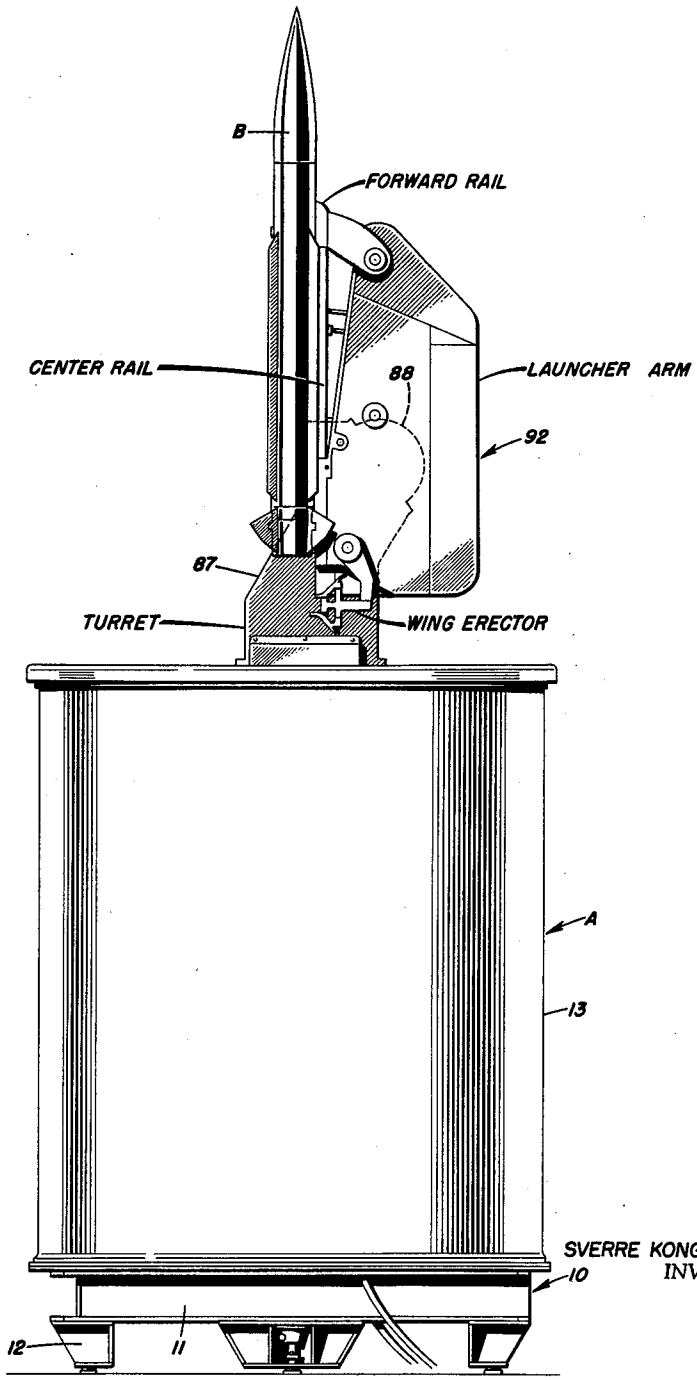
Dec. 10, 1963 S. KONGELBECK 3,113,486

TURRET LAUNCHER

Filed June 10, 1959 38 Sheets-Sheet 1

FIG.1



SVERRE KONGELBECK
INVENTOR

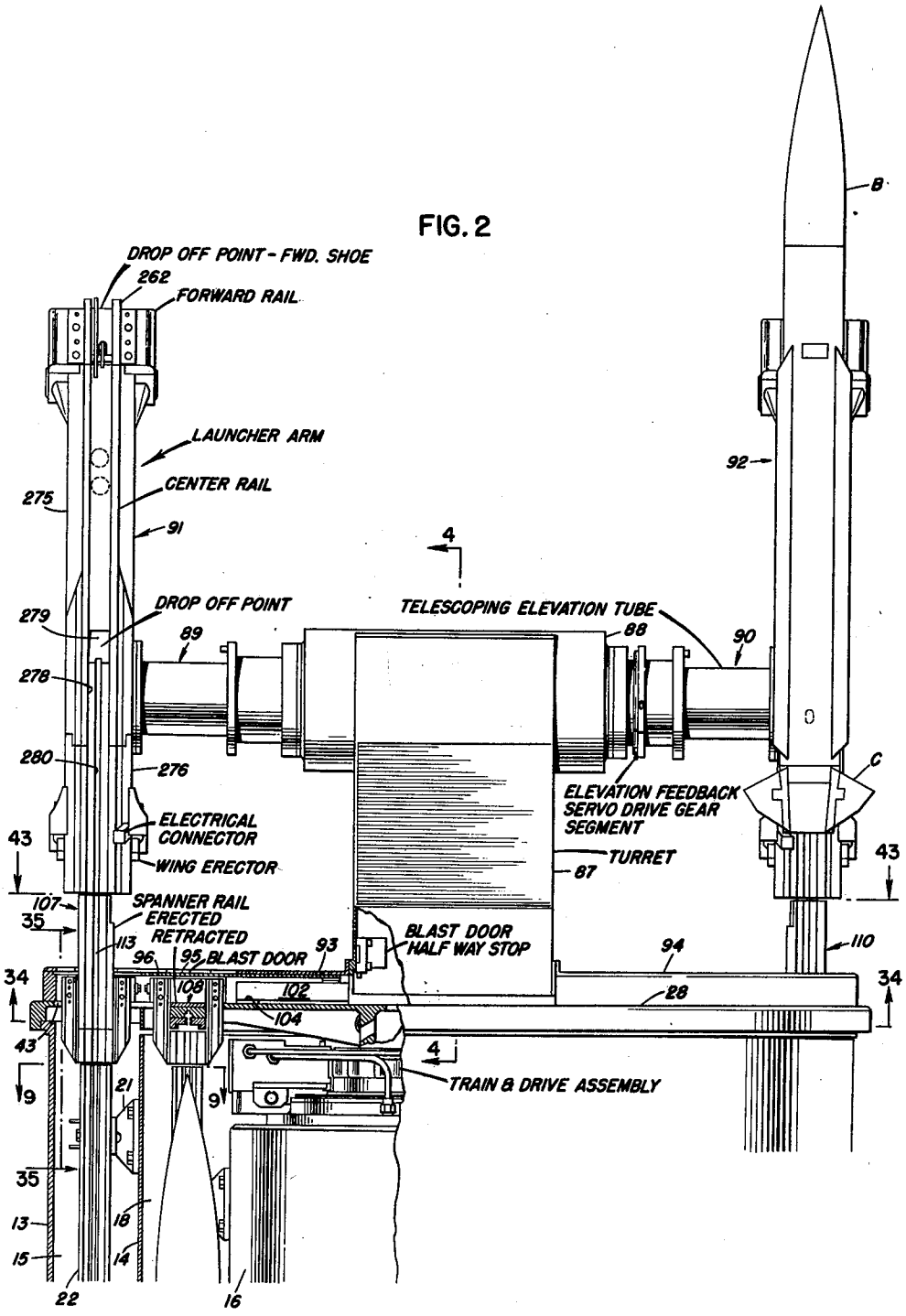
BY Claude Funkhouser
ATTORNEY

Dec. 10, 1963 S. KONGELBECK 3,113,486

TURRET LAUNCHER

Filed June 10, 1959 38 Sheets-Sheet 2

FIG. 2



Dec. 10, 1963 S. KONGELBECK 3,113,486

TURRET LAUNCHER

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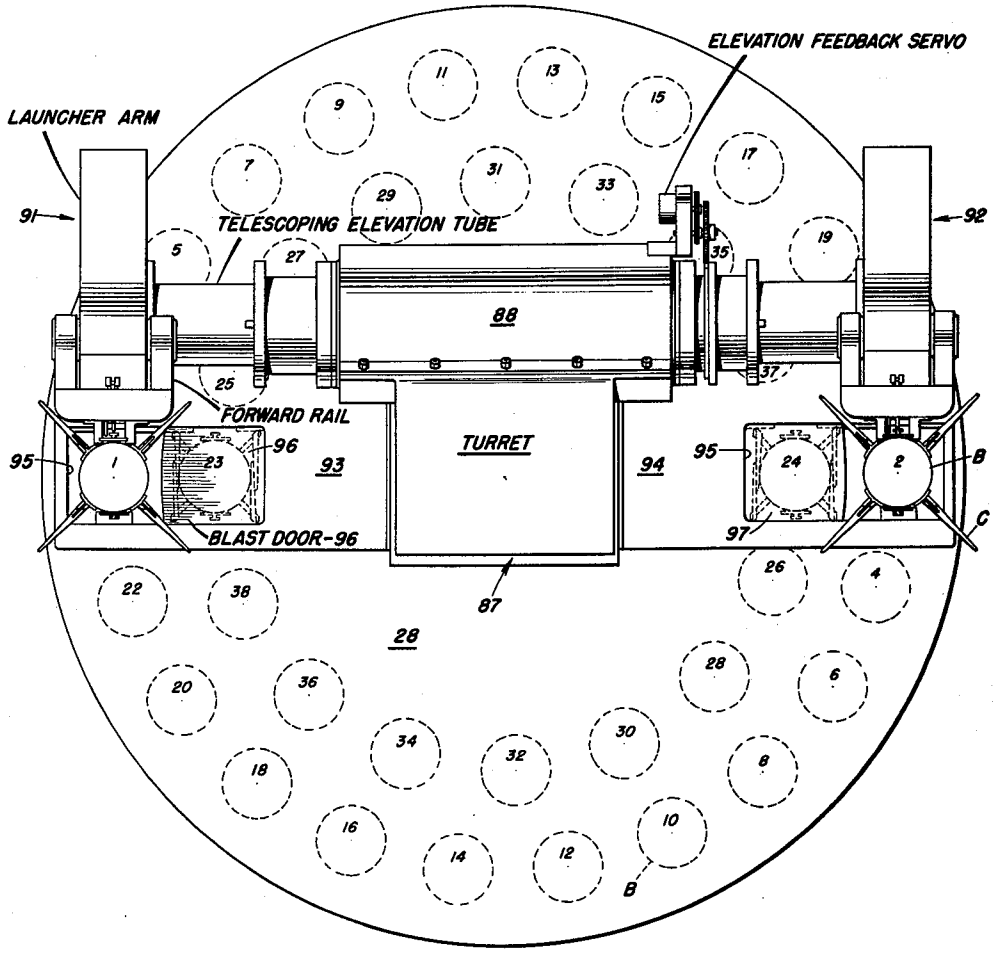
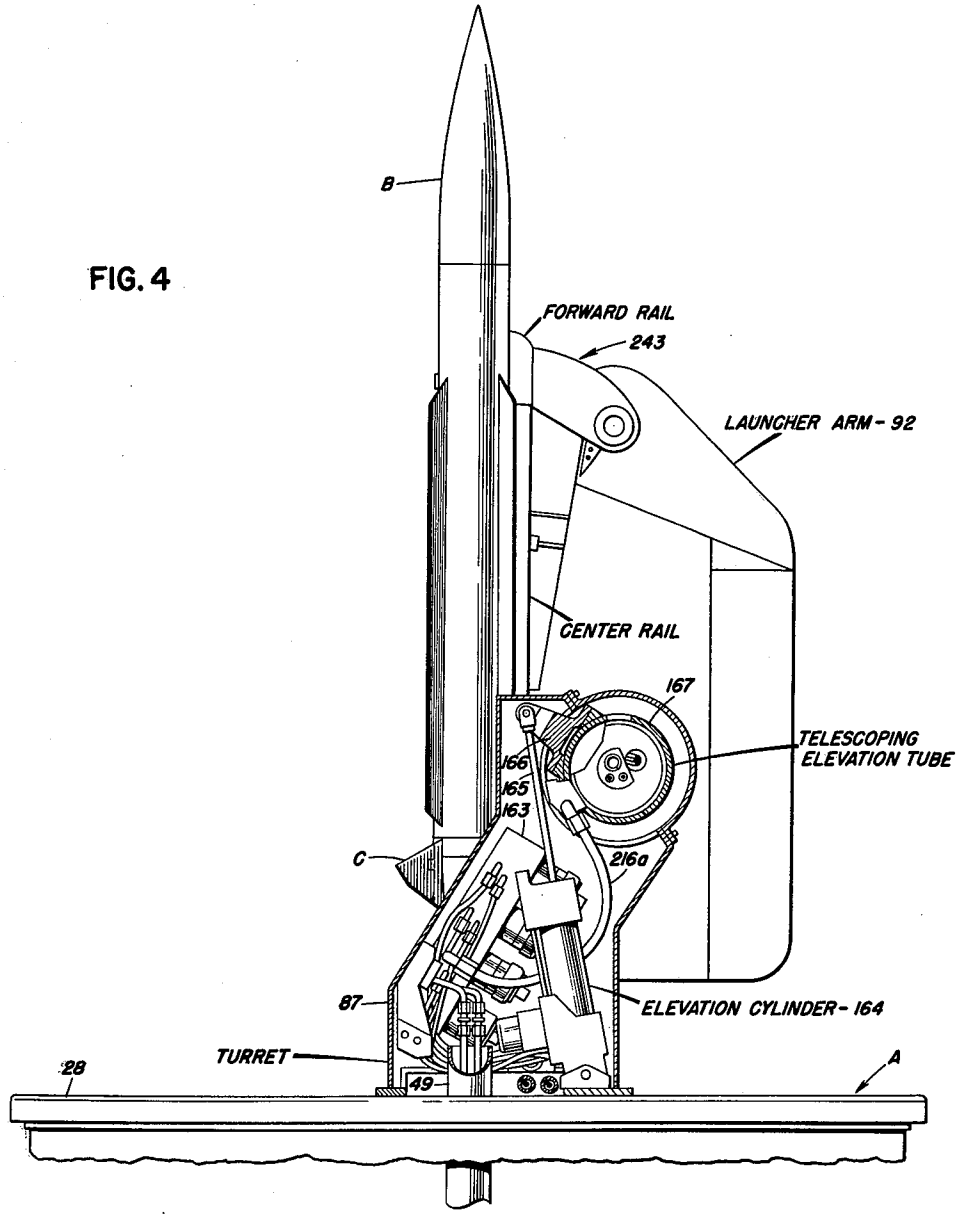


FIG. 3

TURRET LAUNCHER

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FIG. 4



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TURRET LAUNCHER

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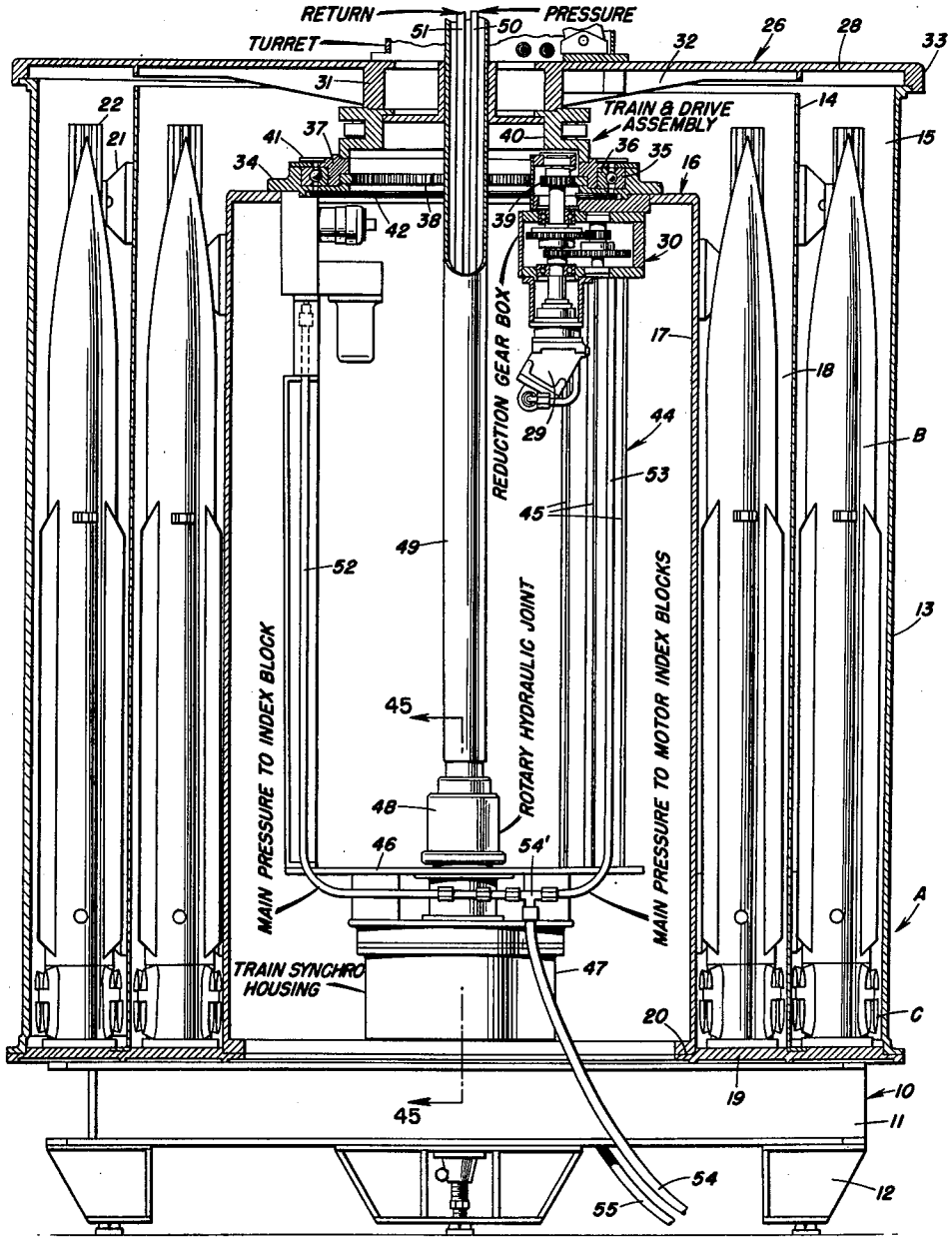


FIG.5

TURRET LAUNCHER

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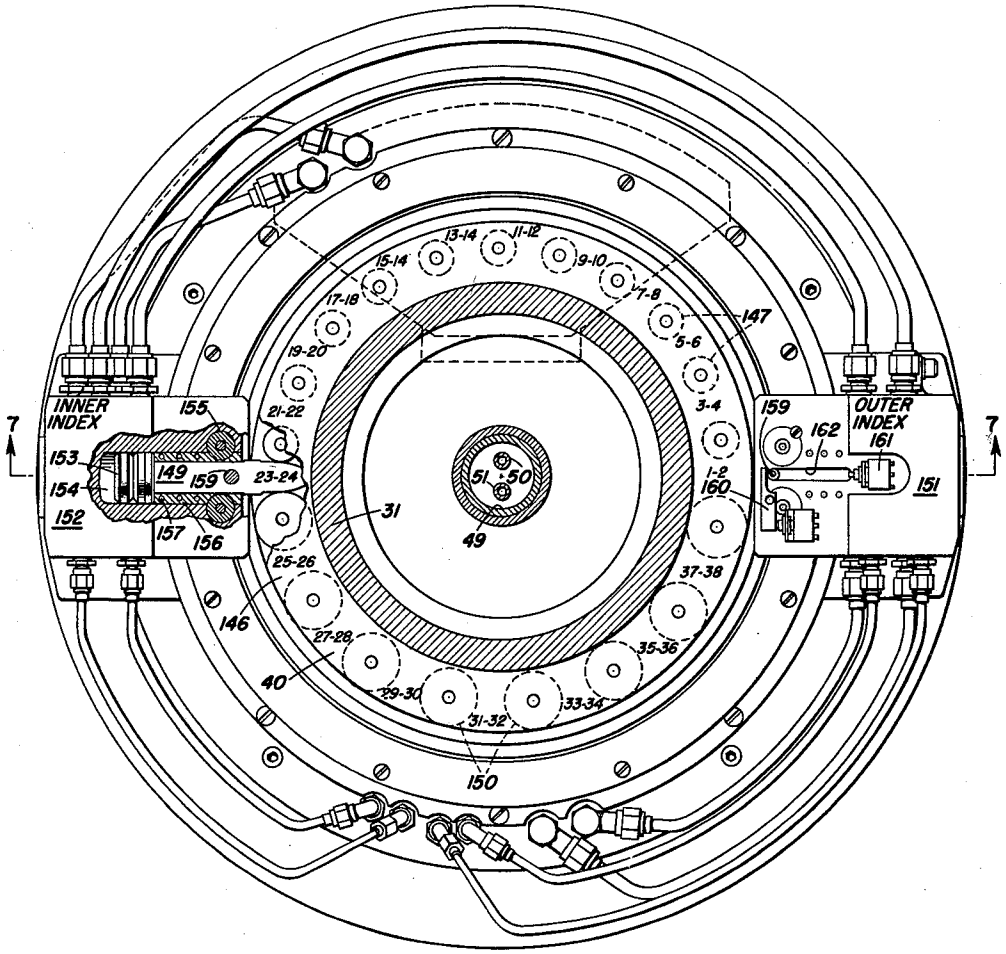


FIG. 6

TURRET LAUNCHER

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FIG. 7
(TRAIN & DRIVE ASSEMBLY)

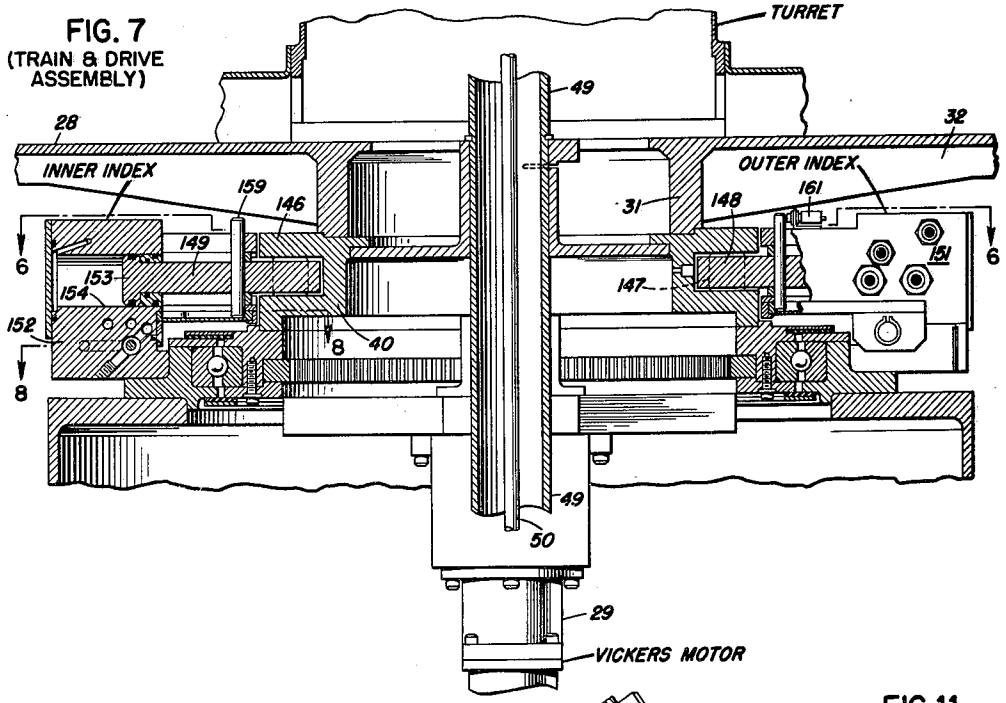
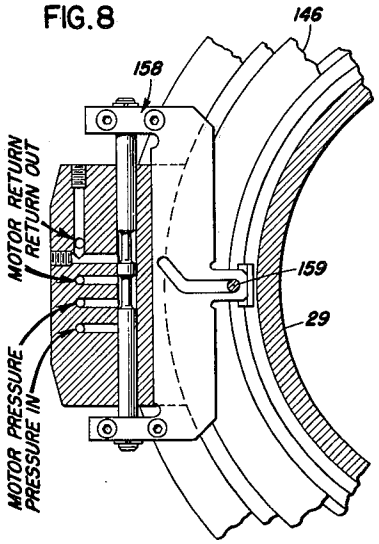
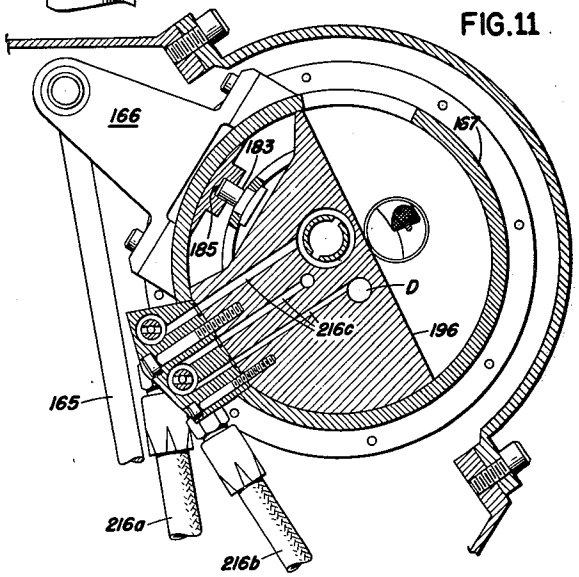


FIG. 8



FOR THE PURPOSE OF SIMPLICITY, THE HYDRAULIC PASSAGES IN THE ABOVE FIG. HAVE BEEN SHOWN IN A COMMON PLANE.

FIG. 11

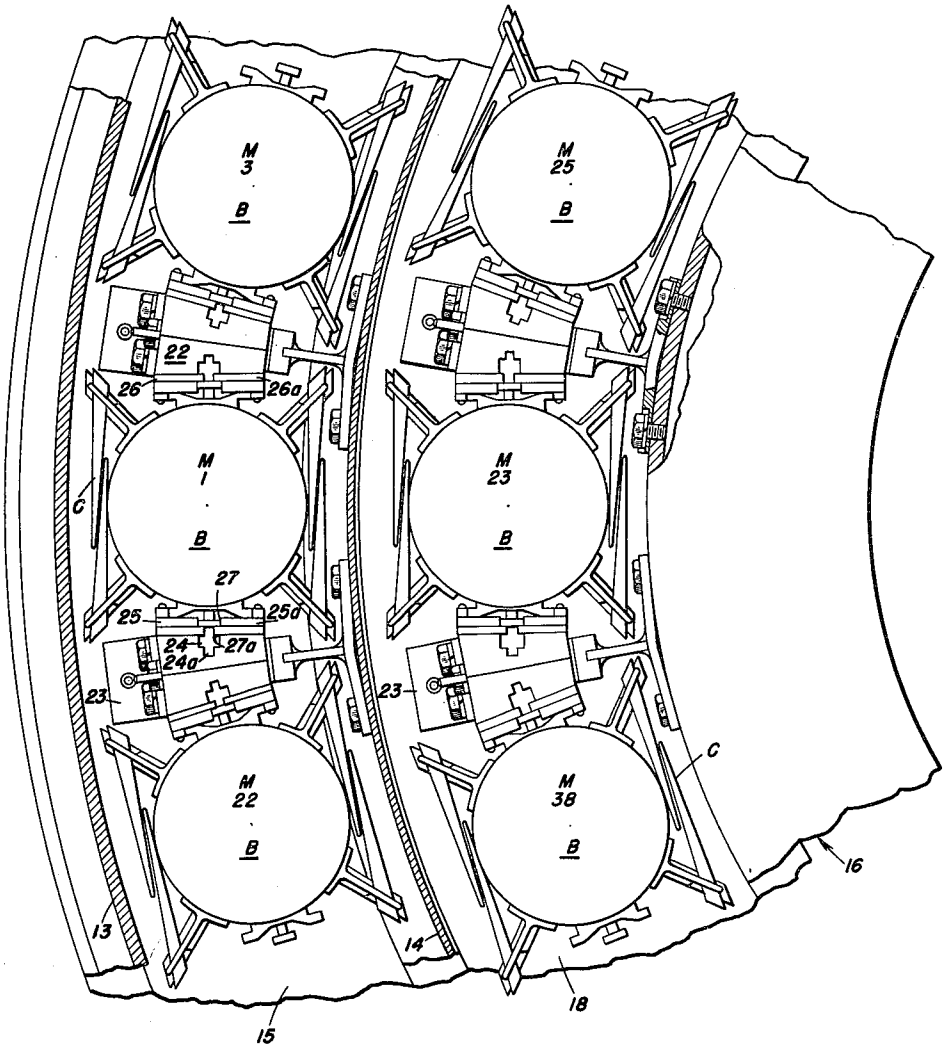


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TURRET LAUNCHER

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FIG.9.



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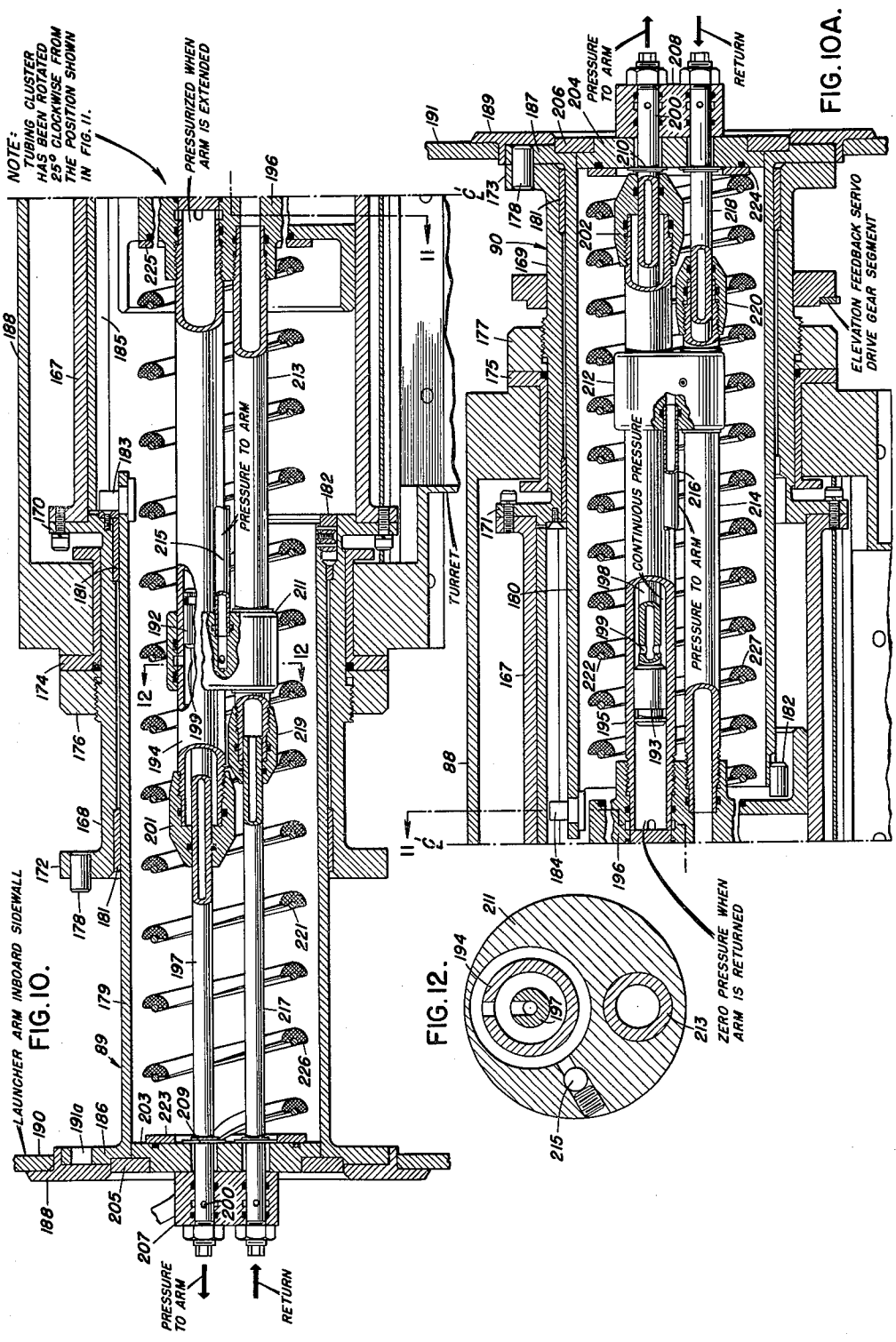


FIG. 10.

FIG. 10A.

FIG. 12.

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TURRET LAUNCHER

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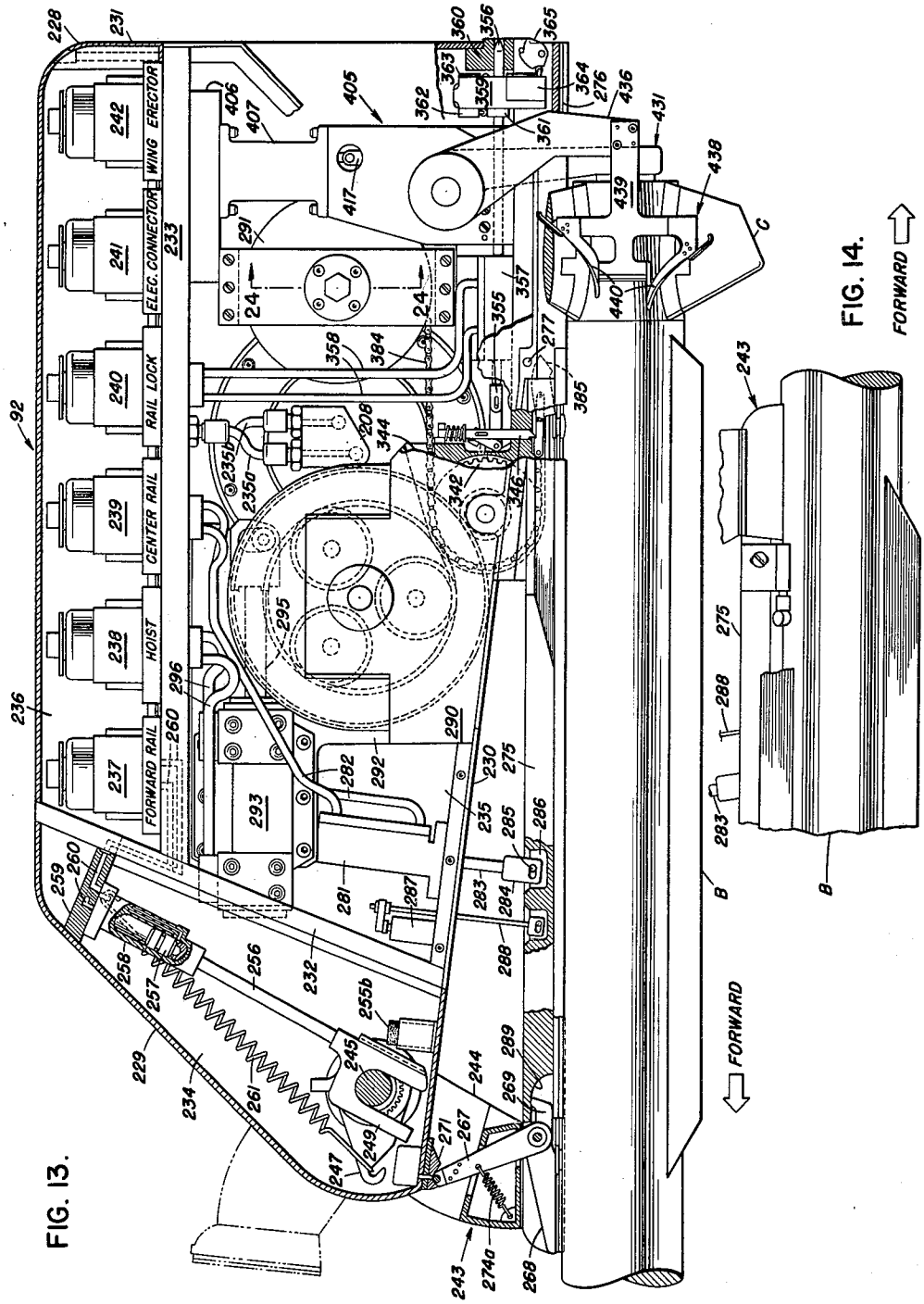


FIG. 13.

FIG. 14.

FIG. 15.
FORWARD RAIL UP
CENTER RAIL UP
RACK YOKE DOWN

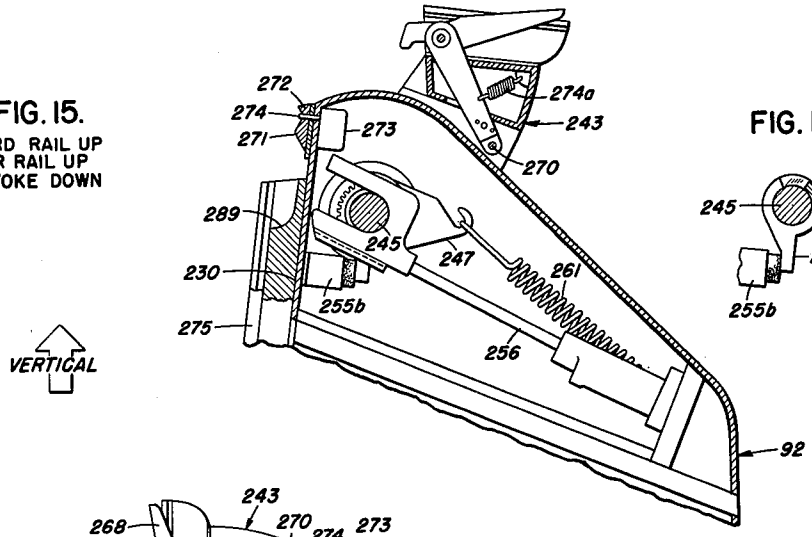


FIG. 16.

FIG. 15A.
RACK YOKE UP
FORWARD RAIL DOWN

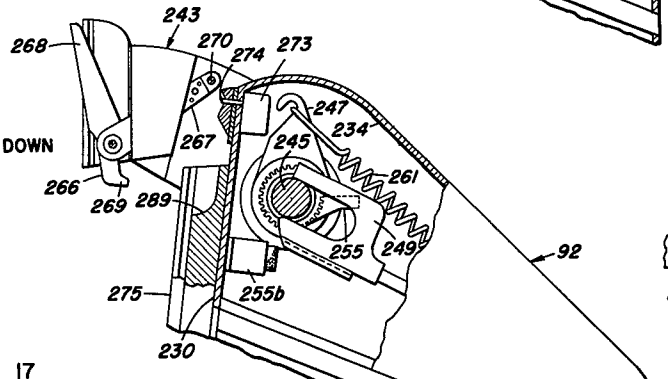
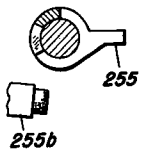


FIG. 16A.



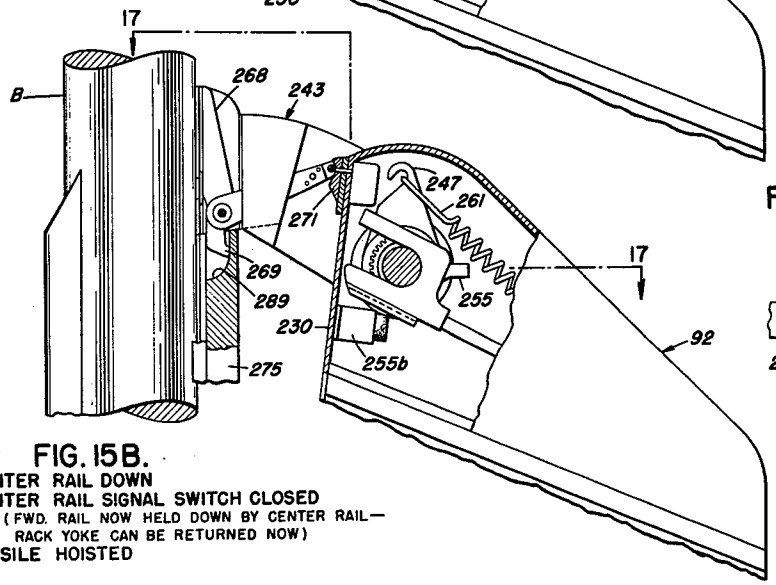


FIG. 16B.

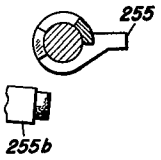


FIG. 15B.
CENTER RAIL DOWN
CENTER RAIL SIGNAL SWITCH CLOSED
(FWD. RAIL NOW HELD DOWN BY CENTER RAIL—
RACK YOKE CAN BE RETURNED NOW)
MISSILE HOISTED

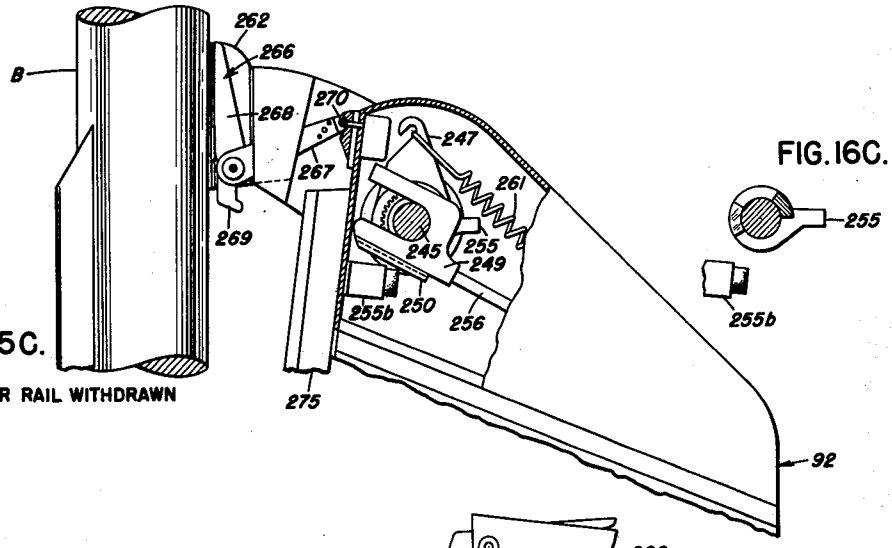


FIG. 15C.
CENTER RAIL WITHDRAWN

FIG. 16C.

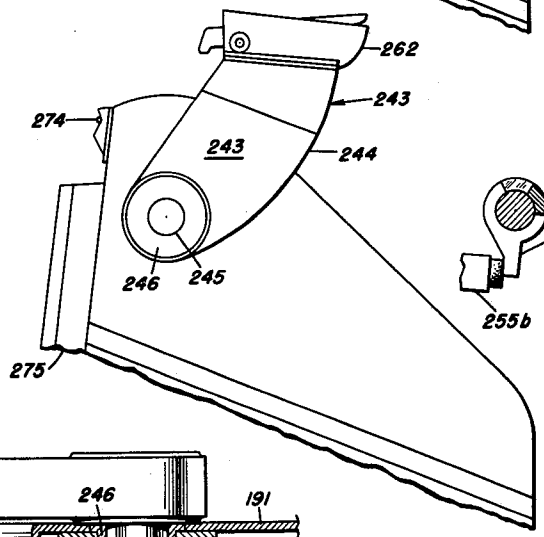


FIG. 15D.
MISSILE AWAY
FWD RAIL UP

FIG. 16D.

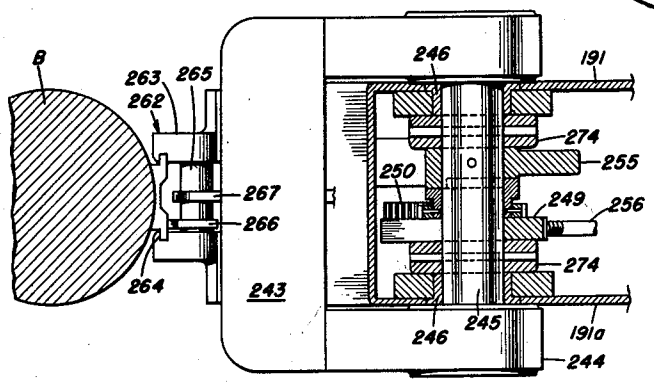


FIG. 17.

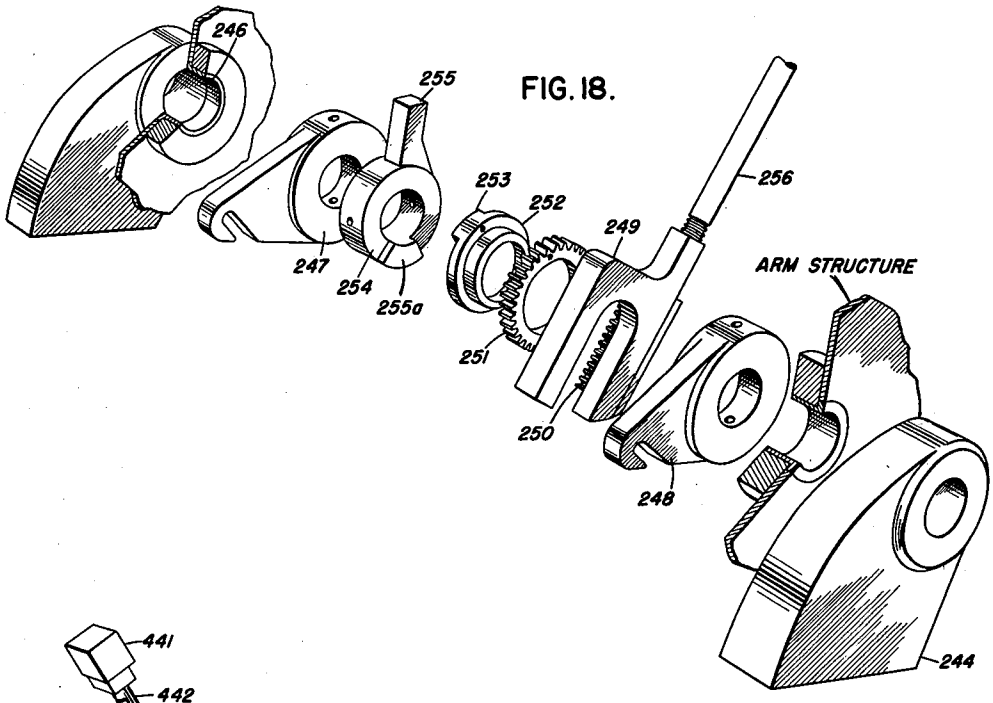

246
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255a
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ARM STRUCTURE
248
244

FIG. 18.

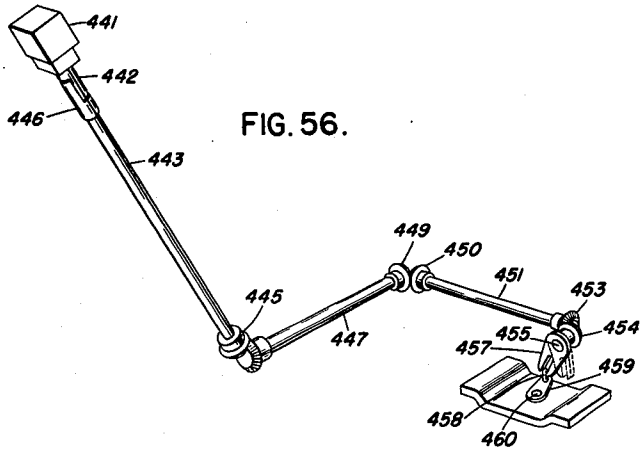

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460

FIG. 56.

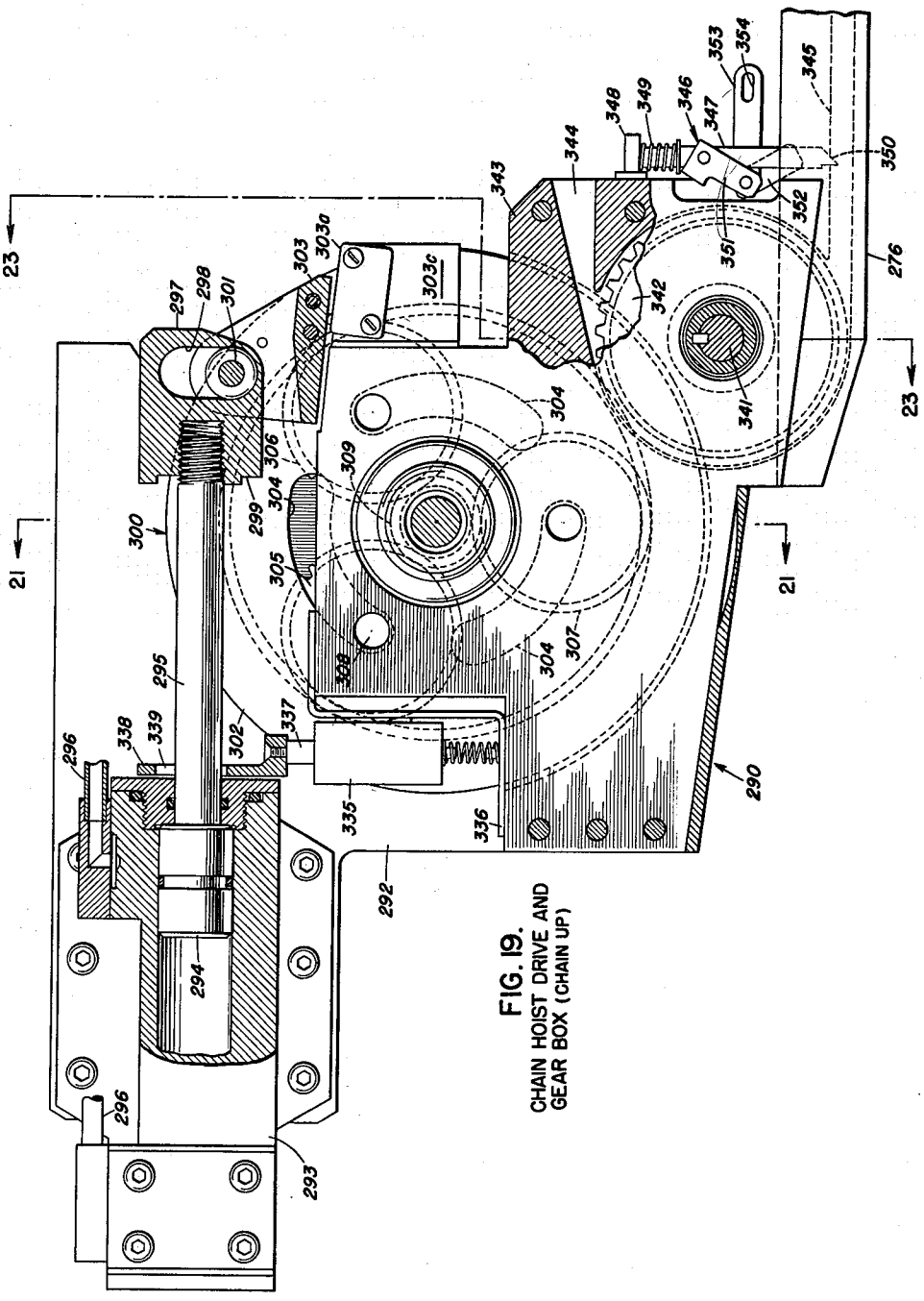


FIG. 19.
CHAIN HOIST DRIVE AND GEAR BOX (CHAIN UP)

FIG.20.

CHAIN TRAVEL LIMIT SWITCHES
CHAIN "UP" POSITION SHOWN.
ROTATE CLOCKWISE TO
LOWER CHAIN.

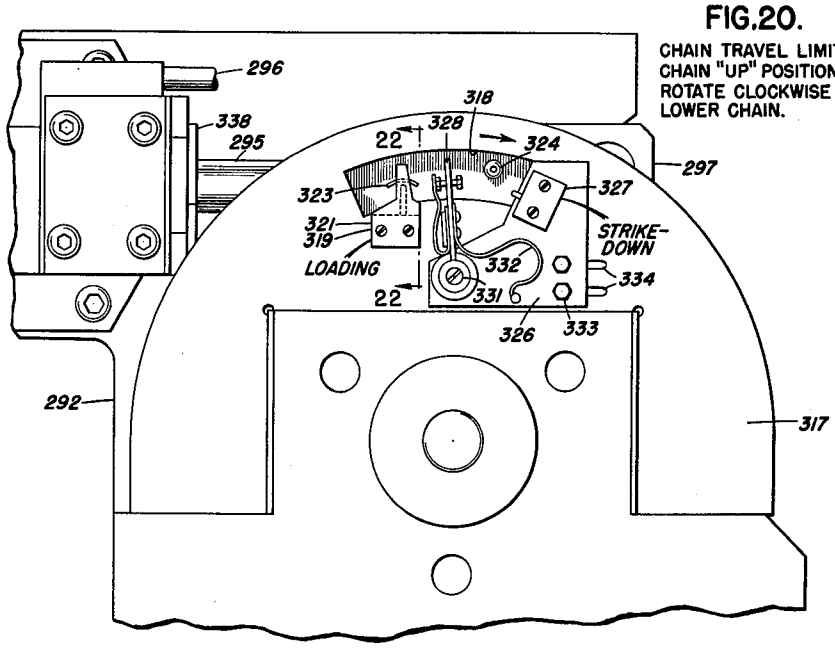
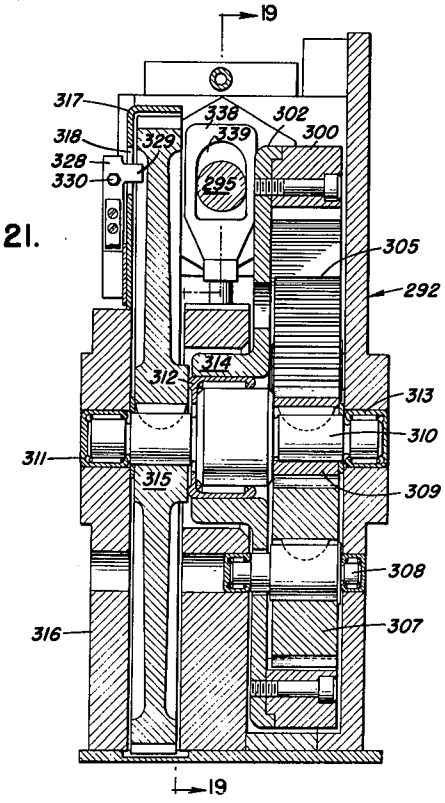


FIG.21.



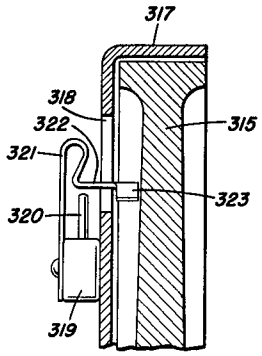


FIG.22.

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FIG.25.

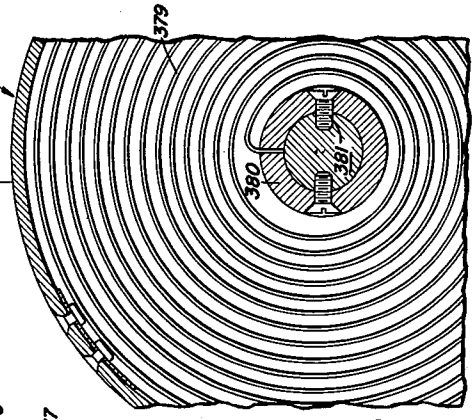


FIG.24.

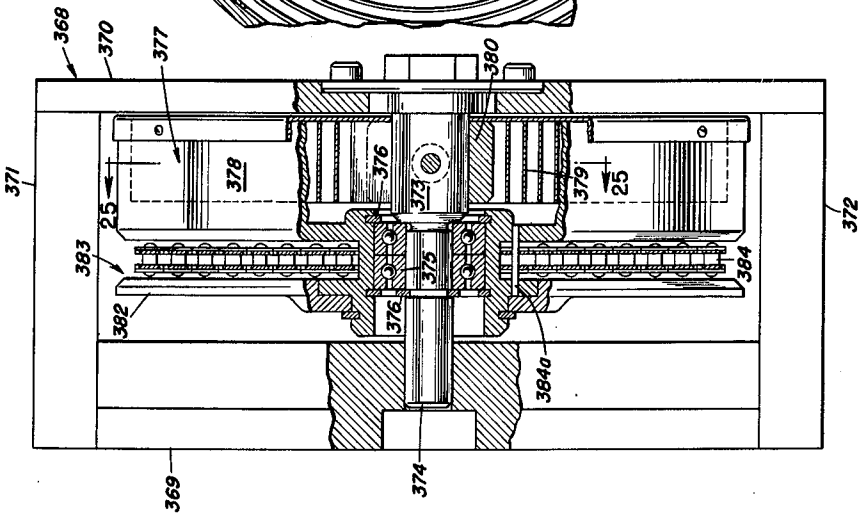
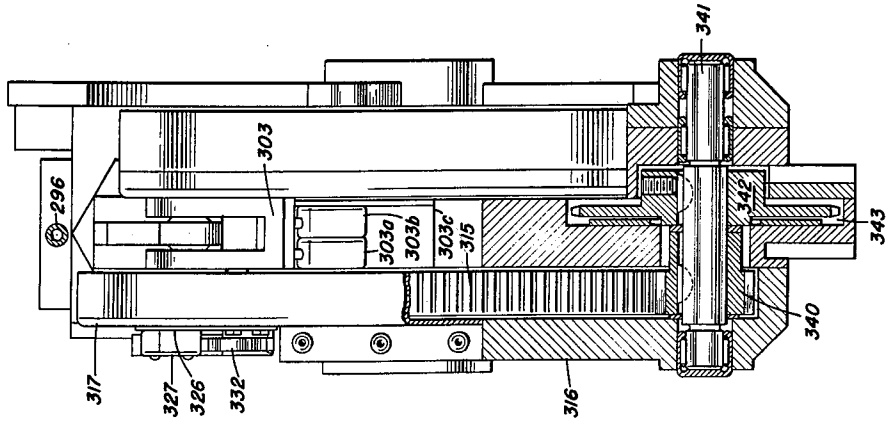
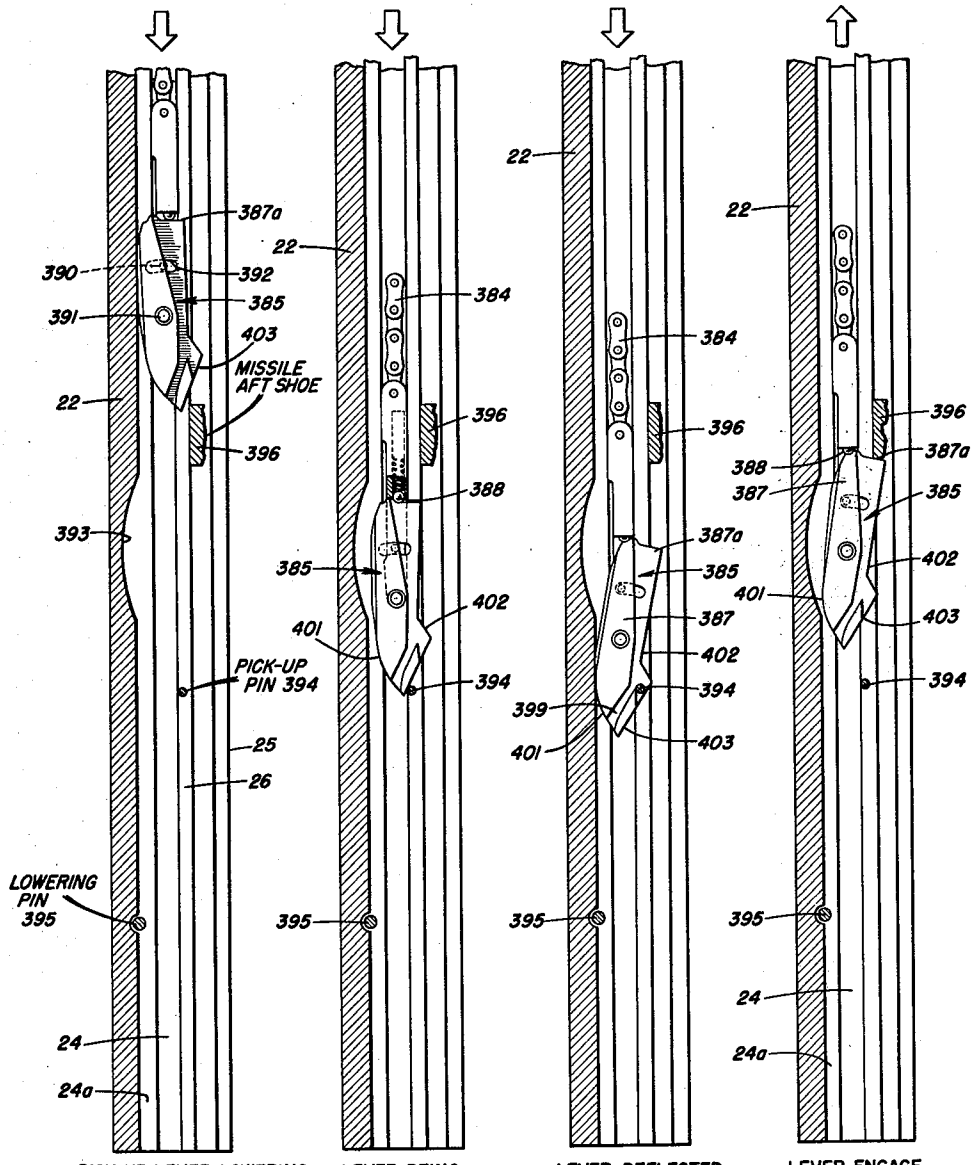


FIG.23.





PICK-UP LEVER LOWERING PAST AFT SHOE

FIG.26.

LEVER BEING DEFLECTED BY PICK-UP PIN

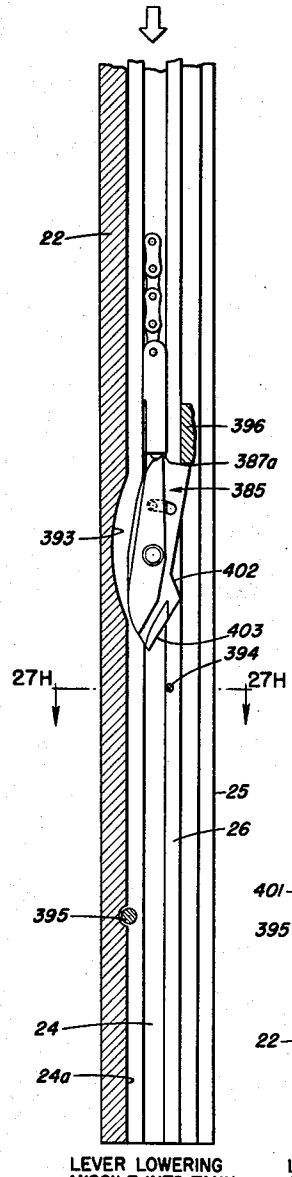
FIG.26A.

LEVER DEFLECTED AND COCKED

FIG.26B.

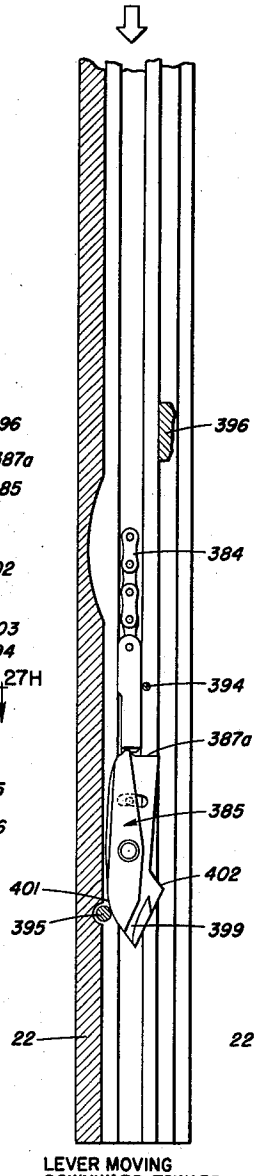
LEVER ENGAGE, MISSILE BEING HOISTED

FIG.26C.



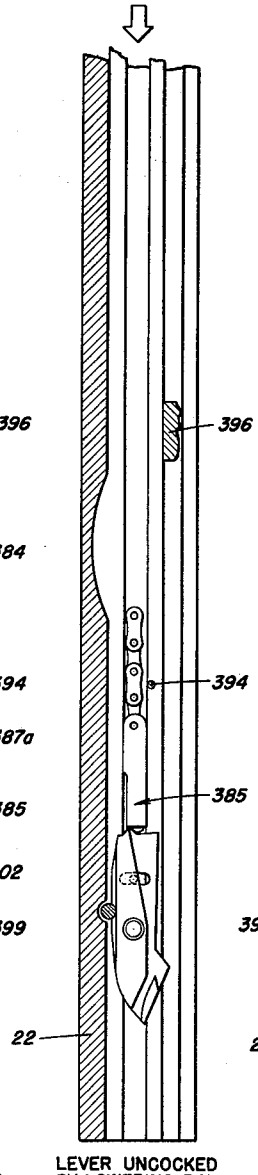
LEVER LOWERING MISSILE INTO TANK

FIG.27



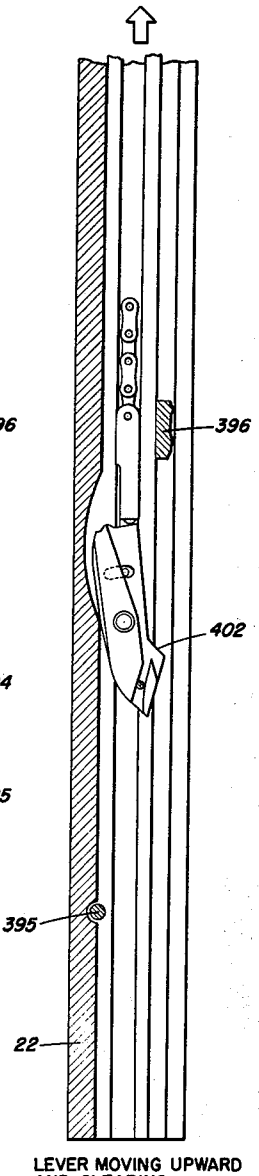
LEVER MOVING DOWNWARD TOWARD LOWERING PIN

FIG.27A.



LEVER UNCOCKED BY LOWERING PIN

FIG.27B.



LEVER MOVING UPWARD AND CLEARING PICK-UP PIN

FIG.27C.

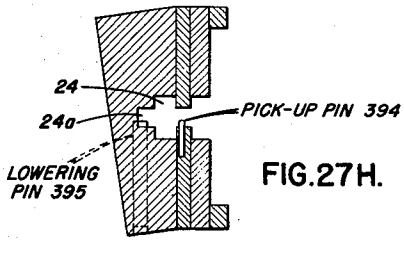
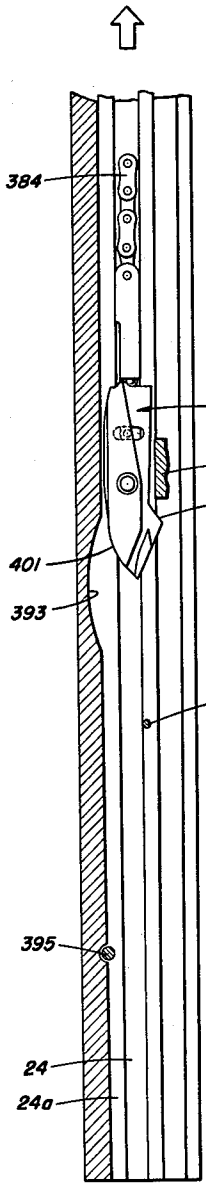
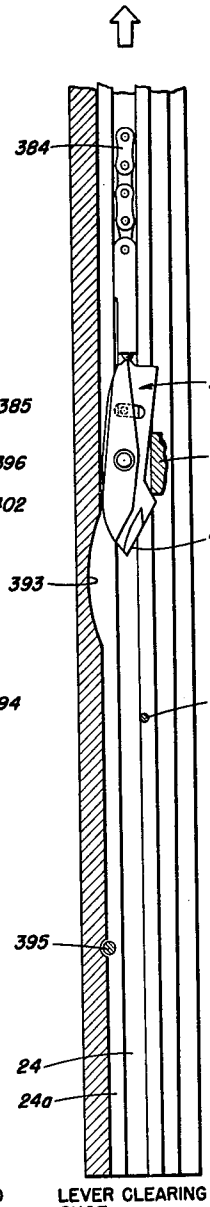


FIG.27H.



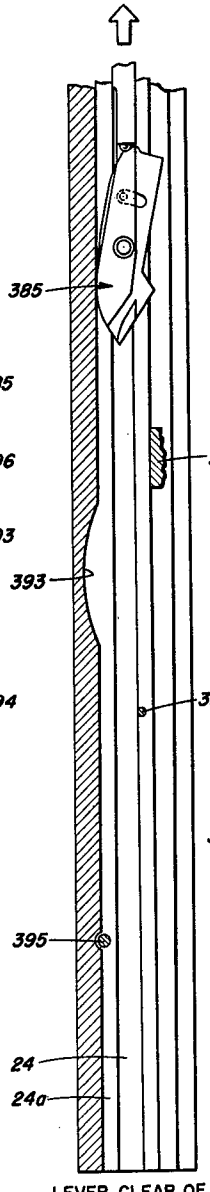
LEVER MOVING UPWARD APPROACHING MISSILE SHOE

FIG.27D.



LEVER CLEARING SHOE

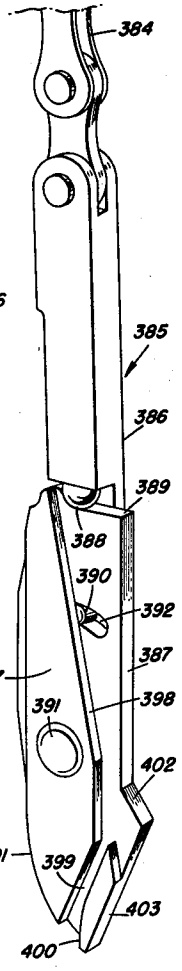
FIG.27E.



LEVER CLEAR OF MISSILE SHOE — LOADING COMPLETE

FIG.27F.

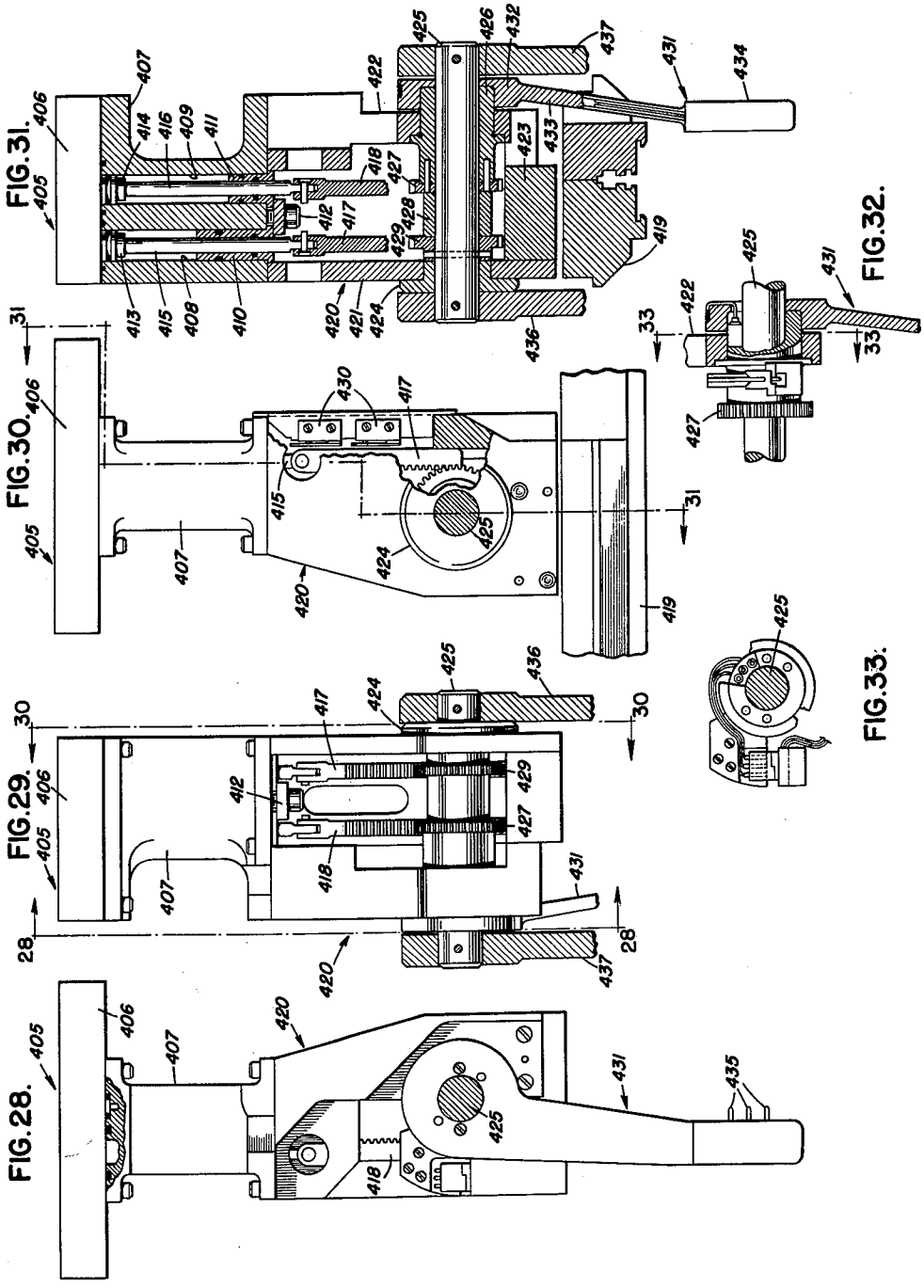
FIG.27G.



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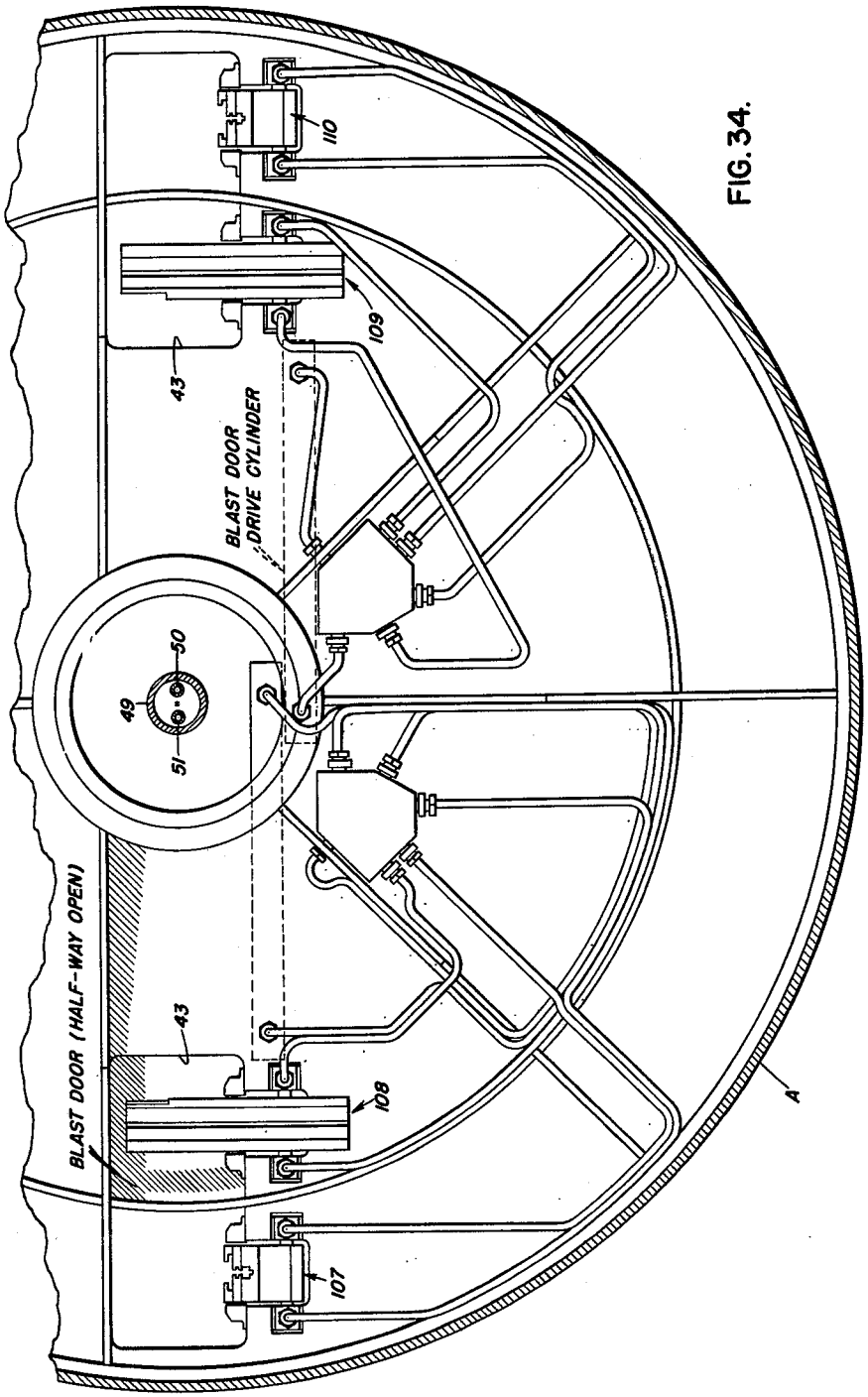
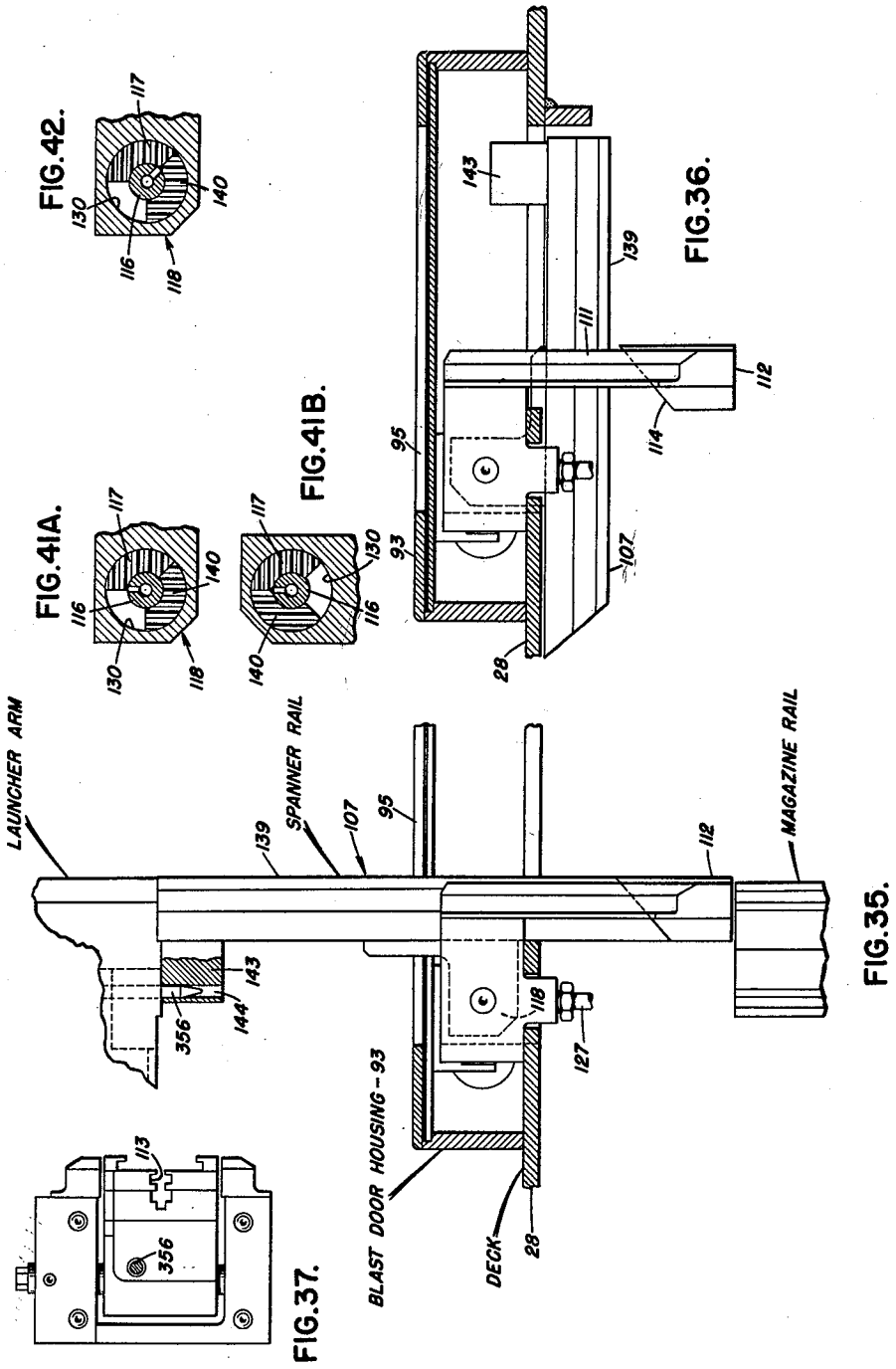

110
109
43
BLAST DOOR DRIVE CYLINDER
50
49
51
43
BLAST DOOR (HALF-WAY OPEN)
108
107
A

FIG. 34.

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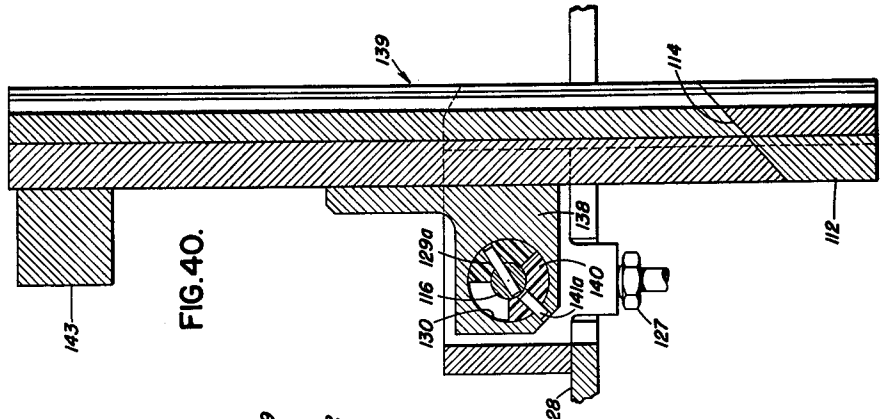


FIG.40.

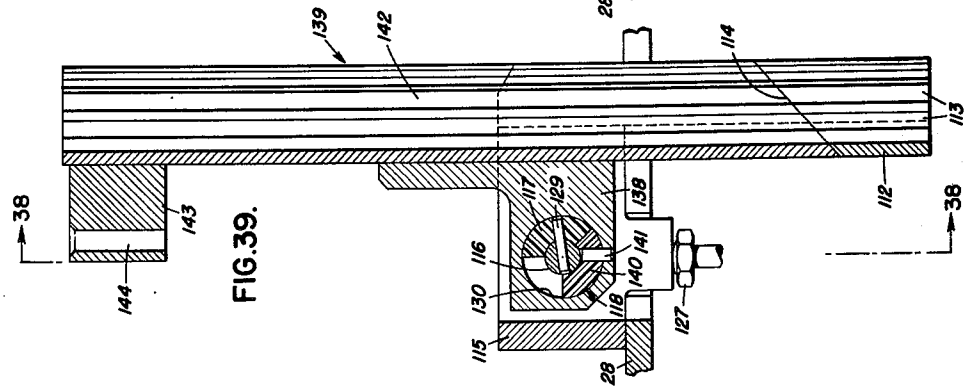


FIG.39.

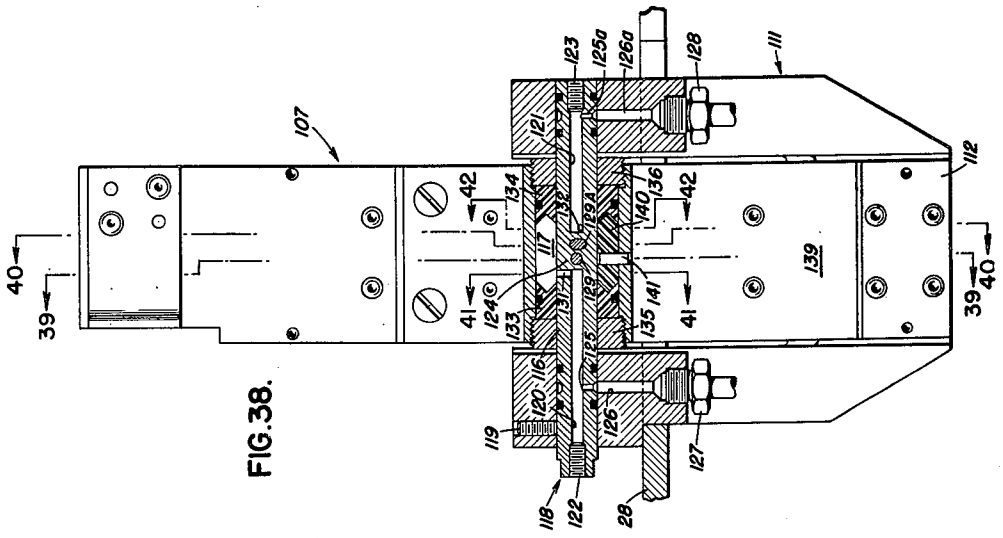


FIG.38.

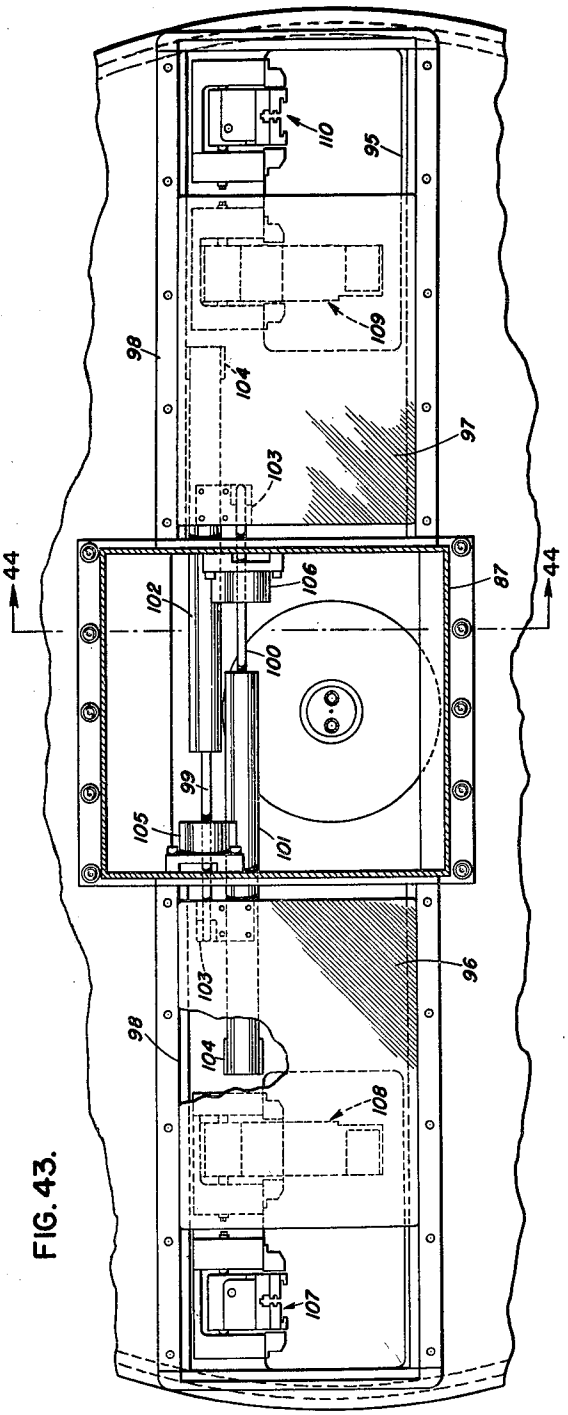

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FIG. 43.

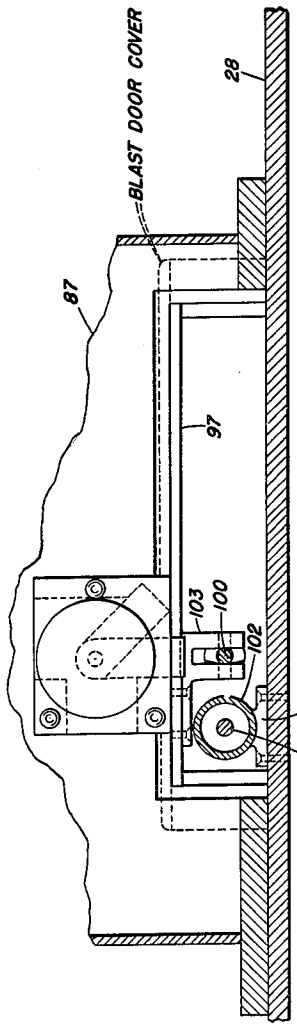

BLAST DOOR COVER
28
87
97
103
100
102
104
99

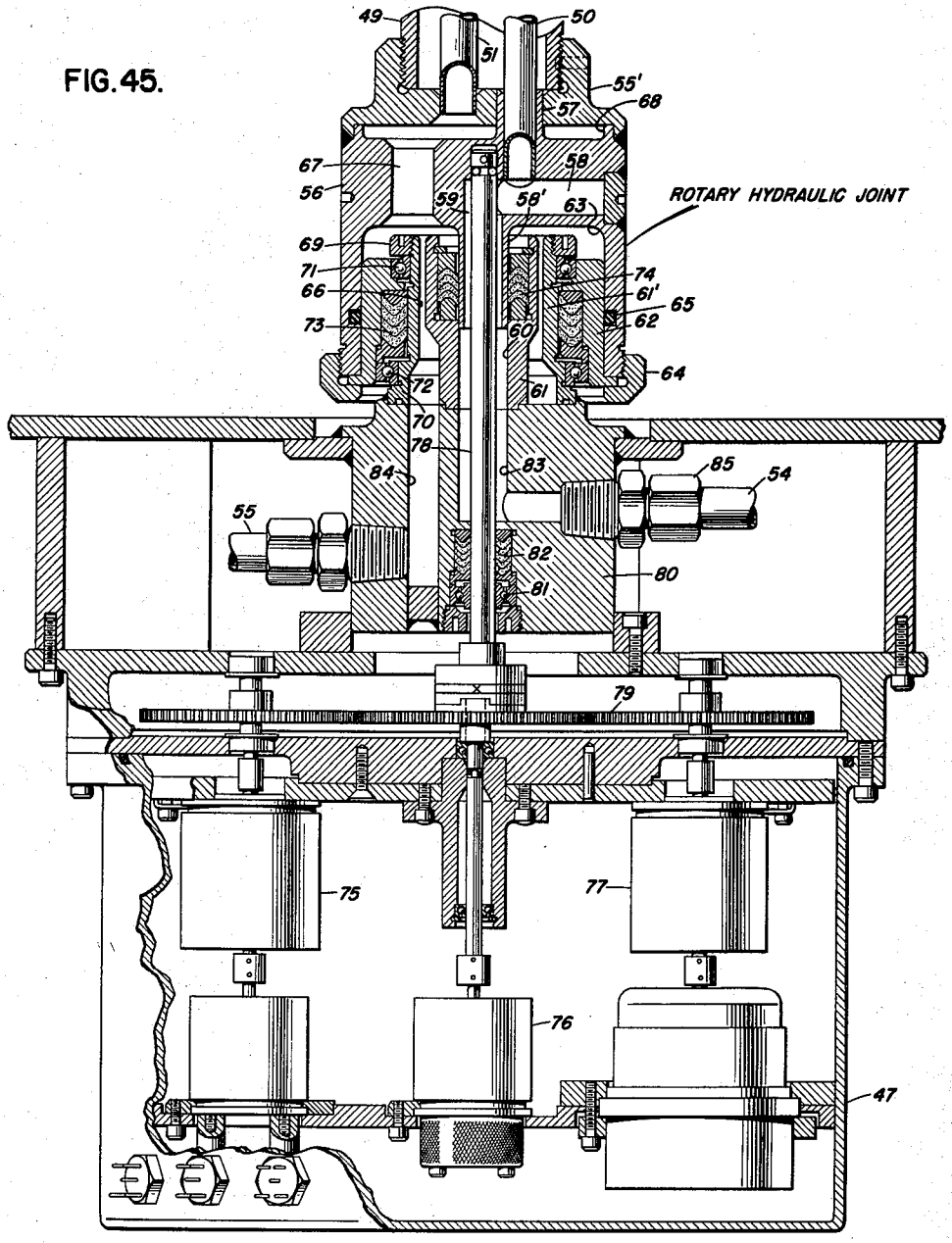
FIG. 44.

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TURRET LAUNCHER

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FIG. 45.



Dec. 10, 1963 S. KONGELBECK 3,113,486

TURRET LAUNCHER

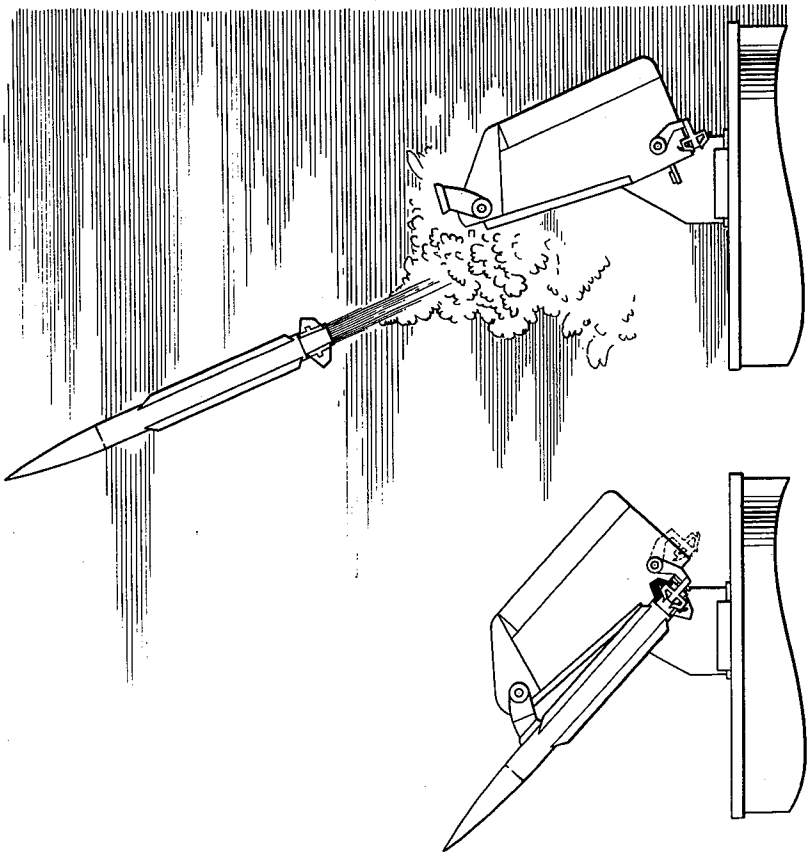
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TURRET LAUNCHER

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STRIKE DOWN

1-LAUNCHER SWITCHED FROM RADAR (IF SUCH BE THE CASE)
2-SWITCH TO STRIKE DOWN (MANUAL)
3-BACKSCRATCHER DISENGAGED
4-ELECTRICAL CONTACTOR DISENGAGED SELECTED (MANUAL)-TRAIN DRIVE FOLLOWS SELECTOR
5-ELEVATE TO 90° (MANUAL)
6-DECK INDEX PINS WITHDRAWN
7-ARMS TELESCOPED OUTWARDLY (IF NECESSARY)
8-BLAST DOORS OPENED
9-SPANNER RAILS ERECTED AND LOCKED
10-MISSILE LOWERED
11-RAMMER CHAIN UP
12-SPANNER RAILS SWUNG DOWN
13-BLAST DOORS CLOSED
14-READY TO SELECT NEW MISSILES



1-MISSILE FIRED
2-AS FORWARD SHOE LEAVES FORWARD RAIL, FORWARD RAIL SWINGS AWAY TO PROVIDE CLEARANCE FOR MISSILE

FIG. 46g.

1-TRACK AND ELEVATE ON TARGET
2-WINGS ERECTED (MANUAL)
3-CENTER RAIL RAISED (AUTOMATIC WITH WING ERECTION)

FIG. 46f.

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FIG. 47

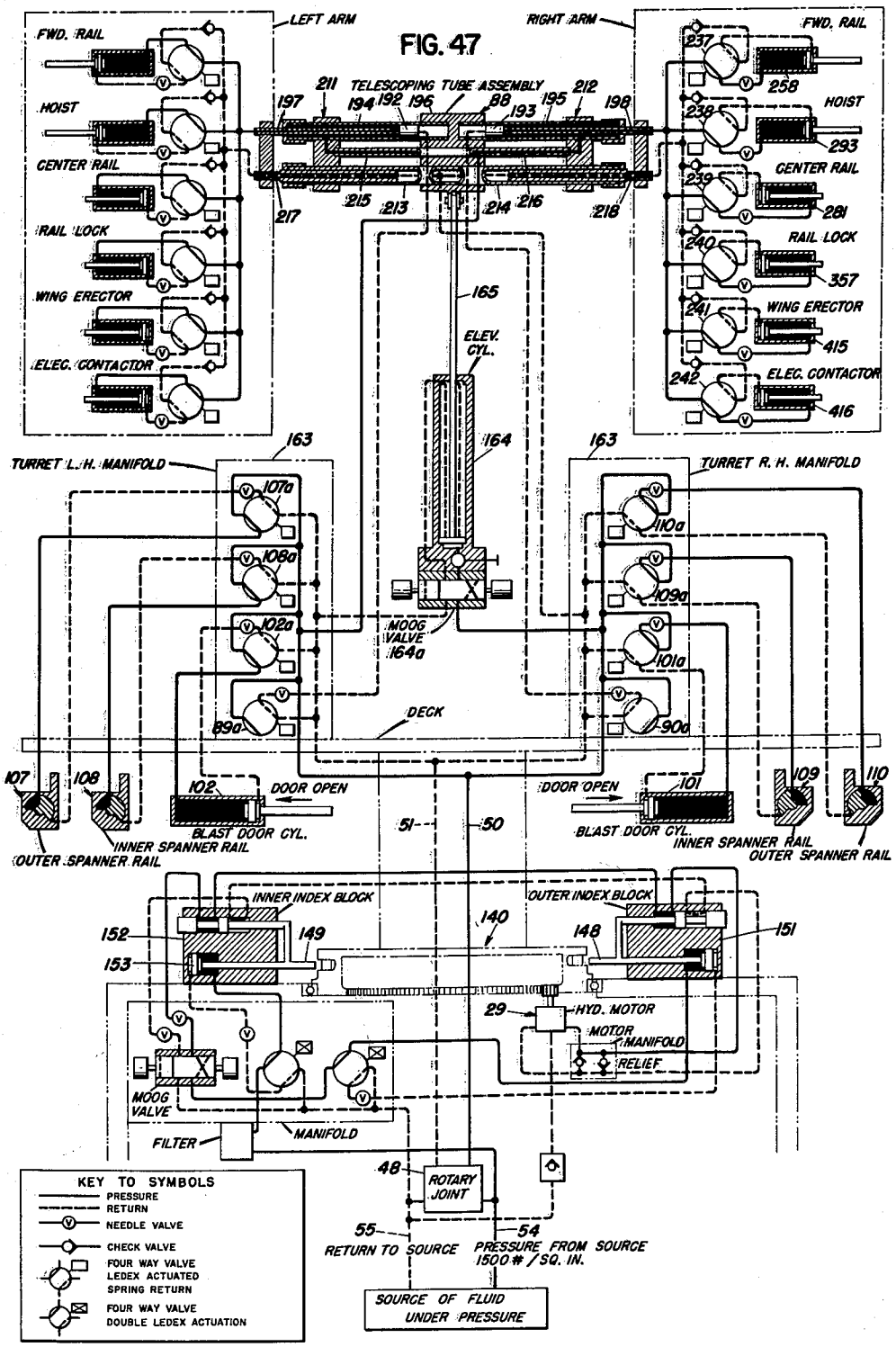
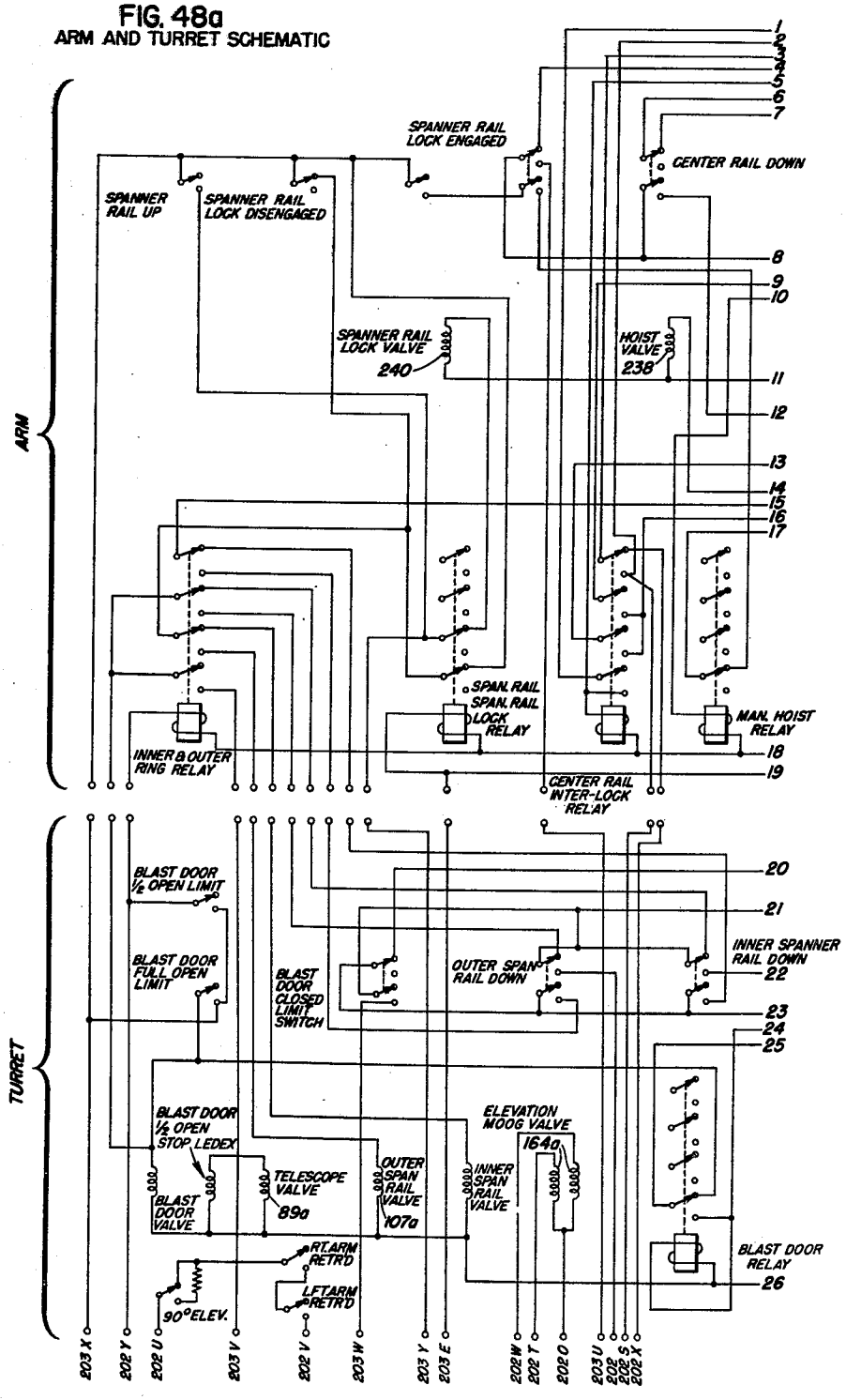


FIG. 48a
ARM AND TURRET SCHEMATIC



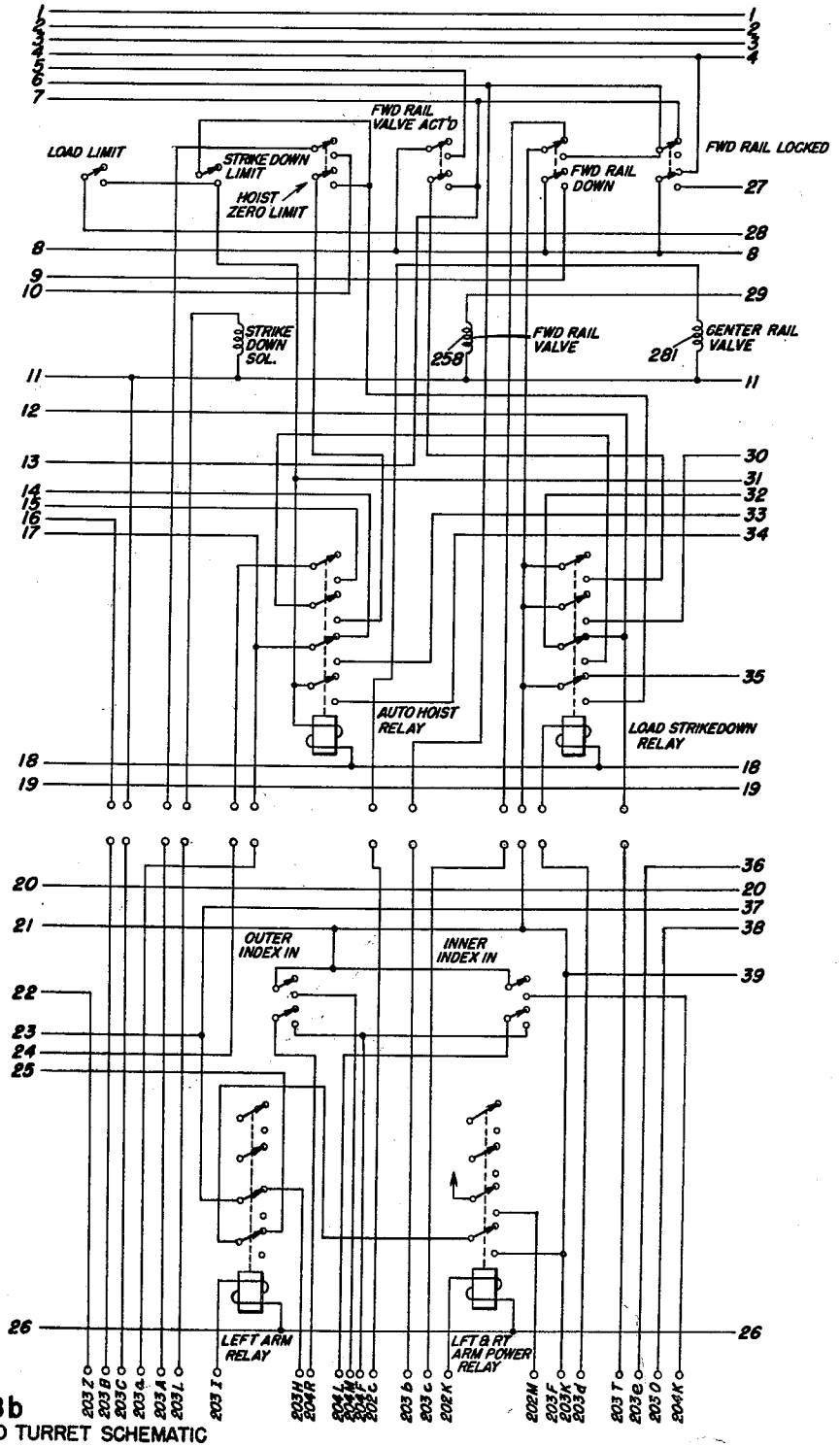


FIG. 48b
ARM AND TURRET SCHEMATIC

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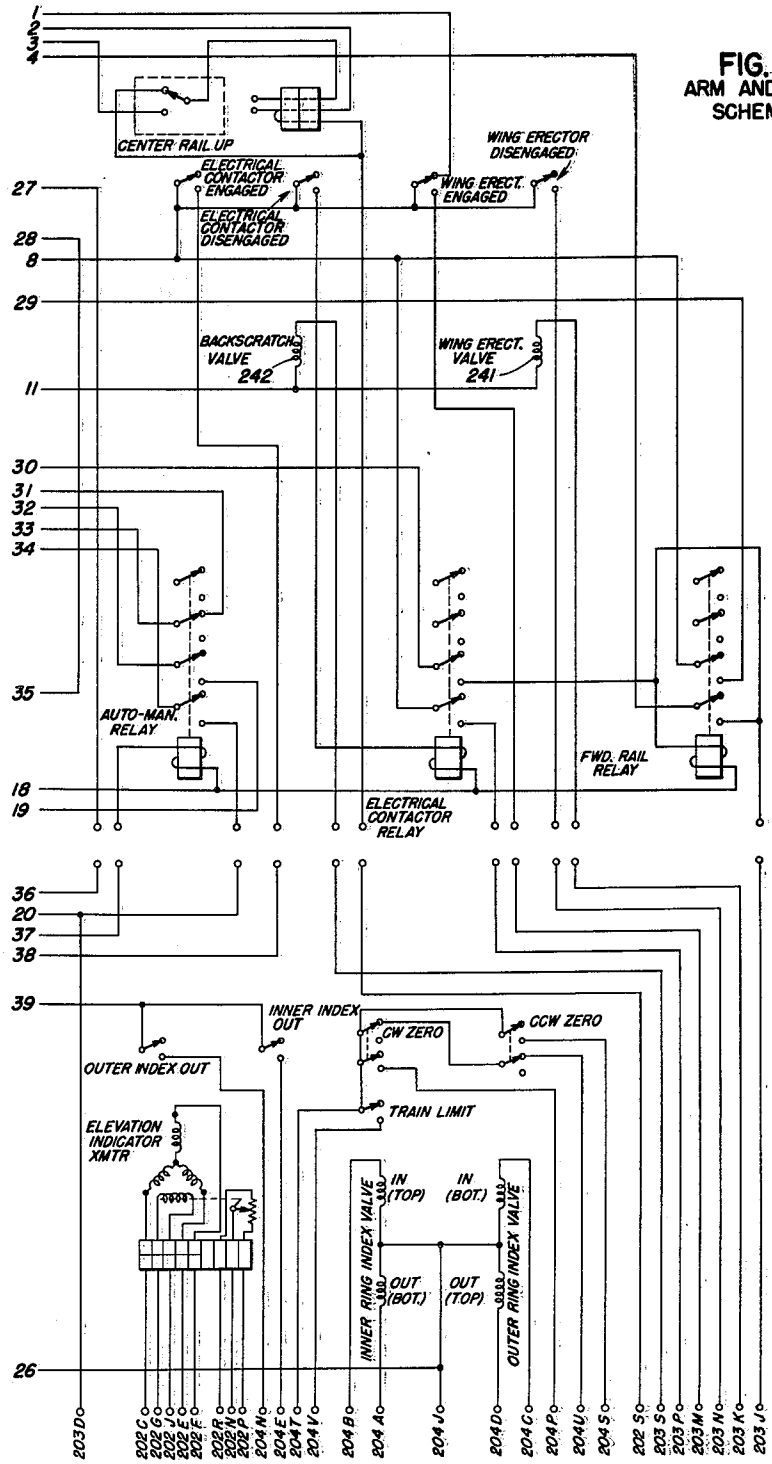


FIG. 48c
ARM AND TURRET SCHEMATIC

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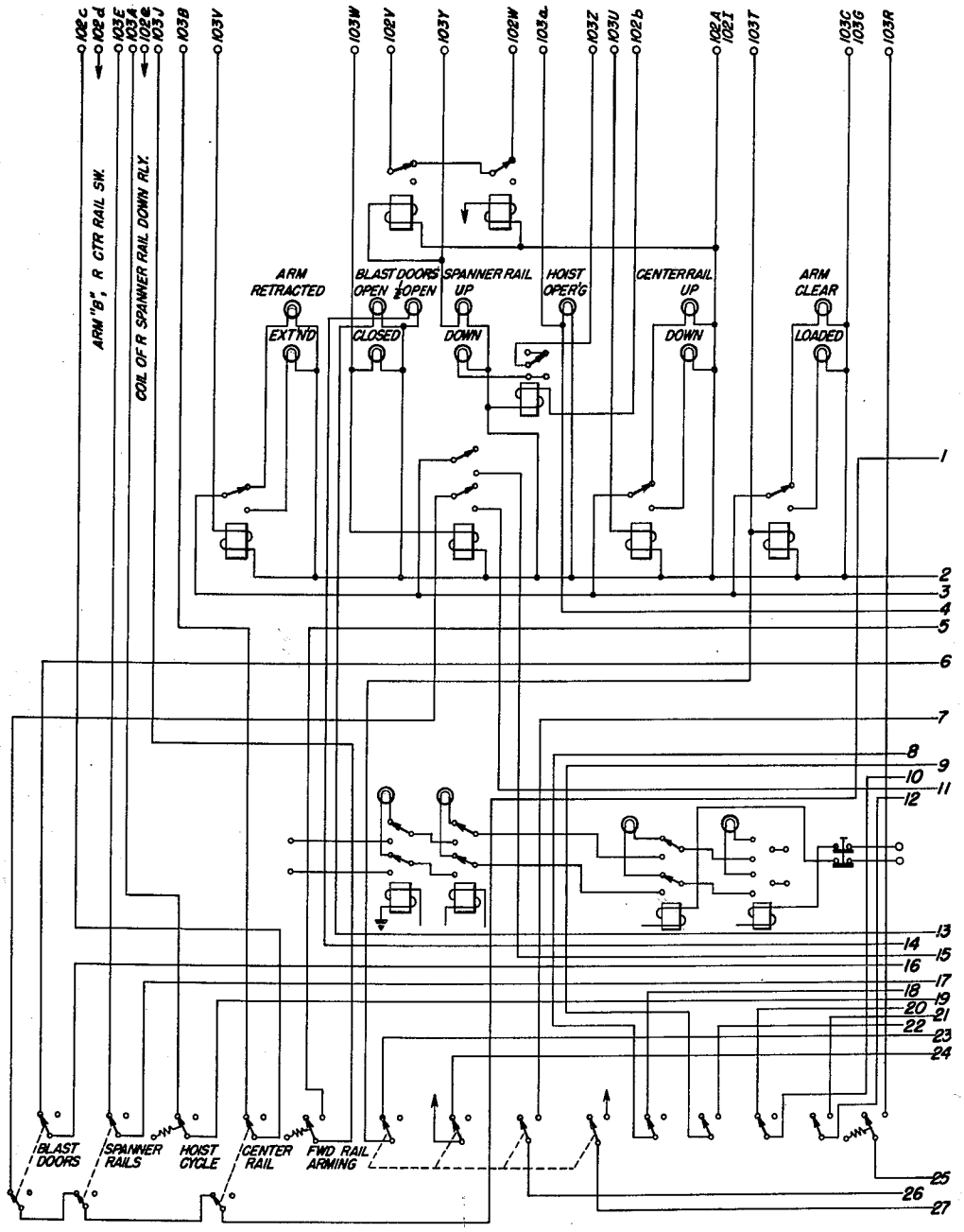
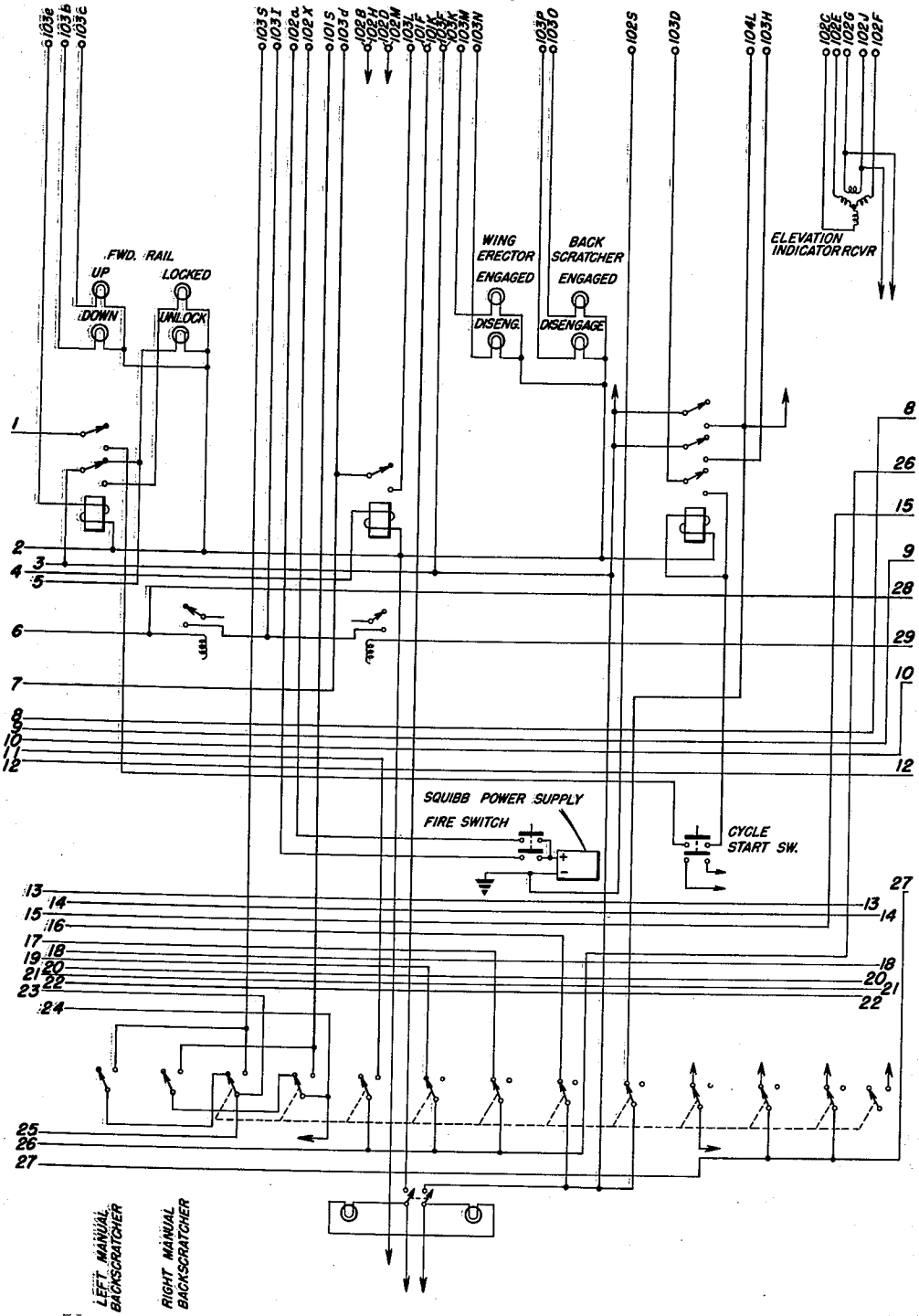


FIG. 49a
CONSOLE SCHEMATIC

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FIG. 49b
CONSOLE SCHEMATIC



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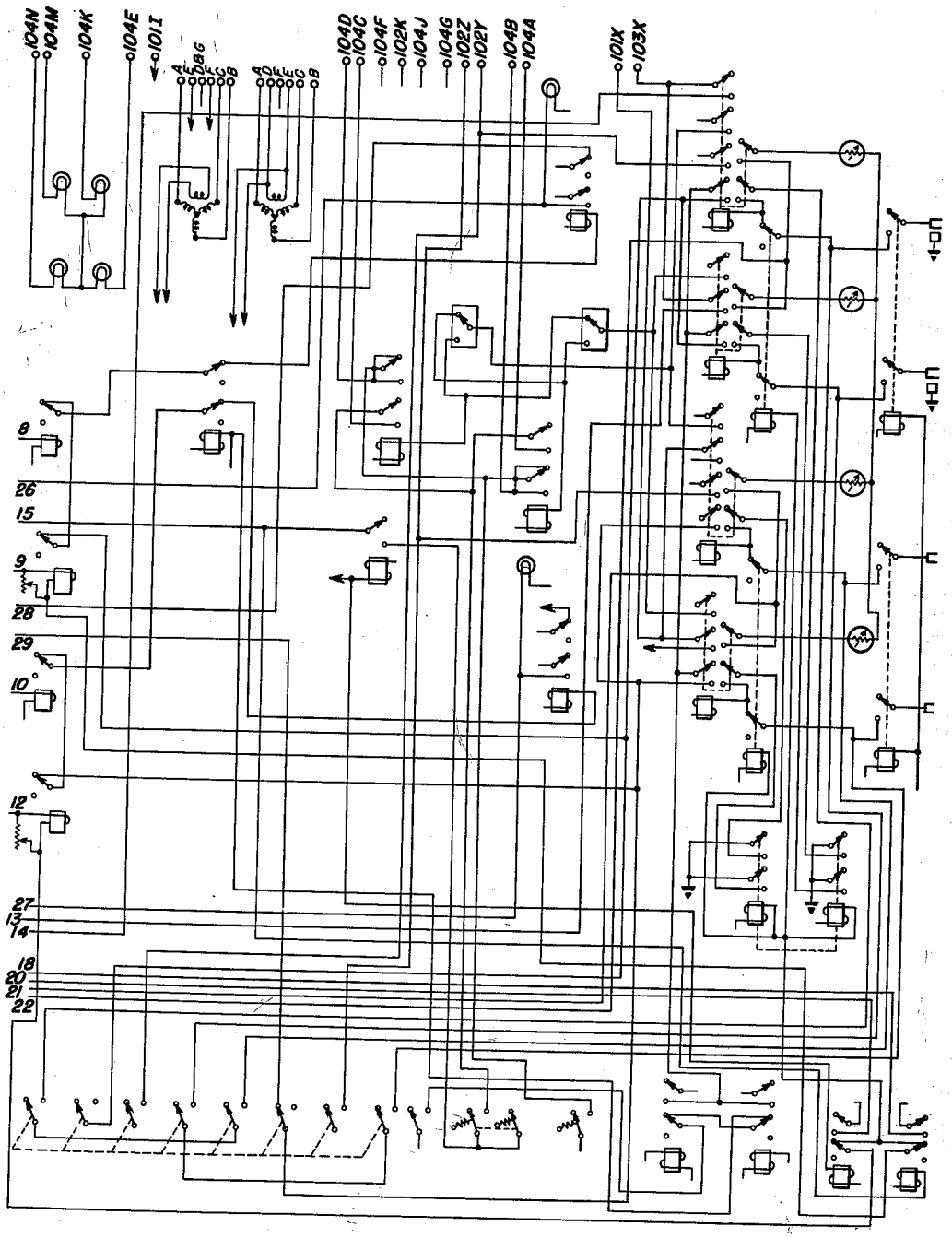


FIG. 49c
CONSOLE SCHEMATIC

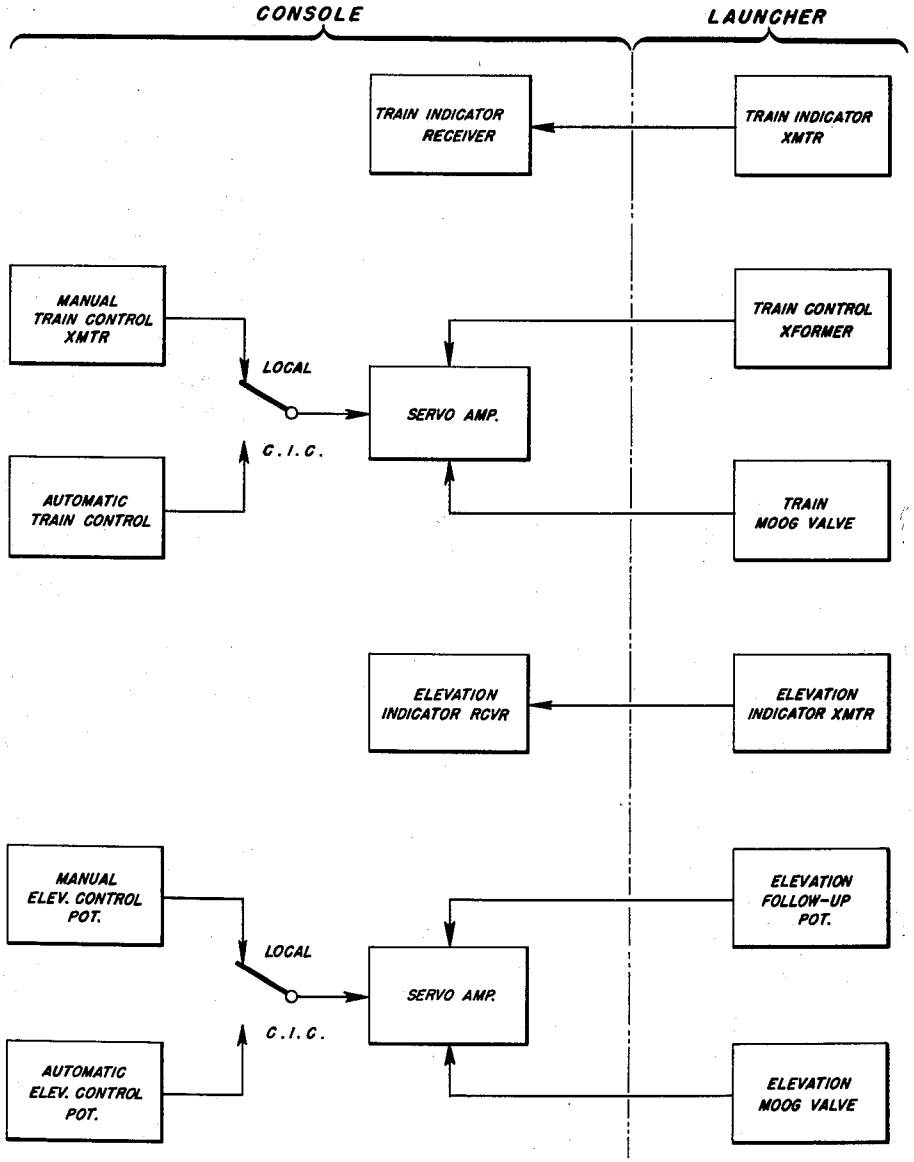


FIG. 50
BLOCK DIAGRAM OF SERVO ELEMENTS

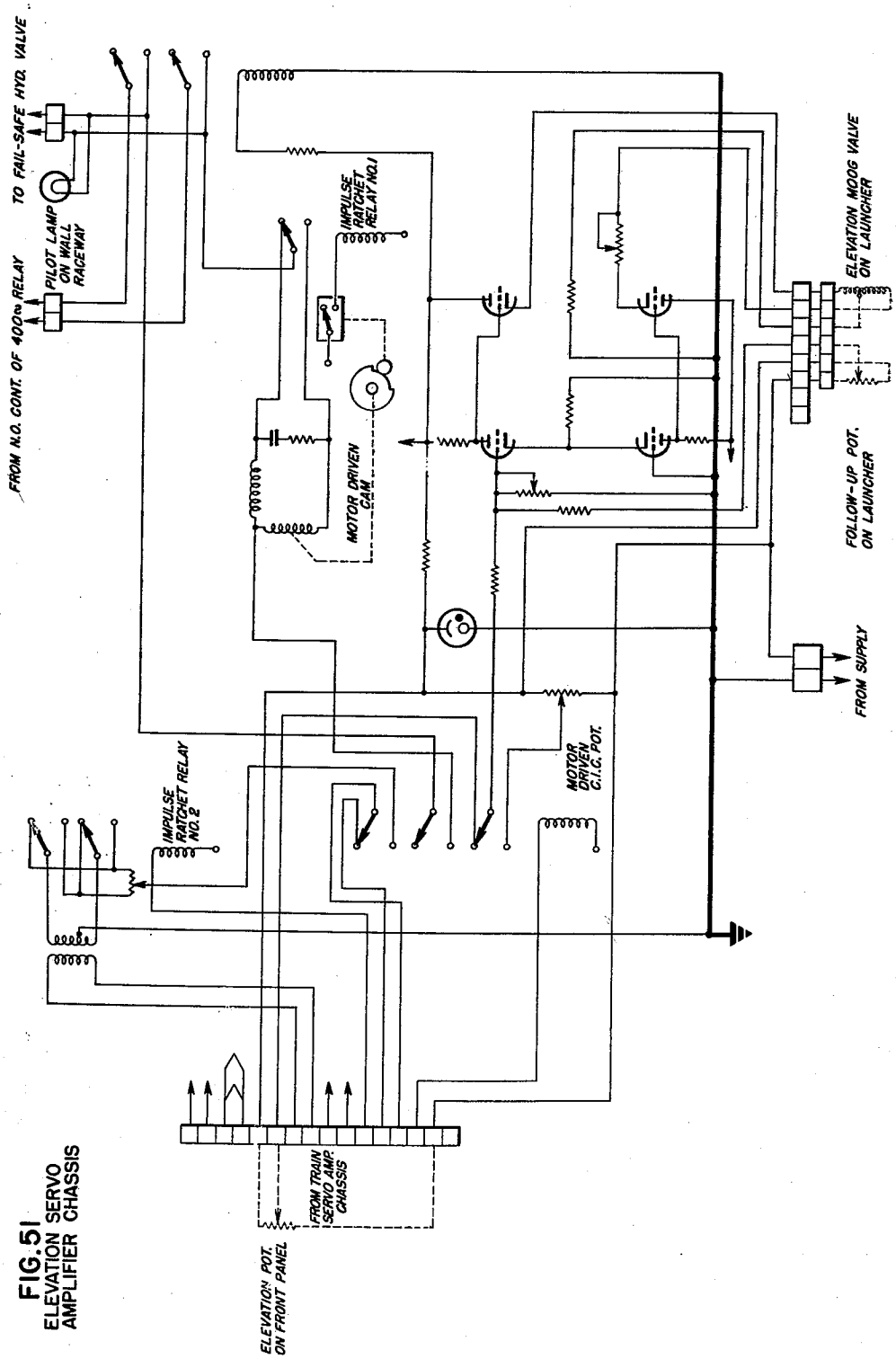


FIG. 51
ELEVATION SERVO AMPLIFIER CHASSIS

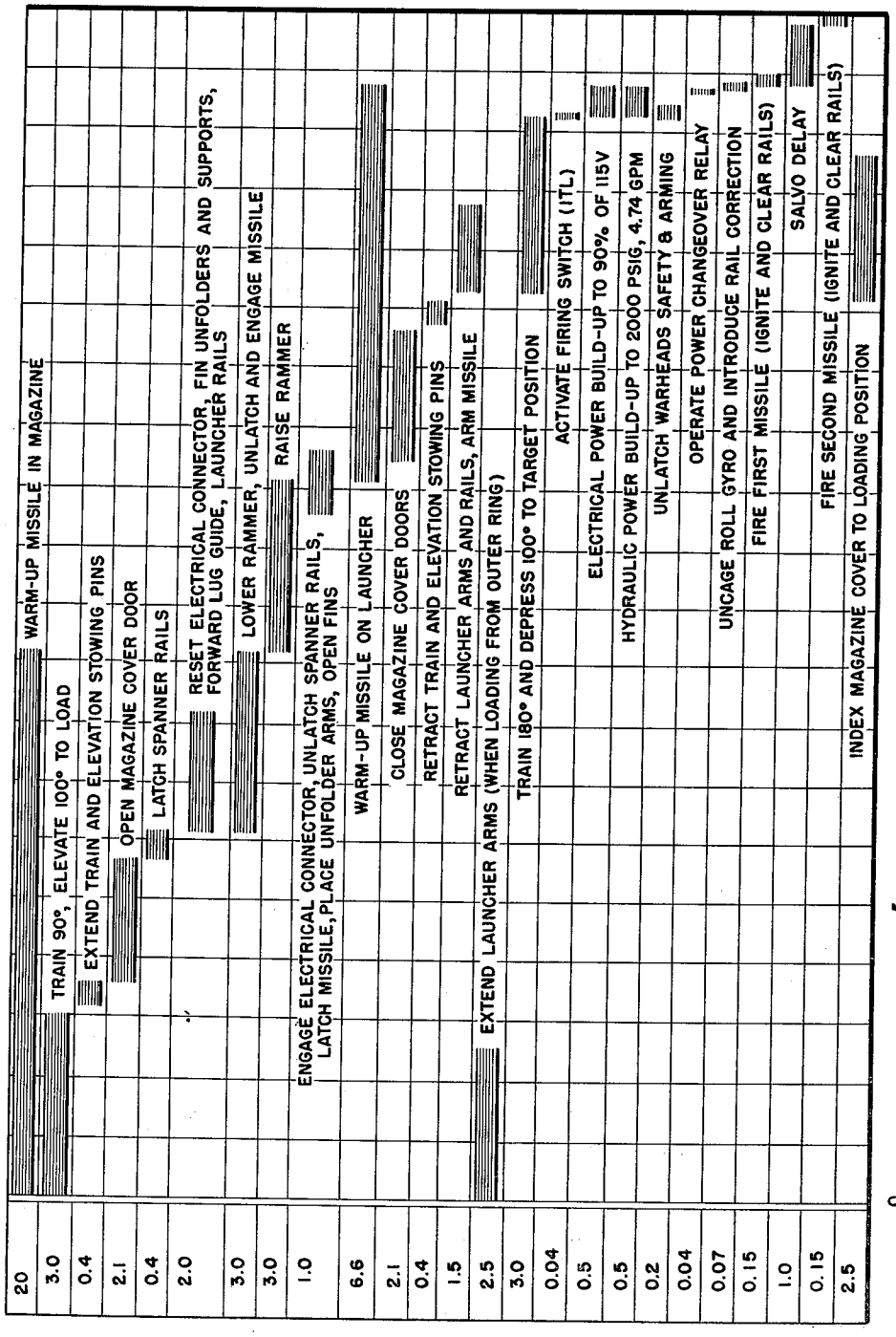


FIG. 52 – MISSILE LAUNCHING CYCLE

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FIG. 53

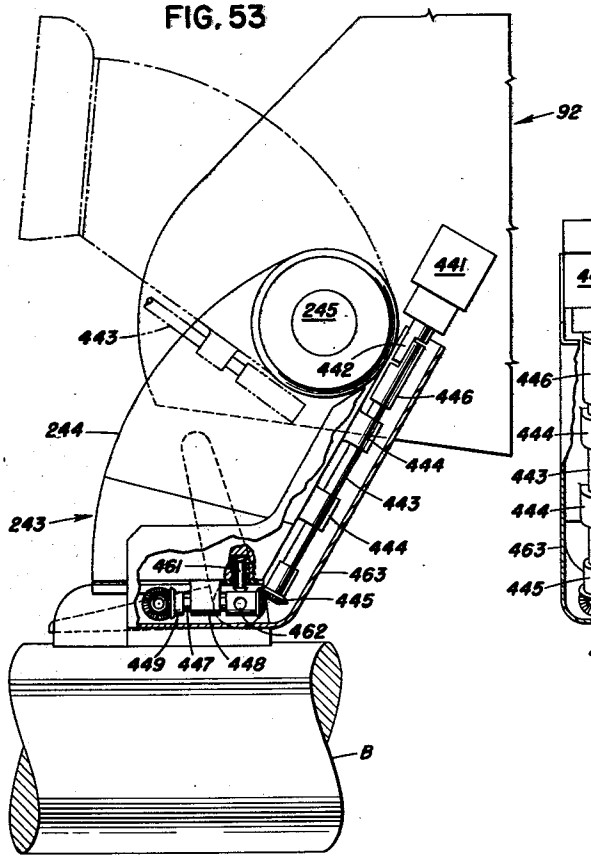
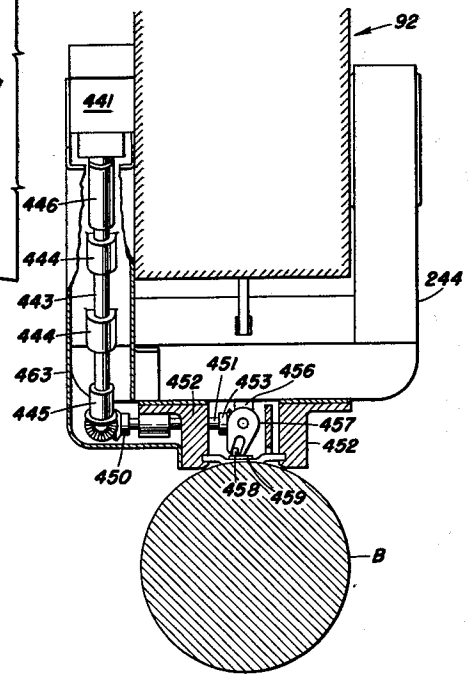


FIG. 54



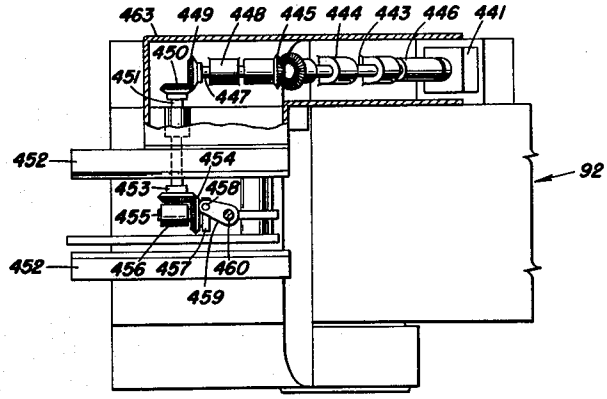


FIG. 55

United States Patent Office

3,113,486

Patented Dec. 10, 1963

3,113,486

TURRET LAUNCHER

Sverre Kongelbeck, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy

Filed June 10, 1959, Ser. No. 819,517
56 Claims. (Cl. 89—1.7)

This invention relates generally to an improved system for launching surface-to-air guided missiles against incoming air targets approaching at supersonic velocity within pre-determined intercept parameters. More particularly, the invention relates to a missile launcher which includes launching apparatus, train and elevation power drives, a turret-type missile stowage magazine, loading mechanism and associated control and operating systems.

Modern ships, such as destroyers, cruisers and aircraft carriers, are no longer able to defend themselves from attacks by enemy launched guided missiles and piloted aircraft solely by the use of anti-aircraft guns, because of the limited range of such guns. Guided missiles serve well as defensive weapons and such missiles are capable of seeking and destroying attacking aircraft or missiles. However, some means must be provided for rapidly and accurately launching these missiles.

One important object of the invention, therefore, is to provide a launcher that can be trained in azimuth and elevation and which will include means for loading and firing guided missiles singly or in dual salvos.

Another object of the invention is to provide a missile launcher which is so designed and constructed that it may be substituted as a "package" replacement for gun mounts aboard destroyers and other ships already in service.

Another object of the invention resides in the provision of a missile launcher which will be able to withstand extreme ship motion, shock, icing, salt water spray and vibration incident to ship operation, rough sea conditions and high impact, the latter to an extent equivalent to or greater than that which a missile to be launched is able to withstand.

As still another object, the invention provides a launcher that will be capable of loading, synchronizing with fire control computer orders and launching guided missiles at a continuous cyclic rate equal or equivalent to, say, the launching of a two-missile salvo every twenty seconds or less, and that will be capable of activation from a standby condition to full operating condition in not more than a minute after personnel man their stations.

It is another object of the invention to provide a launcher that may be caused to operate automatically from electrical signals originating in remotely located control apparatus, or under manual control in such a manner that each operating function can be separately initiated, performed or terminated at controlled speed and in either normal or reverse direction and sequence without initiating the next sequential function until its initiation is desired by the operator, and with means for effecting rapid switchover from automatic to manual operation, or vice versa, at the option of the operator.

Another object of the invention is to provide a missile launcer which incorporates unique mechanisms for missile hoisting, providing missile to launcher arm clearances, and for selecting missiles from one or the other of concentric rows in the magazine.

As another object the invention seeks to provide a missile launcher which incorporates meritorious features including safety spanner rail and blast door designs.

Other objects and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the

following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a side elevation of the present invention and showing one of the launcher arms with a missile thereon.

FIG. 2 is a front elevation, on an enlarged scale, showing the turret and the upper end portion of the missile stowage magazine, and with a portion of said magazine broken away and with certain elements shown in section, a missile being shown on one of the launcher arms.

FIG. 3 is a plan view, also on an enlarged scale, of the launcher, the arrangement of missiles in concentric rows in the stowage magazine being shown in dotted lines.

FIG. 4 is a vertical section on line 4—4 of FIG. 2, certain components being shown in elevation.

FIG. 5 is a vertical section through the missile stowage magazine in the same plane as FIG. 4.

FIG. 6 is a transverse section, on line 6—6 of FIG. 7, illustrating the missile selection indexing apparatus.

FIG. 7 is a vertical section on line 7—7 of FIG. 6.

FIG. 8 is a detail horizontal section through an index block, on line 8—8 of FIG. 7.

FIG. 9 is a fragmentary transverse section on an enlarged scale, on line 9—9 of FIG. 2, disclosing the arrangement of missile stowage rails within the stowage magazine, missiles being shown in position and on said rails.

FIG. 10 is a vertical axial section through one-half (longitudinal dimension) of the telescopic tube structure which supports the missile launcher arms, the inner or launcher arm supporting tube being shown extended; and FIG. 10A is a view similar to FIG. 10 but showing the other half of the telescopic tube structure with the opposite launcher arm supporting tube retracted.

FIG. 11 is a detail vertical section on lines 11—11 of FIGS. 10 and 10A, illustrating the position assumed by the centrally located hydraulic fluid distributing manifold when the launcher arms are in missile loading positions.

FIG. 12 is a detail vertical section, through one of two secondary manifolds, on line 12—12 of FIG. 10.

FIG. 13 is a section showing the general arrangement of various missile hoisting and launching components within one of the launcher arms, with certain elements shown in section and with cover plates removed, a missile being shown in position for launching.

FIG. 14 is a fragmentary view of the missile shown in FIG. 13.

FIGS. 15 through 15D are fragmentary elevations, with certain elements in section, illustrating the complete operational cycle of the forward launcher rail.

FIGS. 16 through 16D are fragmentary sectional views through the forward launcher rail shaft illustrating the position of the forward rail driving segments and stop, through a complete cycle of operation of the forward rail. FIGS. 16 through 16D correspond to FIGS. 15 through 15D respectively.

FIG. 17 is a section, on an enlarged scale, through the forward launcher rail, on line 17—17 of FIG. 15B.

FIG. 18 is an exploded perspective illustrating the arrangement of elements in one of the forward launcher rails.

FIG. 19 is a vertical section through the chain hoist drive and gear box assembly, on the line 19—19 of FIG. 21, with certain elements shown in elevation.

FIG. 20 is a fragmentary elevation of the chain hoist drive and gear box, disclosing the arrangement of the loading and strike down limit switches, the elements being shown as they appear in a chain "up" position.

FIG. 21 is a detail section, on the line 21—21 of FIG. 19.

FIG. 22 is an enlarged fragmentary section, on line

22—22 of FIG. 20, disclosing the arrangement of the loading limit switch.

FIG. 23 is a vertical section on line 23—23 of FIG. 19.

FIG. 24 is a vertical section on an enlarged scale, on the line 24—24 of FIG. 13, and showing the hoist chain tensioning assembly.

FIG. 25 is a detail section on the line 25—25 of FIG. 24.

FIGS. 26 through 26C are four semi-schematic vertical sections through the missile stowage rails, illustrating the positions of the rammer head during the missile pick-up and hoisting cycle.

FIGS. 27 through 27F constitute a series of seven views similar to those of FIG. 26 but illustrating the positions of the rammer head during the missile lowering, or stowage magazine loading cycle.

FIG. 27G is an enlarged detail perspective of the rammer head.

FIG. 27H is a detail section particularly showing the positions of the missile pick-up and lowering pins.

FIG. 28 is a vertical section on the line 28—28 of FIG. 29, the electrical contactor and portions of the fin erector mechanism being shown in elevation.

FIG. 29 is a front elevation of the electrical contactor and fin erector drive assembly, certain of the elements being shown in section.

FIG. 30 is a vertical section through the electrical contactor and fin erector drive assembly, on the line 30—30 of FIG. 29, with certain elements broken away and others shown in elevation.

FIG. 31 is a vertical section on the line 31—31 of FIG. 30.

FIG. 32 is a detail section showing portions of the electrical contactor, and the printed circuit switch mechanism, a portion of the shaft that carries the fin erectors and the sleeve that mounts said contactor also being shown.

FIG. 33 is a fragmentary section, on line 33—33 of FIG. 32.

FIG. 34 is a fragmentary horizontal section, on an enlarged scale showing the arrangement of the hydraulic components for driving the spanner rails and the blast doors.

FIG. 35 is an elevation, partly in section and on an enlarged scale, illustrating the relationship between one of the spanner rails, when erected, and a launcher arm and one of the stowage magazine rails.

FIG. 36 is a fragmentary section similar to FIG. 35 wherein, however, the spanner rail is shown in disengaged position.

FIG. 37 is a detail plan view showing one end of the spanner rail, the lock pin being shown in cross-section.

FIG. 38 is a vertical section showing the spanner rail actuator, on the line 38—38 of FIG. 39.

FIG. 39 is a vertical section on the line 39—39 of FIG. 38 and illustrating the manner of securing the stator of the spanner rail actuator to a stationary shaft and the rotor to the spanner rail.

FIG. 40 is a vertical section somewhat similar to FIG. 39, on the line 40—40 of FIG. 38.

FIG. 41A is a detail section, on the line 41—41 of FIG. 38, illustrating the rotor-stator relationship when the spanner rail is erect, and further illustrating the hydraulic port which is pressurized in order to erect the spanner rail.

FIG. 41B is a view similar to FIG. 41A but showing the rotor-stator relationship when the spanner rail is in retracted position.

FIG. 42 is a fragmentary section, generally similar to FIG. 41, on line 42—42 of FIG. 38, and showing a second hydraulic port which is pressurized when it is desired to retract the spanner rail.

FIG. 43 is a fragmentary horizontal section on an enlarged scale, illustrating the actuating mechanism for the blast doors which are shown in a nearly half-way open position, the blast door cover plates having been removed.

FIG. 44 is a fragmentary section on a further enlarged scale, on the line 44—44 of FIG. 43, illustrating, in elevation, a blast door "half-way stop" device which prevents the blast doors from being fully opened when missiles are to be removed from or placed in the outer ring of the stowage magazine.

FIG. 45 is an axial section, on the line 45—45 of FIG. 5, through the synchro driving gear box and the rotary hydraulic joint that permits rotation of the deck and launcher arms with respect to the stowage magazine.

FIGS. 46 through 46G constitute a sequence diagram illustrating the various steps of a complete missile loading and firing cycle for the present invention. FIGS. 46A, 46C and 46E are plan views corresponding to 46, 46B and 46D respectively.

FIG. 47 is a diagram showing the hydraulic circuits utilized for effecting operation of the various components of the launcher.

FIGS. 48A through 48C are wiring diagrams showing electrical connections and components in the launcher arms and the turret.

FIGS. 49A through 49C are wiring diagrams showing electrical connections and components in a typical control console.

FIG. 50 is a block diagram showing the basic control elements in a typical console connected to their associated elements in the launcher.

FIG. 51 is a circuit schematic of one of the servo amplifiers.

FIG. 52 is a chart showing a possible missile launching cycle as a function of increments of time.

FIG. 53 is a vertical sectional view showing a missile arming mechanism, the associated launcher arm components being shown in elevation.

FIG. 54 is a transverse sectional view of the arming mechanism.

FIG. 55 is a detail bottom plan view particularly showing the arming mechanism linkage and gearing; and

FIG. 56 is a perspective, showing the arming mechanism linkage and how it cooperates with an arming switch on the missile.

It is believed desirable, prior to proceeding with a detailed description of the present invention, to provide a brief discussion thereof, mainly pointing out the principal components, their functions and the sequence of operations that take place during the strike-down of missiles into the stowage magazine and during the loading and launching of said missiles from the launcher arms. It should be understood that although the following description pertains to a launcher that was actually constructed, launchers to be manufactured in quantity will differ in certain structural respects but still incorporate the general principles described herein.

Briefly, the invention comprises, as its basic components, the aforementioned stowage magazine wherein missiles are arranged nose-up in a pair of concentric rows, a rotatable cover or deck above the magazine, a pair of launcher arms mounted on the deck, and apparatus utilizing the launcher arms and related mechanisms for initially stowing missiles in the magazine and then selectively withdrawing said missiles from said magazine, indivdually or in pairs, training them on a target in accordance with commands from an associated radar, and launching them toward said target.

The improved launcher is designed to launch missiles against all incoming, outgoing and crossing targets which the missile is capable of intercepting. It will be relatively compact, that is, to the extent that shipment from the point of manufacture to the shipboard installation site may be facilitated.

The launcher and its associated loading equipment operates under automatic control from electrical signals originating remotely in a weapons control system. The

loading and launching functions, including the positioning of the launcher arms for loading, the magazine cover door opening, the extension of the spanner rails, the positioning of the missiles, the completion of missile to launcher electrical connections, the extension of the missile fins, the arming of the igniters for the missiles, the retraction of the spanner rails, the closing of the magazine blast doors, the synchronization of the launcher with fire control computer orders, and finally the actual missile launching, are automatically sequenced in such a manner that all of said operations will be performed in response to a final order from a remote control point, such as a console located below decks on shipboard. However, the launcher is so designed that all of the above-named functions may be performed under manual control in such a manner that each function can be separately initiated, performed, or terminated, in either normal or reverse direction and sequence, as desired by operating personnel.

In FIG. 1 the improved launcher is shown in its complete form (apart from a control console) with a missile loaded on one of the launcher arms. For purposes of clarity it is deemed advisable to describe the individual basic components, more or less in their entirety, one by one, followed by a description of how the said components are inter-related and how they cooperate to perform the aforementioned missile strike-down, loading, training and launching functions. Accordingly, the description immediately following relates to the stowage magazine, the rotatable deck, the drive mechanism for said deck and the indexing mechanism for positioning the launcher arms above selected missiles to be loaded.

The detailed description of the hydraulic and electrical systems will be set forth following that of the basic component assemblies and as a part of the discussion of the operation of the invention as a whole.

The stowage magazine is indicated generally at A. It is of circular contour and is mounted on a base **10**, consisting of I-beams **11** and feet **12**. Obviously, any suitable mounting for the magazine may be employed. The magazine includes a side wall **13** and an inner wall **14**, the latter being mounted concentrically within the side wall **13** in spaced relation thereto for defining an annular outer missile compartment **15**. An inner casing **16**, of cylindrical contour, has a side wall **17** which is spaced from the inner wall **14** for defining an annular inner missile compartment **18**. As best seen in FIG. 5, the walls **13** terminate at their lower ends in radial flanges which are fitted in a base ring **19**, the upper end of the wall **14** terminating short of the upper end of the magazine. The lower end of the inner casing **16** is supported on a shoulder **20** on the base ring **19**.

In FIG. 5, the stowage magazine A is shown with missiles loaded therein. By referring to this view and to FIGS. 2, 3, and 9, the structure for supporting the missiles in the compartments **15** and **18** will be seen. As stated hereinbefore, the missiles are arranged in circular rows. To effect this arrangement as to the missiles in the outer compartment **15**, spaced generally T-shaped brackets **21** are secured to the inner wall **14** near its upper end, and these brackets support the corresponding upper ends of guide rails **22**, the lower ends of said rails being secured to the base ring **19** by brackets **23**.

The rails **22** are formed with longitudinally extending channels **24** which, as seen in FIG. 9, are oriented to confront the missile side walls. The channel of each rail has a medially disposed longitudinally extending guide trough **24***a* therein. Closing the channels **24**, to define guides, are pairs of companion plates **25** and **25***a* and **26** and **26***a* which define relatively wide and narrow longitudinal slots **27** and **27***a* respectively. The rails **22** and the plates **25**, **25***a*, **26** and **26***a* are adapted to receive launcher shoes, to be described hereinafter, which are fitted on the missiles and slidably connect said missiles with the guide rails. The missiles are shown generally at B and include foldable tail fins C. Since the missiles themselves form no part of the present invention, it is believed that further description of them, other than that which relates to the launcher shoes thereon, is believed to be unnecessary. The missiles shown are of the self-contained rocket type, requiring no booster rockets for initial flight operations.

In FIGS. 3 and 9 the positioning of the missiles in the compartments **15** and **18** is shown, the missiles having been numbered for convenience in the description. The missiles in each compartment are equally spaced and are arranged so that each missile in a given compartment will lie diametrically opposite another missile in the same compartment.

The top of the magazine A is closed by a rotatable cover or deck **28** which is driven by a hydraulic motor **29** through a gear train **30**. As best seen in FIG. 5, the deck **28** has a flat upper surface and, on its under side, a hub **31**, a reinforcing web **32** and a rim flange **33**, the latter overhanging the upper rim of the side wall **13** of the magazine. The deck **28** is rotatably mounted on the inner casing **16** by structure which includes a bearing ring **34** fitted in the top wall of said casing **16**, a bearing including balls and bearing elements **35** and **36**, a driving ring **37** which carries the planetary gear **38** driven by a pinion **39** of the gear train **30**, an indexing ring **40** (to be described in more detail hereinafter) and the lower end of the aforementioned hub **31**. Suitable seals for the bearing are shown at **41** and **42**. It will be understood that operation of the hydraulic motor **29** will result in rotation of the deck **28** above the magazine A. As best seen in FIG. 3, the wall of the deck **28** is formed with a pair of diametrically opposed rectangular openings **43**. The openings **43** are located near the rim flange **33** and are of sufficient length and width to permit free passage of a missile into or out of either the outer compartment **15** or the inner compartment **18** of the magazine A.

Reference is again made to FIG. 5 of the drawings, wherein it will be seen that the inner casing **16** has depending axially therein a frame **44** which includes side members **45** and a bottom plate **46**. The frame provides a support for a train synchro housing **47** and for a rotary hydraulic joint **48** which receives a central column **49**, the latter carrying hydraulic fluid pressure and return lines **50** and **51**. The frame **44** also provides guidance and support for hydraulic fluid pressure lines **52** and **53** for the indexing mechanism, to be described hereinafter. Main hydraulic fluid pressure and return lines **54** and **55** are connected to the joint **48** and to the lines **52** and **53** through suitable couplings, one of which is shown at **54'**.

The details of the structure of the hydraulic joint **48** are shown in FIG. 45. The lower end of the central column is screwed into a cap **55'** which is apertured to receive the lower ends of the fluid pressure and return lines **50** and **51**. The cap **55'** is flared and provided with a flange which fits about the reduced upper end of a body **56**, said body having a nipple **57** extending into the cap and receiving the lower end portion of the line **50**. The lower end of the nipple **57** communicates with a chamber **58** which, in turn, communicates with a tube **58'** having an axial bore **59**, said bore communicating with a similar bore **60** in a hub **61** which is positioned within a core **61'** which is, in turn, mounted within a sleeve **62** mounted in a recess **63** in the body **56**. A retainer cap **64** secures the sleeve **62** in place in the body and an O ring **65** provides an effective seal. Communication with the line **51** is effected through an annular passage **66** between the core and the hub **61**, the upper end of the recess **63**, a passage **67** and a chamber **68** at the upper end of said body **56**.

The core **61'**, it will be seen, is threaded at its upper end to receive a bearing retaining ring **69**. At its lower end the core is enlarged to define a mounting ring **70**

which also serves as a lower bearing retainer. Upper and lower bearings 71 and 72 rotatably couple the core 61' with the sleeve 62 and thus with the body 56, the cap 55' and the central column 49. The hub 61 receives the lower end of the tube 58', and has its lower end fixed to the upper surface of a distribution block, to be described hereinafter. Annular packings 73 and 74 provide effective seals.

The train syncho housing 47 carries synchros 75, 76 and 77 which are driven by a shaft 78 and appropriate gearing 79. The shaft 78 extends upwardly through a distribution block 80 and through the hub 61, being pinned at its upper end to the body 56, so that rotation of the central column 49 will be imparted to said shaft for operating the synchros. A bearing 81 and packing 82 are provided in the lower end of the block 80 for journaling the shaft 78. The upper end of the distribution block 80 is formed with a central bore 83, which communicates with the bore 60, and an outer bore 84, which communicates with the passage 66.

Hydraulic fluid under pressure is supplied to the inner bore 83 from the line 54 through a nipple 85. From the bore 83 hydraulic fluid is forced upward through the bores 60 and 59 and the chamber 58 into the line 50. Return fluid from the line 51 passes through the chamber 68, the passage 67, the recess 63, the annular passage 66 and the outer bore 84 to the return line 55.

A more complete description of the operation of the hydraulic system will be provided, in the description of the operation of the complete launcher.

The deck 28 carries an axially positioned turret which, in turn, mounts the launcher arms. The turret is best seen in FIGS. 1, 2, 3 and 43 and is shown generally at 87. The turret 87 is generally rectangular in cross-section at its base and, as seen, partially in outline, in FIG. 1, the upper portion of said turret is inclined forwardly and, as shown in FIGS. 2 and 3, carries a tubular housing 88. The housing 88 supports mounting tubes 89 for launcher arms 91 and 92. The mounting tubes and launcher arms each contain structure that must be described in detail, and this descriptive material will appear hereinafter.

On the upper surface of the deck 28 at each side of the turret 87 are blast door housings 93 and 94. The housings 93 and 94 are rectangular in cross-section and extend radially, on the same diameter, and have formed in their top walls, near their outer ends, rectangular openings 95 which register with the openings 43 in the deck 28. The openings 95 are of sufficient size to permit free passage of missiles B into and out of the magazine A, and are normally closed by blast doors 96 and 97 (FIGS. 3 and 43) which are slidably mounted on the under side of the housings 93 and 94 in guides 98. The doors 96 and 97 are moved, either individually or in unison, by hydraulically actuated pistons 99 and 100 working, respectively, in cylinders 101 and 102. Hydraulic fluid flow to the cylinders is controlled by valves, as will be described hereinafter. The doors 96 and 97 are so controlled that they may be moved, either in unison or individually, to expose missiles (or a single missile) in the outer missile compartment 18. More specifically, each of the doors may be opened half-way, for exposing a missile in the outer compartment, or fully for exposing a missile in the inner compartment. The rods of the pistons 99 and 100 have their free ends secured to yokes, one of which is shown at 103 in FIG. 44, and the cylinders 101 and 102 are secured to the deck 28 by blocks 104. Solenoids 105 and 106 are provided with stop bars 106*a* (FIG. 44). The stop bars are movable by said solenoids to engage the inboard edges of the doors 96 and 97 for limiting movement thereof to half-open positions when it is desired to remove missiles from the outer compartment only.

The blast door housings also enclose spanner rail mechanisms which are mounted on the deck 28 and are movable from horizontal positions beneath said deck to vertical positions extending between the launcher arms and the missile supporting rails in the magazine. For a detailed showing of the spanner rail mechanisms, attention is directed to FIG. 2 and to FIGS. 34 through 43. The spanner rail mechanisms are four in number, two being provided for each opening 43 in the deck 28, and are shown at 107, 108, 109 and 110. The spanner rail mechanisms are of identical construction so that a description of one will suffice for all of them. Referring to FIG. 38, it will be seen that the spanner rail mechanism 107 includes a frame 111 which is generally U-shape in contour and is secured in one of the openings 43 in the deck 28. The bight 112 of the frame defines a bridge block having grooves 113 (FIG. 39) in its side walls, and an inclined top wall 114. The upper end portion of the frame 111 is provided with a laterally extending yoke 115 the arms of which are relatively thick and are apertured to receive the end portions of the hub 116 of the stator 117 of a rotary actuator 118. The hub 116 is secured against rotation in the frame 111 by a setscrew 119 and is formed with axial bores 120 and 121 which are closed at their respective outer ends by screw plugs 122 and 123, said bores terminating at their corresponding inner ends in a barrier 124. Fluid communication with the bores 120 and 121 is effected by orifices 125 and 125*a* and passages 126 and 126*a* which communicate with pressure and return line nipples 127 and 128. As best seen in FIGS. 39 and 40, the stator 117 is arcuate in section and constitutes a segment of a circle. It is rigidly secured to the hub 116 by pins 129 and 129*a* and is positioned in a cylinder 130, communication between the bores 120 and 121 and said cylinder 130 being effected by orifices 131 and 132. The cylinder 130 (see FIG. 38) is closed at its opposite ends by bushings 133, 134 having at their inner ends V-shaped grooves to receive V-shaped end walls of the stator 117 and of the rotor shortly to be described. The bushings 133 and 134 surround the hub 116 and are held in place by plugs 135 and 136 which are screwed into the ends of the cylinder 130.

The cylinder 130 is formed transversely in a rail mounting block 138 which carries the spanner rail element 139. A rotor 140 is secured by pins 141 and 141*a* in the cylinder 130 to cooperate with the stator 117.

In FIG. 35 the spanner rail mechanism 107 is shown with the spanner rail element 139 erect; in FIG. 36 it is shown with said rail element retracted. As best seen in FIG. 39, the side walls of the spanner rail are provided with grooves 142 that match and align with the grooves 113 in the bight 112 of the frame 111 when the spanner rail is in erect position. The grooves 142, when the spanner rail is erect, also align with grooves in this missile rails on the launcher arm and with the guide rails 22 in the magazine A.

The spanner rail element 139 carries at its upper end an aligning block 143 which is formed with an opening 144 to receive the free end of a locking rod carried on the associated launcher arm. The locking rod is projected, by mechanism to be described hereinafter, when the spanner rail element has reached full erect position.

It will now be understood that when the spanner rails 107 through 110 have been actuated, missiles may be moved, either singly or in pairs, from the magazine A to the launcher arms. It should also be understood, however, that operation of the spanner rails cannot be effected until the launcher arms 91 and 92 have been elevated to the missile loading (or stowing) positions and until the deck 28 has been oriented properly with respect to missiles in the magazine A (or to compartments in said magazine that are to have missiles stowed therein). Orientation of the deck 28, with the launcher arms 91 and 92, the blast doors 96 and 97 and the spanner rails 107–110 (and associated mechanisms) thereon, is effected by the operation of indexing mechanism now to be described.

The indexing mechanism is best seen in FIGS. 2, 3, 5, 6,

7, and 8 of the drawings, FIGS. 6 and 7 being the most detailed. The indexing ring 40 which, as previously mentioned, forms a part of the rotatable mounting for the deck 28, consists of upper and lower flanges which define an annular yoke 146. Mounted for rotation in the yoke 146 is a semi-circular series of relatively small, spaced indexing rollers 147. As best seen in FIGS. 6 and 7, the rollers 147 are eleven in number and are arranged for engagement by an outer indexing plunger 148. More specifically, the indexing plunger 148 is movable, by apparatus to be described presently, to engage between a given pair of the rollers 147 following partial rotation of the deck 28, for latching said deck, with the launcher arms 91 and 92 and the blast doors 96 and 97 and corresponding spanner rails, above a given pair of diametrically opposed missiles in the outer missile compartment 15. An inner indexing plunger 149, located diametrically opposite the plunger 148, is similarly movable to engage between relatively large indexing rollers 150 which are arranged in a semi-circular series in the yoke 146 opposite the rollers 147 and on the same horizontal plane therewith.

The plungers 148 and 149 of the indexing mechanism are mounted, respectively, in outer and inner index blocks 151 and 152, and are operated by pistons 153 working in hydraulic cylinders 154. To guide the plungers 148 and 149 pairs of rollers 155 are employed (FIG. 6). For convenience the plungers are mounted in sleeves, one of which is shown at 156, and said sleeves are anchored in place by a plurality of staking pins 157. Hydraulic connections are made to the index blocks 151 and 152, and said blocks each are bored and provided with valves 158 which are operated by actuating rods 159 on the plungers 148 and 149. A more detailed discussion of the operation of the plungers 148 and 149 and the valves 158 will be contained in the description of the hydraulic system, shown in FIG. 47. Electrical switches 160 and 161, mounted respectively at the inner and outer ends of slots 162 in the index blocks 151 and 152, are connected in circuits with suitable indicators, such as colored lamps, on a remotely located control console. The switches are actuated by the actuating rods 159 for showing the positions of the indexing plungers 148 and 149, i.e., engaged or disengaged.

The mechanism for elevating the launcher arms and laterally positioning said arms above the magazine will now be described. This mechanism is shown in FIGS. 3, 4, 10, 11, 12 and 47. Referring first to FIG. 4, it will be seen that the upper end of the column 49 terminates within the turret 87 above the deck 28. The hydraulic fluid lines 50 and 51 carried in the column 49 are, as shown in FIG. 47, connected to distribution manifolds within the turret, one of said manifolds being shown at 163 in FIG. 4. From the manifold 163 fluid lines are led to and from an elevation cylinder 164 in the turret, said cylinder being pivoted at its lower end and having a piston rod 165 which is pivotally connected at its upper end to a lever 166 mounted on an elevation tube 167. As best seen in FIGS. 10 and 10A, the elevation tube 167 includes end sections 168 and 169 which define the inner elements of pairs of telescopinig tubes, and that have corresponding inner end flanges 170 and 171, respectively, which are bolted to mating end flanges on the said elevation tube. At their corresponding outer ends the sections 168 and 169 are provided with connecting flanges 172 and 173. For mounting the elevation tube 167 for rocking movement in the tubular housing 88 of the turret 87 bearings 174 and 175 are employed. The bearings are mounted in the end walls of the turret and surround the end sections 168 and 169. The bearings are held in place by threaded nuts 176 and 177. In the structure shown in FIGS. 10 and 10A the bearings and nuts would be of the split variety, to permit installation. Fitted in each of the connecting flanges 172, 173 is a locking pin 178.

The launcher arm mounting tubes 89, 90 include tube elements 179 and 180 which are mounted for telescoping movement within the sections 168 and 169, respectively, and which define the outer of the aforementioned telescoping tubes. The tube elements are spaced from the sections 168, 169 by bushings 181, and are keyed against relative rotation by pins 182. The tube elements 179 and 180 are also limited against rotation with respect to the elevation tube 167 and its end sections 168 and 169 by keys 183 and 184 on the corresponding inner ends of said elements, said keys slidably engaging in a keyway 185 (FIG. 11) secured to the inner surface of said elevation tube 167. At their outer ends the tube elements 179 and 180 are provided with coupling flanges 186 and 187 which are bolted or otherwise firmly secured to coupling rings 188 and 189 that are secured to the inner walls 190 and 191 of the launcher arms 91 and 92. Formed in each of the flanges 186, 187 is an opening 191*a* for engagement by each of the locking pins 178. It will now be understood that rocking movement imparted to the mounting tubes 89, 90, by operation of the piston rod 165 working in the elevation cylinder 164, will cause the launcher arms 91, 92 to rock about the axes of said tubes. More specifically, when hydraulic fluid is supplied to the lower end of the cylinder 164, the piston therein will be moved upwardly and this movement will be transmitted by the piston rod 165 to the lever 166, the elevation tube 167, the end sections 168, 169, and the tube elements 179, 180 to the arms 91, 92 for rocking said arms to vertical positions, as shown in FIG. 4. When in vertical positions, and properly oriented with respect to the blast doors 96, 97 in the deck 28, the arms may receive from (or stow into) said magazines the missiles B.

For positioning the arms 91, 92 above either the outer missile compartment 15 or the inner missile compartment 18, the mounting tubes 89, 90 are moved outwardly or inwardly. In more detail, and referring to FIGS. 10, 10A, 11 and 12 of the drawings, telescoping movement of the elements 179, 180 is effected by the action of hydraulic fluid under pressure working against pistons 192 and 193 working, respectively, in cylinders 194 and 195 which have their inner ends secured in a central manifold 196 mounted in the elevation tube 167 (FIG. 11). The pistons 192 and 193 are mounted on hollow piston rods 197 and 198 that extend outwardly and into the launcher arms 91 and 92, ports 199 and 200 being provided near the ends of each of said rods. Cap nuts 201 and 202, with suitable packings, close the outer ends of the cylinders 194, 195 and provide guides for the piston rods. The piston rods 197, 198 are connected to the mounting tubes 89, 90 by plugs 203, 204, connecting rings 205, 206, distribution blocks 207, 208, and snap rings 209, 210.

The cylinders 194, 195 pass through secondary manifolds 211, 212 which also receive therethrough fluid return tubes 213, 214, to be described presently. The secondary manifolds also receive fluid pressure through inlet pipes 215, 216 which are connected at their corresponding inner ends to the central manifold 196. As best seen in FIGS. 4 and 11, flexible fluid pressure and return lines 216*a* and 216*b* are connected between the central manifold 196 and the pressure and return lines 50 and 51 in the central column 49, suitable bores 216*c* being provided in said manifold 196. Referring again to FIG. 12, it will be seen that the secondary manifolds, the cylinders 194, 195, and the piston rods 197, 198 are so ported that hydraulic fluid under pressure will be permitted to flow from the inlet pipes 215, 216 to said cylinders and outwardly through said piston rods to the launcher arms 91, 92 for distribution therein.

The fluid return tubes 213, 214 are of such inside diameter that they will slidably receive fluid return pipes 217, 218 from the launcher arms, the slidable connection between tubes 213, 214 and the pipes 217, 218 being effected by cap nuts 219, 220 which are similar to the nuts 201, 202. The outer ends of the pipes 217, 218 are se-

cured in the plugs 203, 204 and distribution blocks 207, 208 in the same manner as are the hollow piston rods 197, 198 and are provided with bores for communication with said blocks.

Coiled loosely about the cylinders, tubes and pipes within the elevation tube 167 and the mounting tubes 89, 90 are helical springs 221 and 222. The springs extend between opposite sides of the central manifold 196 and the plugs 203 and 204, retainer rings 223 and 224 securing the outer ends of said springs to said plugs. Similar retainer rings 225 secure the inner ends of said springs to the central manifold 196. The sole function of the springs 221, 222 is to lead electric conductor cables 226, 227 from the area of the central manifold to the interior of the launcher arms 91, 92 in such a way that kinking of the cables and interference with the operation of the components within the tubes 89, 90 by said cables will be prevented.

The mounting tubes 89, 90 are moved outwardly and inwardly in unison and in telescoping fashion by the action of hydraulic fluid under pressure working against the pistons 192, 193. That is, the mounting tubes 89, 90 are normally maintained in their innermost positions by fluid under pressure which is constantly applied against the relatively small annular surface areas of the inner faces of the pistons 192, 193. When it is desired to shift the tubes 89, 90 outwardly for locating the launcher arms 91, 92 at diametrically opposite points above the outer missile compartment 15, fluid is directed to act against the outer faces of the pistons. More specifically, although the fluid pressure applied to the outer faces of the pistons is of the same value as that applied to the inner annular faces thereof, the greater surface areas contacted by the fluid acting against the outer surfaces will result in the action of said fluid overcoming the pressure applied to the relatively small area inner piston faces, when the mounting tubes 89, 90 will move outwardly.

The launcher arms 91, 92 are of identical construction so that a description of one will suffice for both. In describing the launcher arm 92 reference is made to the following figures of the drawings: 13, 14, 15 through 15D, 16 through 16D, and 17 through 25.

The launcher arm 92 includes a sheet metal housing 228 having an inclined forward wall 229, an upwardly sloping bottom wall 230, a rear wall 231, inboard side wall 191, and a corresponding outboard side wall 191*a*. Within the arm 92 partitions 232 and 233 define a forward compartment 234, a central compartment 235 and an upper compartment 236. In the upper compartment are located electrically operated hydraulic control valves 237 through 242 which, in response to electrical signals, function to direct hydraulic fluid under pressure to the several cylinders in the compartments 234 and 235 for actuating components in said compartment, that will presently be described. As best seen in FIG. 13, the partition 233 defines a manifold for distributing fluid to the valves 237–242, said manifold being connected to the rod 197 and return pipe 217 by pipes 235*a* and 235*b* and suitable couplings.

The launcher arm 92 mounts, near its forward end, the launcher forward rail assembly which is shown generally at 243. The launcher forward rail assembly includes a yoke 244 which straddles the forward end of the housing 228 and is mounted on a shaft 245 that extends transversely of the forward compartment 234 and is journaled in bearings 246 in the side walls 191 and 191*a*. As best seen in FIGS. 17 and 18, the shaft 245 has mounted thereon or associated therewith the following elements: return levers 247 and 248, an actuator fork 249 having a rack 250 mounted to extend laterally from beneath its lower tine, a pinion 251, a bushing 252 to which the pinion is pinned and which has a laterally projecting segment 253, and an actuating sleeve 254 which has a radially projecting stop lug 255 and a segment 255*a* thereon. The return levers 247, 248 are pinned to the shaft 245 and are positioned adjacent the bearings 246. The actuator fork 249 straddles the shaft 245 and is movable to a limited extent with respect to said shaft. The pinion 251 and bushing 252 are rotatable freely about the shaft. The actuating sleeve 254 is pinned to the shaft 245.

As seen in FIG. 13, the actuator fork 249 is fitted on the free end of a piston rod 256 which carries at its opposite end a piston 257 working in a cylinder 258 mounted on a support 259 in the upper end portion of the forward compartment 234. The cylinder 258 is operatively connected with the valve 237 by suitable bores 260. The return levers 247, 248 are suitably notched to receive the corresponding lower ends of heavy spiral springs, one of which is shown at 261, the opposite ends of said springs being anchored to the support 259 (as shown in dotted lines).

The launcher forward rail assembly 243, including the yoke 244, is fitted to the ends of the shaft 245 to rock therewith and to swing about the forward end of the launcher arm 92. More specifically, and as shown in FIG. 13 and in the FIG. 15 series (FIGS. 15, 15A, etc.), movement of the actuator fork 249 by the piston rod 256 will impart partial rotation to the shaft 245 for swinging the assembly 243 from the position shown in broken lines in FIG. 13 to the position shown in full lines in said figure. As shown in the FIG. 16 series, rearward movement of the return levers 247, 248 is limited by engagement of the stop lug 255 with a cushioned bumper 255*b* mounted on the wall 230 within the forward compartment 234.

The launcher forward rail assembly 243, as shown in the above-mentioned figures and also in FIG. 17, includes a rail element 262 which is secured to the outer face of the bight of the yoke 244 medially of its width, and is provided with side walls 263 formed with opposed slots, or tracks, 264. Extending between the walls 263 inwardly of the tracks 264 is a stub shaft 265 on which are fixed a latch member 266 and an actuating lever 267. The actuating lever 267 is constituted by a shoe 268 and a dog 269, the shoe lying between the side walls 263 and the dog projecting below the rail element 262. The actuating lever 267 extends rearwardly through the bight of the yoke 244 and has a roller 270 at its inner end for engagement in a depression 271 in the front face of a latch plate 272 secured to the forward end of the bottom wall 230 of the housing 228. A microswitch 273 is mounted in the housing 228 behind the plate 272 and has a plunger 274 that extends through the wall 230 and the plate 272 into the depression 271 therein. A spiral spring 274*a* normally urges the lever 267 away from the plate 272.

The numeral 275 indicates generally the center rail which cooperates with the forward rail element 262 and with an aft rail element 276, the latter being fixed to the housing 228 aft of and at a slight angle with respect to the bottom wall 230. At its rear end the center rail is hinged to the aft rail element by a pin 277. The center rail 275 is best seen in FIGS. 2 and 13 of the drawings and when in operative position cooperates with the forward rail element 262 and the aft rail 276 to receive a missile and support it in a position ready for launching. More specifically, the center rail moves from an inoperative position against the bottom wall 230 of the housing 228, as shown fragmentarily in FIGS. 15, 15A, 15C, and 15D, to operative position in alignment with the forward rail element 262 and aft rail 276, as shown in FIGS. 2, 13, and (fragmentarily) 15B. The aft, or lower, end of the center rail 275 is stepped to mate with the recessed forward, or upper, end of the aft rail 276, and is formed with a slot 278 to receive a rectangular extension 279 on said aft rail. As best seen in FIG. 2, the extension 279 and the aft rail 276 are formed with a continuous longitudinal guide slot 280, which is in align-

ment with the groove 113 in the spanner rail 107 when the spanner rail is in operative position.

To move the center rail 275 into and out of operative position a hydraulic jack is employed. The hydraulic jack includes a cylinder 281 (FIG. 13) which is mounted on the bottom wall 230 of the housing 228. Fluid is introduced to the cylinder by pipes 282 which are connected to the source of fluid under pressure and to the return line through the electrically controlled valve 239. The hydraulic jack includes a piston rod 283 which has a slotted fitting 284 on its free end, the slot in said fitting receiving a pin 285 in a recess 286 in the rear wall of the rail. To control a remotely located electrically operated indicator a switch 287 is used, said switch being mounted on the wall 230 and being operated by a rod 288 connected with the rail 275.

At its forward end the center rail 275 is provided with a recess 289 which receives the end of the dog 269 when said center rail is in operative position. As shown in FIG. 15B, when a missile is in place on the launcher the actuating lever 267 will be engaged in the depression 271 with the result that the launcher forward rail assembly will be held down, i.e., in operative position. Launching of the missile will free the shoe 268, when the spring 274*a* will move the lever 267 out of the depression 271 and permit the springs 261 to raise the forward rail to the inoperative position shown in FIGS. 15 and 15D. The center rail 275 will also be retracted.

The mechanism for stowing missiles in the magazine A and for elevating said missiles and placing them on the launcher arms will now be described Since identical stowing and elevating mechanisms are used in both of the launcher arms, a description of one such mechanism will suffice for both. The stowing and elevating mechanism is best seen in FIGS. 13, 19 and 20 through 25 of the drawings.

Referring first to FIGS. 13 and 19, the stowing and elevating mechanism comprises a drive unit, which is shown generally at 290, and a chain reel 291. The drive unit and chain reel are carried in the central compartment 235, the drive unit being secured to the bottom wall 230. The chain reel is also mounted in the central compartment, but aft of the drive unit 290.

The drive unit 290 is best seen in FIGS. 13, 19, 21, and 23, and include a frame 292 on which is mounted a cylinder 293 which carries a piston 294 and piston rod 295. Opposite ends of the cylinder 293 are connected with the valve 238 by tubes 296, for conducting hydraulic fluid under pressure to and from said cylinder. At its free end the piston rod 295 is threaded to receive a coupling element 297 having a slot 298 and a recessed front face 299. The element 297 is pivotally connected to an internal driving gear 300 by a pin 301, said gear having a wall 302 with a yoke 303 mounted thereon and arcuate slots 304 formed therein. Pinions 305, 306, and 307 each have a stub shaft 308 with one end journaled in the frame 292 (FIG. 21) and the other end in a center plate of said frame. The pinions 305, 306 and 307 mesh with a driven gear 309 which is mounted on the same axis as the internal gear 300, said gear 300, the pinions 305, 306, and 307, and the driven gear 309 constituting an epicyclic gear train.

The driven gear 309 is keyed to a shaft 310 that is journaled in bearings 311, 312, and 313 the bearings 311 and 313 being relatively small and being mounted in opposite walls of the frame 292, and the bearing 312 being relatively large and being mounted within a hub 314 in the wall 302 of the gear 300. Also keyed to the shaft 310 is a relatively large gear 315. The gear 315 is located adjacent a wall of the frame 292, which wall is designated 316 for convenience. Partially surrounding the gear 315 is a housing 317, of sheet metal.

Formed in the housing 317 near the top of the rim thereof is an arcuate slot 318, and mounted on the housing adjacent the slot is a switch 319 having a plunger 320 and an actuating element 321. As best seen in FIG. 22, the element 321 includes an arm 322 extending through the slot 318, and a curved shoe 323 on the end of said arm. The shoe is engageable by a stud 324 on the gear 315 for depressing the arm 322 and actuating the plunger 320 for operating the switch 319. Also mounted on the face of the housing is a bracket plate 326 which carries a microswitch 327 that confronts the end of the slot 318 and has a plunger engageable by a switch arm 328. The switch arm 328 includes a projection 329 extending through the slot 318 for contact by the stud 324, and a spring-pressed actuating screw 330 for contact with the plunger of the switch 327. The switch arm 328 is pivotally mounted on the bracket plate 326 by a screw 331 and is biased away from the microswitch 327 by a leaf spring 332. Bolts 333 in slots 334 adjustably mount the bracket plate on the housing 317.

Referring again to FIG. 19, a solenoid 335 is mounted on a bracket 336 secured to the wall 316 of the frame 292. The solenoid 335 has a plunger 337 which carries a control plate 338 on its upper end. The control plate 338 is also seen in FIG. 21 and is formed with a slot 339 which receives the piston rod 295 therethrough, said plate being located adjacent the inner end of the cylinder 293. Operation of the solenoid 335 is controlled by the switches 319 and 327 for shifting the control plate up or down for limiting inward travel of the piston rod 295. More specifically, when the control plate 338 is in "up" position, it will engage the unrecessed portion of the front face of the coupling element 297 for limiting slightly the inward movement of the piston rod 295; when the control plate is in the "down" position, it will engage in the recessed portion 299 of the front face of said element 297, for permitting slightly greater inward movement of the piston rod. As will be explained in more in more detail hereinafter, travel of the piston rod controls the extent of movement of the hoisting chain which is employed either for raising a missile from the magazine A and positioning it on the launcher arm or for lowering said missile into said magazine for stowage. Microswitches 303*a* and 303*b*, mounted on a bracket 303*c*, are engageable by the bight portion of the yoke 303 when the piston rod 295 is in its outermost position for controlling indicator circuits.

Returning again to the drive unit 290, and to FIGS. 19, 21, and 23, the relatively large gear 315 meshes with a pinion 340 keyed on a shaft 341 which is journaled in bearings in the walls of the frame 292 at its lower right-hand corner (as seen in FIG. 19). Also keyed to the shaft 341 is a sprocket 342 which rotates within a sprocket housing 343 having chain passages 344 and 345 (FIG. 19).

Fitted to the drive unit 290 adjacent the end wall of the sprocket housing 343 is a chain latch mechanism 346 (FIG. 19). The chain latch mechanism includes a plunger 347 which is mounted on a bracket 348 and is biased toward the passage 345 by a spring 349. At its lower end the plunger is shaped to form a tooth, shown in dotted lines at 350. To move the plunger away from the passage a toggle arrangement is employed, the same comprising relatively short links 351 and 352 and a relatively long actuating link 353, said actuating link having a slot 354 therein and being connected, by a yoke 355 (FIG. 13), with a lockind rod 356 (FIG. 13).

The locking rod 356 is operated by a jack 357 which is supplied with hydraulic fluid from the valve 240 by pipes 358, and extends through the jack, through a switch block 359, and through a guide block 360, the latter communicating with the rear wall 231 of the housing 228. Positioned on the rod 356 near the switch block 359 is a collar 361 which actuates microswitches 362 and 363, which control indicator circuits and devices for showing the position of the spanner rail 107 with respect to the launcher arm 91, said microswitches being mounted on the said block 359 and being actuated by the collar 361

upon movement of the locking rod 356. A microswitch 364 is also positioned on the switch block 359 and is operated by a cam 365 that projects slightly beyond the rear wall 231 at the lower right-hand corner thereof as viewed in FIG. 13. The cam 365 is actuated by the spanner rail 107 when in elevated position for closing the switch 364 which controls the valve 240 that, in turn, causes operation of the jack 357. Operation of the jack 357 shifts the locking rod 356 for engaging the free end of said rod in the opening 144 in the aligning block 143 of the spanner rail (FIGS. 35 and 36). Shifting of the locking rod 356 into locking position will retract the plunger 347 of the chain latch mechanism 346 so that the chain, to be described in more detail hereinafter, will be released for projection into the magazine A.

The chain reel 291 is best seen in FIGS. 24 and 25 as well as in FIG. 13. It is mounted in a rectangular internal frame 368 (FIG. 24) having side walls 369 and 370 and top and bottom walls 371 and 372, respectively. A shaft 373 extends transversely of the frame medially of its height and width and includes a reduced portion 374. At the junction of its reduced and unreduced portions the shaft 373 carries bearings 375 which are retained in position by snap rings 376. Mounted to rotate on the shaft 373 in the frame 368 (and journaled by the bearings 375) is a reel 377 which includes a spring case 378 that surrounds the unreduced portion of the shaft 373 and carries a coil spring 379 therein. As shown in FIG. 25, one end of the coil spring is riveted to the rim of the spring case 378 and the other end of said spring is secured in a sleeve 380 that is fixed on the shaft by screws 381.

The reel 377 includes a wall 382 which is spaced from the inner end face of the spring case 378 to define a spool 383 which receives a chain 384 wound thereon. The inner end of the chain is secured to the hub of the reel by a pin 384*a*. The outer end of the chain is, as best seen in FIG. 13, extended forwardly and trained about the sprocket 342 after passing through the chain passage 344. At the free end of the chain 384 is a rammer head 385 which is shown in FIG. 13, in the FIG. 26 series, and in the FIG. 27 series (particularly FIG. 27G).

The rammer head 385, as best seen in FIG. 27G, comprises a frame 386 and a dog 387 pivoted on said frame. The body of the frame contains a spring-pressed plunger 388 which is engageable with a slightly inclined ridged end surface 389 of the dog 387 in such a manner that the dog will be maintained either in the retracted position shown, for example, in FIGS. 26 and 26A, or in the extended position shown in FIGS. 26B and 26C. To limit movement of the dog a pin 390, carried by the frame 386 in spaced relation to the pivot 391, works in an arcuate slot 392 in said dog.

The frame 386 is movable in the chain groove shown in the lower right-hand corner of FIG. 13, in the grooves 113 and 142 in the spanner rail 107, and in the guide troughs 24*a* in the guide rails 22 in the magazine A.

Attention is now directed particularly to the FIG. 26 series (FIGS. 26 through 26C) and to the FIG. 27 series (FIGS. 27 through 27G). In each of these views one of the guide rails 22 is shown, with its channel 24 and guide trough 24*a* therein. It will be seen in all the views above-referenced that the guide rail 22 is formed with an arcuate depression 393, a pick-up pin 394 and a lowering pin 395. A portion of the aft shoe of a missile entering or leaving magazine A is shown at 396. The depression 393 is formed in the rear wall of the guide rail near its mid-point; the pick-up pin 394 is located on the plate 26 of the guide rail below said depression 393. The lowering pin 395 is located in the trough 24*a* substantially midway between the plane of the lowering pin and the bottom of the rail.

As best seen in FIG. 27G, the dog 387 is provided with a raised portion 397 having an inclined cam surface 398 and a slot 399, said slot having a flared mouth 400 at its outer end. The dog is also provided with a curved inner edge 401 and an angular outer edge 402, the latter terminating in an inclined straight cam surface 403.

By carefully scrutinizing FIGS. 1, 19 and 20 and the FIG. 27 series of the drawings, it will be seen that when it is desired to lower a single missile or a pair of missiles into the magazine A, the launcher arms, after loading thereof from a suitable source, are first positioned vertically, as shown in FIG. 1, and the blast doors opened above channels defined by the pairs of guide rails in the outer compartment 15 or in the inner compartment 18. The spanner rails are then erected for coupling the launcher arms with said guide rails, the rail locks are engaged and the chain latch mechanisms released. The hydraulic circuit diagram (FIG. 47) illustrates the valves and controls for effecting the above-described (and other) operations. Then, as to each launcher arm, the solenoid 335 is energized for positioning the control plate slot 339 (FIG. 19) to clear the recessed front face 299 of the coupling element 297, permitting the piston 294, to make a slightly longer stroke in the cylinder 293, with the result that the chain 384 will be lowered to missile stowage position on the guide rails in the magazine. More specifically, the missile is lowered into the magazine by the chain 384 and with the upper end corner 387*a* of the dog 387 of the rammer head 385 in contact with the under surface of the missile aft shoe 396, that is, with the dog 387 canted outwardly about the axis of the pivot 391. After the missile has been lowered into position the chain 384 and rammer head 385 are caused to continue to travel downwardly in the guide rail, past the pin 394 and into engagement with the lowering pin 395. The lowering pin will engage the curved inner edge 401 and will cause the dog 387 to rock inwardly about the pivot 391. As the chain 384 is raised in the guide rail slot, the dog will move past the pick-up pin 394, the unraised portion of said dog and the slot 399 allowing said dog to pass said pin. As best seen in FIG. 27C, when the pin 394 is in the slot 399, the upper end portion of the dog is disposed in the arcuate depression 393. Said upper end portion of the dog is thus caused to clear the lower end of the missile aft shoe 396. When the angular outer edge 402 strikes the missile shoe 396, as shown in FIG. 27E, the dog will be caused first to rock outwardly and subsequently, by the action of the plunger 388 on the slightly inclined ridged end surface 389, to move to the intermediate position shown in FIG. 27F. Further withdrawal of the chain 384 will cause it to clear the guide rails and the spanner rails and to move into stored position on the drum or spool 383. After retraction of the spanner rails and closure of the blast doors, the launcher turret may be repeatedly oriented for locating the launcher arms, with missiles loaded thereon, above other pairs of channels in the inner or outer missile compartments, and the stowage procedure above-described repeated until the magazine is fully loaded with missiles.

When a missile (or a pair of missiles) is to be removed from one of the compartments of the magazine A, the turret is oriented for positioning the launcher arms in erect positions above diametrically opposite missile containing channels of either the inner or the outer compartment. In each said launcher arm the control plate 338 is positioned, by energization of the solenoid 335, for locating the control plate slot in a position to confront the un-recessed portion of the front face 299 of the coupling element 297, to shorten the travel of the piston 294 and piston rod 295. After the blast door is opened and the spanner rail is erected, the chain latch mechanism of each of the launcher arms may be released. Operation of the drive unit 290 in each of the launcher arms will lower the chain 384 into the magazine A.

The FIG. 26 series of drawings show the positions assumed by the rammer head 385 during lowering of the chain. More specifically, in FIG. 26 the head 385 is shown above the missile aft shoe 396; in FIG. 26A

the head has passed below the shoe **396** and has its cam surface in engagement with the pin **394**; the pick-up pin **394** rocks the rammer head **385** to the position shown in FIG. 26B, when the upper end corner **387***a* of said head will be presented for engagement with the lower end of the shoe **396**. In FIG. 26C the rammer head **385** is shown in contact with said shoe **396**, in which position the missile may be raised from the magazine compartment and mounted on the launcher arm. The chain will continue to move until it is fully stored on the drum or spool **383**. The associated spanner rail may then be retracted and the blast door closed thereabove. It should be noted that the rammer head **385** and the pick-up and lowering pins are arranged in such cooperative relationship that the rammer head may lower a missile into position in the magazine or hoist such missile into operative position on a launcher arm, depending upon the distance of travel of the piston rod **295**.

FIGS. 28, 29, 30, and 31 illustrate the electrical contactor and fin erector unit, which is shown generally at **405**. One of the units **405** is mounted in each of the launcher arms; said units are identical so that a description of one will suffice for both. As best seen in FIG. 13, the electrical contactor and fin erector unit **405** includes a base **406** that is mounted on the under side of the partition **233** near the rear wall **231** of the housing **228**. Secured to and depending from the under side of the base **406** is a cylinder block **407** having parallel cylinders **408** and **409** therein. The cylinders are closed at their upper ends by the base **406** and at their lower ends by relatively long and relatively short plugs **410** and **411**, respectively, the plugs being held in position in the cylinders by a bolt and washer assembly **412**.

Pistons **413** and **414**, mounted, respectively, on piston rods **415** and **416**, are slidable in the cylinders **408** and **409**, the relatively long plug **410** limiting to a relatively short distance the travel of the piston **413** and rod **415**. As best seen in FIG. 31, the lower ends of the piston rods **415** and **416** are flattened, and pivotally connected to the flattened ends of said rods are gear racks **417** and **418**. Secured to the lower end of the cylinder block **407** and extending downwardly into close spaced relation to the rail section **276** (FIG. 13) is a cast metal housing **420** having side walls **421** and **422** and a bottom wall **423**. A bearing **424** is mounted in the side wall **421** and journals one end portion of a fin erector shaft **425**, the other end portion of said shaft being journaled by an electrical contactor actuating sleeve **426** which is, in turn, rotatable in a bearing formed in the side wall **422**. A pinion **427** is pinned to the inner end face of the sleeve **426**. Surrounding the fin erector shaft **425** between the pinion **427** and the bearing **424** and pinned to said shaft is an erector pinion sleeve **428** having a pinion **429** thereon. As shown in FIGS. 29 and 30 the gear racks **417** and **418** mesh with the pinions **429** and **427**, respectively. To retain the racks against displacement in the housing **420**, sheet metal brackets **430** (FIG. 30) are employed.

Fitted on the contactor actuating sleeve **426** to rotate therewith is an electrical contactor **431**. The contactor **431** comprises a hub **432**, an arm **433**, and a head **434**, and is mounted between the side wall **422** and one of the fin actuators, presently to be described. Contact prongs **435** (FIG. 28) project from one side of the head **434** and are engageable in sockets carried in the base of the missile (see FIG. 13).

Fin erector arms **436** and **437** are pinned to the end portions of the shaft **425**. As shown in side elevation in FIG. 13, the arms **436** and **437** are of generally obtuse angular contour. Each of the arms carries at its free end a fin erector **438** which consists of a flat metal frame **439** and outwardly projecting curved and flared erector elements **440**, a pair of said elements being provided on each said frame. The erector elements are so arranged that when the arms are swung forwardly, as will be described hereinafter, the said elements will engage the folded fins on the missile and move said fins to full operative positions prior to launching the missile.

The operation of the fin erector and electrical contactor will now be described briefly. Referring again to FIGS. 28 through 31, after a missile has been installed on a launcher arm, in the manner previously described, fluid under pressure is introduced into the cylinder **409** when the piston **414** and rack **418** will cause the pinion **427** to rotate, for swinging the contactor **431** from the position shown in FIGS. 28 and 31 to that shown in FIG. 13, i.e., with the prongs **435** engaged in suitable receptacles in the base of the missile. Similarly, fluid under pressure introduced into the cylinder **408** will cause the piston **413**, rod **415**, and rack **417** to rotate the pinion **429**, when the shaft **425** will rotate for swinging the erector arms **436** and **437** to engage the elements thereof with the fins for erecting said fins. The introduction of fluid under presure into the cylinders **408** and **409** is controlled by operation of the valves **241** and **242** (FIG. 13), which valves are included in the hydraulic system shown schematically in FIG. 47, and in the electrical system shown partially in FIG. 48C.

In FIGS. 53, 54, 55, and 56 (the last-mentioned figure being on the sheet containing FIG. 18) there is shown a mechanism for arming a missile on one of the launcher arms. It should be understood, however, that the structure of the arming mechanism now to be described would in actual practice be altered as to its details; that the structure shown is presented merely to show an operative missile arming device. Although the arming mechanism is shown applied to one of the launcher arms, identical such mechanisms would be applied to each of said arms.

Essentially, the arming mechanism comprises an hydraulic motor which is connected to a switch actuating element through a clutch, a plurality of rods connected by a universal joint and a bevel gearing arrangement. In FIGS. 53 and 54 the launcher forward rail assembly **243** is shown mounted on the launcher arm **92**, the motor for the arming mechanism being shown at **441**. The shaft of the motor is shaped near its outer end to define a clutch element **442**. As shown in FIG. 53, the motor **441** is mounted near the shaft **245** of the rail assembly **243** with the motor shaft inclined downwardly. An actuating rod **443** is rotatably mounted on the underside of one of the legs of the yoke **244** by guide sleeves **444**, said rod carrying one element of a bevel gear assembly **445** at its lower end and a clutch element **446** at its upper end. The other element of the bevel gear assembly **445** is secured to a second rod **447** rotatable in a guide sleeve **448**, a bevel gear **449** being mounted on the opposite end of said rod **447**.

Referring to FIGS. 54 and 55, it will be seen that the bevel gear **449** meshes with a similar gear **450** on one end of a transverse rod **451** that extends beneath the bight of the yoke **244** and between (modified) forward launcher rail elements **452**. A third bevel gear **453** meshes with a fourth such gear, shown at **454**, the bevel gear **454** being mounted on a journal **455** which is rotatable in a bearing **456** secured to the yoke bight between the rails **452**. As best seen in FIG. 56, the journal **455** has mounted thereon a slotted actuator arm **457**, the slot of which receives a pin **458** on a switch arm **459**. The switch arm **459** is mounted on a shaft **460** that forms a part of an electric arming switch (not shown) mounted in the missile B.

To prevent over-travel of the rods **443**, **447**, due to "coasting" of the motor **441**, a spring-pressed detent **461** is employed. The detent is mounted above the universal joint **445** and engages in spaced recesses **462** in the outermost element of said joint. A housing **463** surrounds the arming mechanism to project the components thereof.

The manner of operation of the arming mechanism will be obvious from a scrutiny of FIGS. 53 and 56. Briefly, however, when the launcher forward rail assembly **243** is in the "up" position, as shown in broken lines

in FIG. 53, the clutch elements 442, 446 will be disengaged and the arming mechanism rendered inoperative. When the assembly 243 is in the "down" position, as shown in full lines in FIG. 53, the clutch elements will be engaged, so that rotation of the motor shaft will be transmitted to the rods, universal joint, and bevel gears for causing the actuator arm to rock from the unarmed position shown in full lines in FIG. 56 to the armed position shown, in dotted lines in said figure. With a missile on the launcher arm, movement of the actuator arm 457 in the manner just described will rock the pin 458 and switch arm 459 to switch-closed position, for arming the missile. After the missile has left the launcher arm, the actuator arm 457 will be returned to unarmed position and ready for engagement with the arming switch of the next missile, such return of said arm being effected by counter-rotation of the rod 443 by the motor 441 in response to an appropriate signal from the control position.

The hydraulic connections for the moving parts of the launcher are shown diagrammatically in FIG. 47, and the electrical connections in FIGS. 48A, 48B, 48C, 49A, 49B, and 49C. A block diagram of the servo elements is shown in FIG. 50 and a circuit schematic of an elevation servo amplifier in FIG. 51. It will be noted that legends on the FIG. 48 and FIG. 49 series, and on FIG. 51, refer to a console. Since such a console may be of any desired mechanical construction, it has not been considered necessary to illustrate more than the electrical circuits employed; even these may be modified as desired to suit special situations. Furthermore, it is not considered necessary to describe the electric circuits in detail, since the wiring of the console and the launcher proper may be followed by carefully examining the above enumerated figures of the drawings. Where appropriate, however, reference numerals have been applied, particularly to FIG. 47.

Referring to FIG. 47, the valves in the manifolds 163 are shown schematically, with the connections to the components they control. More specifically, the valves 107*a*, 108*a*, 109*a*, and 110*a* control respectively, the spanner rail mechanisms 107, 108, 109, and 110; the valves 101*a* and 102*a* control, respectively, the blast door operating mechanisms 101 and 102. Valves 89*a* and 90*a* control hydraulic fluid flow to and from the mounting tubes 89 and 90 and the manifolds in the arms 91 and 92. Control of fluid entering and leaving the cylinder 164 is effected by a valve 164*a*.

The circuit schematics of the FIGS. 48 and 49 series depict a multitude of switches and relays in the console and in the launcher proper. These switches and relays are of conventional design and are utilized in the various circuits wherever found necessary. Moreover, the circuits themselves are entirely functional and need no detailed treatment. The same statement applies to the amplifier circuit shown in FIG. 51.

In FIG. 52 there is shown a chart which indicates the sequence of events that take place during a missile launching cycle. As will be seen from an examination of the chart, the time consumed for each step is indicated. It will also be observed that total time consumed, including the time required for missile warm-up in the magazine and the indexing of the turret and launcher arms to a new loading position, is twenty seconds. As will be obvious, the operation of the launcher need not follow exactly steps shown on the chart of FIG. 52. That is, alterations in the sequencing of functions as well as in the increments of time required for their completion may be made as required to satisfy special operating conditions.

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

What is claimed is:

1. A launcher for aerial missiles, including a magazine having a plurality of missile compartments arranged in concentric rows, a deck closing the magazine at its upper end, said deck having an opening, a blast door movable in the opening, means for mounting a plurality of missiles in the magazine compartments, means for rotating the deck on the magazine, a turret on the deck, a launcher arm, means mounting said launcher arm on the turret, said means being operable for moving said arm from a position for receiving a missile from the magazine to a train position from which said missile may be launched, means in said launcher arm for moving a missile between one of said compartments through said blast door and a position on said arm, means on said deck for guiding said missile during its travel between said magazine and said arm, and means for moving said last-mentioned means through said blast door opening.

2. A launcher for an aerial missile as recited in claim 1, wherein said last-mentioned means comprises a spanner rail connected with said deck and movable from a position lying beneath the deck to a position projecting thereabove and into cooperative relation with said launcher arm.

3. A launcher for aerial missiles as recited in claim 1, including additionally hydraulically operated means for opening and closing the blast door.

4. In a launcher for aerial missiles, a magazine including a side wall, an inner wall, and an inner casing, said walls and casing defining concentrically arranged inner and outer missile compartments, guide rails in said compartments for supporting missiles in concentric rows, a deck closing the magazine at its upper end, means in the inner casing and cooperating with said deck for rotating the deck on the magazine and above said compartments, said deck having an opening of sufficient length to extend above a pair of adjacent inner and outer missile compartments, a blast door movable in said opening, a turret on the deck, a launcher arm movable on the turret from a loading position to receive a missile from one of said compartments to a train position for launching said missile, means for moving the launcher arm to a position above one of said inner compartments or to a position above one of said outer compartments, and means carried by the launcher arm and movable along said rails for transferring a missile from one of said compartments to said arm through said opening.

5. A launcher for aerial missiles as recited in claim 4, wherein said last-mentioned means includes a chain in said arm, missile pickup means in said arm on said chain, and means for moving said chain along said magazine rail for engagement with the missile.

6. A launcher for aerial missiles as recited in claim 4, wherein said deck rotating means comprises an hydraulic motor within the inner casing, and a gear train positioned between said motor and the deck.

7. A launcher for aerial missiles as recited in claim 4, including additionally means on the inner casing and on the deck for indexing said deck whereby said door and launcher arm will be positioned above a missile in one of the compartments of the magazine.

8. A launcher for aerial missiles, comprising a magazine, a turret rotatable on the magazine and having telescoping mounting tubes, fluid pressure means remote from the magazine for extending or retracting the tubes above the magazine, launcher arms on certain of the tubes, missiles in the magazine, doors on said magazine above said missiles, remotely controlled means for operating said doors, and means on the arms for moving said missiles between said arms and said magazine through said doors.

9. In a launcher having launcher rails thereon for aerial missiles, comprising, a source of missiles, a launcher arm mounted above said source, and means in the arm for transferring missiles to or from the source, said means including a hoist mechanism having a chain movable from a position within the arm to a position in said source,

a rammer head on the free end of the chain for engagement with a missile, motor means, and a gear train connecting the motor means with the chain.

10. In a launcher having launcher rails thereon for aerial missiles, a magazine containing a plurality of missiles, a launcher arm, means rotatably mounting the launcher arm on the magazine, and means carried by the launcher arm and movable to engage one of the missiles and move it from the magazine to launching position on said arm or from said arm to a stowed position in the magazine, said last-mentioned means including a hoist mechanism having a chain, and a rammer head on the chain.

11. A launcher for aerial missiles, comprising, a magazine containing a plurality of missiles, a deck on the magazine, an hydraulic motor for rotating the deck, a turret on the deck, telescoping tubes on the turret, a launcher arm on one of said tubes and disposed above the deck, a blast door on the deck, hydraulic fluid operated means for operating each of the telescoping tubes and the blast door, hydraulic fluid operated means for moving the launcher arm initially to a position for receiving a missile from the magazine and subsequently to a missile launching position, a hoist mechanism in the launcher arm and having a chain movable into the magazine when said arm is in said initial position, a rammer head on the chain and engageable with a missile, hydraulic fluid operated means in the arm for operating the hoist mechanism, means for mounting on the arm a missile received from the magazine, hydraulic fluid operated means for actuating said last-mentioned means, a source of hydraulic fluid under pressure, and electrically operated means for controlling the distribution of hydraulic fluid to all of said hydraulic fluid operated means.

12. In a launcher for aerial missiles, a magazine having a side wall, a casing, an inner wall between the side wall and the casing, said walls and the casing defining concentric inner and outer missile compartments, guide rails in the compartments for receiving missiles, a deck closing the upper end of the magazine and having spaced openings, means on the casing and on said deck for rotatably mounting the deck on the magazine, a turret on the deck, launcher arms above the openings, means operatively connecting the launcher arms with the turret, a central column in the magazine and communicating with the turret, a rotary hydraulic joint connected with the column, fluid pressure and return pipes connected with the joint, a source of fluid pressure connected with the pipes, means supporting the column and joint within the casing, and means in the launcher arms and movable into the magazine through the deck openings for engaging missiles in one of the compartments.

13. A launcher for aerial missiles as recited in claim 12, wherein said second-mentioned means comprises telescoping tubes, and cylinders and pistons within the tubes, said cylinders being connected to said fluid pressure and return pipes, and including additionally an elevation cylinder mounted in the turret and having a piston rod connected with one of the telescoping tubes, said elevation cylinder and piston rod being connected to said fluid pressure and return pipes and being operable for moving the launcher arms from missile loading or stowing positions to desired positions in train.

14. In a launcher for aerial missiles, a magazine, a deck rotatable on the magazine, a source of fluid under pressure, a motor for rotating the deck and operable from said source, a turret on the deck, telescoping tubes mounted on the turret and rotatable about their axes, launcher arms connected to the outermost of the tubes, means locking the tubes to rotate in unison, an elevation tube rotatable in the turret and connected to the innermost of the telescoping tubes, an elevation cylinder in the turret and connected to said fluid pressure source, said cylinder having a piston and piston rod and said piston rod being connected to the elevation tube, and electrically operated valve means in the turret and operable for controlling fluid flow to the elevation cylinder, said elevation tube being movable by the elevation cylinder piston rod for rocking the telescoping tubes and the launcher arms.

15. A launcher for aerial missiles as recited in claim 14, including additionally missile engaging means carried by the launcher arms, fluid pressure operated means in said arms for actuating said missile engaging means, means connecting the fluid pressure operated means to said source, and electrically operated valve means in the arms and controlling operation of the fluid pressure operated means.

16. A launcher for aerial missiles as recited in claim 15, wherein the missile engaging means includes a launcher forward rail assembly having a forward rail element, a center rail, and an aft rail to which said center rail is connected.

17. In a launcher for aerial missiles, a magazine, a deck closing the magazine at its upper end and having an opening, a launcher arm, means mounting the launcher arm on the deck, said arm having forward, center, and aft rails, a guide rail in the magazine, means for moving the launcher arm to a position aligning the forward, center, and aft rails with said guide rail, a spanner rail connected with the deck, and means for moving said spanner rail through said opening into a position in alignment with said guide rail and said forward, center, and aft rails.

18. A launcher for aerial missiles as recited in claim 17, including additionally an hydraulic motor for moving the spanner rail to said aligned position, a blast door above the opening, and fluid pressure operated means for opening and closing the blast door.

19. In a launcher for aerial missiles, a magazine for receiving and discharging missiles, a deck closing the magazine at its upper end and having an opening, means for rotating the deck on the magazine, a blast door housing mounted on the deck above the opening and having a blast door opening in registry with the deck opening, a blast door in the housing and movable to a position opening or closing the blast door opening, fluid pressure means for shifting the door to open, partially open or closed position, a launcher arm, means mounting the launcher arm on the deck and above the blast door having in spaced relation thereto, said launcher arm having rails, guide rails in the magazine, a spanner rail mounted on the deck, fluid pressure operated means for moving the spanner rail from a retracted position below the deck to an extended position extending through the openings and above the deck and in alignment with certain of the guide rails, fluid pressure operated means for orienting the launcher arm to align the rails thereof with the extended spanner rail and one of the guide rails, fluid pressure operated means in the arm for moving a missile to or from the magazine on said rails, a source of fluid under pressure for operating all of said fluid pressure operated means, and electrically operated valve means for controlling fluid flow to all of said fluid pressure operated means.

20. A launcher as recited in claim 19, wherein the third-mentioned means includes a turret, an elevation tube in the turret, telescoping tubes connecting the launcher arm to the elevation tube, a cylinder in the turret and having a piston, a piston rod and a lever connecting the piston rod to the elevation tube.

21. A launcher as recited in claim 20, including additionally means for indexing the deck and spanner rail above certain of the guide rails.

22. A launcher as recited in claim 20, including additionally means on the arm and engageable with the spanner rail for locking the arm with the rails thereof in alignment with said spanner rail.

23. In a missile launcher, a cylindrical magazine having inner and outer concentric missile compartments, a deck closing the magazine at its upper end, means for rotating the deck on the magazine, said deck having an opening disposed above radially aligned portions of the

compartments, annularly spaced guide rails in each of the compartments, a pair of spanner rails mounted on the deck, means for moving the spanner rails to extended positions projecting through the opening, one of said spanner rails being positioned above each of said compartments, and means carried by the magazine and by the deck for indexing the deck for positioning one of the spanner rails above a guide rail in the inner compartment or the other of said rails above a guide rail in the outer compartment.

24. The structure recited in claim 23, wherein said last-mentioned means includes a series of spaced indexing rollers, a plunger engageable between certain of said rollers for positioning the deck with the opening above a guide rail in the outer compartment, a second plunger engageable between certain other of said rollers for positioning the deck with the opening above a guide rail in the inner compartment, and fluid pressure operated means for actuating the plungers.

25. A missile launcher including a cylindrical magazine having inner and outer concentric missile compartments, a deck closing the magazine at its upper end and having diametrically oppositely disposed openings, said openings extending above radially aligned portions of the compartments, a turret on the deck, an elevation tube in the turret, launcher arms, telescoping tubes connecting the launcher arms with the elevation tube, means for rocking the elevation tube and telescoping tubes for moving the launcher arms from positions in train to positions in vertical alignment with the openings, and means for shifting the outermost telescoping tubes whereby the launcher arms will be moved from positions above the inner compartment to positions above the outer compartment or vice versa.

26. A missile launcher as recited in claim 25, wherein said last-mentioned means comprises cylinders mounted within the elevation tube and extending into the innermost telescoping tubes, pistons in said cylinders and connected with said outermost telescoping tubes, and means for introducing fluid under pressure to said cylinders.

27. A missile launcher as recited in claim 26, wherein said last-mentioned means includes a central manifold within the elevation tube, a secondary manifold on each of the cylinders, a fluid pressure inlet pipe connecting the central manifold with each of the secondary manifolds, and fluid pressure return pipes connected between the secondary manifolds and the central manifold.

28. In a missile launcher, a magazine having concentrically arranged missile compartments, a deck closing the magazine at its upper end and having an opening near its rim and extending radially above the compartments, a turret on the deck, a launcher arm, telescoping tubes connecting the launcher arm with the turret, and means for telescoping the tubes for shifting the arm above that portion of the opening which is above one of the missile compartments to a position above the opening and above the other of said missile compartments.

29. In a missile launcher, a magazine having concentrically arranged missile compartments, a deck closing the magazine at its upper end and having an opening extending radially above the compartments, a turret on the deck, a launcher arm, an elevation tube in the turret and having sections, tube elements, said sections and tube elements cooperating to provide telescoping tubes connecting the arm with the turret, hydraulic fluid pressure operated means for telescoping the tubes for shifting the arm from above the opening and above one of the missile compartments to a position above the opening and above the other of said missile compartments, and a source of fluid under pressure for said means.

30. In a missile launcher, a magazine, a launcher arm above the magazine, said launcher arm having aft, center, and forward rails cooperating to mount a missile for launching, means in the arm for moving a missile from the magazine to a position on said rails, and means in the arm for retracting the forward and center rails during launching of a missile.

31. A missile launcher as recited in claim 30, wherein said center rail retracting means includes an hydraulic jack cylinder in the arm and having a piston rod connected to the center rail, a source of fluid under pressure for the cylinder, and electrically operated valve means in the arm for controlling hydraulic fluid flow to the cylinder.

32. A missile launcher including, in combination with a missile initially mounted on the launcher and having folding tail fins in folded position prior to launching, a launcher arm for receiving the missile for launching, means connected to the arm and engaging the fins for shifting them to extended positions, and means for actuating said last-mentioned means prior to missile launching.

33. In a missile launcher, a magazine, a missile compartment in the magazine and having a guide rail therein, a missile having a shoe, a launcher arm above the magazine, a pick-up pin on the guide rail, a lowering pin on the guide rail below the pick-up pin, hoist mechanism in the arm and including a retractable chain movable into the magazine along the guide rail, a rammer head on the chain and having a movable dog thereon, said dog being engageable with the missile shoe, and means for controlling the chain whereby said chain will be moved a predetermined distance along the guide rail to engagement with the lowering pin for release thereby from the shoe for storing the missile in the magazine, or moved a predetermined shorter distance along said guide rail for engaging the pick-up pin whereby the dog will engage the shoe for raising the missile from the magazine onto the launcher arm upon retraction of the chain.

34. In a missile launcher, a magazine having a guide rail, a missile movable between the arm and said magazine, said missile having a shoe, a pick-up pin on the rail, a lowering pin on said rail below the pick-up pin, a launcher arm above the magazine and having a hoist mechanism therein, said hoist mechanism including a chain reel, a spool, a chain on the spool, a sprocket having the chain trained thereabout, a rammer head on the free end of the chain, an hydraulic motor, and a gear train connecting the motor with the sprocket, said motor, gear train and sprocket being operable for moving the chain into the magazine for engaging the rammer head with the pick-up pin and shoe for readying the missile for removal from the magazine or for engaging the rammer head with the lowering pin for stowing said missile in the magazine.

35. A missile launcher as recited in claim 33, wherein said rammer head is provided with a pivoted dog movable by contact with the pick-up pin or with the lowering pin to engage the missile shoe.

36. A missile launcher as recited in claim 33, including additionally means on the hoist mechanism for extending the distance of movement of the chain and rammer head into the magazine.

37. A missile launcher as recited in claim 36, wherein the hydraulic motor includes a piston and piston rod, a coupling element on the piston rod and having a recessed front face, a control plate having a slot receiving the piston rod therethrough, and a solenoid energizable to position the control plate for engagement in the recess upon movement of the element by the piston, whereby the piston stroke will be lengthened.

38. In a missile launcher, a magazine having a deck and a missile compartment below the deck, said deck having an opening, a blast door housing on the deck above the opening and having an opening in registry with the deck opening, a launcher arm mounted above the deck and having forward, center, and aft rails, a guide rail in the missile compartment, a spanner rail mounted below the deck and movable to a position in alignment with the guide rail and with the forward, center, and aft rails on the arm, a hoist mechanism in the arm and having a chain fitted with a rammer head, means engageable

with the rammer head for latching said head and the chain in retracted position in the arm, means in the head and movable to engage the spanner rail to latch it in alignment with all of said other rails, and fluid pressure actuated means for simultaneously moving said first and second mentioned means for unlatching the rammer head and chain and latching the spanner rail.

39. In a missile launcher, a magazine having a guide rail, a pick-up pin on the guide rail, a hoist mechanism including a chain and a rammer head, said rammer head having a dog pivotally mounted thereon, a launcher arm mounting the hoist mechanism above the magazine and having rails for alignment with the guide rail, and means forming a part of the hoist mechanism and operable for moving the chain and rammer head into the magazine and along the guide rail, said rammer head dog being tilted by engagement with the pick-up pin for positioning a corner of said dog for contact with a missile shoe, said means being operable for withdrawing the chain and rammer head from the magazine with a missile thereon and positioning said missile on the launcher arm rails in a position for launching.

40. In a missile launcher, a magazine having a compartment, a guide rail in the compartment and having a pick-up pin and a lowering pin, the lowering pin being mounted in spaced relation below the pick-up pin, a launcher arm mounted above the magazine, and means carried by the launcher arm for stowing a missile in the magazine, said means including a hoist mechanism having a chain, a rammer head on the chain and having a dog pivotally mounted thereon, said dog having a corner engageable with a missile shoe and having cam surfaces, said chain being movable into the magazine compartment along the guide rail with a missile shoe in engagement with the corner of the rammer head dog whereby said missile will be stowed in said compartment, said chain being further movable along the guide rail for initially contacting one of the cam surfaces of the dog with the pick-up pin for tilting said dog for moving the corner thereof out of the path of the missile shoe, said chain being still further movable for effecting contact between the dog and the lowering pin for positioning the rammer head to clear the missile shoe and pick-up pin upon withdrawal of the chain from the magazine.

41. In a missile launcher, a magazine, a deck rotatable thereon, a launcher arm on the deck, said deck having an opening located above an off-center positioned missile in the magazine, and means in the launcher arm and movable through the opening a predetermined distance into the magazine for stowing in said magazine a missile connected with said means, said means being movable a predetermined shorter distance in the magazine and being engageable with a missile for removing said missile from the magazine.

42. A missile launcher as recited in claim 41, including additionally means in the magazine cooperating with said first-mentioned means for transferring a missile to or from the magazine.

43. A missile launcher as recited in claim 42, wherein said first-mentioned means includes a hoisting mechanism having a chain and a rammer head, and said second-mentioned means comprises a pick-up pin and a lowering pin in the magazine.

44. In a missile launcher, a magazine having missiles therein, a launcher arm, means mounting the launcher arm on the magazine, said launcher arm having a fixed aft rail, a retractable center rail connected to the aft rail, and a forward rail assembly including a forward rail element, said aft and center rails and said forward rail element cooperating to receive a missile from the magazine, and means displacing the forward rail assembly and element and the center rail fom the path of a missile during launching thereof, whereby said missile will clear said arm.

45. A missile launcher as recited in claim 44, wherein the means for displacing the center rail includes an hydraulic fluid cylinder having a piston, a piston rod connecting the piston with the center rail, and valve means in the launcher arm for controlling fluid flow to the cylinder.

46. A missile launcher as recited in claim 44 wherein the means for displacing the forward rail assembly and element includes an actuating sleeve, a pinion connected with the sleeve, an actuator fork having a rack meshing with the pinion, a cylinder having a piston, a piston rod connecting the piston with the fork, a shaft mounting the sleeve and pinion in the launcher arm, a yoke secured to the shaft and mounting the rail element, means controlling fluid flow to the cylinder, return levers on the shaft, springs connecting the return levers with the launcher arm interior, and stop means in the arm and engageable with the return levers for limiting movement of the shaft.

47. A missile launcher including in combination, a magazine containing missiles each having initially folded fins, a launcher arm mounted above the magazine for supporting one of said missiles for launching, means in the arm and movable into the magazine for hoisting a missile onto the launcher arm, means connected to the arm and engaging the fins for shifting said fins to extended positions, and means for actuating said last-mentioned means prior to missile launching.

48. A missile launcher including, in combination, a magazine containing missiles each having initially folded tail fins, a launcher arm mounted on the magazine thereabove, a hoist mechanism in the launcher arm for transferring a missile between said launcher arm and the magazine, means mounted on the launcher arm and movable into engagement with the tail fins of a missile on said arm for shifting said fins from folded positions to positions extending radially from said missile, and means for operating said last-mentioned means following operation of the hoist mechanism.

49. A missile launcher as recited in claim 48, wherein said tail fin engaging means includes a pair of fin erector arms, one of said erector arms being movable along each side of the missile aft end, a fin erector frame on each of said erector arms, and a pair of fin elector elements on each of the frames.

50. A missile launcher including, in combination, a magazine having a plurality of missiles therein, each of said missiles having a plurality of tail fins folded to lie tangent to the missile body and each of said missiles having receptacles in its base, a launcher arm, means mounting the launcher arm on the magazine, means in the arm for transferring a missile between the magazine and the arm, and an electrical contactor and fin erector unit mounted on the launcher arm, said unit including fin erector arms having elements engageable with the fins for moving said fins to erect positions extending radially from the missile body, a contactor arm having a head fitted with prongs engageable in the receptacles, and means for shifting the erector arms to engage the fin erecting elements with the fins and the contactor arm to engage the prongs in the receptacles.

51. A missile launcher as recited in claim 50, wherein said last-mentioned means includes a shaft mounting said fin erector arms, a sleeve about said shaft and mounting the contactor arm, a pinion on the shaft, a gear rack meshing with the pinion, a pinion on the sleeve, a gear rack meshing with the second pinion, and fluid pressure operated means for shifting the gear racks for rotating the pinions and the shaft and sleeve.

52. A missile launcher as recited in claim 51, wherein said fiuid pressure operated means includes a cylinder block having a pair of parallel cylinders therein, a piston in each cylinder and having a piston rod, and means connecting each of said rods with one of the gear racks.

53. In a launcher for aerial missiles, a magazine having a plurality of annularly arranged missile compart-

ments, a deck, means rotatably mounting the deck on the magazine, said deck having an opening, means on the deck and in the magazine for indexing the deck for positioning the opening above a missile in one of the compartments, said last-mentioned means comprising an indexing ring mounted on the deck thereunder and movable therewith, spaced rollers mounted on the ring and arranged in an annular series, a cylinder fixed in the magazine and having a piston movable therein, a plunger on the piston, and a source of fluid under pressure for the cylinder, said piston being movable by said fluid under pressure for engaging the plunger between adjacent rollers.

54. A launcher for self-propelled missiles, comprising, a magazine for missiles, a deck closing the magazine at one end and having an opening, a launcher arm mounted on the deck and including a housing and missile support means, and means mounted in the housing and movable into the magazine through the opening for transferring missiles between said magazine and said missile support means.

55. In a missile launcher, a magazine, a launcher arm on the magazine, means in the launcher arm and movable a predetermined distance into the magazine for stowing in said magazine a missile connected with said means, said means being movable a predetermined shorter distance in the magazine and being engageable with a missile for removing said missile from the magazine, and means in the magazine and cooperating with said first-mentioned means for transferring a missile to or from the magazine, said first-mentioned means including a hoisting mechanism having a chain and a rammer head and said second-mentioned means comprising a pick-up pin and a lowering pin in the magazine.

56. In a launcher having launcher rails thereon for aerial missiles, a launcher arm receiving a missile thereon for launching, an arming switch on the missile, and means on the arm and engageable with the switch for moving said switch from unarmed to armed position immediately prior to missile launching, said means including a hydraulic motor mounted on the arm, an actuator arm engageable with the switch, a plurality of rods, bevel gears coupling the rods, one of said bevel gears being connected to said actuator arm, and a clutch coupling one of said rods with the motor.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,113,486 December 10, 1963

Sverre Kongelbeck

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 22, line 43, for "having" read -- housing --; column 26, line 44, for "elector" read -- erector --.

Signed and sealed this 30th day of June 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents