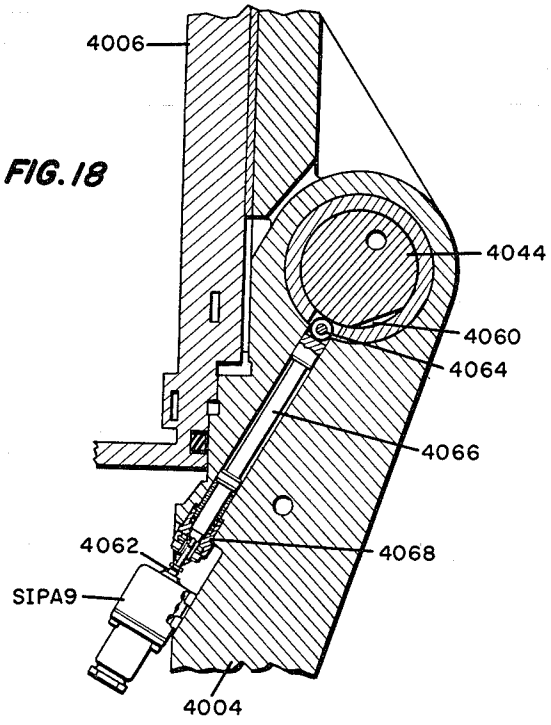


FIG. 19

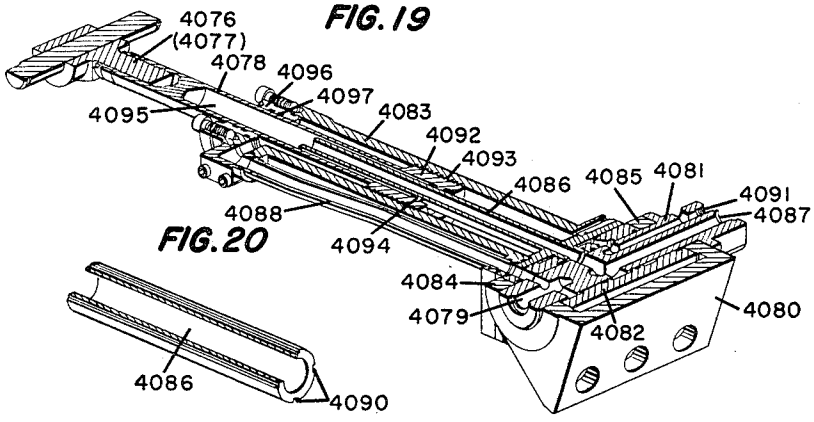


FIG. 20

FIG. 21

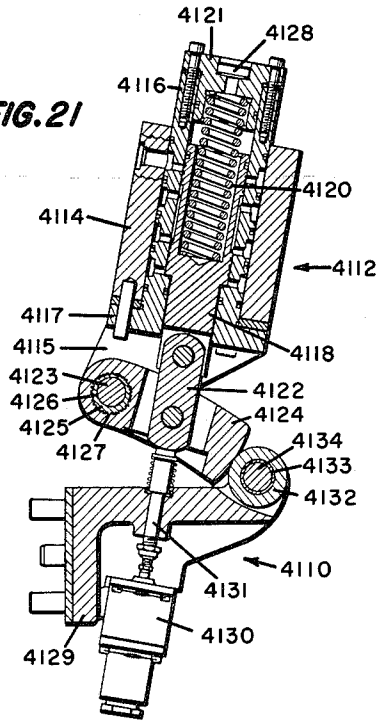


FIG. 22

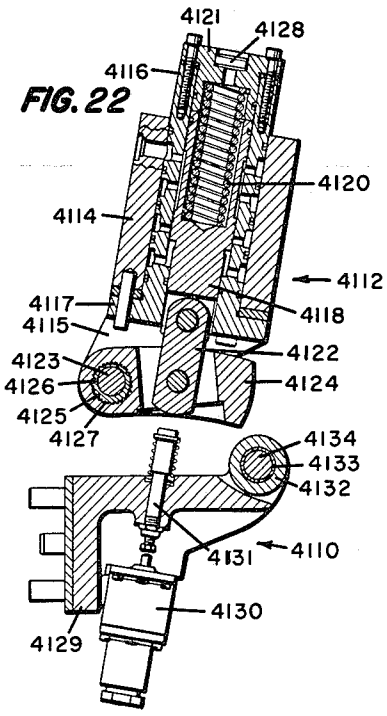


FIG. 23

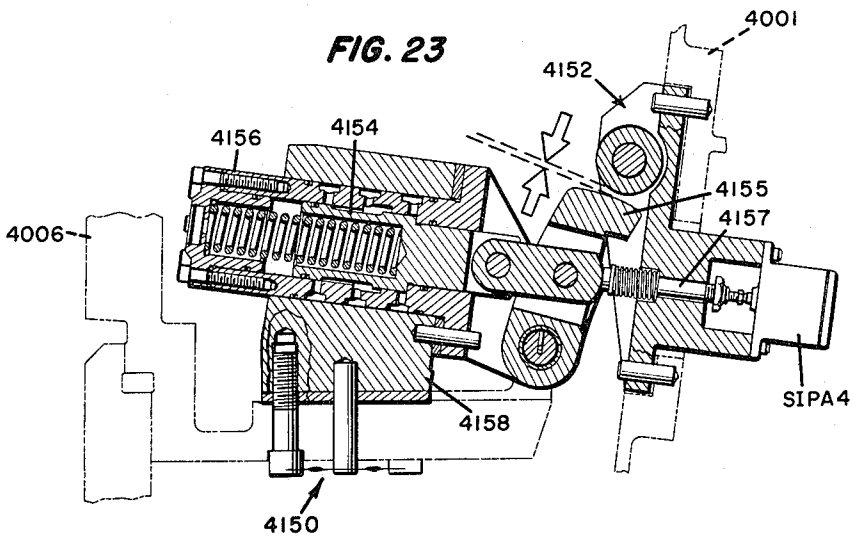


FIG. 24

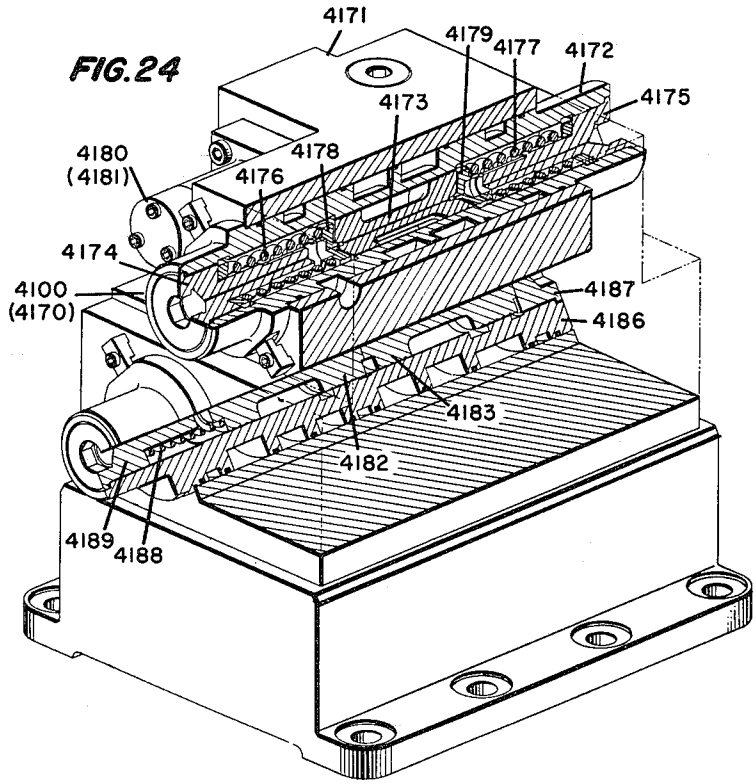
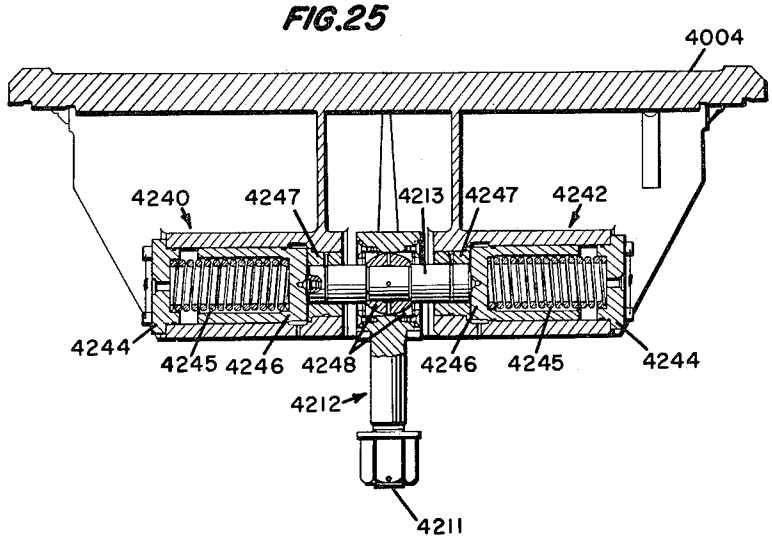

4171
4179
4177
4172
4175
4173
4180
(4181)
4178
4176
4174
4100
(4170)
4187
4186
4183
4182
4189
4188

FIG. 25


4004
4240
4247
4213
4247
4242
4244
4245
4246
4248
4246
4245
4244
4212
4211

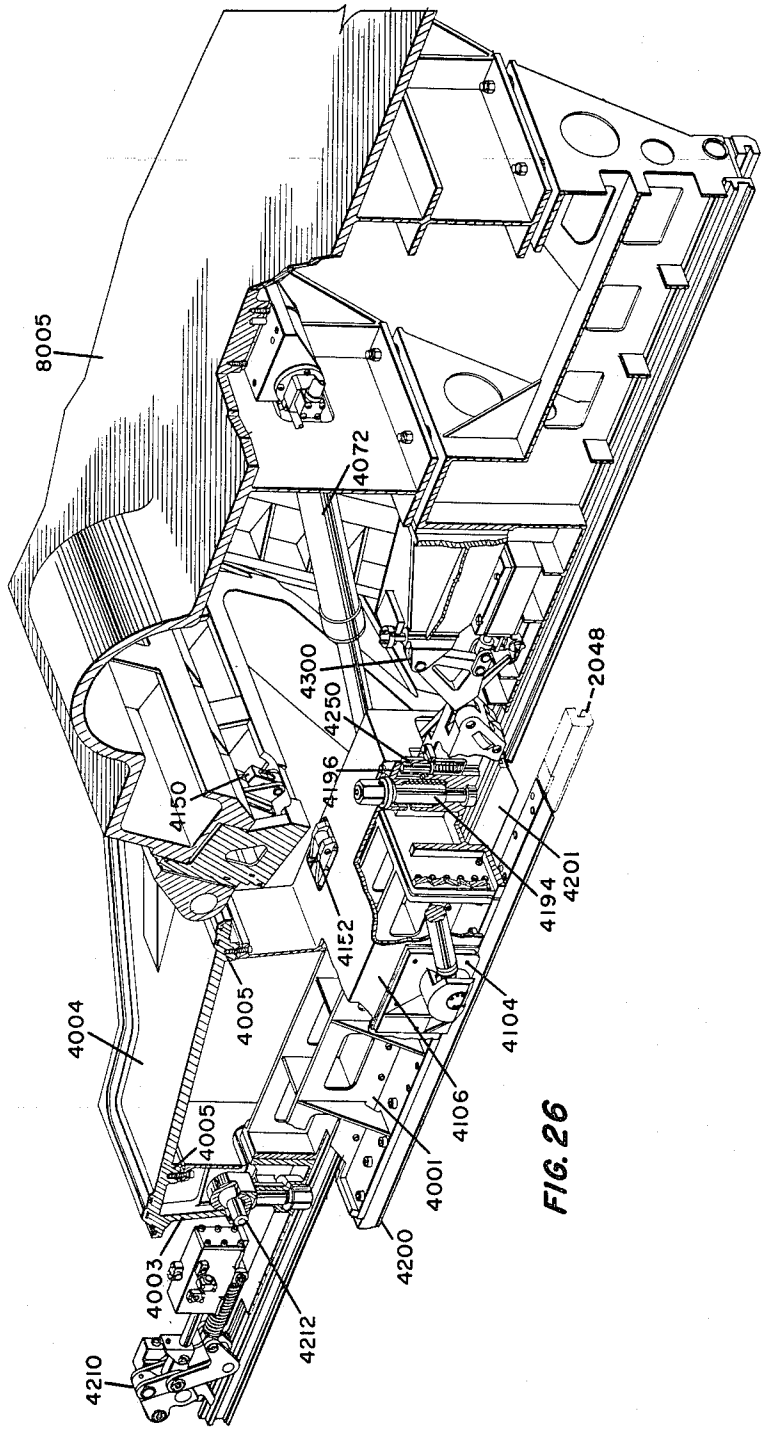

8005
4072
4300
4250
2048
4196
4150
4201
4194
4152
4005
4104
4004
4106
4005
4001
4200
4003
4212
4210

FIG. 26

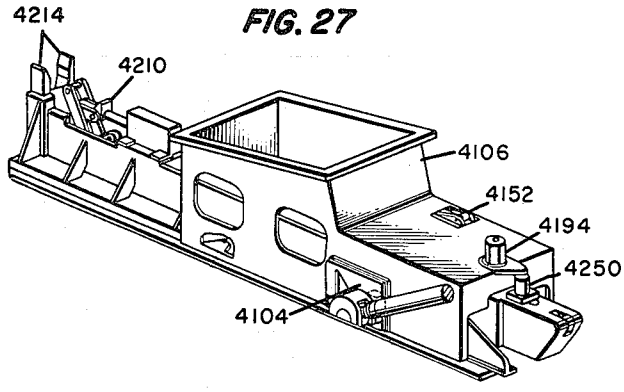


FIG. 27

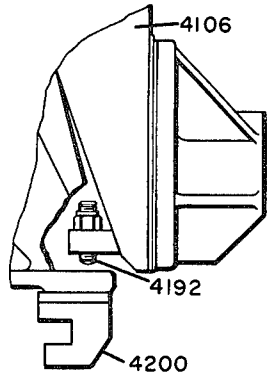


FIG. 27a

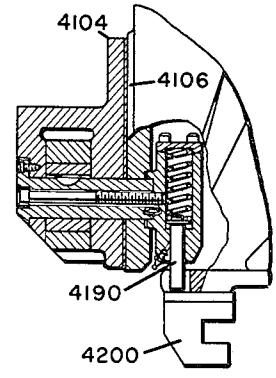


FIG. 27b

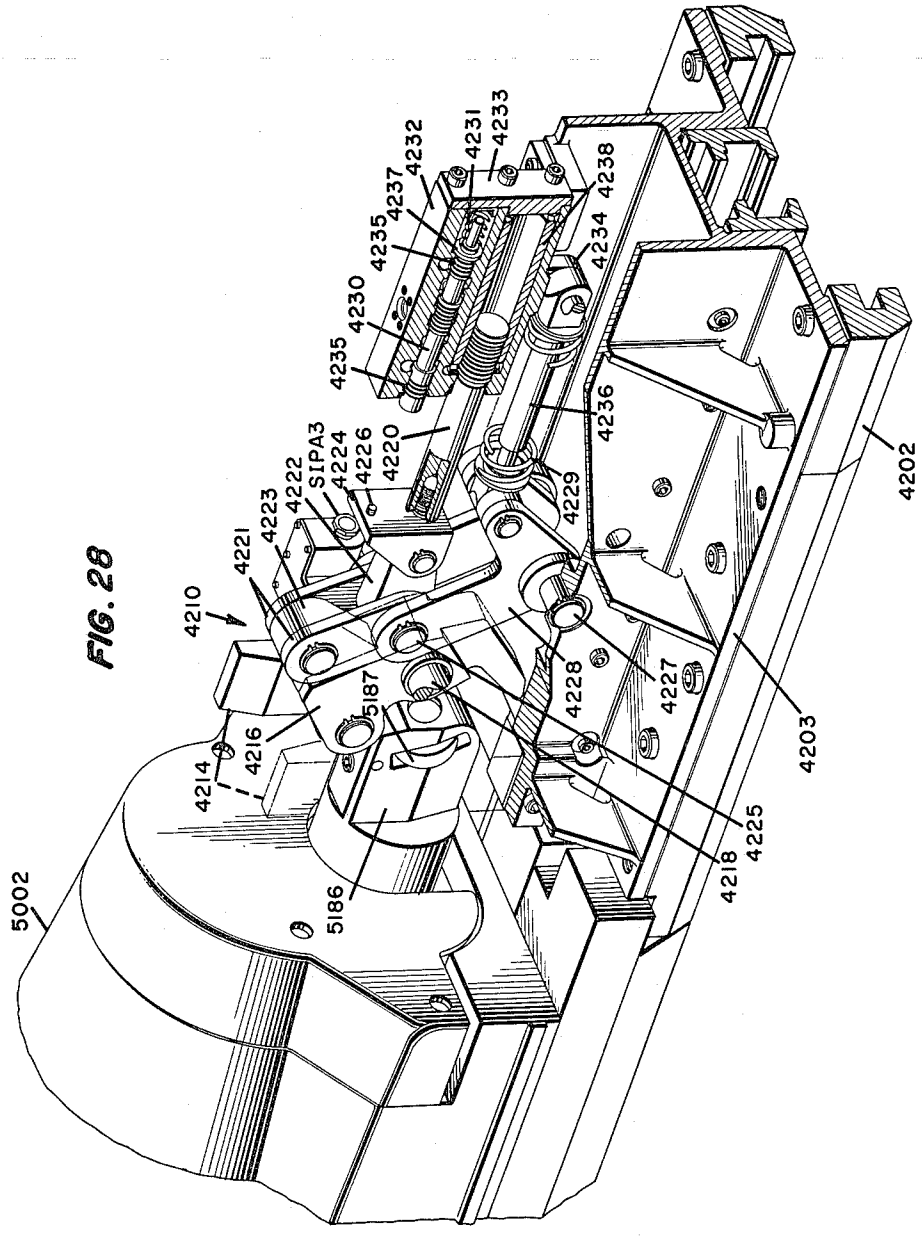

4232
4231
4233
4237
4238
4235
4234
4230
4235
4236
4202
SIPA3
4224
4226
4220
4222
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5187
4216
4203
4214
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4218
5186
5002

FIG. 28

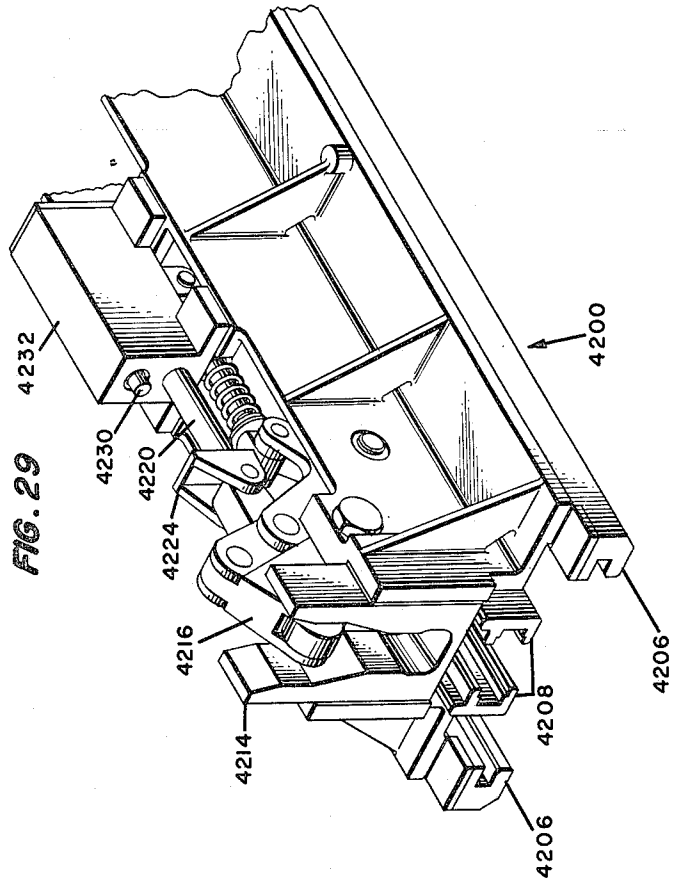

4232
4230
4220
4224
4216
4214
4200
4206
4208
4206

FIG. 29

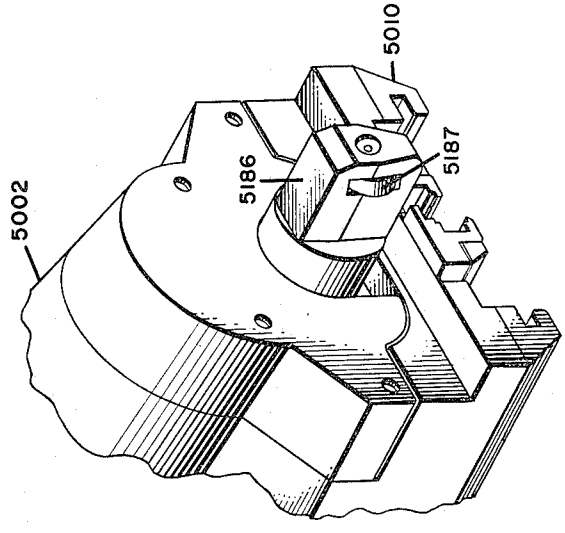
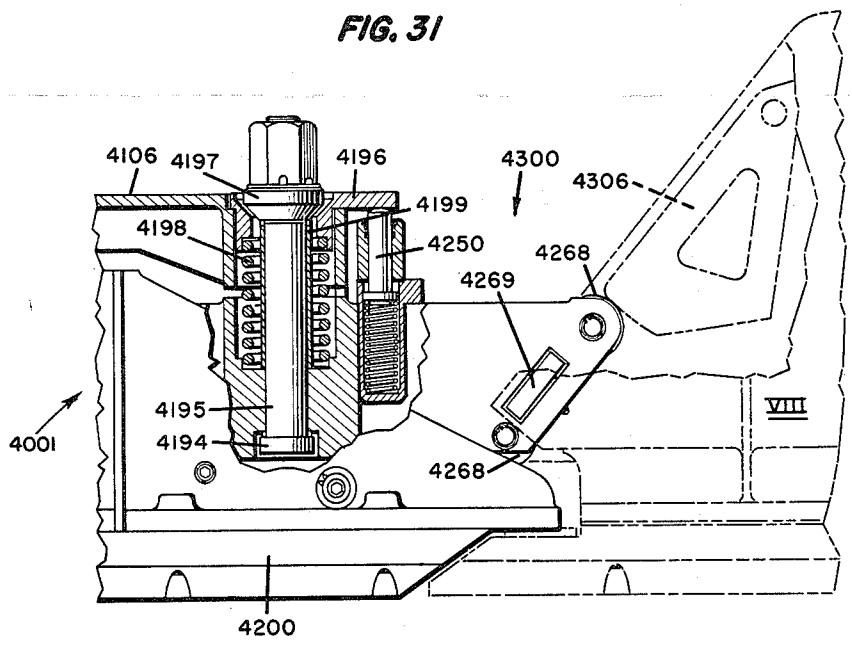

5010
5187
5186
5002

FIG. 30

FIG. 31


4106
4197
4196
4300
4306
4199
4198
4250
4268
4269
4195
4194
4001
VIII
4268
4200

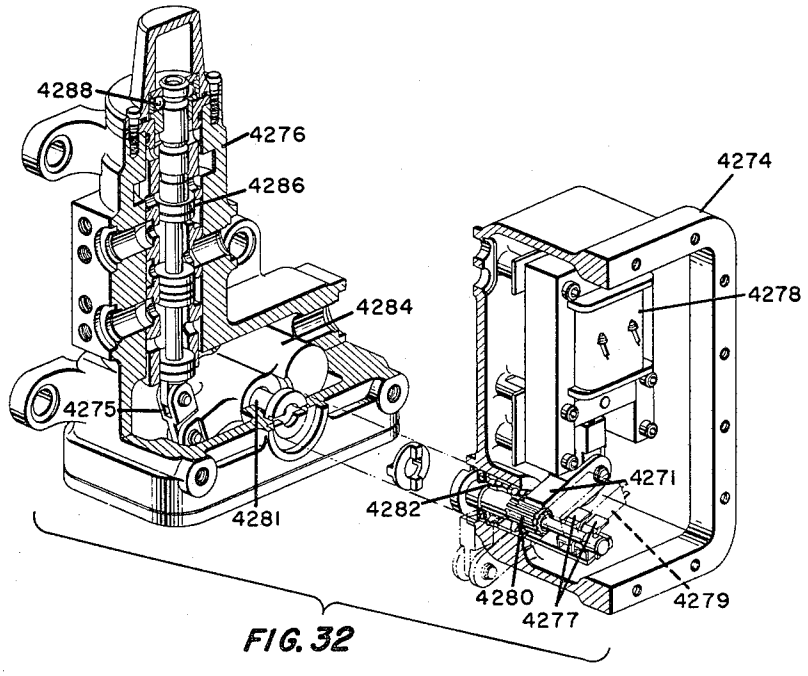
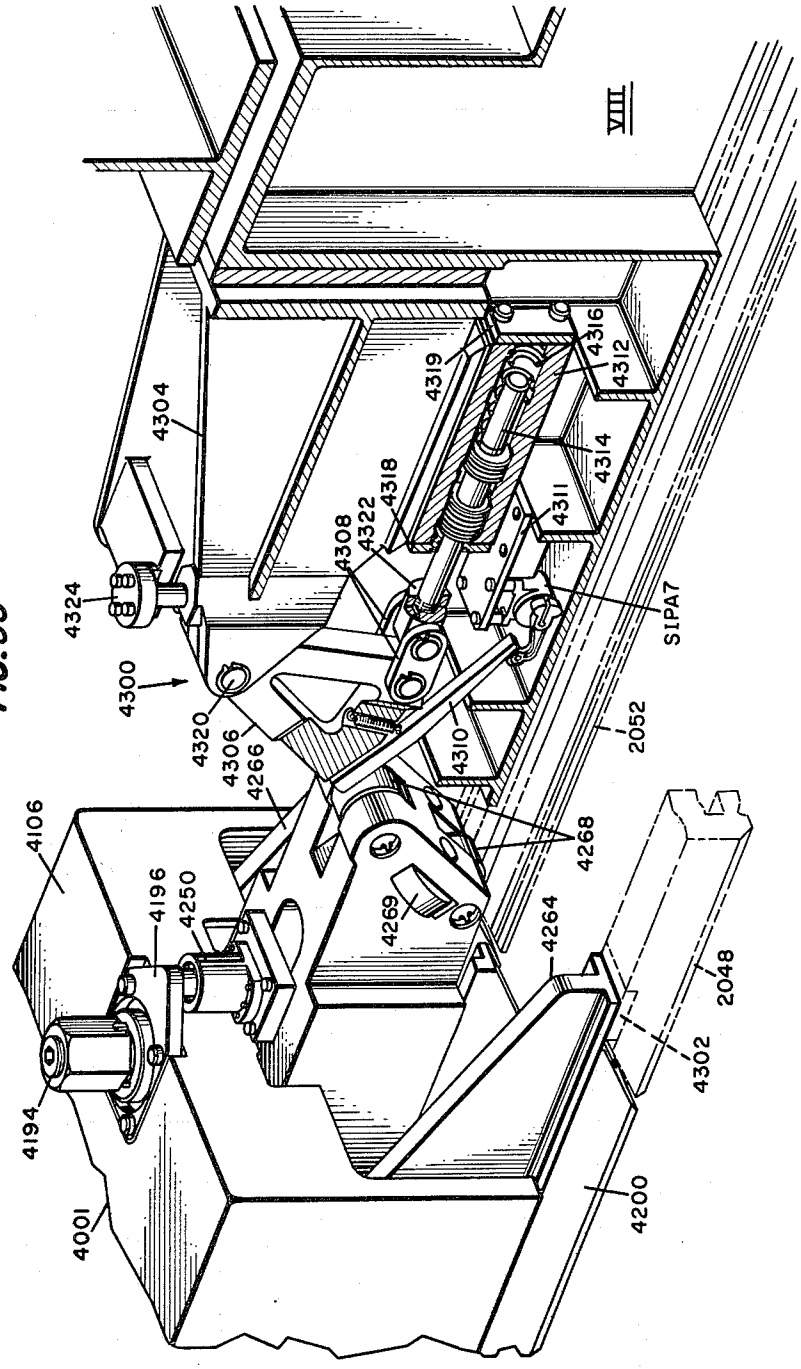

4288
4276
4274
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4284
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4280
4277
4279

FIG. 32

FIG. 33


VIII
4316
4312
4319
4304
4314
4318
4311
4322
4308
4324
S1PA7
4300
4320
4306
4266
4310
2052
4106
4268
4196
4250
4269
4264
2048
4302
4194
4200
4001

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BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Original Filed Oct. 22, 1959 29 Sheets-Sheet 23

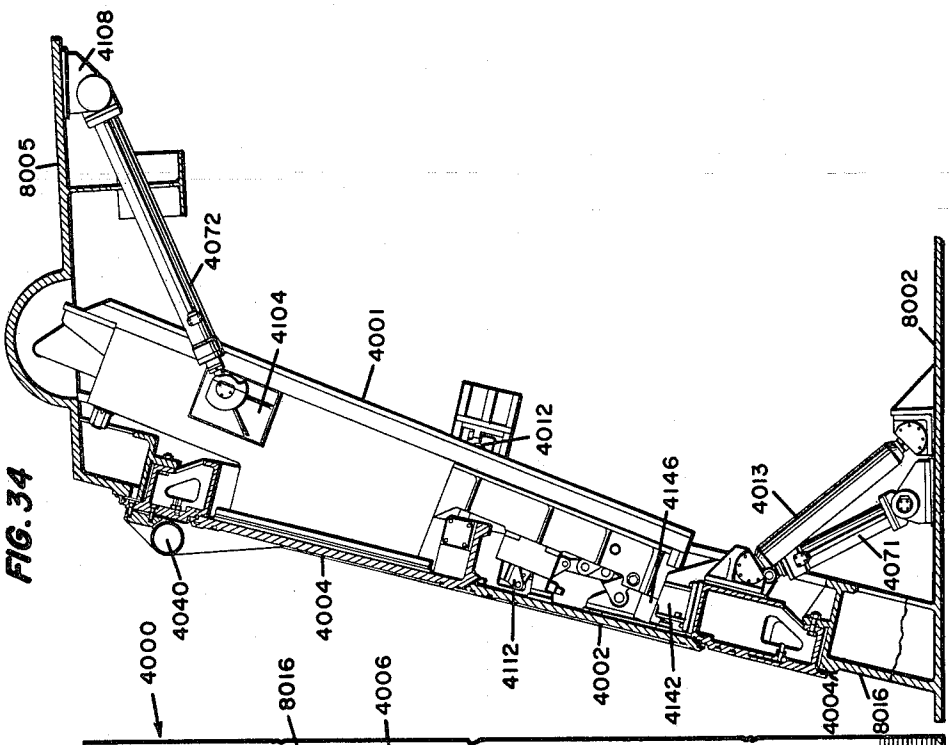


FIG. 34

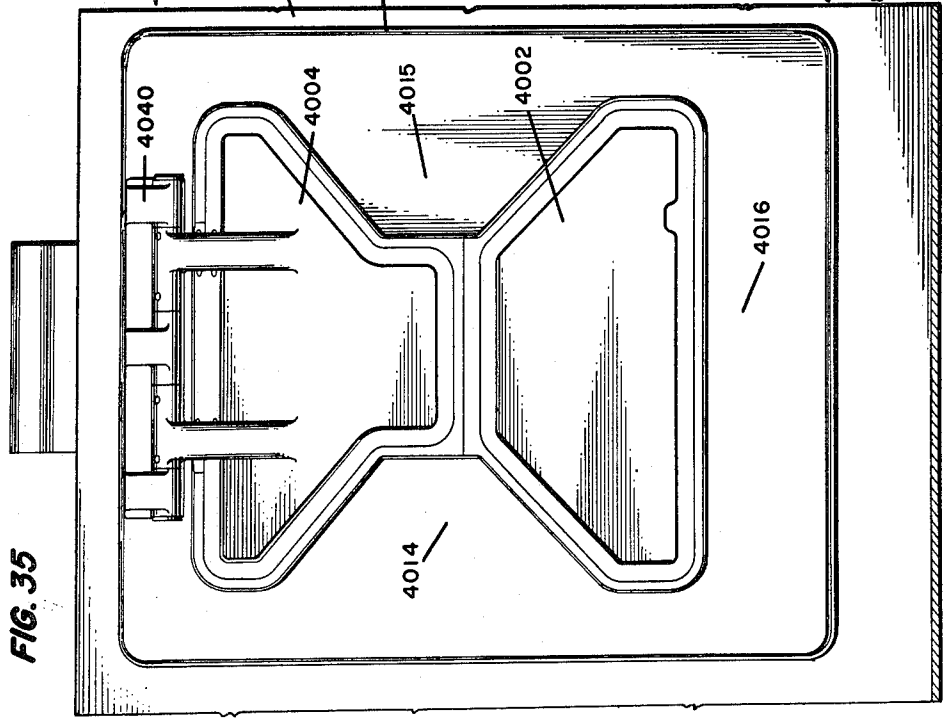


FIG. 35

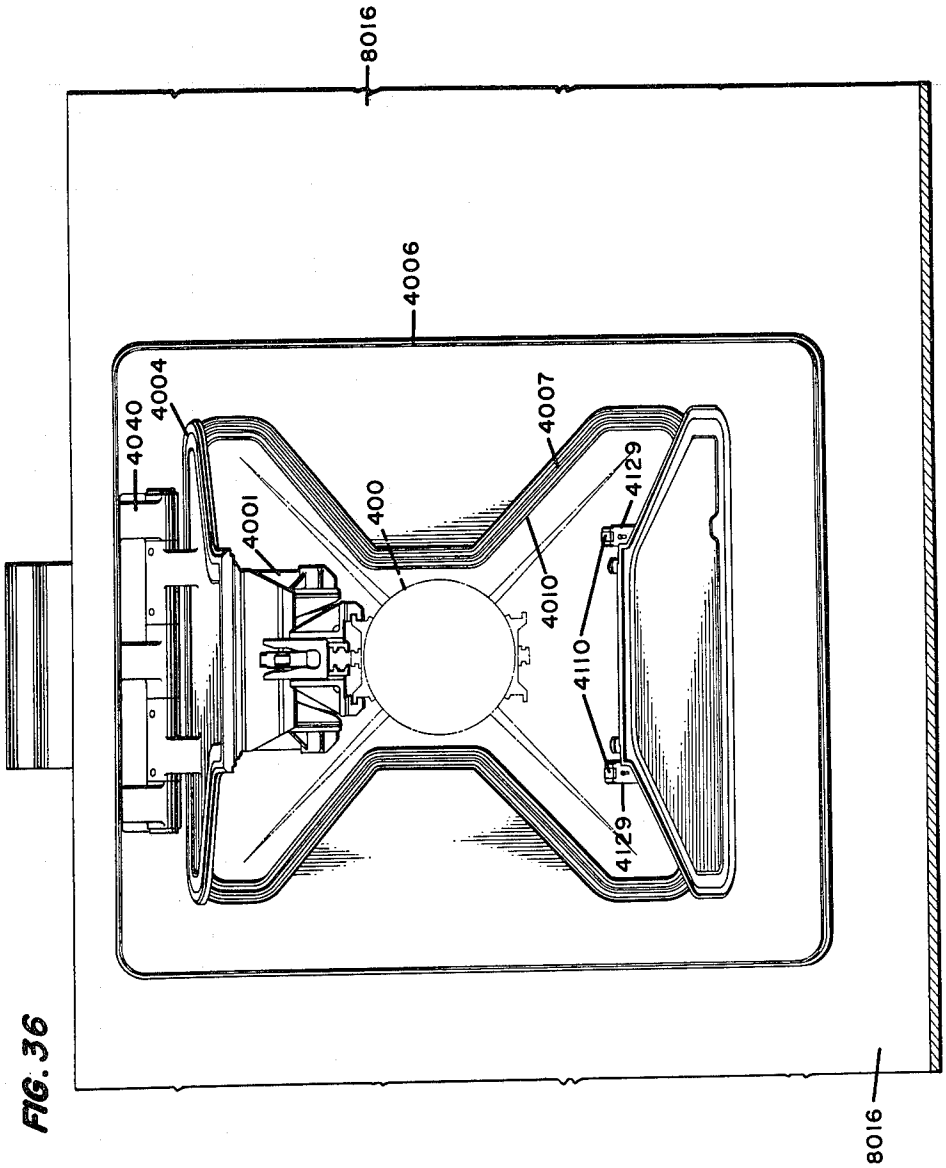


FIG. 36

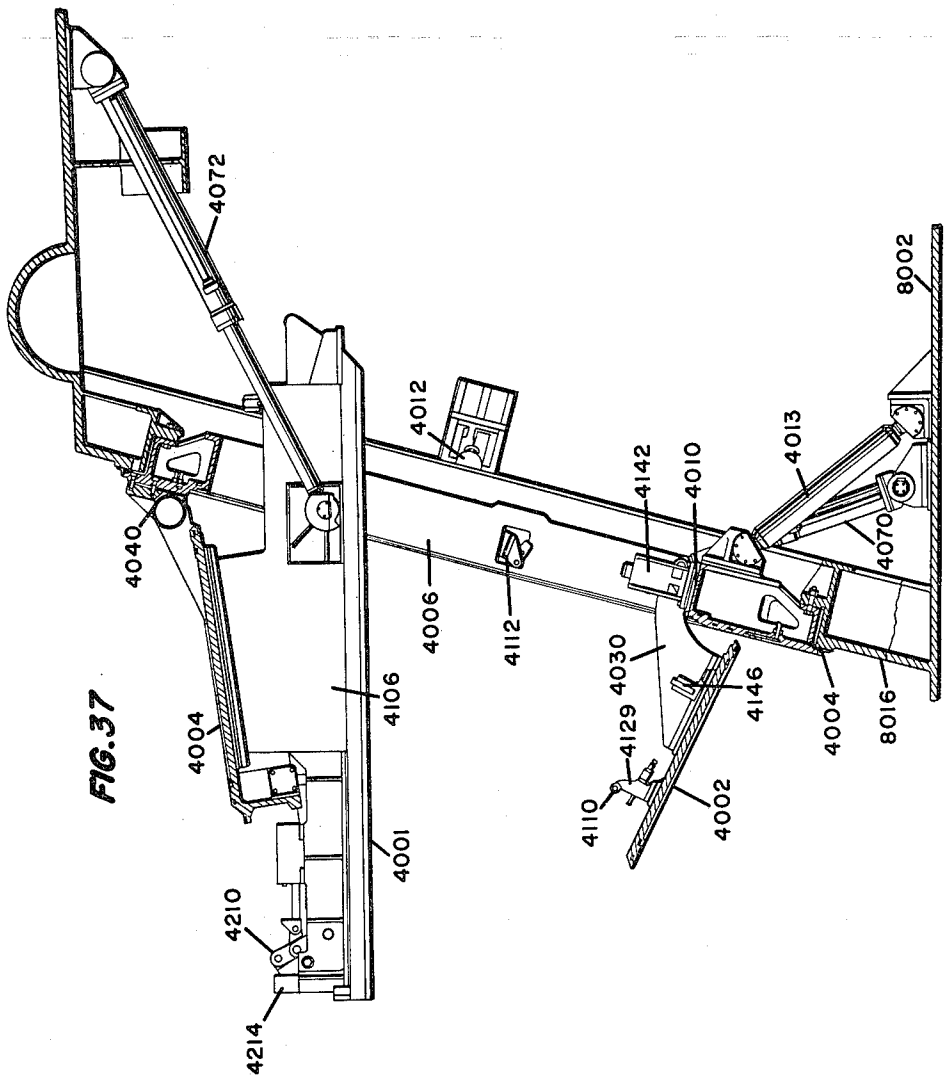

4072
8002
4012
4142
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8016
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4004
4110
4002
4001
4210
4214

FIG. 37

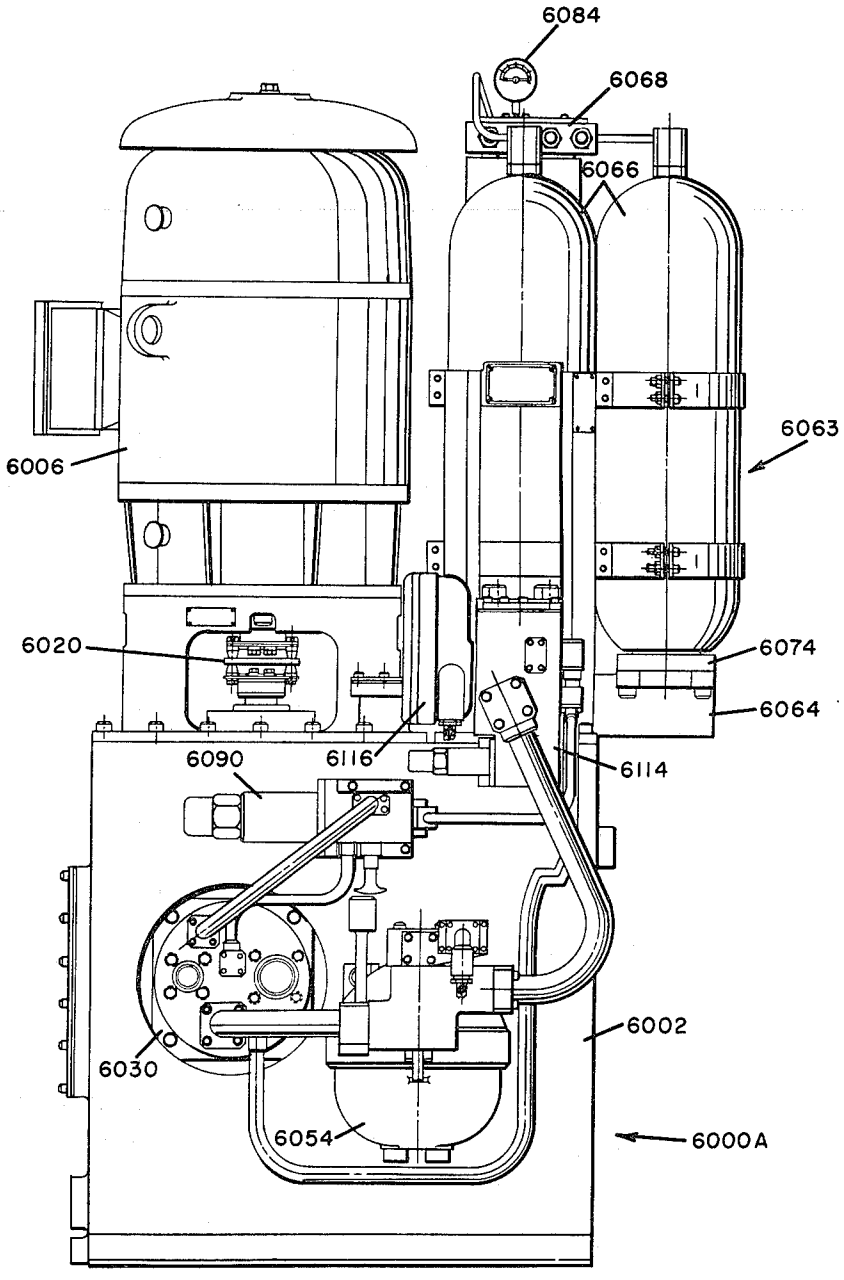

6084
6068
6066
6063
6006
6020
6074
6064
6090
6116
6114
6002
6030
6054
6000A

FIG. 38

FIG. 39

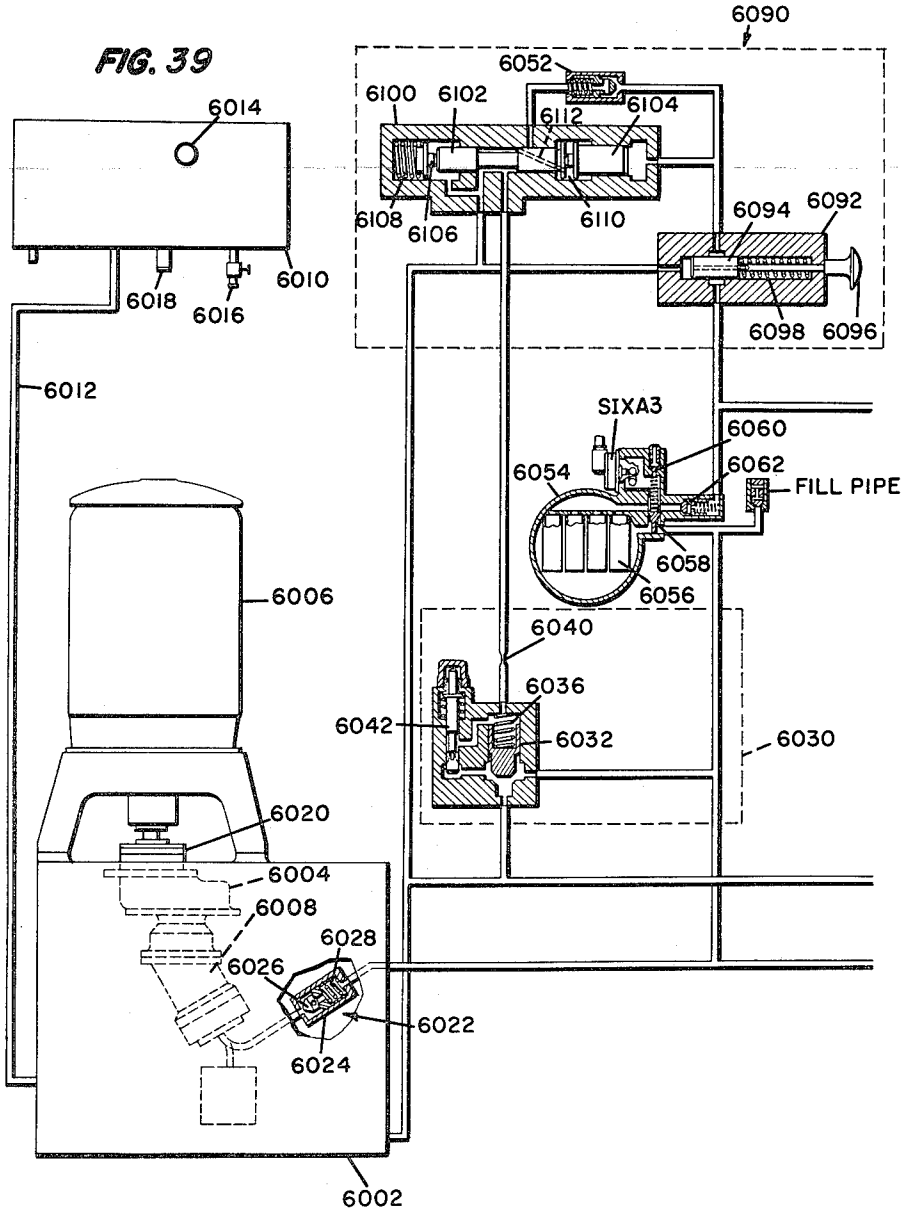
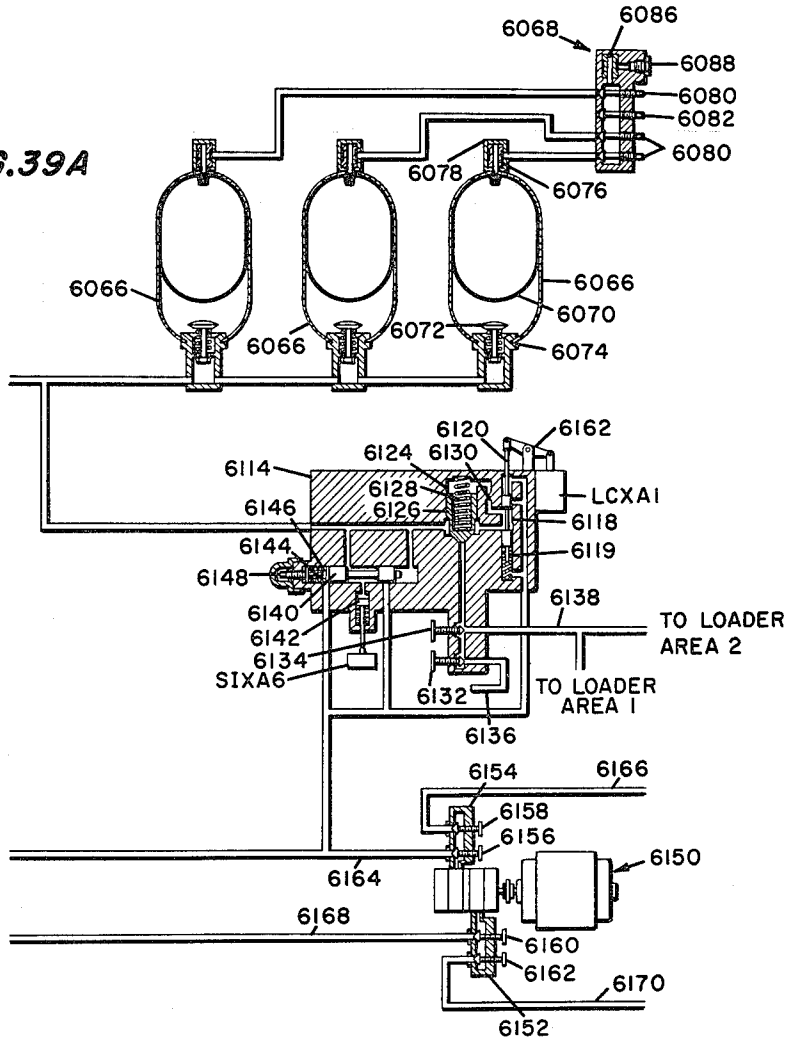

6090
6052
6100
6102
6104
6112
6014
6108
6106
6110
6094
6092
6010
6018
6016
6098
6096
6012
SIXA3
6060
6062
6054
FILL PIPE
6058
6056
6006
6040
6036
6042
6032
6030
6020
6004
6008
6028
6026
6022
6024
6002

FIG. 39A


6068
6086
6088
6080
6082
6080
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6076
6066
6066
6066
6072
6070
6074
6120
6162
6124
6130
6114
6128
6126
LCXA1
6118
6146
6144
6119
6148
6140
6138
TO LOADER AREA 2
6142
6134
SIXA6
6132
TO LOADER AREA 1
6136
6154
6166
6158
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6150
6164
6168
6160
6162
6170
6152

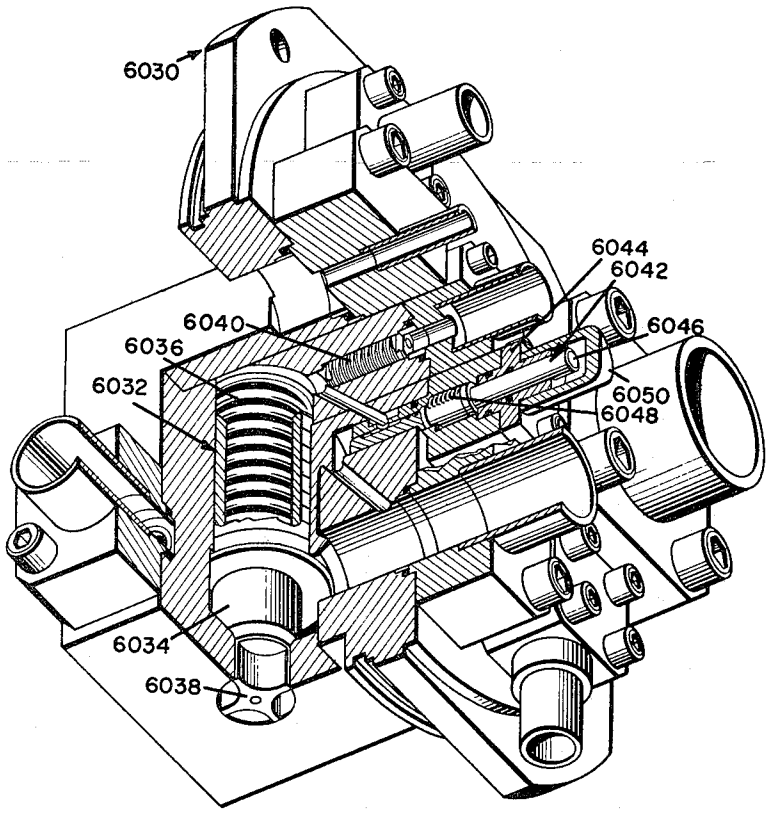


FIG. 40

United States Patent Office

3,095,780

Patented July 2, 1963

3,095,780

BLAST DOORS AND SPAN TRACK ARRANGEMENT FOR GUIDED MISSILE LAUNCHING SYSTEM

Myron J. Bauer, St. Paul, and Richard C. Wilson, Champlin, Minn., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Original application Oct. 22, 1959, Ser. No. 848,163. Divided and this application Mar. 18, 1960, Ser. No. 16,108

12 Claims. (Cl. 89—1.7)

This invention relates generally to a handling and launching system for launching surface-to-air guided missile weapons against high speed air targets or missiles approaching a target at supersonic velocities within predetermined intercept parameters.

More particularly, this invention relates generally to movable blast doors and span track arrangement therefor for use as a part of ordnance weapon handling and launching systems for use in handling and launching large or small type missile weapons from movable installations, such as naval vessels.

It is to be pointed out, however, that the handling and launching system of the present invention is not limited to use with naval ship installations, as it most readily can be adapted for use in fixed installations, such as land base missile launching systems.

This patent application is a division of U.S. patent application, Serial Number 848,163, entitled "Guided Missile Launching System," filed October 22, 1959, by Myron J. Bauer et al.

Modern naval vessels, such as cruisers, destroyers, and aircraft carriers, are no longer able to adequately defend themselves from attacks by guided missile weapons launched from enemy aircraft solely through the use of anti-aircraft guns because of the limited ranges of such ordnance armament. Guided missile weapons of a supersonic type serve well as defensive weapons. Such supersonic missile weapons are capable of seeking and destroying attacking aircrafts or missiles by use of either conventional or atomic warheads. However, some means must be provided for rapidly and accurately launching these supersonic missile weapons in order that they can destroy the incoming and attacking aircrafts or missiles.

For a long time, there has been a demand for an automatic missile weapon handling and launching system located completely above deck of a naval vessel so as to provide a tactical installation, with a limited number of missile weapons in ready service at a substantially lower installation cost than a missile handling and launching system having below-deck stowage of the missile weapons. In addition, such demand requires that the system be capable of repetitive use and be tactically capable of operating as an optimum system.

Any handling and launching system for ordnance missile weapons which is designed for repetitive use is made up of several major components, including a twin launcher, a magazine, and a feeder mechanism for transporting the missile weapons from the magazine to the launcher. There may be two types of magazines, that is, a ready service magazine often referred to broadly as a ready service mechanism, from which missile weapons (with or without their aerodynamic surfaces) can be removed at the firing rate of the system, and stowage magazines, usually used to replenish the ready service mechanisms during lulls in operation.

In order to readily present a clear understanding of the present invention, it is to be pointed out that the twin launcher is generally positioned at the aft part

of the naval vessel, which may be a cruiser. Forward of the launcher there is provided a deckhouse, with fire-control equipment being mounted on top of it. The deckhouse itself is divided into three sections, each about 40 feet in length. The section of the deckhouse closest to the launcher contains a wing and fin assembly area, with missile weapon checkout areas on each side, separated from the assembly area by flametight bulkheads.

The middle section of the deckhouse contains two ready service mechanisms, each of which holds eight unarmed missiles and their boosters, completely assembled except for aerodynamic surfaces. The furthest section of the deck house contains the stowage magazine and the strike-down area. This stowage magazine has a capacity of 30 missiles and 30 boosters, which can be stowed either attached or separately. Strikedown of missiles and boosters is through hatches on each side of the deckhouse overhead.

In the ready service mechanisms, missiles attached to boosters are stowed in steel trays which resemble bridge trestles. The missile weapons are rigidly supported at the booster shoes, and flexibly supported about a forward station of the missile weapon.

The trays, which are supported only at their ends, not only provide a convenient method of handling the missile weapons, but also are designed so as to damp out any of the vertical vibrations of the naval vessel at frequencies from zero to more than twenty-five cycles per second. In addition, they provide a considerable degree of shock protection.

In this handling and launching system, a selected one of a plurality of missile-booster combination weapons are transferred from the ready service mechanisms to overhead loader rails of a feeder system. It is not necessary to load the missile-booster weapon combinations consecutively. The trays for the missile-booster weapon combinations can be shifted until any desired missile-booster weapon combination is brought below the loader rail. Each mechanism is provided with three pairs of hoists, one at each end of the row, and one directly beneath the loader rail.

The end pairs of hoists operate to raise a missile-booster combination from either end of the lower row to the upper row of missile-booster weapon combinations, but will not raise them simultaneously. This arrangement enables the ready service mechanism to be operated in either direction, so as to provide the shortest path for moving the selected missile-booster weapon combination to the center pair of hoists. When a missile-booster weapon combination is being transferred to the launcher, the forward booster shoe slides in the loader rail, while the rear shoe is carried in a saddle cart which rolls in the rail.

In moving to the assembly area, the missile-booster weapon combination passes through a door in a flametight bulkhead. In the assembly area, wings and fins are attached to the missile-booster weapon combination to form a completed weapon, which is then warmed up. These are the only manual operations in the handling and launching cycle of the system.

From the assembly area, the completed missile-booster weapon passes through open blast doors to the launcher. A span track arrangement attached to the upper part of each blast door latches to the launcher rail, and completes the rail from the assembly area to the launcher. The present invention is concerned with the blast doors and span track arrangement for the dual feeder of the guided missile launching system.

When the missile weapon reaches the launcher, the loader chain which has pushed the missile weapon out to the launcher retracts and the blast door closes.

The handling and launching system can be operated to load a single-missile weapon on either side of the launcher, or it can load a salvo of two-missile weapons. When both blast doors are closed and the weapon on the launcher is warmed up and the missile thereof is armed, if of the atomic type, the launcher automatically trains and elevates to the firing position, if ordered by the fire control system, and is then ready to fire the missile weapon.

A principal object of this invention is to provide a ballistically and blast protected structure for protection of an assembly compartment for missile weapons from an adjacent deck launching arrangement, including a blast door arrangement positioned in the structure to provide for the passage of a missile weapon through the opening in the structure when being transferred to the launcher for launching therefrom.

And another object of this present invention is to provide a span track arrangement affixed to a blast door to form an extension of a feeder system to a launcher when the blast door arrangement is in an open position.

And still even another object of the present invention is to provide, in combination with a launcher having a guide arm positioned on the launcher, a span track arrangement for forming a longitudinal extension of a feeder system and the guide arm of the launcher for transferring a missile weapon from a stowage area to the launcher for launching therefrom.

A still further object of this invention is to provide a floating span track arrangement which can be utilized to compensate for misalignment between a launcher guide arm and the loader trunk of a feeder mechanism of a guided missile launching system.

Still a further object of this invention is to provide blast door arrangements for allowing missile weapons to be transferred from loaders in a ballistically and blast protected structure onto guide arms of a dual missile weapon launcher, either singly or in pairs.

To provide a floating span track arrangement in combination with a blast door, which permits the span track assembly to shift either vertically or laterally to compensate for slight discrepancies in position of the loader trunk and launcher rail, is still another object of this invention.

A further object of this invention is to provide a floating span track arrangement which cooperates with a blast door to bridge a gap between a loader trunk and its respective launcher rail in a dual feeder for a guided missile launching system.

In accordance with the invention, a pair of blast door assemblies and pairs of span track assemblies are provided as part of a dual feeder for a guided missile launching system. Each blast door assembly and span track assembly are major subassemblies of each guided missile loader of the dual feeder. The two blast door assemblies allow weapons to be transferred from their respective loaders in Area 1, onto the respective guide arms of a missile launcher.

Each blast door assembly for the A-side and B-side of the guided missile launching system is composed of a frame, an upper door, a lower door, and the span track assembly. The span track assembly is secured to the inner face of the upper door. Both blast door assemblies are mounted in the slanting bulkhead or face of the wing and fin assembly compartment of Area 1 which forms the aft end of the deckhouse of a cruiser.

When the blast doors of each blast door assembly are closed, they protect personnel and equipment within a wing and fin assembly compartment in Area 1 against sea spray and the hot gases and fumes from the booster during the take-off of the missile weapon from the launcher. When the blast doors are open, the span tracks mounted on the back of each upper door, permit completely assembled weapons to be loaded (or unloaded) on the

launcher guide rails on the A-side and B-side of the guided missile launching system.

Each upper and lower door of each blast door assembly is hinged on the horizontal plane, with the lower door being hinged to the bottom of the frame opening and the upper door being hinged to the top of the frame opening.

Each door is opened and closed by the two pairs of differential-area hydraulic pistons. Electrical interlock switches connect the operation of the upper door with the operation of the lower door of each blast door assembly. Both doors, however, do not open or close simultaneously, but act in sequence.

The lower door of each blast door assembly opens first and actuates electrical interlock switches when completely open. When these interlock switches are actuated, the upper door, of its respective assembly, then opens. In closing, the doors are sequenced and interlocked in a like manner, with the upper door closing first, followed by the closing of the lower door of each blast door assembly.

The opening and closing speed of both upper and lower doors is regulated to maintain a given velocity, regardless of gravitational forces or motion of the ship or vessel. As the doors near the fully open or fully closed positions, however, the speed of each door is gradually reduced.

Each lower door is equipped with latches for securing the door when open, and two other latches for securing it when it is closed. In addition, a span track-guide arm latch and a span track-loader latch, which hold the upper door open also align and secure the span track when it is raised in the horizontal position. In addition, the upper door is provided with a door open safety latch.

The span track assembly, when latched in position, bridges the gap between the track of its respective loader in Area 1 and its respective launcher rail. This arrangement allows the loader chain and the saddle cart to move a weapon on or off of its respective launcher rail.

The span track assembly is not rigidly attached to the upper door, but is designed with a "floating" self-aligning feature, which permits the span track assembly to shift either vertically or laterally to compensate for slight discrepancies in position of the rail of the launcher.

Hydraulic pressure, which is used to power the hydraulic components of each blast door assembly and its corresponding span track assembly of each loader, is supplied by an accumulator unit located in Area 1, or in an emergency, by the auxiliary accumulator unit.

Separate control supply circuits are used to feed the A-side electrical components and the B-side electrical components of the system. It should be noted, however, that certain electrical components on both blast door assemblies are interconnected, and may be supplied by either circuit. Thus, with the operation of the dual feeder on one side only, the blast doors on the opposite side are still able to close.

Both blast door assemblies are identical. The B-side blast door assembly differs primarily by the A-side blast door assembly in the position of its components.

Many other objects and attendant advantages of this invention mentioned above will become more readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a cruiser type vessel showing the general location of the guided missile launching system which incorporates the loaders comprising the present invention;

FIG. 2 is a perspective view of a weapon including a missile and booster;

FIG. 3 is a perspective view, with parts removed, of the guided missile launching system including a launcher

and a portion of the wing and fin assembly compartment (Area 1);

FIG. 4 is a continuation of the perspective view of FIG. 3, with parts removed, of the guided missile launching system including the wing and fin assembly compartment (Area 1) and a ready service compartment (Area 2) containing a pair of ready service mechanisms positioned therein;

FIG. 5 is a continuation of the perspective view of FIG. 4, with parts removed, of the guided missile launching system including the ready service compartment having the pair of ready service mechanisms positioned therein;

FIG. 6 is a dimetric view of span track and blast door components showing relationship to the launcher;

FIG. 6A is a continuation to the right of FIG. 6, showing part of the loader trunk and weapon in position thereunder;

FIG. 7 is a hydraulic schematic of the upper blast door in an open position;

FIG. 7A is a continuation to the lower right of FIG. 7;

FIG. 7B is a continuation to the lower left of FIG. 7;

FIG. 7C is a hydraulic schematic of the lower blast door in an open position;

FIG. 8 is a side elevation, partly in cross section, of span track-to-guide arm latching mechanism (contacting position);

FIG. 9 is a side elevation, partly in cross section, of span track-to-guide arm latching mechanism (rotating position);

FIG. 10 is a side elevation, partly in cross section, of span track-to-guide arm latching mechanism (latched position);

FIG. 11 is a hydraulic schematic of the lower blast door in a closed position;

FIG. 12 is a cross section of a frame base;

FIG. 13 is a side elevation of a brace;

FIG. 14 is a dimetric view, partly cut away, of a hinge pin;

FIG. 15 is a dimetric view, partly cut away, of an upper blast door hinge;

FIG. 16 is a cross section of a grease fitting;

FIG. 17 is a cross section of a hinge bracket;

FIG. 18 is a cross section, partly in elevation, of a cam operated switch actuator;

FIG. 19 is a dimetric cut away view, partly in cross section, of a power piston assembly;

FIG. 20 is a dimetric cutaway view, partly in cross section, of a control rod;

FIG. 21 is a side elevation, partly in cross section, of the door-closed latch in an engaged position;

FIG. 22 is a side elevation, partly in cross section, of the door-closed latch in a disengaged position;

FIG. 23 is a cross section of a safety latch;

FIG. 24 is a dimetric view, partly cut away, of a control block;

FIG. 25 is a cross section of a centering piston and T-hanger;

FIG. 26 is a dimetric view, in longitudinal cross section, of the span track;

FIG. 27 is a dimetric view of span track latches and stabilizers;

FIG. 27*a* is a detail view of a stabilizer to limit the vertical movement of the span track;

FIG. 27*b* is a detail view, partly in section, of a span track latch;

FIG. 28 is a dimetric view, partly cutaway, of span track-to-guide arm latching mechanism in an engaged position;

FIG. 29 is a dimetric view, with parts removed, of span track-to-guide arm latching mechanism in an engaged position;

FIG. 30 is a dimetric view of guide arm latching block;

FIG. 31 is a sectional view, with parts in phantom and elevation, of centering bolt and a hold down piston therefor;

FIG. 32 is a dimetric exploded view, partly in section, of solenoid operated pilot valve assembly;

FIG. 33 is a dimetric view, partly cutaway, of the span track-to-loader latching mechanism;

FIG. 34 is a side elevation, with parts removed, of upper and lower blast doors in a closed position;

FIG. 35 is a front elevation of upper and lower blast doors in a closed position;

FIG. 36 is a front elevation of upper and lower blast doors in an opened position;

FIG. 37 is a side elevation, with parts removed, of upper and lower blast doors in an opened position;

FIG. 38 is a side elevation of the Area 1 accumulator unit showing generally the location of the component parts;

FIG. 39 is a hydraulic schematic of the Area 1 accumulator unit fully charged and with the pump bypassed to tank;

FIG. 39A is a continuation to the right of the hydraulic schematic of the Area 1 accumulator unit of FIG. 39; and

FIG. 40 is a dimetric view, taken from below, of an adapter block assembly.

In view of the complex nature of the present invention, there is incorporated at this point in the application an index which is followed in the detailed description of the loaders for the feeder of the guided missile launching system. This index not only indicates the sequence in which the descriptive matter is presented, but also makes possible a ready reference to any major part of the descriptive matter when desired by listing the first page of the description and the figures used in connection with that section of the description.

Major Item	Figure	Col.
I. Guided Missile Launching System—General.	1, 2, 3, 4, 5	7
II. Span Track and Blast Doors	6 through 40	10
A. General Introduction	1, 3, 6, 6A, 7C, 33, 34, 35, 36, 37, 39, 39A.	10
B. Detailed Description	6, 6A	12
1. Blast Door Frame	1, 3, 6, 12, 34, 35, 36, 37.	12
a. Braces	6, 13	12
2. Blast Doors	6, 6A, 12, 14, 15, 34, 35, 36.	13
a. Lower Blast Door	6, 6A, 7C, 21, 34, 35, 36, 37.	13
(1) Lower Door Hinges	37	13
b. Upper Blast Door	25, 26, 34, 35	14
(1) Upper Door Hinges	14, 15, 16, 17, 18, 34, 35, 36, 37.	14
c. Power Pistons	6, 6A, 7, 7C	15
(1) Lower Door Power Pistons	6, 6A, 7, 7C, 11, 19, 24.	15
(2) Upper Door Power Pistons	1, 6, 6A	17
d. Latches	7C, 34, 37	17
(1) Lower Door Closed Latches	7C, 21, 22, 34, 37	17
(2) Lower Door Open Latches	7, 7C, 21, 34, 37	18
(3) Safety Latch	7, 23, 26	19
e. Door Control Block Assemblies.	6, 6A, 7, 7C	19
(1) Metering Valve	6, 7C, 20, 24	20
(2) Throttle Valve	7, 7C, 23	20
(3) Directional Valve	7, 7C, 24	20
3. Span Track Assembly	3, 6, 6A, 7, 8, 9, 10, 26, 27, 28, 29, 31, 33, 37.	21
a. Support	6A, 26, 27, 30, 34, 37.	21
b. Span Truck	27, 28, 29, 31, 33, 35.	22
c. Span Track-Guide Arm Latch	6, 7, 8, 26, 27, 28, 33, 37.	22
(1) Latch and Linkage	28, 30	23
(2) Valve Block	28	23
(a) Tripping Valve	28	23
(b) Span Track-Guide Arm Piston.	28	24
d. Centering Pistons and T-hanger.	7B, 25, 26	24
e. Centering Bolt and Hold-down Piston.	26, 31	25
f. Span Track-Loader Latching Mechanism.	26, 31, 33	25
g. Tracks	26, 28, 29, 30, 33	26
4. Pilot Valves	6, 7, 7A, 7B, 7C, 32	27
C. Area 1 Accumulator	3 through 40	27
1. General Introduction	3, 3B	27

Major Item	Figure	Col.
2. Area 1 Accumulator Units		28
a. General Description	3, 38, 39, 39A, 40	28
b. Detailed Description		28
(1) Main Tank	3, 38, 39, 39A, 40	28
(2) Header Tank	39	29
(3) Motor	39	29
(4) Pump and Gear Reducer	39	29
(5) Check Valve	39	29
(6) Adapter Block Assembly	39, 40	29
(a) Unloading Valve	39	29
(b) Orifice	39	30
(c) Manual Starting Valve	39, 40	30
(7) Filter Assembly	39	30
(a) Bypass Valve and Bleeder Valve.	39	30
(b) Check Valve	39	31
(8) Accumulator Flask Assembly.	38, 39A	31
(a) Accumulator Flasks	39, 39A	31
(b) Nitrogen Valve Block Assembly.	38, 39A	31
(9) Accumulator Control Assembly.	38, 39	31
(a) Manual Unloading Valve.	39	32
(b) Check Valve	39	32
(c) Accumulator Control Valve.	39	32
(10) Pressure Cutoff Assembly	38, 39A	32
(a) Control Valve	39A	32
(b) Cutoff Valve and Solenoid.	39A	33
(c) Manual Shutoff Valves.	39A	33
(d) Switch Valves	39A	33
(11) Auxiliary Motor-Driven Pump.	39, 39A	34
D. Theory of Operation	See 1 and 2 below	34
1. Door-Open Cycle		34
a. Automatic Operation	7A, 7C, 32	34
(1) Lower Door-Open Circuit	3, 7C	35
(2) Lower Door-Open Operation.	7C, 11, 19, 20, 34, 37.	35
(3) Upper Door-Open Circuit	6, 7, 7A, 7C, 8, 9, 10, 28, 30.	36
(4) Upper Door-Open Operation.	6, 6A, 7, 7A, 7B, 8, 9. 10, 19, 20, 23, 25, 28, 33.	37
2. Door-Close Cycle	7A, 7C	38
a. Automatic Operation		38
(1) Upper Door-Close Circuit	7A	38
(2) Upper Door-Close Operation.	7, 7A, 7B, 11, 23, 25, 26.	38
(3) Lower Door-Close Circuit	11	40
(4) Lower Door-Close Operation.	7C, 11	40

I. GUIDED MISSILE LAUNCHING SYSTEM—GENERAL

The loaders **2002** of the present invention are part of a guided missile feeder **2000**, which, in turn, is a part of a missile weapon system utilized aboard guided missile vessels or ships **8000**, such as the cruiser type vessel shown in FIG. 1, to insure maximum fleet protection against targets, such as aircraft or missiles, and surface and shore targets.

The missile weapon system abroad each vessel **8000** consists generally of a guided missile launching system including a dual guided missile launcher **5000**, and a guided missile launcher feeder **2000** including a guided missile launching system control; two tracking radars (not shown), two missile-guidance transmitters (not shown), a computer (not shown), and weapon direction equipment (not shown), which, except for the dual launcher **5000** and the dual feeder system **2000**, are generally described in U.S. patent application Serial Number 594,067 filed by Wilbur H. Goss et al., on June 26, 1956, for "Guided Missile."

As illustrated in FIGS. 1 to 5, the guided missile launching system consists generally of the previously mentioned dual guided missile launcher **5000**, and the guided missile launcher feeder **2000**. The guided missile launcher feeder **2000** consists generally of a guided missile assembler **3000**, a pair of guided missile loaders **2002A** and **2002B**, and a pair of ready service mechanisms **500A** and **500B** for feeding weapons **400** to the dual launcher **5000** from the pair of ready service mechanisms and their control components. The letters "A" and "B" refer to the right (starboard) and left (port) sides of the vessel **8000**, respectively. This guided missile launching system is designed as an abovedeck installation for guided missile cruiser type vessels **8000**, and it is located aft (stern) of the vessel, as shown in FIG. 1. However, with minor modification and adaptation, the same guided missile launching system can be installed off ship, if desirable, i.e.: as a land installation.

The dual launcher **5000**, as shown in FIGS. 1 and 3, is mounted on the centerline of the vessel **8000**, aft of the main deck **8002** thereof. The guided missile feeder **2000** extends forward toward the bow of the vessel **8000**, as illustrated in FIGS. 1, 3, 4, and 5. The guided missile feeder **2000** and the control components therefor are mounted above the main deck **8002**, and are housed in an aft deckhouse **8004** from the main deck **8002** to the overhead level indicated by numeral **8005**.

As illustrated in FIGS. 1 and 3, the dual launcher **5000** has two arms (A-side) indicated generally by reference numeral **5002A** and (B-side) **5002B** which are supported on a single rotatable carriage **5006**. Each launcher arm **5002A** or **5002B** is secured to the end of a trunnion tube **5008**, which, in turn, is mounted in the launcher carriage **5016** so that both arms move together, although they are located on opposite sides of the carriage. Each launcher arm **5002A** or **5002B** is capable of handling a weapon **400**. The guided missile feeder **2000** is, therefore, provided for supplying weapons **400** to its associated launcher arm **5002A** or **5002B**.

Although each loader **2002A** or **2002B** and its corresponding ready service mechanism of the guided missile feeder **2000** operates independently, both loaders operate simultaneously so that both launcher arms **5002A** and **5002B** can be loaded with weapons **400** at the same time. Each loader **2002A** or **2002B** of the guided missile feeder **2000** is only capable of loading its associated arm with a weapon **400**, that is, the A-side loader **2002A** will load the arm **5002A** of the launcher **5000** with a weapon **400**. Thus, if one-half of the guided missile feeder **2000**, that is, either the A-side or B-side loaders **2002A** or **2002B**, respectively, develops an operation malfunction, or a reload of a single arm **5002A** or **5002B** of the launcher **5000** is desired, only one loader of the guided missile feeder **2000** is operated.

The components of the guided missile feeder **2000** are contained in two adjoining compartments, referred to hereinafter as the wing and fin assembly compartment **8010**, or Area **1**, and the ready service compartment **8012**, or Area **2**, illustrated in FIGS. 1, 3, 4, and 5, in the aft deckhouse **8004**. These compartments **8010** and **8012** are separated by an athwartships bulkhead **8008**, as illustrated in FIG. 1. The fin and assembly compartment **8010** (Area **1**) contains the guided missile assembler **3000** and two pairs of transversely spaced blast doors **4000** for use in feeding weapons **400** to the guided missile launcher **5000**, and the latter is positioned adjacent thereto, as illustrated in FIGS. 1 and 3.

The guided missile feeder **2000** for the launcher **5000** consists of the previously mentioned A-side loader **2002A** and the B-side loader **2002B** corresponding to the arms **5002A** and **5002B** on the launcher, respectively (when the launcher is in the load or stowed position), as illustrated in FIGS. 3, 4, and 5). The A-side loader **2002A** and the B-side loader **2002B** of the guided missile feeder **2000** thus provides a separate loading mechanism for each launcher arm **5002A** and **5002B**, respectively. As will be pointed out in detail subsequently, although the loading mechanisms function simultaneously in an identical manner, they both operate independently. Thus, either loader **2002A** or **2002B** of the guided missile feeder **2000**, or both loaders thereof may be used at one time.

As will be pointed out in the detailed description of the guided missile launching system, all handling of the weapons **400** in the guided missile feeder **2000** and the loading thereof onto the launcher **5000** are accomplished by moving the weapons horizontally, including trans-

versely in the ready service compartment 8012 (Area 2) and longitudinally along the guided missile feeder 2000 from Area 2 to the launcher. During actual loading of weapons 400 onto the launcher 5000, pairs of blast doors indicated generally by 4000, which are mounted in the face 8016 of the aft deckhouse 8004 adjacent to each launcher arm 5002A and 5002B, are open, as illustrated in FIGS. 1 and 3.

A span track, indicated generally by reference numeral 4001, as illustrated in FIG. 3, which is an integral part of each upper blast door 4004 of the pairs of blast doors 4000, bridges the gap between its respective loader 2002A or 2002B of the guided missile feeder 2000 and the launcher 5000.

The components of the guided missile launching system, as will be described in detail subsequently, function automatically to deliver missile-booster combinations 300, which consist of a missile 100 and a booster or booster rocket 200, as shown in FIG. 2, without the wings 102 or fins 104 for the missile and fins 208 for the booster rocket from Area 2 to Area 1 where these components are assembled thereto to form weapons 400 in condition for firing to the power-driven remotely controlled launcher 5000.

In the wing and fin assembly compartment 8010 (Area 1), illustrated schematically in FIGS. 3 and 4, delivery of the missile-booster combinations 300 to the launcher 5000 is interrupted briefly to assemble four wings 102 and four fins 104 to the missile 100 as well as four fins 208 to the booster 200, to install an arming mechanism 110, as shown in FIG. 2, to obtain a complete weapon 400. A missile-booster clamping ring 402, shown in FIG. 2, positioned between the missile 100 and booster 200 holds them together during movement by the guided missile feeder 2000 and the first part of aerial flight of the weapon 400. Upon installation of all airborne equipment, each missile-booster combination 300 becomes a weapon 400, and it is loaded onto the launcher 5000 by the guided missile feeder 2000.

As will be pointed out in detail later, delivery of weapons 400 to the launcher 5000 may be either continuous or as needed, and firing may be in two-round salvos (single or multiple) or by single rounds, according to the demands of the tactical situation.

Two types of missiles 100 can be handled by the guided missile launching system, namely an S-type missile 100S which operates on beam riding, mid-course guidance, and interferometer-homing, terminal guidance (with the terminal guidance circuitry being enabled by automatic command from the fire control equipment of the vessel 8000). Each S-type missile 100S carries a high-explosive warhead which is arranged to be detonated by a proximity fuze. The other type of missile which can be handled by the guided missile launching system is a W-type missile 100W which operates on beam riding guidance throughout its aerial flight, with the warhead of each missile being armed and detonated by an automatic command from the fire control equipment of the vessel 8000.

Firing of S-type missiles 100S from the launcher 5000 may be in two-round salvos or by single rounds, according to the demands of the tactical situation, W-type missiles 100W can be loaded onto the launcher 5000 in the same manner as S-type missiles 100S, that is, onto both launcher rails 5010 at one time, as illustrated in FIGS. 1 and 3, but if either rail 5010 (A-side or B-side) contains a W-type missile, firing of the weapon 400 from the launcher 5000 can occur only in single rounds (A-side arm 5002A or B-side arm 5002B only). All elements of this system are operable in step control as well as in normal automatic control.

Referring now to FIG. 2, the weapon 400 handled in the guided missile launching system consists of the previously mentioned missile 100 and booster 200, with wings 102 and fins 104 and 208 assembled thereto, mated together by the missile-booster clamping ring 402.

The missile 100, of either the S or W type, is a ramjet-propelled, supersonic missile, while the booster or rocket 200 is of a solid propellant rocket type. However, other types of missiles, boosters, or combinations thereof, can be handled by the guided missile launching system herein described and illustrated. The mated missile 100 and booster 200 make the missile-booster combination 300, and as previously explained, after installation of the wings 102 and fins 104 and 208, together with the arming mechanism 110, the combination is an assembled weapon 400.

In the following specification, therefore, the missile-booster combination will be referred to by reference numeral 300 until after the assembly of all airborne equipment including the wings 102, fins 104 and 208, and the arming mechanism 110, and then it will be referred to as a weapon by the reference numeral 400. The S-type and W-type weapons 400 use wing control during boost thereof by the boosters 200 for attitude stabilization to provide stable flight of the missile 100 with low dispersion.

The missile-booster combinations 300 are stowed in the previously mentioned ready service mechanisms 500A and 500B located in the ready service compartment 8012 (Area 2) in trays 502 in ready condition for delivery to the guided missile launcher 5000 by the loaders 2002A and 2002B of the guided missile feeder 2000.

Following the "load" order, the missile booster combinations 300 (A-side and B-side) are moved into the wing and fin assembly compartment 8010, as previously mentioned, and then the weapons 400 are loaded through the blast doors 4000 onto the launcher 5000.

Upon receipt of the "Fire" orders from the Weapon Direction Equipment, the weapon 400 is launched by the booster rocket 200 to a speed of about 2,000 feet per second. After the propellant of the booster rocket 200 is exhausted, the empty booster casing 201 drops away from the missile 100 (having its wings 102 and fins 104 assembled thereto) due to the drag of the air thereon, while the ramjet engine in the missile, which was previously started in operation, propels the missile on the target either through beam-riding, or beam-riding and homing guidance, as mentioned above.

During the flight of the missile 100 to the target, the missile is controlled by movement of its four independently movable wings 102 arranged in a cruciform configuration at the center of gravity thereof and which are actuated in response to signals from the missile-borne electronic guidance equipment.

II. SPAN TRACK AND BLAST DOORS

A. General Introduction

As previously mentioned in Section I and as best illustrated in FIGS. 3, 6, and 6A, of this application, the blast door assembly, indicated generally by reference numeral 4000, and the span track assembly, indicated generally by reference numeral 4001, are major subassemblies of each guided missile loader 2002. The two blast door assemblies 4000A and 4000B allow weapons 400 to be transferred from their respective loaders 2002A and 2002B in Area 1, onto the respective rails 5010 of the launcher 5000.

As shown best in FIGS. 6 and 6A, each blast door assembly 4000A and 4000B for the A-side and B-side of the guided missile launching system is composed of a frame 4006, an upper door 4004, a lower door 4002, and the span track assembly 4001. The span track assembly 4001 is secured to the inner face of the upper door 4004. Both blast door assemblies 4000A and 4000B are mounted in the slanting bulkhead or face 8016 of the wing and fin assembly compartment 8010 (Area 1) which forms the aft end of the deckhouse 8004, as shown best in FIGS. 1 and 6.

As illustrated best in FIGS. 1, 3, 6, 34, and 35, when the blast doors 4002 and 4004 of each blast door assembly 4000A and 4000B are closed, they protect personnel and equipment within the wing and fin assembly compartment 8010 in Area 1 against sea spray and the hot gases and fumes from the booster 200 during the take-off of the weapon 400. When the blast doors 4002 and 4004 are open, as shown best in FIGS. 6A, 36, and 37, the span tracks 4001, mounted on the back of each upper door 4004, permit completely assembled weapons 400 to be loaded (or unloaded) on the launcher rails 5010 on the A-side and B-side of the guided missile launching system.

Each upper and lower door 4004 and 4002, respectively, of each blast door assembly 4000A and 4000B, is hinged on the horizontal plane, with the lower door 4002 being hinged to the bottom of the frame opening 4010 and the upper door being hinged to the top of the frame opening 4010, as best illustrated in FIG. 37, and as will be described in detail subsequently.

Each door 4002 and 4004 is opened and closed by two differential-area hydraulic pistons 4070 and 4071, and 4072 and 4073, respectively, as shown best in FIGS. 3, 6, 6A, 34, and 37. Electrical interlock switches connect the operation of the upper door 4004 with the operation of the lower door 4002 of each blast door assembly 4000. Both doors 4002 and 4004, however, do not open or close simultaneously, but act in sequence, as will be described subsequently.

The lower door 4002 of each blast door assembly 4000 opens first and actuates electrical interlock switches when completely open. When these interlock switches are actuated, the upper door 4004, of its respective assembly 4000, then opens. In closing, the doors 4002 and 4004 are sequenced and interlocked in a like manner, with the upper door 4004 closing first, followed by the closing of the lower door 4002 of each blast door assembly 4000.

The opening and closing speed of both upper and lower doors 4004 and 4002 is regulated to maintain a given velocity, regardless of gravitational forces or motion of the ship or vessel 8000, as shown in FIG. 1. As the doors 4002 and 4004 near the fully open or fully closed positions, however, the speed of each door is gradually reduced.

As shown in FIG. 7C, each lower door 4002 is equipped with latches 4142 and 4143 for securing the door when open, and two other latches 4112 and 4113 for securing it when it is closed. In addition, a span track-guide arm latch 4210 and a span track-loader latch 4300, as shown best in FIGS. 26 and 33, which hold the upper door 4004 open also align and secure the span track 4001 when it is raised in the horizontal position. In addition, the upper door 4004 is provided with a roller 4152 for a safety latch 4150.

The span track assembly 4001, when latched in position, bridges the gap between the track 2034 of its respective loader 2002 in Area 1 and its respective launcher rail 5010. This arrangement allows the loader chain 2004 and the saddle cart 2006 to move a weapon 400 on or off of its respective rail 5010. The span track assembly 4001 is not rigidly attached to the upper door 4004, but is designed with a "floating" self-aligning feature, which permits the span track assembly 4001 to shift either vertically or laterally to compensate for slight discrepancies in position of the rail 5010 of the launcher 5000.

Hydraulic pressure, which is used to power the hydraulic components of each blast door assembly 4000 and its corresponding span track assembly 4001 of each loader 2002, is supplied by an accumulator unit 6000 located in Area 1, or, in an emergency, by an auxiliary accumulator unit 6150, shown in FIGS. 39 and 39A.

Separate control supply circuits are used to feed the A-side electrical components and the B-side electrical components of the system. It should be noted, however, that certain electrical components on both blast door assemblies 4000A and 4000B are interconnected, and may be supplied by either circuit. Thus, with the operation of the feeder 2000 on one side only, the blast doors 4002 and 4004 on the opposite side are still able to close. Since both blast door assemblies 4000A and 4000B are identical, only the A-side blast door assembly 4000A will be discussed hereinafter.

B. Detailed Description

As previously mentioned, each blast door assembly 4000 consists of the frame 4006, two two blast doors 4002 and 4004, the span track assembly 4001, and two solenoid-operated pilot valves 4166 and 4168, as shown best in FIGS. 6 and 6A. The following detailed description of the blast door assembly 400 and span track assembly 4001 locates each of these major components, and described its operation as related to other components of the system.

1. *Blast Door Frame*

The blast door frame 4006, as shown best in FIGS. 35, 36 and 37, is basically a rectangular-shaped weldment which holds both blast doors 4002 and 4004 and their components. The blast door frame 4006 is fitted into an opening on the slanting bulkhead or face 8016 aft of the missile launcher 5000, as shown best in FIGS. 1, 3, 6, 34, and 35.

The frame 4006 is provided with an hour-glass-shaped opening 4010 in the center thereof. This opening 4010 is covered by the upper and lower blast doors 4004 and 4002 when they are in a closed position. The hourglass-shaped opening 4010 permits the weapon 400, equipped with its wings 102 and fins 104 and 208, to be moved from Area 1 onto its respective guide arm 5002 of the launcher 5000.

For protection against the blast of the gases from the booster 200 when the weapon 400 is launched and against enemy missiles and ordnace weapons, the outer face of the frame 4006 is preferably constructed of armor plate. In addition, structural members are welded to the inner face of frame 4006 to add rigidity to the frame structure. Two narrow center sections 4014 and 4015 and the base 4016 of the frame 4006 receive additional support from angularly placed braces mounted to the bulkhead 8016 and deck 8002 of the vessel 8000. The frame 4006 is bolted to the slanting bulkhead or face 8016 and this juncture is equipped with seals 4008 around its periphery as indicated best in FIGS. 12 and 34.

The frame 4006, like the blast doors 4002 and 4004, is provided with built-in passages which carry heated anti-icing fluid. As shown best in FIG. 12, anti-icing fluid passages 4018 and 4020 are located in the base 4016 of the frame 4006. The lower set of passages 4018, as shown in FIG. 12, duct the anti-icing fluid through the frame base 4016 of the frame 4006. The set of passages 4020, located directly above the first mentioned set of passages 4018, duct the anti-icing fluid around the periphery of the hourglass-shaped opening 4010 of the frame 4006.

a. Braces

Three braces 4011, 4012, and 4013, as shown in FIG. 6, provide the frame 4006 with additional support. Braces 4011 and 4012 support the sides of the frame 4006, while brace 4013 supports the frame base 4016 of the frame 4006. As shown best in FIG. 13, each brace 4011, 4012, and 4013 consists of a hollow cylinder 4022, with ball shafts 4024 being screw into the opposite ends thereof. The balls 4026 of the ball shafts 4024 are fitted to sockets 4028 which are bolted to the frame 4006 at one end, and to the bulkhead or deck 8002 of the vessel at the other. When the braces 4011, 4012, and 4013 are adjusted, the ball shaft 4024 for each is pinned to its respective cylinder 4022.

The previously mentioned two angularly mounted braces 4011 and 4012, which support the narrow center sections 4014 and 4015 of the frame 4006, are fastened to

bulkhead cross members. The brace **4013** which supports the base **4016** of the frame **4006** is mounted to the deck **8002** of the vessel between the two lower door power pistons **4070** and **4071**. This brace **4013** is provided with a longer cylinder **4022** than the other two braces **4011** and **4012**, as best illustrated in FIG. 6.

2. *Blast Doors*

As previously indicated, the upper and lower blast doors **4004** and **4002** form a cover for the hourglass-shaped opening **4010** in the frame **4006**, as shown in FIGS. 34, 35, and 36. The periphery of the opening **4010** is provided with a rubber door seal **4007** to exclude spray water and blast gases from the booster **200** when the weapon **400** is fired and the doors **4002** and **4004** are closed. The outer face of both doors **4002** and **4004** is constructed of armor plate. The blast doors **4002** and **4004** are designed to take the full blast of the booster **200** when the weapon **400** is fired.

Both blast doors **4002** and **4004** are pivotally mounted on hinge pins and are opened and closed by the previously mentioned hydraulically operated pistons **4070**, and **4071**, and **4072**, and **4073**. Latches **4112**, **4113**, and **4142**, **4143** secure the blast doors **4002** and **4004** in either open or closed position. Each blast door **4002** and **4004** is provided with a pair of embedded passages **4032**, in the lower door **4002**, as shown in FIG. 12, to carry heated anti-icing fluid. A similar pair of embedded passages (not shown) is provided in the upper blast door **4004** for the same purpose. The design of these blast door passages **4032** and the corresponding pair in the upper blast door **4004** are identical to the previously mentioned frame passages **4018** and **4020**, shown in FIG. 12. The anti-icing passages follow the periphery of each blast door **4002** and **4004**.

The lines which supply or return the anti-icing fluid to either blast door **4002** and **4004** are ported through the respective hinge for that door. Lines leading to the passages in the lower blast door **4002** are ducted through the outboard hinge **4030** of this door, as shown in FIG. 6 and 6A. Lines to the upper door **4004** lead through the upper door hinge **4044**, as illustrated in FIGS. 14 and 15.

a. LOWER BLAST DOOR

The lower blast door **4002**, which is substantially of trapezoidal shape, is illustrated in FIGS. 35 and 36. Two lower door hinges **4030** and **4031**, as shown in FIGS. 6, 6A, 7C, and 37, bolted to the lower inner face of the blast door **4002**, are pin-pivoted on brackets **4129**, as shown in FIGS. 36 and 37. The previously mentioned lower door power pistons **4070** and **4071** are pinned to the outrigged portion of the hinges **4030** and **4031**.

Door-open latch rollers **4140**, shown in FIG. 7C, are provided for both of the door-open latches **4142** and **4143** and they are bolted to the door hinges **4030** and **4031** mentioned above. Door-closed latch rollers **4110** are also provided for the door-closed latches **4112** and **4113** and they are attached directly to the upper portion of the door **4002**, as best illustrated in FIGS. 7C, 21, 34, and 37.

A roller assembly **4146**, as shown in FIG. 37, is mounted to the lower center of the door **4002**, and it holds the forward end of the span track assembly **4001** when stowed. When the blast doors **4002** and **4004** are closed, this roller assembly **4146** engages a guide block **4148** mounted to the end of the span track assembly **4001**, and prevents the span track assembly **4001** from shifting or swaying, as shown best in FIG. 6.

(1) *Lower door hinges.*—As mentioned above, the lower door hinges **4030** and **4031** not only hold the lower door **4002**, but they also provide a means of attaching the lower door power pistons **4070** and **4071**. In addition, they hold the door-open latch rollers **4140** and their associated interlock switches.

The lower outboard hinge **4030**, moreover, serves as a manifold, and it ducts the anti-icing fluid from the supply pipes to the blast door passages. A supply pipe (not shown) and a return line (not shown), leading to the hinge **4030**, are attached to the bracket **4129** which holds the hinge pin. This pin is channeled and grooved, and it is able to duct the fluid to or from the door passages regardless of the position of the door **4002**. Both the inboard and outboard hinge pins for the hinges **4031** and **4030** are also equipped with lubricant grooves.

b. UPPER BLAST DOOR

The previously mentioned upper blast door **4004**, as shown best in FIGS. 34 and 35, covers the upper portion of the hourglass-shaped opening **4010** in the frame **4006**. This door **4004** is as wide as the lower door **4002**, but is slightly higher. The upper door **4004** is hung from an upper door hinge **4040** bolted to the outside of the frame **4006**, directly above the door **4004**. The inner face of the upper door **4004**, as best illustrated in FIG. 26, is provided with a rectangular mounting flange **4005** which is utilized to attach a support **4106** for the span track assembly **4001**. A raised section **4003** at the lower end of the upper door **4004** holds a **T**-hanger **4212**, as shown in FIG. 26, and centering pistons **4240** and **4242**, shown best in FIG. 25. The extreme lower edge of the upper door **4004** is beveled and equipped with a rubber seal to insure a tight closure.

(1) *Upper door hinges.*—The previously mentioned upper door hinge **4040**, as illustrated generally in FIGS. 34, 35, 36, and 37, and in detail in FIG. 15, supports the upper door **4004** and the span track assembly **4001**. In addition, it ports hydraulic oil and anti-icing fluid to the upper door **4004** and components of the span track assembly **4001**.

The hinge **4040** consists essentially of a hinge bracket **4050**, a hinge pin **4044**, and two sleeves **4046** and **4047**. These sleeves **4046** and **4047** are fitted into bores on the two hangers **4048** and **4049** which extend upwardly from the upper door **4004**. The hinge pin **4044** extends through both of the sleeves **4046** and **4047** and through the three sections **4051**, **4052**, and **4053** of the bracket **4050**. The hinge pin **4044**, hinge bracket **4050**, and the sleeves **4046** and **4047** are preferably constructed of non-corrosive materials.

The hinge pin **4044** is arranged so that it does not move when the upper door **4004** is opened or closed. Caps **4042** are bolted to the opposite ends of the hinge pin **4044** to prevent any longitudinal movement thereof. Dowels are utilized to secure the caps **4042** to the hinge bracket **4050** in order to avert rotation thereof.

Four knobs **4054**, which protrude from the top of the door hangers **4048** and **4049**, are used to protect hinge pin grease fittings **4055**, as shown generally in FIG. 15 and in detail in FIG. 16. Each fitting **4055** is located near one of the four joints of the hinge **4040**, and opens onto a hinge pin lubricant groove. As indicated in FIG. 16, these fittings **4055** are screwed into the hange sleeves **4048** and **4049**. A plug **4056** is screwed into each knob **4054** above each fitting, and it provides protection against water and the blast gases liberated during the burning of the propellant of the booster **200** when the weapon **400** is launched.

Suitable lines are provided for ducting hydraulic oil or anti-icing fluid to or from the upper door **4004** and the span track assembly **4001** and lead through the hinge **4040**. Supply and return pipes are fastened to the inner wall of the bulkhead **8016** of the aft deckhouse **8004** and they port the fluid through this bulkhead to the hinge bracket **4050**. Suitable recessed openings are provided on opposite ends of the bracket **4050**, as shown in FIG. 17, and they mate with similar recessed openings on the outer face of the frame **4006**. Adapters **4058**, equipped with rubber seals **4059**, are fitted between the openings and prevent leakage of fluid from the system.

Hydraulic oil or anti-icing fluid, supplied to the blast door 4004, passes through the frame 4006, the adapter 4058, and the bracket 4050, to annular sets of grooves 4036, 4037, and 4038 provided on the hinge pin 4044, as shown in FIGS. 14, 15, and 17. Lengthwise passages 4041 are drilled into the end of the hinge pin 4044 to join these grooves 4036, 4037, and 4038 to other annular grooves 4036, 4037, and 4038 located beneath the previously mentioned door hangers 4048 and 4049.

Oil and anti-icing fluid is ducted from the bracket 4050, through the drilled passages 4041, to the corresponding hinge pin grooves located in the hangers 4048 and 4049. Each annular groove 4036, 4037, and 4038 is sealed from another, or from grooves carrying lubricant, by rubber O-rings. Two sets of dual grooves 4034 and 4035, shown best in FIG. 15, at the inboard end of the hinge pin 4044 duct anti-icing fluid to and from the upper blast door 4044.

The previously mentioned sets of dual passages 4036, 4037, 4038 in the outboard end of the hinge pin 4044 supply or return hydraulic oil to the mechanism of span track-guide arm latch 4210 and other span track components. These sets of dual passages 4036, 4037, and 4038 open to connecting pipes on the inner outboard face of the upper door 4004, and to three hydraulic lines 4039 attached to hinge bracket 4050, only one of which is shown in FIG. 17. The three hydraulic lines 4039 consist of a return line to tank T, a line supply control pressure, and a PA fluid line.

A cam-like groove 4060, as shown best in FIG. 15, cut into the inboard side of the hinge pin 4044, operates an interlock switch actuator 4062, shown in FIG. 18. A roller 4064, attached to a spring-loaded plunger 4066, rides in the hinge pin cam groove 4060. A guide 4068, fastened to the upper inboard face of the upper door 4004, holds the other end of the plunger 4066 which contacts the interlock switch actuator 4062.

A switch SIPA9 is actuated by the cam-operated plunger 4066 when the upper door 4004 has been closed sufficiently to clear the launcher 5000 but which door is not entirely closed. Switch SIPA9 forms an element in the latch circuit of the launcher 5000 and it energizes a solenoid (not shown). This element allows the solenoid to retract the train and elevation latches as soon as the upper door 4004 is clear of the launcher 5000.

c. POWER PISTONS

Each blast door 4002 and 4004 is opened and closed by the two previously mentioned hydraulically operated pistons 4070 and 4071, and 4072 and 4073, respectively, as shown best in FIGS. 6, 6A, 7, and 7C. The pistons 4070 and 4071, and 4072 and 4073, on both the upper and lower doors 4002 and 4004, respectively, are similar in design and identical in operation, but differ in size and assigned designations. The lower door power pistons 4070 and 4071 for the lower door 4002 are shorter than the two upper door power pistons 4072 and 4073 operating the upper door 4004. Each power piston 4070, 4071, 4072, and 4073 is designed for either left-hand or right-hand operation.

(1) *Lower door power pistons.*—The power pistons 4070 and 4071, as shown best in FIGS. 6, 6A, 7, and 7C, open and close the lower blast door 4002. The left-hand piston 4070 is located on the outboard side and right-hand piston 4071 on the inboard side of the vessel 8000.

As indicated in FIG. 6A, a pair of mounting brackets 4080 are provided to hold the lower end of the pistons 4070 and 4071. These brackets 4080, in turn, are mounted to the deck 8002 of the vessel 8000. Adjustable links 4076 and 4077 are screwed to the top of the piston rods 4078 of the pistons 4070 and 4071, and they are pinned to the out-rigged section of the lower door hinges 4030 and 4031, respectively.

The principal components of the assembly for each power piston 4070 and 4071 includes the mounting bracket 4080, a pivot pin 4081, a cylinder block 4082, a cylinder 4083, a control rod 4086, a piston 4092, a sleeve 4096, the adjustable connecting link 4076 (4077), and a pipe assembly 4088, as shown in detail in FIG. 19.

The mounting bracket 4080 is bolted to the deck 8002 of the vessel 8000 and it anchors the piston 4070 (4071). The pivot pin 4081 is arranged to extend through the bracket 4080 and hold the cylinder block 4082. Suitable hydraulic lines are provided which lead to the piston 4070 (4071) and which are connected to the ends of the pivot pin 4081. Passages are drilled into the ends of the pivot pin 4081 and they lead to annular grooves, which connect with fluid passages in the cylinder block 4082. The flanged end of the pivot pin 4081 is bolted to the mounting bracket 4080.

The cylinder block 4082 is pivotally mounted on the pivot pin 4081. This cylinder block 4082 is fitted between a pair of spaced ears 4084 and 4085 of the mounting bracket 4080. Other piston components, such as the cylinder 4083, the control rod 4086, and the pipe assembly 4088, are bolted to this cylinder block 4082.

The control rod 4086 is essentially a hollow steel rod which extends upwardly from the cylinder block 4082. Control grooves 4090, that is, tapered longitudinal grooves, are cut into the outer surface of the rod 4086, as shown in FIG. 20. The depth of each groove 4090 increases progressively from either end of the rod 4086 to a point intermediate the ends of the grooves. This variation of groove depth acts as a variable orifice, since hydraulic fluid must pass through these grooves 4090 when the blast door 4002 opens or closes.

The piston 4092 is provided with a cylindrical opening therethrough so that it can fit onto the control rod 4086. The larger lower end, or head of the piston 4092, slides in the bore of the cylinder 4083, and it is equipped with small annular grooves 4093, as shown in FIG. 19. The grooves 4093 prevent hydraulic slippage from building up more separating force between the piston diameter and the cylinder wall, on one side than on the other.

A flange 4094 on the inside of the head slides on the control rod 4086. This flange 4094 forces the hydraulic fluid to flow through the control grooves 4090 when the piston 4092 is either extending or retracting. The piston rod 4078, which is formed of monel or similar material, is welded to the head of the piston and it extends from the top of the cylinder 4083. A shallow threaded hole at the upper end of the piston rod 4078 holds the adjustable link 4076 (4077).

The cylinder 4083 is a hollow steel tube in which the piston 4092 slides. The lower end of the cylinder 4083 is bolted to the cylinder block 4082, while the upper end thereof holds the sleeve 4096. The sleeve 4096 is bolted to the top of the cylinder 4083, and it is utilized to guide the piston rod 4078. The sleeve 4096 is equipped with grooves and seals 4097 to prevent leakage of hydraulic fluid.

The previously mentioned pipe assembly 4088 is attached to the outside of the cylinder 4083. This pipe assembly 4088 ports PA fluid from the cylinder block 4082 to the rod end of the piston 4078. The adjustable link 4076 (4077) screwed into the end of the piston rod 4078 is pinned to the outrigged section of the lower door hinges 4030, 4031, as shown in FIG. 6A. When adjusted, a locknut 4098 and a lock ring 4099 secure the link 4076 (4077) in position.

To extend the piston rod 4078, PA fluid is ported from a metering valve 4100, shown generally in FIG. 11, and in detail in FIG. 24, to the piston pivot pin 4081 to port 4087, shown in FIG. 19. The pressure of the PA fluid passes through the control rod 4086 to the piston rod cavity 4095. As the piston 4092 extends, hydraulic fluid passes from the cavity 4095, through the control grooves 4090, to the cylinder 4083 below the face of the piston 4092.

One end of the spring-balanced metering valve 4100

is connected to this lower cylinder area, through port 4091, as shown in FIG. 19, while the other end of valve 4100 is connected to the PA fluid line 4087 leading to the cavity 4095 of the piston rod 4078.

With the piston 4092 in a particular position in the cylinder, the piston velocity is limited to a particular value regardless of the direction in which it is moving. This is accomplished by means of the control grooves 4090 and the metering valve 4100. The metering valve 4100 is held in a centered position by a spring at each end when the pistons are not in motion. When the pistons are in motion, a pressure drop across the control grooves 4090 causes a pressure differential between the two ends of the metering valve 4100, moving the valve from its centered position and throttling the flow of fluid through the valve.

Any tendency to increase the flow of fluid through the control grooves 4090 will increase the pressure drop across the grooves, moving the metering valve 4100 still further from its centered position and increasing the throttling effect. The action of the metering valve 4100 thus limits the pressure drop across the control grooves 4090.

The velocity of the piston 4092 is thus determined by the fluid flow permitted through the control rod grooves 4090, and is a variable function dependent on the extended position of the piston rod 4078 and of the lower door 4002.

As the differential-area piston 4092 extends, PA fluid supplied by the pipe assembly 4088 to the rod of the piston 4070 (4071) is forced out of the cylinder 4083 and back into the PA system, through a port 4079, shown in FIG. 19. This occurs because the PA fluid at the bottom of the piston 4092 acts against a greater area than the PA fluid at the rod end of the piston 4092.

To retract the piston 4092, the line, which supplied PA fluid to port 4087, is ported to tank T. PA fluid supplied by the pipe assembly 4088 to the top of the cylinder 4083 is then effective against the rod end of the piston 4092. The control grooves 4090 and the metering valve 4100 regulate the flow of fluid to the tank T, and again determine the velocity of the piston 4070 (4071).

(2) *Upper door power pistons.*—The right-hand inboard power piston 4073 and the left-hand outboard power piston 4072 open and close the upper blast door 4004.

As shown best in FIG. 6, the rod ends 4102 of the upper door power pistons 4072 and 4073 are pinned to brackets 4104 located on each side of the span track support 4106. The piston mounting brackets 4108 are bolted to the interior wall of the over head 8005 of the aft deckhouse 8004, as shown in FIGS. 1 and 6. With the exception of their greater length, the assemblies for the pistons 4072 and 4073 resemble the assemblies for the lower door piston 4070 and 4071 in all significant details.

d. LATCHES

The previously mentioned spring-loaded latches 4112 and 4113, and 4142 and 4143, as shown best in FIGS. 7C, 34, and 37, secure the blast doors 4002 and 4004 and span track assembly 4001 when they are either open or closed. In addition to securing the blast doors 4002 and 4004 and span track assembly 4001, the latches 4112 and 4113, and 4142 and 4143 also act as sequence valves.

(1) *Lower door-closed latches.*—The two-door-closed latches 4112 and 4113, shown in FIGS. 7C and 34, lock the lower blast door 4002 in position when closed. One latch 4112 (4113) is attached to the frame 4006 on either side of the upper portion of the lower door 4002. Latch 4112 is located on the inboard side, while the latch 4113 is positioned on the outboard side of the vessel 8000. Both latches 4112 and 4113 are identical in design and operation, but differ as to their respective mountings.

The previously mentioned latch rollers 4110, one on each side of the lower door 4002, as shown in FIG. 37, acts as catches for the door-closed latches 4112 and 4113. Each assembly for the latch 4112 (4113) includes a block 4114, a sleeve 4116, a plunger 4118, a spring 4120, a spring retainer 4121 for the spring 4120, a link 4122, pin 4123, and a latch 4124, as shown in FIGS. 21 and 22. Each assembly 4112 (4113) is bracket mounted to the frame 4006. Both latches 4112 and 4113 are mounted in the vertical position, as shown best in FIGS. 7C, 21, 22, 34, and 37.

The latch block 4114 holds the latch components and provides openings for connecting the hydraulic lines, as shown in FIGS. 21 and 22. The plunger 4118 slides in the sleeve 4116 which projects through the block 4114. A square flange 4117 at the bottom of the sleeve allows it to be bolted to the block 4114. Ears 4115 projecting downwardly from this flange 4117 hold the pivot pin 4123. A latch 4124 pivots on this pin 4123 when extending or retracting. As shown in FIGS. 21 and 22, the latch pivot point consists of a splined bronze bushing 4125 which has an offcenter bore 4126. This bushing 4125 fits a splined hole 4127 in the latch 4124. By relocating the bushing 4125, the latch 4124 can be adjusted.

The spring 4120, pushing against the plunger 4118, causes the latch 4124 to assume a closed, extended position, unless hydraulic fluid pressure is ported to the latch 4112 (4113). The spring 4120 is held in place by the spring retainer 4121 which is bolted to the upper portion of the sleeve 4116. A porous bronze breather 4128, mounted in the retainer 4121, allows the air to move in or out of the spring chamber when the plunger 4118 shifts.

The previously mentioned latch rollers 4110, located on opposite sides of the lower door 4002, are held by brackets 4129 which are bolted to the inner face of the door 4002. The steel rollers 4132 are equipped with bushings 4133 and roll on a pin 4134. Each bracket 4129 also holds an interlock switch assembly 4130. A plunger operated interlock switch SIPA2 is mounted to the outboard roller bracket 4129 and a second plunger operated interlock switch SIPA6 is mounted to the inboard bracket 4129, as shown in FIG. 7C. These interlock switches SIPA2 and SIPA6 will be described subsequently in connection with the electrical system. Switch actuator rods 4131, shown in FIG. 21 and FIG. 22, contact the latch links 4122, when the door 4002 is closed and latched and actuate the interlock switches SIPA2 and SIPA6.

The door-closed latches 4112 and 4113 have to retract before the lower door 4002 can open. During the cycle of opening the lower door 4002, hydraulic fluid pressure acting against the shoulders of the plungers 4118, retracts the plungers, and unlatches the door 4002. With both door-closed latches 4112 and 4113 retracted, control fluid pressure is ported from the rear of latch plunger 4118 of latch 4112 and through the plunger 4118 of the latch 4113 to the lower door directional valves 4136 and 4138, shown in FIG. 7C, which then cause the power pistons 4070 and 4071, respectively, to open the lower door 4002.

(2) *Lower door-open latches.*—Door-open outboard latches 4142, and inboard door-open latch 4143, shown best in FIG. 7C, with latch 4142 also being shown in FIGS. 34 and 37, are similar in design to the door-closed latches 4112 and 4113. In their application, however, these latches 4142 and 4143 function opposite from the door-closed latches 4112 and 4113. The two door-open latches 4142 and 4143 secure the lower door 4002 when it is open.

Both door-open latches 4142 and 4143 are attached to individual mounting brackets which are bolted to the lower horizontal ledge of the door frame opening 4010, as shown for latch 4142 in FIGS. 34 and 37. When the lower door 4002 is open, each latch 4142 and 4143 catches a roller 4140, shown in FIG. 7, attached to one

of the lower door hinges 4030 and 4031, and locks the lower door 4002 in the open position.

These rollers 4140 are held by brackets 4144 attached to the side of each lower door hinge 4030 and 4031, as shown best in FIGS. 7C and 37. Like the door-closed latch rollers 4110, illustrated in FIG. 21, each roller 4140 also holds an interlock switch assembly 4130 and a switch actuator rod 4131. A plunger-operated switch SIPA1 is attached to the outboard roller bracket 4144, and a switch SIPA5 is attached to the inboard roller bracket 4144.

To close the lower door 4002 when open and latched, hydraulic pressure is ported to the door-open latches 4142 and 4143 to retract them. When retracted, these latches 4142 and 4143 act as sequence valves and port control fluid pressure to the lower door directional valves 4136 and 4138. This control fluid pressure causes the directional valves 4136 and 4138 to shift, which then permit the lower door power pistons 4070 and 4071 to close the lower door 4002.

(3) *Safety latch.*—The safety latch 4150 is a device which prevents the upper blast door 4004 from opening in case of failure of the power before the lower door is closed. Although this latch 4150 is as similar in design to the lower door latches 4112, 4113, and 4142, 4143, it does not actually lock the upper door 4004 when closed, as shown in FIGS. 7 and 23. When the upper door 4004 is completely closed, there is a small clearance, as shown by the arrows, between the latch element 4155 and the roller assembly 4152. During power-off conditions, the mating edge of the lower blast door 4002 secures the upper blast door 4004. Latch 4150 is mounted to the upper section of the blast door frame 4006, as shown in FIG. 26. The latch roller assembly 4152, however, is not mounted directly to the upper door 4004, but to the span track support 4106, as shown in FIG. 26.

As indicated in FIG. 23, components of the safety latch 4150 closely resemble those of the lower door latches 4112, 4113 and 4142, 4143. The plunger 4154, the sleeve 4156, and the block 4158 of the latch 4150 differ, however, since one part has been eliminated. Nevertheless, the operation of the safety latch 4150 is identical to the operation of the lower door latches 4112, 4113 and 4142, 4143.

During the door-open cycle, control pressure ported to the latch 4150 acts against the plunger shoulder and causes both the latch element 4155 and the plunger 4154, shown in FIG. 23, to retract. When fully retracted, the plunger 4154 uncovers a port which leads to the upper door directional valves 4162 and 4164 and to a tripping valve 4160. Control fluid pressure passes through this port and shifts the upper door directional valves 4162 and 4164, as shown in FIG. 7.

The roller assembly 4152, which is bolted to the upper aft end of the span track support 4106, holds the interlock switch SIPA4, as shown in FIGS. 7 and 23. The spring-loaded switch actuator rod 4157, as shown in FIG. 23, is depressed and actuates the switch SIPA4 whenever the upper door 4004 is closed.

e. DOOR CONTROL BLOCK ASSEMBLIES

Lower and upper door control block assemblies 4166 and 4168, respectively, as shown in FIGS. 6, 6A, 7, and 7C, are provided for regulating the operation of the blast doors 4002 and 4004. The lower door block assembly 4166 regulates the lower door power pistons 4070 and 4071 which open and close the lower blast door 4002, and the other upper door block assembly 4168 regulates the upper door power pistons 4072 and 4073. Both control block assemblies 4166 and 4168 are identical in design and differ primarily in their location, as shown in FIGS. 6 and 6A.

The upper door control block assembly 4168 is mounted to the overhead 8005 of the aft deckhouse 8004, slightly aft of the power piston mounting brackets 4108. The lower door control block assembly 4166 is fastened to the main deck 8002, inboard of the accumulator unit 6000 in Area 1, as shown in FIGS. 6 and 6A. Each control door block assembly 4166 and 4168, as shown in FIGS. 7 and 7C, consists basically of a valve block 4171, a door metering valve 4100 (4170), an orifice 4169, a throttle valve 4180 (4181), and the two directional valves 4136 and 4138 (4162, 4164).

(1) Metering valve.—The metering valve 4100 (4170), in conjunction with the control rod grooves 4090, shown in FIG. 20, regulates the opening and closing speed of the lower and upper blast doors 4002 and 4004. Metering valve 4170 is located in the upper door control block assembly 4168, and valve 4100 is located in the lower door block assembly 4166. In addition to controlling the speed of the doors 4002 and 4004, the metering valves 4100 and 4170 also assure that both the power pistons 4070 and 4071, or 4072 and 4073, operate in unison.

The metering valve 4100 (4170), as shown in FIG. 24, consists of a sleeve 4172 having a two-land plunger 4173 located therein, with springs 4176 and 4177 and spring seats 4178 and 4179, together with stops 4174 and 4175. The sleeve 4172 extends through a bore in the block 4171 and it is secured at one end. The two springs 4176 and 4177, pushing against the spring seats 4178 and 4179, balance the plunger 4173 between them. The stops 4174 and 4175, which are screwed into both ends of the sleeve 4172, limit the travel of the plunger 4173 and act as spring retainers.

The metering valve 4100 (4170) acts in conjunction with the power piston control grooves 4090 of FIG. 20, to regulate the opening and the closing speed of the doors 4002 and 4004 by controlling the rate of hydraulic fluid flow. The power piston control grooves 4090 vary in depth and thus act as a variable orifice. The opposite ends of these grooves 4090 are ported to the opposite ends of the spring-centered metering valve 4100 (4170). The valve 4100 (4170) shuttles back and forth, regulating the flow of hydraulic fluid to or from the power pistons 4070 and 4071, or 4072 and 4073, as the pressure drop across the control grooves 4090 varies.

Since the control grooves 4090 are completely cut off when the pistons 4070 and 4071, or 4072 and 4073, are fully retracted or extended, a fixed orifice 4169 in the door control block assembly 4166 (4168) joins the opposite end of the metering valve 4100 (4170), as shown in FIGS. 6 and 7C. These orifices 4169 allow the plungers 4173 of metering valves 4100 and 4170 some impact velocity at the end of their stroke, and prevent a complete stall. The fixed orifice 4169 is screwed into the top of the door control block assemblies 4166 and 4168.

(2) *Throttle valve.*—The throttle valve 4180 (4181) is provided so that either of the blast doors 4002 and 4004 may be operated at reduced speed until the system has been purged of air. The throttle valve 4180 (4181), as shown in FIGS. 7, 7C, and 24, is located in the block passage between the directional valves 4100 and 4170 and their corresponding metering valves 4136 and 4138 or 4162 and 4164. Valve 4180 is located in the upper door control block assembly 4166 and a similar valve 4181 in the lower control block assembly 4168.

(3) *Directional valves.*—The lower door directional valves 4136 and 4138, and the upper door directional valves 4162 and 4164, as shown in FIGS. 7, 7C, and 24, control the hydraulic fluid ported to or from the lower door power pistons 4070 and 4071, and the upper door power pistons 4072 and 4073. Directional valves 4136 and 4138 are located in the lower door control block assembly 4166, while the directional valves 4162 and 4164 are located in the upper block assembly 4168.

Each pair of valves 4136 and 4138, and 4162 and 4164 consists essentially of two two-land plungers 4182 and 4183, a sleeve 4186, a spring 4188, and a spring stop 4189, all shown in FIG. 24. Both plungers 4182 and 4183 slide in the sleeve 4186 which is fitted into a

bore in block 4171. The left end of the sleeve 4186 is closed with a screw plug 4187, and the right end is closed with a spring stop 4189. The spring stop 4189 also serves as a spring retainer. The valve spring 4188 forces both the valve plungers 4182 and 4183 against the plug 4187 on the left when no control fluid pressure is ported to the valves 4136 and 4138, and 4162 and 4164.

To open the blast door 4002, control fluid pressure is ported to the end of the sleeve 4186 opposite the spring 4188. Control fluid pressure at this end of the sleeve 4186 causes both the directional valve plungers 4182 and 4183 to shift and compress the valve spring 4188. When shifted, the valve plungers 4182 and 4183 port PA fluid pressure through the metering valve 4100 (or 4170), to the power pistons 4070 and 4071 operating the lower door 4002, or power pistons 4072 and 4073 operating the upper door 4004.

To close the lower door 4002 or the upper door 4004, control pressure is ported to the chamber between the two directional valve plungers 4182 and 4183. Fluid pressure supplied to this chamber forces both valve plungers 4182 and 4183 apart, which then port fluid from the power pistons 4070 and 4071, or power pistons 4072 and 4073 to accumulator tank T. The directional valves 4136 and 4138 as well as the directional valves 4162 and 4164 are placed at the end of the sequence, necessitating that the latches 4112 and 4113 securing the lower and upper doors 4002 and 4004 be released before the valves 4136 and 4138 can shift and allow the power pistons 4070 and 4071, and 4072 and 4073 to move.

3. *Span Track Assembly*

The span track assembly 4001, as previously mentioned, forms a bridge between the loader 2002 and the launcher guide arm 5002, as shown best in FIGS. 3, 6, and 6A. With the span track assembly 4001 horizontally positioned, as shown in FIGS. 6 and 6A, as well as in FIG. 3, a weapon 400 may be moved from Area 1 onto the guide arm 5002 of the launcher 5000.

The span track assembly 4001 is mounted to the inner face of the upper blast door 4004, as previously mentioned, and both act as a single unit. With the upper blast door 4004 open, as shown best in FIGS. 3, 6, and 6A, the span track assembly 4001 assumes a horizontal position. With the upper door 4004 closed, as illustrated in FIG. 6, the span track assembly 4001 is stowed vertically inside the upper door 4004.

Although the span track assembly 4001 is mounted to the upper blast door 4004, its manner of attachment thereto allows it some lateral and vertical movement. This compensates for any variation in position of the guide arm 5002 of the launcher 5000.

The principal components of the span track assembly 4001 are the previously mentioned span track support 4106, shown best in FIGS. 6A, 26, and 37, a span track 4200, shown best in FIGS. 9, 10, 26, 27, 29, and 33, consisting of three sections 4201, 4202 and 4203 skid tracks 4206, shown best in FIG. 29, chain tracks 4208, shown best in FIG. 29, a T-hanger 4212, shown best in FIG. 26, a centering bolt 4194, as shown best in FIG. 31, a span track-guide arm latch 4210, shown best in FIGS. 6, 7, 8, 26, 27, 28, and 37, and latch rollers 4268 and 4269 shown best in FIGS. 31 and 33, to engage the span track-loader latch 4300, shown best in FIGS. 26, 31, and 33.

a. SUPPORT

The span track support 4106 shown best in FIGS 6A, 26, 27, and 37, is a steel weldment bolted to the inner face of the upper door 4004. The span track support 4106 is solidly attached to the upper door 4004 and it has the previously mentioned power piston bracket 4104 bolted to each side, as shown best in FIGS. 6A, 26, 27, and 37.

A spring and plunger 4190, as shown in FIG. 27, attached to either side of the inner wall of the span track support 4106, stabilizes the roll or tilt of the span track 4200. Screw stops 4192, shown in the left inset of FIG. 27, which are located forward of the spring and plunger 4190, are utilized as positive stops to limit roll or tilt of the span track 4200. These stabilizing mechanisms prevent serious lateral tilt of the floating span track 4200 when stowed, or when the span track is moved to or from the horizontal position.

The previously mentioned safety latch roller assembly 4152 is mounted to the upper aft of the support 4106, as shown in FIG. 27. The aft end of the support 4106 also holds the centering bolt 4194, as shown in FIGS. 27 and 30. The floating span track 4200 fits into the under side of the span track support 4106.

b. SPAN TRACK

The previously referred to span track 4200 is actually composed of three sections, namely, a short aft section 4201, a center section 4202, and a longer section 4203 at the forward end. These three sections 4201, 4202, and 4203 are serially bolted together to form a single unit, as shown in FIGS. 26 and 28, which holds the chain track 4208 and the skid track 4206 and the span track-guide arm latch assembly 4210. The span track 4200, however, is not rigidly attached to the upper door 4004 or the span track support 4106. It is supported by the T-hanger 4212 at the forward end and the centering bolt 4194 at the aft end.

As illustrated best in FIGS. 28 and 29, the forward end of the span track 4200 holds the span track-guide arm latch 4210, which secures the span track 4200 to the launcher guide arm 5002 when it is located in the horizontal position. A tapered guide block 4214, located forward of the span track-guide arm latch 4210, engages a lateral guide roller 5187 which laterally aligns the span track 4200 with the guide arm 5002.

When the span track 4200 is in the stowed or vertical position, however, the tapered guide block 4214 engages the roller of the roller assembly 4146 on the inner face of the lower door 4004, as shown best in FIG. 34. This engagement of the tapered guide block 4214 and the roller of the roller assembly 4146 prevents shifting of the floating section of span track 4200 during power-off conditions. The T-hanger 4212 extending from the end of the upper door 4004, in addition, supports the forward end of the span track 4200. The stabilizing mechanisms, that is, the screw stops, as shown in FIG. 27, bear against the center section 4202 of the floating span track 4200 to minimize tilt.

The short aft section 4201 of the span track is equipped with latch rollers 4269, shown in FIGS. 31 and 33, which engage the lateral cam surfaces 2109 mounted to the stationary loader trunk section VIII. As shown best in FIG. 33, other latch rollers 4268 at this end of the span track 4200 engage the span track-loader latch 4300 when the span track 4200 is in the horizontal position. Two arms 4264 and 4266, projecting on either side of these latch rollers 4269, contact pads 4302, as shown best in FIG. 33, on the top of the trunk skid tracks 2048 and 2050 whenever the span track 4200 is latched to the trunk section VIII of the loader 2002.

The centering bolt 4194, supporting the aft end of the span track 4200, is held by the span track support 4106. Both the T-hanger 4212 and the centering bolt 4194 provide floating connections which allow the span track 4200 to align itself with the guide arm 5002 of the launcher 5000 and the loader trunk 2003, independently of the upper blast door 4004.

c. SPAN TRACK-GUIDE ARM LATCH

The span track-guide arm latch 4210, as illustrated best in FIGS. 6, 7, 8, 26, 27, 28, and 37, is a hydraulically operated toggle-link type latch. When the blast doors 4002 and 4004 are in an open position and the span track 4200 is in the horizontal position, this span track-guide arm

latch 4210 locks and aligns the forward end of the track 4200 to the aft end of the launcher guide arm 5002.

In latching, the span track-guide arm latch 4210 rotates counterclockwise, as viewed from the side, and it actually lifts the span track 4200 slightly to align it vertically with the launcher guide arm 5002. Simultaneously, the previously mentioned lateral guide roller 5187 on the launcher guide arm 5002 engages the guide block 4214 at the forward end of the span track-guide arm latch 4210, as shown in FIG. 28, and it aligns the span track 4200 and the launcher guide arm 5002 laterally. When engaged, the span track-guide arm latch 4210 maintains this vertical and lateral alignment of the span track 4200 and the launcher guide arm 5002, but it allows a small amount of longitudinal movement thereof. A small gap is intentionally provided between the span track 4200 and the launcher guide arm 5002.

The assembly for the span track-guide arm latch 4210, as shown best in FIG. 28, includes a latch roller assembly 4216, links 4221 and 4222, a bell type crank lever 4228, a toggle knee pin 4225, a lever pivot pin 4227, a clevis 4224, a spring 4229, a spring guide sleeve 4236, an interlock switch SIPA3, and a valve block 4232. The valve block 4232 contains a latch piston 4220 and a tripping valve 4230.

(1) *Latch and Linkage.*—The previously referred to latch roller assembly 4216, which engages a guide arm latch block 5186, shown in FIGS. 28 and 30, pivots on a latch pivot pin 4218. This latch pivot pin 4218 is held by the forward section 4201 of the span track 4200.

The link 4221 of the toggle arrangement is pinned to an ear 4223 extending from the latch roller assembly 4216. This link 4221 is then pinned to the link 4222 by means of the toggle knee pin 4225. The aft end of the link 4222 is pinned to the clevis 4224, which is screwed into the end of the latch piston 4220. An adjustable screw 4226, which protrudes from the upper portion of the clevis 4224 depresses the tripping valve 4230 when the latch roller assembly 4216 is disengaged.

The bellcrank-type lever 4228 is pinned to the toggle knee pin 4225, and it pivots on the lever pivot pin 4227, as shown in FIG. 28. This lever pivot pin 4227 is also held by the forward section 4203 of the span track 4200. When the latch piston 4220 extends, the toggle links 4221 and 4222 buckle. When the latch piston 4220 retracts, these links 4221 and 4222 straighten. In both cases, the bellcrank lever 4228 and the latch roller assembly 4216 will rotate. With the bellcrank lever 4228 fuly rotated in either direction, the spring arrangement pinned to the aft end of the bellcrank lever 4228 will be in an over-center position. The spring 4229, which is attached to the bellcrank lever 4228, holds the latch roller assembly 4216 in either the engaged or disengaged position unless it is moved by the latch piston 4220.

The arm-actuated interlock switch SIPA3 is mounted on the inboard side of the latch roller assembly 4216, as shown in FIG. 28. When the latch piston 4220 is extended and the latch roller assembly 4216 is engaged, the head of the pin joining link 4221 to the latch ear 4223 depresses the switch arm of switch SIPA3.

(2) *Valve block.*—The valve block 4232, as shown in FIG. 28, is bolted to the section 4203 of the span track 4200 directly aft of the bellcrank lever 4228. This valve block 4232 contains the span track-guide arm piston 4220 and the tripping valve 4230. A lug 4234, extending from the bottom of the valve block 4232, anchors the spring guide sleeve 4236. A cover 4233 which is bolted to the rear of the valve block 4232 is used as a spring retainer for a tripping valve spring 4231. In addition, the cover 4243 seals both the bores of the piston 4220 and valve 4230. Openings for connecting pipes are located at the top and sides of the valve block 4232.

(*a*) Tripping valve: The tripping valve 4230 is of a three-land plunger type, as shown in FIG. 28, and it houses the tripping valve spring 4231 and ring seals 4235. The plunger of the tripping valve 4230 is fitted into the bore in valve block 4232 and it projects slightly from the forward end. The aft end of the plunger of the tripping valve 4230 is provided with a larger diameter annular flange 4237. The tripping spring 4231 is arranged to bear against this annular flange 4237 in order to hold it against a block shoulder and cause the plunger of tripping valve 4230 to extend, as shown in FIG. 28.

When, however, the adjustable screw 4226 on the clevis 4224 contacts the protruding end of the plunger of the valve 4230 and depresses it, the tripping valve 4230 is retracted. With the tripping valve 4230 retracted, the front of the latch piston 4220 is ported to tank T, while PA fluid pressure is ported to the centering pistons 4240 and 4242.

On the other hand, when the clevis 4224 is drawn forward and the tripping valve 4230 is extended, control fluid pressure is ported to the front of piston 4220 and to a hold-down piston 4250. At the same time, the centering pistons 4240 and 4242 are ported to tank T. Accumulator fluid pressure is always ported to the rod end of the piston 4220, regardless of position of the tripping piston 4230.

(*b*) Span track-guide arm piston: The span track-guide arm latch piston 4220, as shown in FIG. 28, operates the span track-guide arm latch 4210. This piston 4220 slides within a sleeve 4238. The span track-guide arm latch piston 4230 extends from the valve block 4232 and it is screwed onto the clevis 4224. The rod end of this span track-guide arm latch piston 4220, which is of the differential area type, has a smaller area than the face end thereof and it is connected directly to accumulator fluid pressure.

When control fluid pressure is ported to the front end of the span track-guide arm latch piston 4220, the piston extends. As the piston 4220 extends, the toggle links 4221 and 4222 buckle and the latch roller assembly 4216 is rotated counterclockwise. At the same time, PA fluid at the rod end of the span track-guide arm latch piston 4220 is forced back into the system.

The span track-guide arm latch piston 4220 is retracted when the control fluid pressure acting against the face of the piston 4220 is reduced to tank pressure. Accumulator fluid pressure, acting against the rod end of the piston 4220, then forces the piston 4220 to the aft end of the sleeve 4238 and causes the toggle links 4221 and 4222 to unbuckle. As links 4221 and 4222 are straightened, the latch roller assembly 4216 then rotates in a clockwise direction to release the span track section 4203 from launcher guide arm 5002.

d. CENTERING PISTONS AND T-HANGER

The centering pistons 4240 and 4242 and the T-hanger 4212 prevent lateral shifting of the span track 4200 when the span track-guide arm latch 4210 is not engaged to the launcher guide arm 5002. The centering pistons 4240 and 4242 slide in bores located in the previously mentioned raised section 4003, as shown best in FIG. 26, of the upper blast door 4004. Centering piston 4240 is located on the left side of the upper blast door 4004, while centering piston 4242 is located on the right side thereof, as shown in FIG. 25.

The components of each centering piston 4240 and 4242, as shown in FIGS. 7B and 25, include a cover 4244, a spring 4245, a piston 4246, and a bushing 4247. The previously mentioned T-hanger 4212 consists of a plunger 4213, socket bearings 4248, and a swivel bolt 4211.

The spring 4245 for each centering piston 4240 and 4242 pushes against the rear of its respective piston 4246 and is retained in position by its cover 4244. The covers 4244 are provided with openings for connecting hydraulic lines. The face of each piston 4246 bears against an end of the plunger 4213 of the T-hanger 4212. The bushings 4247 support the plunger 4213 of the T-hanger 4212. In addition, the bushings 4247 act as positive stops for movement of the pistons 4246. A swivel bolt 4211

is attached to the plunger 4213 of the T-hanger 4212 through the ball socket-type bearing 4248. The swivel bolt 4211 and plunger 4213 form the T which supports the forward end section 4203 of the span track 4200.

When the span track-guide arm latch 4210 releases from the launcher guide arm 5002 and the span track-guide arm piston 4220 is retracted, the tripping valve 4230 ports PA fluid to the centering pistons 4242 and 4240. With hydraulic pressure acting against the back of the centering pistons 4240 and 4242, these pistons 4240 and 4242 hold and center the span track 4200 as the upper door 4004 closes.

When the upper door 4004 opens, the centering pistons 4240 and 4242 function in a similar manner. Until the span track 4200 contacts the launcher guide arm 5002, the centering pistons 4240 and 4242 prevent lateral movement of the span track 4200 with respect thereto. When contact is made between the span track 4200 and the launcher guide arm 5002, however, and piston 4220 shifts, with the fluid at the rear of the centering pistons 4240 and 4242 being ported to tank T. With only tank fluid pressure at the rear of the centering pistons 4240 and 4242, the T-hanger 4212 may shift when the span track 4200 aligns itself to the position of the launcher guide arm 5002. Only a small maximum lateral displacement of the T-hanger 4212 is required.

e. CENTERING BOLT AND HOLD-DOWN PISTON

The aft section 4201 of the span track 4200 is supported by the centering bolt 4194, as shown in FIGS. 26 and 31. The centering bolt 4194 allows the track section 4201 to float a small distance both vertically and laterally. The hold-down piston 4250 bears against a centering bolt cone block 4196, and assures contact of the span track skid tracks 4206 to the loader skid tracks 2048 and 2050 when the span track-guide arm latch 4210 is engaged.

As shown in FIG. 31, the centering bolt 4194 projects through a bore 4195 provided in the span track 4200 and it extends above the span track support 4106. The head of the centering bolt 4194 is drawn against the bottom of the span track 4200 when the nut is tightened against a centering cone 4197 and a sleeve 4199. The centering bolt cone block 4196, however, is bolted to the top of the span track support 4106. A compression spring 4198 bears against this centering bolt cone block 4196 at the upper end, and against the span track 4200 therebelow.

When the span track 4200 is in the stowed or vertical position, the compression spring 4198 forces the centering cone 4197 into the centering bolt cone block 4196 and maintains the span track 4200 in the nominally aligned position with respect to the launcher guide arm 5002.

When the upper door 4004 opens and the span track-guide arm latch 4210 engages the launcher guide arm 5002, the compression spring 4198 will compress a small distance, as shown in FIG. 31, and allow the centering cone 4197 to move in the centering bolt cone block 4196. This permits the aft section 4201 of the span track 4200 to align with the track 2034 or trunk 2003 of the loader 2002.

With the span track 4200 in the horizontal position and the span track-guide arm latch 4210 engaged, control fluid pressure is ported to the hold-down piston 4250. This pressure fluid causes the hold-down piston 4250 to extend and bear against the lip of centering bolt cone block 4196, as shown in FIG. 31. Since the centering bolt cone block 4196 is firmly attached to the span track support 4106, piston force is reflected downwardly, thus assuring contact of the mating skid tracks 4206 of the span track 4200 with the skid tracks 2048 and 2050 of the loader trunk 2003.

f. SPAN TRACK-LOADER LATCHING MECHANISM

The span track-loader latch 4300, as shown best in FIGS. 26, 21, and 33, secures and aligns the aft section 4201 of the span track 4200 to the loader trunk unit VIII. This spring-loaded span track loader latch 4300 also acts as a sequence valve, porting control pressure fluid to the upper door control block assembly 4168 when the span track-loader latch 4300 is retracted.

The span track-loader latch 4300 is located at the forward end of trunk unit VIII, as shown in detail in FIG. 33. The span track-loader latch 4300 is attached to a mounting bracket 4304 which extends forward from the center of this trunk section VIII. The span track-loader latch 4300 includes the mounting bracket 4304, a latch 4306, spaced links 4308, a spring-loaded switch actuator 4310, a switch SIPA7, and a cylinder block 4312. The cylinder block 4312 contains a piston 4314, a spring 4316, and has two end covers 4318 and 4319.

A pivot pin 4320 is used to secure the upper corner of the triangular-shaped latch 4306 to the mounting bracket 4304. At the lower aft corner of the latch 4306, the latch 4306 is pinned to the links 4308. The links 4308 are then pinned to an anchor link 4322, which is screwed to the end of the piston 4314. The underside of the triangular-shaped latch 4306 holds the spring-loaded switch actuator 4310. Switch SIPA7 is mounted to a small bracket 4311 which is bolted to the bottom of the cylinder block 4312. The cylinder block 4312, in turn, is bolted to the underside of the mounting bracket 4304, and it contains the two-land piston 4314. A cover 4318 and 4319 is fastened to each end of the cylinder block 4312, with the forward cover 4318 being used as a guide for the piston 4314 while the aft cover 4319 serves as a spring retainer.

The spring-loaded piston 4314 remains extended in the latched position unless control pressure fluid is ported to it. When the pilot valve 4272 ports control pressure fluid to the piston 4314, the piston 4314 and latch 4306 retract. When the piston 4314 and latch 4306 have retracted, the switch SIPA7 is deactuated. At the same time, control pressure fluid is ported to the piston 4314 and passes on to the upper door directional valves 4162 and 4164.

A positive stop 4324, as shown in FIG. 33, located above the latch 4306, supports the mounting bracket 4304 against excessive upward thrust, which the span track 4200 may direct against the latch 4306.

The two pairs of latch rollers 4268 and 4269 are located on the aft end of the span track section 4201. In latching the span track 4200 to the loader 2002, the two latch rollers 4268 force the spring-loaded latch 4306 to retract. When the span track 4200 is latched to the loader 2002, the bottom of the triangular-shaped latch 4306 rides the upper roller 4268 and forces the span track 4200 against the projecting loader skid tracks 2048 and 2050. This secures the span track 4200 in the horizontal position with respect to the loader 2002. The engaging surfaces of the loader skid tracks 2048 and 2050 are equipped with the previously mentioned contact pads 4302, as shown in FIG. 33.

The lateral guide rollers 4269 on either side of the latch rollers 4268, align the span track 4200 laterally, as shown in FIG. 33. These rollers 4269 engage a pair of cam surfaces 2109 of trunk section VIII, and secure the span track 4200 in the lateral plane. Although the span track 4200 is aligned and secured laterally and vertically, it may still float longitudinally. A small gap for this purpose is provided between the span track 4200 and the loader trunk 2003.

g. TRACKS

The three span track sections 4201, 4202, and 4203 are provided with the previously mentioned chain tracks 4208 and the skid tracks 4206 which are attached to the underside thereof, as shown best in FIGS. 26, 28, 29, and 33. The chain and skid tracks 4208 and 4206, respectively, are identical to the loader skid tracks 2048 and 2050, and chain tracks 2052 and 2054.

At the points where the skid track 4208 attached to the

span track 4200 meets the skid tracks attached to the launcher guide arm 5002 and the skid tracks 2048 and 2050 of the loader trunk 2003, as shown in FIGS. 28 and 33, the ends of the skid tracks are flush. The joining ends of chain tracks 4208 for the span track 4200 and the inner rails 5044 for the launcher guide arm 5002 and the chain tracks 2052 and 2054 for the loader are staggered, as shown best in FIGS. 29 and 30, to provide roller support on one side as the link passes over the gap.

4. *Pilot Valves*

Two solenoid-operated pilot valves 4270 and 4272 control the hydraulic fluid pressure which operates the blast doors 4002 and 4004 and the span track assembly 4001. One pilot valve 4272 controls the upper blast door 4004, and the other pilot valve 4270 controls the lower blast door 4002. Both valves 4270 and 4272 are identical in construction, but differ in location.

The pilot valves 4270 and 4272 are mounted to the low vertical bulkhead 8016 directly aft of the blast doors 4002 and 4004, as shown in FIG. 6. The pilot valve 4270 which controls the lower blast door 4002 is located on the outboard side of the launching system, while the other pilot valve 4272, which controls the upper blast door 4004 is located on the inboard side thereof.

Each pilot valve 4270 and 4272 consists of a cast aluminum solenoid housing 4274 and a pilot valve block 4276, as shown best in FIG. 32. The solenoid housing 4274 is bolted to the front of the valve block 4276 and it contains a pair of solenoids indicated generally by reference numeral 4278, and a pair of interlock switches indicated generally by reference numeral 4279, only one each of which appears in the cutaway view of FIG. 32, a link 4275, switch actuators 4277, a rocker arm 4271, a spline shaft 4280, and bearings 4282. The solenoid spline shaft 4280 is coupled to a second spline shaft 4281 which protrudes from the pilot valve block 4276. The spline shaft 4281 is splined to a counterweight arm 4284, which is linked, in turn, to a three-land plunger 4286. This plunger 4286 is held in either of two positions by a ball detent 4288.

The opening and closing of the lower blast door 4002, as illustrated in FIGS. 7, 7A, 7B, and 7C, is controlled by the pilot valve 4270. To open the lower door 4002, the solenoid LCPA1 is energized. When energized, solenoid LCPA1 actuates switch SIPA101 and rotates the spline shaft 4280, shown in FIG. 32, counterclockwise. The movement of the spline shaft 4280 is transmitted to the pilot valve 4270, where it shifts the valve plunger 4286 downwardly. To close the lower door 4002, solenoid LCPA2 is energized. This action causes the valve plunger 4286 to shift upwardly and actuate the switch SIPA102.

The pilot valve 4272, which controls the opening and closing of the upper door 4004, operates in a similar manner. With reference to FIG. 7A, solenoid LCPA3 is energized to open the upper door 4004, actuating switch SIPA103. Solenoid LCPA4 is then energized to close the door and actuate switch SIPA104.

Orifices located in the hydraulic lines leading to or from the pilot valves 4270 and 4272, throttle the flow of hydraulic fluid and retard the opening and closing speed of the latch. By retarding the flow of control pressure fluid to the latches, the possibility of damage thereto is reduced. In case a power failure should render the solenoids ineffective, the pilot valves 4270 and 4272 may be operated manually. By inserting a key or wrench 4267 in the socket on the face of the solenoid housing, the spline shaft 4280 may be hand turned to the required position, as shown in FIG. 7A.

C. Area 1 Accumulator

1. *General Introduction*

A pair of accumulator units 6000 furnishes hydraulic pressure to the components of the guided missile feeder system 2000 including the span track and blast door arrangement which will now be described.

As shown best generally in FIG. 3, the pair of accumulator units 6000 is located in Area 1, that is, in the wing and fin assembly compartment 8010, and it supplies the hydraulic components of the blast doors 4000 and the hydraulic components of the A-side and B-side loaders 2002A and 2002B, respectively.

2. *Area 1 Accumulator Units*

a. GENERAL DESCRIPTION

The Area 1 accumulator units 6000, as illustrated best in FIG. 3, furnish accumulator pressure (PA) to the various hydraulically operated components of the guided missile feeder system 2000. The A-side and the B-side accumulator units 6000A and 6000B, respectively, are identical in operation, each supplying hydraulic fluid under pressure to operate the hydraulic components of its respective loader 2002 and blast door 4000.

Each accumulator unit 6000, as shown in detail in FIGS. 38, 39, 39A and 40, includes a main tank 6002, a header tank 6010, a motor 6006, a parallel piston pump 6008 coupled to the motor 6006, a plurality of accumulator flasks 6066, a filter assembly 6054, together with the necessary valves, electrical devices, and pipes associated with these major components.

The two accumulator units 6000A and 6000B are symmetrically located, forward in Area 1, outboard of the respective blast door, as shown best in FIG. 3. On both accumulator units 6000A and 6000B, the motor 6006 is mounted inboard on the rectangular tank 6002, and the accumulator flasks 6066 are positioned outboard thereof, as shown best in FIGS. 3 and 38. The filter assembly 6054, an accumulator control assembly 6090, and a pressure cutoff assembly 6114 are mounted forward on the main tank 6002 of both accumulator units 6000. The header tank 6010, however, as shown in FIG. 39, is suspended from the overhead 8005 of the aft deckhouse 8004, slightly aft of the accumulator unit 6000.

Should the power supply to the motor 6006 fail, an auxiliary motor-driven pump unit 6150, as shown best in FIG. 39A, may be used as an emergency source of accumulator pressure. The single auxiliary motor-driven pump unit 6150 serves either or both the A-side and B-side of the feeder 2000 and it is mounted on the deck 8002, forward in Area 1, near the centerline of the vessel 8000.

Since both the operation and components of the A-side and the B-side of the feeder 2000 are identical, this section of the application will be limited to the A-side accumulator unit 6000A. Whatever applies to the A-side accumulator unit 6000A will also apply to the B-side accumulator unit 6000B, except, of course, its location and position, as pointed out above and hereinafter.

b. DETAILED DESCRIPTION

(1) *Main tank.*—The Area 1 accumulator unit 6000 and its affiliated header tank 6010 and auxiliary motor-driven pump 6150 are located forward in Area 1, as shown in FIG. 3. The A-side accumulator unit 6000A is illustrated in detail in FIGS. 38, 39, 39A, and 40, and it includes the previously mentioned main tank 6002, the header tank 6010, the motor 6006, a gear reducer 6004, the pump 6008, an adapter block assembly 6030, the filter assembly 6054, the control assembly 6090, the accumulator flasks 6066, and pressure cutoff assembly 6114, all connected together, as shown in FIGS. 39 and 39A. Although the auxiliary motor-driven pump unit 6150 is designated as a separate unit, it is directly associated with the Area 1 accumulator 6000 and is discussed in this section.

The main tank 6002 serves both as an oil reservoir and as a stand to support other components of the Area 1 accumulator unit 6000A. The main tank 6002 is a rec-

tangular steel weldment secured to the main deck 8002 of the vessel 8000.

The main tank 6002, as illustrated in FIG. 39, has an opening in the top which is covered by the gear reducer 6004. This gear reducer 6004 supports the motor 6006 and the pump 6008. Another opening on the forward end of the main tank 6002 mounts the circular adapter block assembly 6030. Flanges and lugs for mounting the control assembly 6090, and the filter assembly 6054 are provided on the side of the main tank 6002.

(2) *Header tank.*—The header tank 6010 is suspended from the overhead 8005 of the aft deckhouse 8004 and holds a reserve supply of hydraulic fluid for the Area 1 accumulator unit 6000 and it provides expansion space for fluid in the system. A conduit 6012 from the bottom of the header tank 6010, as shown in FIG. 39, leads to the main tank 6002. Two lines, not shown, which are connected to a T-manifold are attached to the bottom of the tank 6010, and then return hydraulic fluid from the components of the blast door 4000.

Tank 6010 holds a reserve quantity of hydraulic fluid and, in addition, it provides expansion space. The header tank 6010 is of substantially rectangular shape and it has a V-shaped bottom. A window 6014, located on the inboard side thereof, indicates the level of oil in the tank. A fill valve 6016 is located at the bottom of the header tank 6010 and it may be used to drain the header tank 6010, or to fill both the header tank 6010 and the main tank 6002. A porous-bronze air breather and standpipe 6018 extends internally above the oil level.

(3) *Motor.*—The motor 6006 for the accumulator unit 6000A is mounted vertically above the step down ratio gear reducer 6004, which is secured to the top of the main tank 6002. The motor 6006 drives a flexible coupling 6020, which, in turn, rotates the gear reducer 6004 within the main tank 6002.

(4) *Pump and gear reducer.*—The parallel piston pump 6008 is suspended from the gear reducer 6004 within the main tank 6002. Hydraulic fluid discharged by the pump 6008 passes through a check valve 6022 to the adapter block 6030. The check valve 6022, as illustrated in FIG. 39, prevents hydraulic pressure fluid from escaping back to the main tank 6002 when the auxiliary motor-driven pump 6150 is used. This check valve 6022 is located in the pump discharge line, within the main tank 6002, between the parallel piston pump 6008 and the adapter block assembly 6030.

(5) *Check valve.*—The check valve 6022 consists of a housing 6024, and a valve plunger 6026 and a spring 6028, located within the housing 6024. The check valve spring 6028 holds the valve plunger 6026 closed unless the parallel piston pump 6008 is operating. When the parallel piston pump 6008 is in operation, the discharge pressure of the pump 6008 opens the check valve 6022 so that discharge oil is passed in the hydraulic system.

(6) *Adapter block assembly.*—The adapter block assembly 6030, as shown best in FIGS. 39 and 40, includes an unloading valve 6032, a manual starting valve 6042, and a spiral groove orifice 6040. The adapter block assembly 6030 is flange mounted into a circular opening on the side of main tank 6002.

(*a*) Unloading valve: The unloading valve 6032 allows the discharge from the pump 6008 to be dumped back to the main tank 6002 when the pressure of the system is at its maximum limit, that is, 1500 p.s.i. The unloading valve 6032 consists of a plunger 6034 and a spring 6036. The front of the plunger 6034 has a smaller diameter than its land section, and it terminates in an X-shaped guide 6038. The unloading valve 6032 opens directly to the main tank 6002 instead of through the conduits shown schematically in FIG. 39.

As shown in FIG. 39, the discharge fluid from the pump 6008 is ported through the adapter block assembly 6030, past the smaller diameter section of the plunger 6034, and out to the filter assembly 6054. Counter-balancing the pressure of the pump 6008, which acts against the plunger 6034 of the unloading valve 6032, are the valve spring 6036 and the hydraulic pressure ported to the rear of the plunger 6034 from an accumulator control valve 6100.

When the pressure in the system reaches the maximum limit of 1500 p.s.i., the plunger 6102 of the accumulator control valve 6100 shifts, reducing the rear of the unloading valve 6032 to tank pressure. When this occurs, pressure from the pump 6008 will unseat the unloading valve 6032, thus causing discharge fluid of the pump 6008 to be dumped to tank at only enough pressure to compress the unloading valve spring 6036.

(*b*) Orifice: The previously mentioned spiral groove orifice 6040, located in the line between the unloading valve 6032 and the control valve 6102, cushions both the opening and closing of the unloading valve 6032.

(*c*) Manual starting valve: The manual starting valve 6042, shown in FIG. 40, is used to overcome starting difficulties after the accumulator unit 6000A is first installed, or has been overhauled, and the entire system is filled with air. The manual starting valve 6042 consists of a valve guide 6044, a plunger 6046 located within the valve guide 6044, a spring 6048, and a knurled cap 6050. The knurled cap 6050 is screwed to the guide 6044 and it protects the plunger 6046 from accidental movement. When the accumulator unit 6000A is assembled or reassembled, the line between the unloading valve 6032 and the control valve plunger 6102 may become filled with air. If this line contains air when the pump 6008 is started, the pressure generated to force oil through the filter assembly 6054 and into the system may unseat the unloading valve 6032 and bypass discharge fluid from the pump 6008 to the tank 6002. The unloading valve 6032 will open because the air in the line will be compressed.

To overcome this condition, the manual starting valve 6042 is provided. With the pump 6008 in operation and the knurled cap 6050 removed, depressing the starting valve plunger 6046 will admit pressure to the rear of the unloading valve 6032, and cause it to seat. With the unloading valve 6032 seated, the discharge fluid of the pump 6008 will pass into the system and the accumulator control valve 6100 will take over. The accumulator pressure fluid admitted by the starting valve 6042 to the line between valve 6032 and plunger 6102, is prevented from returning to tank by a check valve 6052, which is part of the control assembly 6090, as shown in FIG. 39.

(7) *Filter assembly.*—All hydraulic fluid supplied to the system must pass through the filter assembly 6054 which is in the form of a large sphere bolted to the forward side of the main tank 6002. As shown in FIG. 39, this filter assembly 6054 includes a plurality of filter elements 6056, a bypass valve 6058, a bleeder valve 6060, a check valve 6062, and a switch SIXA3.

The plurality of filter elements 6056 within the filter assembly 6054 are mounted in parallel between steel discs, not shown, for convenient replacement. With clean filter elements 6056, the total pressure drop thereacross is extremely low. As the filter elements 6056 become dirty or clogged, however, the pressure drop thereacross increases.

(*a*) Bypass valve and bleeder valve: A spring tensioned bypass valve 6058 begins to open when the pressure drop across the clogged filter elements 6056 reaches a predetermined value bypassing the accumulator pressure fluid around the filter elements 6056, and directly into the system. The upper section of the bypass valve 6058 operates the switch SIXA3. When the switch SIXA3 is actuated, a red lamp (not shown) is energized, warning that the clogged filter elements 6056 should be changed.

After the filter assembly 6054 has been drained and new filter elements 6056 installed, the filter assembly refilled with oil and bled through the fill pipe, air may still be trapped above the bypass vave 6058. Hydraulic pressure generated by the pump 6008 will force the bypass

valve 6058 open, compressing this air, and pass the accumulator pressure fluid around the new filter elements 6056 directly into the system. To prevent this, the bleeder valve 6060 is provided to vent any trapped air.

(*b*) Check valve: The spring-held check valve 6062 prevents the accumulator pressure fluid system from escaping to the tank 6002 when the system is charged to its maximum and the unloading valve 6032 is open. When closed, the pressure of the spring on the check valve 6052, plus the accumulator pressure, force the check valve 6052 to seat and prevent the escape of accumulator pressure fluid to tank. However, if the pump 6008 resumes charging (with the unloading valve 6032 closed), the discharge pressure of the pump will force the check valve 6052 open, and accumulator pressure fluid will enter the system.

(8) *Accumulator flask assembly.*—An accumulator flask assembly 6063 is provided, as shown in FIGS. 38 and 39A, and it consists of a manifold 6064, the three accumulator flasks 6066, and a nitrogen valve block assembly 6068. The manifold 6064, as shown in FIG. 38, is a T-shaped hollow steel weldment which is fastened to the top of the main tank 6002, outboard from the motor 6006. The three accumulator flasks 6066, as shown best in FIGS. 38 and 39A, are mounted on the manifold 6064, and the nitrogen valve block assembly 6068, located near the top of the flasks 6066, is attached to the flask supports.

(*a*) Accumulator flasks: The three cylindrical accumulator flasks 6066 store accumulator pressure fluid between 1400 and 1500 p.s.i., and also cushion the hydraulic system for pulsations and surges. The major components of each accumulator flask 6066 are illustrated in FIG. 39A. Each flask 6066 includes a neoprene bladder 6070, a poppet valve 6072 located at the bottom of the flask 6066 in a flange mounting 6074, and a nitrogen filter 6076 located at the top of the flask 6066.

The flange 6074 is utilized to secure the assembly to the manifold 6064, shown in FIG. 38. The synthetic rubber bladder 6070 located within the cylinder of the flask 6066 is charged from the top thereof through the filter 6076 with compressed nitrogen. The filter 6076 is preferably of porous-bronze, and it is contained in an adapter 6078 which is attached to the top of the flask 6066. The filter 6076 filters the compressed nitrogen used to charge the bladder 6070. The spring-loaded poppet valve 6072 prevents the bladder 6070 from pushing out into the manifold 6064, of FIG. 38, when there is no hydraulic fluid in the flask 6066.

(*b*) Nitrogen valve block assembly: The nitrogen valve block assembly 6068, as illustrated in FIG. 39A, is attached near the top of the accumulator flasks 6066. This nitrogen valve block assembly 6068 controls the compressed nitrogen contained in the flask bladders 6070. The nitrogen valve block assembly 6068 includes a valve 6080 for each flask bladder 6070, a bleeder valve 6082, a filter 6086, an adapter 6088, and a gage 6084, the latter being depicted in FIG. 38 all arranged as shown. The bleeder valve 6082 controls the vent to atmosphere, while the valves 6080 control connections to the bladder 6070 in each of the three flasks 6066.

The gage 6084, mounted at the top of the nitrogen valve block assembly 6068, as shown in FIG. 38, is used to check the pressure of the nitrogen in the bladders 6070. The fill adapter 6088 is bolted to one end of the nitrogen valve block assembly 6088 and it contains the filter 6086.

(9) *Accumulator control assembly.*—The accumulator control assembly 6090, depicted best in FIG. 39, includes three valves, namely the previously mentioned accumulator control valve 6100 which consists of the plunger 6102 and a piston 6104, a manual unloading valve 6092, and the check valve 6052, arranged as shown. The accumulator control assembly 6090 is mounted on the aft side of the main tank 6002, above the filter assembly, as shown best in FIG. 38.

A release knob 6096 of the manually operated unloading valve 6092 projects from the accumulator control assembly 6090. This manually operated unloading valve 6092 dumps accumulator pressure fluid from the accumulator flasks 6066 and the hydraulic system back to the tank 6002 when the accumulator unit 6000 is shut down.

(*a*) Manual unloading valve: The components of the manual unloading valve 6092 include a plunger 6094, the release knob 6096, and a spring 6098, arranged as shown in FIG. 39. The release knob 6096 is pinned to the plunger 6094 and it acts as a stop against the force of the spring 6098. The spring 6098 holds the plunger 6094 in the closed position until the release knob is pulled.

(*b*) Check valve: Even though other lines of the system may become filled with air, the check valve 6052, of FIG. 39, retains oil in the line between itself and the unloading valve 6032. With this line filled with oil, the unloading valve 6032 will remain seated when the accumulator unit 6000 is activated, allowing the parallel piston pump 6008 to charge the hydraulic system with accumulator pressure fluid. The components of the check valve 6052 are similar to those for check valve 6022, previously described.

(*c*) Accumulator control valve: The accumulator control valve 6100 which consists of the plunger 6102 and the piston 6104, maintains the pressure of the hydraulic system within an operating range of 1400 to 1500 p.s.i. The plunger 6102 and the piston 6104 act as a unit to control the unloading valve 6032. When the pressure of the accumulator unit 6000 is at the minimum limit of 1400 p.s.i., the accumulator control valve 6100 prevents the opening of the unloading valve 6032, thus allowing accumulator pressure fluid from the pump 6008 to charge the hydraulic system. When, however, the pressure of the accumulator unit 6000 has developed to its maximum limit of 1500 p.s.i., the unloading valve 6032 is allowed to open and bypass the discharge of the pump 6008 back to tank 6002.

The two-land plunger valve 6102 includes an adjustable pushrod 6106 and a valve spring 6108, arranged as shown in FIG. 39. The movement of the plunger 6102 is limited by the piston 6104 at one end and the pushrod 6106 at the other. The pushrod 6106 directs the force of the valve spring 6108 against both the plunger 6102 and the piston 6104.

The piston 6104 is positioned in a sleeve. A double shoulder space 6110 located in the accumulator control valve 6100 checks both the movements of the piston 6104 and the plunger 6102 within prescribed limits. A drilled hole 6112 in the accumulator control valve 6100 is arranged to communicate through the right hand land of plunger 6102 into the double shoulder space 6110 to apply hydraulic fluid between the plunger 6102 and the piston 6104.

(10) Pressure cutoff assembly.—The previously mentioned pressure cutoff assembly 6114, illustrated in FIG. 39A, controls the accumulator pressure fluid supplied to the hydraulic system and also indicates when accumulator pressure fluid is available. The pressure cutoff assembly 6114 is bolted to the side of the accumulator manifold 6064, as shown best in FIG. 38. An associated solenoid housing 6116 is attached to its inboard side, as shown in FIG. 38.

The pressure cutoff assembly 6114 includes a solenoid operated control valve 6118, a pressure cutoff valve 6124, switch valves 6140 and 6142, and manual shutoff valves 6132 and 6134, shown in FIG. 39A. The solenoid housing 6116 contains a solenoid LCXA1 and an interlock switch SIXA6.

(*a*) Control valve: The solenoid-operated control valve 6118 is arranged to be shifted by the solenoid LCXA1. This valve 6118, acting as a pilot valve, operates a cutoff valve 6124. Valve 6118 is held by a spring 6119 and it is operated by a rod 6120. The upper end

of the rod 6120 is pinned to a pivoted connecting link 6162 and it transmits the movement of the solenoid LCXA1 to the valve 6118.

When the solenoid LCXA1 is energized, the rod 6120 and the valve 6118 are shifted downwardly, against the pressure of the spring 6118. Accumulator pressure fluid from the accumulator unit 6000 is thus ported from the top of the cutoff valve 6124 and dumped to the tank 6002. When the solenoid LCXA1 is de-energized, tension of the spring 6119 pushes the valve 6118 and rod 6120 upwardly, returning the solenoid LCXA1 to its original position and again porting accumulator pressure fluid to the top of the cutoff valve 6124.

(*b*) Cutoff valve and solenoid: The cutoff valve 6124 as shown in FIG. 39A, is the main pressure cutoff for the hydraulic system. This valve 6124 consists of a plunger 6126 and a spring 6128. When the solenoid LCXA1 is energized and the control valve 6118 is shifted, the accumulator pressure fluid acting against the top of the cutoff valve 6124 is dumped to tank 6002. With merely tank pressure above the cutoff valve 6124, accumulator pressure fluid is effective against the lower section of the cutoff valve 6124 and unseats it. With the cutoff valve 6124 open, accumulator pressure fluid is free to pass through the manual shutoff valves 6132 and 6134 hydraulic operating components of Areas 1 and 2, as indicated in FIG. 39A.

When the solenoid LCXA1 is de-energized, the solenoid-operated control valve 6118 admits accumulator pressure fluid to the top of the cutoff valve 6124. The pressure of the accumulator fluid plus the forces of the cutoff valve spring 6128 will then seat the cutoff valve 6124 and accumulator pressure fluid is thus prevented from passing into the hydraulic system.

An orifice 6130 is located in the passage between the solenoid-operated control valve 6118 and the top of the cutoff valve 6124, and it limits the flow of accumulator pressure fluid. This orifice 6130 delays the action of the cutoff valve 6124, thereby allowing sufficient time for an operating hydraulic unit or component powered by the accumulator unit 6000 to complete its cycle in the event power to the solenoid LCXA1 should fail. The orifice 6130 also functions to cushion the opening and closing of the cutoff valve 6124.

(*c*) Manual shutoff valves: The pair of manual shutoff valves 6132 and 6134 is located on the side of the pressure cutoff assembly 6114 below the solenoid housing 6116, as shown best in FIG. 39A. The shutoff valve 6132 controls a conduit 6136 supplying accumulator pressure fluid to the hydraulic components of the blast doors 4000 and the span track assembly 4001, while valve 6134 controls a conduit 6138 supplying accumulator pressure fluid from accumulator unit 6000 to the hydraulic components of the loader 2002.

(*d*) Switch valves: The two switch valves 6140 and 6142 are provided as shown in the pressure cutoff assembly and they act together to actuate the switch SIXA6. When accumulator pressure fluid is available in the pressure cut-off assembly 6114, switch valve 6140 shifts and ports pressure fluid to the switch valve 6142, which then operates the switch SIXA6.

The switch valve 6140 is of a two-land configuration, and its movement is limited by a pushrod 6144. This pushrod 6144 directs the force of a valve spring 6146 against the switch valve 6140. An adjustment screw 6148 is provided in connection with the switch valve 6140 to vary the compression of the spring 6146. By turning the adjustment screw 6148, the compression thereof is varied to thus increase or decrease the force required to shift the switch valve 6140.

When a predetermined pressure is reached in the hydraulic system, switch valve 6140 shifts against spring 6146. Accumulator pressure fluid is then ported to the switch valve 6142, as shown in FIG. 39A. This switch valve 6142 then actuates the switch SIXA6. When actuated, this switch SIXA6 energizes an amber "ready" lamp. When accumulator pressure fluid is no longer ported to switch valve 6142, the valve spring 6146 returns it to its proper position and a lamp associated therewith will go out.

(11) *Auxiliary motor-drive pump.*—In an emergency operation, the auxiliary motor-driven pump 6150, shown schematically in FIG. 39A, supplies a limited quantity of accumulator pressure fluid to either, or both, Area 1 accumulator units 6000A and/or 6000B. The auxiliary motor-driven pump unit 6150 is mounted on the deck 8002 behind the A-side blast door frame, near the centerline of the ship 8000.

Intake and discharge manifolds 6154 and 6152, respectively, are bolted to the auxiliary motor-driven pump 6150. The intake manifold 6154 communicates with the aft or intake side and the other manifold 6152 to the forward or discharge side of the auxiliary motor-driven pump 6150.

The intake manifold 6154, which is attached to the aft side of the pump 6150 contains two manual shutoff valves 6156 and 6158. The shutoff valve 6156 controls a supply line 6164 from the A-side accumulator tank 6002A, while the shutoff valve 6158 controls a supply line 6166 from the B-side accumulator tank 6002B.

The discharge manifold 6152, which is attached to the forward side of the auxiliary motor-driven pump 6150, also contains two manual shutoff valves 6160 and 6162. The shutoff valve 6160 controls the flow of fluid in the line 6168 carrying accumulator pressure fluid toward the A-side pump 6008A, while the valve 6162 controls a similar line 6170 leading toward the B-side pump 6008B. The accumulator pressure fluid from the auxiliary motor-driven pump flows to the adapter block assembly 6030, illustrated in FIG. 39, and through the filter assembly 6054 and on to the hydraulic system.

D. Theory of Operation

Both upper and lower blast doors 4004 and 4002 of blast door assembly 4000 are opened and closed by means of the previously mentioned hydraulically operated pistons 4072 and 4073, and 4070 and 4071, respectively. The differential-area lower door power pistons 4070 and 4071 operate the lower blast door 4002, while the two other upper door pistons 4072 and 4073 operate the upper door 4004. The span track assembly 4001, attached to the inner face of the upper blast door 4004, moves with this door.

Although the door operation is sequenced so that the lower door 4002 opens first and then the upper door 4004, their operation is neither mechanically nor hydraulically dependent on each other. Each lower or upper door 4002 and 4004, respectively, is equipped with its own solenoid-operated pilot valve 4270 or 4272 which triggers the operation of its respective door. The pair of solenoids 4278 operate each pilot valve, one solenoid 4278 initiates the opening of the door 4002 (or 4004), and the other solenoid initiates the closing of the door. These solenoids 4278 may be operated in either automatic or step control operation. For circuitry description each solenoid 4278 has been assigned a specific code designaton, such as LCPA1, for example.

1. *Door-Open Cycle*

a. AUTOMATIC OPERATION

In automatic operation, the weapons 400 are transferred automatically from Area 1, through the blast door opening 4010, and onto the launcher rails 5010. Before a weapon 400 will move, however, the launcher and feeder components must be in position to actuate the appropriate electrical interlocks. These electrical interlocks energize rotary relays whose contacts form elements in the automatic circuit.

To open the blast doors 4002 and 4004 in automatic

operation, solenoid 4278, which is indicated generally by this reference numeral, and shown in FIG. 32, is energized. This specific solenoid LCPA1, as shown best in FIG. 7C, shifts a pilot valve 4270, which, in turn, triggers the opening of the lower door 4002. When open, the lower door 4002 closes the interlocks which complete an element in the circuit, energizing a solenoid LCPA3, shown in FIG. 7A. When energized, solenoid LCPA3 will shift the pilot valve 4272 and cause the upper door 4004 to open.

(1) *Lower door-open circuit.*—The automatic circuit which energizes the open solenoid LCPA1 for the lower door 4002 is controlled from a feeder panel EP3, shown best in FIG. 3. A control switch on the panel EP3 is turned to "Automatic" while an operation switch is turned to "Load," and a selector switch may be turned to A, or A and B, or B, for the A-side and B-side of the guided missile launching system. If both the A-side and the B-side of the guided missile launching system are to be loaded with weapons 400, selection is made for A and B. On the other hand, if only one side of the guided missile launching system is to be loaded with the weapon 400, the switch is turned to either A or to B, depending on the side of the guided missile launching system chosen to be loaded with the weapon 400. In addition to manually operated switches, the circuitry to solenoid LCPA1 also includes relay elements and delay elements for completing the circuit a predetermined time after being energized.

Since the lower and upper blast doors 4002 and 4004, respectively, may be ready to open, this time delay provided by a relay, assures that the blast doors will be open the least amount of time. It is to be noted that the assembly of the wings 102 and fins 104 and 208 to the missile-booster combination 300 in Area 1, which has to be completed before the loader 2002 will move the weapon 400 onto the rails 5010 of the launcher 5000 also requires a finite time.

Other electrical delays in completing the circuit prevent the blast doors 4002 and 4004 from opening before the blast gases from the booster 200 have dissipated and also assure that a train latch of the launcher 5000 is engaged before the lower door 4002 opens, thus safe-guarding against the blast of a misfire of a booster 200 on the loaded rails 5010 from entering an opening blast door, such as lower and upper doors 4002 and 4004. With the circuit to solenoid LCPA1 completed, the solenoid is energized and it shifts the pilot valve 4270, shown in FIG. 7C. When solenoid LCPA shifts the pilot valve 4270, it also actuates a signal light switch SIPA101, shown best in FIG. 7C.

(2) *Lower door-open operation.*—With the pilot valve 4270 shifted to the position shown in FIG. 7C, accumulator pressure is ported through the pilot valve 4270 to the door-closed latches 4112 and 4113, shown best in FIGS. 7C, 34 and 37 (latch 4112 only). The hydraulic pressure fluid ported from the pilot valve 4270 will hereafter be designated as control pressure fluid.

Control pressure fluid ported from the pilot valve 4270 to the door-closed latches 4112 and 4113, retracts these latches and releases the lower door 4002. Orifices in the lines leading to the latches 4112 and 4113 throttle the flow of hydraulic fluid, thus reducing the opening speed of the latches 4112 and 4113.

The latches 4112 and 4113, in addition to releasing the lower door 4002, also act as sequence valves. With the plungers of both latches 4112 and 4113 depressed, the control pressure fluid is ported through their rear chambers to the left side of the directional valves 4136 and 4138, as shown best in FIG. 7C. The control pressure fluid shifts the directional valves 4136 and 4138 to the right.

With both directional valves 4136 and 4138 shifted, PA pressure fluid is ported from the valve 4138, past the throttle valve 4181, to the metering valve 4100. The valve 4100 regulates the flow of this hydraulic fluid to both the lower door power pistons 4070 and 4071, shown best in FIG. 7C.

The accumulator pressure fluid from the valve 4100 passes through the power piston control rods 4086 to the cavities 4095 in the piston rods, as shown in detail in FIGS. 7C and 19. The pistons extend when the accumulator pressure fluid passes from the cavities 4095, through the control rod control grooves 4090 of FIG. 20, to beneath the piston 4092 of FIG. 19. The control grooves 4090 act as variable orifices and maintain a given rate of flow to the area below the faces of the pistons 4092. Should the pressure in the piston rod cavities 4095 increase, this unbalanced condition will cause the lower door metering valve 4100 to shift to the right and partially restrict the flow of fluid.

It is to be noted that the left end of the lower door metering valve 4100 is connected to the rod cavities 4095, whereas the right end is connected to the bottom of the piston cylinders. Thus, since fluid flow through the control grooves 4090 determines the action of the lower door metering valve 4100, it also determines the speed by which lower door power pistons 4070 and 4071 extend and open the lower door 4002.

As the differential-area lower door power pistons 4070 and 4071 extend and the lower door 4002 opens, accumulator pressure fluid, acting against the rod ends of the power pistons 4070 and 4071, is forced out of the cylinders. This results because the pressure fluid below the faces of the piston 4092 acts against a greater area than that above. The accumulator pressure fluid, forced from the upper portion of the cylinder, passes to valve 4136, and then is either recycled, or forced back into the pressure system.

As the lower door 4002 nears the completely open position, the control grooves 4090 become shallower and are gradually cut off entirely. As the depth of these grooves 4090 decreases, the speed of the opening of the door 4002 is reduced proportionally. To prevent a complete stall and allow the door 4002 some impact velocity as it engages the door-open latches 4142 and 4143, the fixed orifice 4169 is provided in the lower door control block assembly 4166. This orifice 4169 ports hydraulic fluid from one end of the lower door metering valve 4100 to the other end, reducing the pressure drop, and allowing the lower door metering valve 4100 to open sufficiently to enable the lower door power pistons 4070 and 4071 to complete their stroke.

When the lower blast door 4002 is open and latched, switches SIPA5 and SIPA1, as shown in FIGS. 7C and 11, which are attached to the door-open latch roller brackets 4140, are actuated. On actuating these switches SIPA5 and SIPA1, the solenoid LCPA1 is de-energized.

In FIG. 7C, the lower door 4002 is shown open and latched, with solenoid LCPA1 being de-energized. Although solenoid LCPA1 is de-energized, the pilot valve 4170 remains mechanically detented in position. With pressure fluid in both the piston cavities 4095 and the lower portion of the cylinders now equalized, metering valve 4100 centers and fully opens the PA port thereof. By maintaining accumulator pressure fluid to the power pistons helps secure and steady the lower door 4002 in the open position.

(3) *Upper door-open circuit.*—The automatic circuit for energizing the upper door-open solenoid LCPA3, include the same manually operated switches used in the lower door-open circuit. Other elements are included in the electrical circuit to close when the A-side launcher rail 5010 is clear. This permits the weapon 400 to be moved from Area 1 onto the launcher guide arm 5002.

Other electrical elements are closed when the launcher train and elevation latches are engaged. These latches secure the launcher 5000 in the stowed position (180°

train and 0° elevation). It is essential that the launcher 5000 be in the stowed position when the upper door 4004 opens, not only to prevent collision therewith, but also to enable the span track-guide-arm latch 4210 to engage the guide arm latch block 5186, shown best in FIGS. 6, 28, and 30.

When the lower blast door 4002 is open and is latched, switches SIPA1 and SIPA5, which are attached to the door-open latch roller brackets 4144, as illustrated in FIG. 7C, further set up a partial electrical circuit which is only completed when the upper door 4004 is open and the span track assembly 4001 is latched to the launcher rail 5010 and to the loader trunk 4003. When the interlock switches SIPA3 and SIPA7, shown in FIGS. 7, 8, 9, 10, and 28, which are attached to the span track-guide arm latch 4210 and the span track-loader latch 4306 close, an element opens and breaks the circuit to solenoid LCPA3 on the pilot valve 4272. When the circuit to solenoid LCPA3 is completed, the solenoid is then energized and it shifts the pilot valve 4272. As solenoid LCPA3 shifts the pilot valve 4272, it also actuates the signal light switch SIPA103, shown in FIG. 7A.

(4) *Upper door-open operation.*—With the pilot valve 4272 shifted, as shown in FIG. 7A, control pressure fluid is ported from the pilot valve 4272 to the safety latch 4150, shown in FIGS. 7 and 23. The control pressure fluid, acting against the front of the latch plunger 4154, retracts the latch element 4155 and releases the upper door 4004. When retracted, the safety valve 4150 also acts as a sequence valve, porting the control pressure fluid to the tripping valve 4230 and to the upper door directional valves 4162 and 4164, shown best in FIG. 7.

The control pressure fluid ported to the upper door directional valves 4162 and 4164 shifts both of these valves downwardly, as shown in FIG. 7. When shifted, valve 4164 ports the accumulator pressure fluid past the upper door throttle valve 4180 to the upper door metering valve 4170. Upper door metering valve 4170 regulates the accumulator pressure fluid flow to the upper door power pistons 4072 and 4073.

Although the upper door power pistons 4072 and 4073 are somewhat longer than the lower door power pistons 4070 and 4071, they do not differ in operation. Like the lower door power pistons 4070 and 4071, upper door power pistons 4072 and 4073 are equipped with the control grooves 4090 of the control rod 4086, shown in FIGS. 19 and 20, which are leagued with the upper door metering valve 4170 to regulate the opening speed of the lower door 4002.

As the upper door 4004 nears the fully open position, the catch 4215 projecting from the bottom of the span track-guide arm latch 4210 contacts the guide arm latch block 5186, as shown in FIGS. 6, 7, and 8. Upon contacting this lug 5186, the latch 4215 is caused to rotate, and, at the same time, it pulls toggle linkage consisting of links 4221 and 4222 forward.

As the linkage composed of links 4221 and 4222 is drawn forward, the clevis 4224 releases the tripping valve 4230, which then extends, as shown best in FIG. 9. This causes the tripping valve 4230 to port control pressure fluid to the span track-guide arm latch piston 4220. The control pressure fluid ported to the face of this differential-area span track-guide arm latch piston 4220, causes it to extend, and force the accumulator pressure fluid at the rod end from the valve block 4232. As piston 4220 extends, it rotates the span track-guide arm latch 4210 further, thereby lifting the span track 4200 slightly and aligning it with the launcher guide arm 5002. In FIG. 7, there is shown the span track 4200 latched to the guide arm 5002 and the switch SIPA3 actuated.

When the tripping valve 4230 extends, if not only ports control pressure fluid to the span track-guide arm latch piston 4220, but also to the hold-down piston 4250, as shown best in FIG. 7. At the same time, tripping valve 4230 ports the centering pistons 4240 and 4242, shown in FIGS. 7B and 25 to tank. With the centering pistons 4240 and 4242 ported to tank, the "floating" span track assembly 4001 may shift laterally to align with the guide arm rails 5010, as shown best in FIG. 6.

As the span track-guide arm latch 4210 engages the latch block 5186 at the forward end of the span track assembly 4001, the span track-loader latch mechanism 4300 secures the aft end of the span track assembly 4001 to the trunk unit VIII, as shown in FIG. 6A. No hydraulic pressure fluid is ported to the loader latch piston 4314 during the door-open cycle. This is a spring-loaded type latch. Switch SIPA7 is actuated when the loader latch 4306 engages the aft end of the span track assembly 4001.

As the span track assembly 4001 is latched in the horizontal position, the "floating" track 4200 compensates for any slight misalignment with the launcher guide arm 5002. The floating span track 4200, as previously mentioned, is suspended forward by the T-hanger 4212, and aft by the centering bolt 4194. The span track-guide arm latch 4210 and the span track-loader latch 4300 at either end of the span track assembly 4001 provide both the vertical and lateral alignment of connecting skid tracks 4206 and the chain tracks 4208, with their counterparts on both the launcher guide arm 5002 and the loader trunk 2003, respectively. The hold-down piston 4250 is an added safeguard, and it assures vertical alignment of the mating chain tracks 4208 and the skid tracks 4206 to the loader trunk unit VIII regardless of pitch and roll of the vessel 8000 or misalignment of the span track assembly 4001 with the guide arm 5002 of the launcher 5000.

When the upper door 4004 is open and latched, both switches SIPA3 and SIPA7, of FIGS. 7, 8, 9, 10, 28, and 33, are actuated to de-energize the solenoid LCPA3, of FIG. 7A. Although the solenoid LCPA3 is de-energized, the pilot valve 4272 remains mechanically detented in position and it continues to port control pressure fluid to the upper door directional valves 4162 and 4164 and the latch pistons 4220 and 4314, as shown best in FIG. 7. On maintaining the accumulator pressure fluid to the power pistons 4072 and 4073, the latches 4220 and 4314 are assisted in holding the upper door 4004 and span track assembly 4001 in the open position.

2. *Door-Close Cycle*

a. AUTOMATIC OPERATION

In automatic operation, the blast doors 4000 close automatically after the weapon 400 has been transferred onto the launcher guide rail 5010. Before the blast doors 4000 will close, however, certain electrical interlock switches have to be actuated to indicate that the components are in the proper position.

In the door-close cycle, solenoid LCPA4, shown in FIG. 7A, is energized initially. This solenoid LCPA4 shifts the pilot valve 4272, which, in turn, initiates the closing of the upper door 4004. When the upper door 4004 is closed and latched, an element in the circuit to the solenoid LCPA2 of FIG. 7C is completed. With the circuit completed and the solenoid LCPA2 energized, the solenoid LCPA2 shifts the pilot valve 4270 which then initiates the closing of the lower door 4002.

(1) *Upper door-close circuit.*—A switch (not shown) associated with the shoe indicator plungers (not shown) of the launcher arm 5002 is closed when the launcher rail 5010 is loaded, that is, is holding a weapon 400 and another switch (not shown) is closed when the loader saddle cart 2006 has been retracted behind the upper door 4004. Finally, with assurance that the upper door 4004 is open and unlatched, circuitry is established to energize the solenoid LCPA4.

When the circuit is thus completed and solenoid

LCPA4 is energized, the solenoid LCPA4 shifts the pilot valve 4272, and, at the same time, actuates the indicator light switch SIPA104, shown best in FIG. 7A. If the blast doors 4000 are open and the operation of the guided missile launching system is switched to the B-side only, suitable circuitry is provided so that the A-side blast doors 4000A will still close.

(2) *Upper door-close operation.*—When the pilot valve 4272 is shifted from the position shown in FIG. 7A, control pressure fluid is also thereby ported to the span track-loader latch piston 4314, while the safety latch 4150 is ported to tank T. The porting of the fluid in the safety latch 4150 to tank T also reduced the control pressure fluid ported to the span track-guide arm latch piston 4220 to tank pressure. The span track-guide arm latch piston engages the span track-guide arm latch 4210.

The control pressure fluid ported to the loader latch piston 4314 retracts its spring-loaded piston, which then disengages the triangular-shaped latch 4306. With piston 4314 retracted, control pressure fluid is ported thereby to the upper door directional valves 4162 and 4164 in the upper door control block 4168.

The control pressure fluid ported to the chamber between the two upper door directional valves 4162 and 4164, then shifts the piston of the upper door directional valve 4164 upwardly and holds the piston of the upper door directional valve 4162 downwardly. Upon shifting the piston of the upper door directional valve 4164 upwardly, both the upper door power pistons 4072 and 4073 are ported to tank T.

It is to be noted that both the span track-loader latch 4306 and the span track-guide arm latch 4210 disengage before the power pistons 4072 and 4073 are ported to tank T. Moreover, retracting the span track-guide arm latch piston 4220 also causes the tripping valve 4230 to retract. When retracted, valve 4230 ports the accumulator pressure fluid to the centering pistons 4240 and 4242, as shown in FIGS. 7B and 25. Pressure fluid, ported to the centering pistons 4240 and 4242, centers the span track assembly 4001 and prevents lateral shifting thereof while being moved or when being stowed. When the span track-guide arm latch piston 4220 is ported to tank T, the hold-down piston 4250 is also ported to tank T.

Since the upper door directional valve 4164 ports power pistons 4072 and 4073 to tank T, accumulator pressure fluid ported through the upper door directional valve 4162 is now effective against the rod ends of the pistons of these valves. Exhaust oil from the piston rod cavities and from lower portion of the cylinders, passes through the metering valve 4170 to tank T.

The door closing speed, like the door opening speed, is dependent on the flow of hydraulic fluid through the grooves 4090 of the control rod 4086 and through the metering valve 4170, shown best in FIGS. 20 and 7, respectively. The metering valve 4170 will decrease or increase the size of the exhaust port opening, as the pressure drop across the deceleration grooves 4090 varies.

During the door-close cycle, as the pressure drop across the deceleration grooves 4090 increases (between the piston rod cavities and the lower cylinder areas), valve 4170 shifts upwardly, partially closing the exhaust port and restricting the flow of fluid. The depth of the groove is the primary factor governing the acceleration or deceleration of the blast doors 4000 regardless of gravitational forces or motion of the vessel.

The fixed orifice 4169, shown in FIGS. 7 and 11, in the control block 4168 enables the power pistons 4072 and 4073 to complete their stroke as the deceleration grooves 4090 are cut off.

When the upper blast door 4004 is closed, the roller 4152 attached to the top of the span track support 4106 in FIG. 26 engages the spring-loaded latch element 4155 of the safety latch 4150, shown in FIGS. 23 and 26. When the latch element 4155 is engaged, it actuates the switch SIPA4, shown in FIG. 23, to open the circuit to solenoid LCPA4.

Since the pilot valve 4272 is mechanically detented in position, accumulator pressure fluid is still ported to the rod ends of the lower door power pistons 4072 and 4073, although the solenoid LCPA4 is de-energized. The pressure fluid ported to the lower door power pistons 4072 and 4073 helps secure the door in the closed position. Signal light switch SIPA104, shown in FIG. 7A, is actuated when the pilot valve 4272 is detented in this position. When the upper door 4004 is closed and latched, the circuit energizing the solenoid LCPA2, the lower door-closing, may then be completed.

(3) *Lower door-close circuit.*—As previously mentioned, a switch (not shown) on the launcher guide arm 5002 is closed when weapon 400 is loaded thereon. An additional electrical circuit element requires the upper blast door 4004 to be closed and latched before the lower blast door 4002 will move. This allows the span track assembly 4001 to clear the lower door 4002 as it is moved to the stowed position.

Should the A-side lower door 4002A be open and the operation of the launcher 5000 be switched to B-side operation only, the lower door 4002 will still close. As in the upper door-close circuit, the circuit energizing solenoid LCPA2 will, in this case, proceed through the side-selector switch to the completion of closing of the door.

(4) *Lower door-close operation.*—When the circuit is completed and solenoid LCPA2 is energized, pilot valve 4270 is shifted to the position shown in FIG. 11. When the pilot valve 4270 is shifted, it ports control pressure fluid to the door-open latches 4142 and 4143. The pressure fluid ported to the front of the latch plungers retracts both the latches 4142 and 4143 and releases the lower door 4002. Besides releasing the lower door 4002, the door-open latches 4142 and 4143 also act as sequence valves. These door-open latches 4142 and 4143 port control pressure fluid to the chamber between the lower door directional valves 4136 and 4138. This pressure fluid shifts the lower door directional valve 4138 to the left and holds the lower door directional valve 4136 to the right, as shown in FIG. 11.

The lower door directional valve 4138 now ports the fluid for the lower door power pistons 4070 and 4071 to tank T, while the lower door directional valve 4136 continues to port the accumulator pressure fluid to the rod ends of the pistons. With both power pistons 4070 and 4071 ported to tank T, the accumulator pressure fluid ported to the rod ends is effective, and it causes the power pistons 4070 and 4071 to retract. As the power pistons 4070 and 4071 retract, exhaust oil is forced from the piston cavities and the lower cylinder area to tank T. The lower door metering valve 4100 and the grooves 4090 of the control rod 4086 regulate the flow of exhaust oil, and thereby control the closing speed of the door 4002. The function of these grooves 4090 and the spring-centered metering valve 4100 has been discussed previously.

When the lower door 4002 has closed, the spring-loaded door-closed latches 4112 and 4113 engage and secure the lower door 4002. Beside securing the lower door 4002, these latches also hold the upper door 4004, since the beveled upper edge of the lower door 4002 abuts a similar bevel on the lower edge of the upper door 4004.

When engaged, door-closed latches 4112 and 4113 actuate switches SIPA2 and SIPA6, shown best in FIGS. 7C and 11. These switches SIPA2 and SIPA6 through suitable circuitry de-energize solenoid LCPA2 of FIGS. 7C and 11. Although solenoid LCPA2 is de-energized, the pilot valve 4270 remains detented in position. Since pilot valve 4270 is not shifted, accumulator pressure fluid continues to be supplied to the rod ends of the power pistons 4070 and 4071, of FIG. 7C. In FIG. 11, the lower blast door 4002 is closed and latched, solenoid

LCPA2 is de-energized, and the piston 4270 is detented for a close cycle.

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

What is claimed is:

1. In a missile weapon launching system, a launcher having at least one track member, a ballistically enclosed structure having an opening therein, a feeder system located in said ballistically enclosed structure and spaced from said launcher and having at least one track member, a bascule type door structure pivotally mounted in said opening in said ballistically enclosed structure, said door structure including an upper section and a lower section horizontally hinged to said ballistically enclosed structure, a third track member positioned between said first two mentioned track members, means floatably mounting said third track member on said upper section to allow said third track member to compensate for discrepancies in position of at least one of said track members of said launcher and feeder system, said pivotally mounted door structure being movable to shift said third track member into track engagement with said first two mentioned track members, whereby a missile weapon can be moved from said track member of said feeder system to said track member of said launcher for launching therefrom when said pivotally mounted door structure is open.

2. In the missile weapon launching system recited in claim 1, said means for floatably mounting said third track member on said door structure comprising a swivel bolt attached at one end to said third track member, a socket bearing attached to the other end of said bolt, a plunger extending through said socket bearing, a pair of cylinders spaced a distance from each side of said socket bearing and mounted on said upper section, a piston slidably mounted in each sleeve and a spring retained in each cylinder urging said pistons into contact with said plunger.

3. In the missile launching system of claim 2, in which said means floatably mounting said third track member further comprises a centering bolt retained in said third track member, a block having an internal bore and conical portion slidable in said upper section of said door structure, bias means urging said block away from said third track member, an external conical portion on said bolt mating with said internal conical portion whereby vertical and lateral movement of said third track member relative to said door structure is permitted to compensate for discrepancies in position of at least one of said track members of said launcher and feeder system.

4. In the missile launching system recited in claim 3, and said launcher having a latch block protruding therefrom, said third track member having a tapered guide block attached thereto, said guide block adapted to contact said latch block and align said third track member with said launcher track through the coaction of said means floatably mounting said third track member.

5. In the missile weapon launching system of claim 3 and hydraulically operated means for actuating said door structure so as to move said third track member from an inoperative position of said track members being out of engagement to an operative position of track engagement of said track members and back to said inoperative position selectively.

6. In the missile weapon launching system of claim 5, and means for locking said third track member in an operative position of track engagement of said track members.

7. In the missile weapon launching system of claim 5, and means for locking said door structure including said third track member in an inoperative position of said track members being out-of-track engagement with each other.

8. In combination, at least one track member, a wall having an opening therein spaced from said track member, a bascule type door pivotally mounted in said opening in said wall and having a track member floatably arranged thereon for track engagement with said first mentioned track member, at least one variable velocity compound piston device consisting of a cylinder having a re-entrant control element, an annular piston arrangement slidably positioned between said control element and cylinder and connected to said door to be moved and defining an inside piston working area, a first outside piston working area arranged to co-work with said inside piston working area, and a second outside piston working area; fluid conducting passages for subjecting said inside piston working area and said first outside piston working area to a first pressurized fluid, with said second outside piston working area being subjected to a second pressurized fluid of an equal or greater magnitude than said first pressurized fluid, said control element having at least one variable orifice therein serially connecting said inside piston working area to said first outside piston working area for transferring fluid from said inside piston working area to said first outside piston working area at a predetermined rate corresponding to the desired movement of its annular piston arrangement, a metering valve means operable to control the flow of said first pressurized fluid, said metering valve means being operably positioned in response to the pressure differential between said first pressurized fluid and said second pressurized fluid in a manner to reduce the flow of said first pressurized fluid to said inside piston working area as said pressure differential increases and to increase said flow as said differential decreases.

9. In the combination as recited in claim 8, wherein the variable orifice in the control element of the variable velocity compound piston arrangement consists of a groove formed in the surface of its control element which increases progressively in area from either end thereof to a point intermediate the ends of the groove.

10. In the combination as recited in claim 8, wherein said cylinder is pivotally mounted to a base so that said compound piston arrangement can follow the excursions of said door being moved.

11. In combination, at least one track member, a wall having an opening therein spaced from said track member, a bascule type door pivotally mounted in said opening in said wall and having a second track member floatably arranged thereon for track engagement with said first mentioned track member, and a pair of spaced variable velocity compound piston devices, each compound piston device consisting of a cylinder having a re-entrant control element, an annular piston arrangement slidably positioned between said control element and cylinder and connected to said door to be moved so as to position said track members in track engagement so that an article can be moved from said first mentioned track member to said second track member for further disposition thereof and spaced from the connection of the other annular piston arrangement of said other variable velocity compound piston device of said pair of annular piston arrangements to said door and defining an inside piston working area, a first outside piston working area arranged to co-work with said inside piston working area, and a second outside piston working area; fluid conducting passages for subjecting said inside piston working area and said first outside piston working area to a first pressurized fluid, with said second outside piston working area being subjected to a second pressurized fluid of an equal or greater magnitude than said first pressurized fluid, said control element having at least one variable orifice therein serially connecting said inside piston working area to said first outside piston working area for transferring fluid from inside piston working area to said first outside piston working area at a predetermined rate corresponding to the desired movement of its correspond-

ing annular piston arrangement, a metering valve means operable to control the flow of said first pressurized fluid, said metering valve means being operably positioned in response to the pressure differential between said first pressurized fluid and said second pressurized fluid in a manner to reduce the flow of said first pressurized fluid to said inside piston working area as said pressure differential increases and to increase said flow as said differential decreases.

12. In combination, a pair of spaced tracks, a wall positioned between said spaced tracks and having an opening therein, a door structure pivotally mounted in said opening on said wall, and span track means floatably mounted on said door structure, and a variable velocity compound piston device consisting of a cylinder having a re-entrant control element, an annular piston arrangement slidably positioned between said control element and cylinder and connected to said door structure to be moved so that said floatably mounted track means can engage with said pair of spaced tracks, and defining an inside piston working area and a first outside piston working area arranged to co-work with said inside piston working area, and a second outside piston working area; fluid conducting passages for subjecting said inside piston working area and said first outside piston working area to a first pressurized fluid, with said second outside piston

working area being subjected to a second pressurized fluid of an equal or greater magnitude than said first pressurized fluid, said control element having at least one variable orifice therein connecting said inside piston working area to said first outside piston working area for transferring fluid from said inside piston working area to said first outside piston working area at a predetermined rate corresponding to the desired movement of said annular arrangement of said device, a metering valve means operable to control the flow of said first pressurized fluid, said metering valve means being operably positioned in response to the pressure differential between said first pressurized fluid and said second pressurized fluid in a manner to reduce the flow of said first pressurized fluid to said inside piston working area as said pressure differential increases and to increase said flow as said differential decreases.

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