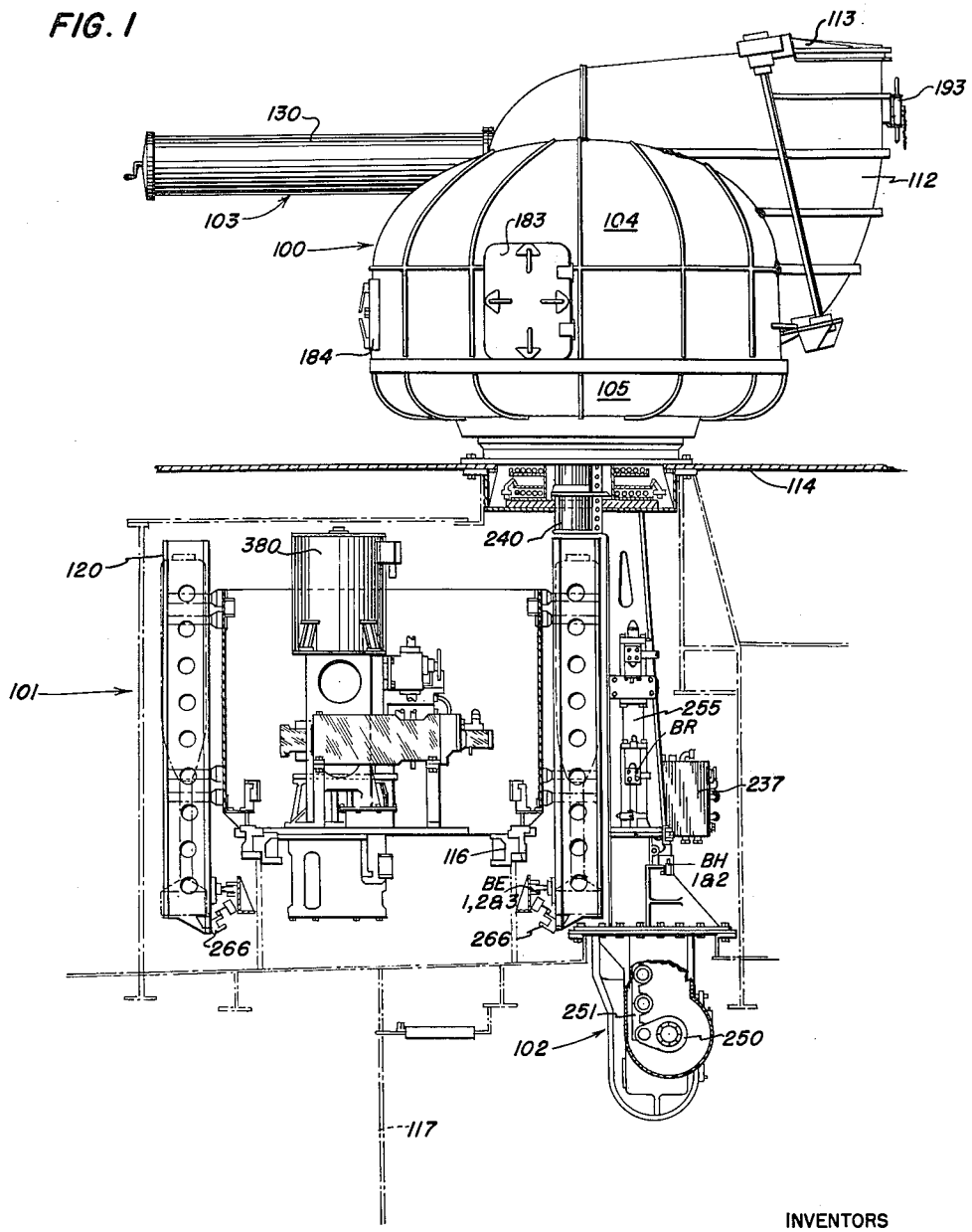
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FIG. 1



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ROCCO DeMASI

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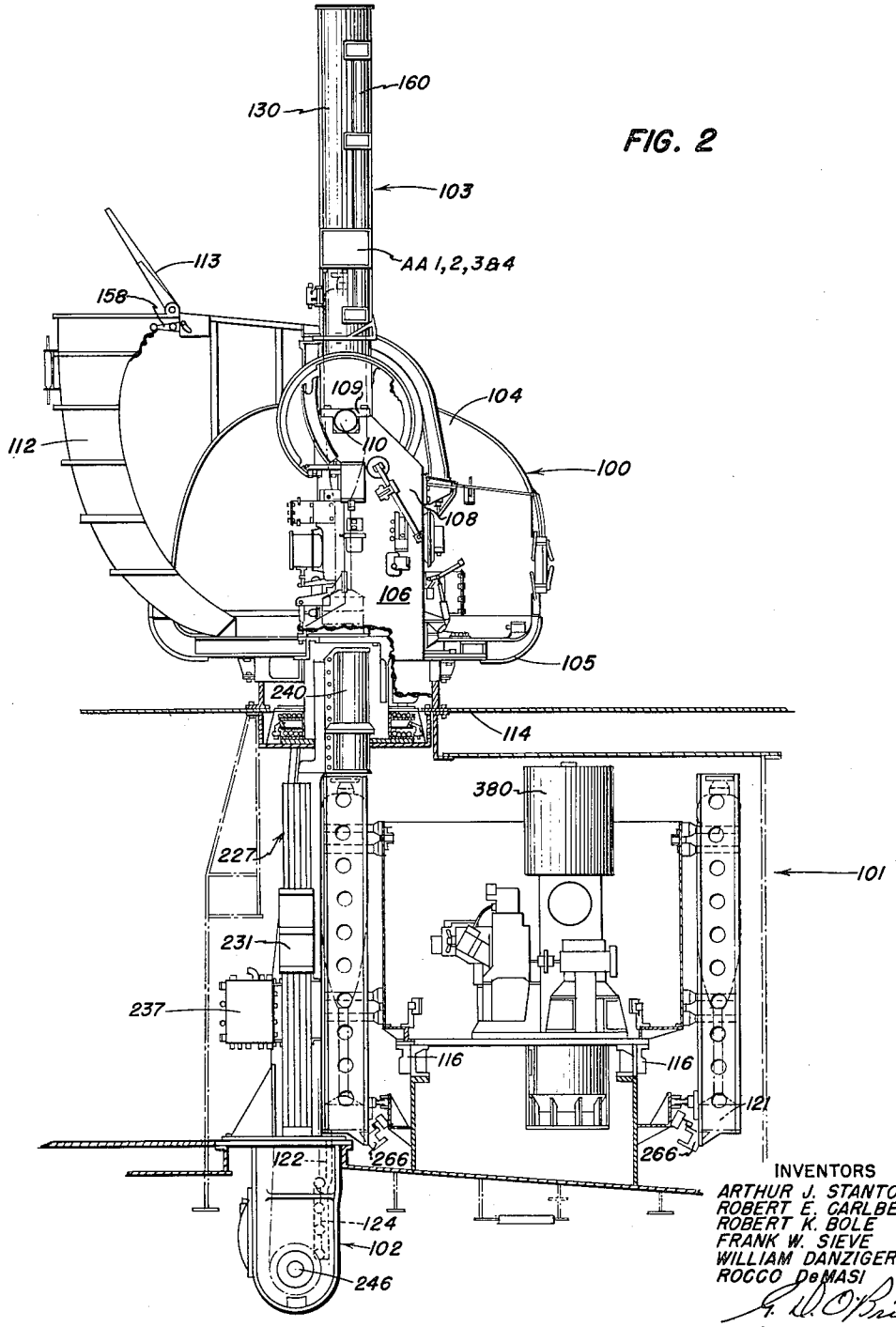
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FIG. 2



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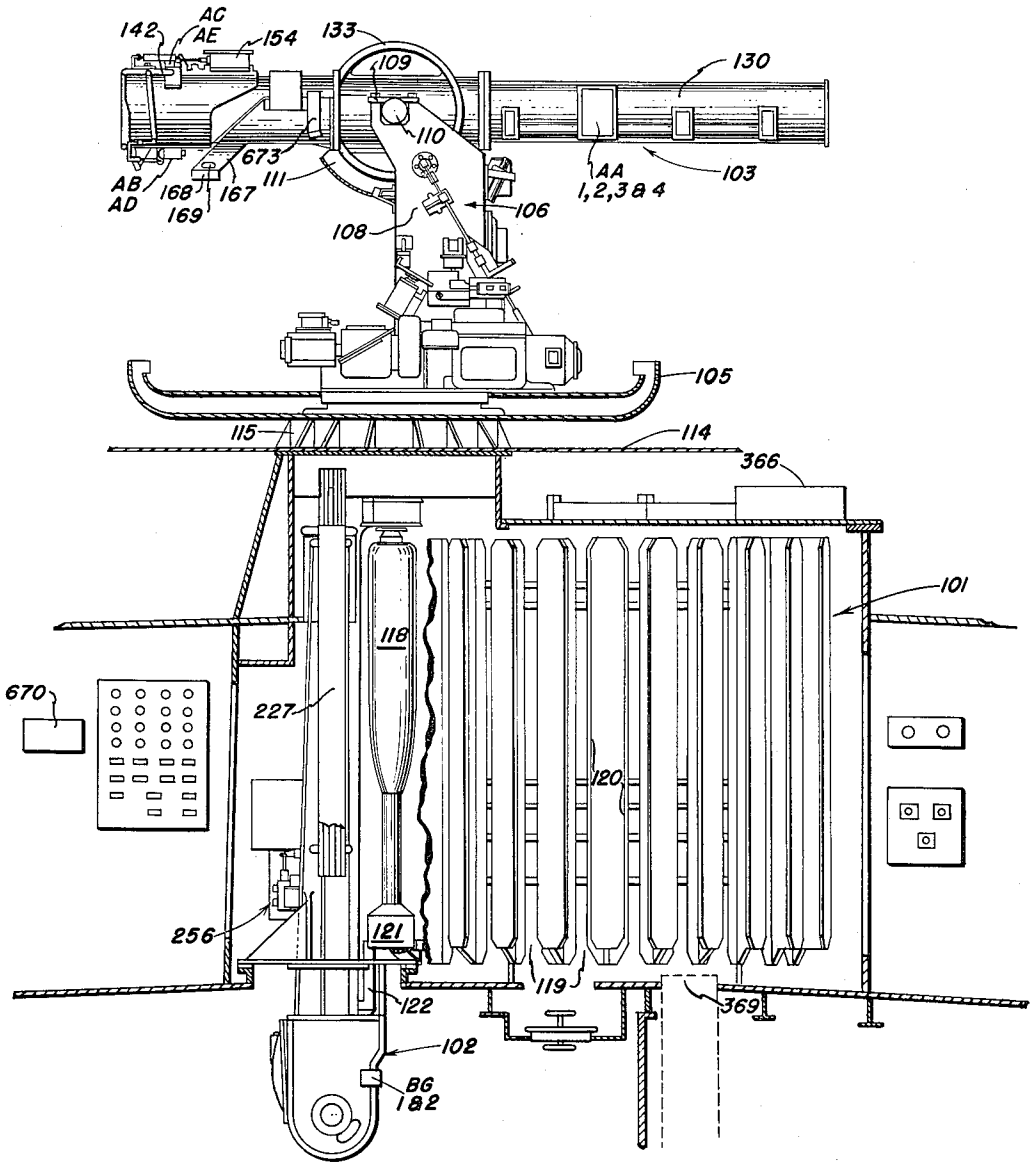


FIG. 3

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FIG. 4

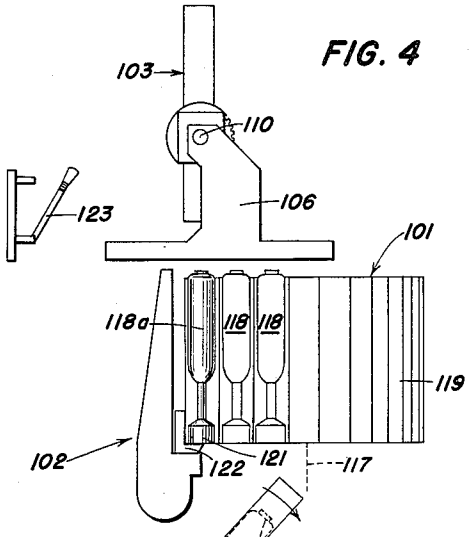


FIG. 5

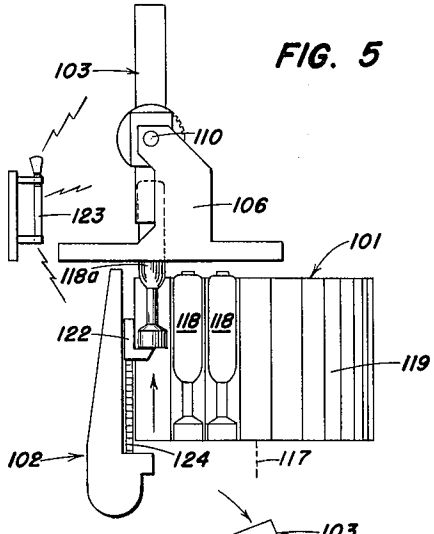


FIG. 6

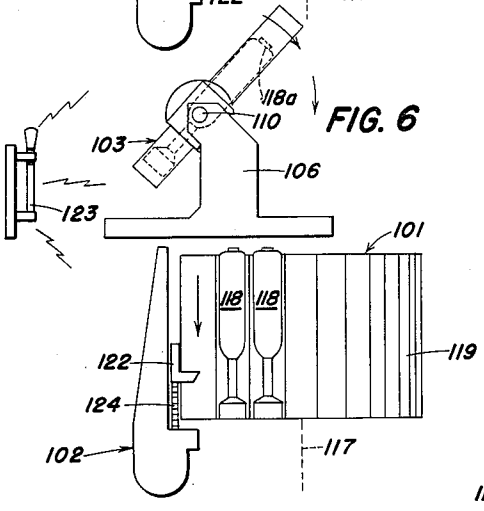


FIG. 7

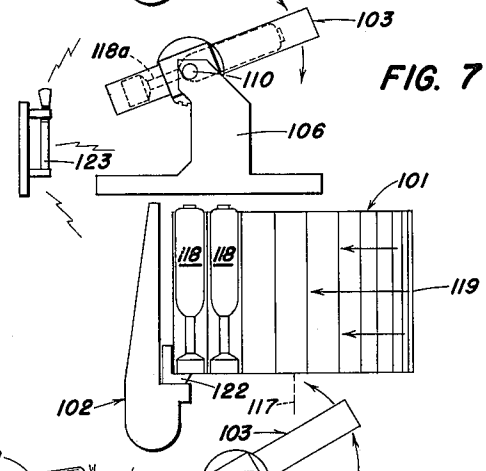


FIG. 8

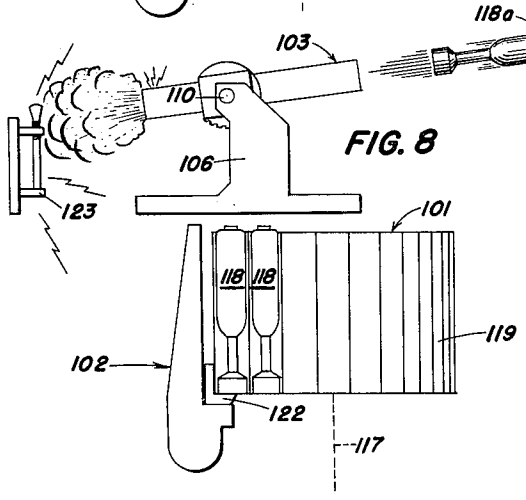
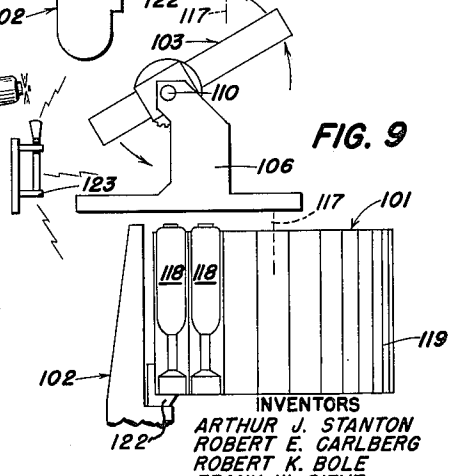


FIG. 9



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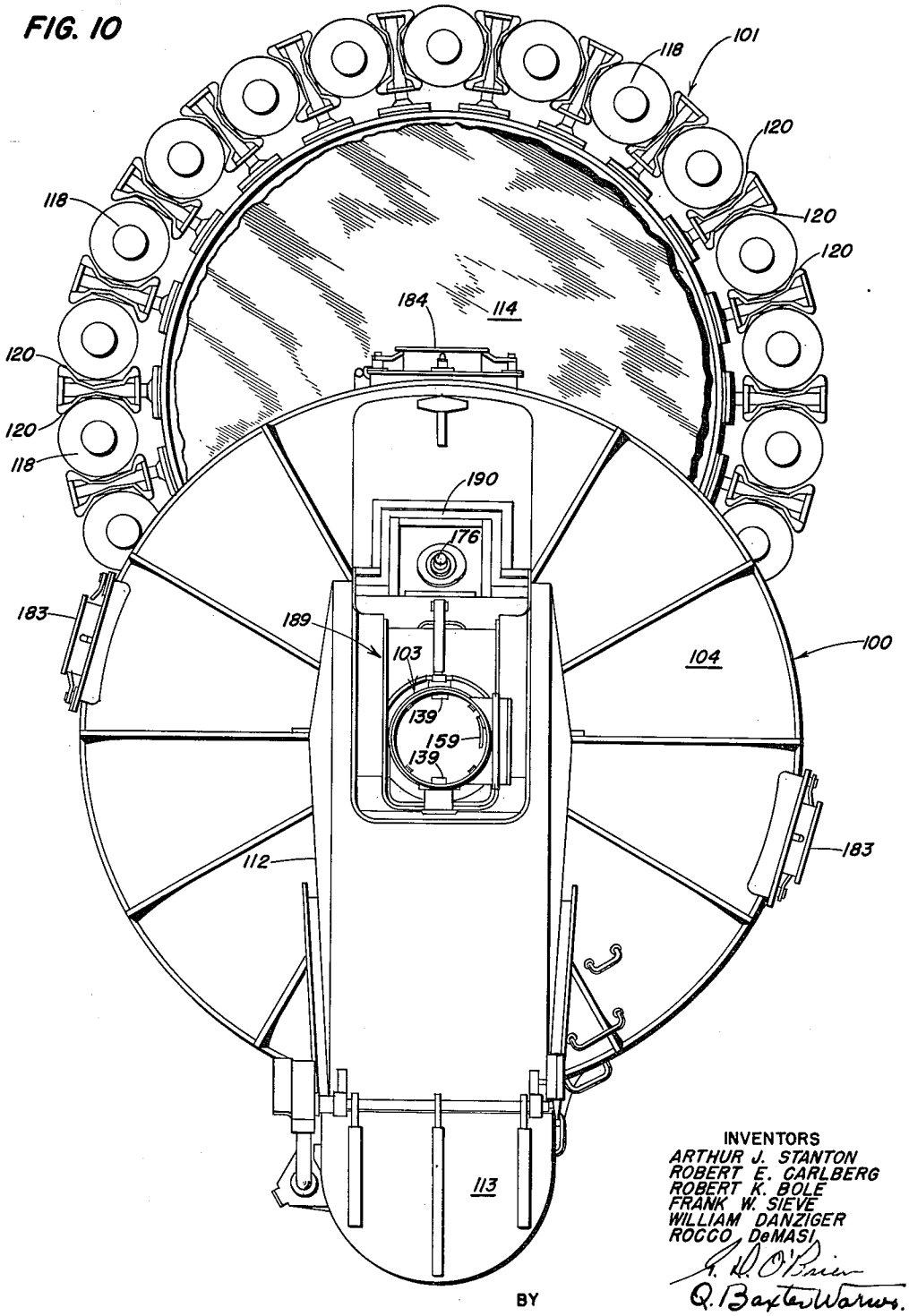
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FIG. 10



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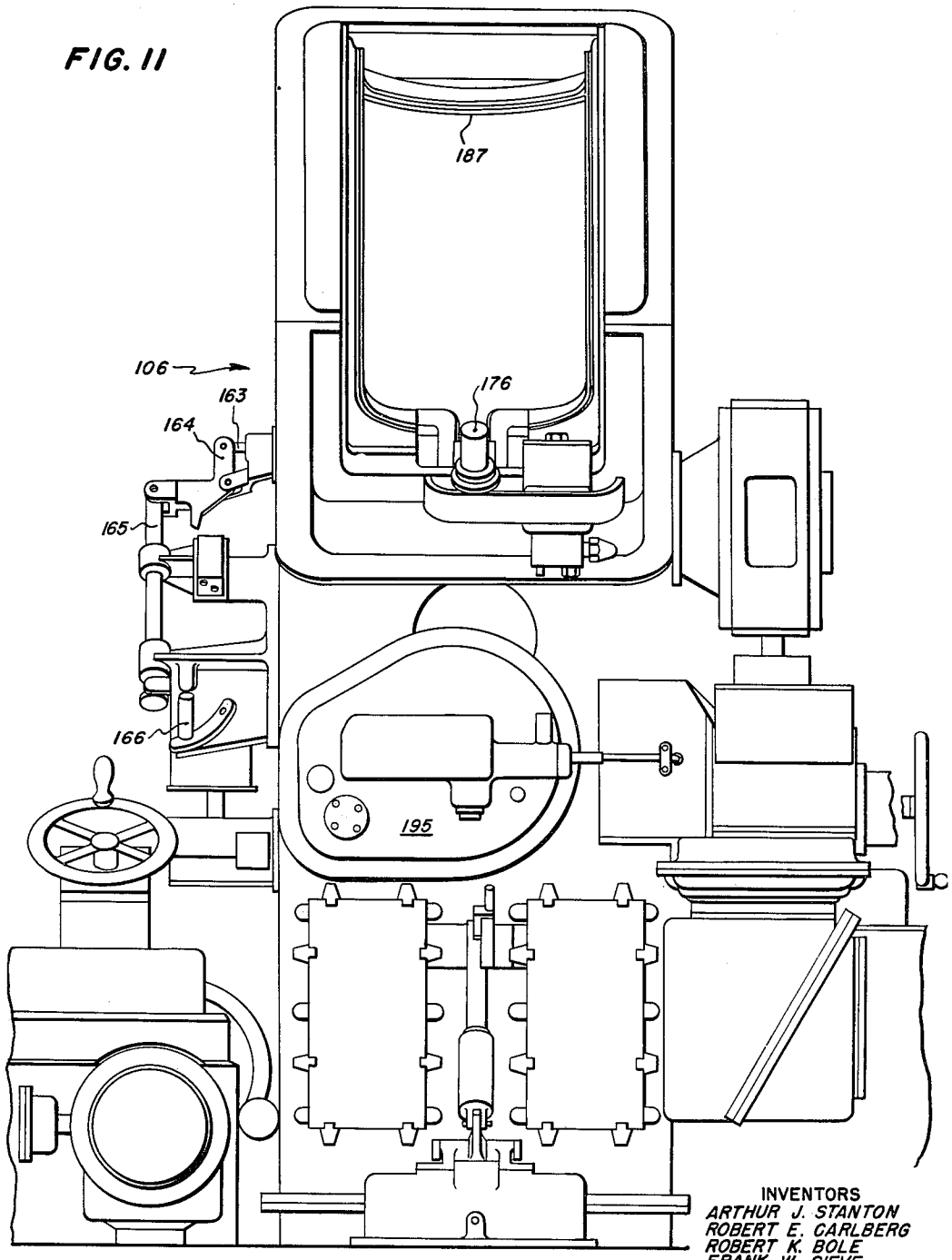
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FIG. 11



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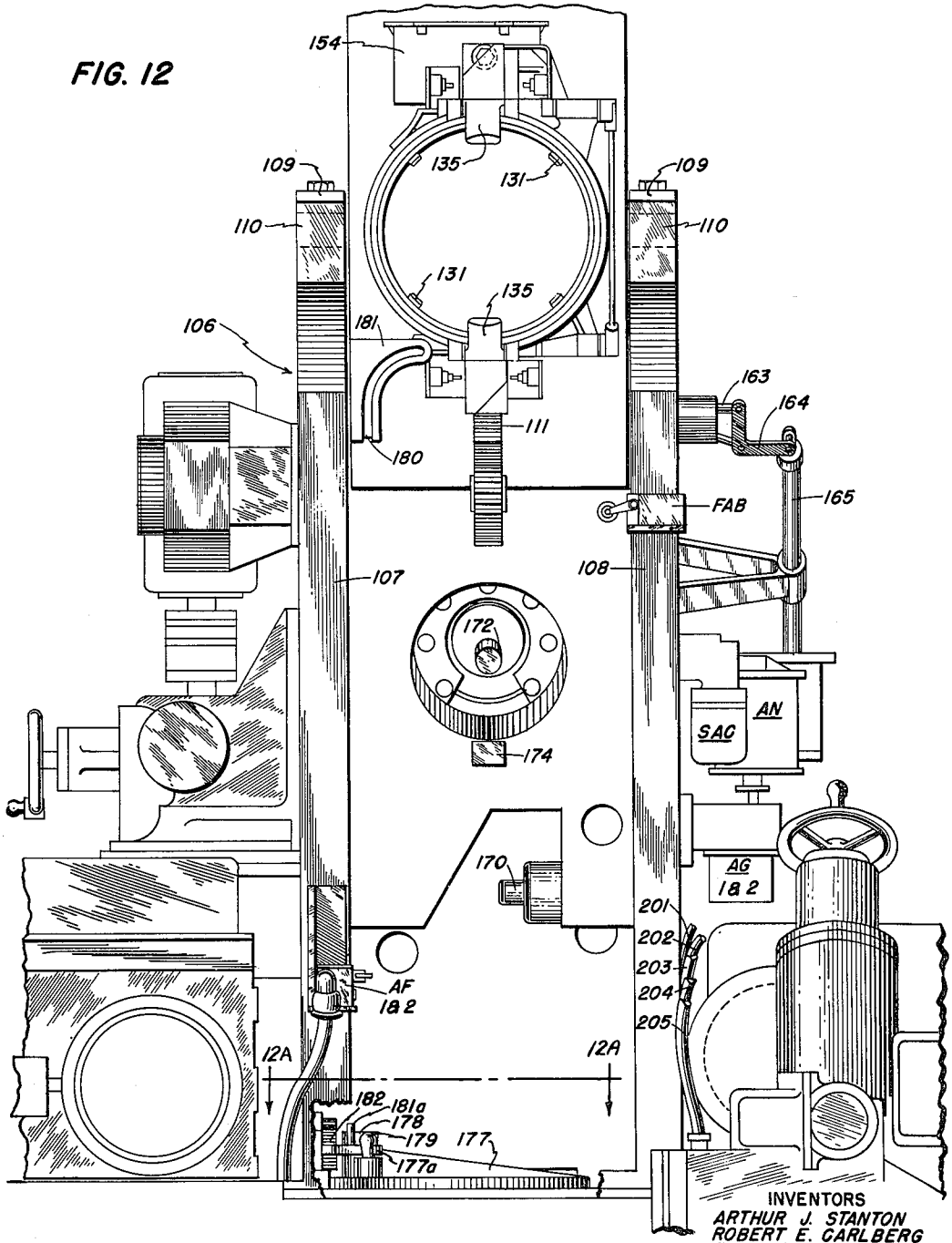
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FIG. 12



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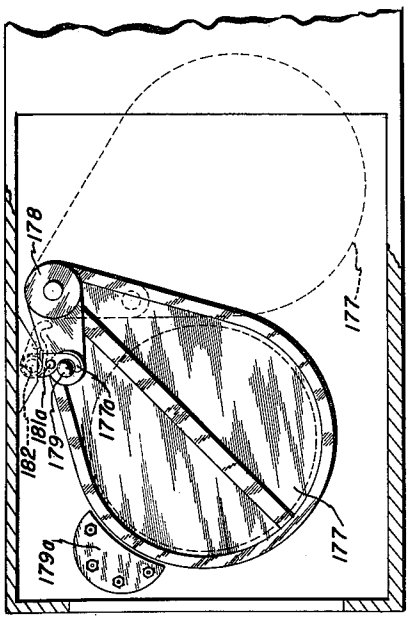


FIG. 12A

FIG. 13

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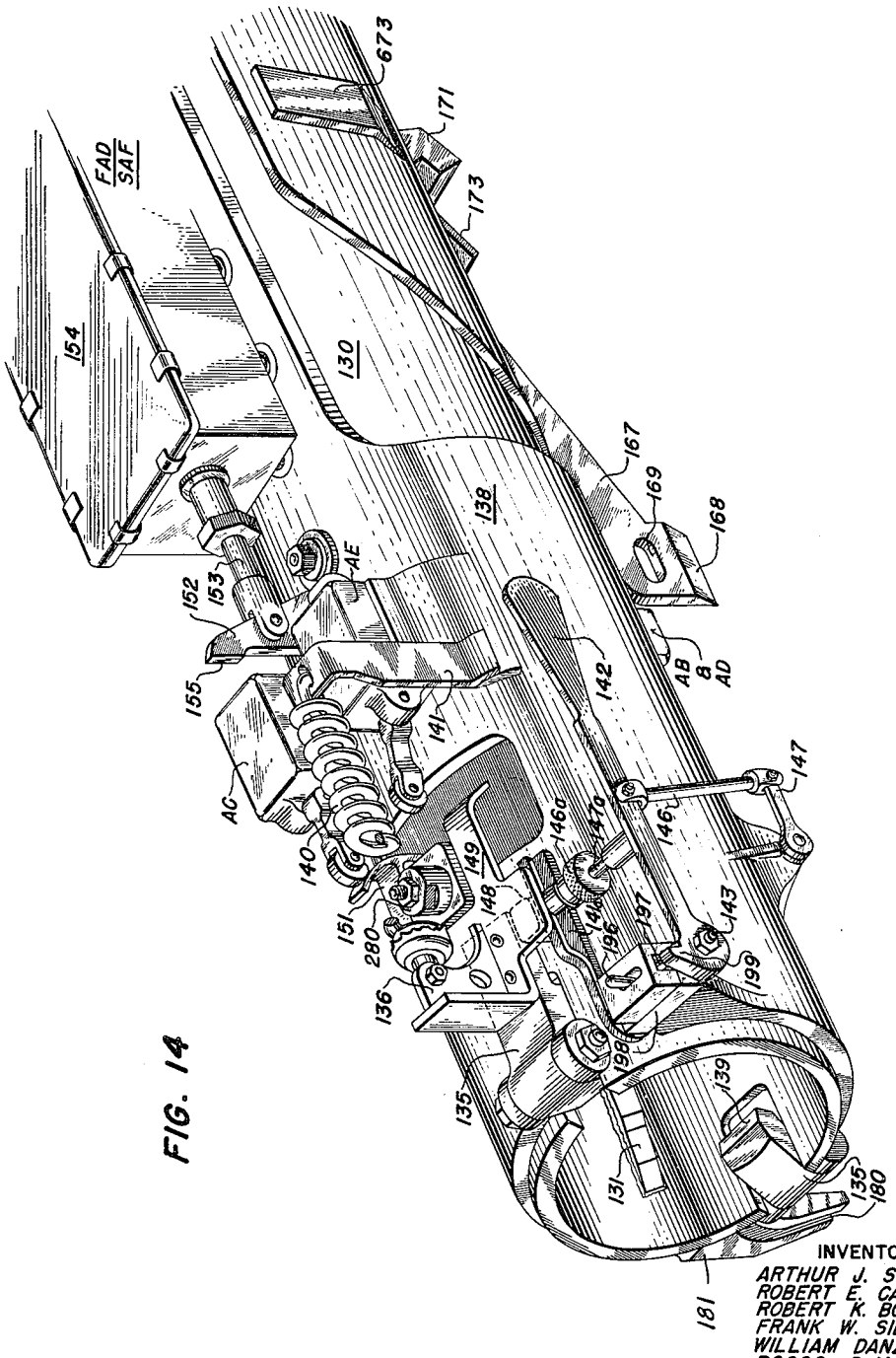


FIG. 14

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FIG. 15

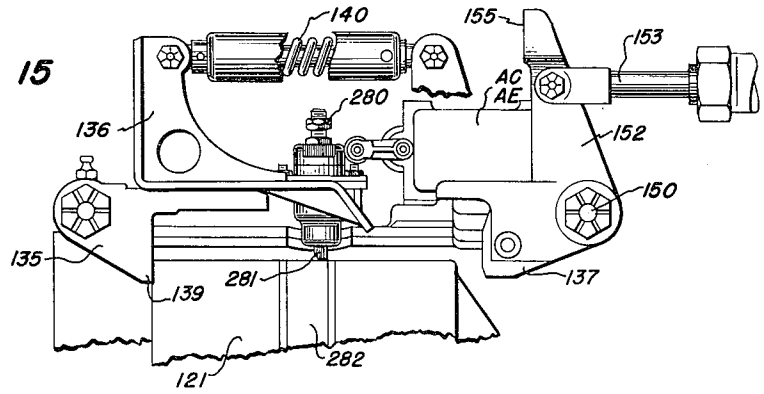
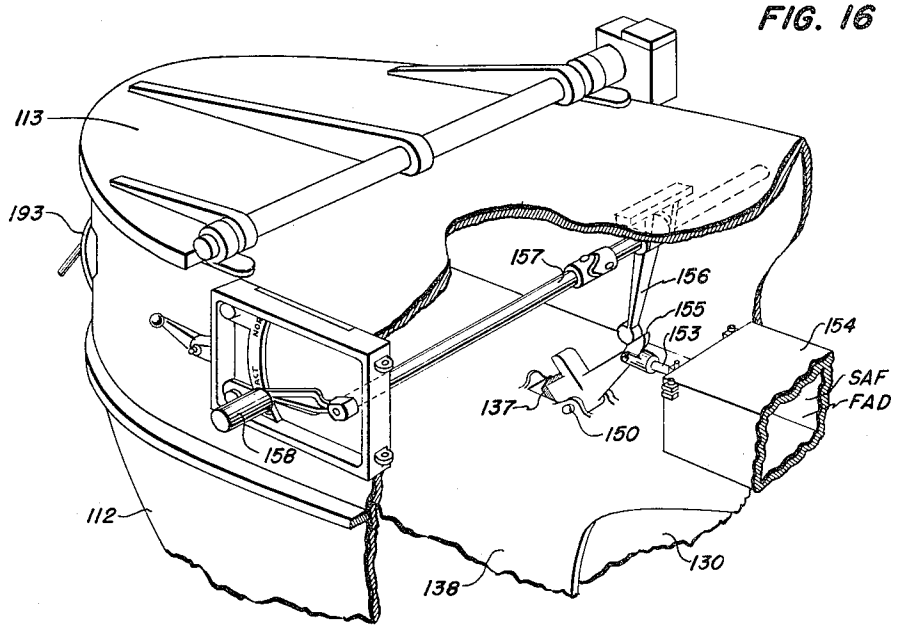


FIG. 16



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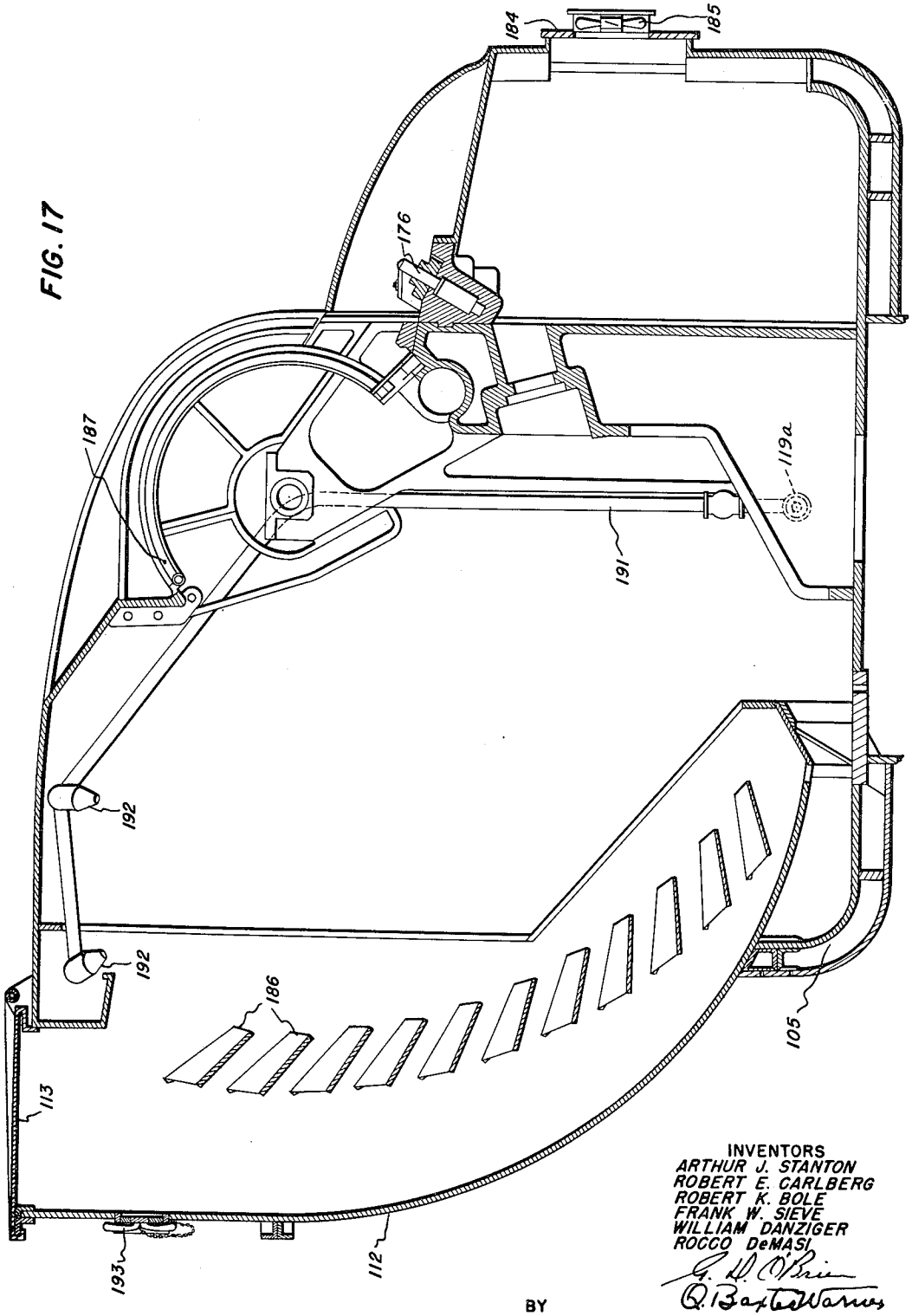
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FIG. 17



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FIG. 18.

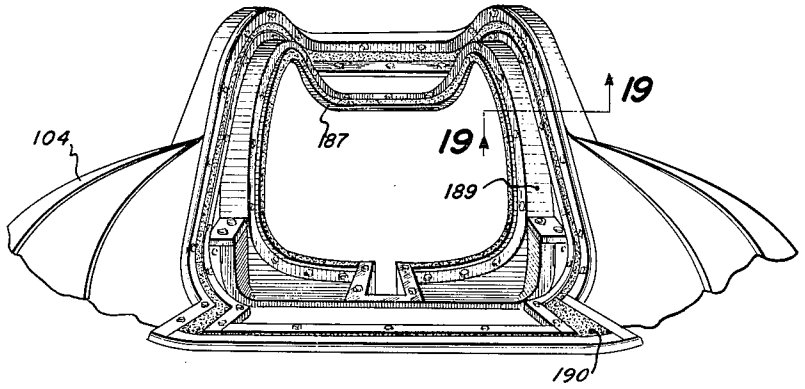


FIG. 19.

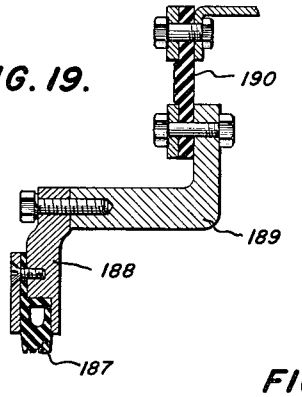


FIG. 20.

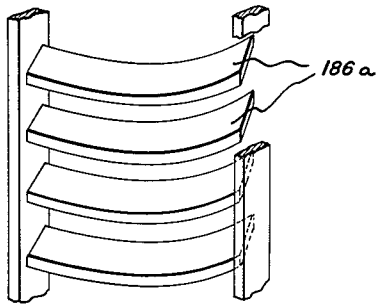
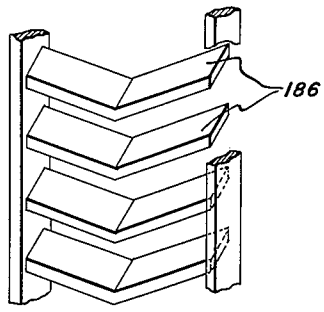


FIG. 21.



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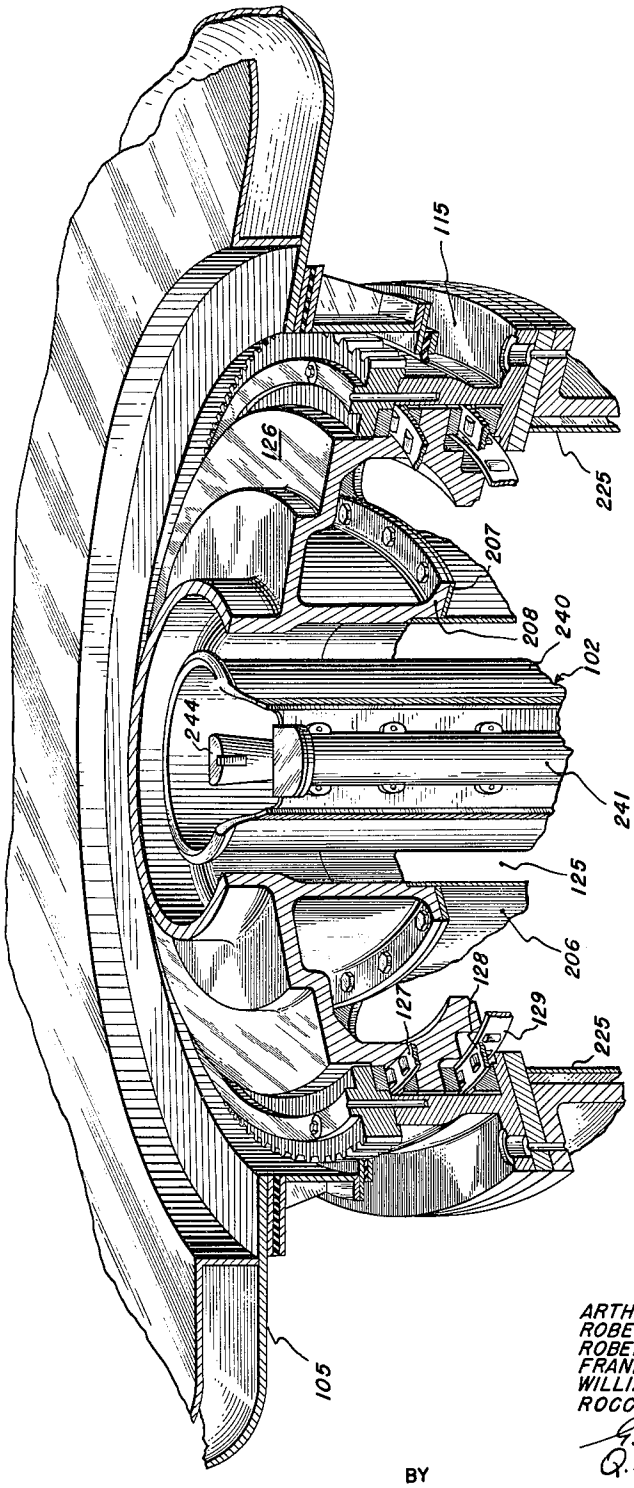
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FIG. 22



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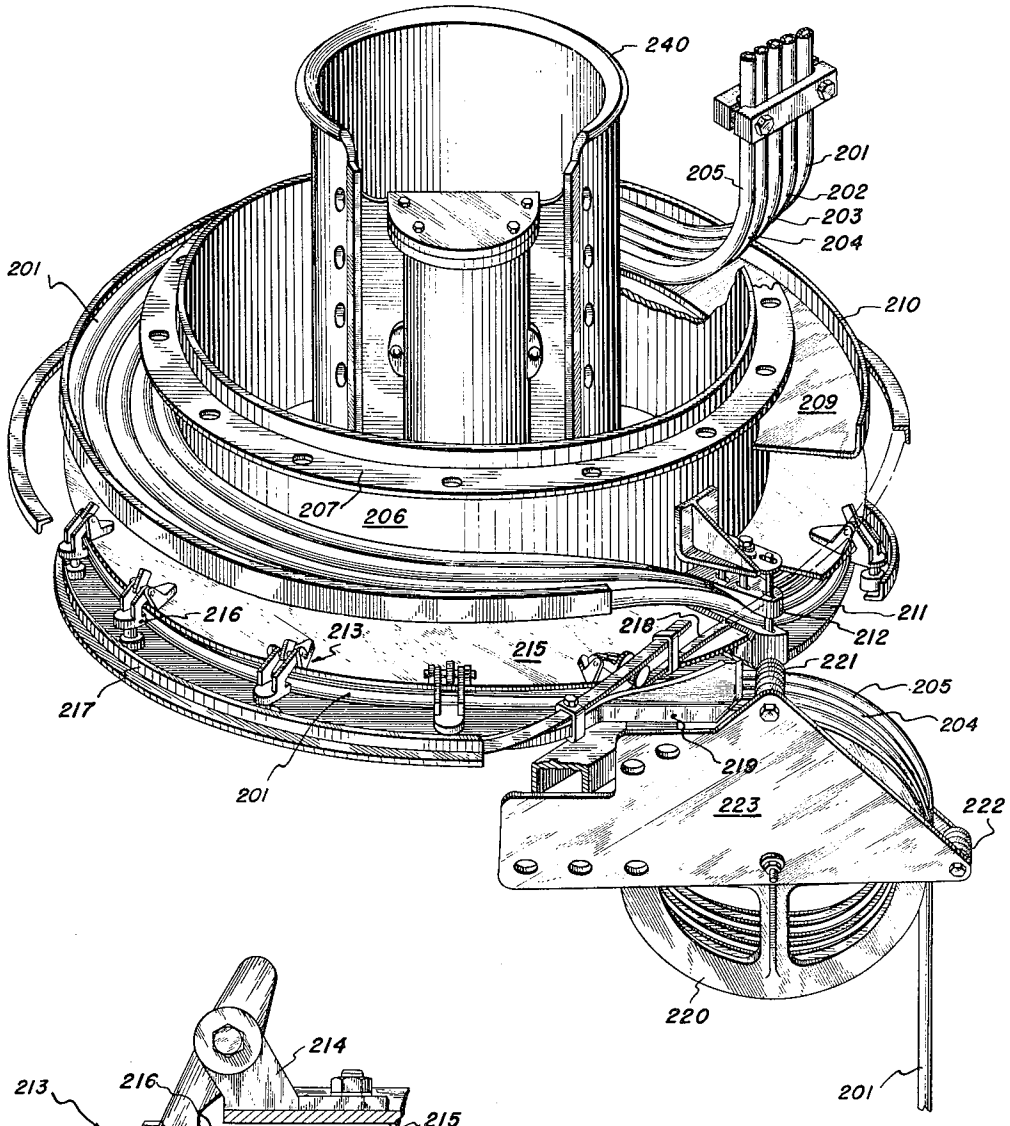
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FIG. 23.



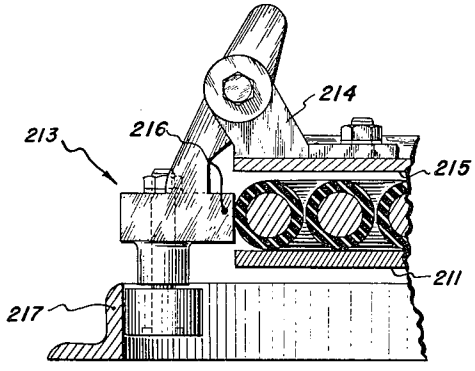


FIG. 23A

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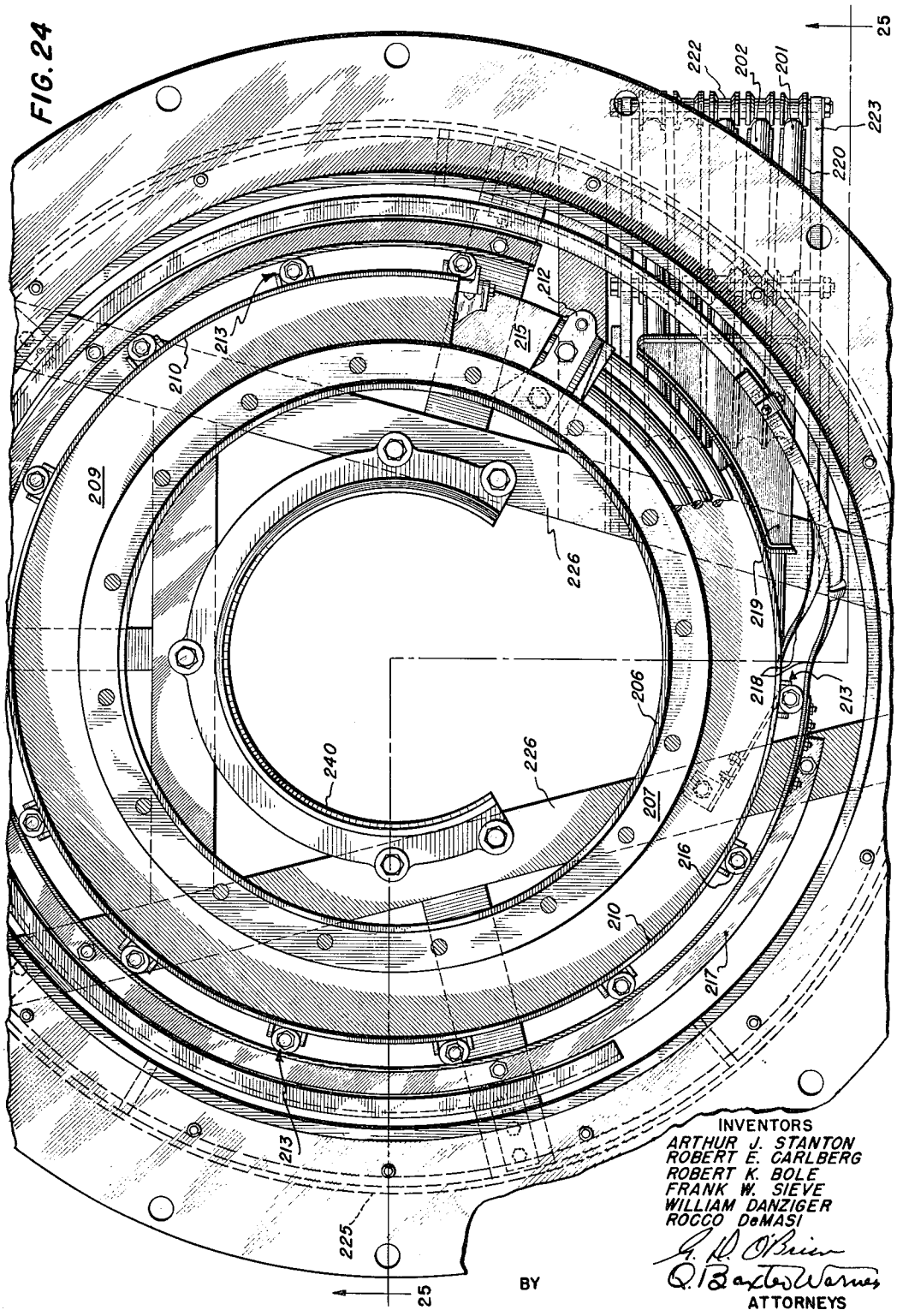
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FIG. 24



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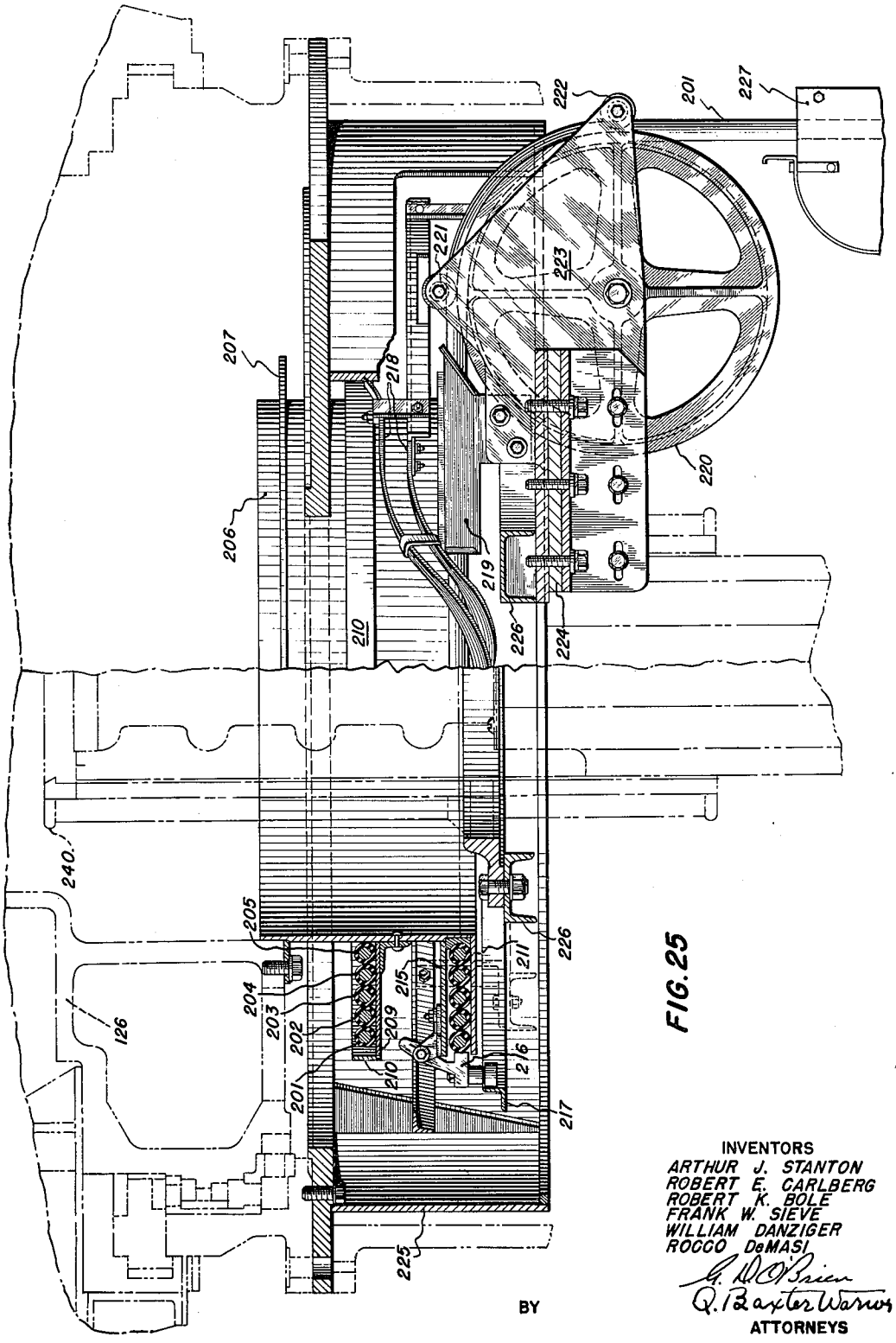


FIG. 25

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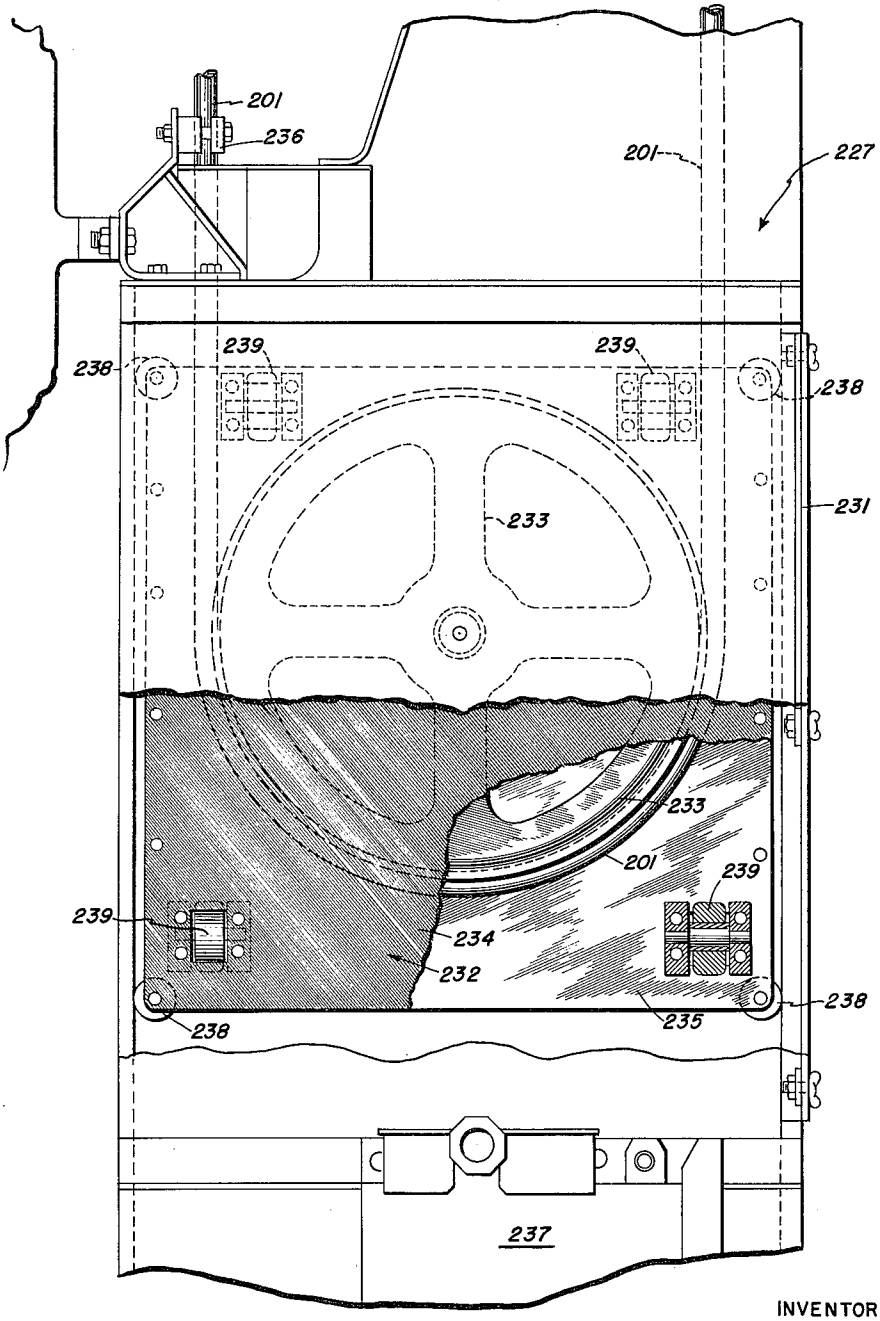


FIG. 26

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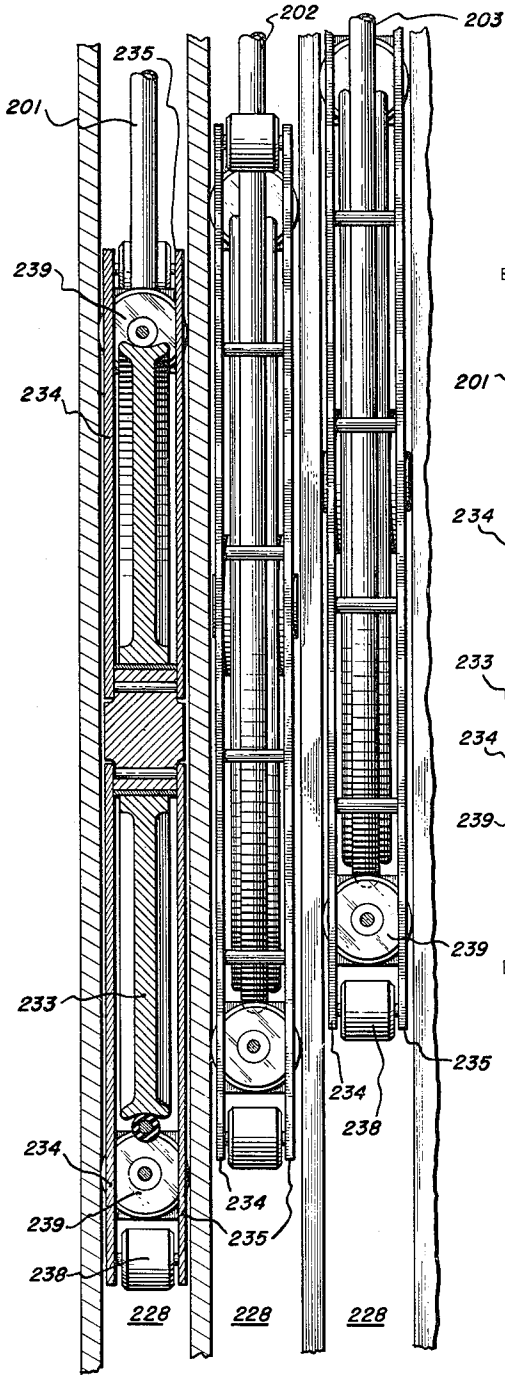


FIG. 27

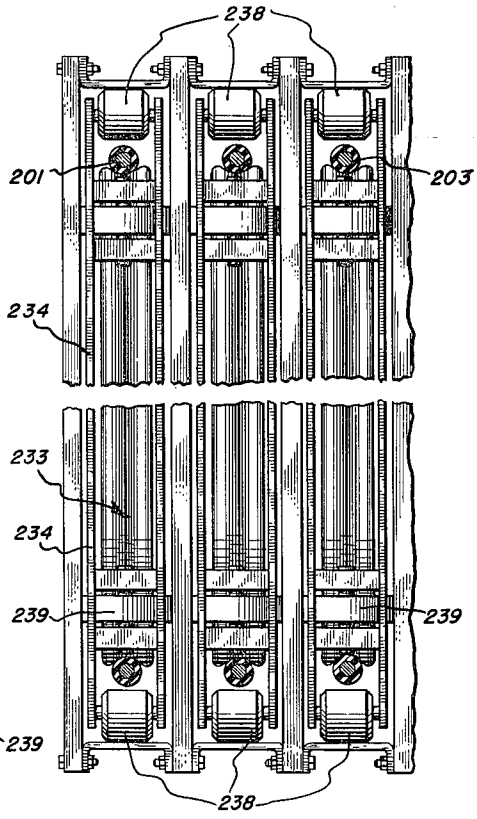


FIG. 28

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FIG. 30

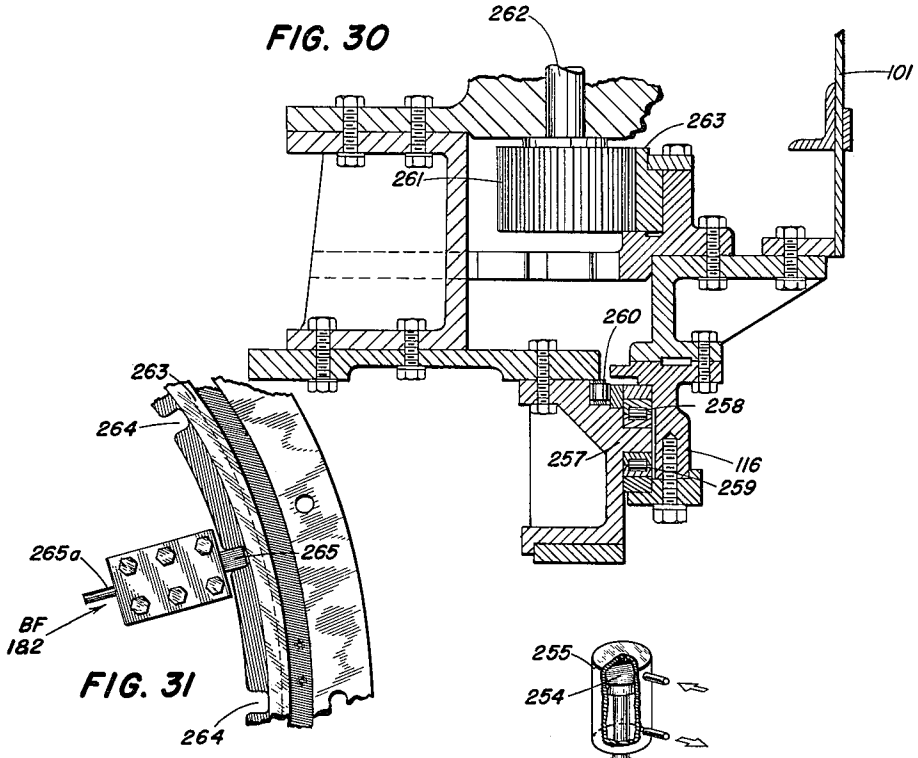


FIG. 31

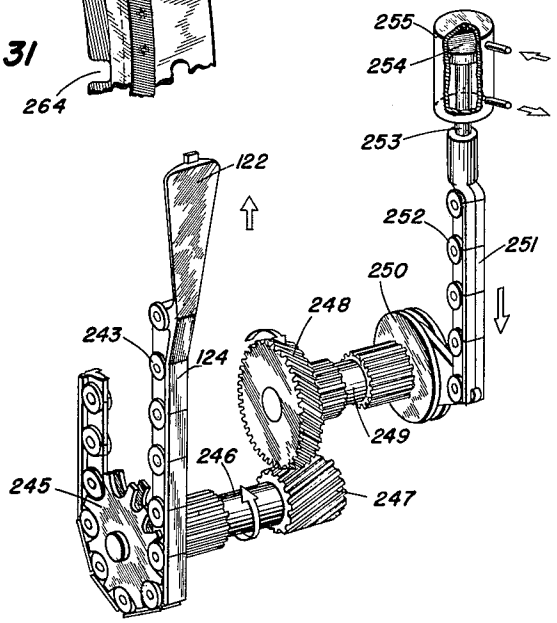


FIG. 29

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FIG. 33

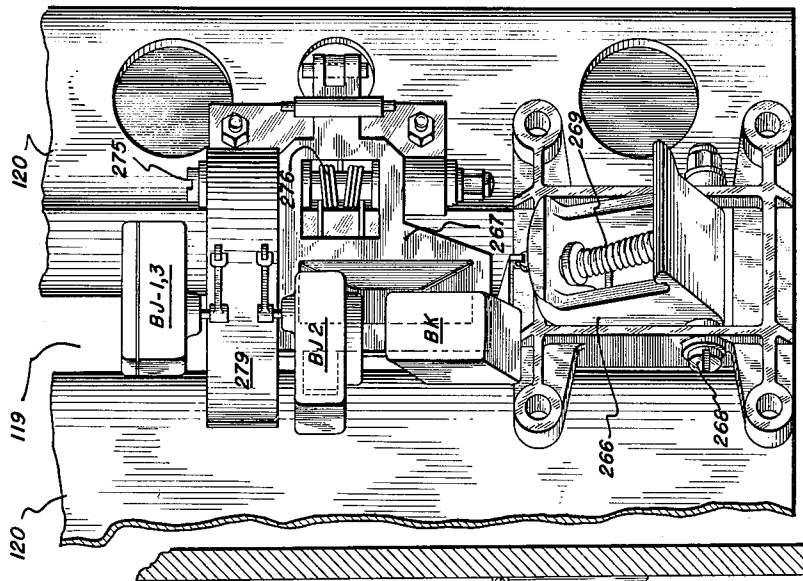
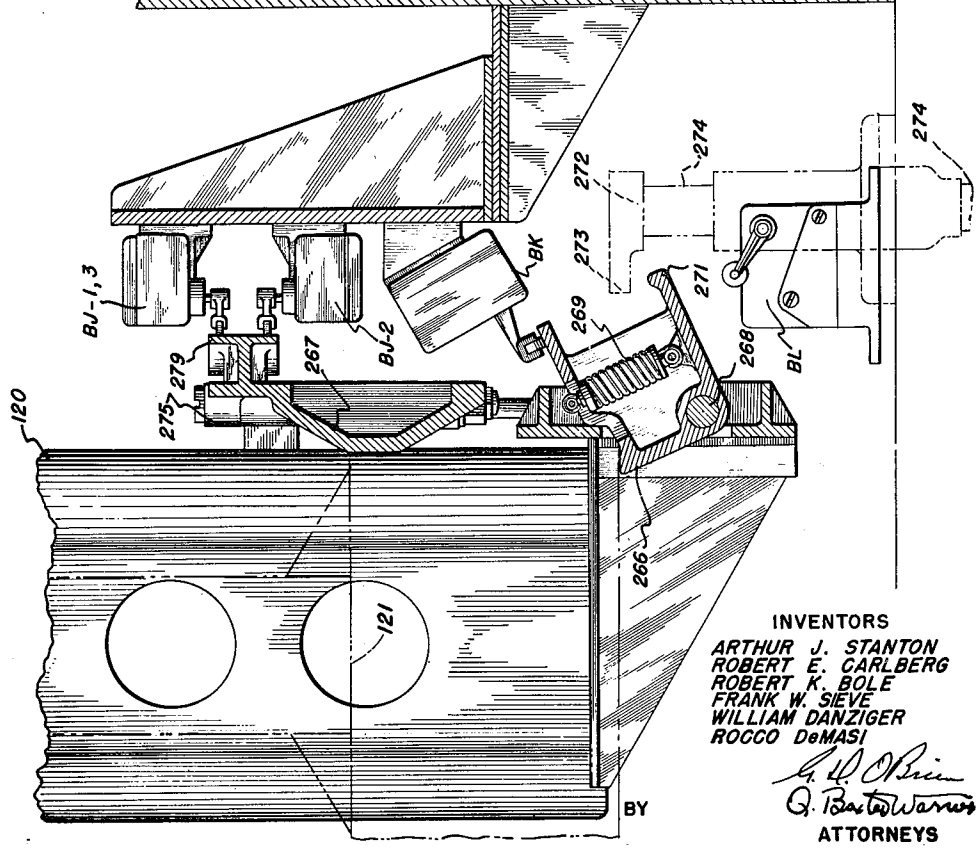


FIG. 32



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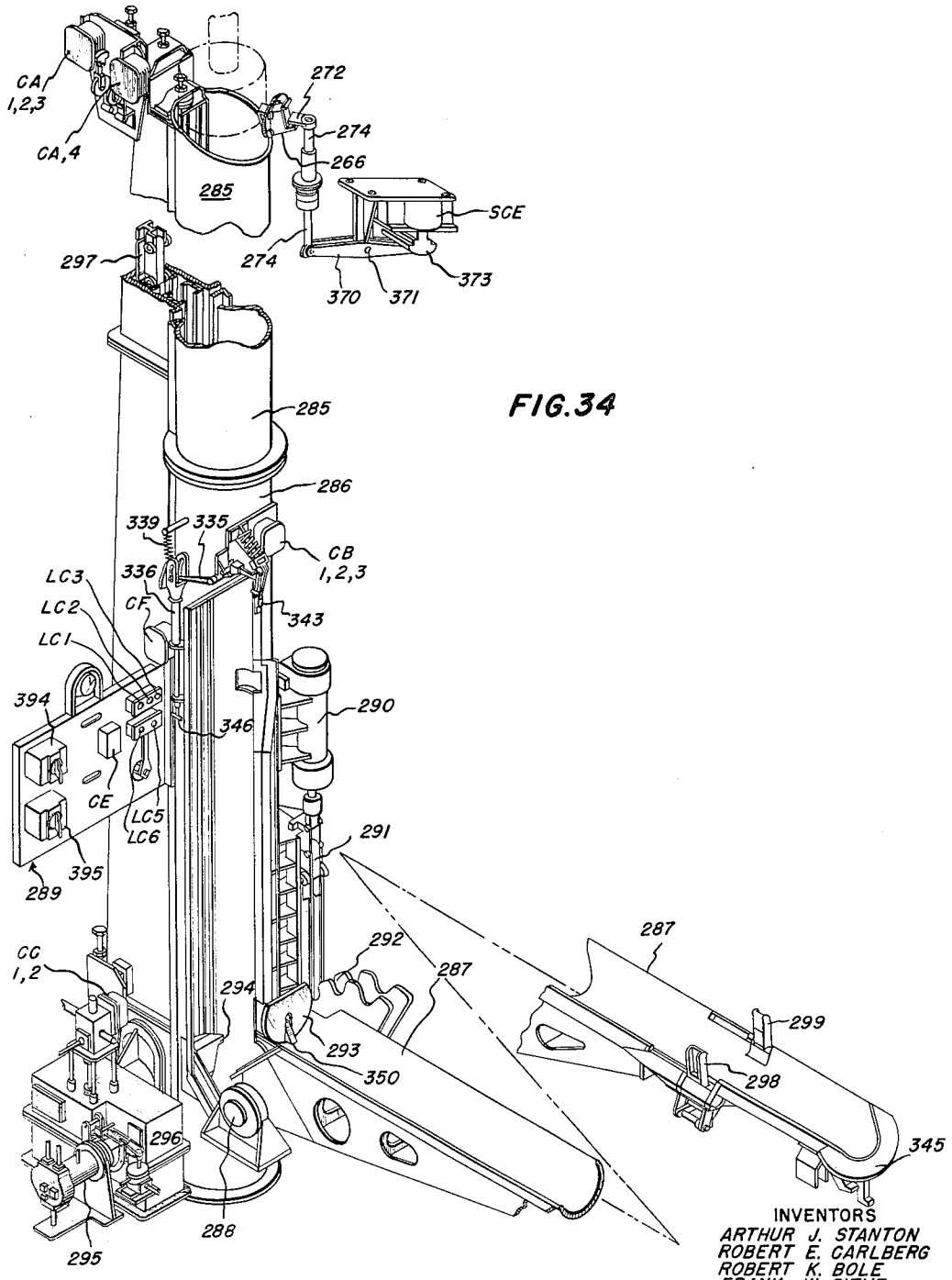


FIG. 34

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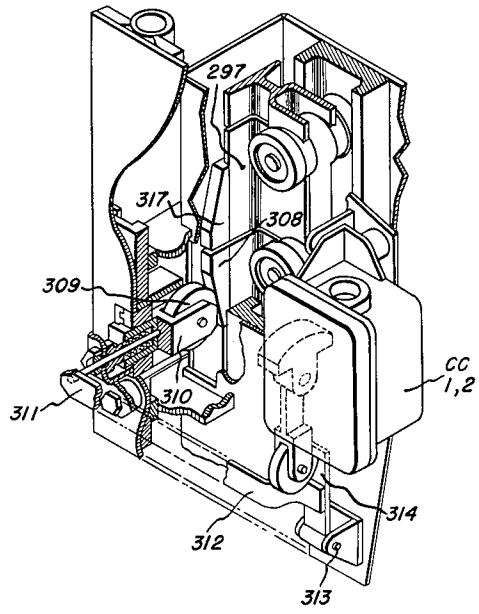
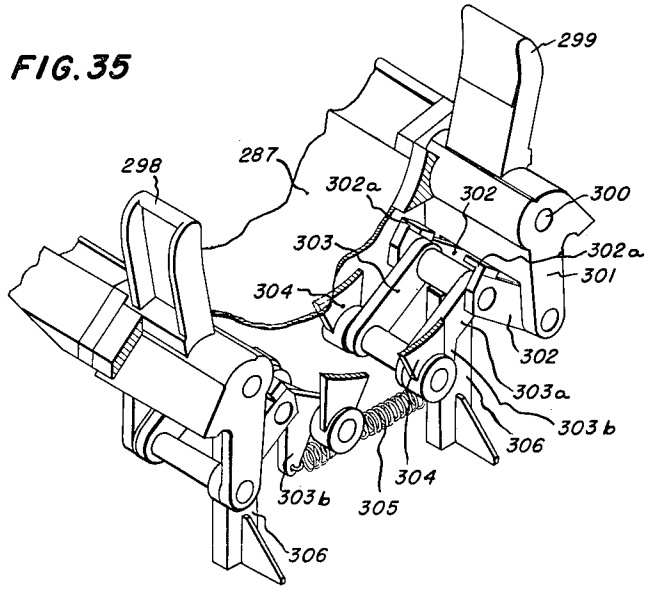


FIG. 36

FIG. 35



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FIG. 37

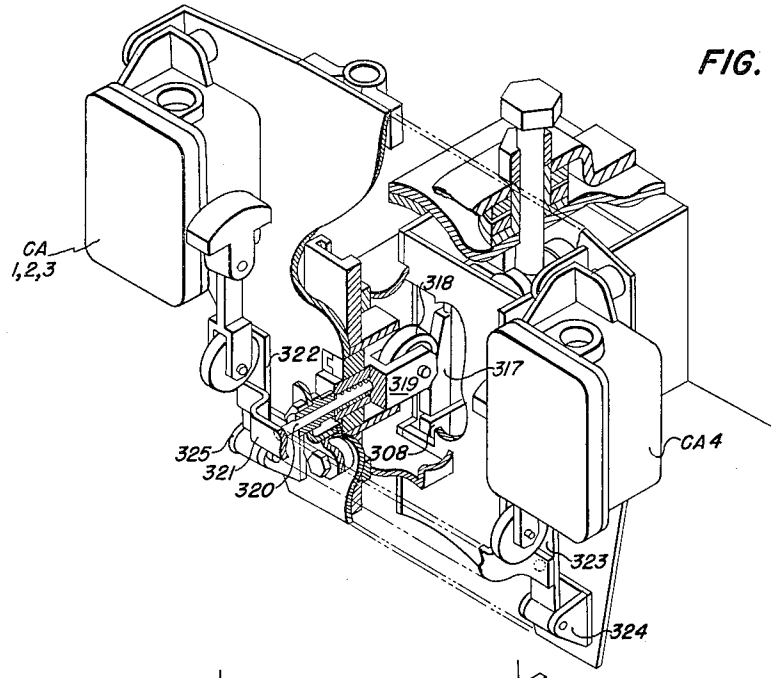
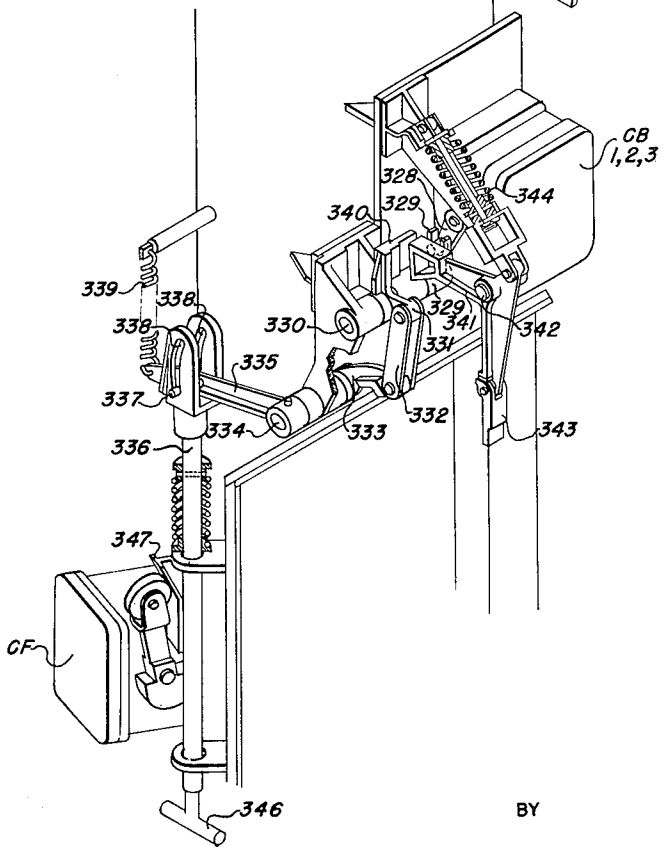


FIG. 38



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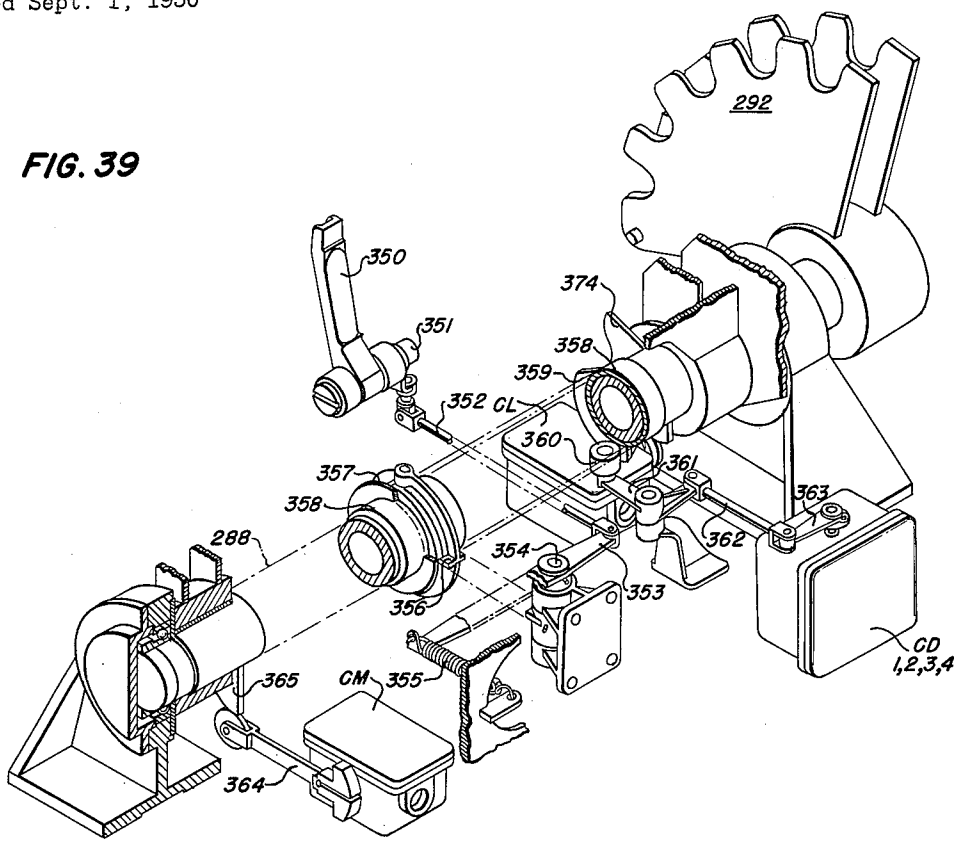
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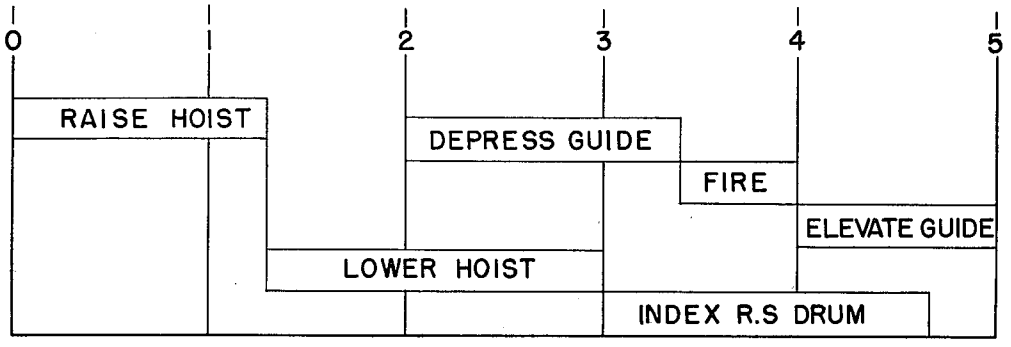
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MISSILE LAUNCHER

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FIG. 39





TIME CYCLE OF OPERATIONS

FIG. 40

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MISSILE LAUNCHER

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FIG. 42

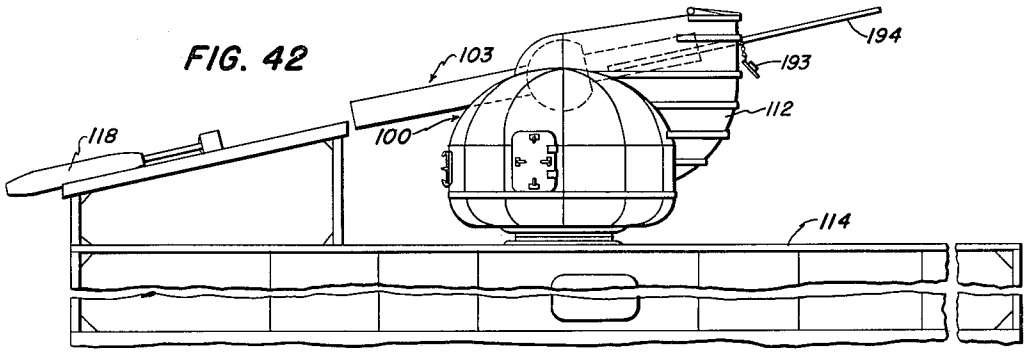
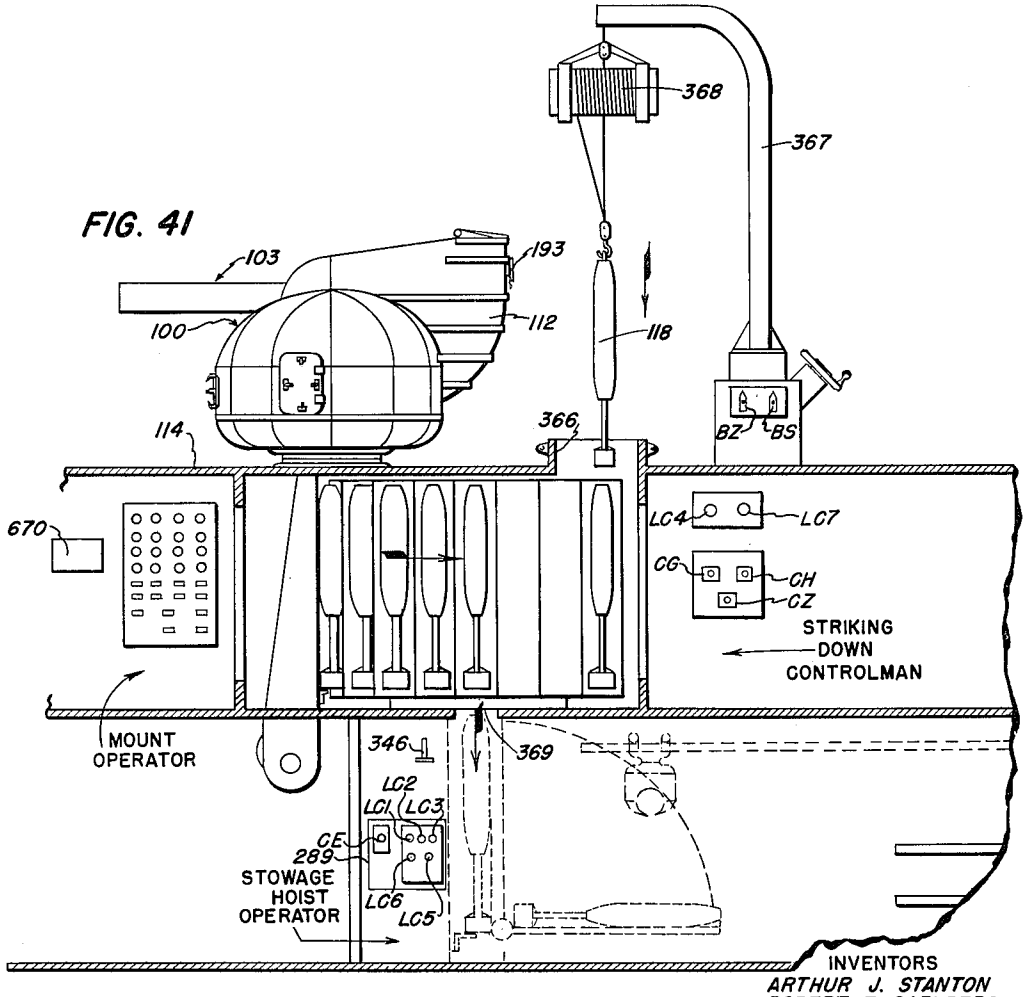


FIG. 41



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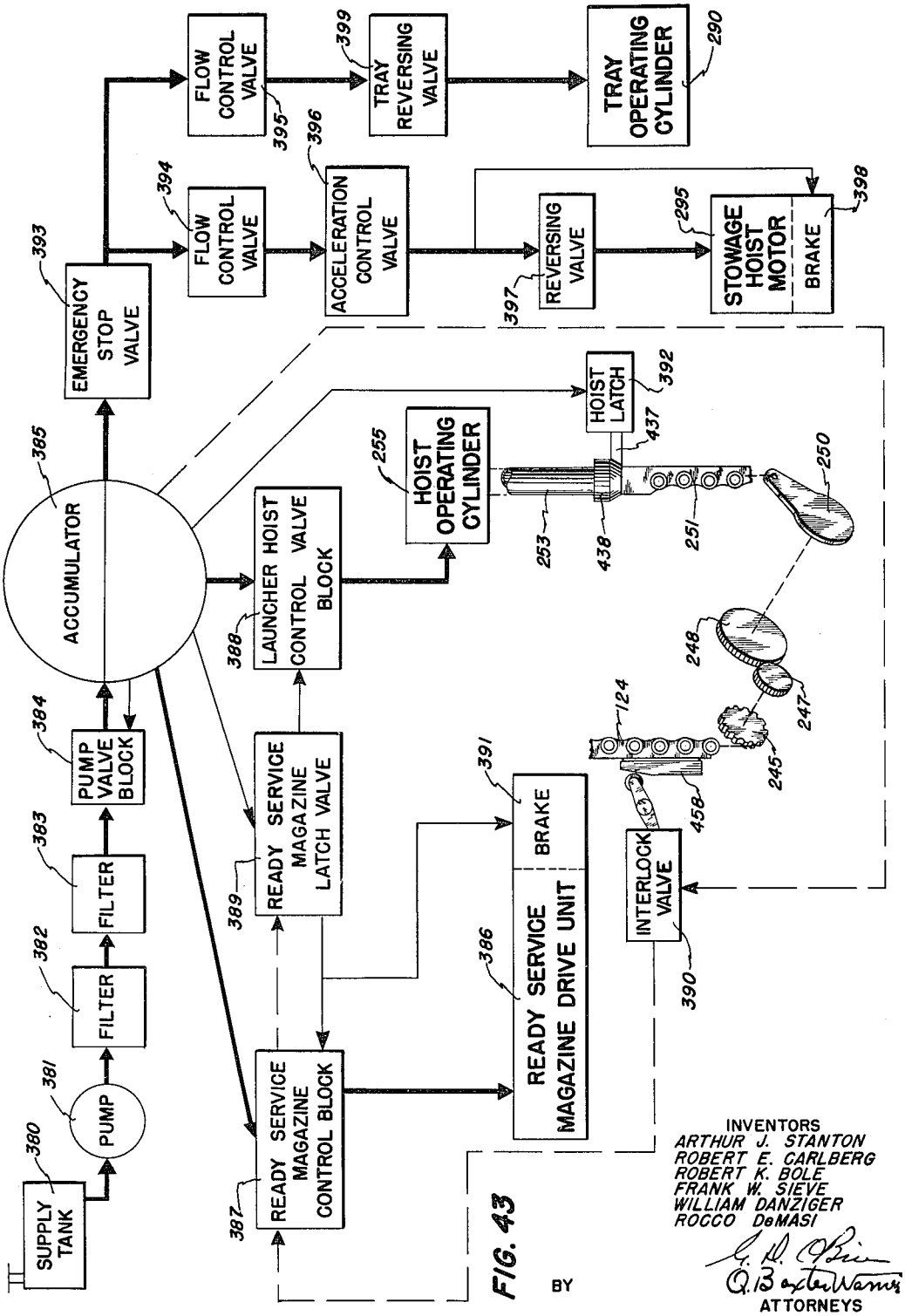


FIG. 43

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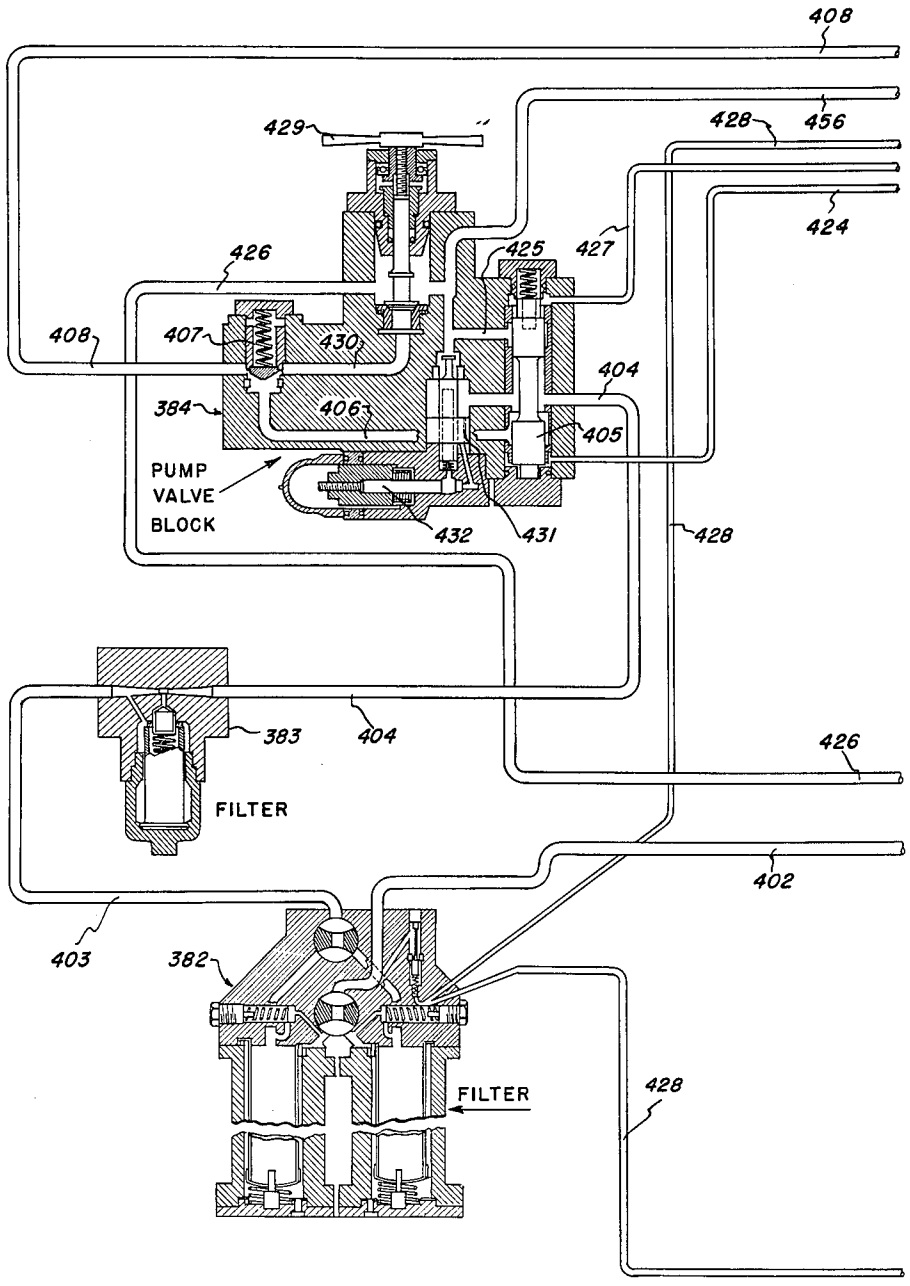


FIG. 44

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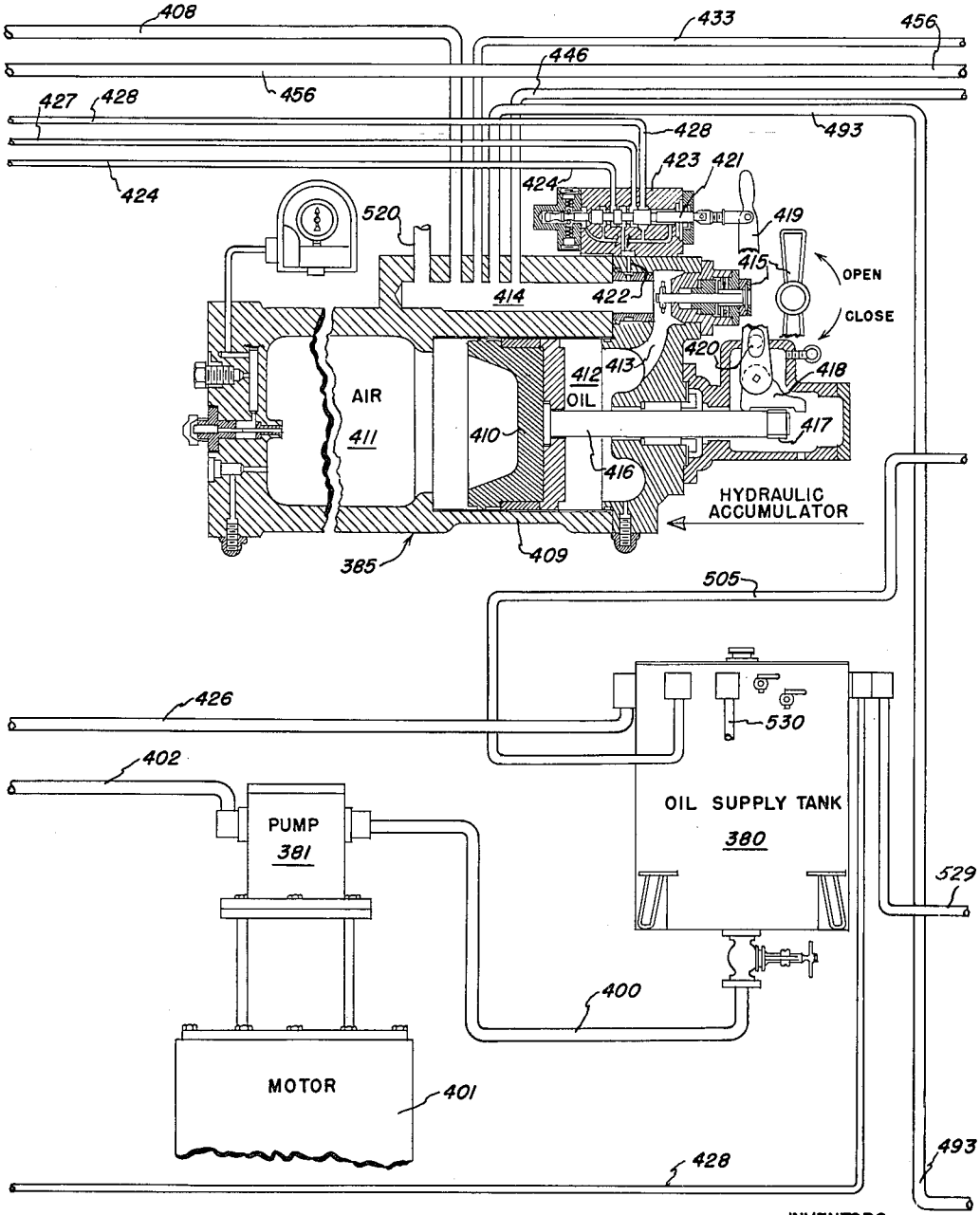


FIG. 45

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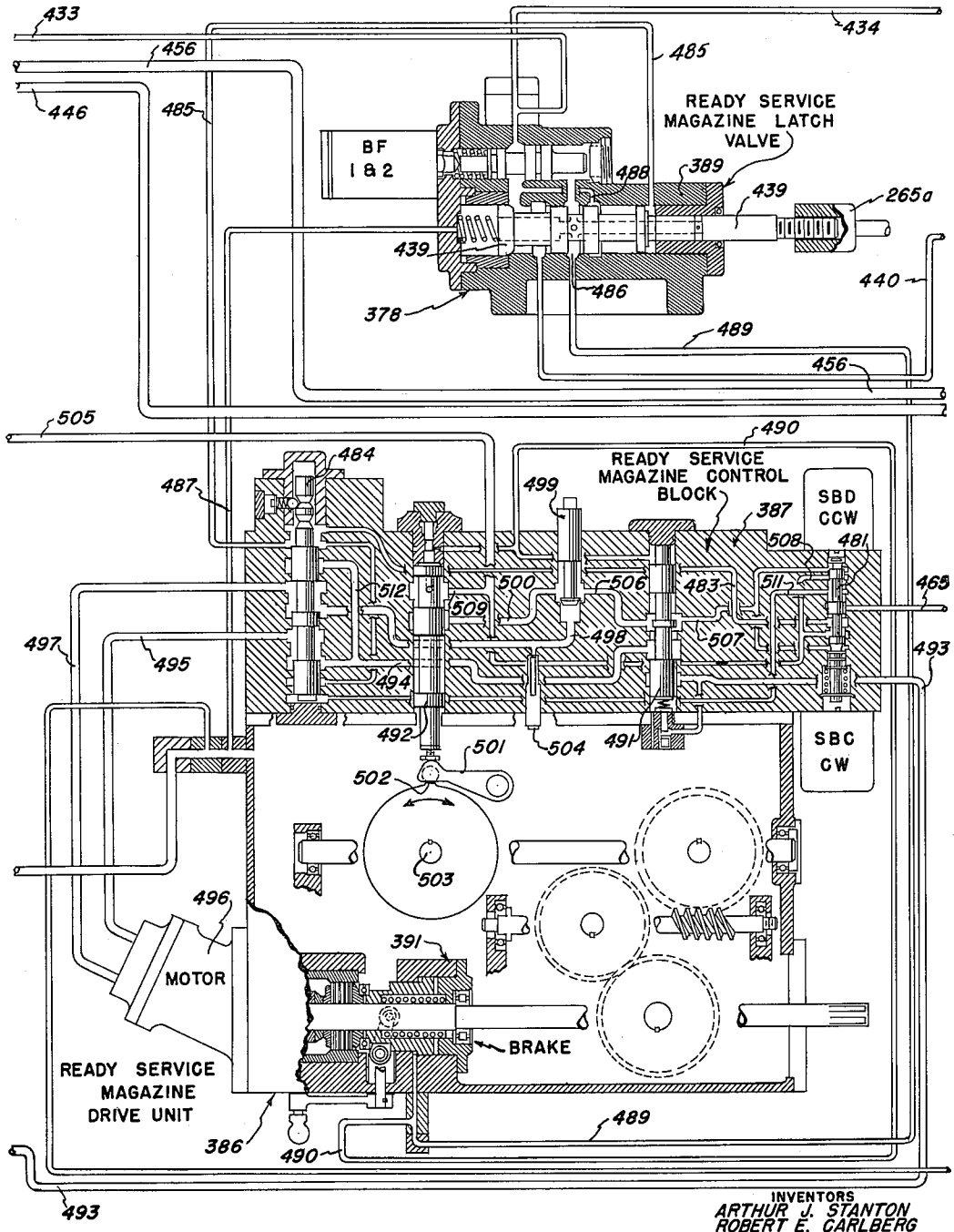


FIG. 46

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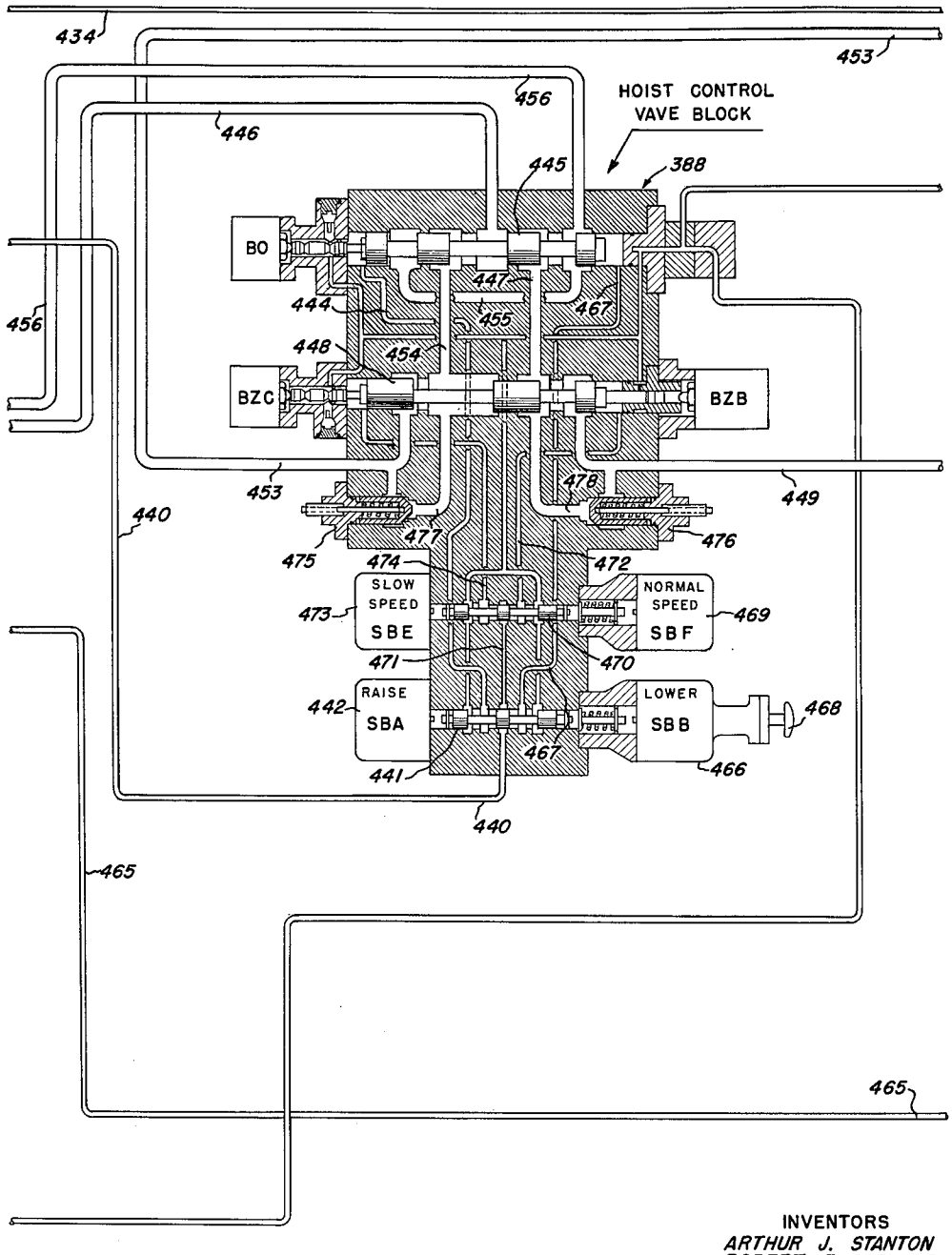


FIG. 47

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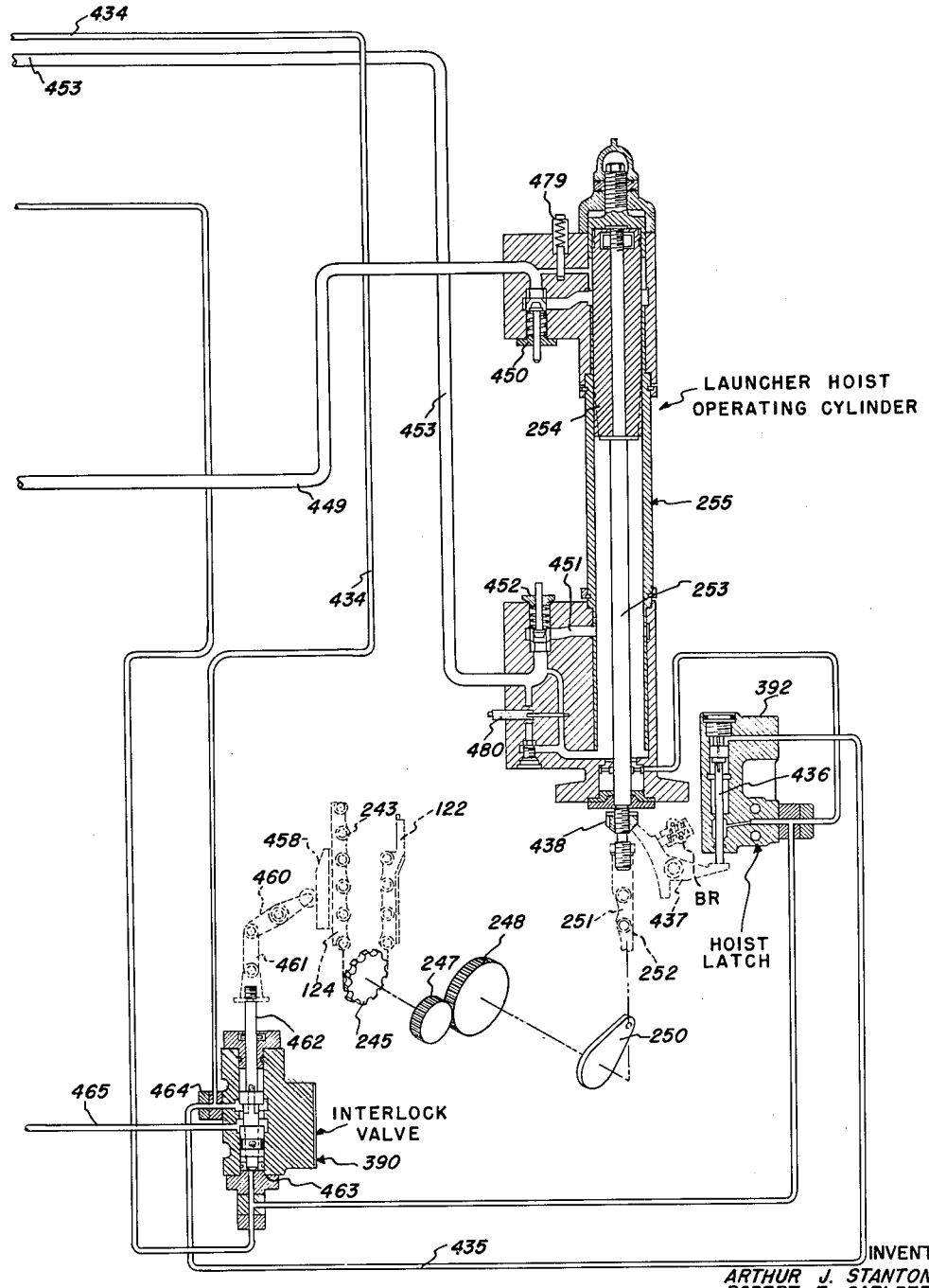


FIG. 48

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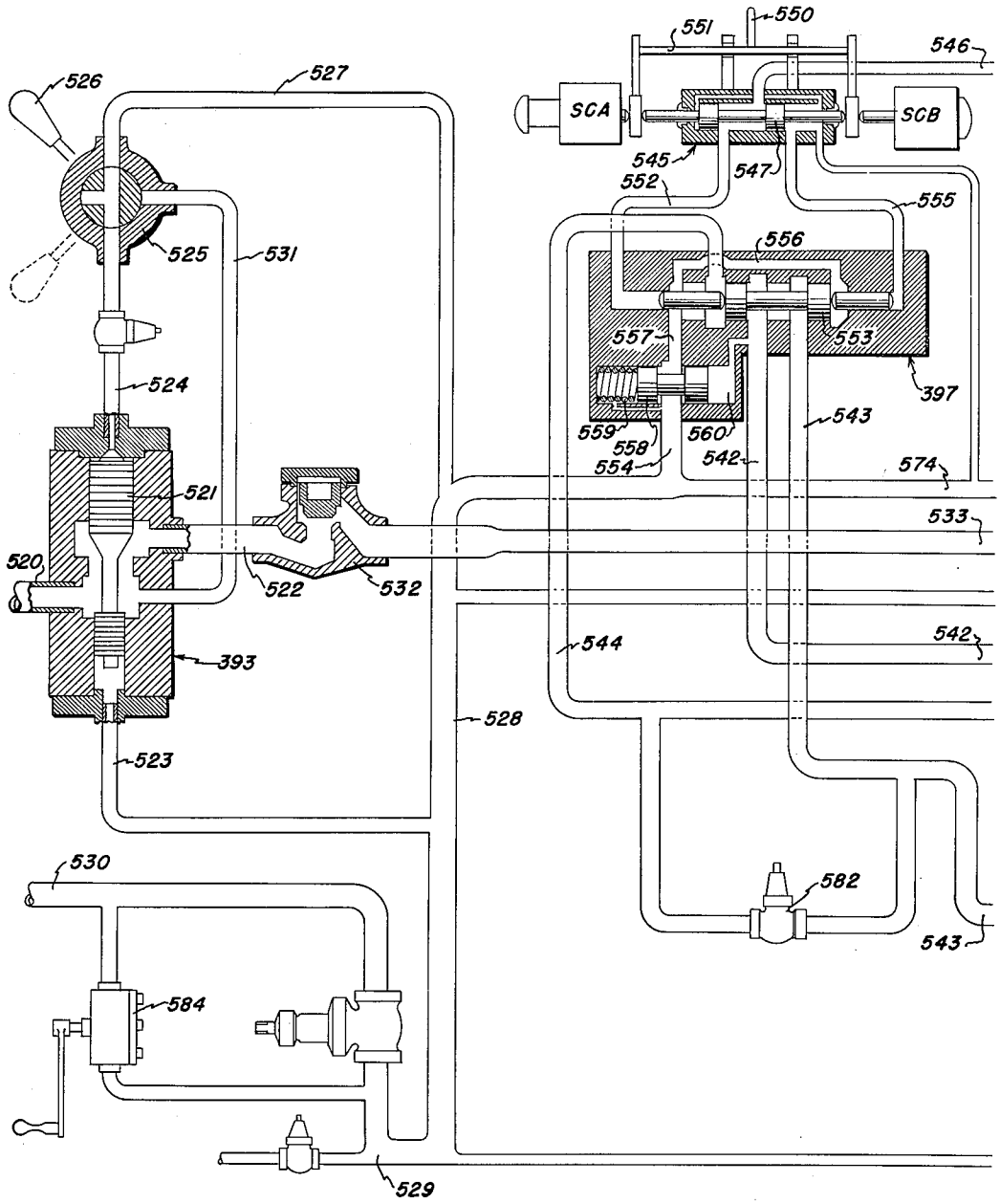


FIG. 49

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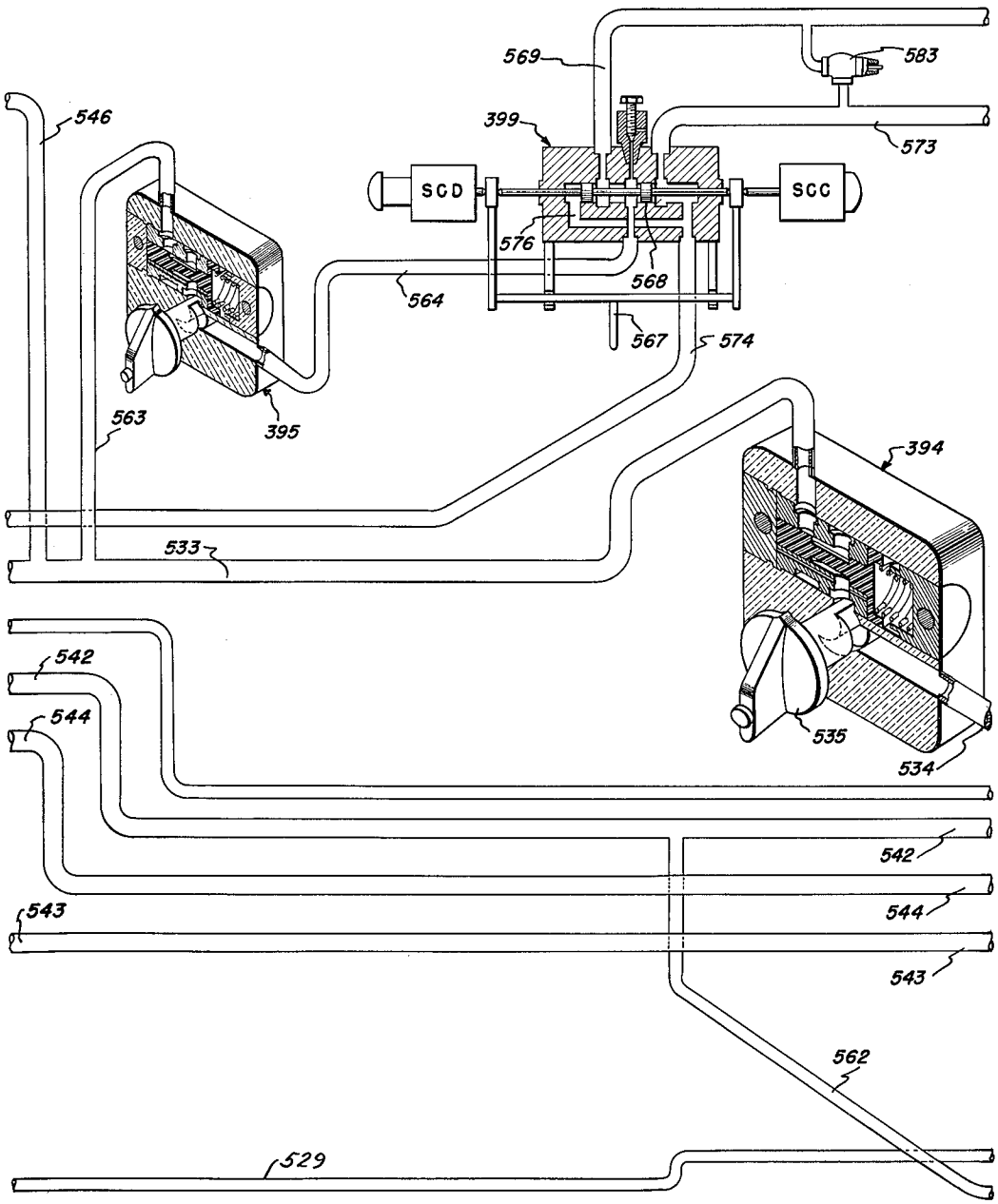


FIG. 50

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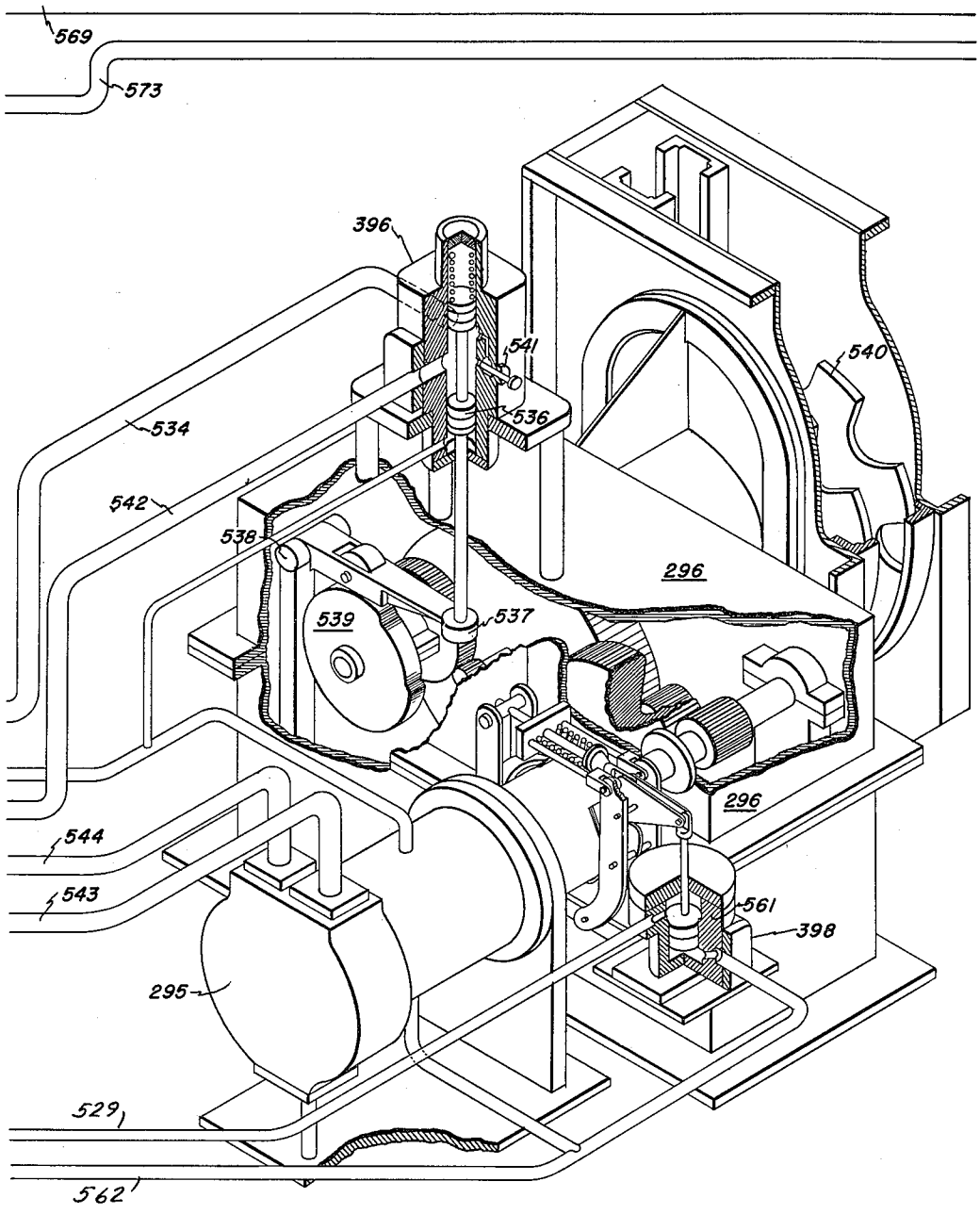


FIG. 51

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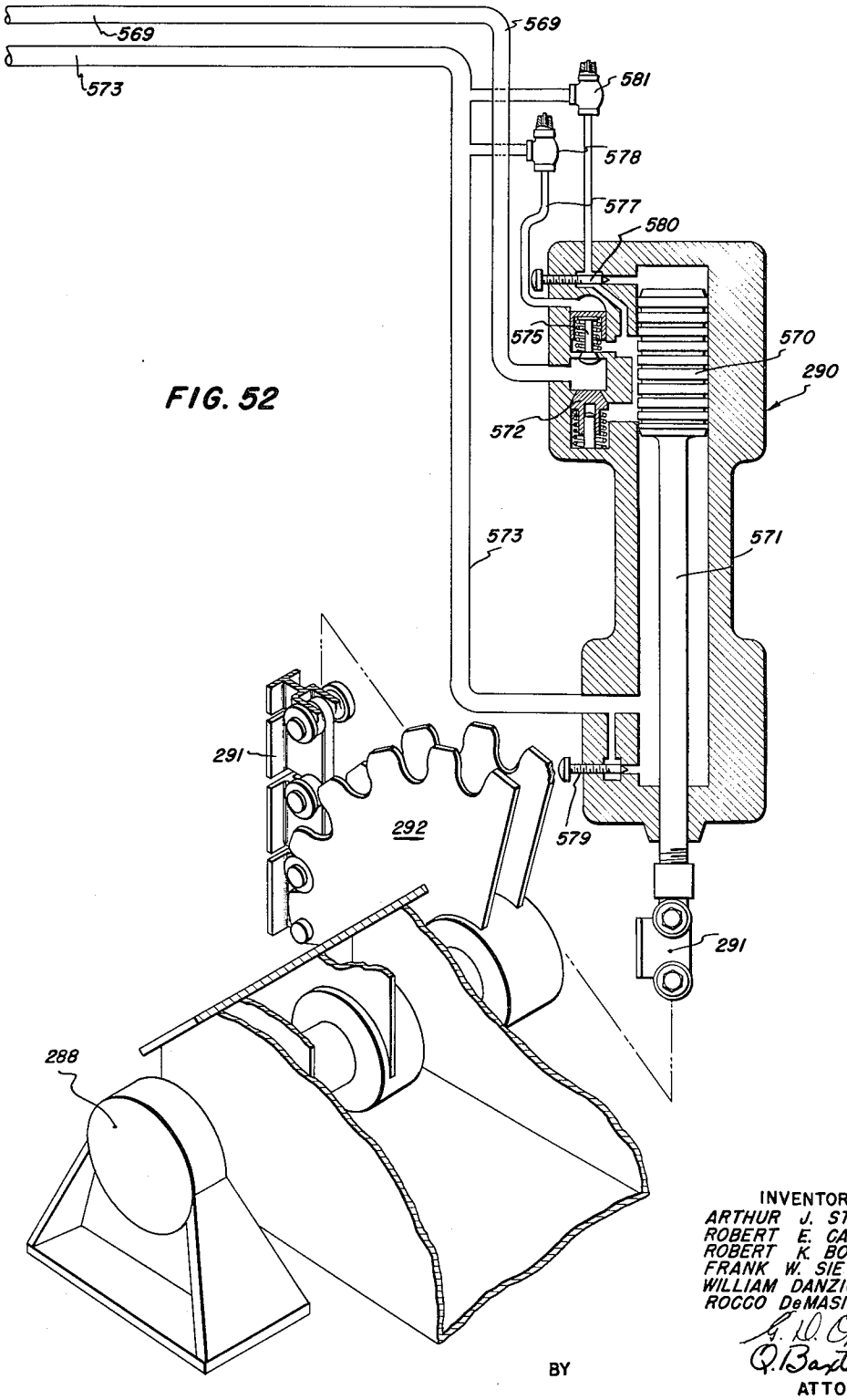


FIG. 52

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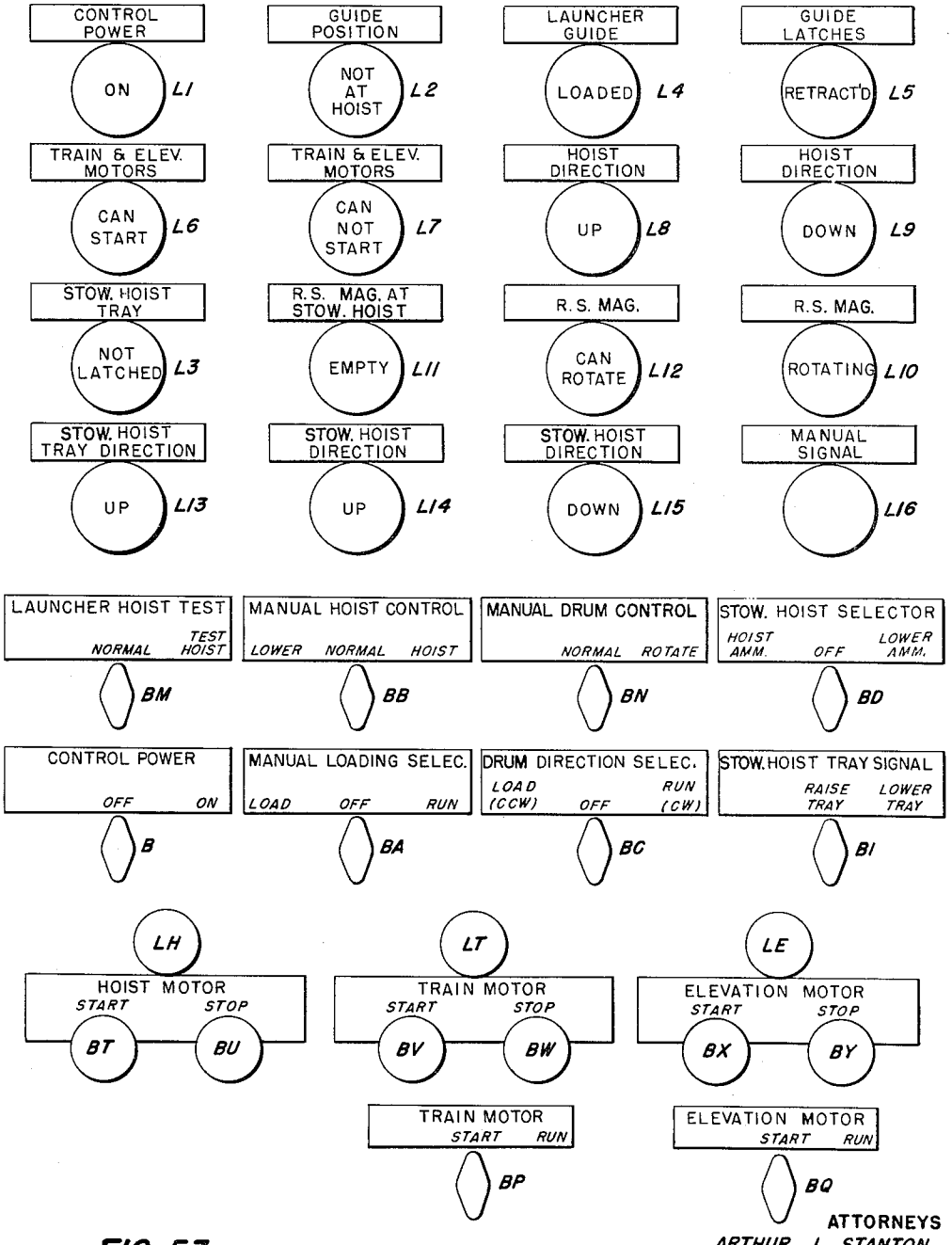


FIG. 53

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FIG. 54

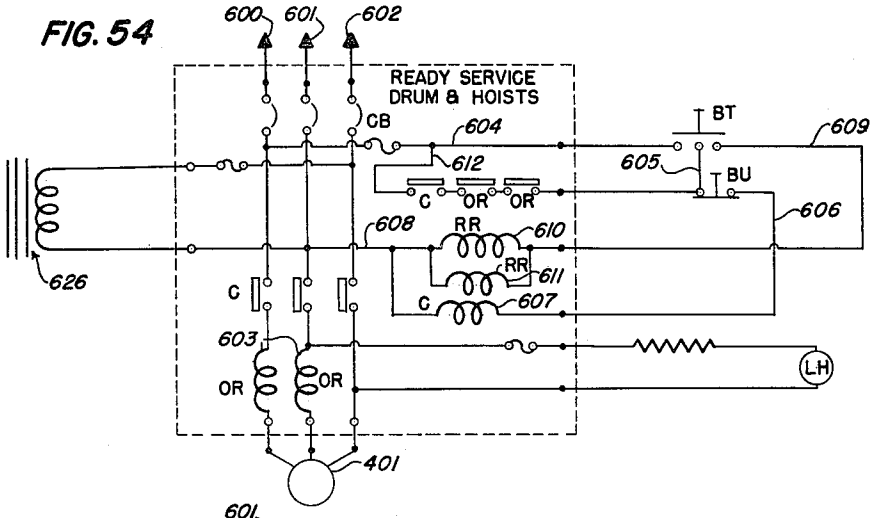
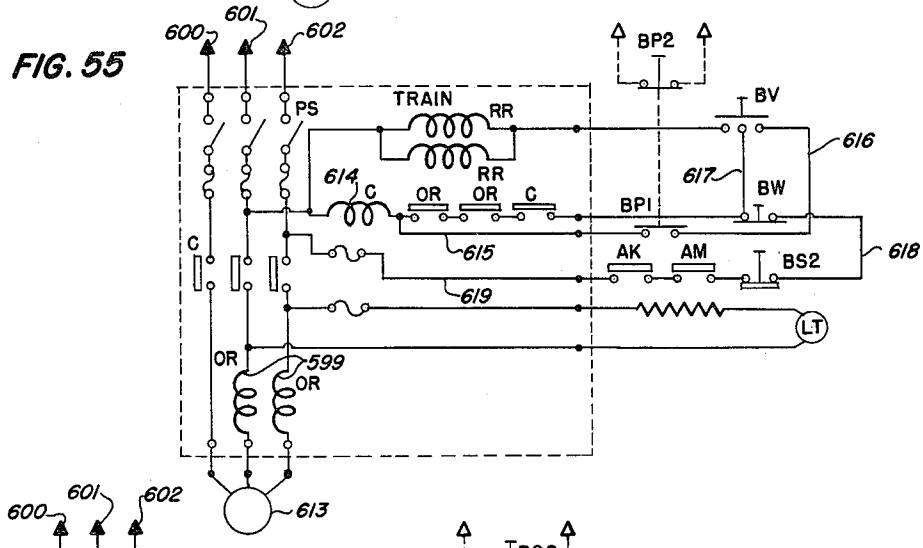


FIG. 55



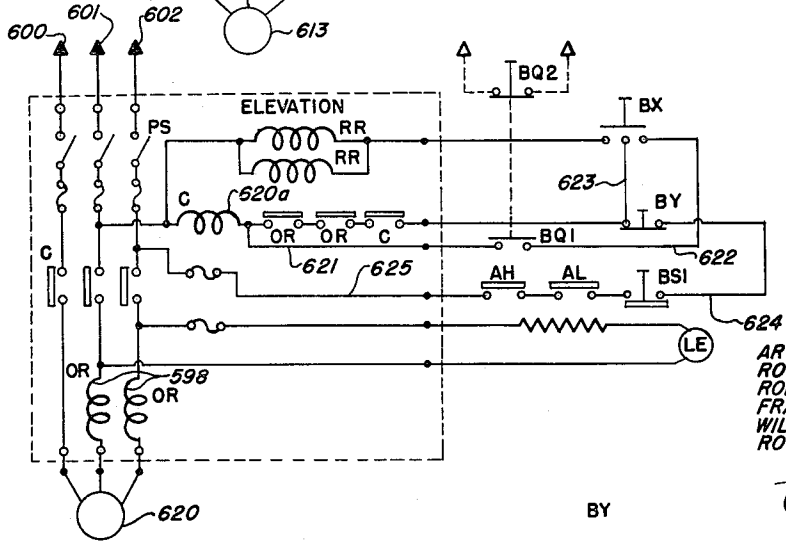


FIG. 55A

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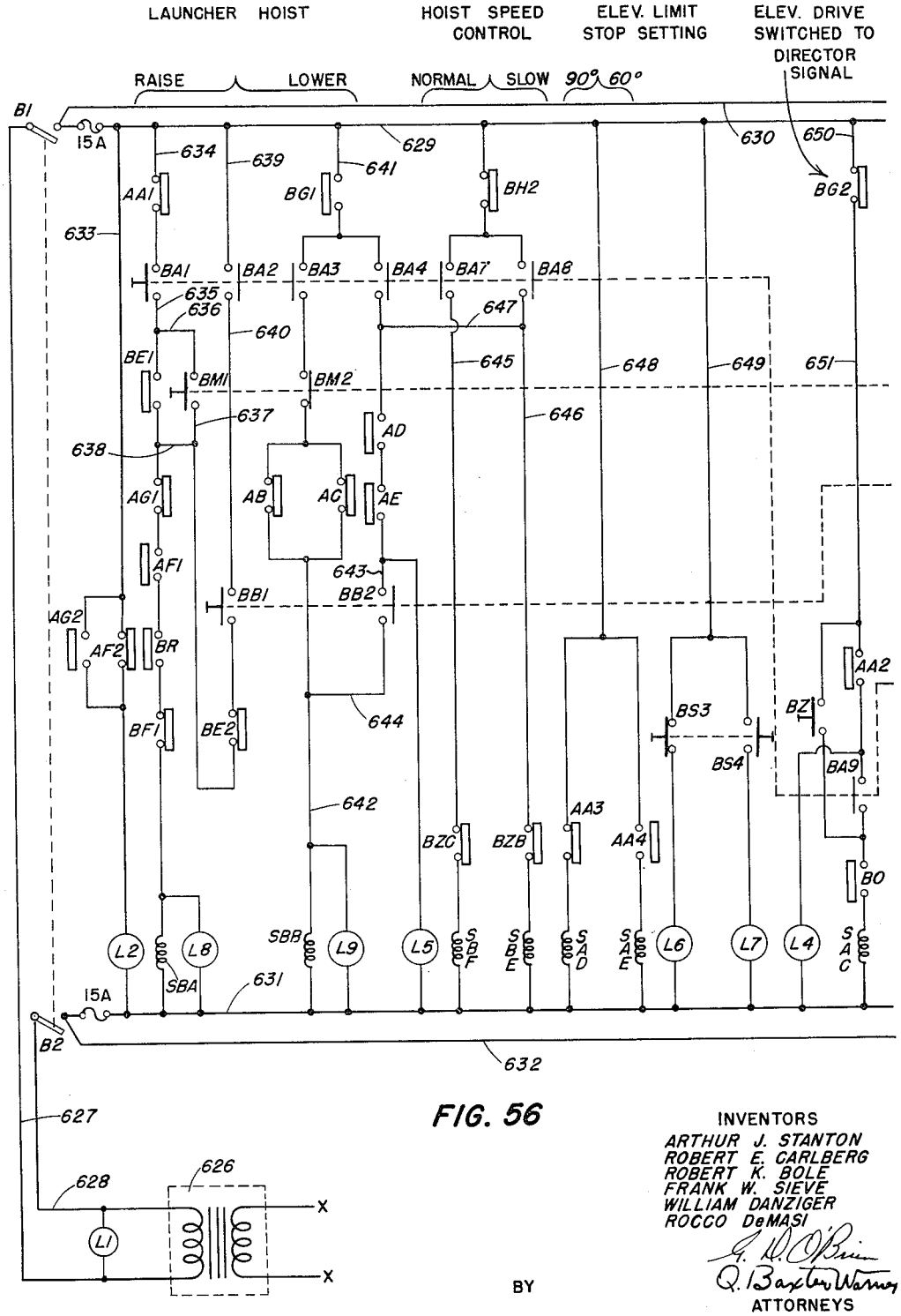


FIG. 56

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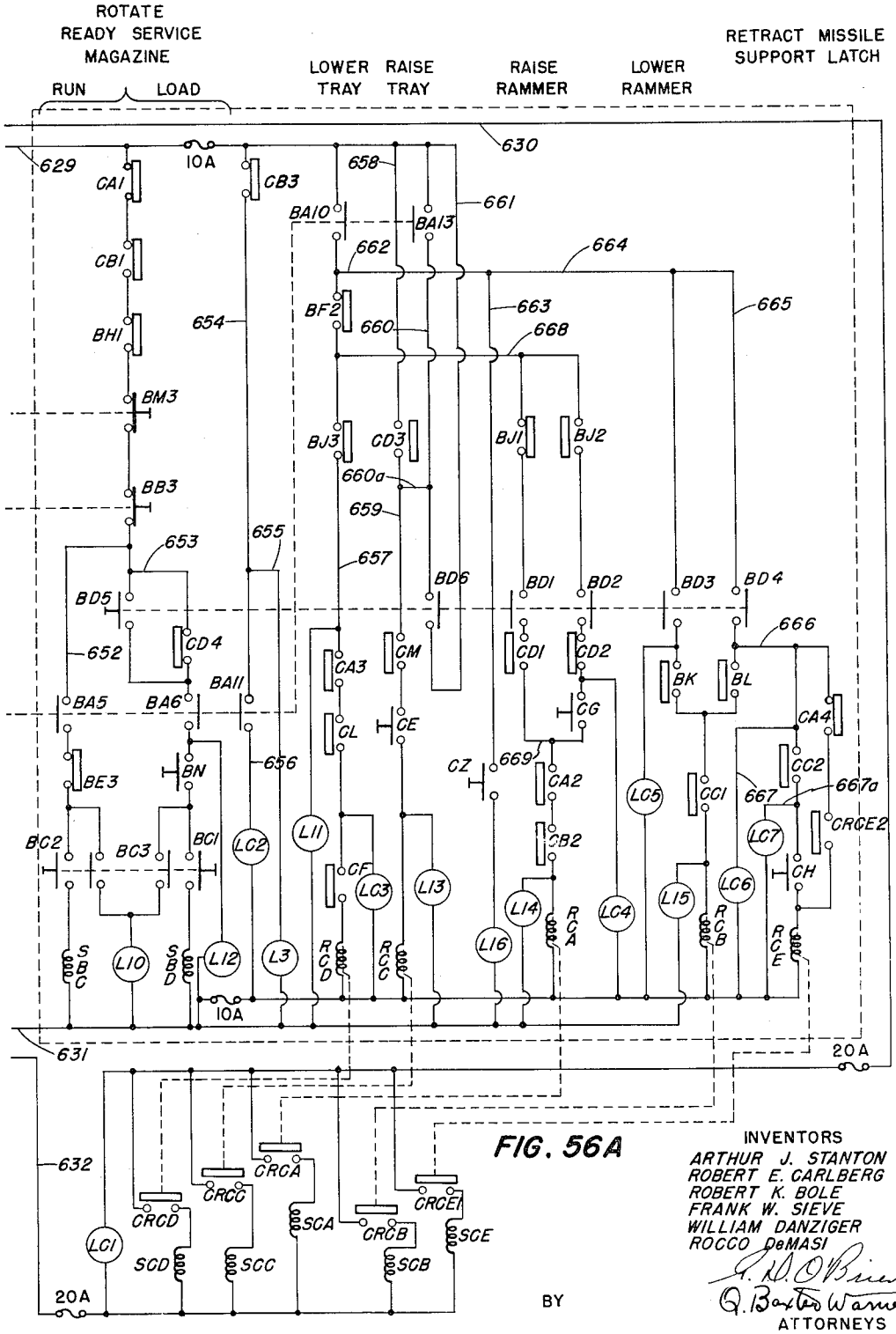


FIG. 56A

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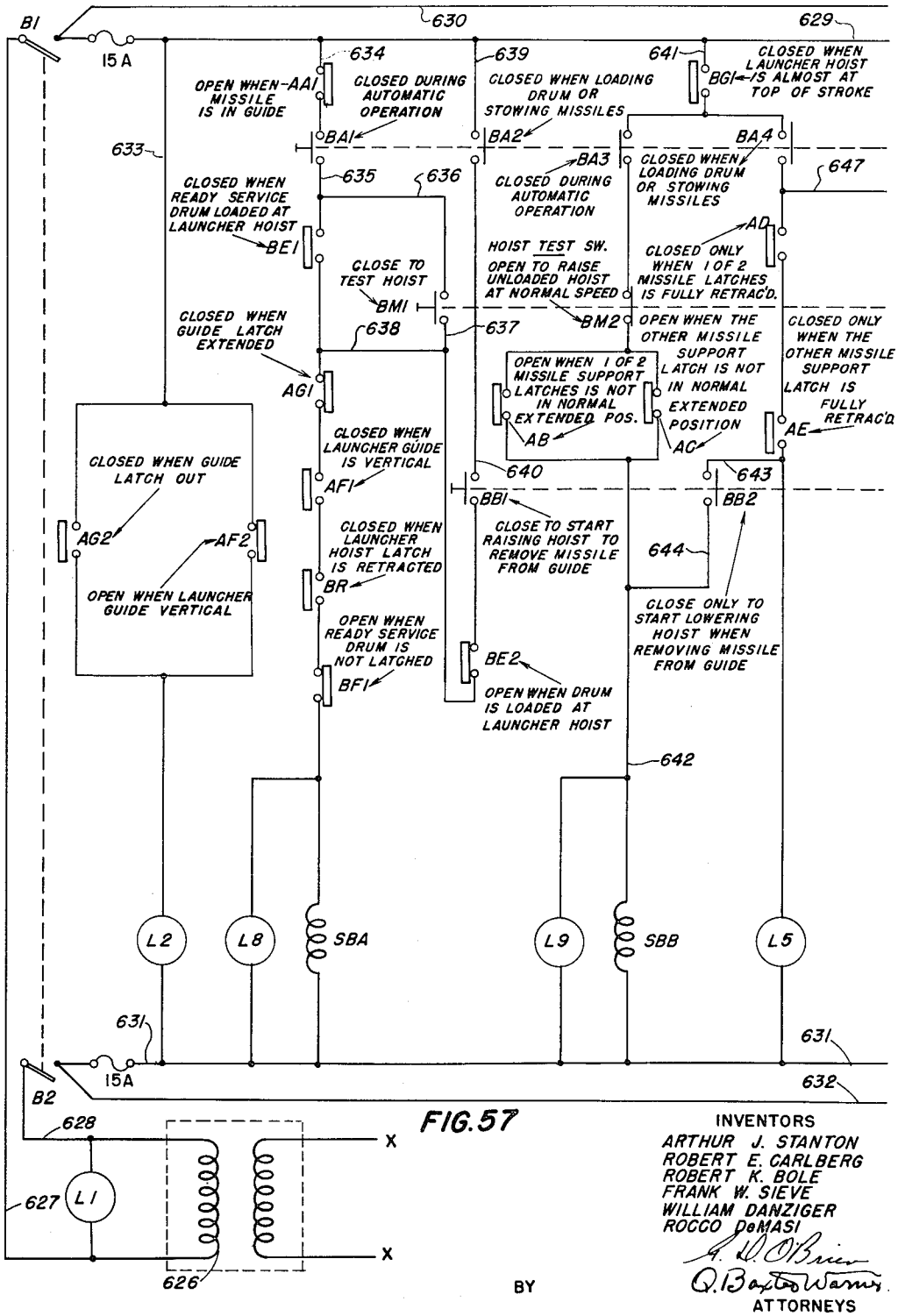


FIG. 57

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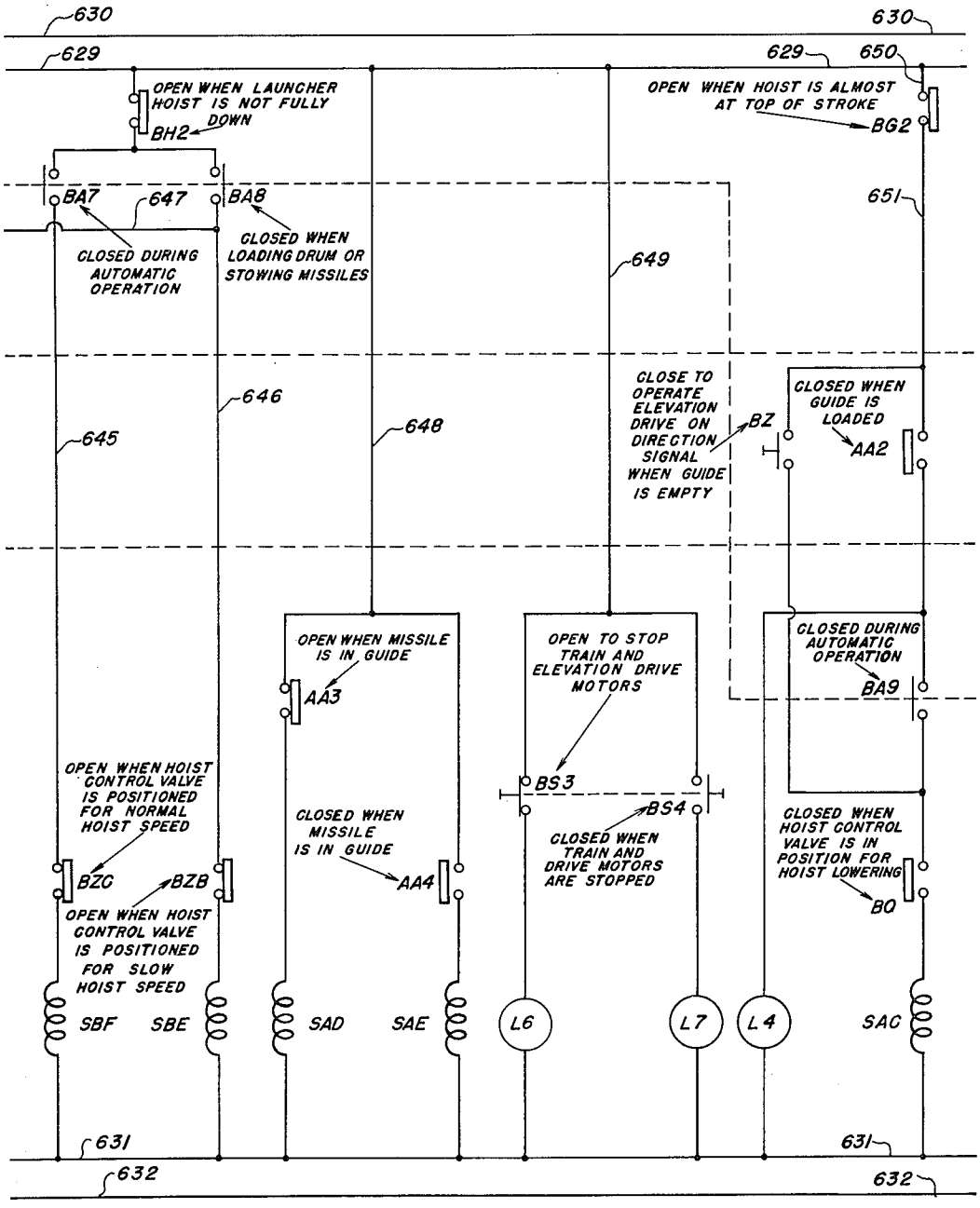


FIG. 58

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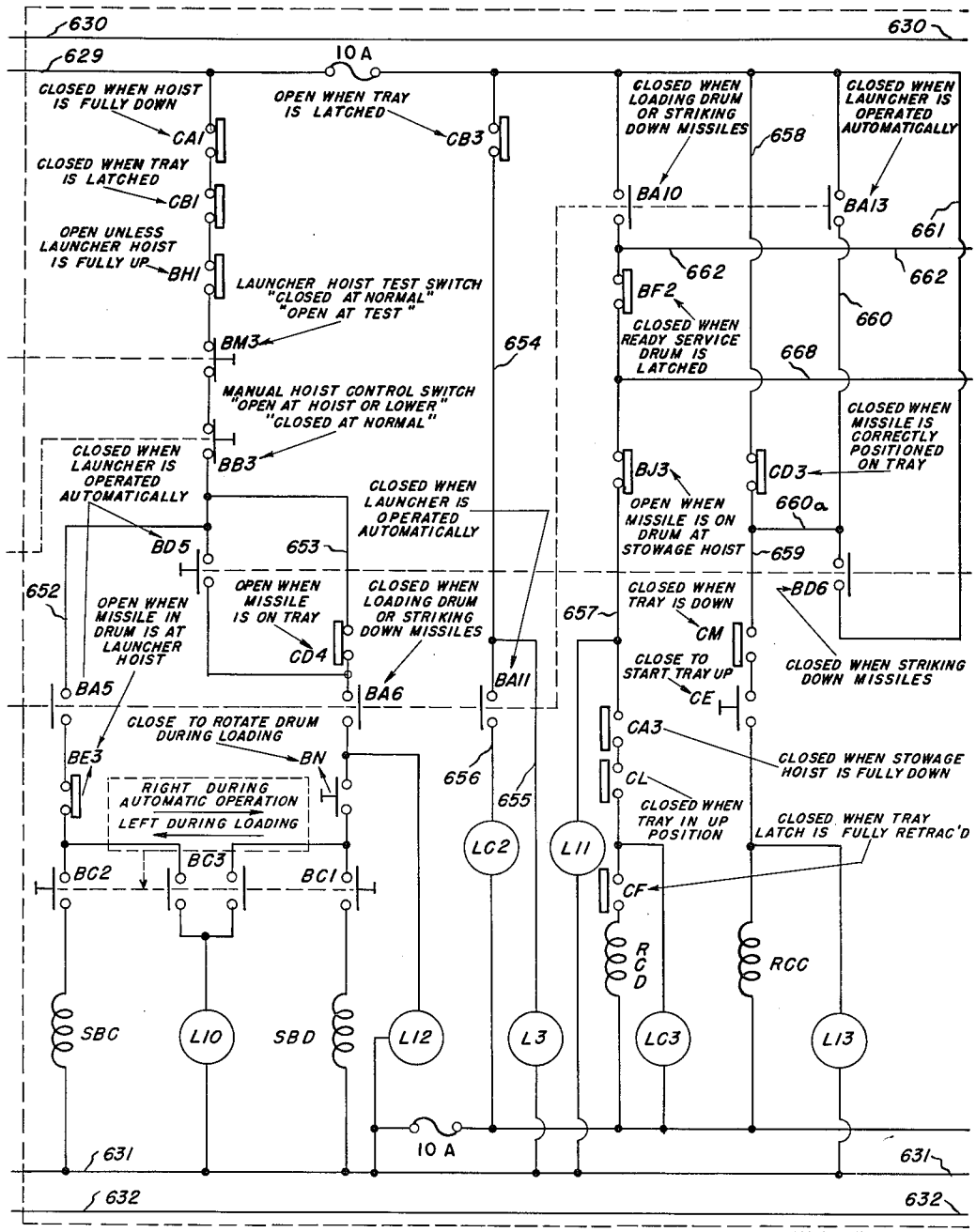


FIG. 59

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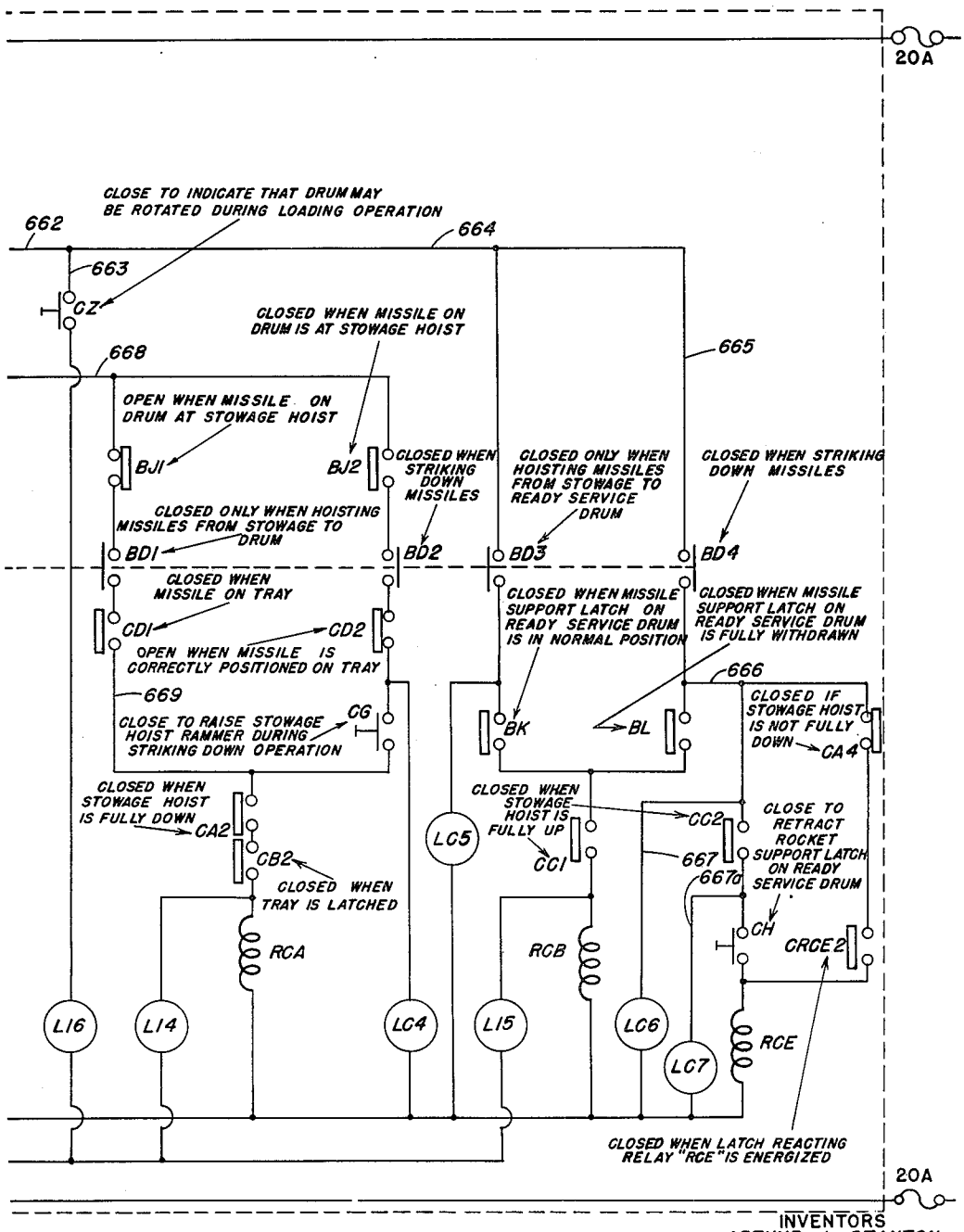


FIG. 60

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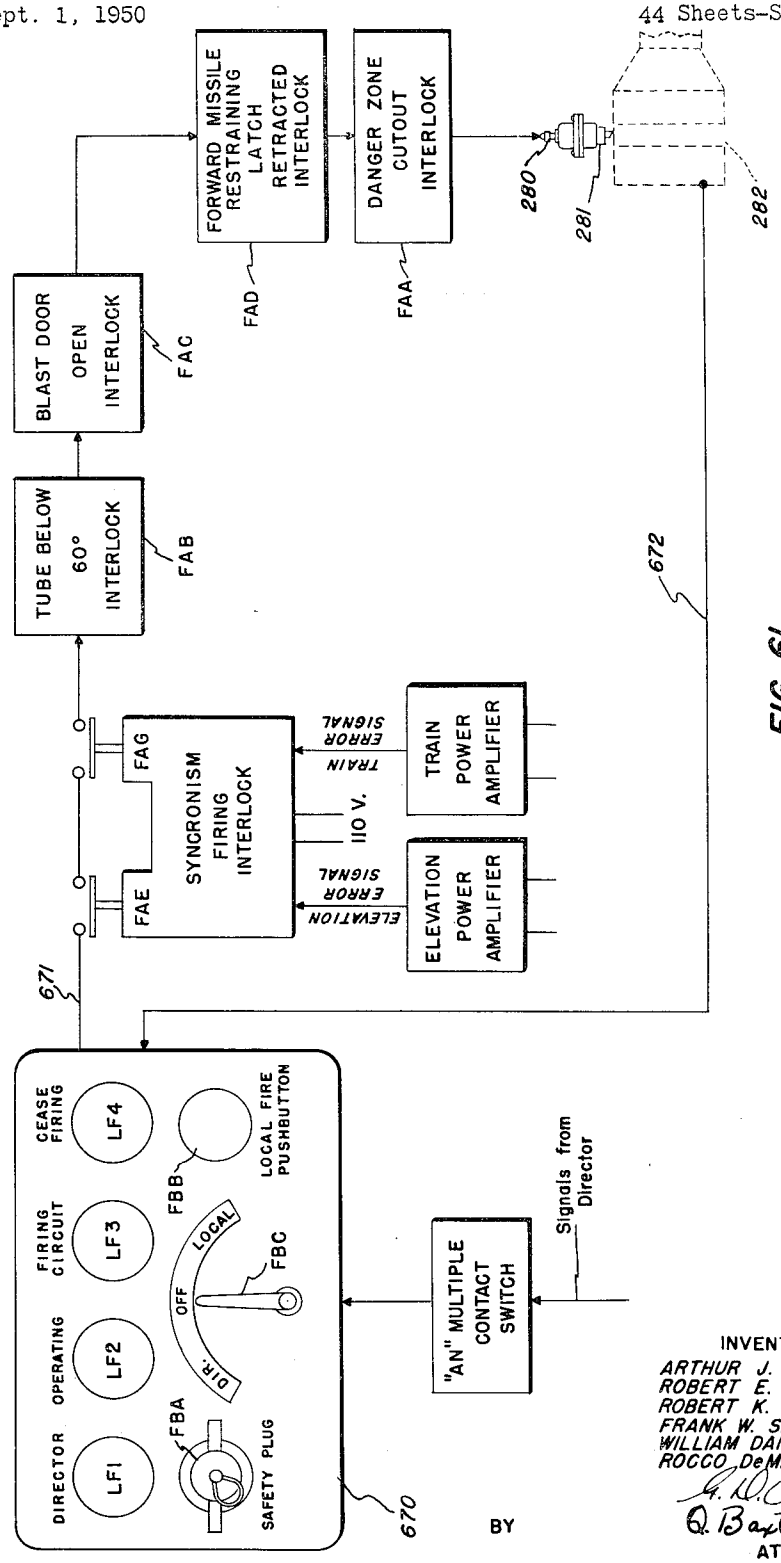


FIG. 61

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United States Patent Office 2,745,317 Patented May 15, 1956

2,745,317

MISSILE LAUNCHER

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Application September 1, 1950, Serial No. 182,696

32 Claims. (Cl. 89—46)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates to missile launchers and more particularly to missile launchers which are automatic in operation and may be controlled from a remote firing station.

In the art of modern warfare the use of self-powered missiles such as rockets has been receiving increasing attention, however, difficulties have been encountered in the handling and launching of such missiles particularly when it is desired to launch a number of them in rapid succession.

Heretofore, devices for launching a multiplicity of rockets have been in the form of relatively simple construction comprising a rack or frame for supporting a number of rockets side by side and means for firing all of the rockets substantially simultaneously whereupon they are broadcast in the general direction of the target. When adapted for shipboard use such devices ordinarily could not independently be moved in train or elevation and their firing accuracy depended upon directing the ship toward the target and arriving at a prescribed range before the missiles were released. It will be apparent that to obtain repeated firing with such an arrangement it was necessary for the launcher to be loaded by hand from above-deck with exposed personnel and this loading step had to be repeated before the launcher could again be fired.

The risks attendant to the exposure of large numbers of rockets and personnel above-decks is readily apparent.

In order to avoid hazard to shipboard personnel loading rockets in an exposed position, there have been developed gravity fed or mechanically fed rocket launchers which fire rockets one by one through a firing trough, however, in such arrangements ordinarily the supply of rockets still must occupy an exposed position and hence is vulnerable to a hit by the enemy.

A further problem, particularly with large rockets, arises out of the tremendous heat generated by the rocket blast as it is fired and a rocket launcher to be effective must provide some means of controlling and isolating the blast or removing the heat so that subsequent rockets will not be prematurely ignited. Furthermore, because of the tremendous heat and blast effects of the rocket as it is launched, it is important that the launcher be automatically loaded and capable of being operated in train and in elevation by remote control means such as the conventional gun director employed aboard ship.

The missile launcher of the present invention overcomes the above and other limitations of prior art devices and is particularly adapted for use on naval vessels where space limitations are important, however, it will be understood that it is not limited to such use but may be used in other installations where a launcher of this character is desired.

Accordingly, it is an object of the present invention to provide an improved missile launcher design which provides optimum control of the missile during launching, is rapid in action and avoids the hazards incident to the use of conventional missile launchers.

A further object of the present invention is to provide a missile launcher that may be completely automatic in operation and may be controlled from a remote station by conventional fire control equipment.

Still another object of the present invention is to provide a launching guide tube having a loading position and a launching position and means for automatically moving the guide tube between the loading and the launching position.

Another object of the present invention is the provision of improved loading means whereby missiles may be supported in a magazine disposed beneath the launcher mount and under the deck structure and carrying a supply of missiles such as rockets which are individually positioned adjacent a vertical hoist for movement into the missile launcher guide.

A further object is the provision of a power and control system for a ready service magazine and missile hoist by means of which missiles carried in the ready service magazine are sequentially moved into loading position and from there carried into the launcher guide by means of the hoist mechanism.

Another object is the provision of a hydraulic and electric power and control system for automatically indexing a rotatably mounted ready service drum or magazine in timed sequence with the up and down movements of a missile hoist whereby missiles carried in stalls about the periphery of the ready service drum are sequentially positioned in alignment with the missile hoist which conveys the missiles into the launcher guide positioned above the periphery of the ready service drum.

A further object is the provision of an improved missile launcher installation wherein the structural relationship between the above-deck mount and below deck magazine and hoist may be varied to conform with structural and space limitations of various naval vessels upon which it may be installed.

Still another object is the provision of a compact missile launcher having a protective shield and blast controlling and directing means to protect the launcher components and adjacent portions of the vessel.

Still another object of this invention is the provision of means for removing a misfire or a dud from the launcher guide without danger to crew personnel.

Still another object is the provision of an automatic missile launcher having interlock means whereby sequential operation of the launcher parts is provided and whereby each part operates in proper timed sequence so that launching can be effected.

Another object is the provision of means for safely conveying an unfired missile from the launcher guide back to the missile magazine.

A further object is to provide apparatus to facilitate the lowering of missiles from above-deck into a ship's stowage magazine.

A still further object is to provide means for loading missiles from the ship's stowage magazine into a launcher ready service magazine.

Still another object is the provision of a novel reeling device which eliminates twisting, fouling or straining of flexible cable members interconnecting relatively movable members.

These and other objects and advantages of the present invention will become more apparent from the following description taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a vertical side elevation with portions removed showing one embodiment of the present invention in stowed condition;

Fig. 2 is a similar view from the opposite side but with the parts arranged in loading position;

Fig. 3 is a side elevation with the launcher mount en-

closing shield removed and the launching tube disposed in firing position;

Figs. 4 to 9, inclusive, are schematic views illustrating the positions of the launching tube, launcher hoist, and ready service magazine during loading and firing operations;

Fig. 10 is a top plan view with the launching tube in load position and the deck surface removed to show the ready service magazine located in one position relative to the launcher mount;

Fig. 11 is an enlarged front elevational view of a portion of the launcher mount of the present invention with shield removed;

Fig. 12 is an enlarged rear elevational view of a portion of the launcher mount of the present invention with shield removed;

Fig. 12A is a top plan view substantially along the line 12A—12A of Fig. 12;

Fig. 13 is an enlarged frontal perspective view of the missile guide tube partially broken away along its length to disclose the bore clear indicator shoe and missile guide rails;

Fig. 14 is an enlarged perspective detailed view of the rear portion of the guide tube as it appears from above and slightly to the rear;

Fig. 15 is an enlarged detailed sectional view of the upper portion of the rear missile end of the guide tube and illustrating the forward and rear restraining latches;

Fig. 16 is a perspective view partly broken away of the blast door and operating mechanism located in the upper portion of the blast shield and showing the linkage employed to manually withdraw the forward restraining latches;

Fig. 17 is an enlarged vertical cross section through the launcher enclosing shield with the guide tube and operating parts removed;

Fig. 18 is a front view with guide tube removed of the sealing means employed between the guide tube and the shield.

Fig. 19 is an enlarged detailed view taken along a line substantially corresponding to line 19—19 of Fig. 18;

Figs. 20 and 21 are perspective views of alternative shapes of blast deflector vanes which may be used in the present invention;

Fig. 22 is a detailed view showing the bearing means whereby the launcher mount is supported for movement in train;

Fig. 23 is a perspective view from above, of a cable reel employed to play out and take up slack in the electrical cables connected to the rotatable mount and prevent fouling thereof during rotation of the mount;

Fig. 23A is an enlarged detailed vertical section of one of the cable engaging dogs used in the reel of Fig. 23;

Fig. 24 is an enlarged top plan view of the cable reel of Fig. 23;

Fig. 25 is a side elevation partially in section of the cable reel illustrated in Figs. 23 and 24 taken along a line substantially corresponding to line 25—25 of Fig. 24.

Fig. 26 is an enlarged fragmentary side elevation of a cable well and follower with portions of both the well wall and the follower side broken away;

Fig. 27 is an enlarged detail elevational view partially in vertical section of the cable well and follower shown in Fig. 26;

Fig. 28 is a foreshortened top plan view of the followers of Figs. 26 and 27;

Fig. 29 is a schematic perspective view of the launcher hoist operating means employed to raise missiles from the ready service magazine into the guide tube;

Fig. 30 is a detailed vertical section through a portion of the ready service magazine bearing means showing the drive pinion and ring gear arrangement;

Fig. 31 is a top view of the ready service latch showing latch receiving notches therefor in the inner periphery of the ring gear;

Fig. 32 is an enlarged detailed vertical section through the lower portion of a magazine stall showing details of the ready service magazine missile support latch and stall loaded indicator mechanism;

Fig. 33 is a perspective view as it appears looking from within a stall and showing the latch and indicator mechanism of Fig. 32;

Fig. 34 is a perspective view partially broken away of the stowage hoist and tray used to load missiles from below into the ready service magazine;

Fig. 35 is an enlarged detailed perspective view of the missile holding clamp employed to clasp the missile and hold it on the tray during tray movement;

Fig. 36 is an enlarged detailed view of a stowage hoist upper limit interlock cam and switch;

Fig. 37 is an enlarged detailed view of a stowage hoist lower limit interlock cam and switch;

Fig. 38 is an enlarged perspective view of the stowage hoist tray latch mechanism together with tray closed indicator and interlock switches;

Fig. 39 is an enlarged schematic perspective view of the stowage hoist tray pivot bearings together with a tray loaded interlock and tray position indicators;

Fig. 40 is a time chart showing the relative movement of the launcher hoist, the launcher guide and ready service magazine during one complete cycle of automatic operation;

Fig. 41 is a schematic view showing the method of lowering missiles from above-deck to the ready service magazine and thence by the stowage hoist to the missile stowage magazine or locker;

Fig. 42 is a side elevation showing the guide tube depressed and a manual missile ejector rod and tray in place for jettisoning overboard a defective missile;

Fig. 43 is a block diagram of the hydraulic system employed to convey missiles to and from the launcher guide, for rotating the ready service drum and for lowering missiles into the ship's stowage magazine;

Figs. 44 through 48 show the hydraulic power and control system employed for operating the launcher hoist and rotating the ready service magazine;

Figs. 49 through 52 show the hydraulic power and control system for operating the magazine stowage hoist;

Fig. 53 is a face view of the main electrical control panel used in the present invention;

Fig. 54 is a schematic electrical diagram of the motor controller circuit for the pump which provides hydraulic power for operating the ready service magazine and both hoists;

Fig. 55 is a schematic electrical diagram of the motor controller which controls the train pump drive motor;

Fig. 55A is a schematic electrical diagram of the motor controller which controls the elevation pump drive motor;

Figs. 56 and 56A together constitute a schematic diagram of the electrical portions of the control system used in the present invention;

Figs. 57 through 60 taken together show the major portion of the circuit of Figs. 56 and 56A with functional legends applied to the switch members; and,

Fig. 61 is a schematic representation by block diagram of a firing circuit with its interlocks, together with a face view of a firing control panel which may be used in the present invention.

The present invention is shown as a remotely controlled automatic operating shipboard type of missile launcher installation wherein all components except the launcher guide tube are protected by enclosure within a shield or by location below-deck.

In the embodiment illustrated, a single launcher guide tube is supported by trunnions for pivotal movement from an upright loading position to an inclined firing position at which time it is lowered to some angle between 0° and 60° of elevation as determined by a signal

received from the ship's gun director. This guide tube and its trunnions are mounted upon a carriage supported upon a mount which is similar to the conventional 40 mm. gun mount and includes the necessary apparatus for moving the guide tube both in train and elevation in response to director signals received from conventional fire control equipment. By this means the mount may be moved in train and in elevation so that it may bear upon the target up to the very instant of firing.

A second component part of this launcher is a hoist mechanism which operates to deliver rockets or other missiles from a below-deck ready service magazine into the launcher guide tube when it is at its 90° elevated or loading position.

A third component is a below-deck ready service magazine in the form of a large upright drum having a plurality of missile receiving stalls spaced about its periphery. By suitable means the drum may be rotated to successively present missiles to the launcher hoist for loading into the guide tube.

A fourth component of the present invention is the provision of a stowage hoist whereby missiles may be supplied to the stalls of the ready service magazine from a remote missile stowage compartment so as to replenish the supply of missiles in said ready service magazine during a period when the launcher is not in automatic operation. This stowage hoist embodies transfer means including a tray upon which the missiles may be loaded and which tray then tilts to transfer the missiles from a horizontal stowed position to an upright position in alignment with the stowage hoist whereupon they may be moved into empty stalls of the ready service magazine.

The first three components above set forth work together during automatic firing operation to automatically and continually load and fire missiles until the supply in the ready service magazine has been exhausted or until a "Cease fire" order is given. Thereafter the last component works to reload the ready service magazine so that it will be ready for another burst of automatic fire. These operations are carried on in timed relationship under the control of electrical and hydraulic interlocks which assure the completion of each step before the start of the next.

In normal service, operation of the missile launcher is remotely controlled by a director fire control system. When the launcher is in operating condition, and is following the director, the entire magazine supply of 22 missiles may be loaded and launched in succession simply by closing the firing circuit and holding it closed. During this automatic loading and launching operation, no action is required of launcher personnel. The firing of the launcher is ordinarily controlled remotely, and successive loading of missiles from the ready service magazine is performed automatically by the missile hoist, hence personnel are not stationed in or about the mount above-deck during firing operation.

Local control features of train and elevation are not incorporated in the launcher, however, handwheels are provided to move the mount manually in train and elevation for the performance of stowing and casualty operations and to facilitate service or maintenance work. Local control of the firing circuit may be provided at a below-deck control station as an alternative to director firing.

In the embodiment of the invention illustrated, and referring particularly to Figs. 1 to 12, inclusive, the present automatic missile launcher is shown as it may be installed on a naval vessel with an above-deck mount generally designated **100**, a below-deck ready service magazine **101** and a missile hoisting mechanism **102** adapted to convey missiles from the magazine directly into a missile guide tube **103** carried by the mount.

The above-deck mount **100** is provided with a dome type protective shield **104** resting upon a shield base **105**. Within the shield is mounted a carriage **106** having spaced cheeks **107** and **108** mounting trunnion bearings **109**. The guide tube **103** has trunnions **110** supported in the bearings **109** about which the tube may pivot from an upright loading position to an inclined firing position, the tube **103** being provided with a gear sector **111** which may be engaged by the usual drive pinion to move the tube in elevation. The shield **104** is enlarged at **112** to form a curved blast chamber and may be provided with a hinged weather hatch **113** (Fig. 16) at the top which is kept closed except during actual firing of the launcher.

In the embodiment illustrated the device is shown supported upon deck **114** by means of a flanged roller bearing stand **115** and in use the entire above-deck launcher mount may be rotated in train while the launcher tube is simultaneously moving in elevation.

Immediately below the deck **114** may be located the launcher magazine or ready service magazine **101** which in the present embodiment includes an upright drum mounted upon a suitable bearing **116** for rotation about its vertical axis **117**. As shown in the top view Fig. 10, a number of missiles **118** may be supported in stalls **119** formed by guide rails **120** spaced about the periphery of the ready service magazine and so arranged as to bring each missile into axial alignment with the center of rotation of the mount as the magazine is indexed during a missile loading operation.

When a missile has been moved into alignment with the axis of rotation of the launcher mount and the guide tube **103** is vertical, the missile may be automatically raised from the ready service magazine into the guide tube by means of a launcher hoist **102**, the sequence of operation of which is schematically illustrated in Figs. 4 to 9, inclusive. In Fig. 4 the guide tube **103** supported upon the carriage **106** is shown in the vertical loading position and the ready service magazine **101** is shown loaded with several missiles **118**, one of which **118***a*, is located in coaxial alignment immediately below the upright guide tube **103**. The rear end or shroud **121** of the missile is positioned at that time just above a hoist lifter member **122**.

In Fig. 5 operating switch **123** has been closed and, as the first step of the automatic launcher operation, the hoist **102** is energized to raise lifter **122** by means of a rammer type one-way chain **124** so as to lift the missile **118***a* into the guide tube **103** where it is retained by suitable retaining latches hereinafter described. As shown in Fig. 6 the rammer then descends and guide tube **103** pivots about its trunnions to the firing elevation as determined by the conventional fire director means aboard ship and, as shown in Fig. 7, as soon as the hoist lifter reaches the bottom the ready service magazine may index to move another missile **118** into the loading position.

When the guide tube **103** descends to the desired elevation the missile is automatically fired as indicated in Fig. 8, whereupon the guide tube **103** starts automatically to return to its upright position as shown in Fig. 9. If switch **123** is maintained closed, then the hoist **102** automatically proceeds to load another missile into the guide tube from the ready service magazine **101**. This operation continues until switch **123** is opened or until the supply of missiles in the ready service magazine is exhausted.

The above deck mount

The above-deck mount **100** receives missiles from below through a central opening **125** (Fig. 22) in a rotatable base ring **126** supported on roller bearings **127**, **128** and **129**. As is shown in Fig. 2 the guide tube **103** in its vertical loading position is disposed with its longitudinal axis in coaxial alignment with the axis of rotation of the above-deck mount and hence missiles fed from below by hoist **102** are received directly into the after end of the guide tube **103**.

The guide tube **103** (Figs. 13 and 14) comprises a cylindrical tube member **130** preferably formed of sheet steel and having spaced about its inner surface a plurality of inwardly projecting guide rails **131**. Tube **130** may be removably secured in a guide tube engaging sleeve **132** extending from a guide tube housing **133** from the sides of which the trunnions **110** extend. Because of the substantial absence of recoil the trunnions need not be large. A spanner nut **134** may secure the guide tube **130** in the guide tube receiving sleeve **132**.

An elevating gear sector **111** is secured to the undersurface of the guide tube housing **133** and may be engaged by the usual operating pinion of conventional elevating mechanism so as to elevate the guide tube in response to fire control signals. In order to retain a missile in the guide tube after the launching hoist rammer is lowered there may extend into the after end of the tube a pair of oppositely disposed, hinged, spring biased missile support latches (Figs. 14 and 15), which latches are mechanically cammed out by a missile entering the vertically positioned guide tube and snap into place behind the lower edge of the missile shroud when the hoist has raised the missile clear. Subsequent lowering of the hoist lifter member leaves the missile supported in the guide by these latches. A forward missile restraining latch **137** (see Fig. 15) normally protrudes into the bore of the guide forward of the missile shroud **121**. This latch is held retracted by a solenoid when the guide is empty or when it is locked in loading position but after the guide is loaded this latch prevents the missile from sliding forward and out of the mouth of the guide tube as the guide depresses to the firing position.

As will hereinafter appear when all other electrical and mechanical actions necessary to firing have been completed the missile restraining latch **137** is withdrawn by its operating solenoid and the firing circuit may thereafter be completed. As is shown in Fig. 14 the rear of the guide tube **130** is enclosed in a breech sleeve **138**, the after end of which is notched to receive the missile engaging latches **135**. The latter are hinged so that toe portions **139** normally project into the bore of the guide tube but entry of a missile from below cams the latches outwardly against the tension of a latch spring **140**, the fixed end of which is secured to a latch spring bracket **141** welded or otherwise suitably secured to the breech sleeve **138**. The other end of the spring **140** is secured to the upstanding arm of an L-shaped bracket **136** bolted or otherwise secured to the external surface of the missile engaging latch **135** whereby the tension of spring **140** serves constantly to urge the toe **139** into the guide tube.

The missile engaging latches **135** are linked together so that they may be moved in unison by latch operating lever **142** keyed to shaft **143**. An arm **141***a* is also keyed to shaft **143** so that movement of the handle **142** raises arm **141** against the undersurface of bracket **136** to lift it and withdraw the toe **139**. By link lever **146** secured to arm **147**, as shown, the lower missile engaging latch **135** may simultaneously be retracted.

Normally the missile engaging latches **135** will not manually be retracted from the guide tube, however during testing operations etc. it may be necessary to remove a missile from the after end of the guide tube and then handle **142** may be raised about its pivot **143** to cam up bracket **136** and withdraw the toes **139** of the missile engaging latches **135**. A detent including knurled thumb nut **146***a* may be operated to screw the threaded end of a bolt **147***a* into a threaded opening in boss **148**. Loosening of this detent is necessary before handle **142** may be operated. To retain the handle **142** in the missile engaging latch retracted position, a finger latch **196** controlling a spring biased bolt **197** is mounted in a bolt block **198** and when the handle **142** is raised the bolt **197** moves into the path of projection **199** on the lever **142** and holds it in missile supporting latch retracted position until the finger latch **196** is operated.

In order to indicate the condition of the missile engaging latch there is provided a switch AE whose roller tipped actuating arm is positioned in the path of a tripping lug **149** of the bracket **136** to indicate when the upper missile engaging latch has been completely retracted. A similar switch AC is located with its roller tip actuated arm disposed in the path of a cam member **151** mounted upon the bracket **136** and serving to indicate when the upper missile engaging latch is in normal position. The underside of the guide tube is provided with similar switches AB and AD which are operated by the positioning of the lower missile supporting latch. This is because of possible interference by the hoist lifter member with one of the latches.

Toe **139** of each missile engaging latch is preferably inclined on its forward face to prevent manual release of the latch unless the weight of the missile has first been removed by the hoist lifter member.

The forward missile restraining latch **137** disposed ahead of the missile shroud when the missile is located in the launcher tube is illustrated in detail in Fig. 15 and may be supported for pivotal movement around a pin **150**. It has a bell crank arm **152** which may be linked to a plunger rod **153** for actuation by a solenoid SAF housed within the container **154**. If desired the forward missile restraining latch **137** may be actuated by mechanical means instead of the solenoid SAF aforementioned and, to accomplish this, the upper arm of the bell crank **152** is provided with a pad **155** which is located to be engaged by the rounded end of a manually actuated arm **156** (Fig. 16) supported upon a transversely extending operating shaft **157** extending to the outside of the blast chamber **112** for operation by a hand crank **158** for the purpose of permitting manual removal of a missile from the front end of the guide tube in a manner hereinafter to be described.

As shown in Figs. 14 and 15 there may be provided a firing pin including an upwardly extending terminal **280** and an inwardly directed shroud engaging pointed tip **281** which latter is resiliently urged against an electric contact band **282** about the periphery of the missile shroud. The tip is preferably of extremely hard material such as "Stellite" so as to engrave the band **282** and insure positive electrical contact therewith.

As shown in Fig. 13 the guide tube is provided with a bore clear indicator in the form of a long shoe **159** located within the tube and the presence of a missile in the guide tube depresses the shoe **159** and rotates a support shaft located within the tubular housing **160** which in turn actuates switch means within the switch box **161** which conditions the control circuit to show that the guide tube is loaded. The shoe **159** extends close to the forward end of the tube and hence remains depressed until the missile has entirely cleared the guide tube.

The guide tube housing **133** may be provided on one side with a latch pin receiving opening **162** to receive a horizontal stowage pin **163** which when in place locks the guide tube in the horizontal stowed position illustrated in Fig. 1. Actuating mechanism for the horizontal stowage pin **163** is illustrated in Figs. 11 and 12 where pin **163** is shown connected to one arm of a bell crank **164**, the other arm of which is connected to rod **165** operable by hand crank **166**. In order to secure the guide tube in its vertical loading position there is provided on the undersurface of the guide tube an apertured lug **167** (Fig. 14) having an inclined lower edge **168** and elongated opening **169**. This lug cooperates with an axially slidable (spring biased) lock pin **170** (Fig. 12) mounted upon one cheek of the carriage and having a rounded end whereby it may be cammed back out of the way by the inclined face **168** to then snap into opening **169** and retain the guide tube

in its vertical "load" position and prevent unintended movement from that position during loading. The pin **170** is controlled in its movement by a solenoid which, when energized, acts through a hydraulic operating means hereinafter described to retract the pin against spring compression and permit the guide tube to be moved out of its vertical position. As shown in Fig. 14 the after portion of the guide tube has secured to its undersurface a pad **171** which, when the guide tube reaches vertical strikes the pin **172** of a hydraulic buffer (Fig. 12) to cushion the movement of the guide tube to its vertical position. A similar pad **173** is disposed to abut stop **174** (Fig. 12) to provide a positive stop which is engaged after the buffering action has taken place. This assures positive vertical alignment of the guide tube with the launcher hoist.

The undersurface of the forward portion of the guide tube (Fig. 13) is similarly provided with a pad **175** which abuts a buffer pin **176** (Fig. 11) when the guide tube is depressed to approximately minus 10°.

To flame seal the upper end of the launcher hoist when the guide tube is not vertical there is provided a hatch **177** (Figs. 12 and 12A) which may be mounted for pivotal movement about a vertical pin at **178** and bears an upstanding cam pin **179** which, when the hatch is closed, is disposed in the path of a curved groove **180** formed in a door operating cam block **181** (see Fig. 14) mounted on the rear of the guide tube. The hatch **177** is normally held in flame seal position by means of a pivotally mounted latch arm **177***a* having a hooked end portion which is urged against cam pin **179** by a spring **182** so as to force the edge of the hatch against a stop plate **179***a*. As the guide tube pivots towards vertical position the face of cam block **181** engages an upstanding striker pin **181***a* on the latch arm thereby pivoting the latch arm rearwardly and freeing the hatch from the tension of spring **182**. It will be apparent that continued movement of the guide tube towards vertical causes the pin **179** to enter the groove **180** and be cammed to one side by the curvature of slot **180** causing the hatch **177** to swing out of the way of the rear end of the guide tube. This uncovers the top of the launcher hoist simultaneously with movement of the guide tube into the vertical position so that missiles issuing from the hoist enter directly into the rear of the guide tube. When the guide tube starts its return movement to depressed position the camming action of pin **179** in groove **180** causes the hatch to pivot to its closed flame sealing position where it is held in place by the force of spring **182** urging it against the stop plate **179***a*.

As indicated in Figs. 1, 10, and 17 the above-deck mount shield may be provided with suitable access hatches **183** on opposite sides thereof and for ventilation a screened hatch **184** may be provided in the front part of the shield. To provide forced ventilation a fan **185** (Fig. 17) may be mounted in the ventilation hatch, or if desired, the fan may be positioned between the cheeks of the cradle and connected by suitable duct-work to the ventilation hatch, in the latter event the components illustrated in Fig. 11 mounted at the front of the carriage may be moved to one side and mounted upon brackets secured to the carriage. In order to assist in confining the blast to the after portion of the shield and to direct it out of the blast chamber **112** at the rear of the shield there may be provided partitions and walls, extending aft from the cheeks of the carriage and serving to confine the blast to keep it from reaching the various components mounted upon the launcher. It will be apparent that a blast of air entering from the front and conducted rapidly about the rear of the guide tube and out through the blast chamber will cool that member and aid in evacuating exhaust blast gases from the shield.

The interior of the blast chamber **112** may be provided with a number of vertically spaced generally horizontally arranged vanes **186** or **186***a*, preferably of the general shape illustrated and either inclined or curved somewhat in the manner illustrated in Figs. 17, 20 and 21 so that irrespective of the degree of guide tube elevation the exhaust blast will be directed upwardly and out of the opening at the top of the blast chamber **112**.

The outer surface of the guide tube housing **133** (Fig. 13) is cylindrical and constitutes a guide tube port fairing which engages the contact surface of an inflatable rubber seal **187** (Figs. 18 and 19) which in turn is supported upon the depending flange of a seal retaining strip **188** which is secured to a laterally extending carriage supported frame **189**. A flexible rubber strip **190** connects frame **189** with the edge of the shield **104** adjacent the launcher tube receiving opening. This seal **187** may be deflated when the launcher is in use but otherwise should be kept inflated to insure sealing contact with the guide tube port fairing.

As part of the procedure for handling misfires, a sprinkler system is provided to spray the after end of the guide tube so as to cool it before the misfired missile is disposed of. For this purpose a sprinkler line **191** (Fig. 17) may have an exterior connection **191***a* to which a water supply hose may be attached. Several sprinkler heads **192** are spaced along the line **191**.

For cold weather operation suitable heating elements may be mounted along the length of the guide tube and at other locations adjacent important operating parts of the launcher mount so that they may be retained at operating temperature in spite of low ambient temperatures.

A small rammer hatch **193** may be provided at the rear end near the top of the blast chamber **112** and is in alignment with axis of the guide tube when that tube is depressed to minus 10° elevation so that a manual rammer pole **194** may be inserted to push a missile from the forward end of the tube. This operation is illustrated in Fig. 42 where the missile is shown being conducted overboard along a suitable chute after it has been forced from the launcher tube by the rammer **194**.

In order to prevent firing of the launcher when it is aimed at the ship's own superstructure and also in order to prevent firing when the launcher elevation exceeds 60° there may be provided on the mount a firing interlock cam of any suitable type which may be located within housing **195** (see Fig. 11) and which cam may be adjustable in the conventional manner to control the limits of train and elevation during which firing of the launcher may occur.

The cable reel

The electrical connections for the above-deck mount including the train and elevating motor power circuits and the control systems are carried through a number of electrical cables of which five are employed in the embodiment illustrated. In the present embodiment as shown in Figs. 23 through 28 these cables have been numbered **201**, **202**, **203**, **204** and **205** and descend through the lower deck of the above-deck mount and are collected and supported by a cable reel member which protects them against abrasion and supports them against strain or twisting which might occur during rotation of the above-deck mount. This cable reel device comprises a hoist encircling drum **206** having a flange **207** about its upper edge which latter is provided with a plurality of equidistantly spaced bolt openings therethrough adapted to register with corresponding openings in a radially extending flange **208** (Fig. 22) encircling the lower edge of the base ring **126** of the rotatable mount. With flanges **207** and **208** bolted together the drum is carried by the mount in rotation.

The cable reel drum **206** supports a radial shelf **209** having an upturned edge **210** upon which shelf the cables **201** to **205**, inclusive, lay as they encompass the drum. The shelf **209** is interrupted to provide an opening through which the cables descend to a lower shelf **211** and in this opening is located a cable clamp **212**. The shelf

211 may be continuous and, since it too is secured on and rotates with the drum, there is no relative rotation between the cable and the shelf.

As the cable drum rotates, the cables are fed tangentially on and off this lower shelf **211** by a pulley arrangement shortly to be described. As shown in Figs. 23, 23A and 25, the cables are retained in a close side by side relationship on the lower shelf by a plurality of equally spaced roller operated cable retaining dogs **213** (Fig. 23A) which are pivotally mounted on brackets **214** secured to the edge of a top plate **215** secured to the cable drum and spaced slightly more than the thickness of a cable above the lower shelf. During the rotation of the mount the cable retaining dogs are guided so that a pad portion **216** on each dog engages the outer coil of cable and holds the five cables together in side by side relationship. This feature is particularly illustrated at the left side of Fig. 25. The roller portion of each dog rides in engagement with a peripheral track **217** which at the point where the cables are drawn tangentally off of the lower shelf connects with an inclined ramp **218** comprising spaced curved guides which move the rollers first outwardly and then upwardly thus freeing the cables from the side pressure of pads **216**. As the cables pass tangentally off of the lower shelf they are guided by a cable guide member **219** so as to pass over independently rotatable sheaves **220** being retained in contact with the sheaves by sets of idler rollers **221** and **222**.

The independently rotatable sheaves are supported upon a bracket **223** which in turn is mounted upon the stationary structure of the ship. This may be accomplished by securing it to a pad **224** supported by the reel encircling shroud **225** (Fig. 25) or by supporting it from one of the several horizontally disposed channel members **226** which form a part of the supporting structure.

It will be apparent that as the cable reel rotates in one direction with the mount it will play out slack which must be accommodated or else the cables are likely to become twisted and fouled, likewise reverse rotation of the mount will take up this slack. In order to provide a cable tensioning and slack accommodating means there is provided immediately under the rotatable sheaves **220** a cable receiving well **227** which may be secured to the stationary launcher hoist housing and comprises an elongated casing which is preferably divided into a plurality of narrow vertical chambers **228**, etc., one for each cable and a portion of which is shown in vertical cross section in Fig. 27. An access plate **231** may be provided at one side to permit the installation of cable followers 232, one in each chamber. These cable followers may be of the construction illustrated wherein a centrally mounted loosely rotatable sheave **233** is supported between spaced follower side plates **234** and **235** to receive one of the cables. The weight of the follower assembly is sufficient to keep the cable taught at all times, however, additional weight may be added if desired. The cables after passing around their respective sheaves **233** extend upwardly to the outside of the cable well where they are clamped in place by a clamping means **236** from which they extend to a suitable connection box 237 (Fig. 2) on the hoist housing. In order to guide the follower in its vertical movement within the elongated chamber there are provided a plurality of edge rollers 238 and side rollers **239** which engage the inside walls of the elongated cable receiving chambers and reduce frictional contact therewith.

The launcher hoist

The launcher hoist **102** raises missiles from a ready service magazine **101** into the after end of the guide tube **103** when the latter is disposed in the vertical load position. The upper end of this hoist is shown in Figs. 22 and 23 as a hollow tube **240** concentric with the axis of the cable reel drum and the axis of rotation of the launcher mount. As indicated in Figs. 1 and 2 the launcher hoist tube **240** has an adjacent hoist rammer chain guide housing **241** at one side thereof. Within this housing is located a rammer chain **124** and the housing **241** serves to guide rollers **243** on this chain so that a rammer spade **244** may be raised and lowered to lift missiles through the hoist tube and into the launcher tube.

As shown in Fig. 29, the chain **124** is of the conventional rammer type which will flex only in one direction and may be driven by a sprocket type driving member **245** mounted on shaft **246** and engaging with a helical gear **247**. This helical gear mates with a larger helical gear **248** mounted upon shaft **249** and connected to a crank arm member **250**. A similar one-way chain **251** having rollers **252** is secured at its upper end to a piston shaft **253** bearing a piston **254** slidable within a hydraulic cylinder **255**. Movement of the piston shaft **253** downwardly is transmitted through chain **251** to the crank arm member **250** to rotate the gears and raise the rammer chain and its lifter **122** to hoist a missile upwardly through the launcher hoist tube. In the embodiment illustrated the gearing is preferably such as to provide a 1 to 5 ratio between the downward movement of the piston **254** and the upward movement of the lifter **122**. Suitable hoist raising and lowering interlock switches are mounted in a control group **256** (see Fig. 3) and will hereinafter be discussed in more detail in the discussion of the hydraulic and electrical systems (see Figs. 29, 30, 43, 48, and 53).

The ready service magazine

The ready service magazine is shown in Figs. 3, 10, 30, 31, 32, and 33 and comprises a circular drum shaped framework of peripherally disposed channel like guide members **120**, each spaced from the other a sufficient distance to receive a missile therebetween, the entire framework being mounted for rotation about support bearings **116** shown in detail in Fig. 30. As there illustrated the ready service magazine drum includes a radially extending flange member **257** spaced between upper and lower roller bearings **258** and **259**, respectively. A similar roller bearing arrangement **260** is provided to receive radial thrust. In order to rotate the ready service magazine **101** there may be provided a pinion **261** mounted upon a shaft **262** driven by power drive means located within the magazine. This pinion drives the magazine drum through engagement with the teeth of an internal ring gear **263**.

As shown in Fig. 31, there may be provided adjacent the ring gear **263** a flange having a plurality of stop receiving notches **264** which may be engaged by a hydraulically actuated stop member **265** comprising a ready service drum latch mechanism. Engagement of this stop member **265** in a notch latches the drum with one stall in registry with the launcher hoist and another stall in registry with the stowage hoist. The control means for operating this stop member will hereinafter be described. Figs. 32 and 33 are enlarged views of the bottom portion of a ready service drum stall showing the details of a missile support latch **266** and a stall loaded indicator cam **267**. It will be noted that the missile support latch **266** pivots about pin **268** and is normally held in missile engaging position by a suitable spring **269**. With this arrangement, as a missile is fed upwardly from the stowage hoist hereinafter to be described, the stall is loaded from below and the forward end of the missile forces the missile support latch back until the shroud of the missile clears the latch, whereupon spring **269** moves the latch behind the missile and into missile supporting position. During the process of loading missiles from the ready service magazine drum into the stowage hoist it is necessary to retract the missile support latch so as to permit the missile to lower and for this purpose the after lower edge of the missile support latch member **266** is provided with an extension **271** which may be engaged by the overhanging lip **273** of a tripping head **272** mounted upon

stem 274 extending downwardly and actuated by means hereinafter described to retract the missile support latch during missile stowage operation. Suitable grounding means well known in the art may be employed to contact the body of the missile and maintain it at ground potential.

The stall loaded indicator may comprise a cam member 267 which has inclined upper and lower faces presented to the stall so that it will be cammed out of the stall when a missile is moved into place. This cam may be hinged at one side as by bolt 275 and is normally urged into the stall by a suitable compression spring 276.

There are provided one missile support latch and one stall loaded indicator for each stall, the stall loaded indicators actuate switches BJ–1 and 2 and BJ–3 the operating arms of which ride upon a ramp 279 which has inclined surfaces at each end.

The stowage hoist

The above-deck mount, cable reel, launcher hoist and ready service magazine operate together during automatic firing operations to load and fire missiles as long as the supply in the ready service magazine holds out, however, when said supply is exhausted it is necessary to replenish the ready service magazine from the ship's store of missiles and this is accomplished through a stowage hoist illustrated in Figs. 34 to 39, inclusive, and Fig. 41. This stowage hoist may extend one or more decks below the ready service magazine and is disposed in alignment with one of the peripheral stalls of the drum when latched in place and sufficiently spaced from the launcher hoist to prevent interference therewith. As a practical matter it has been found that it may be located at any position three or more stalls distant from the launcher hoist. By this arrangement missiles may be stowed in a well protected compartment on suitable racks and may be moved to the stowage hoist by conventional conveyor means.

As shown in Fig. 34, the stowage hoist comprises a tubular upper trunk 285 and a missile receiving lower trunk 286 which has a tray portion 287 hinged at 288 to permit the tray to be lowered down to a substantially horizontal position to receive a missile. In use, a missile is placed upon tray 287 by suitable conveyor means whereupon controls located on the stowage hoist control panel 289 may be actuated by the stowage hoist operator to cause the tray to be raised through the medium of a hydraulic raising cylinder 290 operating through one-way chain 291 upon a sprocket sector 292. This pivots the tray about a point 288 and raises the missile to a vertical position within the lower trunk portion 286 of the hoist. When the missile is in such vertical position its base rests upon a semicircular platform 293, one edge of which is cut away to accommodate a stowage hoist lifter 294. With the tray closed and the missile in position and with suitable interlocks and control circuits properly actuated the hoist lifter 294 may be raised by the operation of a hydraulic motor 295 acting through a suitable transmission 296 upon a one-way chain 297 to raise the missiles into an empty stall of the ready service ring immediately over the stowage hoist upper outlet.

In Fig. 35 is illustrated in detail a missile clamping arrangement whereby opposed arms 298 and 299 may be linked together to retain the missile on the tray against unintended movement while it is traversing the distance from its horizontal load position to a vertical hoist position. As there shown, the arm 299 pivots about a pin 300 and has a downwardly projecting bifurcated extension 301, between the arms of which is pivoted one end of a pair of link arms 302, which in turn are linked pivotally with the ends of a second pair of link arms 303 and 303*a* which are journaled in bosses 304 depending from the undersurface of the tray 287. These link arms 302 and 303 form a toggle linkage arrangement which because of stops (302*a*) can break only in one direction. Upright arm 298 is provided with a similar toggle linkage. Projections 303*b* on each toggle are connected by a spring 305 which normally urges the arms 298 and 299 to approachment to each other in missile grasping relationship. When the tray 287 is lowered the toggle linkage is broken by engagement of the knee of the toggle with spaced upright posts 306 positioned on the floor of the stowage room and in alignment with said knees. It will be apparent that with the tray at rest in its horizontal position the arms are separated and a missile may be loaded on the tray, however, as soon as the tray is lifted enough to free the knees from the upright posts 306, then spring 305 causes the arms 298 and 299 to grasp the missile. In order to control the operation of the stowage hoist and to provide electrical interlocks to prevent improper sequence of operation there are provided a number of electrical switches and actuating mechanisms therefor as follows.

In Fig. 36 is shown a stowage hoist lifter upper limit switches CC1 and 2 which are mounted near the base of the stowage hoist trunk (Fig. 34) and may be actuated by a cam 308 mounted upon the stowage hoist rammer chain 297 when the lifter reaches the upper extent of its travel. To accomplish this a roller 309 is mounted on a block 310 for sliding movement and the block is normally held inwardly by a spring and has a stem adapted upon outward movement of the block to engage the tip 311 of an actuating arm 312 pivoted at 313 and and having a portion 314 which engages the actuating roller of switches CC–1 and 2. Engagement of cam 308 with roller 309 actuates switches CC1 and 2 to reverse the direction of movement of the hoist lifter.

In Fig. 37 is shown in enlarged detail the stowage hoist lower chain limit switches CA–1, 2 and 3 and CA–4 which are arranged for simultaneous actuation by chain mounted cam 317 as follows: when the cam 317 in its upward movement reaches the position shown it engages a roller 318 mounted upon the end of a slidable block 319 which is normally spring biased inwardly but has a stem 320 which upon outward movement engages a crosspiece 321 to operate levers 322 and 323 pivoted at 324 and 325. Outward movement of the block 319 opens the contacts of switch CA–4 and closes the contacts of switch CA–1, 2 and 3.

Fig. 38 shows a switch operating mechanism whereby tray latch switch CB–1, 2 and 3 and a tray lowering switch CF may be actuated when desired. Considering first the tray latch switch CB–1, 2 and 3, its operating crank arm 328 has a pin at the end which rides in a yoke 329, keyed to a shaft 330. Likewise secured to said shaft is a bell crank 331 at one end of which engages links 332 connected to a second bell crank 333 pivoted at 334 and having an elongated operating arm 335 which is positioned in the bifurcated end of a reach rod 336 and connected thereto by a pin 337 movable in elongated slots 338 in the bifurcated end. The tension spring 339 secured to the end of the operating arm normally urges that arm upwardly. In the position indicated in Fig. 38 a stop lug 340 of the bell crank 331 abuts the end of a stop arm 341 pivoted at 342 and having a downward extension terminating in a spring biased tip 343. Spring means 344 serves to retain the stop arm 341 normally in the position indicated in Fig. 38.

As the tray 287 is raised to move a missile into the lower hoist trunk the end 345 of the tray forming a part of the flame seal brushes against the dangling tip 343 of the stop arm 341 to rotate that arm about its pivot 342 and lift the end abutment thereof out of the path of the stop lug 340 on the bell crank 331, thus permitting the spring 339 acting through the linkage aforesaid to move the stop lug under the end of the arm 341 and hence through the yoke 329 actuates switch arm 328 to close contacts CB1 and 2 and open contacts CB3 thereby to condition the control system so that the stowage hoist may operate to raise the missile up through the trunk and into an empty stall of the ready service magazine.

When the T handle 346 is grasped and pulled, reach rod 336 moves downwardly and ramp 347 thereon bears against the operating arm of tray lowering switch CF to close that switch and condition the control circuit to initiate downward movement of the tray.

Fig. 39 shows the actuating means employed for operating a tray loaded switch CD–1, 2, 3 and 4 and a tray position indicator switch CL. The former is operated when a missile has been correctly positioned on the tray by downward movement of missile engaging foot treadle 350 which pivots upon shaft 351 and moves a clevis rod 352 which rotates lever 353 about a pivot shaft 354 against the tension of spring 355. All of these parts are located on the undersurface of the tray and pivot shaft 354 has keyed for movement therewith an inwardly extending arm 356, the end of which is yoked and rides in a grooved collar 357 mounted upon an axially slidable sleeve 358 which floats about tray pivot shaft 288. The opposite end of the floating sleeve 358 has a flange 359 against which roller 360 on one arm of bell crank 361 bears. The other arm of the bell crank engages a clevis shaft 362 linked to a switch actuating arm 363 of the switch CD–1, 2, 3 and 4.

The tray position indicator switch CM has an arm 364 with a roller thereon which bears against cam surface 365, the contour of which conforms to the position of the tray and serves to close the switch CM when the tray is fully closed. Likewise, an interlock switch CL has a similar arm in engagement with the periphery of a cam 374 which serves to close switch CL when the tray is fully down.

It will be apparent that rockets or missiles must be loaded from above-deck down into the ship's stowage magazine and for this purpose the ready service magazine drum may be employed to carry missiles from the loading hatch 366 into alignment with the stowage hoist opening 369. Missiles are loaded into the ready service drum through hatch 366 (Fig. 41) through which they are lowered by means of a conventional crane 367 and motor operated hoist 368. Thereafter the drum may be rotated to position the missile immediately above the stowage hoist lifter 294 (Fig. 34) which may be raised empty and, at the top of its stroke, receive the missile to thereafter lower the same to the bottom of the stowage hoist, whereupon operation of the T handle reach rod 346 will cause the tray to lower to horizontal position with the missile thereon. As the tray reaches its horizontal position the arms 298 and 299 automatically release from the missile and it may be lifted by any suitable hoist means and conveyed to a rack for stowage.

It is during the missile stowage operation that the missile support latch 266 (Fig. 32) which supports the missile in the ready service drum stall is withdrawn by engagement of tripping head 272 therewith. This permits the missile to rest on the lifter 294 and be lowered thereby. The tripping head 272 may be actuated by any suitable means such as the lever 370 (Fig. 34) pivoted at 371 and moved by energization of solenoid SCE to raise armature 373.

The hydraulic power and control systems

As heretofore mentioned the guide tube and mount are moved in elevation and train by power and control systems of conventional design which are not shown in detail in the embodiment illustrated. Such conventional systems include power circuits and control and interlock circuits.

In addition to such conventional systems the present embodiment employs hydraulic power means for raising and lowering the launcher hoist; for indexing the ready service magazine drum; for operating the ship's stowage hoist and for actuating the stowage hoist transfer tray.

In Fig. 43 is illustrated by block diagrams a schematic representation of the novel hydraulic system shown in detail in Figs. 44 through 52. Many of the hydraulic components, such as the supply tank, filters, pump, pump valve block and accumulator are mounted on a stationary platform within the ready service magazine drum so as to provide a compact arrangement wherein the hydraulic lines may be kept to minimum lengths. As illustrated in Fig. 43, a tank 380 provides a source of hydraulic fluid to a pump 381 from which fluid under pressure emerges to pass through filters 382 and 383 to a pump valve block 384. From the pump valve block the fluid passes to an accumulator 385 where it is stored under pressure and from which it is distributed to the various hydraulic units of the system.

From the accumulator the hydraulic fluid is distributed to a ready service magazine drive unit 386; a launcher hoist operating cylinder 255; a stowage hoist operating motor 295; and a stowage hoist tray operating cylinder 290. As illustrated, suitable control and interlock means are provided so that the desired sequential operation of these components may be obtained. Such control means includes a ready service magazine control block 387 and a launcher hoist control valve block 388.

Considering the diagram first with respect to the operation of the ready service magazine drive unit and the launcher hoist operating cylinder only, it will be noted that a ready service magazine latch valve 389 is connected to both the ready service magazine control block 387 and the launcher hoist control valve block 388. The purpose of this interlock arrangement is to prevent operation of one when the other is operating. As will hereafter become apparent, the hoist interlock valve 390 unless actuated will prevent shifting of the ready service magazine latch valve and hence prevents retraction of the ready service magazine latch member, and, by interlock circuits, conditions the launcher hoist control valve block 388 and the ready service magazine control block 387 for operation while simultaneously releasing the ready service magazine drive unit brake 391.

A hoist latch 392 is normally biased to keep the hoist operating shaft 253 in raised position and this latch is retracted when operating pressure is built up in the accumulator. This latch simply serves to keep the hoist from creeping out of position when there is no pressure in the accumulator. The manner in which the interlock valve 390 is operated by a cam on the hoist rammer chain is schematically shown in this drawing.

Considering now the stowage hoist motor 295 and the stowage hoist tray operating cylinder 290; these units receive hydraulic pressure from the accumulator through an emergency stop valve 393 which may be of the quick acting manually operable type. The hydraulic fluid thereupon passes through separate flow control valves 394 and 395, one for the stowage hoist motor and the other for the stowage tray operating cylinder. From flow control valve 394 the fluid passes through an acceleration control valve 396 which is cam operated to control the speed of operation of the stowage hoist as it reaches its upper or lower operating limit. A reversing valve 397 actuated by solenoids automatically returns the hoist to its lower position at the end of each operating cycle. A brake 398 is connected to the hydraulic line between the acceleration control valve 396 and the reversing valve 397 so that the brake is released whenever power is supplied to the stowage hoist motor 295 to drive the same.

From flow control valve 395 hydraulic pressure passes to a stowage tray solenoid actuated reversing valve 399 which determines the raising and lowering movements of a tray operating cylinder 290.

The launcher hoist and ready service magazine hydraulic system

In Figs. 44 to 48 is shown in detail the hydraulic system employed to operate and control the hydraulic drive of the launcher hoist and the ready service magazine.

Referring first to Fig. 45 there is provided a fluid supply tank 380 from which oil passes through line 400 to

the inlet of a pump 381 driven by suitable means such as a constant speed electric motor 401. The output of this pump is directed through line 402 to a first filter 382 (Fig. 44) and through line 403 to a second filter 383 from which it emerges through line 404 to enter the right side of a pump valve block 384. Within the pump valve block the entering fluid is received by a spool type unloading valve 405 which is normally spring biased to its lower position as shown to permit the fluid under pump pressure to pass through a lower channel 406 and past a spring biased check valve 407 to leave the pump valve block through line 408 connected to manifold 414 of a hydraulic accumulator 385 (Fig. 45).

The hydraulic accumulator 385 may be of any satisfactory conventional design and, in the embodiment illustrated, comprises a cylindrical housing 409 which receives a movable piston 410 having on its left side an air chamber 411 and an its right side a hydraulic fluid chamber 412. The latter communicates through passage 413 with the hydraulic oil manifold 414. Passage 413 may be closed by manipulation of a manually operable valve 415.

In order to maintain the hydraulic fluid flow within prescribed limits the piston 410 is provided with a central shaft 416 having an enlarged tripping cam 417 at its right end, which cam engages the trigger portion 418 of an accumulator pilot valve operating arm 419 so that as piston 410 moves to the extreme left, as it does when the quantity of fluid in chamber 412 reaches the desired amount, shaft 416 with its cam 417 moves to the left and engages the trigger to fulcrum the pilot valve operating arm 419 about its pivot 420 thereby drawing accumulator pilot valve 421 to the right. This movement permits fluid under pressure to pass from manifold 414 through channel 422 and emerge from the pilot valve housing 423 through pilot line 424 to be conducted to the bottom of the unloading valve 405 (Fig. 44) and raise that valve against the compression of its spring and thereby disconnect the fluid inlet 404 from the channel 406 and connect such inlet 404 to the oil supply tank return channel 425 which connects with return line 426 leading back to the top of the oil supply tank 380. In this position the flow of fluid from the pump 381 simply recirculates back to the supply tank.

When the amount of fluid within the accumulator manifold 414 drops below the desired quantity, then the pressure of the air in chamber 411 returns the piston 410 to the right carrying with it shaft 416 and its cam to act upon the trigger 418 to return the upper end of the accumulator pilot valve control lever 419 to the left thereby moving the pilot valve 421 to the position shown whereby the fluid pressure from manifold 414 passing upwardly through port 422 emerges through line 427, assisting the spring to move the unloading valve 405 (Fig. 44) to its lower position so that the accumulator is again charged as hereinabove pointed out.

In order to permit the pump to be operated for testing and warm up purposes, without building up pressure in the accumulator, and in order to release accumulator pressure when desired, there is provided a manual by-pass valve 429 which may be operated to connect channel 430 to channel 426. A suitable relief valve 431 is provided to vent inlet pump pressure from line 404 to line 426 if it exceeds a predetermined relief valve adjustment pressure which may be varied by changing the tension on a spring 432.

Assuming that the ready service magazine is loaded, a missile has been indexed to hoist loading position (Fig. 4) and an automatic cycle is being initiated; in this condition the hoist lifter 122 (Fig. 29), is at its lowermost position and the ready service magazine drum is locked by engagement of latch 265 in one of the notches 264 (Fig. 31) to prevent rotation of the drum during the operation of the launcher hoist. With accumulator pressure built up (Figs. 44 and 45), fluid under pressure leaves manifold 414 through lines 433, 434 and 435 to act upon the hoist latch 392 (Fig. 48) to force the latch spool 436 downwardly and withdraw the latch member 437 which has been in engagement with the collar 438 upon the hoist operating cylinder shaft 253 to permit the launcher hoist to be operated.

At the same time pressure through line 433 (Fig. 46) enters the ready service ring latch valve 389 which, when in latched position, permits pilot pressure to flow past a latch valve spool 439 and out through line 440 to the hoist valve control block 388 (Fig. 47) where it is applied to the hoist direction pilot valve 441. By energizing solenoid SBA spool valve 441 is shifted to the right to port pilot pressure from line 440 to channel 444 to pass upwardly to the left-hand end of a hoist direction control valve 445 shifting the latter to the right so that pressure from the accumulator manifold arriving through line 446 is diverted into channel 447 leading to the speed control valve 448 from which it emerges through line 449 to enter the top of the hoist operating cylinder past maximum speed control valve 450. This forces the hoist operating piston down and hoists the rocket into the guide tube.

Return fluid from the lower end of the hoist cylinder flows out line 451 through the maximum speed control valve 452 which is adjusted to limit the maximum speed at which it is desired the hoisting operation shall take place and returns through line 453 which leads to the opposite end of the speed control valve 448 through which it may pass to enter channel 454 leading to the direction control valve which has now been moved so as to connect channel 454 with channel 455 connecting to return lines 456 and 426 so that the fluid may return to the oil supply tank 380.

As soon as the missile lifter starts its upward movement a cam 458 (Fig. 48) on the hoist rammer chain 124 moves out of engagement with the end of a rocker arm 460 which is connected by link 461 to the stem of spool 462 of the interlock valve 390. This permits compression spring 463 acting on the lower end of the spool 462 to move the spool upwardly thereby blocking the flow of fluid from pilot line 434 and 464 through the valve and out pilot line 465 extending to the ready service magazine control block 387. This prevents operation of the ready service magazine drive unit during movement of the hoist lifter as hereinafter will become apparent.

When a missile has been hoisted into the launching tube an interlock switch there located closes an electrical circuit to energize solenoid SBB (Fig. 47) to move the hoist direction pilot valve 441 to the left. This permits pilot pressure entering from line 440 to pass through channel 467 leading to the right end of the direction control valve 445 thereby shifting the direction control spool valve to the left and porting the entering fluid pressure from the accumulator through line 446 to channel 454 through speed control valve 448 to line 453 communicating with the lower end of the hoist operating cylinder so as to raise the hoist piston and consequently lower the hoist lifter member so that it may be in position to receive a new missile.

At the same time fluid from the upper end of the hoist operating cylinder is ported through the maximum speed control valve 450 which limits the rate of lowering of the hoist lifter and thence through line 449 to the speed control valve 448 through conduit 447 to the direction control valve 445 and out through return lines 456 and 426 to the oil supply tank 380.

It will be noted that solenoid SBB which initiates lowering of the hoist may be provided with a control knob 468 by which the hoist direction pilot valve 441 may manually be shifted to the left and hence by local control the hoist may be lowered.

When it is desired to operate the hoist slowly, as for example, when lowering an unfired missile from the guide tube back into the ready service magazine, a solenoid SBE may be energized to move the speed pilot valve 470

back to the right. This ports pilot pressure from channel **471** to channel **474** which leads to the left end of the speed control valve **448** forcing said valve to the right so as to close the passage between channels **454** and **453** and also the passage between channels **447** and **449**. Thus, the fluid is diverted so as to pass through channels **477** and **478** to the respective slow speed adjusting valve **475** which controls the hoisting slow speed and slow speed adjusting valve **476** which controls the lowering slow speed. Suitable creep adjustment valves **479** and **480** may be provided at the upper and lower ends of the hoist operating cylinder.

When the hoist lifter **122** (Fig. 48) approaches the bottom of its travel the cam **458** on the hoist chain **124** engages the lever **460** to force link **461** downwardly lowering the interlock valve spool **462**, and hence porting pilot oil pressure from line **434** through the interlock valve **390** to pilot line **465** leading to the ready service magazine control block **387** (Fig. 46). At the ready service magazine control block the entering pilot oil is controlled by a ready service magazine direction pilot valve **481** which is operable by solenoids mounted at its opposite ends so that upon energization of the lower solenoid SBC, for example, the ready service direction pilot valve is raised and oil entering from pilot pressure line **465** is ported through channel **483** to the upper end of a reversing valve **484** to move that valve downwardly. Simultaneously pressure from line **483** passes out through line **485** extending to the ready service magazine latch valve **389** where it acts upon the spool **439** to move it to the left together with a mechanical latch means **265***a* which withdraws a latch **265** (Fig. 31) from one of the notches **264** in the ready service magazine indexing circle.

When the spool **439** moves to the left it blocks pilot pressure from line **440** diverting it through a small opening **486** to drain line **487** and simultaneously communicates pilot pressure line **433** through channel **488** with line **489** leading to the brake **391** and at the same time pilot pressure flows by way of line **490** to the top of blocking valve **491** and to the top of the deceleration valve **492**. When the pilot pressure through line **485** has shifted the ready service magazine latch valve to the unlatched position as foresaid and has permitted pilot line pressure from line **433** to enter line **489** and release the brake **391**, the pressure rises within line **490** acting upon the top of valve **491** and forces that valve downwardly to port accumulator pressure from line **493** to chanel **494** and through reversing valve **484** to motor line **495** leading to the hydraulic motor **496** which operates the ready service magazine drive unit.

A return line **497** leads from the motor **496** to the reversing valve **484** where it connects with channel **498** in which is interposed a preset maximum speed control valve **499** having a passage **500** leading to the deceleration valve **492**. This latter valve is closed since the roller at the end of its operating lever **501** is riding upon the lobe **502** of a cam **503** which is driven by the hydraulic motor through the various shafts and gears indicated, however, a small portion of the hydraulic fluid from the return line **498** is permitted to leak through a creep adjustment valve **504** to a tank return line **505**. Through speed control valve **499** a portion of the fluid flows through a chanel **506** which leads through blocking valve **491** to channel **507** which is branched to connect to the upper and lower ends of the ready service magazine direction pilot valve **481**.

As will be seen by examination of Fig. 46, positioning of the ready service magazine direction pilot valve **481** at its upper limit, as by energization of solenoid SBC permits a slight amount of the motor discharge pressure to be vented to a return line **508** which connects to the return line **505**. This arrangement permits the hydraulic motor to rotate the ready service magazine at a slow rate until the lobe **502** moves out from under its roller and deceleration valve **492** is permitted to move downwardly under the pressure at its upper end coming through line **490** from the ready service magazine latch valve. When this occurs channel **500** is ported to chanel **509** and connects directly to the return line **505** permitting accelerated rotation of the ready service magazine. It will be apparent that as the lobe again raises the roller of the deceleration valve arm **501**, the valve returns to its illustrated position blocking off passage between channels **500** and **509**, thus decelerating the ready service magazine during the final portion of its rotation.

During loading operations or for other purposes it may be desirable to rotate the ready service magazine in the opposite or counterclockwise direction and for this purpose solenoid SBD may be energized to move the ready service direction pilot valve **481** downwardly to thereby connect pilot pressure line **465** with channel **511** to conduct fluid to the lower end of the reversing valve **484**, thus raising that valve so as to connect channel **494** by means of branch line **512** with motor return line **497** so that fluid under pressure passes through line **497** through motor **496** and back out line **495** to return through the reversing valve which in its upper position ports return fluid to channel **498** where it is controlled in the manner hereinabove described for clockwise rotation.

The stowage hoist and tray hydraulic system

In order to load missiles into the ready service magazine from the ship's stowage lockers and for striking down operations whereby missiles may be lowered from above-deck into the ready service magazine and from there to the ship's lockers, there are provided separate stowage hoist and stowage tray drive mechanisms which may be hydraulically actuated from the same source of hydraulic pressure as is described above.

As shown in Fig. 43, a single emergency stop valve **313** connected to the accumulator by a hydraulic fluid line controls the flow of hydraulic fluid to both stowage hoist motor **295** and tray operating cylinder **290**. This hydraulic line may lead from the accumulator manifold **414** (Fig. 45) through line **520** to an emergency stop valve **393** illustrated in the schematic detailed representation of the stowage hoist and tray operating circuit comprising Figs. 49 to 52, inclusive. As there illustrated, hydraulic fluid entering from line **520** under accumulator pressure acts upon a free-floating unbalanced valve stem **521** to raise said valve and flow out through line **522**. The undersurface of the unbalanced valve **521** is normally vented to a return line **523** and the upper surface communicates with a control line **524** leading to a three-way pilot valve **525**. When the handle **526** of this valve is in the up position, the top of the emergency stop valve piston **521** is vented through line **527** to return line pressure via lines **528** and **529** and **530**. The incoming pressure is conducted through pilot line **531** to the three-way pilot valve housing **525** in such a manner that when the handle **526** is lowered to the stop position the incoming pressure is ported to line **524** while line **527** is cut off. The incoming pressure acting through line **524** upon the head of the piston **521** forces the piston firmly to its seat against the differential of lower pressure existing in line **523** and hence immediately interrupts the pressure flow to the entire stowage hoist and tray operating hydraulic system.

From the emergency stop valve through line **522** the hydraulic fluid passes through a check valve **532** to line **533** and thence to a hoist flow control valve **394** (Fig. 50). This valve may be of the construction illustrated in H. F. Vicker's Patent 2,272,684 issued February 10, 1942 to utilize the principle that if a given pressure differential is maintained across an orifice of given size the flow through said orifice will remain constant. The effect of this valve is to maintain a predetermined constant volume of hydraulic fluid flow from the hoist flow control valve **394** to the hoist motor **295**. The hoist flow control valve **394** is provided with a handle **535** which

may be adjusted to vary the rate of flow of fluid out through line 534 leading to an acceleration control valve 396 (Fig. 51).

Valve 396 controls acceleration, deceleration and speed of the hoist in either direction and includes a vertically reciprocable spool member 536, the elongated lower end of which bears against a tappet member 537 which is pivoted at 538 and has a roller which bears against the periphery of a cam wheel 539. The cam wheel 539 is geared to the stowage hoist operating sprocket 540 so as to make a substantially complete revolution during a complete stroke of the hoist. The cam drive ratio is such that the spool valve member 536 is normally raised upon the lobe of the cam except near the end of the raising and lowering stroke of the stowage hoist rammer at which times the valve is moved downwardly to first throttle, and then completely shut off the passage of fluid therethrough.

A creeping, holding and leveling valve 541 of the needle valve type may be so located as to by-pass a very small part of the fluid flow around the upper part of the pilot and accelerating control valve 396 when the valve is in the down position. This assures that the stowage hoist will "creep" to its positive stops at each end of its movement and be held in such positions by pressure in the line which might otherwise drop due to leakage, etc.

From valve 396 the pressure then passes through line 542 to a hoist reversing valve 397 (Fig. 49) which is connected to the stowage hoist drive motor 295 by means of conduits 543 and 544. The reversing valve 397 is controlled by a pilot valve 545 which has a high pressure inlet from line 533 by means of line 546 and contains a valve spool 547 which may be shifted, either to the right or the left by a hoist up solenoid SCA and a hoist down solenoid SCB, respectively. This valve is also capable of manual operation by manipulation of a removable handle 550 which is insertable in an opening in an operating bar 551 which has terminal portions acting upon opposite ends of the spool valve 547. In the position illustrated in the drawings solenoid SCB has been energized to shift the valve stem 547 to the left, thus porting pilot pressure through line 552 to the left end of a reversing valve spool 553 thereby shifting said spool to the right and permitting pressure from the pilot and accelerating control valve 396 passing through line 542 to be ported to reversing valve outlet line 543 extending to the stowage hoist operating motor 295. The return line from said motor is through line 544 to the reversing valve 397 and hence through channel 557 to line 528 for return via lines 529 and 530 to the main hydraulic supply system. For this purpose, line 530 may return directly to the oil supply tank 380 (Fig. 45).

When solenoid SCA is energized in order to raise the stowage hoist lifter, then spool valve 547 is shifted back to the right and pilot pressure from line 546 thereupon passes out through line 555 to the right-hand end of the reversing valve spool 553 to move said spool to the left, thereby permitting entering fluid pressure from line 542 to be ported to line 544 and thereupon drive the stowage hoist motor 295 in the opposite direction so as to raise the stowage hoist. The discharge from said motor then passes through line 543 and channel 556 which communicates with conduit 557 and joins line 528 to return to the supply tank. Between lines 557 and 528 is interposed a back pressure valve 558 which is urged to the right by a spring 559 and is urged to the left by the pressure in a chamber 560 which communicates with inlet line 542. By proper selection of the spring 559 the device may be adjusted so that a predetermined back pressure is maintained in the system at all times irrespective of direction of operation of the stowage hoist motor.

A brake 398 (Fig. 51) is provided in the stowage hoist drive system and is preferably positioned adjacent the stowage hoist drive motor 295 as illustrated. The operating means for this brake may include a cylinder 561 containing a piston to which operating pressure may be applied through line 562, and since line 562 connects to the main pressure line 542 leading from the pilot and accelerating control valve 396, the brake will automatically be released each time the motor 295 is energized for driving in either direction.

From the main hydraulic fluid pressure line 533, fluid pressure may be drawn for operation of the tray operating mechanism by means of line 563 connected to a tray flow control valve 395 (Fig. 50) which may be identical to the hoist flow control valve 394 described above. From that valve and through line 564 fluid at a uniform rate of flow is conducted to a reversing valve 399 which, like the pilot valve 545 aforesaid, may be operated by an up solenoid SCC or by a down solenoid SCD, or by a removable handle 567. Within the reversing valve is a spool valve member 568 having oppositely extending stem portions engageable by the solenoids so that upon energization of solenoid SCC, for example, the tray may be raised to the up position through the shifting of the spool 568 to the left thereby porting pressure from line 564 through the valve and out through line 569 to enter the top of the tray operating cylinder 290 (Fig. 52). This forces downwardly a piston 570 connected to a shaft 571 to drive downwardly the tray chain 291 thereby rotating the spur sector 292 to raise the tray 293 to its upright position. The fluid under pressure coming from line 569 forces its way past a tray up control valve 572. The fluid in the space below the piston 570 is ported out through line 573 back to the reversing valve 399 from which it emerges through a return line 574 connecting with return lines 528, 529 and 530 which communicate with the supply tank 380.

To reverse the operation and lower the tray, solenoid SCD (Fig. 50) is energized to drive the reversing valve spool 568 to the right thereby porting inlet pressure from line 564 to line 573 from which it passes to the undersurface of the piston 570 to raise it to the uppermost limit of its movement. During the upward movement of piston 570 fluid escaping from above the piston is unable to pass through one-way valve 572 and hence must pass through the poppet type down control valve 575 which when open allows fluid to return through line 569 to the reversing valve from which it is ported through channel 576 to line 574 and thence back to the main hydraulic supply. The upper end of poppet valve 575 is vented through line 577 and a control valve 578 to line 573. Thus, the pressure below the piston 570 acts upon the upper surface of valve 575 to open that valve only when pressure exists in line 573. The control valve 578 permits varying the speed of operation of the down control valve 575 by controlling the flow of fluid thereto.

Tray acceleration and deceleration needle valves 579 and 580 control the final movement of the tray operating piston and a suitable by-pass valve 581 may be connected in the line linking valve 580 with line 573. Suitable crossover valves 582 and 583 (Figs. 49 and 50) may be provided as illustrated to shunt the tray operating and hoist operating power lines if desired. A hand pump 584 may be employed to assist in completely draining the system.

The electrical power and control system

The mount is driven in train and elevation by conventional electric and hydraulic systems, such for example, as the train and elevation power and control systems employed with the 40 mm. mount as aforesaid.

The hydraulic power for raising and lowering the launcher hoist, rotating the ready service magazine and raising and lowering the stowage hoist and its tray may be provided by pumps driven by electric motors operated by the ship's electrical system and these motors together with the hydraulic control valves may be con-

trolled and actuated by suitable power and control circuits as illustrated in Figs. 53 through 60, inclusive.

Considering first the ready service drum and hoist motor controller circuit illustrated in Fig. 54. As there shown, the three-phase ship's electrical circuit is tapped by lines **600**, **601**, and **602** which may pass through a manual circuit breaker CB and three main controller contacts C, through coils **603** of overload relay OR and to the electric motor **401** which drives the large hydraulic pump **381** Fig. 45. In order to close the contacts C of the main controller, a start pushbutton BT (Fig. 53) may be depressed to conduct current through control line **604** to the center contact of switch BT, down through line **605** to one side of normally closed stop switch BU, through line **606** to the operating coil **607** of relay C and thence back through line **608** to main line **601**. Coil **607** thereupon closes contacts C of the main controller to connect the motor **401** directly to the line and start the motor.

Simultaneously with the above, current flows from pushbutton switch BT through line **609**, the coils **610** and **611** to reset relays RR, and through line **608** to main line **601**. Coils **610** and **611** reestablish overload relay contacts OR if they had been broken and hence current may now pass from line **604** through line **612** and contacts C—OR—OR to stop switch BU and hence back to the main line **601**. This provides a holding current through coil **607** to maintain the main motor controller contacts C in engagement. The motor will stop either upon manual opening of pushbutton contacts BU or by separation of a pair of overload relay contacts OR—OR upon a predetermined overload being imposed upon the drive motor **401**. In order to show operation of the hoist pump drive motor, there is provided a pilot light LH mounted upon the control panel (Fig. 53).

Similar to the above there are provided suitable train and elevation motor controller circuits which, because they may be controlled if desired by interlocking portions of the launcher circuit are shown in Figs. 55 and 55A. As shown in Fig. 55 the train motor may likewise be tapped to the ship's electrical system and current passes from the ship's power lines by lines **601**, **602** and **603** through a manual switch PS, main motor controller contacts C and the coils **599** (OR—OR) of an overload relay to the train pump drive motor **613**. In order to start the train power supply motor, control handle BP upon the control panel Fig. 53 is set at the start position and the start pushbutton BV is depressed. Current may then pass from wire **601** to main controller operating coil **614**, thence through line **615**, switch BP1, and line **616** to the start pushbutton BV; down line **617** to stop pushbutton BW and through line **618**, and switch BS2 which is the manual above-deck stop switch, through contacts AM which are open when the train is set for manual operation, and through the contacts of switch AK which is closed when the train stowage pin is moved to the unlocked position, returning by line **619** to the main line **602**.

Control handle BP, unless moved to the "Start" position, opens contacts BP2 which are located in the train power drive circuit (not shown) so that training load may not be applied while the train motor is starting. A pilot light LT is provided on the control panel to indicate operation of the train motor **613**.

In Fig. 55A is illustrated the elevation motor controller circuit and, as there shown, current from the main lines **600**, **601** and **602** passes through a manual switch PS, the main controller contacts C and the coils **598** (OR—OR) of an overload relay to the elevation drive motor **620**. In this circuit current from main line **601** is conducted through main controller operating coil **620***a* and line **621**, through contacts BQ1 and line **622** to pushbutton start switch BX and by line **623** to stop switch BY and thence through line **624** to switch BS1 located above-deck and operable to stop the elevation drive motor when the above-deck mount is being worked on, thence through contacts AL which are open whenever the elevation drive mount is set for manual operation, through switch AH which is closed when the elevation stowage pin is moved to the unlatched position, returning by way of line **625** to main line **602**.

It will be noted that control handle BQ when moved to the "Start" position opens contacts BQ2 located in the elevation power drive circuit (not shown) so that elevation load may not be applied while the elevation motor **620** is starting. A pilot light LE is connected across the main lines **601** and **602** near the motor to show on the control panel when it is operating.

In Fig. 56 is illustrated a control and interlock circuit which is shown in detail in Figs. 57 to 60, inclusive, together with suitable operation indicating legends. As shown in Fig. 56 the power received from a step down transformer **626**, the operation of which is indicated by light L1, is conducted through lines **627** and **628** to a double pole switch B Fig. 53. With switch B closed current may flow from line **627** to lines **629** and **630** and from line **628** to lines **631** and **632**.

From line **629** current may pass downwardly through line **633** and either through the contacts of switches AG2 or AF2 so as to illuminate light L2. Switch AG2 (Fig. 12) is actuated by the latch which holds the guide vertical and is open when the latch is secured. Switch AF2 (Fig. 12) is located on the carriage and is normally closed but will be opened by movement of the guide when it reaches the vertical load position.

In order to complete a launcher hoist "raise" circuit current may flow from line **629** through switch AA1 (Fig. 13) which is actuated by the bore clear indicator shoe and is closed only when the guide tube is empty, to manually operable switch BA1 operated by control handle BA located on the launcher control panel (Fig. 53) and which is of the three position type to control switches BA1 to BA13 inclusive. This handle BA is shown in its off position. It is movable to the left to close the contacts of all even numbered switches during "Load" operations and is movable to the right to close the contacts of all odd numbered switches for automatic "Run" operations. With switch BA1 closed current may then flow through line **635** to the contacts of stall loaded indicator switch BE1 which are closed when a missile is properly positioned in the ready service magazine stall and is indexed into alignment with the launcher hoist. Switch AG1 (Fig. 12) is actuated by the launcher tube vertical load position latch and is closed when the guide tube is vertical and the latch pin is in place so as to lock the guide tube during operation of the launcher hoist. The current may then pass through the contacts of switch AF1 (Fig. 12) which is located on the carriage and is closed when the launcher guide tube is vertical and ready for loading. Thereafter the current may pass through the contacts of switch BR (Fig. 48) which is mounted near the launcher hoist operating cylinder and are closed when the operating cylinder detent is withdrawn so that the hoist may operate. The current then may pass through the contacts of switch BF1 (Fig. 31) which is closed when the ready service magazine drum is locked against rotation and thence through solenoid SBA to energize the same to operate the pilot valve **441** (Fig. 47) in the hoist control valve block thereby setting the valve to start the hoist to raise. An indicator light L8 on the launcher control panel may simultaneously be illuminated to indicate that the hoist is raising.

It will be noted that unless the contacts of switch BE1 (Figs. 1 and 2) are closed, which occurs only when a missile is properly positioned in the ready service ring at the launcher hoist station, there can be no current through the above-described circuit in order to raise the launcher hoist. However, in order to test the launcher hoist without a missile at hoist position, there is provided

a by-pass "test" circuit including lines 636, 637 and 638 which is controlled by manually operable switch BM on the control panel, Fig. 53. The control handle of this switch may momentarily be moved from its spring biased normal "Open" position to a "Test Hoist" position to close the contacts BM1 and thus complete the circuit even though no missile occupies the stall at hoist position.

The launcher hoist "raise" circuit may also be operated by current passing through line 639, contacts BA2 which are engaged when control handle BA is turned to "Load," line 640 and contacts BB1 of manual hoist direction control switch BB. However, if a missile is presented to the lower end of the hoist by the ready service magazine and is ready to be raised into the tube, then switch BE2 in this circuit is opened and operation of the hoist cannot be effected. This prevents accidental raising of the hoist when a missile is in the ready service magazine at the hoist position during manual hoist operations.

Continuing to the right of the circuit just described there is provided a launcher hoist "lower" circuit including lead 641 connected to the contacts of switch BG1 (Fig. 3) located on the hoist gear housing and which is actuated by a cam on the launcher hoist chain when the lifter member reaches substantially the top end of its stroke in raising a missile into the guide tube. From this switch lines lead in parallel to contacts BA3 and BA4 operated by control handle BA which is the "Manual loading selector" switch. With the control handle BA in "Run" position current will pass from line 641 through contacts BA3 to switch BM2 which is normally closed except when the control handle BM is turned to the "Test hoist" position in which case the lowering circuit is broken. From switch BM2 the current may pass through the contacts of either switch AB or switch AC (Fig. 14) connected in parallel, both of which are located at the rear end of the guide tube, one on top and the other on the underside and each of which is closed when its respective missile support latch is in missile supporting position. From either of these switches the current may pass through line 642 to solenoid SBB mounted on the hoist control block and serving to shift pilot valve 441 (Fig. 47) to initiate hydraulic lowering of the launcher hoist. A suitable indicating light L9 positioned on the hoist control panel is simultaneously illuminated.

If the switch BA is moved to "Load" position, which may be done, for example, when lowering an unfired missile from the guide back into the ready service magazine, then the contacts of switch BA3 are opened and the contacts of switch BA4 are closed and current may flow from line 629 through line 641, switch BG1 and the contacts of switch BA4 to the contacts of switches AD and AE (Fig. 14), which latter are connected in series and are closed only when the respective missile support latches have been fully retracted. Thence, current may flow through line 643 to switch BB2 operated by control handle BB on the control panel. The contacts BB2 are closed when the handle is moved to the "Lower" position and current is then conducted through line 644 and line 642 to energize solenoid SBB as aforesaid. This permits manual control of the lowering of the launcher hoist, and in addition to illuminating light L9, also illuminates light L5 to indicate that the guide latches are retracted.

Continuing the discussion, the next circuit to consider is the "hoist speed control" circuit which provides means for shifting valve 470 Fig. 47 for either normal rapid speed hydraulic operation or slow speed hydraulic operation. As shown, current may be conducted from line 629 to switch BH2 which is closed only when the launcher hoist lifter member is at its fully down position, and thence current may flow either through switch BA7 or BA8, depending upon whether the control handle BA is at its right "Run" position or its left "Load" position. With handle BA in its "Run" position current flows through the contacts BA7 to line 645 to contacts of switch BZC (Fig. 47) which is mounted on the hoist control valve block and these contacts are closed only when the pilot valve is positioned for slow speed hoist operation. Thus, if the valve is set for slow speed when the circuit is energized, current will pass through the contacts of this switch to solenoid SBF to shift the pilot valve back to the position for normal rapid speed position.

With the control handle BA in its "Load" position switch BA7 is opened and current from contacts BH2 may pass through contacts BA8 and hence through line 646 to the contacts of switch BZB which is mounted on the hoist control block (Fig. 47) and is closed only when the hoist speed control pilot valve is in its "normal speed" position. From this switch current may flow through solenoid SBE to line 631 to move the aforementioned pilot valve for slow speed operation in the event it is in the opposite position when the circuit is energized. When control handle BA is moved to the "Load" position to close the contacts of switch BA4 current will also pass through line 647 to line 646 to energize solenoid SBE and shift the speed control pilot valve for "slow speed" operation.

The next circuit to consider is the "elevation limit stop setting" circuit including line 648 which leads to contacts of switch AA3 operated by the bore clear indicator shoe (Fig. 13) which contacts are open when a missile is in the launcher tube. When the tube is empty these contacts are closed and current may flow to a solenoid SAD which establishes a 90° elevation limit stop for the guide tube. The parallel circuit including switch AA4 has contacts which are closed only when a missile is within the guide tube, hence establishing a second circuit through solenoid SAE which conditions the elevation limit stop setting for a 60° maximum elevation. These two switches and their solenoids thus permit the guide tube return to vertical when it is empty so that it may be reloaded, but prevent the guide tube's automatic return to vertical as long as a missile is within the guide tube.

In order to prevent unintended operation of the launcher while repairs or adjustments are being made on the above-deck components, there is provided an emergency stop circuit the indicator portion of which includes line 649 extending in parallel to lights L6 and L7 (Fig. 53) through switches BS3 and BS4, respectively. Control handle BS is ordinarily located on a small control panel mounted above-deck and close to the above-deck mount, and when operated to close contacts BS3, light L6 on the launcher control panel below deck is illuminated to indicate that the train and elevation motors "Can start." Conversely when the contacts BS4 of this switch are closed light L7 on said control panel lights to show that the train and elevation motors "Cannot start." The control portion of this circuit is provided by mechanical linking of the control handle of switch BS with switches BS1 and BS2 in the elevation and train motor controller circuits, respectively (Figs. 55 and 55A). As there shown opening of switches BS1 and BS2 breaks the circuit to the operating coil of the main motor controllers and prevents closing of the main line switches.

The next circuit to consider determines which director signal will control movement of the launcher guide. It will be apparent that with a missile in the guide tube it is desired that the tube follow the ship's fire control director signal, while after the missile has left the tube it is desired that the tube return to vertical where it may be loaded with another missile. To this end current from line 629 may pass through lead 650 to switch BG2 which is mounted upon the launcher hoist (Fig. 2) and is opened by a cam on the rammer chain when the hoist lifter member arrives within a short distance of the upper limit of its travel. Since it is necessary for the lifter to enter into the after end of the guide tube to deposit a missile on the missile support latches this interlock switch BG2 prevents movement of the guide tube when the launcher

hoist lifter is in a position to interfere with movement of said guide tube.

From switch BG2 current may pass through line **651** to bore clear indicator shoe switch AA2 (Fig. 13) which is closed when a missile is in place in the tube and thereafter the current may pass through switch BA9 which is closed when the manual loading selector control handle BA is in the "Run" position. Thence the current may pass through switch B0 which is mounted on the hoist control valve lock **388** Fig. 47 and is closed when the valve parts are set for hoist lowering operation. The current then energizes solenoid SAC (Fig. 12) which by suitable means (not shown) may cause withdrawal of the guide latch **170** and simultaneously rotate a switch AN, to switch the elevation drive to ship's director signal so that the guide tube will follow the ship's director in elevation. One method of accomplishing this is to have solenoid SAC control the positioning of a directional hydraulic valve to port oil under pressure against a piston which upon movement retracts the guide latch **170** and simultaneously through a sector arrangement rotates the multicontact switch AN. Certain of the AN switch contacts may be employed to automatically retract the forward missile restraining latch when the guide latch **170** is retracted as above. At the same time current passes through light L4 on the control panel to indicate that the launched guide is loaded. Switches AA2 and BA9 may be by-passed by a manually operable switch BZ connected in parallel therewith and mounted above-deck adjacent the above-deck launcher components so that when the switch BZ is closed the guide tube may be operated on director signal for test purposes even though the guide tube is not loaded as above-described.

As related to the operation of the launcher guide tube and the launcher hoist with their interlock and control systems the following discussion will describe the electrical circuits for controlling the ready serice magazine rotation, the operation of the stowage hoist and the operation of the stowage hoist tray together with their various interlocks. It will be apparent, of course, that the launcher hoist does not operate while the stowage hoist is being used.

The ready service magazine control circuit includes contacts CA1 (Figs. 34 and 37) which receive current from line **629** and are located on the stowage hoist and closed only when the stowage hoist rammer is at its extreme down position. Current then flows to the contacts CB1 located on the tray latch for the stowage hoist (Figs. 34 and 38) and which are closed only when the tray is completely latched in the fully up position. Next the current flows through contacts BH1 (Fig. 1) mounted on the launcher hoist housing which are closed only when the launcher hoist is at its fully down position. The current may then pass through contacts BM3 which are controlled by the position of control handle BM (Fig. 53) and these contacts are normally closed except during hoist testing. Thence, the current passes through contacts BB3 which are closed when the control handle is in the "Normal" position. Thereafter current flows through line **652** to contacts BA5 which are closed when the manual loading selector control handle is set to the "Run" position. The current then flows to contact BE3 (Fig. 1) located within the ready service ring and closed when an empty stall is presented to the launcher hoist. Thereafter the current flows through contact BC2 which are part of the ring direction selector switch and are closed when the control handle BC (Fig. 53) is turned to the "Run" (CW) position. This permits current to pass to solenoid SBC (Fig. 46) which shifts the direction control pilot valve **481** (Fig. 46) for the ready service magazine drive unit to cause the ready service drum to rotate in a clockwise direction during automatic operation of the launcher.

From contacts BB3 current may flow through line **653** to contacts CD4 (Fig. 39) which are located on the stowage hoist tray and are closed when no missile is positioned on the tray, hence to contacts BA6 which are closed when control handle BA is set for "load." The circuit is thereby completed to light L12 to indicate that the ready service magazine "Can rotate." Thereafter control handle BN may momentarily be closed, shifted to close contacts and cause counterclockwise rotation of the ready service magazine. From the latter contacts current passes through contacts BC1 when the control handle BC on the launcher control panel is set at "Load," and thence to solenoid SBD (Fig. 46) which when energized shifts the direction control pilot valve **481** of the ready service magazine drive unit in order to cause the ready service drum to rotate in a counterclockwise direction.

Contacts CD4 may be by-passed through contacts BD5 which are closed only when control handle BD is in the "Off" position. However, since switch contacts CD4 are open when a missile is on the tray, the ready service magazine cannot rotate if either control handle BD is not at the "Off" position or if there is a missile on the stowage tray during ready service magazine loading operations. When either circuit for the rotation of the ready service magazine is energized, light L10 will be illuminated.

The next circuit to consider includes contacts CB3 (Figs. 34 and 38) which are closed only when the stowage tray is not latched and permits current to flow from line **629** to line **654** and through light L3 on the control panel which indicates that the tray is not latched. Through a parallel circuit light LC2 at the stowage hoist operator's control panel may be illuminated when control handle BA is at the run position. Light LC2 advises the tray operator to close the tray immediately.

The electrical circuit for lowering the stowage hoist tray extends through contacts BA10 which are closed when control handle BA is turned to "Load" position, through the contacts BF2 (Fig. 46) which are closed when the ready service magazine latch is in latched position, and through contacts BJ3 (Fig. 32) which are closed when an empty ready service magazine stall is positioned above the stowage hoist. Thence the circuit continues through line **657** to contacts CA3 (Fig. 34) on the stowage hoist trunk and which are closed when the stowage hoist rammer is at the fully down position. Thereafter current flows through the contacts CL (Fig. 39) on the stowage tray and which are closed when the tray is in up position, thence through contacts of switch CF (Figs. 34 and 38) which is on the tray latch and is closed only when the tray latch is fully retracted and through relay coil RCD closing contacts CRCD to energize solenoid SCD which shifts the hydraulic pilot valve **565** (Fig. 50) to start the tray downwardly. Light L11 shows that the tray can be unlatched while light LC3 on the Stowage Hoist Operator's control board indicates that the loading tray can be lowered.

The next circuit to be considered controls the raising of the stowage hoist tray and includes line **658**, contacts CD3 which are closed when a missile is correctly positioned on the tray, line **659** to contacts CM which are closed when the tray is in down position and thence to manually operable pushbutton CE located in the stowage hoist room. When the pushbutton is pressed current flows through relay RCC to close contacts CRCC and energize solenoid SCC (Fig. 50) to shift valve and thereby condition the hydraulic circuit to raise the tray to its vertical position. An indicating light L13 (Fig. 53) show that the solenoid SCC has been energized to condition the tray operating circuit to raise the tray.

The raise tray circuit may also be energized through contacts BA13 and lines **660**, **660***a* which shunt the contacts of switch CD3 (Fig. 39) which are open when no missile is on the tray. Contacts BA13 are closed when control handle BA is in the "Run" position. A second shunt circuit includes lines **661** and **660***a* to permit current to pass through contacts BD6 operated by control handle BD located on the control panel and contacts are closed when the handle is in the "Hoist amm." position. With control handle BA in the "Load" position, contacts BA10

will be closed permitting current to flow through lines 662 and 663 to pushbutton CZ which is located within or adjacent to the ready service magazine, and when depressed, serves to illuminate light L16 on the control panel to serve as a manual signal to the Mount Operator during loading operations.

Line 662 also connects to line 664 leading to contacts BD3 and BD4 which are in parallel and are actuated by control handle BD. Movement of control handle BD to the "Hoist amm." position closes contacts BD3 to permit current to illuminate light LC5 at the stowage hoist operator's station to indicate that the ready service drum is being loaded. Current then flows through switch BK (Fig. 32) which is closed when the missile support latch in the stall at the stowage hoist position is in normal position. From there current may pass through the contacts CC1 located on the magazine hoist trunk and which are closed when the stowage hoist is at its fully up position. This permits current to flow to relay RCB, thus closing contacts CRCB to energize solenoid SCB which in turn operates the pilot valve 547 (Fig. 39) to start the stowage hoist rammer downwardly. At the same time light L15 on the control panel (Fig. 53) is illuminated to indicate that the stowage hoist is energized for downward movement.

Through a parallel circuit current may pass from line 664 through line 665 to contacts BD4 which are closed when the control handle BD is in the "Lower amm." position. Current is then conducted through contacts BL (Fig. 32) which are closed when the missile support latch on the ready service magazine stall at stowage hoist position is fully retracted. Thereafter current may flow through contacts CC1 to relay RCB to cause the stowage hoist rammer to lower as aforesaid.

In addition, current may flow from the contacts of switch BD4 through a line 666 to contacts CC2 (Figs. 34 and 35) which are closed when the stowage hoist is fully raised and then through pushbutton CH which may be closed to operate relay RCE which in turn controls contacts CRCE to energize solenoid SCE (Fig. 34) which retracts the missile support latch on the ready service drum at the stowage hoist station. From switch CC2 current may pass through line 667*a* to illuminate light LC7 (Fig. 41) and show that the missile support latch 226 can be retracted.

At the same time current passing through line 667 illuminates light LC6 at the stowage hoist control panel to indicate that striking down operations are in progress, whereby missiles are being lowered from the ready service drum through the stowage hoist to the stowage magazine.

Simultaneously current may flow from line 666 through contacts CA4 (Figs. 34 and 37) which are closed unless the stowage hoist is fully down and through contacts CRCE2 which are closed when latch retracting relay RCE is energized.

From contacts of switch BF2 (Fig. 46) current may flow through line 668 to switches BJ1 and BJ2 (Figs. 32 and 33) connected in parallel. Switch BJ1 is closed if the ready service magazine stall at the stowage hoist is empty and permits current to pass through to contacts BD1 which are closed unless control handle BD is at the "Hoist amm." position used when hoisting missiles from the stowage hoist to the ready service magazine. Current then passes to contacts of switch CD1 (Fig. 39), located on the stowage hoist loading tray which are closed when a missile is correctly positioned on the tray, and through line 669 to switch contacts CA2 (Fig. 34) on the magazine hoist trunk which are closed when the hoist rammer is fully down. Thence current may pass through switch CB2 on the loading tray latch, closed when the loading tray is latched in the up position, to energize relay RCA, thus closing the contacts of switch CRCA to energize solenoid SCA (Fig. 49) which shifts pilot valve 547 to condition the hydraulic circuit to raise the stowage hoist rammer. Light L14 on the launcher control panel connected in this circuit is illuminated when the solenoid SCA is energized.

A second portion of the stowage hoist control circuit in parallel with a portion of the above circuit includes contacts BJ2 (Figs. 32 and 33) which are connected to line 668 and are closed when the missile stall at stowage hoist position is loaded. Current may then be conducted to contacts BD2 which are closed when control handle BD is at "Lower amm." position, thence to contacts CD2 (Fig. 39) on the stowage hoist tray which are closed when no missile rests upon the tray. Next the current may pass through pushbutton CG located at the striking down station which when closed, completes the circuit through switch contacts CA2 and CB2 (Fig. 34) to energize solenoid SCA as aforesaid. In addition to indicating light L14 the light LC4 is illuminated when this circuit is energized to indicate to personnel at the striking down station that the rammer can be raised.

The firing circuit and firing interlock means

In Fig. 61 is illustrated a block diagram of a firing circuit which may be used with the launcher of the present invention and includes a control panel 670 from which the firing circuit may be controlled by the mount operator, either by a local control pushbutton FBB which is effective when a selector control handle FBC is moved to local position or, if desired, the firing circuit may automatically be controlled by moving the control handle FBC to the "Director" position. In either case the firing impulse leaving the fire control panel along path 671 must pass through the contacts of relays FAE and FAG, which are controlled as hereinafter discussed, to an interlock switch FAB which is closed by disengagement of ramp 673 (Fig. 14) from the rollers of this switch, only when the guide tube is at less than 60° elevation, then through another switch FAC which is closed only when the blast chamber door is open, then through another switch FAD which is closed only when the forward missile restraining latch has been fully retracted, and finally through a switch FAA which is closed only when the launcher guide tube is not pointing towards a danger zone, such as part of the ship's own superstructure.

Thereafter firing circuit current is led to the firing pin 281 (Fig. 15) to be applied to the missile through the shroud encircling contact ring 282. The grounded portion of the missile thereupon connects back to the control panel to complete the circuit through path 672.

The synchronism firing interlock including relay operated switches FAE and FAG receives an elevation error signal from the launcher elevation power amplifier and a train error signal from the launcher train power amplifier, these signals are fed into the synchronizing firing interlock which has for each signal a rectifier and a thyratron tube, the grid current of which is varied by changes in the error of the signals and serves to control separate train and elevation relay circuits which close the contacts of switches FAE and FAG as aforesaid when the mount and guide tube are operating in synchronism with the ship's fire control director.

On the firing panel, in addition to the selector control handle FBC and the local fire control pushbutton FBB, there is provided a safety plug FBA which is intended to be removed and carried about by personnel when making adjustments on the mount.

The panel also has control lights such as LF1 which indicates when the 115 volt firing circuit from the director is energized; LF2 which indicates when 115 volts is being supplied to the synchronized firing interlock; LF3 which indicates when the firing circuit is completed and LF4 which is a "Cease fire" signal for advising the Mount Operator that the firing should stop.

Operation

In the above description has been set forth the struc-

tures and functions of the guide tube and its mount, the launcher hoist, the ready service magazine, and the stowage hoist and tray together with the hydraulic and electrical power, control and interlock circuits therefor. The following discussion is concerned with the operation of the entire launcher equipment during loading of the stowage magazine, automatic fire, reloading of the ready service magazine from the stowage magazine, and testing and casualty operations such as would be encountered by actual use of a launcher embodying the present invention. For this purpose, it will be assumed to start with that the launcher mount is in stowed condition, that all control and power circuits are off and that both ready service and stowage magazines are empty.

As before-mentioned only a minimum number of personnel is necessary in order to carry out the above operations with the present missile launching equipment. These personnel are located at suitable control panels and there is illustrated in Fig. 41 one arrangement and location of such panels and operation stations which may be employed. As there shown a "Mount operator," a "Stowage hoist operator" and a "Striking down controlman" are located below decks while above-deck missile handlers may assist during missile striking down operations. In addition stowage magazine personnel transport missiles from the tray to missile stowage racks in the main stowage compartments of the vessel and similarly transport the missiles to the stowage hoist tray when loading the ready service magazine with a supply of missiles to prepare the launcher for operation. It will be noted that with the present launcher equipment the missiles need never be lifted by hand and therefore large and cumbersome missiles may conveniently and rapidly be handled and launched.

Striking down operations.—There will first be considered the operations necessary to lower missiles into the ready service magazine and thereafter lower missiles from the ready service magazine into the ship's stowage magazine by the use of the stowage hoist. This loading operation is commonly referred to as a "Striking down" operation.

During this procedure the ready service drum serves as a conveyor to move the missiles from a position below a striking down hatch in the weather deck to a position above the stowage hoist by which latter they then may be lowered into the ship's missile stowage magazine area. In these striking down operations either of two procedures may be employed; a number of successive magazine stalls may each be loaded with a missile and then the several missiles may sequentially be moved into alignment with the stowage hoist for lowering into the ship's missile stowage compartments or, in the alternative, a single missile may be lowered into a stall and the ready service magazine then indexed so as to position that missile above the stowage hoist. However, in either case substantially the same controls are employed.

As shown in Fig. 41, a crane **367** and a hoist **368** may be used to support a missle **118** over a striking down or loading hatch **366** through which the missile may be lowered into an empty stall of the ready service magazine drum. Before any missiles are lowered into the ready service magazine drum, however, as a safety precaution, personnel topside first ascertain that the (BS), conveniently located above-deck, as on the pedestal of the crane, is turned to "Off." This prevents starting of the train and elevation motors during the striking down stowage operation. The mount operator then closes the hoist motor controller circuit breaker CB, which illuminates light L1 on the launcher control panel. Next he turns the control handle B to "On," thereby energizing the control and interlock circuits. The mount operator then presses the "Start" pushbutton BT on the control panel, starting the hoist motor and illuminating light LH; turns control handle BA to "Load"; turns control handle BC to "Load"; and turns control handle BD to "Lower Amm." The ready service drum is now in condition to be loaded, and a missile may be lowered from above through hatch **366** into an empty stall directly beneath the striking down hatch. When the shroud at the lower end of the missile rests on the missile support latch in the lower end of the stall, the crane cable is unhooked and the striking down controlman signals the mount operator who then turns control handle BN momentarily to "Rotate," thus indexing the ready service magazine one position and placing the next empty stall directly beneath the striking down hatch. This procedure is repeated until the desired number of missiles are in the ready service magazine stalls. The number of missiles lowered into the ready service magazine will depend on the method of loading, as explained above. A manual signal switch CZ at the striking down station enables the striking down controlman to signal the mount operator by flashing light L16 on the control panel. The mount operator therefore, is notified when to rotate the ring by prearranged signals from the striking down station. The next step in the striking down operation involves lowering missiles from the ready service drum to the ship's stowage magazine. To do this the mount operator first ascertains that the control panel light, L3 is not lighted. If this indicator is lighted, showing "Not latched," operations cannot be carried on. (As the hoist tray acts as a flame seal, a missile should never be in position above the magazine hoist unless the tray is raised and latched; consequently, the interlock circuit is so arranged that the ready service magazine cannot be rotated until the latter condition exists.) The stowage hoist operator observes that light LC1 and light LC6 are illuminated indicating that power is on and that striking down operations are in progress.

During the lowering of missiles into the ready service magazine the mount operator watches the signal light L11 which will go on (displaying "Empty") each time the ring is latched, so long as empty stalls are presented to the magazine hoist. When the first loaded stall arrives over the magazine hoist, light L11 will stay out when the ring latches. This advises the mount operator to discontinue indexing operations.

Thereafter pushbutton CG is depressed by the striking down controlman to raise the stowage hoist. At the top of its stroke, the hoist lifts the missile above the missile support latch at the bottom of the magazine stall and stops. Pushbutton CH may then be operated, by the striking down operator to withdraw the missile support latch. Withdrawal of this latch closes switch BL in the interlock circuit and the stowage hoist automatically starts downwardly, lowering the missile to the vertically positioned tray at the bottom of the hoist. The start of the up and the down travels of the stowage hoist are indicated to the mount operator by lights L13 and L15, respectively, on the control panel.

When the stowage hoist with a missile reaches the bottom of its stroke, light LC3 illuminates, indicating that the tray may be lowered. The stowage hoist operator then pulls on the **T** handle **34** to retract the tray latch and the tray will then lower the missile to a horizontal position. The exposed missile may thereafter be removed from the tray by stowage room personnel and transported to suitable stowage racks.

After the missile has been removed from the tray, the stowage hoist operator presses pushbutton CE to start the tray up. When the tray pivots to the vertical position it automatically latches and the light L3 goes out to indicate that the tray is now latched. Thereafter the mount operator moves control handle BN momentarily to rotate the ready service magazine one position, and so place the next loaded stall over the magazine hoist. The missile lowering operation is then repeated. Indexing of the ready service magazine also places an empty stall under the striking down hatch, and if desired another missile may be lowered into the empty stall by the whip hoist. Through the use of signals from the striking down

controlman to the mount operator the action of personnel at both of these stations can be coordinated to load missiles into the stowage magazine from topside as a continuous operation.

Loading ready service magazine from below.—The ready service magazine may be loaded from below where it is desired to prepare the launcher for a state of readiness for action. In order to accomplish this the mount operator first starts the hoist motor and conditions the control circuits as aforesaid. He then turns control handle BA to "Load"; turns control handle BC to "Load"; and moves control handle BD to "Hoist amm." The stowage hoist operator then observes that lights LC1, LC3 and LC5 are illuminated and pulls the T handle 346 and the tray lowers to a horizontal position.

When a missile has been correctly positioned on the tray, the stowage hoist operator presses pushbutton CE, thereby raising the tray and missile to the vertical position whereupon the stowage hoist automatically raises the missile into the empty ready service magazine stall directly above the hoist, raising the missile high enough to clear the missile support latch which snaps back to its normally extended position under the missile shroud. The stowage hoist then reverses direction and starts downwardly, but the missile is retained in the ready service magazine stall by the missile support latch. When the stowage hoist reaches the bottom of its stroke, one loading cycle will have been completed and the ready service magazine can be indexed by the mount operator to permit the next stall to be loaded in similar position. This is continued until the ready service magazine is filled.

The mount operator follows the action of the magazine hoist and tray by observing the lights on the control panel. These lights indicate the start of travel of the magazine hoist "Up" (L14) or "Down" (L15), and the condition of the hoist tray "Up" (L13) or "Not latched" (L3). In addition, light L12, displaying the words "Can rotate," notifies the mount operator when conditions are such that the ready service magazine can be rotated in manual control. This condition occurs when the magazine hoist rammer is fully down, the magazine hoist tray is latched in up position, either no missile is on the magazine hoist tray or switch BD is at the "Off" position, the launcher missile hoist is fully down and switch BA is at the "Load" position.

Launcher hoist test.—It is desirable from time to time to raise and lower the launcher hoist without a missile so as to test the operation of the hoist and be sure that it is in proper operating condition. This may be done only when the guide tube is in vertical position and the hoist motor has been started as described above. When so conditioned the mount operator moves control handle BM to the "Test hoist" position which will cause the empty hoist to rise at normal speed to the upper limit of its travel and when the control handle BM is released the hoist will return automatically at normal speed to its lower position.

Automatic firing run operation.—When the ready service magazine is loaded and the entire launcher is prepared for operation, the mount operator may set up his control panel (Fig. 53) for automatic firing operation as follows: the hoist, train and elevation motors are started by pushbuttons BT, BV and BX, respectively; thereafter control handle B is moved to "On" position; control handle BA is moved to "Run" position and control handle BC is moved to "Run" (CW) position. The remaining handles are left in their indicated positions. At the same time switch FBC on the fire control panel is moved to "Director" position and the Safety Plug FBA must be in place.

Immediately the guide tube, if horizontal, will pivot to vertical "Load" position and a missile will be hoisted from the ready service magazine up into the guide tube which will then move downwardly beyond 60° elevation, whereafter it operates in response to signals received from the ship's fire director system and will follow the ship's director until the firing circuit is closed to launch the missile from the guide tube, whereafter the tube will pivot upwardly to receive another missile. This loading and firing cycle will continue until all of the missiles in the ready service magazine have been fired in rapid succession without any further action on the part of launcher personnel, or until the firing circuit is left open. When the ready service magazine becomes empty it will continue to rotate intermittently until stopped by the mount operator turning the control handle BA to "Off" position. Such automatic operation is schematically indicated in Figs. 4 to 9, inclusive, and the time cycle of operation of Fig. 40.

In the event the automatic "Run" operation is stopped with an unfired missile in the guide tube this missile may be returned to the ready service magazine as follows: the mount operator turns switch BA to "Off," the train and elevation power drives are stopped by pushbuttons BW and BY or by moving switch BS topside to "Off," the train and elevation drives at the mount are shifted from automatic to manual operation, the guide tube is elevated manually to its vertical position and the mount is trained manually to a position where the hoist lifter 122 will not strike the missile support latches 135. The control handles of switches BA and BC are then turned to "Load," the control handle of switch BN is operated momentarily to rotate the ready service drum one stall counterclockwise, switch BB is turned momentarily to "Hoist" to raise the hoist lifter 122 so as to engage the bottom of the missile shroud to raise the missile off of the missile support latches whereupon the missile support latches 135 may be manually retracted by lever 142 (Fig. 14). Switch BB is then momentarily turned to "Lower" to cause the hoist lifter with the missile to descend and return the latter to the empty ready service magazine stall.

Casualty operation procedures.—In the event a missile in the guide tube fails to fire then the missile cannot be returned to the ready service magazine but must be jettisoned over the side of the ship. This operation is controlled by the mount operator who first turns control handle BA to the "Off" position, stops the train motor, elevation motor and hoist motor and turns off the control and firing circuits. Thereafter the above-deck crew connects a water hose to the external sprinkler connection of line 191 and the sprinkler system is operated for several minutes or until the guide tube is cool. The mount may then be trained manually so that the guide tube is athwartship and the guide tube may then be depressed manually to approximately minus 10° so as to be aligned with an overboard chute shown in Fig. 42 which has been moved into the position illustrated. Thereafter the forward missile restraining latch 137 may be retracted by movement of handle 158 to the position indicated in Fig. 16. By removing rammer access door cover 193 a rammer pole 194 may be inserted to shove the rocket out of the guide tube and along the chute to be disposed of overboard.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A device for launching a plurality of missiles in rapid succession comprising; a structure mounted for rotation relative to other components of the device, a guide carried by said structure for directing the initial flight of the missiles and supported for oscillating movement from an inclined firing position to a vertical loading position, a ready service magazine for carrying a plurality of

missiles and sequentially presenting the carried missiles to a position below and in longitudinal alignment with said guide when the latter is in loading position, means for sequentially loading missiles from the ready service magazine through a straight, vertical path into the guide when the guide is in the vertical loading position, means for firing a missile from the guide when the guide is inclined to the firing position, both said means including electric cables connected between said rotatable structure and stationary components therebelow, means for preventing twisting, straining, and chafing of the cables during rotation of said rotatable structure, and means for protecting said guide from back blast of missiles being launched.

2. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of the missiles and movable from a vertical loading position to an inclined firing position, a rotatable ready service magazine for carrying a supply of missiles and sequentially presenting the carried missiles to a position below and in longitudinal alignment with said guide when the latter is in loading position, means for rotating the ready service magazine for effecting such an alignment between the missiles in the ready service magazine and the guide hoist means operable in timed relationship with the rotation of the ready service magazine for sequentially conveying missiles from the ready service magazine through a straight path to the guide when the guide is in vertical loading position, means for firing missiles so conveyed to the guide, both said means including electric cables and control circuits, means for maintaining said cables in a desired disposition regardless of the train setting of the guide, and means for protecting components of the launching device from back blast of a missile being launched.

3. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of the missiles and movable from a vertical loading position to an inclined firing position, means for moving said guide from the loading position to the firing position, a rotatable ready service magazine supporting a plurality of missiles for successive movement into vertical alignment with the guide when it is in vertical loading position, hoist means operable in timed relationship with the rotation of the ready service magazine for sequentially conveying missiles from the ready service magazine into the guide when the guide is in vertical loading position, ignition means for firing missiles conveyed to the guide, means including control circuits and electric cables for controlling the operation of the launching device, means for maintaining said cables in desired disposition regardless of the train setting of the guide, and means for protecting components of the launching device from back blast of missiles being launched.

4. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of the missiles and supported for oscillating movement from a vertical loading position to an inclined firing position, means for oscillating the guide between said positions, a rotatable ready service magazine having a number of missile stalls disposed about its periphery the stalls being movable into alignment with the guide when in its vertical position, hoist means operable in timed sequence with the positioning of the stalls in alignment with the guide for conveying missiles from the stalls into the guide when the guide is in vertical loading position, firing means for launching the missiles from the guide when in inclined firing position, control means including electric cables, means for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

5. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of a missile and supported for oscillating movement from a vertical loading position to an inclined firing position, means for oscillating the guide between said positions, a rotatable ready service drum, a plurality of missile receiving stalls disposed about the periphery of the drum and movable sequentially into axial alignment with the guide when it is in its vertical loading position, means for intermittently rotating the drum so as to sequentially position the stalls in alignment with the guide, hoist means operating when the drum is stationary for conveying a missile from an aligned stall into the guide when it is in vertical loading position, a missile firing circuit, means for energizing the circuit, control means for the launching device including electric cables, means for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

6. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of missiles and supported for oscillating movement from an inclined firing position to a vertical loading position, means for oscillating the guide between said positions, a rotatably supported ready service drum, a plurality of missile stalls about the periphery of the drum and movable into axial alignment with the guide, means for rotating the drum to successively move the stalls into axial alignment with the guide, hoist means to raise a missile from an aligned stall into the guide when it is in vertical loading position, means for locking the stall in alignment with the guide during the missile hoisting operation, a firing circuit to fire the missiles, control means for the launching device and including a plurality of electric cables, means for maintaining said electric cables in a desired dispostion free from twisting, straining and chafing forces regardless of train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

7. A device for launching a plurality of missiles in rapid succession comprising; a trainable guide for directing the initial flight of a missile and mounted for oscillating movement from an inclined firing position to a vertical loading position, means for oscillating the guide between said positions, a ready service magazine drum mounted below the guide, missile compartments disposed about the periphery of the drum, means for rotating the drum to succesively move missiles contained in the compartments into axial alignment with the guide when it is in loading position, means adjacent the drum for hoisting missiles from the compartments into the guide, control means for synchronizing the rotation of the drum with the movement of the hoisting means whereby missiles contained in the compartments may sequentially be hoisted into the guide, a firing circuit for a missile in the guide, means for energizing the circuit, said last-mentioned means including at least one electric cable, means for maintaining said electric cable in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

8. An automatic missile launcher comprising; a trainable above-deck mount, a launcher guide pivotally supported on the mount and movable from an inclined firing position to a vertical loading position, means for pivoting the guide between said positions during automatic operation, a below-deck missile magazine supported independently of the mount and having a plurality of missile receiving stalls longitudinally alignable in sequence with said guide when the latter is in loading position, a stationary launcher hoist having a missile lifter movable

through a vertical, straight-line path adjacent the magazine for linearly conveying missiles from sequentially aligned stalls into the guide when it is in loading position, means for actuating the hoist and the magazine, interlock means for preventing movement of either the hoist or the magazine when the other is operating whereby missiles contained in the stalls may sequentially be conveyed into the guide in loading position, a firing circuit energizable when the guide is at firing position, control means for training the mount, elevating and depressing the guide, and energizing the firing circuit, said control means including electric cables connected between the above-deck mount and below-deck components, means for maintaining said electric cables in a desired position free from twisting, straining and chafing forces regardless of train setting of the mount, and means for protecting components of the launching device from back blast of missiles being launched.

9. A rapid fire automatic missile launcher comprising; a trainable above-deck mount having an aperture in its base to admit missiles therethrough from below, a missile guide supported on the mount and pivotable from an inclined firing position to a vertical loading position in alignment with the aperture, a ready service magazine located beneath the mount, the magazine including a a plurality of spaced missile carrying stalls, means for moving each of the stalls into axial alignment with the guide, conveyor means for lifting a missile contained in an axially aligned stall through the aperture and into the guide, means for operating the conveyor means in timed relation with the movement of the stalls whereby a number of missiles may be fed in succession from the magazine into the guide, means for retaining a missile in the guide during pivoting movement to firing position, a missile firing circuit, means for interrupting the firing circuit when the guide is in loading position, control means for training the mount, elevating and depressing the guide, and energizing the firing circuit, said control means including electric cables connected between the above-deck mount and below-deck components, means for maintaining said electric cables in a desired position free from twisting, straining and chafing forces regardless of train setting of said mount, and means for protecting components of the launching device from back blast of missiles being launched.

10. A device for successively launching a plurality of missiles comprising in combination; a guide for directing the initial flight of the missiles, a trainable mount supporting the guide for movement from a loading position to a firing position, means for moving the mount in train, means for moving the guide from loading position to firing position, the guide when in loading position being disposed in coaxial alignment with the axis of train of the mount, a launcher hoist positioned to raise and lower missiles in a straight-line path along the axis of train, a ready service magazine below the mount and having stalls to support a plurality of missiles adjacent the launcher hoist, the magazine being movable to successively position missiles in coaxial alignment with the axis of train so that they may be raised by the launcher hoist and deposited in the guide when the latter is in its loading position, a magazine drive, control means acting on the drive to index the magazine to successively present missiles to the launcher hoist, interlock means to prevent movement of either the hoist or the ready service magazine when the other is in operation, the stalls being reloadable from below, a separate stowage hoist to reload missiles into the magazine stalls from below, means for operating the stowage hoist, control and interlock means whereby individual missiles may be fed from below into the magazine to replenish the missile supply therein during periods when firing operations are not in progress, electric cables connected between components on the mount and components below the mount, means for maintaining said electric cables in a desired position free from twisting, straining and chafing forces regardless of train setting of the mount, and a protective shield including deflecting vanes for directing blast gases through an escape opening in the protective blast shield and ventilating means to provide a flow of cooling and scavenging air through the shield.

11. In an automatic missile launcher the combination of; a trainable mount, a guide for directing the initial flight of a missile, and supported on the mount for oscillating movement from a vertical loading position to an inclined firing position, means for oscillating the guide between the positions, a hoist registering with the lower end of the guide and in longitudinal alignment with said guide when the latter is in vertical loading position, the guide and its mount being rotatable about the upper end of the hoist so that a missile may be hoisted into the guide during training movement of the mount, control means for training the mount, and elevating and depressing the guide, said control means including electric cables connected between the above-deck mount and below-deck components, means for maintaining said electric cables in a desired position free from twisting, straining and chafing forces regardless of train setting of the mount, and means for protecting components of the launching device from back blast of missiles being launched.

12. In an automatic missile launcher; a trainable mount, a missile guide supported on said mount and movable in train therewith, means for moving the guide in elevation from an inclined firing position to a vertical loading position at which time the axis of the guide aligns with the training axis of the mount, hoist means in longitudinal alignment with the after end of the guide in loading position for loading missiles along a straight-line path into the after end of the guide when it is in loading position and during training movement, control means for training the mount and elevating and depressing the guide, said control means including electric cables connected between the mount and said elevation moving means for the guide and said hoist means, means for maintaining said electric cables in a desired position free from twisting, straining and chafing forces regardless of train setting of the mount, and means for protecting components of the launching system from back blast of missiles being launched.

13. In a launcher for successively firing a plurality of missiles; a vertical straight-line missile hoist, a ready service magazine for automatically presenting missiles to the hoist in sequence, a rotatable launcher mount supporting a guide for movement from an inclined firing position to a vertical loading position in which the guide, the hoist, and the presented missile in said magazine are in substantial longitudinal alignment, the mount being located at the upper end of the hoist and rotatable thereabout, the axis of rotation of said mount substantially coinciding with the longitudinal axis of said hoist whereby a missile may be hoisted from the ready service magazine into the guide during rotation of the mount, control means for training the mount and elevating and depressing the guide, said control means including electric cables, means for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said mount, and means for protecting components of the launching device from back blast of missiles being launched.

14. In an automatic missile launcher comprising a trainable missile launching guide pivotally mounted for oscillation in a vertical plane between an inclined firing position and a vertical loading position a straight-line hoist and a rotatable magazine, said magazine having a plurality of object supporting stalls movable past said hoist, said stalls being open at one end to allow an object therein to emerge, each of said stalls having the longitudinal axis thereof in alignment with the longitudinal axis of the guide in loading position when the stall is positioned for emergence of the supported object, drive

means for moving said stalls, drive means for said hoist, said hoist including an object engaging lifter to remove an object endwise from a stall, the sides of the stall in hoist position forming guideways for guiding the object in its endwise movement from the stall through a straight-line path into the launching guide, control means for training, elevating and depressing the guide, said control means including electric cables connected between relatively rotatable components, means for maintaining the cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of the guide, and means for protecting components of the launching device from back blast of missiles being launched.

15. In an automatic missile launcher the combination of; a trainable guide for directing the initial flight of a missile, the guide being movable between a firing position and a loading position, the guide at its loading position being in alignment with the axis of train, a hoist including a missle engaging lifter movable along the axis of train for loading missiles into said guides, a ready service magazine for successively delivering missiles into the path of the lifter, a drive for the magazine comprising a source of hydraulic pressure and a motor to be driven by the pressure, transmission means between the motor and the magazine, a valve to control the flow of hydraulic fluid to the motor, means in the transmission to shift the valve upon approach of a missile into the path of the lifter whereby to decrease the supply of hydraulic fluid to the motor and thereby reduce the speed of movement of the magazine, electric control means including electric cables interconnecting relatively rotatable components, means for maintaining the cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of the mount, and means for protecting components of the launching device from back blast of missiles being launched.

16. In an automatic missile launcher the combination of; a guide for directing the initial flight of a missile the guide being movable in elevation from an inclined firing position to a vertical loading position, a mount supporting the guide and rotatable in train, a missile hoist including a lifter for moving a missile into the guide along a path coaxial with the train axis of the mount, said lifter when in its uppermost position being in the path of movement of the guide, means for operating the hoist to raise a missile into the guide, missile engaging latches to retain a missile in the guide after it has been raised thereinto, interlock means to prevent movement of the guide out of loading position until the hoist has lowered sufficiently to clear the after end of the guide, control means for training the mount and elevating and depressing the guide, said control means including electric cables interconnecting relatively rotatable components, means for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of the guide, and means for protecting components of the launching device from back blast of missiles being launched.

17. In an automatic missile launcher the combination of; an above-deck trainable mount, a guide carried by said mount for directing the initial flight of a missile and movable in elevation from an inclined firing position to a vertical loading position coaxial with the axis of train of the mount, a below-deck missile hoist for loading missiles into the after end of the guide, a hoist lifter member reciprocably carried by said hoist and movable in a straight-line path parallel with the axis of train of the mount, a below-deck ready service magazine adjacent the missile hoist and supporting a plurality of missiles therein, means below-deck for operating the magazine to successively present missiles to the hoist, each of said successively presented missiles being positioned with the longitudinal axis thereof in alignment with the longitudinal axis of said guide in loading position, means on said magazine for enabling said hoist lifter member to engage each missile after the latter is presented to the hoist and to move the missile in a vertical straight-line path into the guide, locking means for retaining the magazine stationary during movement of the hoist lifter member, interlock means to prevent operation of the hoist except when the magazine is stationary, control means for training the mount, and elevating and depressing the guide, said control means including electric cables connected between the above-deck mount and below-deck components, means for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

18. A rapid fire automatic missile launcher comprising; a trainable mount having a central aperture in the base thereof to permit the hoisting of missiles therethrough, a guide for directing the initial flight of a missile and oscillatably supported on the mount for movement from an inclined firing position to a loading position in alignment with the aperture, means for oscillating the guide between these firing and loading positions, a missile supporting magazine below the mount and movable to sequentially position missiles into alignment with the aperture, conveyer means for raising missiles so aligned through the aperture into the guide, power means for moving the magazine, a control system for effecting cyclic operation of the magazine and the conveyer means whereby missiles may be moved successively into the guide, a firing circuit energizable automatically to fire a missile from the guide when the guide moves to firing position, electric cables interconnecting relatively rotatable components, a cable reel device for maintaining said electric cables in a desired disposition free from twisting, straining and chafing regardless of the train setting of the mount and the elevation setting of the guide, and means for protecting components of the launching device from back blast of missiles being launched.

19. A missile launcher comprising in combination; a trainable guide, a hoist, and a magazine, the guide being reciprocable between an inclined firing position and an upright loading position in which latter position the guide is aligned with the hoist so as to receive a missile therefrom, means for operating the hoist including a motor, and a control for the motor, the control preventing motor operation except when the guide is properly aligned with the hoist, said magazine being movable to bring additional missiles to the hoist, the magazine including a drive means and a control circuit therefor, interlock means to condition the magazine drive so that it may operate only when the hoist is in condition to receive a missile, control means for training, elevating and depressing the guide, electric cables connecting guide components with said control means, a cable reel mechanism for maintaining said electric cables in a desired disposition free from twisting, straining and chafing forces regardless of train setting of said guide, and a blast shield for protecting components of the launching device from back blast of missiles being launched.

20. A missile launcher comprising in combination; a missile guide, a trainable mount supporting the guide, the guide being supported in the mount for movement between a vertical loading position and an inclined firing position in which latter position the after end of the guide is adjacent a blast chamber through which blast gases may be directed away from the mount, means on the guide for retaining a missile on the guide so that it will not fall from the after end of the guide, firing mechanism for the missile launcher, hoist means for loading a missile into the after end of the guide when the guide is vertically disposed, the entire length of said hoist means being in substantial longitudinal alignment with said missile guide when the latter is in vertical loading position and out of alignment when said guide is in an inclined

firing position, an automatic magazine to feed missiles to the hoist means while the guide is moving to firing position and returning therefrom, control means for training the mount and elevating and depressing the guide, said control means including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said electric cables in a desired disposition and free from twisting, straining, and chafing forces regardless of the train setting of the mount, and back blast protective means for protecting components of the guide and mount from the back blast of missiles being launched.

21. A missile launcher comprising in combination; a guide, a trainable mount supporting the guide for movement in elevation between a vertical loading position and an inclined firing position, a hoist for loading missiles into the guide when the guide is in vertical position, and a magazine automatically operable to position a new missile in the hoist, means for actuating the magazine to position a new missile by return of the empty hoist to the ready position, means for actuating the hoist to hoist the missile upon return of the guide empty to the vertical loading position, means for firing a missile from the guide, control means for controlling the operation of the launcher, said control means including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said electric cables in a desired disposition, and a protective shield having a blast chamber therein for protecting components of the launching device from back blast of missiles being launched.

22. A missile launcher comprising in combination; a guide, a mount supporting the guide for movement in elevation between a vertical loading position and an inclined firing position, means for moving the mount in train, a hoist including a missile lifter member for loading missiles into the guide when the guide is in vertical positon, and a magazine automatically operable to position a new missile in the hoist, means for actuating the magazine to position a new missile by return of the empty missile lifter member to the ready position, means for actuating the hoist to hoist the missile upon return of the guide empty to the vertical loading position, means for maintaining the entire hoisting path of a new missile along the axis of train of the mount whereby the guide may be loaded during training movement of the mount, means for firing a missile from the guide, control means for controlling the operation of the launcher, said control means including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said cables in a desired disposition under constant tension regardles of the train setting of said guide, and means for protecting components of the launching device from back blast of missiles being launched.

23. A missile launcher comprisng in combination; a trainable guide, a missile hoist, a reciprocable missile lifter member on said hoist, a ready service magazine adjacent the hoist, the guide being movable between an inclined firing position and a vertical loading position in which latter position the after end of the guide is in substantial longitudinal alignment with the hoist, means for vertically moving the missile lifter member from a ready position adjacent the ready service magazine to a load position on the guide when the latter is in vertical loading position, means for actuating the ready service magazine upon return of the empty missile lifter member to the ready position to position a new missile in the hoist, interlock means to prevent loading of the missile from the hoist into the guide unless the guide is empty and at its loading position, means for firing a missile from the guide, control means for the missile launcher including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said electric cables in a desired disposition and under constant and desired tension regardless of the train setting of said mount, and blast shielding means for protecting components of the launching device from back blast of missiles being launched.

24. In missile launching apparatus, a trainable guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a loading position, a magazine beneath the guide and having a plurality of missile bearing stalls sequentially movable into longitudinal alignment with the guide when it is in loading position, a hoist including a missile lifter member for moving a missile along a straight-line path from an aligned stall into the guide, means for moving the magazine to successively align stalls thereof with the guide in loading position and to thereby present stalls to the hoist, control means for selectively causing the missile lifter member to move a missile from an aligned stall into the guide, the control means also being selectively operable for causing the hoist to move a missile from the guide into an aligned empty stall in said magazine, means for training, elevating and depressing the guide, said means including electric cables connected between substantially vertically spaced and relatively rotatable components, means for maintaining the electric cables in a desired position under constant tension and free of twisting, straining, and chafing forces regardless of the train setting of the guide, and blast protection means for protecting components of the launching apparatus from back blast of missiles being launched.

25. In missile launching apparatus, a trainable guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a vertical loading position, a magazine beneath the guide and having a plurality of missile bearing stalls movable into longitudinal alignment with the guide when it is in vertical loading position in all positions of train, a hoist for raising a missile from an aligned stall into the guide in any desired train setting of the guide, means for moving the magazine to successively present stalls to the hoist, control means for selectively causing the hoist to raise a missile from an aligned stall along a straight-line path into the guide, the control means also being operable to cause the hoist to lower a missile from the guide into an aligned empty stall in said magazine, interlock means to prevent raising of a missile except when the guide is empty, means for training, elevating and depressing the guide, said means including electric cables connected between substantially vertically spaced and relatively rotatable components, means for maintaining the electric cables in a desired disposition under constant tension and free from twisting, straining and chafing forces regardless of the train setting of the guide, and blast protection means for protecting components of the launching apparatus from back blast of missiles being launched.

26. In missile launching apparatus, a trainable guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a vertical loading position, a magazine beneath the guide and having a plurality of missile bearing stalls movable into longitudinal alignment with the guide when it is in a vertical loading position, a hoist for raising a missile from an aligned stall along a straight-line path and into the guide, said hoist being in substantial longitudinal alignment with the guide when the latter is in loading position, means for moving the magazine to successively present stalls to the hoist, control means for selectively causing the hoist to raise a missile from an aligned stall into the guide, interlock means to prevent raising of the hoist except when a missile is in the stall, control means for positioning the guide and firing missiles therefrom, said last-mentioned control means including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said electric cables in a desired disposition

and under a desired and constant tension and free of twisting, straining, and chafing forces regardless of the train setting of the guide, and a protective shield disposed about a portion of said guide for protecting components thereof from back blast of missiles being launched.

27. In missile launching apparatus, a trainable guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a vertical loading position coaxial with the axis of train, a magazine beneath the guide and having a plurality of missile bearing stalls movable into longitudinal alignment with the guide when it is in vertical loading position, a hoist for raising a missile from an aligned stall along a straight-line path, coaxial with the axis of train, and into the guide, means for moving the magazine to successively present stalls to the hoist and simultaneously therewith to a position in longitudinal alignment with the guide in loading position and in any desired setting of train, latch means for locking a stall at hoist position, control means for selectively causing the hoist to raise a missile from an aligned stall into the guide the control means also being operable to cause the hoist to lower a missile from the guide into an aligned empty stall in said magazine, interlock means to prevent operation of the hoist unless a stall is locked at hoist position, control means for positioning the guide and firing missiles therefrom, said last-mentioned control means including electric cables connected between relatively rotatable components, a cable reel mechanism for maintaining said electric cables in a desired position under constant tension and free from twisting, straining and chafing forces regardless of the train setting of the guide, said cable reel mechanism including a pair of cable supporting shelves carried for rotation with said guide during training of the guide and sheaves for taking up slack in said cables under constant tension, and a protective shield enclosing portions of said guide for protecting components thereof from back blast of missiles being launched.

28. In missile launching apparatus, a trainable guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a vertical loading position on the axis of train, a magazine beneath the guide and having a plurality of missile bearing stalls movable into longitudinal alignment with the guide when it is in vertical loading position, a hoist operable to raise a missile from an aligned stall, along a straight-line path for its entire distance of travel between the magazine and the guide, and into the guide or to lower along said straight-line path a missile from the guide into an aligned stall in said magazine, said hoist being operable for raising and lowering missiles into and from said guide, respectively, at any selected train setting of the guide, means for moving the magazine to successively present stalls to the hoist, latch means for locking a stall at hoist position, interlock means to prevent lowering of a missile from the guide into an aligned empty stall except when the stall is locked at hoist position, control means for positioning the guide and firing missiles therefrom, said last-mentioned control means including electric cables connected between substantially vertically spaced and relatively rotatable components, a cable reel mechanism for maintaining the electric cables in a desired position under desired and constant tension and free from twisting, straining, and chafing forces regardless of the train setting of the guide, and a guide protective shield for protecting components of the guide from back blast of missiles being launched.

29. A missile launcher comprising a missile guide supported for movement in train and elevation, its movement in elevation being between an inclined firing position and a vertical loading position in which the longitudinal axis of the guide aligns with the axis of its in train movement, a stationary hoist in substantial longitudinal alignment with said guide, means including a missile lifter member reciprocably carried by said hoist for loading missiles into the after end of the guide when the latter is in loading position, thereby enabling the direct, straight-line loading of missiles at any train position of the guide from a fixed loading installation, means for training, elevating and depressing the guide, said means including electric cables connected between substantially vertically spaced and relatively rotatable components, means for maintaining the electric cables in a desired postion under constant tension and free from twisting, straining, and chafing forces regardless of the train setting of the guide, and blast protection means for protecting components of the launcher from back blast of missiles being launched.

30. In an automatic missile launcher the combination of; a rotatable mount, a guide for directing the initial flight of a missile, blast shielding and deflecting means carried by said rotatable mount and enclosing a portion of said guide, said guide being mounted upon said mount and movable between a firing position and a loading position, said guide at its loading position beng in alignment with the axis of train, a stationary mount disposed below said rotatable mount, a hoist carried by said stationary mount and including a missile engaging lifter movable for the entire length of travel thereof along the axis of train for loading missiles into said guide when the latter is in loading position, a ready service magazine for successively delivering missiles into the path of the lifter, a drive for the magazine comprising a source of hydraulic pressure and a motor to be driven by the pressure, transmission means between the motor and the magazine, a valve to control the flow of hydraulic fluid to the motor, means in the transmission to shift the valve upon approach of the missile into the path of the lifter whereby to decrease the supply of hydraulic fluid to the motor and thereby reduce the speed of movement of the magazine, electrical circuits carried by the rotatable mount, control means for electrically controlling the operation of said launcher and carried by said stationary mount, a plurality of electrically conductive cables connecting said electrical circuits on said rotatable mount to said control means, and means for maintaining said cables in a desired disposition independent of relative rotation between said electrical circuits on the rotatable mount and said control means on the stationary mount.

31. In a missile launching apparatus; a guide for directing the initial flight of a missile and supported for movement from an inclined firing position to a vertical loading position, a rotatable mount, blast shielding and deflecting means carried by said rotatable mount and enclosing one end of said guide, said guide being carried by said rotatable mount, a stationary mount disposed below said rotatable mount, a magazine carried by said stationary mount and beneath the guide and having a plurality of missile bearing stalls sequentially movable into longitudinal alignment with the guide when the latter is in loading position, a hoist carried by said stationary mount, said hoist including a missile lifter member for moving a missile along a straght-line path from an aligned stall into the guide, means carried by said stationary mount for moving the magazine to successively align stalls thereof with the guide in loading position and to thereby present stalls to the hoist, control means on said stationary mount for selectively causing the missile lifter member to move a missile from an aligned stall into the guide, the control means also being selectively operable for causing the hoist to move a missile from the guide into an aligned empty stall in said magazine, electrical actuating circuits for actuating the movement of said rotatable mount and said guide and carried by the rotatable mount, a plurality of electrically conductive cables connecting said electrical actuating circuits on said rotatable mount to said control means on said stationary mount, and means for maintaining said cables in a desired disposition independent of relative rotation between said electrical actuating circiuts on the rotatable mount and said control means on said stationary mount.

32. A missile launching apparatus comprising, in combination, a trainable mount, a guide carried by said mount for directing the initial flight of a missile and supported for movement on said mount from an inclined firing position to a vertical loading position coaxial with the axis of train, means for shielding components from and deflecting the blast from said guide when a missile is launched, a stationary mount disposed below the trainable mount, a magazine carried by said stationary mount and disposed beneath the guide and having a plurality of missile bearing stalls movable into longitudinal alignment with the guide when the latter is in vertical loading position, a hoist secured to said stationary mount for raising a missile from an aligned stall along a straight-line path coaxial with the axis of train and into the guide, means carried by said stationary mount for moving the magazine to successively present stalls to the hoist and simultaneously therewith to a position in longitudinal alignment with the guide in loading position in any desired setting of train, latch means for locking a stall at hoist position, control means carried by said stationary mount for selectively causing the hoist to raise a missile from an aligned stall into the guide, said control means also being operable to cause the hoist to lower a missile from the guide into an aligned empty stall in said magazine, and interlock means on said stationary mount for preventing operation of the hoist unless a stall is locked at hoist position, electrical actuating circuits carried by the trainable mount for effecting train and elevation settings of the trainable mount and the guide respectively, a plurality of electrically conductive cables connecting said

electrical actuating circuits on said trainable mount to said control means on said stationary mount, and means for maintaining said cables in a desired disposition independent of relative rotation between said trainable and stationary mounts.

References Cited in the file of this patent

UNITED STATES PATENTS

36,438	Lee et al.	Sept. 9, 1862
221,516	Cain	Nov. 11, 1879
1,339,614	Woken	May 11, 1920
1,422,678	Dawson et al.	July 11, 1922
2,036,126	Daum	Mar. 31, 1936
2,062,212	Daum	Nov. 24, 1936
2,208,093	Brown	July 16, 1940
2,399,136	Mount	Apr. 23, 1946
2,401,654	Molins et al.	June 4, 1946
2,403,883	Thomas	July 9, 1946
2,426,610	Hopkins	Sept. 2, 1947
2,440,723	Macdonald	May 4, 1948
2,451,522	Uhl et.	Oct. 19, 1948
2,456,620	Chadwick et al.	Dec. 21, 1948
2,490,797	Girouard et al.	Dec. 13, 1949
2,517,660	Haas	Aug. 8, 1950
2,546,823	Holloway	Mar. 27, 1951
2,592,790	Brereton	Apr. 15, 1952

FOREIGN PATENTS

582,252	Great Britain	Nov. 11, 1946
628,772	Great Britain	Sept. 5, 1949